ENVIRONMENTAL PROTECTION AUTHORITY
BEFORE AN EXPERT CONSENTING PANEL

IN THE MATTER OF THE FAST-TRACK APPROVALS ACT 2024

AND IN THE MATTER OF AN APPLICATION BY MATAKUNUI GOLD LIMITED UNDER SECTION 42 OF THE FTAA

FOR THE BENDIGO-OPHIR GOLD PROJECT

APPLICATION NO: FTAA-2507-1089

Hearing:	Held in Monarch Room, Willeston Conference Centre, 11-15 Willeston Street, Wellington Central
Date:	16 June 2026
Panel:	Hon Matthew Muir KC (Chair) Gina Sweetman Phillip Barry Roger MacGibbon (via AVL) Peter Kensington
Counsel:	Joshua Leckie and Mia Turner, Lane Neave, for the Applicant David Randal for Otago Regional Council Mike Holm and Nicole Buxeda (via AVL) for Kā Rūnaka Sally Gepp for Sustainable Tarras
Experts:	Paul Weber, Trevor Matuschka, Eric Torvelainen, Peter O’Bryan (via AVL) for Applicant Colin Macdiarmid for Otago Regional Council Mark Pizey (via AVL) for Kā Rūnaka Alex McAlpine, Steve Emmerman (via AVL) Bernd Lottermoser (via AVL) for Sustainable Tarras

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Hearing commenced at 9.30am

Mr Muir: Good morning and welcome to the concurrent hearing focused on the geotechnical issues which emerge from the proposed development. For those experts who are new to this panel, I'll just do a quick introduction. I'm Matthew Muir. I'm the BOGP panel chair. To my left is Mr Peter Kensington, landscape architect, Mr Phil Barry, economist, and Mr Roger MacGibbon, ecologist. To my right, Ms Gina Sweetman who, like Mr Kensington, a very experienced hearings commissioner in her own right – if I drop dead during the course of the day, she will no doubt pick up the cudgels – and a town planner, and to my far right is Mr Tim Mulliner, engineer and specialist in water matters. To the keen observer, you will note that we are sitting as six and not as seven. Our seventh panel member, Mr Doug Johnson, is currently overseas. Mr Johnson has specialist expertise in the area under discussion today. And we had very much hoped, and indeed banked until quite late yesterday, his presence by Zoom during this conference – during this concurrent hearing today. But the unpredictable has happened and he is unable to join us. He will be reviewing in AVL form the entire proceedings today and if there are any matters that emerge from that that he requires to interrogate further, no doubt that will be reflected in some further communication, whether by minute or request for information from the Panel. You can be assured that he is a keen observer of the proceedings today but unfortunately cannot be with us.

That does sort of change slightly the character of the hearing today. For those counsel who have been here for the last six or seven days, you will have observed that we've fallen into a pattern whereby the principal questioning from the Panel has come from – as reasonably predictable – from the Panel member with the specialist expertise in the issue that's under consideration. So as one of my panel members and engineer pointed out in our discussions earlier this morning, we might have to start some of the questions from a stage one engineering geotechnical perspective rather than masters or doctorates which have been very much on show during the course of the proceedings to date. So just bear with us to that extent.

It also perhaps changes the character of the hearing a little, to the extent that we would be very happy with an even more dynamic exchange of ideas between the various experts than has been reflected in some of the hearings to date, as you pick up the responsibility for testing to the extent – testing oppositions to the extent that might otherwise have been tested by our specialist Panel member. If I think that is not tracking, either time wise or tone wise, in a way that I think is appropriate, I will intervene. But throughout the proceedings over the last seven days we have been singularly impressed by the professionalism of all of the experts appearing before us and we have got to the point now where we are very comfortable that we can rely on dynamic exchanges of ideas in a civilised, professional way which ultimately serves the only purpose which is relevant here ultimately, which is that we be better informed for our decision-making.

So I'm just going to ask – some of the faces here of course are very familiar to me. We had Mr Weber with us – Dr Weber with us all day yesterday. And some of the other faces I've also seen but if I could just go round and introduce – each person introduce themselves, and including those that are coming in remotely. And then what I ask you as the day proceeds, conscious of the fact that our proceedings are being recorded also by a stenographer off site, to whenever you're making contributions during the course of the day, at least until the latter part of the afternoon when the stenographers will get used to your respective voices, just to introduce yourselves so that the record reads coherently in that respect. Very good. Now to my right then?

Mr Torvelainen: Eric Torvelainen, civil and technical engineer.

Mr Muir: Yes, good morning Mr Torvelainen. I haven't got honorifics in front of here. Are you Dr Torvelainen?

Mr Torvelainen: No.

Mr Muir: Thank you.

Dr Matuschka: My name's Trevor Matuschka. I'm a civil geotech dam engineer.

Mr Muir: Very good Mr Matuschka, thank you very much. Completing your team, just staying with the applicant, of course we have Dr Weber and then I think that we also have Mr O'Bryan remotely do we Mr O'Bryan?

Mr O'Bryan: Yes, I'm here. Good morning. Peter O'Bryan. I'm a geotechnical engineer.

Mr Muir: Thank you very much Mr O'Bryan and I'd just – I have the inevitable late middle-aged problem of the fact that no sets of glasses seem to actually work at this distance. Okay, I think I'm probably being optimistic describing myself as late middle age but it serves my purposes for the day. Right. Now, for Sustainable Tarras, yes.

Dr McAlpine: I'm Alex McAlpine. I'm a geoscience consultant.

Mr Muir: Good morning Mr McAlpine.

Dr McAlpine: I am a doctor but I will leave any medical issues to [inaudible 00:10:37].

Mr Muir: Very good. Well, I'll put the D-R in front of your name so please excuse me if I omit any honorifics during the day. And then Mr Lottermoser, I think that we heard your dulcet tones as we walked into the room and you're somewhere in the United States at the moment, is that right?

Prof Lottermoser: No, that's a different colleague. I'm calling from Germany so good evening.

Mr Muir: You're in Germany at the moment? Very good, okay.

Prof Lottermoser: I'm a professor in sustainable resource extraction at Aachen University in Germany and I lead a group of mining engineers and geoscientists here.

Mr Muir: Right, very good Professor Lottermoser. Thank you so much for joining us from probably what's the middle of the night over there. We do appreciate it. And Mr Emmerman, you're online somewhere?

Prof Emmerman: Yes. I'm Professor Steven Emmerman.

Mr Muir: Yes, you're the gentleman I heard as I walked into the room.

Prof Emmerman: Right.

Mr Muir: You're in Utah at the moment?

Prof Emmerman: That's right, yeah. I'm in Utah in the United States. It's Monday afternoon and the height of summer. And very nice to see everyone I've been having the expert conferences with. It's like we're old friends now.

Mr Muir: Excellent. And peace has descended over the United States in the last 24 hours to add to your good humour. Right, okay, thank you. Now for Otago Regional Council?

Mr Macdiarmid: I'm Colin Macdiarmid, civil and geotechnical engineer.

Mr Muir: Yes, good morning Mr Macdiarmid and thank you for your attendance. And Mr Pizey – how do you pronounce your name Mr Pizey?

Mr Pizey: Pizey sir. I'm not sure of its origins.

Mr Muir: Pizey. I see, right.

Mr Pizey: The Americans who end their alphabet with the letter Zee have less problem with it. So PIE-ZEE.

Mr Muir: Pizey. Well, I'll just think of my favourite potato top and - - -

Mr Pizey: There you go. You're away.

Mr Muir: - - - get it right. Thank you Mr Pizey.

Mr Pizey: And I am a mining engineer sir.

Mr Muir: Yes. Okay. Excellent. Right, now no doubt counsel representing the various interests we've got for today have been in discussion with the experts over the last little while and informed them of the way in which we are approaching each of these concurrent hearings, which is a model that we alighted on on the first day last week, and which has served us well thus far, and that is to identify at the outset of each such hearing the five or six, thereabouts, critical topics that need to be discussed during the course of the day. This is not intended to be an exclusive list and we always wrap up at the end of the day with any other issues that any expert considers we need to discuss before we close. And inevitably some issues drop out of the headline issues, but we do like to try and keep the headline issues to around about five or six. And have – I don't imagine for a moment that all of you are able to confer simultaneously about this – but has there been some opportunity to discuss at a headline level where we would be going today?

Dr McAlpine: We did just over the course of the last 24 hours or so, or 12 hours probably, put out a proposal that we would cover essentially the items that we covered and which we were directed to cover at the joint working conferencing by the Panel, with small adjustment to schedule such that we get maximum benefit from our overseas participants. So – and that has been discussed around the group so we've got six.

Mr Muir: Thank you all and particularly Dr McAlpine for that. We are also conscious of the fact that in this inter-disciplinary environment, lots of particular specialities are bleeding into others and we've given – we can see in the context of the geotechnical conferencing that there has been some focus and particularly Professor Lottermoser, your supplementary paper that came in as an annexure to the most recent conference or JWS raised a number of issues in relation to the discipline that was under discussion yesterday – water. And we feel that that has had a thoroughly good airing. And Professor Lottermoser, I asked a number of questions of the experts yesterday arising out of content of your supplementary paper. So we're going to, as much as we can, quarantine that issue off, having given it a thoroughly good airing yesterday and focus on the others. So I'm going to ask Commissioner Sweetman, whose fine hand we have had the benefit of over the last six or seven days, to record on our whiteboard what these topics are. Dr McAlpine?

Dr McAlpine: Yes, the first one is – and I'm going to call it topic C because that was the topic that was given by the Panel as a suggested comments, which is Shepherd's Tailings Storage Facility. And a subset under that, just a small bullet point, is including Tailings Disposal Options. The second priority is what we called Choice of Mining Method, which comes from Bernd Lottermoser, and again a subpoint, Excessive Production of Waste Rock. And after that, we follow the remaining four items which – pretty much as per the [inaudible 00:18:18], the next one is Slope Designs. ELF Designs, that being engineered landforms of course. And then Shepherds Seepage Sump and the sixth was Silt Dam and Process Plant Platform.

Ms Sweetman: Silt Dam and - - -

Mr Muir: Process Plant Platform.

Dr McAlpine: That's correct.

Mr Muir: Dr McAlpine, one issue that emerged from Professor Lottermoser's supplementary paper, the issue of landslides. Where would – it's something that the Panel would like to discuss at some stage during the day. Where would we put that in – with our discussion generally of the TSF?

Dr McAlpine: I think it – it's one of those geotechnical issues that can fit into another. I think the best choice would be to put it in Shepherd's TSF even though the landslide risk is for other aspects of the whole mine footprint.

Mr Muir: It could take up diversion channels or all these sorts of other – we recognise that it has wider implications than that.

Dr McAlpine: If we introduce it there then that deals with it because it gets it front up for Bernd's benefit.

Mr Muir: [Inaudible 00:20:13]. Very good, okay, right. Well, let's get to work and starting with the TSF. The usual arrangement, but we mixed it up a little bit during the course of the day, is to start with the applicant's experts on each topic but sometimes it's better just to frame your positional argument first before you come back but we'll just – on this one we'll start off with – would it be you Mr Torvelainen?

Mr Torvelainen: Or Dr Matuschka?

Mr Muir: Dr Matuschka. Thank you Dr Matuschka.

Dr Matuschka: Is the mic on? Can you hear me?

Mr Muir: Yes, I can. Just pull it forward a little bit would you there, Dr Matuschka.

TOPIC 1: SHEPHERDS TAILINGS STORAGE FACILITY

Dr Matuschka: So there's a few subtopics under the TSF, Shepherd's TSF and they relate to selection of the type of TSF and tailings disposal. Other comments were – we discussed were the New Zealand practice versus GISTM and the third of those issues is seepage containment and collection and also the issue of landslides.

Mr Muir: Yes.

Dr Matuschka: So maybe if I start with the selection of the type of tailings storage that was – so the tailings disposal options. And so there were some concerns raised by submitters regarding the options of wet tailings slurry disposal and that there were other technologies available that should have been considered. There's an international standard, GISTM, for tailings management that was published 2020 that has a requirement to do a multiple criteria assessment of different options and we did review options but that study was not formally documented. So options that were considered at different locations. These included the Shepherd's Creek which is the application that's been put forward, the Rise and Shine Creek and also along the gravel terraces located further downstream. The option of locating further downstream was dismissed because of the presence of potential ground water contamination. Both the Rise and Shine and Shepherd's Creek can provide similar storage quantities in a similar concept to tailings dams by waste rock from the open pit – the excess over-burden material.

There's different technologies for the disposal of tailings. The conventional one is wet tailings slurry. That's by far the most common method that's used. There are other variations. There is options to thicken the tailings so they're pumped like a – at a lower water - - -

Mr Muir: Like concrete?

Dr Matuschka: Not concrete, no, but just thickened like – up to a – you can thicken it up to various degrees up to a paste.

Mr Muir: I didn't mean concrete as such but sort of like you'd see coming out the back of a concrete mixer?

Dr Matuschka: Well, a little bit yeah. I guess so. That's an analogy, yes. And so there's options for doing – thickening the tailings, reducing the water content, you need different types of pumps and you can go to what they call, in some cases, a central discharge where you can actually discharge from the centre of a pond and towards the perimeter and you decant off the water to a separate pond and you end up with a slightly higher tailings density?

Mr Muir: What are the advantages of that?

Dr Matuschka: Water recovery. So if you're in a very dry area, the options for these thickened tailings have an advantage and you can recover more of the water to utilise in the process plant, and thicker tailings and they are more commonly used in dry climates. They're not particularly I guess suited in a valley situation where we're dealing with that – this site. There's a greater capital cost for thickened tailings. You have to have thickeners and different types of pumps so they have a higher up-front cost. There's also an option that some people have used is co-disposal where you mix the tailings with the waste rock. That's very seldom used. It's something that's been used on a few jobs that I'm aware of but not very common. It's very hard to get the mixing in the right proportion and you can end up with zones with more tailings, and also geochemically it's not the best option if you've got waste rock or tailings with potential contaminants within them. So it's hard to manage the oxygen ingress. So if you've got acid-forming tailings, it's good to keep them saturated so the oxygen can't get in and generate acid.

And one of the options that was raised has been mentioned by the submitters is filtered tailings. So this is a relatively new technology where you mechanically squeeze the tailings to squeeze the water out of them and lower the water content to an extent where they can be transported either on a conveyor – typically on a conveyor into a truck and the truck transports the tailings to the disposal area where they can be tipped and then typically bulldozed out in thin lifts. And the advantage with filtered tailings is that they have a much lower water content and a higher strength and so they're touted as being safer because of that and they're less susceptible to strength loss under earthquake – the ground or earthquake shaking. But there are some issues – you have to be very careful with filtered tailings because they can actually saturate due to rainfall infiltration and they can be susceptible to liquefaction in the base layers. And there have been recently three failures of filtered tailings operations. I think we're still trying to get to grips with the technology and how – for it to be applied properly. And there's also limitation with the production rate. So this mechanical squeezing of the tailings is quite a process in that the amount of tailings that can be produced with that technology is limited and if they haven't got the rates of production up to the levels for large mines.

Mr Muir: Theoretically in this context, filtered tailings could result in on-site or off-site disposal of the filtered tailings?

Dr Matuschka: Yes, yes. If you had it off-site, you'd have to put down a low permeability liner though to prevent seepage from the stack. You can still get some seepage because over time the tailings can saturate and there will be some seepage generated through the filtered tailings mass. So – and particularly in a high earthquake environment, you need to be very cautious with filtered tailings and they would probably need a containment dike around that perimeter or special efforts to compact them to a higher standard around the perimeter to reduce the likelihood of failure under an earthquake. So - - -

Mr Muir: What's the failure mechanism – not liquefaction?

Dr Matuschka: Yes, it can – they can liquefy. They can liquefy unless the compaction is very strictly controlled. And so the technology is not perfect and it's not 100 per cent reliable and often the filters have to be taken out of commission for maintenance purposes and also in very wet areas you can't take that material which is – filtered tailings are not dry, they're moist. And the moisture content can vary depending on how well the thickeners are working, the filter pressers are working typically, and you can – and if you're in an area of high rainfall, the additional moisture from rain can make it impossible to actually push the material out and doze it into place. It's just too weak. And so in those situations when there may be heavy rainfall and it's not practical to brace the materials, or there's breakdown in the filters, you have to have an alternative storage area. So you still need a wet slurry containment in conjunction with a filtered tailings stack – filter stack. So that's my experience.

And the other big issue for them is their capital and operating cost. So a project I'm involved with the assessment, they are using filtered tailings [inaudible 00:31:12] to them, but the cost is 10 times what it would be for a wet slurry. So extremely expensive.

Mr Muir: So you've just identified the principal advantage of the wet slurry approach which is essentially not in any pejorative way but economic. It is the most cost-efficient effort?

Dr Matuschka: Yes, it is, it is cost efficient. But in this particular case, at the site where Bendigo – or this project, it has some unique characteristics that make it – the selection of a wet slurry very easy to make because you've got – it's located in a valley and the ground water level in the hills on either side of the valley is very high and that provides a constraint for seepage out of the valley. So there's an inward seepage gradient because the ground water level is much higher than that of the level of the tailings. So it constrains the seepage from seeping out laterally or up-valley. And there's only one way that the seepage can go and that's down-valley - - -

Mr Muir: Down valley.

Dr Matuschka: - - - down valley.

Mr Muir: Where it can be captured.

Dr Matuschka: Where it can be captured. And so it's – you've got to realise that a lot of tailings storage facilities are not in valley situations, you know. If you go overseas in a lot of areas where mining is undertaken, it's quite flat land and they have to construct what they call paddock style facilities. So they're essentially ponds that have a ring embankment and there's no constraints on ground water seepage. You don't have this natural ground water confining effect in the valley – in the valleys. And so the seepage can go out in all directions. And so this site is quite different to many sites and so that has a, if you like, a unique and natural advantage constraining the seepage. And there's both design and operational constraints associated with the design of the TSF to intercept any seepage so seepage from the tailings can move down the valley and so the – there's design elements included to intercept the seepage and they include underdrains beneath the tailings and along the upstream toe of the embankment.

Mr Muir: We spent a lot of time on this yesterday.

Dr Matuschka: Did you, okay.

Mr Muir: Yes.

Dr Matuschka: And the embankment's got a low permeability zone and a chimney drain so you understand why - - -

Mr Muir: We discussed the possibility and indeed likelihood that over a long post-closure period some of these drains are likely to degrade in performance and then the – what has been called the primary water treatment systems, the secondary primary water treatment systems which were tabled yesterday, contingent responses and then passive water treatment systems so we spent a lot of time on that.

Dr Matuschka: Okay, well that's good.

Mr Muir: Right, and then so – and what is the – for the non-geologists and geotechnologists in the room, what is the principal opposition to wet slurry disposal in this environment? Do you – is it really this – could it be identified as an emotional response to the fact that there is this large 60, 80-hectare containment facility with a contaminated load in there in perpetuity? Is that - - -

Dr Matuschka: I think that's perhaps largely correct. And you do end up with a mass of tailings that has a higher water content. There's potentially greater seepage but the seepage in the long term, even from a wet slurry, is quite low. What happens is the tailings consolidate under self-weight. The weight of the tailings squeezes the water out and the tailings attain a denser state and as it achieves a denser state, the permeability reduces and also the amount of seepage coming out reduces. And that – the tailings effectively have the permeability of a soil when they're consolidated. And also in closure the tailings will be capped and there's no longer fresh tailings being discharged with a pond of supernatant water on top of the tailings. So the amount of water available to seep through the tailings mass reduces significantly. So in closure, in comparison with operation, the amount of seepage coming from the tailings reduces significantly and continues to reduce with time.

Mr Muir: Very good, thank you.

Dr Matuschka: So the other issues that we've discussed are the adequacy of the New Zealand practice. And there was some comments made that the New Zealand practice may be inferior to the global industry standard on tailings management – GISTM. So I think maybe that – there are some features in GISTM which is just totally associated with tailings storage facilities and not covered by the New Zealand Dam Safety Guidelines. But I think if we're looking at dam safety in New Zealand, you need to look at the total system that controls that and so we have statutes that cover dam safety. We have the Building Act which covers – there's two elements to that. One is the Building Code which covers structural integrity and durability and so all dams have to go through a building consent application process and – where it has to be demonstrated that the design meets to an acceptable standard and the level of safety. And normally the means of demonstrating compliance with the Building Act is to design in accordance with the New Zealand Dam Safety Guidelines. And that process – the building consent process – also includes an independent review requirement. That's a high, medium or high PIC dam – this is a high PIC dam. It has to be subjected to an independent review as part of the building consent process and when we move to – and as part of the New Zealand Dam Safety Guidelines, that doesn't only just cover design, it covers assessment of the consequences – the first thing is the assessment of the consequences of failure – the consequence classification as a consequence classification system – and then you also have to then do investigation design - - -

Mr Muir: Risk assessment tool combining a combination of probability and outcome?

Dr Matuschka: Well, you look at the consequences of breach. You basically assume the dam will fail and what will the consequences be on property, infrastructure, environment, and you – in New Zealand it's either low, medium or high. Other practice guidelines overseas have a different classification system. The GISTM has five levels of classification – low, significant, high, very high and extreme.

So the proposed TSF classifies under GISTM as only high. It's not very high or extreme. And that's principally because the New Zealand guidelines are very conservative with respect to what we call the population at risk and potential loss of life. So the threshold for getting into the high category in the New Zealand Dam Safety Guidelines is very low in comparison with most overseas guidelines for tailings dam design or dam design. What that means in practice is that during operation, the design criteria in the New Zealand Dam Safety Guidelines is more conservative. So we have to design for essentially a one in 10,000-year return period earthquake and we design for a run-off from a 72-hour probable maximum precipitation rainfall event, which I think is about 750 millimetres for this site. In comparison, GISTM for a high consequence classification only requires design for an earthquake for one in 2,500-year return period. And similarly for the design flood for assessing freeboard is one in 2,500 in comparison with the BMP in the NZ design guidelines. So it's probably only one in 2,500. I haven't done the calculations. But it's probably only one third of the BMP could be on that order. I could check that.

Mr Muir: One is 2,500?

Dr Matuschka: Year return.

Mr Muir: For?

Dr Matuschka: Rainfall.

Mr Muir: Right, yes.

Dr Matuschka: For a flood – design flood. For closure – so the GISTM differentiates between the design criteria for operation and for closure. For closure, the GISTM is the same as the NZ design guidelines. And so – and then the NZ design – New Zealand design guidelines – Dam Safety Guidelines – cover construction and commissioning. They cover safety during operation, so that covers monitoring and surveillance, governance and independent inspections – you have to undertake annual inspections and comprehensive dam safety reviews. And it also covers life cycle management which is really managing deficiencies that might arise during the lifetime of the project.

Very recently, we introduced legislation or regulations covering dam safety in New Zealand, so that's the Dam Safety Regulation. That's another part of the Building Act. That was 2022 the Dam Safety Regulations came into being. And that specifically covers the safety of dams post-construction. So this is relatively new but it's a big – it formalises I guess what was covered in the New Zealand Dam Safety Guidelines but it's now a legal requirement. So all dams have to have the consequence classification assessed that they meet a minimum threshold. If they are medium or high PIC, they must put in place what's called a dam safety assurance programme which is essentially a system for managing the safety of a dam during its operation, including periodic reviews. This includes annual dam safety inspections and certification by a recognised engineer. It includes comprehensive dam safety reviews every five years and then re-assessment of the potential impact classification every three to five **[??]** years because circumstances can change. There can be development downstream, for example, which can affect the population at risk that could impact on the consequence classification. That's not going to make any difference to this particular project because it already is high PIC – it's the highest category that exists.

Mr Muir: Right.

QUESTIONS FROM THE PANEL:

Mr Barry: [Inaudible 00:44:55].

Mr Muir: Yes.

Mr Barry: When you say the lifecycle of the project?

Dr Matuschka: Of the dam, yes sorry. Sorry, of the dam, yeah.

Mr Barry: It's a very, very long time.

Dr Matuschka: As long as the dam remains in existence, it's covered by the Dam Safety Regulations. So it's essentially in perpetuity unless those Dam Safety Regulations are revoked. Or unless you can demonstrate that the tailings are no longer a liquid that if they were unrestrained they wouldn't flow. That's unlikely to be the case.

Mr Muir: At least within our lifetimes?

Dr Matuschka: But from a dam safety perspective, this tailings storage facility is unique in that it's got an approximately one kilometre long waste rock stack engineered landform buttressing the embankment. And so that provides great assurance that it's not going to go anywhere.

Mr Muir: Thank you.

Mr Mulliner: I've just got a quick question. So in terms of the original application, there was an assessment of what would happen in a potential failure. And with some assessment of the area that would be affected. Are you able to – and there is some concern in the community – are you able to put that into context in terms of the credible failure loads and this embankment buttressing?

Dr Matuschka: Are you talking about a dam breach? Well, dam breach analyses are really hypothetical. And the likelihood of a release of the tailings is going to be extremely low because of the buttressing effect of the ELF.

Mr Muir: So if we just sort of stood back at a very high level and looked at the possible – the conceivable failures, they would be seismic, one?

Dr Matuschka: Yes.

Mr Muir: Liquefaction of the wall?

Dr Matuschka: Well, that's – the seismic would be what would cause potentially liquefaction. But the wall's not going to liquefy. But the embankment's compacted material to an engineered standard where it's not liquefiable.

Mr Muir: Not liquefiable, right.

Dr Matuschka: The only thing that's liquefiable is the tailings.

Mr Muir: Is the tailings, right.

Dr Matuschka: Yes. And the ELF itself is not liquefiable.

Mr Muir: Right. And overtopping?

Dr Matuschka: That's - - -

Mr Muir: I've got a particular sensitivity to this because I was counsel in relation to the Opuha Dam. So overtopping is a considerable failure mechanism of the dam?

Dr Matuschka: No, I don't believe so. Not in a way that it would release a significant quantity of tailings because the closure will be designed in a way where – there's a reasonable catchment so in a massive rainfall event there's quite a lot of volume of water that comes down into the TSF. But the outlet works can be engineered in a way where that water is stored temporarily and released at a controlled rate. So it might be stored for a few days rather than all of the water sheeting off at the same time as the rainfall event's occurring.

Mr Muir: Ultimately requires sufficient freeboard.

Dr Matuschka: Yes, it has freeboard. It has freeboard but it can be designed in a way – the spillway outlet channel – the outlet channel can be designed in a way that it attenuates the peak inflows into the [inaudible 00:48:54]. And so those flows are not very high.

Mr Muir: Sorry, I interrupted the question from Commissioner Mulliner.

[Inaudible and laughter 00:49:05]

Mr Torvelainen: I think that I probably should make a comment as well. I think that there is always risks to manage and it's important that overtopping is managed in terms of starting embankment construction in the early stages of the project and in those stages the more water that's potentially retained in a flood and the dam safety – so overtopping is something that has to be, you know, considered in terms of normal design practice for the dam.

Dr Matuschka: Yeah, but the risks of overtopping during construction are much higher than the risks of overtopping in the longer term.

Mr Muir: Exactly.

Dr Matuschka: But the consequences - - -

Mr Muir: That's what [inaudible 00:49:54] Opuha.

Dr Matuschka: Yes, yes, of course. Yes. And that's always the case. The risks during construction are always higher than operation.

Mr Mulliner: So in terms of the actual potential seismic risk then, I think it would be useful if you could explain and why it is considered that that failure mode is – it's not non-existent but how that would be, I guess, contained within the site from this buttress.

Dr Matuschka: From the seismic perspective and flood perspective? Yeah, well the seismic perspective – I mean there's about 1,000 metres of ELF downstream and it's constructed of rockfall. The external geometry is relatively flat – one in three – which is not steep rockfall. And so in a design earthquake, all we'd expect is some minor deformation on the outside shoulder and that – there's no way that that could impact on the integrity of the TSF. Even without the ELF there, we'd only expect minor displacements of an embankment that was properly engineered and designed, or would not expect any release of contents under a seismic loading event.

Mr Muir: One in 10,000?

Dr Matuschka: Yes. That's the same criteria - - -

Mr Muir: The bottom line is that the dam itself, excluding the ELF, has to meet the requirements?

Dr Matuschka: It will be designed in that way so it will also take into consideration the fact that the ELF will be present and provides additional assurance.

Mr Muir: Yes. And then just again on flood?

Dr Matuschka: Yes, well, the – it's designed in a way that it can take an extreme flood event and pass it via the spillway which was essentially the diversion channel. And those peak flows can be attenuated by the way in which the outlet works are designed. So as I said before, the outlet channel can be designed such that the – a lot of the water that comes in, in say a two or three day major storm event, is stored and then released over time. And that can be simply achieved by the geometry of the spillway outlet. You can allow the water level to rise and have a controlled discharge from the spillway itself which reduces the peak flow that will pass over the spillway and pass downstream. And so the outlet channel and the spillway have to be designed to be very durable so that they don't erode in the long term and they will require to be inspected and occasionally some maintenance undertaken.

Mr Muir: When we talk about the outlet channel, wouldn't it be the case that as this – I mean what's the terminal height of the TSF?

Dr Matuschka: TSF. It's - - -

Mr Torvelainen: 690 RL **[??]**

Dr Matuschka: Yeah.

Mr Torvelainen: So effectively 100 metres high.

Mr Muir: Effectively 100 metres.

Dr Matuschka: 100 metres high so your discharging – the outlet channel has to have an elevation change of over - - -

Mr Muir: Over time.

Dr Matuschka: 100 metres from where the tailings are stored - - -

Mr Muir: [Inaudible 00:53:27] channel, it's a constantly reformed outlet channel to be able to essentially deal to the problem that took Opuha down?

Dr Matuschka: It will be a final engineered channel designed for long-term, for closure.

Mr Muir: For long-term. And during the course of construction, it is – there is - - -

Dr Matuschka: There'll be temporary - - -

Mr Muir: - - - temporary - - -

Dr Matuschka: - - - drainage works. But there will be a diversion channel at the higher level too, to avert the catchment from upstream and then that will be re-engineered as part of the final spillway.

Mr Torvelainen: I think it's important to be clear here – there's effectively three stages of the facility. One is the construction of the initial starter dam, which is when there's just water that can potentially come behind the dam and in that state there will be spillways cut as appropriate to protect that dam as it's constructed. Once the facility is in operation, it's effectively operated as a no-release facility so – and how that's operated is with designing for a notable flood which is the PMP plus one metre freeboard. And in that situation, no water will be spilled from the facility. In closure, once it's capped and clean at the surface – that's when the outlet channel is put in. And that's important because – for everyone to understand so that there's no concern about release of contaminants – surface water – from supernatant water on the TSF in operation.

Mr Mulliner: It's probably worth you briefly describing what a PMP event is.

Mr Torvelainen: Sure. Sorry, that's probable maximum precipitation event that Trevor referred to.

Mr Muir: This is a 72-hour event?

Dr Matuschka: Yeah, it's a 72-hour PMP so it's 748 millimetres I think to be exact is the estimate so it's more than the annual rainfall in three days.

Mr Muir: Dr Lottermoser is critical of the fact that this does not allow promptly for anticipated effects of climate change?

Dr Matuschka: That will be considered, or has been considered, so there's – you can apply an adjustment factor to – there are adjustment factors for rainfall events with shorter durations that are related to climate change models. And there's actually a new methodology that's about to be released and it will be in the form of a toolbox that will allow adjustment to PMP rainfall for climate change. And that will be considered during the design. So the climate change effects are taken into account in the rainfall intensities that have been used for design of different elements of the project and will also be - - -

Mr Muir: Will continue to be?

Dr Matuschka: Continue to be, yeah.

Mr Muir: As the knowledge base is refined?

Dr Matuschka: And the PMP will also have a climate change adjustment made to it.

Mr Muir: Right. Thank you very much Dr Matuschka. That introduces all of the topics that you wanted to discuss under one, or are we missing - - -

Dr Matuschka: Well, there's just the landslides.

Mr Muir: Just the landslides.

Dr Matuschka: There has been some concern raised about the potential effects of landslides on the safety of the tailings storage facility and reservoir landslides is always an issue that is considered in dam design. There's been some notable events with dams with large landslides resulting in overtopping and failure of dams. Not tailings dams but water storage dams. There has been some tailings dams too. But – so that's always a consideration. You know, as part of the design of a dam you have to consider the potential for reservoir landslides and what effect that would have on the safety of the tailings – the safety of the dam.

Mr Muir: So if I could just try to capture this, we could have potentially a landslide that resulted in a displacement of liquefied slurry - - -

Dr Matuschka: Yes.

Mr Muir: - - - over the top?

Dr Matuschka: Down the spillway.

Mr Muir: And down the spillway.

Dr Matuschka: In the long-term, or even during operation. It would go down the spillway if it was - - -

Mr Muir: Down the spillway, yes. And then the consequences of that are not a destruction of the dam but an uncontained discharge of slurry which would overwhelm the water treatment systems, or could?

Dr Matuschka: Could potentially.

Mr Muir: Could potentially overwhelm the water treatment systems, right. Okay, potentially also I suppose you could have a landslide of such volume that it necessitated a higher dam because you've lost some of your storage?

Dr Matuschka: True, yes.

Mr Muir: Yes, can landslides occur – let's assume five or more years of operation and we now have not the ultimate height of the TSF but we perhaps are at say 60 or 70 metres, and we have got part of the natural terrain which is now part of the – the terrain is now containing a vast volume of this slurry. Can we have landslides beneath – can I call it the water level?

Dr Matuschka: It would be unlikely because generally it would be above. Because the tailings themselves provide some restraint of the ground at lower elevations and so they tend to buttress the – if the landslide was present.

Mr Muir: You don't get the same sort of mechanism that applies offshore in relation to landslides that are occurring into offshore trenches?

Dr Matuschka: Marine - - -

Mr Muir: Marine landslides.

Dr Matuschka: Yes, well, there you're talking about material that probably has the same consistency as tailings. And they're totally unconstrained. So here we're talking about, you know, a landslide – a natural landslide on reasonably strong ground. So it stands at a much higher slope. The valley slopes are much steeper than the sediments in the marine environment.

Mr Muir: And as we fill the more contained part of the valley and we move into the upper slopes of the valley, presumably the landslide risk then diminishes with just the fact that we now have - - -

Dr Matuschka: Yes, I think, yeah, a TSF doesn't fill the valley to a very high elevation.

Mr Muir: Right, yes.

Dr Matuschka: I think it's probably only one quarter or one third the height. So it's not – there's potential or ancient landslides that exist above the final tailings level.

Mr Muir: I see, yes.

Dr Matuschka: And so there's lots of landslides in the Otago region associated with schist rock. In most of them the geomorphological evidence – that's I guess the interpretation of the shape of the ground and what lies below the ground is that these occurred geologically a long time ago and they're not considered as - - -

Mr Muir: Active landslides.

Dr Matuschka: - - - as highly active. Some of them might have some small amount of debris but there's no evidence of significant large mass failures because we'd see that in the shape of the ground – there'd be evidence of the ground hummocking and accumulation of slope debris in the valley floor. And that's just not the case.

Mr Muir: They probably said that of Mt Cook too though, didn't they?

Dr Matuschka: But there's literally thousands of landslides in the Otago region and there's no evidence of significant movement – mass movement down valley and accumulation of the debris in the valley floor. If you look at the valley at this particular site, the valley floor is quite narrow and the material that has accumulated at the bottom is not really – is not from landslides, it's from material that's been eroded off the surface of the slope and we call it colluvium.

Mr Muir: Colluvium, yes.

Dr Matuschka: And so it's resting at the bottom of the valley. And the bottom of the valley - - -

Mr Muir: [Inaudible 01:02:50] So that's actually quite deep within the valley. It's – new testing is showing that, you know, up to 30 metres deep.

Dr Matuschka: Well, not at the tailings - - -.

Mr Muir: Not the TSF. Further down the valley.

Dr Matuschka: I'm not too sure whether that's colluvium or alluvium. So there's two different processes. But again, yes, but there's no – and also - - -

Mr Muir: Sorry, I don't understand the difference in the processes?

Dr Matuschka: Well, colluvium is material that's been eroded off the sides of the hills.

Mr Muir: I see.

Dr Matuschka: And alluvium material is what's been transported down the water course. The site is in a moderately, I guess, seismically active area and there's [inaudible 01:03:30] capable of generating quite large earthquakes within about 10 kilometres of the site. And if those – and those earthquakes would have occurred many times, in terms of geological time – in recent geological time and there's no evidence that those – such earthquakes have resulted in large landslide instability. So that gives us – that I guess gives confidence that there's a low likelihood that they will reactivate again in future earthquakes. And so that as part of the building consent process, it has to be demonstrated that the landslide risk can be managed. And so investigations are underway and some have been undertaken – some [inaudible 01:04:25] have been undertaken to better understand the geology of the site. But there will be – it will essentially be a risk-informed approach that will be adopted that's allowed in the New Zealand Dam

Safety Guidelines and it's essentially a performance-based design approach in which the deformation and ground water levels associated with the landslides will be monitored and triggers will be set for different loading conditions – static, earthquake, rainfall events. And if they are exceeded, some action will have to be undertaken.

Now probably the worst-case scenario is that there could be a build-up of ground water levels in the landslide above the tailings because the presence of the tailings restricts the drainage from the lower part of the landslide because you're raising the water level. There's two things happening. The tailings are buttressing the slope but they're also raising the potential low point at which water can come out of the landslide. And so monitoring will be put in place to monitor those ground water levels and if they show any change or rise, then some mitigation measures will have to be installed and these are typically bore horizontal drains or drainage shafts. So that's what happened with the landslides at the Clyde Dam. Effectively the solution was to put in drainage. So there are solutions to reduce the risks associated with potential reservoir landslides and that has to be demonstrated as part of the building consent approval process and there's consent condition – I think there's a landslide management plan as a condition of schedule 2 of the resource consent that also is required.

Mr Muir: Dr McAlpine, can I ask you to comment on any issue – any of those issues that we've just covered.

Dr McAlpine: I'd be very happy to do that. And I would like to – may I respectfully suggest that Steven and Bernd would be the more appropriate to comment since this is specifically focused to tailings storage facilities.

Mr Muir: That's excellent. Could we go to Mr Emmerman.

Prof Emmerman: I suggest that we hear from Professor Lottermoser first. It's already 12.30 in the morning for him.

Mr Muir: I see. Very good. I'm in your hands. Professor Lottermoser.

Prof Lottermoser: Thank you very much for allowing me to speak to you and to respond to some of the comments. I don't want to give you an emotional response. I want to give you a rational response why I consider this tailings disposal option is the most riskiest option. First of all, the first reason is, if you're looking at the failure rates, there have been more than 250 wet tailings dam failures in the last few decades, much more than any filtered tailings have failed. The prediction is there will be more than - - -

Mr Muir: We could break that down couldn't we to downstream construction and upstream construction dams where the failure rate among upstream construction is higher, isn't it?

Prof Lottermoser: With the upstream construction method, it's much higher therefore it's also forbidden in certain countries like Chile.

Mr Muir: Yes, and this is a downstream construction dam so it does fall into – to start with, when we take the incidence of failure, we should really take out the upstream construction failure shouldn't we?

Prof Lottermoser: We should consider all types of constructions of the tailings dam walls of course. But the fact is – the prediction is that these wet tailings dam failures will increase in years to come, whether they are constructed centre line or down or upstream. And the consequence was that the global industry standard on tailings management was created because of these very high failure rates. And the consequence was also that the standard was looking for new technologies which actually reduce these failure rates and filtered tailings are one disposal option. So filtered tailings is only one disposal option. Another option is, of course, you put the tailings into a mined out open pit. So in-pit tailings disposal is another option, or you place the tailings into a mined-out underground working, you mix it up with cement and you provide more geotechnical strength to your underground workings so you can pursue further underground mining. So filtered tailings is only one option.

Now the second reason why I consider this as a very risky option is the tailings are to be placed on top of landslide materials, next to landslide materials and below landslide materials. And that is a tailings disposal technique which was done in the 1950s in a former soviet republic in Kyrgyzstan. And as a consequence of this tailings disposal, you have significant tailings movement – rupturing of the tailings repositories and the International Atomic Energy Agency, who have been working on tailings disposal, had to actually visit the site and advise the government of Kyrgyzstan how to deal with these massive environmental issues because the tailings moved with the landslide materials down further into the tailings repository and in some cases into this alpine catchment. Very, very similar environment to the alpine catchment you have there in Central Otago. So for a number of rational reasons, I perceive that option is very risky.

And the other problem I see is, we don't have an option analysis – the global industry standard on tailings management requires a detailed analysis of all sites and of all options. And they have to consider these in such a detail that you have to consider environmental, technical, socio-economic aspects for each alternative and for each site throughout the project cycle. So this is a very, very detailed document to come up then with a final option. And I don't see the data. I don't see the evidence. I don't see the knowledge that you can claim that this is the best option.

Now moving on to the global industry standard on tailings management, I need to elaborate on this – what Dr Matuschka was saying. I agree that the New Zealand guidelines are guidelines and I don't question the engineering principles and the standards. But the fact is the world didn't use the New Zealand guidelines as a global standard. The standard has evolved like all standards evolve – standards do evolve over time and the global industry standards not only includes civil engineering aspects but it also includes corporate, social, governance, human rights aspects. So it's much more than a civil engineering guideline and the objective - - -

Mr Muir: Dr Lottermoser, could I just ask you a quick question there. Dr Matuschka took us today to some examples of where the New Zealand Dam Safety Guidelines, and the associated requirements of the Building Act which incorporate the Dam Safety Guidelines, would provide for this high-impact dam for a more conservative approach than would under GISTM. Are you suggesting that this Panel should be cherry-picking GISTM and NZDSG to overall adopt the most conservative approach? Or are you - should [inaudible 01:14:20] with GISTM?

Prof Lottermoser: They should use the best standards. The best guidelines.

Mr Muir: Is that GISTM in your view?

Prof Lottermoser: Yes, from my point of view they are because they go beyond civil engineering methods. They look at human rights, social, governance, corporate issues.

Mr Muir: Yes, I understand that but just looking at engineering components for a moment, that would mean a lower standard, wouldn't it because - - -

Prof Lottermoser: In some aspect it is, yes.

Mr Muir: Yes, right, okay, thank you. Do continue Dr Lottermoser.

Prof Lottermoser: Coming back to the objectives of the GISTM and the New Zealand guidelines, the New Zealand guidelines are really there to guide the design, the construction, to framework the management of a dam and to assist owners, so the objectives are very clear. They are very focused on civil engineering aspects where the objective of the global standard is zero harm to people, zero harm to the environment and zero tolerance for any human fatality or injury, and it also says that the economic viability cannot override human safety. So it is – regardless – whatever it costs to keep the tailings safe, that money must be spent because the overall objective is zero harm to people and the environment. So economics are totally irrelevant to the global industry standard.

Mr Muir: And have you considered the potential applicability of such a narrowly focused set of standards in the context of the Fast Track Approval Act which clearly enlivens cost-benefit analyses?

Prof Lottermoser: I haven't looked at that to be honest and truthful so I didn't look at the economics, no.

Mr Muir: Thank you. Do continue.

Prof Lottermoser: When you look at the global industry standard, as I said, it is much more inclusive. For example there's a requirement and a principle that you have whistle-blower protection, that you actually have incentive payments to mining personnel who look after the tailings repositories, or performance reviews. And you need to have a requirement where you minimise tailings and water placed into an external tailings facility. That is one of the requirements and that means, of course, the consequence you have to look at other technology options like in-pit disposal, underground tailings placement, cement-based backfill or the application of these filtered stack tailings technologies.

Now that brings me to filter tailings technologies – that technology comes from sewage treatment. And sewage treatment has evolved over decades – over 100 years. And the same thing is that tailings disposal and tailings treatment is evolving over the years, filtered stack tailings to position technology exists for about 40 years so it's been around for quite a few decades and it has found its place also in the global standard because the global standard is trying to minimise water and tailings in an external tailings facility. And this filter tailings technology has been accepted successfully in many mining regions around the world – in the United States, in Australia, in Peru and Chile, in Namibia, in Turkey, and there are several hundred, possibly thousands of sites which use filtered tailings repositories and that's about five to 10 per cent of total tailings management world-wide, so the adoption of this technology is happening. And it's happening also by the big players like BHP and Rio Tinto. They recently published their second guide on filtered stack tailings to position technologies and so there are detailed technology guidelines out there, written by industry for industry, how to deal with these. And they not only cost money, they also have a positive net present value so they actually save money or generate funds for mining companies. And it's also detailed in that industry guidelines written by BHP and Rio Tinto. And BHP and Rio Tinto say that filter technology is favoured for water saving – its water saving capabilities and enhanced stability which Dr Matuschka was referring to. So it allows this long-term stability, less likelihood of liquefaction and movement of material because the material contains less water it is geotechnically more stable. It also allows more rapid closure because we don't have to wait for the tailings mass to dry out. It has significantly less water – they are still moist but there is significantly less water in them so the mine closure and the mine site rehabilitation can happen much quicker. And the seepage control, it's also much better because the tailings mass contains a lot less water and therefore it will generate a lot less seepage. So it offers many, many advantages compared to wet tailings repositories.

And it's particularly recommended by BHP and Rio Tinto for arid and semi-arid terrains. And Central Otago has a semi-arid climate.

Mr MacGibbon: Professor Lottermoser, just a question on that. I know – I think Dr Matuschka touched on it – that the filtered tailings facilities weren't potentially suitable for high-earthquake environment zones. What would be your comment on that?

Prof Lottermoser: You're asking me whether they are?

Mr MacGibbon: Well, are they suitable in areas prone to earthquakes?

Prof Lottermoser: Yes, they are very suitable because they do have less liquid in them.

Mr MacGibbon: That's slightly contrary to what Dr Matuschka said earlier. Would that be correct Dr Matuschka?

Dr Matuschka: Yeah, I can clarify. I think the challenge is in the practical realities of what can be achieved with filtered tailings. If everything was done in accordance with, I guess, specifications and the design intent, yes, they could be made to be – to resist quite high seismic loads. But there are some concerns that where things are not placed quite in spec and the water content is a bit higher than what it was intended and the compaction level was not strictly controlled, then there's some risks that could result in instability under high seismic loads. It's something that – I guess it's a risk with that technology that in theory it should work – it should be able to resist the high seismic loads – but there's some risks if things aren't done properly then there could be vulnerability under seismic loads. It needs to be factored into the design as a design uncertainty and the appropriate design decisions made.

But I'm just going to make another comment. I think that this site is not particularly – I think the risks with a wet slurry are exceedingly small and with the volume of waste rock that's available to construct the embankment and the ELF that provide a tremendous buttress reduces the risks associated with loss of containment to an extremely low level.

I think another comment I'd make about filtered tailings – they're particularly useful in sites where you don't have waste rock. Not all mines have open pits. Some mines are underground and so they don't have material available to build tailings dams. And so, you know, the filtered technology – filtered tailing technology is particularly suited to those types of sites. So there's – you know, they all have their - - -

Mr Muir: Advantages and disadvantages.

Dr Matuschka: - - - advantages and disadvantages, yes, and you've got to put it in the context of the site you're dealing with.

Mr Muir: Right, thank you. Back to you Professor Lottermoser.

Prof Lottermoser: Yeah, that's something I would expect in an option analysis to see. A detailed option analysis which argues the case why a particular option is chosen and as I said, because we don't have that evidence and we have no knowledge, we are hypothesising whether the tailings disposal is truly the best option. But as it is just proposed as this is, wet tailings disposal is the riskiest tailings disposal option compared to filtered tailings, compared to in-pit disposal or compared to putting the waste back into underground workings.

Now there's one statement – there were quite a few other statements on climate and – but I just want to briefly comment. Climate risk assessment and resilience assessments are now part of the Commonwealth Mining Feasibility Guidelines and this is not just about rainfall and high rainfall. This is also about something to do of where do you get your energy from because you have pumps working at your mine site and the pumps have certain roles and responsibilities, for example, in your sumps to lower your water levels or to keep your water levels in your tailings repository at a certain level. So you need electricity to actually operate at a mine. Of course, if you do have extreme climatic events, what can happen is that your energy supply system will fail, either through a bush fire or if it's not resilient enough to actually operate under climate stress because everybody is using the fridge and who knows what. So a climate risk assessment, it's not just about rainfall. It's about many other things. It's also about drought, it's about energy and these factors need to be considered also in the operation of a tailings repository, not only in the operation but also at the closure stage. And I don't see that. There is no climate risk and resilience assessment which looks beyond rainfall.

Mr Muir: Any other points, Dr Lottermoser?

Prof Lottermoser: I think that's quite enough at this time of the day from me.

Mr Muir: You've done very well. You're obviously well-sustained by caffeine there. Now, Mr Emmerman, was there any additional point that you wished to raise on this topic?

Prof Emmerman: Yeah. Sorry, I'm a professor also, sorry.

Mr Muir: I'm sorry Professor.

Prof Emmerman: No, it's okay.

Mr Muir: I won't make the mistake twice.

Prof Emmerman: No it's fine, I'm sorry to bring it up even. Okay. I think I want to reinforce what Professor Lottermoser said but also I want to emphasise – I want to further develop one particular point. The GISTM requires a multiple accounts analysis. It's also called a multi-criteria alternatives analysis. It's an actual study of the document. It's not simply a recollection of a conversation. And this document has only two objectives – two and only two. The first objective is minimise the volume of water in tailings stored on the surface, and the second is minimise the risk to people in the environment. Those are the only objectives. And this analysis considers factors, also called accounts, and there's only three categories of accounts. There's three and only three. The three are technical, environmental and socio-economic. And the GISTM clarifies that socio-economic refers to the local society and the local economy, not the balance sheet of the company. So the cost to the company cannot be part of that analysis. So any discussion as to how much it cost the company to undertake a certain alternative is completely irrelevant, according to GISTM. Okay.

Now interpretations of the GISTM like this big book, Tailings Management Handbook, clarifies that this multiple accounts analysis must include the option of open pit backfill or backfill of underground galleries. That must be considered as one of the options. And this open pit backfill – it's generally regarded throughout the mining industry as the best practice. Putting the tailings back in the depleted pit. You permanently remove any possibility of a catastrophic failure of aboveground tailings storage facilities, you remove any possibility of seepage into surface water, you can improve the stability of the open pit, you facilitate the return of the entire mine site to some useful purpose. You have many more options for managing the physical and chemical stability and the generation of acid and mine drainage, etc. This is regarded as the best practice.

Mr Muir: In the context of this proposed development, where are these tailings to be held and how until such time as they can be repatriated to the pit?

Prof Emmerman: Okay, I will answer that question but I want to make one point first, okay. So I'm kind of skipping overall why backfill is good idea and I'm applying it to this specific situation. Okay. We have something they call the stripping ratio which is the ratio of waste rock to ore. Okay. Typical for open pit gold mining is 4.2. This project has a stripping ratio of 15.2. It's probably the highest of any open pit that's ever existed in the history of mining. And only 10 per cent of that waste rock is being put back into the pit and there's much discussion about pit lakes. By that I mean there's plenty of space in these pits for tailings. Okay.

Your question is where do you put it back. Well, you have two categories of options. There's many situations in which you – projects are carrying out exploitation, that is mining, and in-pit disposal in the same pit. I mean, basically you have like a tailings storage facility within a pit. There's many examples in Canada, Saskatchewan, Alberta, uranium mines. There's simply many examples of this technology, even in New Caledonia that's practised. There's the nickel mine where they actually – it's both waste rock and tailings are put back in the pit and they never remove that from the pit. It's just moved around into the pit. And there also is the option of having a temporary, aboveground tailings storage facility and then after mining, moving those materials to the open pit. Okay. Yes, that would cost money. Okay. But two points. First, cost is not supposed to be a factor – safety comes first. And second, we're comparing the cost of putting tailings into the pit with the cost of perpetual maintenance of this aboveground facility. I'll stop here. I don't want to give too long of an answer to your question.

Mr Muir: Thank you. Any additional points you wanted to address Professor Emmerman?

Prof Emmerman: I'm kind of stepping back a bit before you asked your question. Is that – in many jurisdictions you're required either to backfill the open pit or to consider the possibility. The state of California requires the backfill of open pits. The province of Quebec in Canada requires a feasibility study, that is, you don't have to backfill the open pit but you have to consider the possibility – that's the default. You either backfill an open pit or you prove to the regulatory agency that it's not technically possible. If I were in your position, that's the question I'd be putting to the applicant. Why are we building this Shepherd's TSF? Why are we bothering with that? Why not just put the tailings back into the pit with so much empty space. I'd be asking that question. I would consider that the default. Open pit backfill, that's the default unless the applicant can explain why that is technically impossible. I guess that will sum it up.

Mr Muir: Thank you. We'll round back to the applicant on that at the end. Mr Pizey?

Mr Pizey: Yes sir. I am interested in the concept of backfilling the pit because I believe yesterday you heard some concerns about water quality over time in the pit and I – whilst I personally believe the buttressing of the TSF facility with the downstream ELF will render it stable under any foreseeable circumstance, the rehandling of the tailings or a portion of the tailings to the pit once mining is complete would perhaps mitigate the risk in the TSF over time and address the issue of water quality in the pit, which will need to be dealt with in perpetuity as well. It's the only issue I'd raise at this stage.

Mr Muir: Yes. Mr Macdiarmid?

Mr Macdiarmid: Thank you. Firstly, I don't want to talk to you much about sort of tailings disposal options. My view is the applicant has decided their option is wet tailings and a tailings storage dam and there may be other options there but our – my sort of focus is assessing the effects of what they've selected and not looking back at different options because once you go there, there's options for everything really. So I don't want to talk too much about that. Certainly the tailings storage facility proposed with the buttressing from the ELF is very robust and I would agree there is not really any credible geotechnical failure mechanisms for it just due to that buttressing, especially considering the dam is essentially designed without the buttress and the buttress is just an extra sort of [inaudible 01:36:25] safety for the dam and certainly once everything – at closure with the ELF to its full height, I really can't see any sort of credible mechanisms where the dam could fail.

The GISTM discussion, yes, certainly the New Zealand Dam Safety Guidelines technically do provide, you know, higher levels of seismic loading, higher levels of flood loading required for the dam so the dam itself potentially is going to be a more robust structure using New Zealand Dam Safety Guidelines. My understanding from one of the recent RFIs from the applicant is that a lot of the other aspects of the GISTM around, you know, specifying sort of engineers and some of the, sort of, publicly provided information is going to be – is going to happen now via their tailings management plan. So I'm not sure how many – apart from the options stuff at the start which I'm putting to the side, I'm not sure I have any other aspects sort of moving forward or not covered at the moment and it would probably be worth just getting your sort of thoughts on that once you wrap things up here.

I guess finally the landslide issue. As Dr Matuschka mentioned, Otago is riddled with landslides. If you look at the Otago Regional Council hazard map, the whole of Central Otago is mapped as having landslides. A lot of these landslides aren't active and haven't moved for tens of thousands or hundreds of thousands of years and as part of the, sort of, the detailed design of the dam, these landslides will have to be investigated so there will have to be drilling carried out, assessments carried out to assess if these landslides are active or they aren't, and then the stability of the landslides will need to be assessed as part of the dam design. And that will have to go through a purity process and I'm fully confident that that aspect can be dealt with via that process. The reason I say that is that, I think as Dr Matuschka mentioned, the Clyde Dam, which is 20 kilometres away from the site, has several active schist landslides on the flanks of the reservoir and these have all been dealt with via stabilisation measures, usually sort of drainage. And the Clyde Dam scenario is actually much more onerous than the tailings storage dam scenario primarily because the Clyde Dam is just full up with water which weighs less, there's lesser buttressing effect from the water in the Clyde Dam. And also the water level goes up and down which causes changes in the poor water pressures within the landslide which can destabilise it. So landslides, yes, they are there. Whether they're active or not I don't know. I suspect there are potentially not a lot of – you know, in other parts of Central Otago there have been developments in landslides like residential constructions, subdivisions and that kind of thing. So just because they're there, doesn't mean they're, you know, a big issue. And as I said, I'm confident they can be dealt with via the sort of detailed design process and the peer review process.

Yep, that's everything.

Mr Muir: Thank you. Can I just round back to you Dr Matuschka. The gauntlet was laid down by Professor Emmerman and having done so, I think it's fair to send it back to – why were these alternatives not actively explored?

Dr Matuschka: I think not all the options that Professor Emmerman referred to were necessarily explored – weren't explored. I think the in-pit disposal option, there's some practical limitations with that and you need to temporarily store the tailings before you can backfill into the pit. One of the limitations with this pit is that the ground surface around the perimeter of the pit varies enormously so there's a low side to the pit because it's on a hillside. And so the effective amount of storage or tailings storage that you can get back into the pit is actually small relative to the volume of material that's removed from the pit. So I'm not – I haven't done the numbers but there could be a practical limitation on actually how much tailings can actually fit into the pit because it is low on one side. But I think other – I think we've discussed the filtered tailings. I guess at the end of the day I would say that the risks associated with the containment of the safe storage of the tailings and containment of seepage from TSF are very low for the selected option and the risks are acceptably small. So although filtered tailings you could say is the less riskier option, I think if you look – if you consider the actual risks of the safe containment and contamination of seepage downstream, the risks with the wet slurry are extremely low and acceptable.

Mr Muir: Any additional questions from the Panel before I invite counsel to cross-examine?

QUESTIONS FROM THE PANEL:

Mr Kensington: Yes I have a question. Dr Matuschka, just in terms of your response of the backfilling option, I thought that was a little lightweight potentially, given that the Come in Time pit is being backfilled, right. Isn't that a similar kind of - - -

Dr Matuschka: It follows on.

Mr Kensington: - - -that we're dealing with?

Dr Matuschka: It follows on. So my understanding is that you would, for the first pit, you'd actually have to – you'd have to temporarily store the tailings before you backfill. At subsequent pits there's – the opportunity exists for some backfilling.

Mr Kensington: You go straight from one to the other kind of thing?

Dr Matuschka: You could, yes.

Mr Muir: Come in Time is not being backfilled with tailings, is it? It's being backfilled with - - -

Dr Matuschka: Waste rock I believe.

Mr Muir: With waste rock.

Mr Kensington: So there's always going to be some tailings that have to be put somewhere, is that what you're saying?

Dr Matuschka: Yes, yes.

Mr Kensington: But it's possible?

Dr Matuschka: I guess it's physically possible. I'm not sure you'd be then potentially contaminating another water source. Yes, I'd probably have to defer to Paul or Eric who's done some further work on that option.

Mr Torvelainen: Mr Torvelainen speaking now. I don't see that it's practical to place tailings in Rise and Shine pit as described co-currently with mining. That raises serious safety concerns for those that are in the pit. The pit is mined down dip and is a constrained environment, and to have personnel in that pit while you're placing tailings, that's a very high risk to life safety. Where you can use in-pit storage is where the sequencing of the mine allows it. So for instance, Come in Time is an example of where it can be – material can be placed – the pits are being mined, one pit's being mined at the same time as the other is open and it can be direct haul. One of the key things with this site is the Rise and Shine pit is the largest pit and that's where the majority of the material is coming out in terms of the rock and also where the majority of the ore is coming from and ends up in the tailings storage facility. So it's not practical to mine in one spot and backfill at the same time. The only practical thing I can see is that from – just from a general physical point of view is you run it out and then you run it back in. But if you're going to do that, you – all the time that you've taken to take it out, you need to add that time on to the end of the project to run it all back in.

Mr Kensington: Double handling.

Mr Torvelainen: Double handling, yeah. And the important thing with this site is that the satellite pits like Come in Time pit and Shrek's pit that are potential options to put material and are very small – they're small compared to the Rise and Shine.

Mr Kensington: It's interesting you mention the Shrek's pit. Why isn't that one being backfilled in your mind?

Mr Torvelainen: I think that it's just what was proposed. The material that's being run out from the – it's proximate – it's quite a way away from the other pits. It's locally got – it's been mined and the material's been placed beside it. If you were to run material I guess practically you would be running waste rock over from Shepherd's ELF as an extra haul into that pit. I don't see any practical reason why that couldn't be done. That's not what the applicant has asked for. I think from my perspective it's a balance of other environmental considerations like landscape, etc that might drive that decision.

Mr Kensington: And that's kind of where I'm coming from – the landscape considerations – and so could the Shrek's ELF be put back into the Shrek's pit, for example.

Mr Torvelainen: Well, yeah, practically it could but it's the same thing. You're double handling and from a sequencing point of view, the opportunity is when you're running another concurrent pit at the same time that you can – you've got one open – you've already got the Shrek's pit open and you're running material from somewhere else and you run it into that pit, that's the practical decision because it's just extra overhaul.

Mr Kensington: Thank you.

Mr Muir: Yes, Dr McAlpine.

Dr McAlpine: Yes, if I may just return. I deferred to my order in the queue as it were for our sleepy partners on the other side of the world. And I would just like to make a couple of comments. The first one is with respect to understanding the design – the physical robustness of the tailings storage facility, given that it's buttressed by a large landform. And I think there was quite a wide consensus at the joint conferencing that it was – it was a belt and braces type of situation. It's not particularly common that you have a tailings facility – constructed facility braced by a rock pile. So there was that on the positive side. However, the overtopping or the breach of the dam, or shall we say the – there is indeed very much at risk from the landslide. And we've heard earlier about the description of the landslides in the area, some fairly contradictory information as to whether the landslides were entirely above the stored pit content or whether they were in fact more extensive than that and went direct to the margins, or even I heard an expert say right into the footprint of where the tailings would be stored.

Mr Muir: So can I just size the risk first. So we're talking about the landslide risk to the TSF and we're not – you're happy enough that with the buttressing of the Shepherd's ELF that we're not talking about a failure mechanism of the TSF dam but we're talking about effectively the – just like the iceberg falling into the ocean, or the face of an ice flow falling into the ocean, like a bow wave of toxic slurry being pushed over but not destroying the TSF or down through the spillways and the consequences of trying to deal with that?

Dr McAlpine: That's correct. And I'm glad that you mentioned the "or the down the spillways" at the end of that because to overtop that mountain of engineered – the landfill – the waste rock fill – would be a mighty heft required for that because there are the peripheral conduits which are diverting the Shepherd's Creek water and they would presumably also be totally overwhelmed by a landslip into the bowels of the TSF.

And the discussion around the ancient – or the inactive or the very old geological nature of the landslips that are identified as being right there next to the tailings dam, I think is a little bit out of kilter with the current thinking – the experts at the University of Otago but more particularly at Geological Nuclear Sciences or ESNZ as it is now – where the sensitivity of land – central landslips is recognised to be affected by water – rain, snow melting events and so forth. And of course climate change – more extreme rain events. So I think that the factors that probably didn't come out to me in the discussion that we had was, one, that risk of landslides – there are some factors which I don't think were really brought out which is climate change and we're very, very well aware of ancient or even unknown landslides now becoming too frequently in the news. And the other is the effect of the water pressure from the tailings dam – the increased hydraulic pressure providing – the scientific mechanism is that it increases the pressure of the water in little gaps between the rock in the surrounding area and that reduces their strength.

Mr Muir: Can you just explain that in sort of lay terms for me please?

Dr McAlpine: Yes, I will try. Rock has – its load that the rock bears is borne by the solid particles in contact with each other but also partly by the fluid that is within the – between the gaps and so forth in the rock. One way of causing a rock to fail – weakening it – is to increase the pressure of the fluids within the rock. So it takes more of the load and less of the load is then borne by the rock locked together and that lessening of the pressure of the rock fabric weakens the overall structure of the rock. It's very, very much the mechanism of rock failure associated with well fracking in the oil industry.

Mr Muir: Thank you, I understand.

Dr McAlpine: So those would be great concerns for me with respect to the landslips – just the recognition that – and I guess generally in New Zealand there is movement towards describing landslips and faults as active, inactive, but now much more potentially active and starting to get a little bit more nuanced around what might cause them to – something that has been inactive for, you know, a number of thousands of years to then become active. So I think there is knowledge and current work going on within Earth Science New Zealand to refine our understanding of landslip risks – landscape risk as you would expect given the current social situation.

The other thing I wanted to mention is that at some point I'm going to have to bring up mining-induced seismicity and the effect of that is that we – getting to the bottom line is that mining of large quantities of – removal of very large quantities of rock and moving it to another place, even if that place is nearby, has the effect of lowering the gravitational loading that's been applied to the shallow crust underneath that big hole as it were. That reduction of the vertical load in Central Otago, which is under a compressional tectonic regime – as the eastern part of Otago pushed towards the Southern Alps it's under a by and large compressional regime. If you remove the load off the top to the crust, you can drive the shallow crust into rock failure mechanism and the rock fails and I must say usually in a non-catastrophic way with respect to the magnitude of the failure, the magnitude of the shaking intensity of the failure so that would be the magnitude of the earthquake as we usually hear about them – magnitude 3 or 2 or 5 or 6 – usually they're very minor with respect to the damage that they cause because of their magnitude, ie the shaking, but they can be very damaging because they occur right within or very close to the mine itself and you get varying disruptions.

Mr Muir: Are we primarily talking here about pit wall – potential damage within the pit?

Dr McAlpine: We are talking more actually about the surrounding region and into the deeper rock away from the pit wall itself. There is nothing - - -

Mr Muir: We're taking off load and we're adding load in another part of the site, aren't we?

Dr McAlpine: We are, and so we're creating actually an even more complicated situation because we're removing stress from one part and we're increasing stress in the other part and you get some very complex interactions between all of those. So what was previously a very stable environment for millions of years – well, that's not quite right – a stable environment since the last glaciation because the glaciers were lifted off as they melted and created a big change in the earth's crust and a lot of earthquake activity is – dates back to that period when the ice was removed and - - -

Mr Muir: And the load came off.

Dr McAlpine: - - - the load came off and the earthquakes happened. This is very lay and simplistic. Please don't – and when I say "please don't", I meant please don't take me to court for saying anything misleading. It's just a great simplification. The – so we're now going to disturb the site quite dramatically with taking off, you know, several hundred metres of rock from one place and moving it to another place and it can be very, very strongly concluded by looking at end logs that that will cause induced seismic effects. It's very, very common in Australia and Canada and other places which have compressive tectonic regimes and it – the consequence in terms of Shepherd's TSF, to answer your question, or answer my own question, is that the ground ruptures and ground fracturing and so forth can be very pervasive. So whereas in the geo – in ground water discussions that we've been having, there is probably inadequate consideration of the nature in which the foundation rocks for the TSF – the foundation for the – yes, the foundation rock – will be changing as a result of mining-induced seismicity fracturing of the schist. And that has profound implications for complicating our understanding of where seepage will go.

Mr Muir: So that's really – the principal risk we're dealing with – this seismic – this mining-induced seismicity – this change in the load in various parts of the site is unlikely to be a mechanism for I think you said catastrophic failure.

Dr McAlpine: Catastrophic in terms of lots of action and instantaneous impact. Catastrophic won't be catastrophic in terms of the slow insidious dawning on us that the tailings storage facility doesn't have the integrity.

Mr Muir: Through flow paths?

Dr McAlpine: Through flow paths and so forth, yes.

Mr Muir: Thank you. Does that conclude what you wanted to say?

Mr Mulliner: I have a short question on that Dr McAlpine. Is the Macraes gold mine, is that a suitable proxy to understand some of these effects that may occur?

Dr McAlpine: Well, the answer to that is yes and in just talking about mining-induced seismicity in a broader context than just the point – the tailings storage facility – I just key point my initial evidence is that a recommendation that came up from joint conferencing was that there is certain work that's identified in – by Peter O'Bryan & Associates that is recommending further work to look at assessing induced seismicity risks and we went on to – I went on to point out that that work is essential to benchmark and there's some – that the modelling results against Macraes and make sure that any modelling that's done for Bendigo fully incorporates the learnings and the information that's available from Macraes.

Mr Mulliner: Thank you.

Mr Muir: Either Dr Matuschka or Mr Torvelainen, a response please on mining-induced seismicity.

Dr Matuschka: Yes, I think it's very much a second or third order effect if it occurs at all. I mean there is – it is possible for micro seismicity to occur with mining and Mr O'Bryan is probably – could pass some comment on that as well, but we're talking about extremely low magnitude earthquakes and the effects at the TSF which is 1,000 metres away or more which in my experience would be negligible. And so I don't think the glaciation and release of stress is a major source of earthquakes in New Zealand that – major earthquakes in New Zealand are due to the interaction between the tectonic plates – the Pacific and Australia plates – that's what drives the tectonic stresses and results in earthquakes. I think the resulting stress relief from glaciers melting could have some – generated some very small seismicity but [inaudible 02:05:30 - coughing] significance. That's I think is a side point. But I just – I've been involved in the Macraes project since 1989 and I am unaware of any seismicity effects due to mining having any impact on the site. I mean, there's stress relief from mining which can result in some pit wall instability but I'm unaware of any earthquakes that have been generated by that.

Mr Muir: What about in the context of this fractured schist environment on potential flow paths?

Dr Matuschka: Well, I can understand that within the proximity of the pit wall where the mining is taking place, there's possibilities – definite possibility of fracture and flow paths developing due to the explosions – the blasting will locally loosen the rock and create higher permeability, but I just don't think it's physically possible for that effect that there be those effects to extend to the TSF which is, as I say, about a kilometre away. There would have to be some major discontinuity, some low-angle, very weak continuous [inaudible 02:07:11 - coughing] I think to allow movement to extend and then I doubt that it could extend that far to have any material impact on the hydraulic conductivity of the foundations.

Mr Muir: Thank you very much.

Dr Matuschka: I've got a comment on the landslides as well, if that's okay?

Mr Muir: Yes.

Dr Matuschka: I acknowledge Dr McAlpine's comments that the presence of the tailings will result in an increase in fall pressure in the ground below the level of the tailings and we understand that. And that will increase the fall pressures in the lower part of the valley sides. It's also partially offset though by the buttressing effect of the tailings that are stored there. They provide a lateral force to resist and provide buttress to the slope. But we're intending to adopt essentially a performance-based design approach and that will include monitoring of the deformation of landslides and measurement of ground water levels and that will provide a trigger for the need for any mitigation measures such as drainage in the slope to stabilise it.

Mr Barry: Could I just go back to the seismic risk for one last time because it is such an important issue and Mr Matuschka, you noted I think that there is an active fault around 12 kilometres away. I guess the experience and learnings of Canterbury in February 2011 – one of them is that there can be active faults where we don't know it. Faults that don't meet the GNS definition of one in 250,000 years surface rupture. But what would be the consequence if there was a hidden fault, you know, even closer than 12 kilometres?

Dr Matuschka: Well, there would be a higher – potentially a higher level of shaking but in terms of the safety to the TSF, I don't think that would be impacted, particularly taking into consideration of the presence of the ELF.

Mr Barry: Because it's in this valley effectively?

Dr Matuschka: Well, just the sheer volume and weight of material downstream of the dam and it's essentially a rockfall structure – both the ELF and the downstream shoulder of the TSF embankment, and rockfall embankments have been subjected to extremely high levels of ground shaking worldwide – they're probably one of the best performing types of dams you can have in very strong earthquake shaking. So – and the other thing is, you're talking about the Canterbury situation. The situation there was there were – the faults were buried below hundreds of metres of gravel and so – and that's one of the reasons why they were unknown. In the near vicinity of this site, that's not the case. There is valley downstream but as far as I'm aware there's – no faults have been identified in that area.

Mr Torvelainen: I'd like to make a comment. Mr Torvelainen. So in terms of the seismic hazard modelling, the potential for unidentified faults is included in the probabilistic modelling. So that chance in terms of a shaking level is countered. The potential for a fault displacement in the facility is considered in terms of looking at the geomorphology and identifying any features that would indicate active faults. There has been none identified. If there was to be displacement on the TSF embankment, for example, it could crack some zones of the embankment. But the drainage network that would be there would perform and it has redundancy in it. There's multiple drains and so the seepage – you could expect that the seepage might increase a bit. But that seepage would still be able to be effectively collected. The risk to the TSF stability is protected by the buttressing and also the dam itself would – without buttressing would be stable as well.

Mr Muir: Any other questions from the Panel? I'm going to try and close this topic off before we break for morning tea so if I could move to cross-examination.

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: Thank you sir.

Mr Muir: Thank you Ms Gepp.

Ms Gepp: Dr Matuschka, I'm going to ask you some questions about the GISTM requirements around multi-criteria analysis and also engagement with project affected people. So first of all, looking at requirement 1.3 of GISTM to demonstrate that project affected people are meaningfully engaged throughout the tailings facility lifecycle and building a knowledge base and in decisions that may have a bearing on public safety and the integrity of the tailings facility, that hasn't happened has it?

Dr Matuschka: There has been public consultation under the RMA but I'm not involved in that process so it's better probably directed to the applicant. But as far as I'm aware, there has been community engagement – I don't know the details of that.

Ms Gepp: Okay. [Inaudible 02:13:59] that there hasn't been public consultation under the RMA but that's not something that you can comment on?

Dr Matuschka: No, that's not something I can comment on.

Ms Gepp: At the Cromwell hearing, were you listening in to the Cromwell hearing?

Dr Matuschka: No.

Ms Gepp: Okay. Because we had a number of neighbours who said they hadn't heard from MGL at all and at the conclusion of that hearing, counsel for MGL said that it was very committed to ongoing engagement with neighbours and that that would continue. Have you had any input from neighbours into the tailings storage facility design or concepts since then?

Dr Matuschka: No.

Ms Gepp: No. Are you aware of whether that discussion's happened?

Dr Matuschka: No.

Ms Gepp: Thank you. Requirement 2.1 is to develop and document knowledge about the social, environmental and local economic context of the tailings facility. Are you aware that there's a social impact assessment that's been prepared but hasn't been presented by MGL?

Dr Matuschka: No, but I think social and economic factors are considered.

Ms Gepp: By who?

Dr Matuschka: The applicant.

Ms Gepp: In terms of you assessing the tailings storage facility, it hasn't been considered, has it?

Dr Matuschka: When we do our dam breach analyses and assess the consequence category, yes, we have to consider impacts on the environment, population at risk, infrastructure, cultural – historical and cultural sites. So it's – they are factors that are considered in arriving at the consequence classification for a dam.

Ms Gepp: The social context goes beyond just the downstream population though, doesn't it?

Dr Matuschka: Yes it would.

Ms Gepp: Now you've accepted that there's no documentation of your consideration of options, but – and that's in the first joint witness statement at paragraph 15, and you've noted that there is an express requirement in the GISTM to use the knowledge base and undertake a multi-criteria analysis of alternative feasible sites, technologies and strategies for tailings management, with two objectives. And then in your RFI4 response on 3 June, you have a high-level description of alternative tailings management options, haven't you? That's a fair description?

Dr Matuschka: Of disposal site options, yes. And options for tailings disposal, yes.

Ms Gepp: No landscape, ecological or heritage advice has informed the decision to adopt the tailings storage facility as the option that you've chosen?

Dr Matuschka: I'm not exactly sure on that, whether those were factors that were taken account of in deciding between the Rise and Shine and Shrek.

Ms Gepp: Right. So I asked the applicant's landscape, ecological and heritage consultants when they gave evidence whether they had had any input into that process and they also said that they hadn't. So you take it from me that they haven't?

Dr Matuschka: Yes.

Ms Gepp: One of your criticisms, or one of the reasons you say that you haven't recommended, to the extent you've considered it, but you haven't recommended filtered tailings is because they provide no significant benefit for the long-term security of tailings and containment of seepage at the BOGP. But I put it to you that that goes against prevailing best practice and industry-leading standards of increasingly adopting this form of tailings management.

Dr Matuschka: I think you need to understand that this type of practice – filtered tailings – is – only represents a very small fraction of the way in which tailings are currently disposed of. It does have some advantages but I would say the advantages for this particular site are not significant. They offer no benefit in terms of the security of the tailings. They offer some small benefit in that the mountain seepage that would come out of the tailings would be a little bit lower.

Ms Gepp: Is one significant benefit that you wouldn't have a very large facility sitting in an area that has – taking up a footprint in an area that has very high ecological values?

Dr Matuschka: Repeat that please.

Ms Gepp: So looking at the site footprint, there's the pits and there's some haul roads and then there's a very large proportion of the site that's taken up by the tailings storage facility and the EFLF. So a different option such as putting the tailings – either disposing of filtered tailings off-site or using some backfilling methodology would reduce that footprint, wouldn't it?

Dr Matuschka: Yes, it could be possible to reduce the footprint a little bit. I guess you'd have to weigh that up against the impacts of storing the tailings elsewhere. This is a very secure site in terms of the long-term containment safety of the storage for the tailings is that there'd be the option that's been selected. If there was an off-site option for example using filtered tailings, it would have to be normally on a fairly level site which is probably going to be alluvial ground which is going to be more susceptible to damage under an earthquake and greater risk of seepage – of containing the seepage.

Ms Gepp: All of that is very much supposition though, isn't it? We don't have an analysis to discount that as an option?

Dr Matuschka: Well, there was a site looked at downslope – downstream in the valley.

Mr Torvelainen: I can comment also. Mr Torvelainen. So if you just look at the layout of the site and where the rocks placed for the Shepherd's ELF and that fills Jean Creek – that effectively fills the whole of Jean Creek and also extends into Shepherd's Creek and then you consider that the tailings themselves are all within Shepherd's Creek, the constrained nature of this site means that even if you went to filtered tailings, you would still effectively be filling those valleys and so it's not offering you a notable benefit to get out of it a particular area. You're effectively in that environment no matter what you choose, unless you go offsite which then raises the issues that Dr Matuschka talks to which is going onto alluvials which is – that's a much bigger problem. And we specifically looked at, with the applicant, going out onto the alluvials and we recommended not to do that. That has much higher risks in terms of ground water.

Ms Gepp: We don't have that analysis do we?

Mr Torvelainen: No you don't.

Ms Gepp: So I can't interrogate that and see that that is what it says or what was considered, can I?

Mr Torvelainen: No, I'm just telling you what I know.

Ms Gepp: Dr Matuschka, you refer to recent failures of filtered tailings but those failings are very rare, compared to failings of conventional wet slurry tailings storage, aren't they?

Dr Matuschka: I think you've got to – it depends what type of wet tailings storage facilities you're talking about. I mean, most of the – or many of the failures with wet tailings slurry are associated with upstream construction. There have been very few failures of downstream constructed tailings dams.

Ms Gepp: So I was actually asking you about the fact that the - - -

Dr Matuschka: The recent failures of filtered tailings.

Ms Gepp: - - - the recent failures that you referred to.

Dr Matuschka: I think that just highlighted the concerns and risks associated with that type of construction that people have been talking about for some time and had been waiting to occur because the – that does rely on the tailings being properly filtered to a particularly – to an adequately low water content and also to the materials being placed in thin lifts and compacted to a high density so they're susceptible to strength loss.

Ms Gepp: Yeah, so it has to be done properly?

Dr Matuschka: It has to be done properly but you've got to take into account the real world and what can happen and these three recent failures I think are just demonstrating the risks that can be associated with that technology. A lot of people have been saying that it's a technology that's foolproof but it's not.

Ms Gepp: So you didn't give any – you didn't specify what the recent failures were that you were referring to. You've now referred to three recent failures.

Dr Matuschka: Yes.

Ms Gepp: Can you – can you say – tell me what those are?

Dr Matuschka: They were – two of them were in Indonesia and where the – I think it was with nickel mining. It may not be nickel mining, sorry. But yeah, they were – it was a reasonably wet environment and the detailed study or report on the cause of the failures has not been released but it's – it's been surmised that it was due to the material being placed not in accordance with specifications.

Ms Gepp: So it was an implementation failure?

Dr Matuschka: Yes.

Ms Gepp: So that was two in Indonesia. What was the other one?

Dr Matuschka: I think that was in Europe somewhere. I'm not aware of the details of that.

Ms Gepp: It wasn't the Tourmalina mine in Brazil in December 2024 that you're thinking of?

Dr Matuschka: I'm not – no – that might be another one.

Ms Gepp: You don't actually know much about these recent failures?

Dr Matuschka: They've been very recent and there hasn't been any detailed studies published on them.

Ms Gepp: Professor Emmerman has published on the Indonesian – the Indonesian examples that you – you're not aware of his report?

Dr Matuschka: No.

Ms Gepp: Right. And I put it to you that in terms of the code of conduct for expert witnesses which you've said you've complied with, you have put out information about the risk of these failures but you haven't provided the data that you're relying on and having asked you these questions, it's clear that you don't actually have an evidentiary foundation for the statement that you made there.

Dr Matuschka: Well, I think it's more than just those examples, and I could provide more detail if you wish. But there has been concerns raised for some time in the industry about the potential risks with filtered tailings. It has been an industry concern that the risks associated with filtered tailings if they weren't constructed in accordance with the specifications, and also concerns with large filter stacks where the loads from the great depths of material can result in material or a weakening of the material and make them more susceptible to failure.

Ms Gepp: The approach that has been proposed for this project, if that's not done in accordance with specifications, there's also going to be risks isn't there?

Dr Matuschka: Yes, but I think the risks are much lower.

Ms Gepp: We could expect if this entity were to adopt a filtered tailings approach that they would do it properly, couldn't we?

Dr Matuschka: Yes, I would expect so.

Ms Gepp: Thank you. Last one is that principle 8 of the GISTM is to establish policies, systems and accountabilities to support the safety and integrity in tailings facility and that applies in the long-term. At the moment we don't have a clear understanding of who would be taking responsibility for this tailings storage facility in the long-term, do we?

Dr Matuschka: You mean in post-closure?

Ms Gepp: Yes.

Dr Matuschka: No, I am not aware of the details for that at this point.

Ms Gepp: Thank you.

Mr Muir: Mr Enright?

CROSS-EXAMINATION BY MR ENRIGHT:

Mr Enright: Thank you sir. Dr Matuschka, Ms Gepp just referred earlier to the 054 response dated 3 June 2026. I'm not sure if you have a copy to hand but I can read out to you the relevant paragraph. It's again just paragraph 108 where it says "In terms of options assessed for new tailings qualities, GISTM recognises that multi-criteria alternatives [inaudible 02:27:26] of feasible sites, technologies and tailings management." Then the key sentence, "consideration of alternatives were undertaken but [inaudible 02:27:32 – paper shuffling]. I just wanted to understand why it hasn't been formally reported?

Dr Matuschka: Just time pressure.

Mr Enright: Right. So do we infer there are written reports you've provided to your client, the applicant, that haven't made their way into the records?

Dr Matuschka: The work was done but it was not formally reported.

Mr Enright: Right. And do you agree that's pretty unsatisfactory here because the issue we're dealing with here is a potentially significant adverse effect to the environment?

Dr Matuschka: I disagree because the option that's been selected has extremely low risk of adverse effect on the environment.

Mr Enright: But the whole point of an options analysis is to do a scoring assessment of other options which have pros and cons. You accept that in principle?

Dr Matuschka: I accept that in principle.

Mr Enright: And of course some of the cons might be in areas other than your expertise such as landscape or ecology or water management?

Dr Matuschka: Yes. I mean my focus is on dam safety.

Mr Enright: Yeah, and so that would be a pros and cons approach or – they call it MCA – multi-criteria – it's multi-faceted, it's not limited to dam safety. For example, it covers ecology, landscape, other factors, doesn't it?

Dr Matuschka: It can do, yes.

Mr Enright: That's the standard practice as I understand it, correct?

Dr Matuschka: Yeah.

Mr Enright: So the – maybe the purpose of me being here is there is an overlap between yesterday, as the Chair mentioned, yesterday's session and today and one of the issues around of uncaptured seepage from the open pits TSF and engineered landforms and the potential transport of contaminants in the underlying fractured schist, and I just wanted to explore with you the extent to which alternatives have been considered to mitigate that contamination risk. And two in particular – the first being use of liners and whether that would be one method you would recommend to manage seepage, and the second around undergrounding. So we'll deal with the liner side of it first.

Dr Matuschka: Yeah. Liners are sometimes used for tailings storage facilities where the ground is permeable or there are no natural constraints on seepage containment. In this particular site, the permeabilities of the foundations are quite low and when you take into account the consolidation characteristics of the tailings, and the amount of seepage that can come out, really a liner doesn't provide any significant advantage.

Mr Enright: Okay. So is that – in answering that question, are you relying on certain assumptions around ground water movement that would be perhaps outside your expertise?

Dr Matuschka: I do have some knowledge of ground water. I've been involved in lots of tailings dams design over the years and ground water is a subject – for a geotechnical engineer is quite important to understand and the ground water levels in the hills surrounding the TSF are elevated above that of the level of the tailings.

Mr Enright: So do you agree that to have certainty on the efficacy of liners, we would need to characterise ground water on site or is that not necessary?

Dr Matuschka: Well, we've done tests on the permeability of the ground. In this particular case, any seepage that does – or seepage that will really release from the TSF is going to be constrained down the valley and it can be picked up.

Mr Enright: Okay, but otherwise you presumably rely on the ground water experts to provide further detail on that risk side of the equation?

Dr Matuschka: Yes, they have some involvement in that. Yes, we normally would work in conjunction with the ground water consultants.

Mr Enright: Okay. And so the other glaring question if I may put it that way is whether you were – you have assessed the option of undergrounding rather than having pit lining – whether that was looked at as an option?

Dr Matuschka: No, I had no involvement in that.

Mr Torvelainen: I just note that there is paste backfill of the underground - - -

Mr Muir: Shaft?

Mr Torvelainen: Yes, the underground shaft.

Mr Enright: Sorry, can you just repeat that.

Mr Torvelainen: There is tailings used in the form of a paste proposed to be used as backfill of the – not the main drives but of the mine rooms, you know, there is backfill proposed.

Mr Enright: Yes, thank you. So just returning to the answer, Dr Matuschka, so you weren't asked and didn't look at whether undergrounding was an option as distinct from the pit, for example?

Dr Matuschka: Not as a main option, no.

Mr Enright: Yep, alright. And Commissioner Kensington asked some questions around pit filling and whether that was feasible. And I just wanted to understand whether the answer given – it sounded like "it's not really a question of the cost but more a question of the pragmatic double-handling sort of aspect". Is that fair? And it may be that Mr Torvelainen might be the better answerer of that.

Mr Torvelainen: Yes, I highlighted two points. One is here's the practicality in terms of like the double-handling, but also in terms of safety. Like that's a major part – you can't put people's lives at risk in the mine.

Mr Enright: Indeed. So just because the international standard – what is it – GISM – doesn't factor in cost, but I just wanted to be clear that the cost aspect isn't a material issue here but obviously safety is critical.

Mr Torvelainen: Well, I think that double-handling of all the material back into the pit, including the tailings, is a material consideration in terms of the feasibility of the site fundamentally.

Mr Enright: And one point that you did make, Mr Torvelainen, on the SRX pit, again answering questions from Commissioner Kensington, was simply filling the pit was – using waste rock from the ELF was not what the applicant has asked for in your own words, correct?

Mr Torvelainen: Yes, correct, and I just – I note that, you know, that's what was proposed but I also note that I can see that there is, for that particular pit, that there could be a practical, you know, situation where material was hauled from another pit so [inaudible 02:35:14] pit and it's put in there to sort of profile the pit, but I note that the final closure outcome and what's required there, you know, that in my mind would be what would drive that decision. So I can't comment on that because I'm not a landscape expert.

Mr Enright: Yeah, sure.

Mr Torvelainen: We're talking about the practicalities of hauling - - -

Mr Enright: We are. But it's just another example where it seems that what I think Dr Baber called optioneering yesterday where essentially you've relied on the client brief for certain fundamental aspects including, for example, the decision not to fill the SRX pit. That's fair, isn't it?

Mr Torvelainen: Sure, we can't make decisions for the client on what they ultimately want to put forward.

Mr Enright: Thank you. Thank you sir.

Mr Muir: Thank you. Mr Randal, did you have any questions?

Mr Randal: No, thank you.

Mr Muir: Mr Leckie?

CROSS-EXAMINATION BY MR LECKIE:

Mr Leckie: Yes, thank you sir. Just one line of questions for Professor Lottermoser who's on the screen.

Mr Muir: Yes, Professor Lottermoser. Are you there, yes, thank you.

Mr Leckie: Thank you Professor Lottermoser. I just have a line of questions for you in relation to the GISM. Would you agree that the preamble to the GISM specifically states that conformance with the standard does not displace the requirements of any national, state or local government statutes, laws, regulations, ordinances or other government directives?

Prof Lottermoser: Yeah, absolutely. It's not written into law.

Mr Leckie: And you'd agree in the case of this proposal that some key relevant laws would be the Fast Track Approvals Act, the Building Act and also the New Zealand Dam Safety Guidelines?

Prof Lottermoser: I'm not a lawyer. I assume it is.

Mr Leckie: And you may have answered my third question already with your response there, just to confirm you haven't assessed those three statutes that I read out within your evidence, have you? Your evidence is focused on that international standard, is that right?

Prof Lottermoser: That's right.

Mr Leckie: Thank you Professor Lottermoser. That's all.

Mr Muir: Thank you. Are there any questions arising out of the cross-examination from the Panel? No, thank you. Well then, we will take our break now just for quarter of an hour and then we will run through to quarter past one on the next topic which we have in part obviously covered – so we will probably focus on the excessive production of waste rock.

Ms Gepp: Just, sir, do you think – Professor Lottermoser are you going to sign off now?

Prof Lottermoser: Yeah, I just sent an email to you Sally. I do sign off now. It's 2am and the brain is saying goodbye.

Ms Gepp: Thank you very much Professor Lottermoser.

Mr Muir: Yes, and thank you from the Panel Professor Lottermoser for making yourself available at such an ungodly hour.

Prof Emmerman: I'm sorry. I couldn't hear what time we reconvene.

Mr Muir: We're going to reconvene in 15 minutes.

Prof Emmerman: Okay, thank you.

Morning adjourment

TOPIC 2: CHOICE OF MINING METHOD

Mr Muir: As I say, we have touched on some aspects of this already and Dr Matuschka your position is that essentially you were not asked to consider a radically different mining method to the extent of an all underground workings model for the mine. So you may be only able to give limited input on this. But this is an issue which is prominent in the positions taken by the experts called for the section 53 parties and so I'm going to go to them first about this. Mr Pizey, did you wish to comment on this issue?

Mr Pizey: Sorry, sir, finding the unmute button. No, I have nothing further to say about the mining method. The [inaudible 00:11:25] body is as is and the method proposed seems a sensible one.

Mr Muir: Very good. Professor Emmerman?

Prof Emmerman: Yes, thank you. So anyway, one of the disadvantages of open pit mining is the production of waste rock. Typical for open pit gold mines is the stripping ratio of 4.2. It's 4.2 x the waste rock for every ton of ore and it's closer to 0.51 for underground mining. When I first looked at this proposal, what really shocked me was the quantity of waste rock that was being produced. I calculated a stripping ratio of 15.2 and I've never seen an open pit mine with such a high stripping ratio. So we have various problems when you have such an excessive production of waste rock.

The first is you have excessive fuel consumption for all the fuel you need to excavate and haul and place that waste rock. Along with that you have excessive greenhouse gas emissions. You have excessive risk of mining-induced seismicity for the release of so much overburden pressure which Dr McAlpine talked about. You have excessive alienation of land from any future beneficial purpose. You also have excessive risk of surface water and ground water contamination. And left me asking why, why are we doing this? Why are we doing open pit mining here instead of underground mining or some other mining method? And I'm assuming that the company has done their economic analysis and they've decided yes, they can still make a profit, even with such a large amount of fuel consumption. But fuel consumption is just one factor that affects the mining company. There's other factors that affect all of society and that's the greenhouse gas emissions, the risk of mining-induced seismicity, the surface water and ground water contamination, the alienation of land from any beneficial purpose and that's what I would be asking if I were on the Panel. It's like why are we even doing this? Why are we creating these huge open pits with such a huge generation of waste rock? Where's the study that explains why underground mining is not feasible. And by not feasible, I'm not just talking about the balance sheet of the company. I'm talking about the benefits to society and the risk to society of the production of so much waste rock. I'll leave it at that.

Mr Muir: Thank you. Dr McAlpine, did you wish to add to this.

Dr McAlpine: I'll just add – I've already mentioned about concerns with induced seismicity. As a sort of general observation, the nature of the gold deposit at Bendigo, as is the case in Macraes and it will be for all future mines along that geological trend because it's basically one feature, is that it's a very finely disseminated zone of rock in one narrow plain – fault plain. And I can understand that that would offer some advantages for underground mining in as much as you're conducting everything pretty much on one plain in the underground and certainly offers a lot of disadvantages with respect to this point about how much rock – if you dig from the surface, how much non-ore material do you have dig through to get through to the rock.

Mr Muir: Ore-bearing material, yes.

Dr McAlpine: So I – but I do strongly believe that, and I've edited my initial statement, that the balance between those two extremes – going undermine exclusively and going surface as far as you can and then going undermine – is a balancing exercise that I would have expected to have been done at the pre-feasibility study. It seems as though we're making a decision on a mine that has had essentially one concept design. Clearly it's the most – I say clearly, intuitively it is the most economic to the company because you get – you're straight into pay dirt, you know, first shovel dig you're starting to get ore, and indeed in the mining conditions for the Bendigo mine there is a requirement under the mining permit to produce at about 75 per cent – I think it is – of maximum capacity within the first year – the first year of operation. So that would not be feasible through underground mining where you'll have a slower return on investment than [inaudible 00:17:27] or sustained. So there's economic reasons why you would go open pit – maximise open pit. That's what you'd certainly do in an environment that was of – if it was not of outstanding natural beauty and many of these very large open pits exist around the world in places where the environment is not too high on the natural beauty list, or that the country does not have too high value on the value – the value of the environment and so forth. So intuitively I think that I would have expected to have seen a balance between those before we got to this point. To be taking decisions on a project of such magnitude and importance both for the benefits that it offers New Zealand, which are overwhelming in terms of revenues and [inaudible 00:18:33] and so forth, they're quite overwhelming, but also overwhelming are the deleterious effects on the environment and the landscape and so forth. So I'm disappointed that we're this far in the process where the applicant has not provided evidence of some of those balance tests – look at the extremes between have we got the balance right. If this was a national park and so forth, the proposal would be for an underground mine essentially to comply with the restrictions. So I think whilst this area is not an underground mine, it is nevertheless an area of outstanding importance to us.

Mr Muir: You appreciate, Dr McAlpine, that the way in which the applicant's case has been brought – my apologies [phone ringing] – my shout later. Having left my phone in Cromwell, I was forced to buy a new iPhone 16 which I don't know how to turn off yet. I'm going to give it to Commissioner Sweetman and she will [inaudible 00:20:04]. Of course whether I can use the phone hereafter is probably not until tomorrow morning when she unlocks it again.

??: Can I suggest that's too much information.

Mr Muir: You can see it's a very technically challenged chair. Anyway, thank you very much. The point before I was so rudely interrupted by my own phone was that the way in which the application had been brought, we don't even have a sense of how technically realistic any alternative mining mechanism is on this site. And probably neither do you.

Dr McAlpine: Possibly a bit of an idea, but – and I'm not really wanting to blame any process and so forth through here, it's just a case of we need, I believe, to be faced with – is this, if we're locked into approving this design concept fundamentally, then we are. And then we have also to go through huge exercise of then saying, okay, how can we mitigate against this massive impacts on the environment through controls and the conditions and so forth which – many of which may well be impossible given particularly the uncertainty around ground water movement control and induced seismicity. My particular subject that I've been studying for several years now in Central Otago, just makes that even more imponderable risk. So there's a balance between minimising the amount of storage waste rock, of minimising the construction of tailings storage facilities and minimising the footprint to both ecological or geotechnical issues.

Mr Muir: And in so doing, also reducing the opportunity probably to buttress at least to the extent possible – currently possible – the TSF? I mean it's still going to be producing a broadly equivalent amount of ore theoretically and you're going to have a broadly equivalent slurry or some alternative which must be contained somewhere. And, yes, the TSF is designed to dam safety guidelines but it's also additionally buttressed by this enormous engineered landfill which would not be possible on that scenario.

Dr McAlpine: No, [inaudible 00:23:46] mitigated by, and here I do have to put the caveat this is outside my – what I say is my specific engineering expertise, but in terms of in an underground mining situation, you basically end up taking out as much rock and having waste rock and tailings which is equal value of what equal volume of what you have created in terms of the holes underneath. So there are, I believe, solutions where mining can be backfilled as it goes so you put back what you have taken out. Interestingly, you earlier talked about cement in terms of slurry and you weren't off the mark there. It's not unknown – it's not even uncommon that tailings are dosed with cement and become solid rock for filling up buoys. And again, this would be something that would weigh favourably in the ledger for minimising [inaudible 00:25:04]. I think you'd actually reinforce the mine as you go. Again, I stress that I don't have sufficient engineering expertise to know whether the economics of that – how that all works out and so forth but I do have sufficient geotechnical understanding to know that that would be a – would so dramatically reduce the environmental deleterious harms and so forth – the footprint – the fact that you've got toxic materials that are in liquid form or in slurry form [inaudible 00:25:37]. So the problem – I can't comment on the problem that we have with the process and where we are at the moment but I really just wanted to really underline the concern that we do not appear to be discussing a concept that is yet sufficiently mature to say yes, we've gone through, looked at all these options and said this one looks the more [inaudible 00:26:13]. Sorry for - - -

Mr Muir: No, no, we understand where you're coming from.

Ms Sweetman: Just to confirm that's your point 14 in the first JWS, is that right?

Dr McAlpine: It will be somewhere there. 14 did you say?

Ms Sweetman: Yes.

Dr McAlpine: Yes. And I would also draw your attention to perhaps statement 36 in the joint witness statement. We had some discussion around this in respect of minimising deleterious effects from induced seismicity, and there were – myself and Steven Emmerman and Mr O'Bryan were of the view that the work described in Peter O'Bryan's own review recommending further geotechnical modelling of the risks of induced seismicity should be undertaken, in fact needs to be undertaken, before you really understand very much about how the ground is going to respond once mining operations get underway.

Ms Sweetman: Is that work something that needs to happen now or is it possible that that occur through conditions prior to construction commencing, should we grant consent?

Dr McAlpine: I wish you hadn't asked that last point. It doesn't make sense to defer it because the potential impacts of mining-induced seismicity are so great that to try and address it in the consents or limitations is really just putting ambulances at the bottom of a cliff. You really need to know whether this is anywhere near the right option in terms of balance of open cast versus underground mining.

Mr Muir: Dr Matuschka's position is this is the third or fourth order concern here. Certainly stability of the TSF is concerned – the idea of seismic induced – of mining seismicity having an effect on the TSF a kilometre away and the nature of its construction is really – it's more theoretical than real. And there's quite sharp divergence of opinion seemingly between you on that?

Dr McAlpine: The – I think it's more a difference in understanding what might categorise as mining-induced seismicity versus the sort of rock failure that occurs naturally just as a result of gravity, [inaudible 00:29:48].

Mr Muir: I think that was acknowledged by Dr Matuschka. Certainly within the pit.

Dr McAlpine: Yes, and that the – if I may – in the absence of Dr Johnson or is it Duncan – sorry - - -

Mr Muir: Yes, Mr Johnson, yes.

Dr McAlpine: Johnson – may I – I have prepared a few slides to illustrate – because I'm a very pictorial person – exactly what I'm talking about with respect to mining-induced seismicity and what the nature of the hazards are because in some of the Panel questions and some of the Panel's submissions there has been a confusion between [inaudible 00:30:45] blasting effects which might disturb heritage sites and so forth and earthquake shaking – factors of safety which is something else and something – and then the other effects from induced seismicity which is, I've tried to stress, it's nothing to do with the shaking, it's almost entirely to do with the ground movement and particularly the fracturing of the schist rock. So would it be alright if I - - -

Mr Muir: What vehicle do we use to do that?

Dr McAlpine: Well, I do have the possibility to put that on the screen and talk through some slides which I had in reserve in case we needed to go here. But I think we do need to go here.

Mr Muir: Right, well I'll just confer with the Panel about whether we do so.

[Panel discussion]

Mr Muir: Dr McAlpine, I'm just going to hold this in reserve at the moment. I'm a little concerned about time and we want to have available the opportunity to come back to this at the end of the day if we have got sufficient time to do so. And before doing so, I want to have some input from the applicants about the utility of it before we make a final decision. But for the moment, can we just defer it to see how we go? Yes.

Ms Sweetman: Have you covered this topic in your evidence with comments, Dr McAlpine?

Dr McAlpine: In terms of the background I have. In terms of specifically moving forwards to address benchmarking and what work would need to be done to – in Bendigo, I have not because I refer to a couple of reports that weren't available at the time I wrote my report, one of which was uncovered by the Panel under an RFI which was to go back and find the report – draft report on the pre-feasibility study performed by a consultant that was not part of the substantial application package. And the other was a report which I then realised was produced by the same company – a report on their assessment and it's in the open file domain on - looked back on some of the ground failure occurrences at the Macraes mine. So it's almost like a portal into the nature of the ground disturbances that have occurred in mining in a similar situation, albeit it's actually in a less tectonically stressed situation. I will say I have reservations because it's relating to – despite it being open file information – it is looking at another company, and a competing company you could argue, work but it is – all the work is in the public domain. Whether it's appropriate in this form to show that I would defer to your - - -

Mr Muir: Your concern is probably a little different to that. I mean, we're at a relatively refined part of the evidence-gathering now and I think that Commissioner Sweetman's concern is that this is effectively introducing new material which hasn't really been processed through the earlier stages of refinement. It's material that's not been the subject of specific discussion at the conferencing and which could take – and which may not be able to be responded to today by the applicant's experts, which means that we open up – in the context of a process which has to continue moving forward – we open up another whole evidential opportunity.

Ms Sweetman: Just coming back. You were wanting to explain the difference to us of the three different things. And one of those was mining-induced seismicity and what that means.

Dr McAlpine: Yes.

Ms Sweetman: You have covered that off in your comments on the 4th of April 2026 so we can just reference that.

Dr McAlpine: Yes.

Ms Sweetman: And you have included some pretty pictures in that for us to look at.

Dr McAlpine: That's right.

Ms Sweetman: So we can come back and have a look at that anyway.

Dr McAlpine: And just my last comment if I may. I really raise that this relates to information that probably Mr Johnson himself requested through an RFI which has come relatively late to the process and by Dr Johnson listening to this conversation, he will probably be in a very good position to understand the points I'm making.

Ms Sweetman: We'll make sure that he watches it and we'll see where we go to when we receive comments from him.

Dr McAlpine: Thank you.

Ms Sweetman: Thank you.

Mr Muir: Mr Macdiarmid, you didn't have any particular input on this subject did you?

Mr Macdiarmid: No I don't.

Mr Muir: No, thank you. Right. Well, then I come back to Dr Matuschka and Mr Torvelainen and conscious of the caveats that you've already sounded, is there anything that you wish to discuss with us on this subject?

Mr Torvelainen: No, I don't have anything further.

Mr Muir: And Dr Matuschka?

Dr Matuschka: The only comment and I've made it before was that the production of excess waste from the pit is a good thing in terms of the stability of the tailings storage facility.

Mr Muir: Yes, that's a point that I made. Right, okay. Thank you. Cross-examination on this topic?

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: Just one or two questions sir.

Mr Muir: Yes.

Ms Gepp: Just – I'm not sure which of you it's best to – I'll just ask both of you if that's alright and whoever's the best person to answer can answer that. We heard from Dr Weber yesterday that 60 to 80 per cent of the contaminant load from this project will come from the waste rock. So it must follow that selection of the method that generates less waste rock is going to give us a lower contaminant load, isn't it?

Mr Torvelainen: Yes, I think that's logical.

Ms Gepp: Okay, thank you.

Mr Muir: Thank you. Mr Randal. No, thank you. And I'm sorry, Ms Buxeda, I should check in with you always. I'm sorry, I forgot. You just – please if you wish to interject yourself into the proceedings, would you just tell me, thank you.

Ms Buxeda: Thank you very much Mr Chair. I have no cross-examination. I'm very happy with that proposal. Thank you.

Mr Muir: Thank you very much Ms Buxeda.

??: I think Dr Weber's got - - -

Mr Muir: Yes, alright. Thank you Dr Weber.

Dr Weber: Thank you. Just a clarification Commissioners. 60 to 80 per cent of the load comes from a traditional waste rock dump. So [inaudible 00:39:37] any engineered landforms here so that will reduce that contribution.

Mr Muir: Yes. This is as a result of, you know, the factors that you've identified like the extent of the encapsulation and all of these sorts of things?

Dr Weber: Yes.

TOPIC 3: SLOPE DESIGN

Mr Muir: Thank you. Okay. Topic Number 3. Slope designs. I imagine from that we're talking about slope designs both of the engineered landforms and of the pits, is that right? Dr Matuschka?

Dr Matuschka: I believe that's the case. We've discussed the stability of the TSF and the landslides in the TSF.

Mr Muir: Right. Who would like to lead off for the applicant on that issue?

Mr Torvelainen: I can talk to the engineered landforms. So in terms of the slope stability for the engineered landforms, the landforms are fundamentally located on a rock foundation, provide an adequate foundation and the design approaches follow typical design methods in terms of characterising the strengths of the foundation and the rock and follow typical design factors of safety, and those are documented in the ELF management plan which are conditions and the – there's also a condition for slopes of one vertical to three horizontal for closure, which are not particularly steep slopes from a geotechnical perspective for rockfill and so overall I guess what I'm noting is that from an engineered landform perspective, the slope design approaches are, I believe, appropriate for this site.

Mr Muir: Against what benchmark? Were you talking here about slope design stability, are we talking about it in a landscape sense?

Mr Torvelainen: I'm assuming that we're talking about it in a geotechnical sense.

Mr Muir: Geotechnical, right.

Mr Torvelainen: Geotechnical perspective. I note though that we've had good discussions as a group on, you know, what constitutes a good closure design and that includes erosional stability as well. So – and the management of water on top of those slopes. And so, you know, as part of the final landform, it's important that the performance of slips [inaudible 00:42:30] confirm that they are appropriate. And so that's part of the processes that are set out in the engineered landform management plan.

Mr Muir: So, on the subject of the pits.

Mr Torvelainen: Pits need to be talked about by Peter O'Bryan.

Mr Muir: Mr O'Bryan?

Mr O'Bryan: Yes, perhaps let me start with just a quick recap of the setting that we're dealing with here. The Rise and Shine deposit lies within the textural zones TZ3 and TZ4 of the Haast schist and the geotechnical issues that relate to mining of the proposed operation relate to the strong influence of two major structures, namely the Dalton Gorge fault and the Rise and Shine sheer zone as well as the variability of the rock strength of those two schist units. So the structures dip shallowly to the north northeast at something between 20 and 25 degrees and they also define the contact between the two textural zones. And mineralisation lies in the upper portion of the underlying TZ4 and within the Rise and Shine sheer zone. The ore zone itself plunges to the north northeast subparallel to the contact and to these major structures.

From the geotechnical perspective, the key issue is [inaudible 00:44:33 - coughing] both the open pit slopes and the underground excavation performance. As I noted, the variation in the quality of the schists, specifically in relation to the TZ3 where it is close to the contact and the Dalton Gorge fault and that's also particularly important to the stability of the underground slopes, the production areas that will be developed eventually. So it's the presence of those structures – sorry, the variation of the rock quality of both of those units because the TZ4 unit also has variations. It is – the upper part of the TZ4 is within the Rise and Shine sheer zone so it can be fragmented but fortunately with depth the quality of the rock and the competence of the rock mass in the TZ4 increases substantially with depth. We also have the presence of major geological structures in the pit walls, other than the TGF – the Thompson Gorge fault. These are structures which we know exist and we know their approximate locations and orientations but we need to find out a little bit more about them as we go on, which is just about always the case in any mining operations, and particularly those of this scale, is where we know the fundamentals but there is always some degree of uncertainty that's lying in front of us and that sort of leads into the issue that's been – I think been hinted at previously by Dr McAlpine – is that we need more work and that it should – more assessment needs to be done before we get into the operation and to refine the detailed design as we go forward.

So the other things that are of concern are groundwater pressures. They've been mentioned previously and it's our opinion that active depressurisation can work in this effect. It would work to alleviate this effect to a sufficient extent to enable the operation to go ahead. And then as we talked about just recently, it's the potential for seismic loading from natural events but also to do with the transfer of the effects of load change due to large-scale excavation and development of the engineered landforms.

In that respect, the change is – the potential for this is something that I would concede to happen, but I stress that we perhaps shouldn't jump to conclusions as to the extreme – possible extreme effects of this. That is, let's not get too carried away with considering what the worst case might be and similarly or conversely not – let's not get too carried away with what the best case might be. And the issue for solving that comes back to the need for further assessment of what becomes a very complex, three-dimensional situation given the orientation of those major structures with the pit walls. It's not a simple case of being able to analyse the stability of pit walls in a two-dimensional sense and extrapolate that for all parts of the pit, even though you might do multiple analyses at different orientations. There really is a three-dimensional complexity that we're dealing with and one of the other things that has to be dealt with in this case is to establish what is the starting condition. And that is something that needs to be taken into account in benchmarking as well in that while you may have two situations that appear to be similar geologically and geotechnically, they may differ substantially due to the stress state that is the fundamental driver for the behaviour that will occur once you change that setting by carrying out some excavation or providing loading in some way. And as part of that, we need to have a modelling method which can take into account the geometric complexity and to also explicitly include the features such as the TGF and the Rise and Shine sheer zone and the aforementioned addition of faults that we know of but we do not know enough about of as yet. So there's a case to be made to go forward and carry out further structural interpretations and also – getting back to the starting conditions for the modelling – is that we need to find out what the active tectonic stress is at the Rise and Shine deposit, which means that to know what the starting conditions are and to make the modelling results meaningful, we need to have the – a measurement of the active stress at the site.

Mr Muir: Mr O'Bryan, could I just ask at this point. To what extent is it possible to undertake that modelling now, to what extent does such modelling necessarily assume at least the first stages of pit construction? First of all, the Panel has got to assess what is the risk here. The risk is that the – that slope stability demands a very much – what do I call it – softer angle of slope. What's the correct technical term?

Mr O'Bryan: To moderate the slope angle to make it shallower.

Mr Muir: Moderate – make it shallower. Right, so what we're talking about here is the possibility of shallower slope angles which means ultimately as it multiplies out through a pit of this size, a very much larger pit than currently anticipated. That's the risk, is it?

Mr O'Bryan: That would be a risk or it would in fact be the action that would be taken to avert a risk and so therefore it takes on a risk of another [inaudible 00:52:59] altogether.

Mr Muir: Well, one takes it that this applicant does not want a pit with collapsing walls. It would have enormous health and safety implications for its employees and I imagine multiple downstream consequences. It will want stable pit slopes if unanticipated consequences occur within the context of this complex three-dimensional modelling, it will want to mitigate all of those risks and I presume, apart from some form of, I don't know, some form of reinforcement of the slopes, one of the first mitigations will be to moderate those slopes thereafter to achieve a greater factor of safety or stability or however you want to call it. Is that right?

Mr O'Bryan: That's correct sir. But - - -

Mr Muir: So come back to my question – this is – you have impressed upon us, probably quite sensibly, that neither should we take best case scenarios nor worst case scenarios. We should operate within a band of likely outcome within – but I am hearing from you is that with a band of likely outcomes there's still significant areas of uncertainty here and I'm just trying to establish – because we're reaching a very critical point here in this application where – and we've heard this over the last week or so – a number of areas where other parties are suggesting that further work needs to be done. Not of the type that facilitates a response within the 10-working day period that we may maximally allow as a Panel, but actually further investigative work in order to be able to promptly size risks. We've heard this in areas of ecotoxicity, we've heard it in areas relating to possible consequences on heritage environment from blasting and in other areas also. And we've got to decide at the conclusion of this hearing process whether we say to the applicant more work has to be done in these particular areas, or we accept that it is within a range of parameters that can be dealt with by conditioning, understanding that no one could ever conceivably have all of the answers for a project of this size at this point and that, to some extent at least, it is inevitable that such a development would have an iterative component to it. So I just wanted to now come back again to my question which is in what you talk about here, where you acknowledge – and I just took a note of your words – further assessment of this complex, three-dimensional structure in the pits is necessary – can that be undertaken now or is that work that necessarily must occur as the pits are – can I call it – unearthed?

Mr O'Bryan: My answer to that is that – well, to qualify it – my comments have been made mostly in reference to the ultimate pit and the stability of the final walls as per the current design. One of the very fortunate things in this case is that the mining is proposed in a number of stages and by my assessments, the first at least half of those stages could be mined quite comfortably now with the parameters that have been recommended, with perhaps only minor needs for variation. The work that is being suggested can be done progressively – and in fact this is the case in all mining operations of this size – is that you have a fundamental understanding at the beginning and then you're going to be carrying on geotechnical investigations and assessments throughout the life of the operation. And the very – there will be high probability that even at the end of mining, you still will not have all the geotechnical data that you would like to have had at the beginning. So to summarise that, I believe that it is perfectly reasonable to proceed with the initial stages of mining and that we would refine the ultimate design parameters on the basis of the results of the investigations that have been suggested and the modelling that would ensue from those.

Mr Muir: And I suppose conceivably if we adopted the worst case scenario for a moment and assumed for the purposes of argument that that occurred and that in order to operate in the context of the worst case scenario, it required a very substantially increased pit size with significantly moderated pit slopes, that we would get to a point at which such a proposal was outside the terms of consent and if the applicant wished to go on, it would have to reconsent it.

Mr O'Bryan: There are other options. You would possibly alter the amount of open pit mining that would be carried out and bring the underground [inaudible 01:00:05] to be carried out at some distance from the smaller open pit. So the actual footprint – if the worst case, as you put it, came about, one of the answers would be – one of the results could be that you would have a much smaller pit and therefore a much smaller footprint and a [inaudible 01:00:31] underground operation.

Mr Muir: Yes, I understand that. Now Professor Emmerman, did you wish to comment on this.

Prof Emmerman: Yeah, at a very high level. I mean Dr O'Bryan's analysis is very good. I have the utmost respect for Dr O'Bryan. I guess one thing I'd like to draw your attention to is the design factor of safety and I think we should be very, very conservative along these lines. I would like us to follow the guidelines for open pit slope design by the large open pit project which I understand is very standard in Australia and in much of the world. For the walls with high consequence – high consequence of failure and for which rock strength parameters are poorly known, which is the entire area really, the factor of safety should be 1.5. I feel like that's something we should establish at this point – what's going to be an acceptable factor of safety because, as Dr O'Bryan was talking about, that's going to affect what size of pit we're talking about or how deep that pit can be constructed or what proportion of this mining is open pit and what proportion is underground.

The other thing I'd like to draw your attention to is the same large open pit project as [inaudible 01:02:19] guidelines for mine closure and the acceptable factor of safety for mine closure is more complex than during operation. It's not just something you can look up in a table. But it can be as high as 2.0. And this is for two reasons. First, no matter how well the rock strength is known during operation, it's very poorly known how that will evolve in the decades after closure when you have rewedding of the pit and you have time-delayed responses to blasting, time-delayed responses to excavation, how erosion and slope stability are going to interact – that tends to be very poorly known. Also there tends to be certainly a decrease in monitoring and on-site personnel after closure. Those are the reasons why you might have a much higher factor of safety after closure which can be a size 2.0.

And so just to summarise, those are the guidelines that I would like us – I would like to see us adopt, with kind of a warning is that could certainly affect that size open pit we're talking about, which I think a lot of these questions need to be settled fairly early. I will leave it at that.

Mr Muir: In adopting a relevant factor of safety, presumably issues such as accessibility of the public after closure, and during operation, other health and safety precautions for mine workers will clearly be relevant, wouldn't they?

Prof Emmerman: You're asking me?

Mr Muir: Why would we – just to take a theoretical example. Why would one want a very elevated factor of safety for something which had no public access? Who are we protecting with the factor of safety?

Prof Emmerman: I see, okay. So we're talking about after mine closure?

Mr Muir: Well yes, and obviously during mine operation, then the issue around factors of safety relate exclusively to the safety of mine employees, does it not?

Prof Emmerman: Well, we have a few factors. I mean, certainly we're talking about the safety of mine employees and of course that's got to be the most important. We have safety of equipment of course. A collapse of a pit wall can have major economic consequences for the project. You could have a temporary shutdown, you could have a permanent shutdown, so that possibility always fits into the whole economic analysis of the project. You could have - - -

Mr Muir: [Inaudible 01:05:26] that it affected the underlying economic fundamentals of the project to an extent that you couldn't finance, you know, ongoing perpetual trusts and closure obligations and those sorts of things. That's one of the concerns?

Prof Emmerman: I do know [inaudible 01:05:45] what I'm talking about during operation and after closure.

Mr Muir: Sorry, I'm blending them all together.

Prof Emmerman: I understand, okay.

Mr Muir: Let's just stay with one.

Prof Emmerman: Okay, I'll do them separately, okay. So first we're talk about during operation. Okay. We have risk to workers, we have risk to equipment, we have risk to the whole economic fundamentals of the project and there have been mining projects that have shut down temporarily or permanently after pit instability. Okay. You can also have pit instability that induces failure of structures outside of the pit, even structures outside of the project boundary. Plus this kind of will sum up during operation. If we look at closure, certainly there is issues of public safety, public access. You also have to look at the consequences of like a long-term unravelling of the pit and what the effect's going to be, which I haven't seen that analysed. You have to look at cultural heritage, protected species, etc. What happens if that pit unravels? What are the consequences going to be? Okay, so those are all the things that need to be looked at.

Mr Muir: When you talk about unravelling, establishing some form of equilibrium slope stability?

Prof Emmerman: Well, there have been pits that actually didn't come to stability after closure. They've been progressively slumping, progressively unravelling.

Mr Muir: Can I come back then please to the applicant's experts on the factor of safety. You've heard Professor Emmerman say it should be 1.5 during mine operations, rising to 2 on closure. Dr O'Bryan?

Mr O'Bryan: The factor of safety for the highest wall of the ultimate pit under dry and static conditions exceeds 1.5 quite readily and if it is partially saturated and therefore partially pressurised, the factor of safety is just roundabout – I'm just trying to think off the top of my head – it's close to 1.5 but not quite 1.5. And I think that's probably the – that is my best estimate of what the operational condition will be at that time when that pit is developed to that ultimate height and that takes us to the – within the Reid and Stacey journal that's been quoted – it takes us into the realm of the overall stability needing to – with a high consequence of failure is listed to be between 1.3 and 1.5. So we meet that criterion. And factor of safety as you go into closure is one of the things that has to be considered amongst a number of other things that are not taken into account in the calculation of factor of safety, such as the propensity for erosion, ongoing relaxation and numerous others. And of course you highlight the requirement to take into account who would be exposed at that time. You have to need to take into account what sort of barrier is in place to prevent access to those voids as to how they will be constructed, construction materials and how they will be maintained if maintenance is needed at all.

Mr Muir: Dr McAlpine, did you wish to contribute on this subject?

Dr McAlpine: Possibly just to say that I concur with Peter that to do the required modelling is not something that you have time to wait for. Sorry, the timeframe does not permit modelling to be done and benchmarked and so forth in the timeframe that is being required in this process. The benchmarking, however, will be a very valuable and is immediately available. I see that I have included in my witness statement two reports – 17 and 18. 18 is the report by PSM Consulting which did the geotechnical assessment for the Bendigo project – it's a pre-feasibility study. And they are a company that have been providing services to the mine operator since very, very early on in the inception in terms of best slope design and so forth in the geotechnical work. The report number 17 – and that report number 18 is the one that was requested by the expert panel as a piece of missing information and has some very powerful analyses and conclusions.

17 is a report by the same company. It was produced a little bit earlier – sorry, about the same time – 2024. And that was a similar piece of work which looks at the history of the open pit at Macraes with a very detailed account of most of the slope movements that have taken place there and addresses some of this unravelling that sits within the mine and around the margins of the mine. So I think if the Panel makes a geotechnical assessment of those two pieces of work, you will have material in which to bypass, shall we say, the need to complete modelling because in a sense if you assume that the two geological scenarios are similar, then it provides some sort of benchmarking.

The only other thing that I'd say is that Bendigo is in a much more tectonically higher strain regime than Macraes. That is evidenced by the pattern of earthquakes – small and shallow earthquakes that are taking place. They are quite – quite different in their overall level of seismic information and so Bendigo is therefore likely to experience more severe pit unravelling and so forth I would suggest than at Macraes.

QUESTIONS FROM THE PANEL:

Mr Mulliner: Just confirming your referencing 17 and 18. Is that of the joint witness statement?

Dr McAlpine: No, that's of my initial statement of evidence.

Mr Mulliner: Okay, thank you.

Ms Sweetman: Dr McAlpine, in an ideal world, irrespective of timeframes, would that be information we should have now?

Dr McAlpine: Do you mean this afternoon? What do you mean "now"? Do you discuss - - -

Ms Sweetman: Before making - - -

Dr McAlpine: Can you elaborate further - - -

Ms Sweetman: Before making a decision.

Dr McAlpine: Absolutely. Absolutely. Absolutely.

Ms Sweetman: And Mr O'Bryan, what's your view on my question I just asked? Is this information we would ideally have now before making a decision?

Mr O'Bryan: Could you please repeat the question. Sorry, there's some interference at this end.

Ms Sweetman: So you have talked about the need for more assessment to be undertaken.

Mr O'Bryan: Yes.

Ms Sweetman: In an ideal world, irrespective of timeframes, should we have that information now before making a decision, or is it something that could come post-decision should we grant consent?

Mr O'Bryan: In an ideal world, yes, that would be wonderful to have the information now. But I do not see it as being an essential requirement in that mining could proceed while we were to gather the information that's required, that is, to obtain a measurement of the stress condition at the Rise and Shine deposit and to conduct the modelling that's required to make some more informed assertation as to the potential of there to be transfer of unloading effects more widely than just around the immediate vicinity of the open pit.

Mr Muir: And if I was the CEO of MGL/Santana and gave you an approval to do so this afternoon, you and your team, how long would that take?

Mr O'Bryan: To conduct that information – to conduct those tests?

Mr Muir: Yes.

Mr O'Bryan: Several months.

Mr Muir: Several months. Is that work in any way seasonally dependent?

Mr O'Bryan: No, it should not be.

Dr McAlpine: Excuse me, can I just make a point to my last statement. I thought the question that you were asking, Gina, was is it important this Panel now – right now – to undertake that sort of - - -

Mr Muir: That wasn't the question from Commissioner Sweetman. It was should, in an ideal world, this – in an ideal world would it be best if we had this information now. Is that fair?

Ms Sweetman: Yeah.

Dr McAlpine: And we're talking about the information from the work that hasn't yet been done which is the modelling?

Mr Muir: Correct. This is the further assessment.

Ms Sweetman: I understand the baseline position.

Dr McAlpine: Okay, well look, I'd like to clarify my statement. I repeated myself "absolutely, absolutely, absolutely" I think three times. So I would say it's an absolutely once on that one. If you're meaning what I described earlier in terms of the work to look at that – those two reports and compare them in the light of a good estimate of what the differences between the stress regimes are between Macraes and Bendigo, then that is work that can be done – in fact should be part, I suggest, of your background due diligence and study because that work can be done almost immediately, and particularly through that reference 17.

Mr Muir: A benchmarking analysis could be done quite quickly, is that what you're saying?

Dr McAlpine: I am, yes.

Mr Muir: Did Dr Pizey or Mr Macdiarmid have any comment on this issue?

Mr Pizey: Thank you for the elevation of status sir. I'm still Mr.

Mr Muir: Why don't I make you Emeritus Professor.

Mr Pizey: Why not, why not. I have two points in relation to this. The first is that I think we are – or should consider ourselves naïve if we believe that barriers or other means of constraining public access in a post-closure world will be probably an abject failure. And given we're looking at an in-perpetuity situation for some of this, I would err towards Professor Emmerman's more conservative factor of safety in final pit wall design. There is going to be legacy issue here that will concern public safety. As I understand it from my brief listening in yesterday, the pit lake will contain elevated arsenic levels and possibly other things at least for a period of time, and that would have to be considered a matter of public safety.

And to rely on a large mound of earth on the access road to restrict public access I think is verging on ridiculous.

The other thing about the final pit slope would be – I would counsel that we should consider designing – Mr O'Bryan's design should allow for a beach to be constructed at the final water level of the lake because despite our best intentions, people will go in it and if they are confronted with vertical or near vertical faces on the entire perimeter of the pit lake, that too is a public safety issue.

My second point relates to a comment I think that Professor Emmerman made, or maybe yourself sir, about the possibility of failure of pit slopes to compromise the economic viability of the operation. And I agree that is possible and I'm sure there are a number of documented cases where this had a significant impact. One party asked whether or not that was potentially a risk to the funding of an endowment sum to manage that post-closure issue for the mine and I would suggest that although we're not talking about bonds today, a mechanism to protect that endowment would be to include in a schedule of bonds that are required, a bond that covered the funding of that enduring entity in the event the company, due to circumstances beyond its control, were unable to complete the mining and funding of that endowment themselves.

Mr Muir: So basically bonding to top up an endowment fund in the event of earlier closure.

Mr Pizey: Correct. I'm assuming an endowment fund would be built over the life of mine so that at end of mining there was a sum available.

Mr Muir: Yes.

Mr Pizey: If that mining were terminated early, then to protect the endowment that was required, a bond could be entered into that would be sufficient to augment the sum required and that bond would sink in value over the life of mine.

Mr Muir: As the fund built up? Yes, thank you for that Mr Pizey, that's certainly something that the Panel will want to reflect on I'm sure. We appreciate you bringing that to our attention. Mr Macdiarmid?

Mr Macdiarmid: Yep, just a couple of points on this. I note there's a few new conditions around sort of pit stability, and new indicia for New 11 to New 15 sort of cover off a lot of these issues including designating some factors of safety for land outside the site, which is currently designated as 1.5.

The second point is regarding factors of safety internal to the site. There is Worksafe guidance for – New Zealand-specific Worksafe guidance for quarries and open cast mining which provides some factors of safety guidance. I think it's 1.2 to 1.3, mainly to protect sort of safety of workers within the pits. So that's specific to New Zealand. There was some discussion about sort of moderating the pit slope. The nature – if the pit slope was going to be moderated, it would probably be a result of finding a defect in the rock like a fault or something, which means that any moderation of the slope would likely not be for the whole pit. It might just be one of the walls.

Mr Muir: One of the walls, yes. Or part of a wall?

Mr Macdiarmid: Or part of a wall, yep. It's unlikely to be the whole pit needs sort of batter back to a shallower angle.

Mr Muir: It was certainly what I was imagining when I referenced that.

Mr Macdiarmid: And then the final point is just around investigation. It's purely standard to defer some investigations to prior to detailed design. You know, often at resource consent stage you've done enough investigations to, you know, check the concepts work and that will be – and it's purely standard practice to then refine that at the detailed design stage.

Ms Sweetman: Mr Macdiarmid, are you happy that the concepts work?

Mr Macdiarmid: I mean certainly the concept of an open pit's going to work. I mean, if there is – as I mentioned, if there is some unforeseen defect, it may mean some of the pit batter slopes need to be modified. I'm confident a pit can be constructed at the site.

Mr Muir: Thank you.

Mr Mulliner: I have a related question around that moderation of the pit to the applicant's experts. If the pit – if the pit slopes did need to be moderated, where would the waste go? Is there capacity – extra capacity in the current facilities for that?

Mr Torvelainen: Yeah, I see if there was extra waste, the logical place for it is in the Shepherd's ELF, that's the largest waste rock storage area. And practically it's effectively placing a thickness over the top of that facility. Practically you can accommodate say a proportional 10 per cent increase with relatively minor extension of the footprint and height of that facility and in terms of controls around seepage collection, you will remain within the system that is already set up. So - - -

Mr Muir: Albeit putting additional load on the system?

Mr Torvelainen: Yes, yep. But you'll remain – you won't have to install extra drainage is my point.

Mr Mulliner: So would the extra lift or capacity, would it fall within I guess the current application being sought?

Mr Torvelainen: I can't be sure. It might mean a consent variation both on height and extent.

Mr Muir: Any other questions from the Panel? Cross-examination?

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: Thank you sir. Mr O'Bryan, I just wanted to start by clarifying something that you said earlier about the factor of safety that's achieved and this could well be just me just not understanding what you are saying. But at paragraph 15 of the reconvened joint witness statement, you talk about the factor of safety under static and pseudo-static loading being 1.3 and 1.1, whereas I understood you to say earlier it's about 1.5?

Mr O'Bryan: Sorry, I just – I may have misremembered. I'm not sure.

Mr Muir: Well, have you got the joint witness statement there in front of you Mr O'Bryan.

Mr O'Bryan: No, I know that that's – now that that's been highlighted, that's correct and I must have – let me find – I have a table here. That's – under pseudo-static loading, the 1.1 is adequate. I was referring to – previously to the case where the slope was dry in the first instance, being greater than 1.5, and at 1.3 and 1.5 is when you had partial saturation and were still under static loading. Pseudo-static loading is when a lateral acceleration is applied to the model. It's a bit of a fudge but that's how – in equilibrium analysis – how the effect of a seismic loading is taken into account.

Ms Gepp: Okay, sorry. Can we just work through this point by point. So this is talking about dry slopes at the start and static equals 1.3. Dry slopes and pseudo-static equals 1.1, yes?

Mr O'Bryan: Yes.

Ms Gepp: And you're saying both of those meet design acceptance criteria?

Mr O'Bryan: Yes. The criteria – the low value for the – in table 9.9 of the Reid and Stacey guidelines for open pit mining is that for an overall slope stability with high consequence, the factor of safety for static loading should be between 1.3 and 1.5 and under dynamic loading, that is the pseudo-static loading, it should be greater than 1.1.

Ms Gepp: Okay, well it's not greater than 1.1 is it according to this paragraph?

Mr O'Bryan: I don't know what it is. I don't have it in front of me.

Ms Gepp: Okay, well it says it is 1.1.

Mr O'Bryan: If it matches 1.1 - - -

Mr Muir: Is the test 1.1 or more or is the test greater than 1.1?

Mr O'Bryan: It's greater than or equal to.

Mr Muir: Greater than or equal.

Ms Gepp: That sorts that out. Then the last sentence was actually where I was heading. It says "However, partially saturated slopes do not meet design acceptance criteria when mining disturbance increases and/or GSI values" – which is I understand geological strength index - - -

Mr O'Bryan: Index, yes.

Ms Gepp: - - - "are reduced". So can you explain what that means and what the implications are?

Mr O'Bryan: That was looking at sensitivity and saying that if you reduce the GSI of the schist units, and I think I reduce them by probably about 10 per cent - - -

Mr Muir: Sorry, just remind me – GSI is something or other - - -

Mr O'Bryan: Geological strength index.

Mr Muir: Thank you.

Mr O'Bryan: Reduce those ratings by five for each of the TZ4 and the TZ3, leaving the sheer strength of the Thompson Gorge fault the same, you've got – the analysis returned a lower factor of safety which is to be expected. Because you've effectively decreased the sheer strength of both the schist units.

Ms Gepp: So we're right on the boundary – we just meet the design acceptance criteria and with some – with the sensitivity applied by changing those features, which are currently not known with certainty, it fails to meet design acceptance criteria. Is that right?

Mr O'Bryan: That would be the case, yes. If it turned out that the sheer strength with enough additional data showed that that was the – a representative sheer strength, well then that would be the case, yes. And if that is the case, then the design would have to be re-assessed and reset.

Ms Gepp: Okay. So – and one of the ways of managing that you've said is that the – is essentially bigger pits with shallower slopes?

Mr O'Bryan: You can have shallower slopes and therefore have a smaller pit in that the walls are in the same position but the floor is at a higher elevation. Or you could reduce the angles of the batters or increase the width of the boom and have a shallower overall angle which, if you wanted to achieve the same floor elevation, would mean that you would need to move more of – more waste material. The other alternative is that you accept that you have to have a smaller pit because as you – even when you apply those reductions in strength, you can still achieve adequate stability with a wall of lesser height - - -

Ms Gepp: Does the smaller - - -

Mr O'Bryan: That would – so that would mean you would have to – to maximise the extraction of the resource you would need to bring in the underground operation at a higher elevation.

Ms Gepp: Okay. So we're talking about some significant differences to what is actually in the application that's before the Panel aren't we?

Mr O'Bryan: They're purely hypothetical.

Ms Gepp: Hypotheticals though where we're right on the boundary of meeting the design acceptance criteria at the moment based on the information that we have?

Mr O'Bryan: As we meet them.

Ms Gepp: Okay. The – who – there was a part of that Panel question A that's being addressed here was about publicly accessible land. We've talked about within the mine site itself and the limitations on excluding the public. But there was no discussion in this – in either joint witness statement about the – sort of the areas around the conservation land and so on that are around it. Is that something that you have looked at in terms of the safety of those areas?

Mr O'Bryan: Yes, we have – we've looked at the area which is the Department of Conversation [sic] covenanted zone to the south of the pit and we find that that is not impacted by the open pit and that the factor of safety of the wall that's closest to that, which is the southern sector, the factor of safety there, if I recall correctly, is above 1.5. It's a very shallow wall.

Ms Gepp: Okay. And then lastly I've got a question about new condition – sorry, condition New 12. So I'm not sure if it's you or one of the other applicant witnesses that's best to put this to. I'll ask you but if someone else then please jump in. And this is the one that says "where project works may alter geotechnical stability, a minimum factor of safety of 1.5 must be maintained under static loading for all ground outside the project site as shown on the plan". So can you explain what the intent of that condition is?

Mr O'Bryan: Not exactly. I'm not quite sure what works would be involved.

Ms Gepp: So in the second joint witness statement, and it might be this question I put to Mr Torvelainen – the second joint witness statement says that the proposal is to amend that condition to clarify it relates to pit stability only, and at that point I got completely confused about what this condition is intended to do. So I'm referring to para 66 of the second joint witness statement. So we have a condition about stability outside the consented site and then you've said there's a proposal to amend it to clarify it relates to pit stability. What's the purpose of the condition and what would it do with that amendment?

Mr Torvelainen: Sure. Mr Torvelainen here. So I understand this new condition was added through discussions with the applicant, with ORC and their experts to include a condition that ensures that land outside the project site, ie the boundaries, maintains adequate stability – I think that's the intent of the condition. And as a group of experts in discussing this, there was discussions about micro seismicity and all sorts of things and so the point that we're trying to make here in paragraph

66 is to point that this condition is primarily related to pit stability, ie pit slope stability and protecting land that is not owned by the applicant or outside the project site. Is that clear?

Ms Gepp: So – no, sorry. So

Mr Torvelainen: Can you explain why it's not clear.

Ms Gepp: Yeah, yeah, sure. So there's no pits outside the project site?

Mr Torvelainen: No. So what we're saying is you design the pit – the pit walls, right. So we're discussing what factor of safety should the wall be designed to and so if the factor of safety inside the property site is, say, achieves 1.3 and what protections are there for land outside the project site. And so this condition is to protect – I understand is to protect land outside the project site from pit.

Ms Gepp: Okay. So where the conditions starts, where project works may alter geotechnical stability, you'd be limiting that to where pit – where the pits may alter geotechnical stability. Is that what - - -

Mr Torvelainen: Yeah, yeah, that's what I'm trying to - - -

Ms Gepp: Okay, thank you. And also just to follow up on that, it refers to a factor of safety of 1.5 under static loading, wouldn't it be more appropriate for that to be under pseudo-static loading so that it's taking into account that.

Mr Torvelainen: I can't comment on that. That would be better answered by Peter but - - -

Mr O'Bryan: They're very different situations there where you appreciate that if the application of the acceleration is due to a – something seismic, then the duration is very limited. So the factor of safety under seismic loading does not need to be as great as it is under static loading. The disturbance lasts for, what, several seconds at most.

Ms Gepp: I suppose just to ask a more fundamental question. If the current – if it's currently more stable than – if the land outside the project site is currently more stable, it's not appropriate to reduce the stability of that land, is it? It should at least be maintained.

Mr Torvelainen: Mr Torvelainen here. I think that there's many situations in the [inaudible 01:43:42] environment where works that aren't on a neighbouring property site which affects, you know, the neighbour and so this is just normal geotechnical practice.

Ms Gepp: Has the effect of reducing the stability of public conservation land – the broader effects – has that been assessed by the applicant?

Mr Torvelainen: I think the point is that the land is stable – that's the point of the condition.

Ms Gepp: But potentially less stable than it is now?

Mr Torvelainen: The point is that it's stable.

Ms Gepp: Right, thank you. Those are my questions.

Mr Muir: Mr Randal, did you have any questions? No. Mr Leckie?

CROSS-EXAMINATION BY MR LECKIE:

Mr Leckie: Just one line of questions for Mr McAlpine if I may. Mr McAlpine, if I could just take you to paragraph 29 of the first joint witness statement. You've got that in front of you. And you've expressed reservations around the viability of the concept design such as premature abandonment of the mine. I appreciate you're not a bonding expert but do you have any familiarity with the proposed bonding conditions that have been put forward by the applicant?

Dr McAlpine: No.

Mr Leckie: Okay. I'll put some propositions to you. That's okay. I didn't expect that you would. But a mine closure plan is proposed in condition C115 of the joint set of conditions and that mine closure plan requires, in condition C116, that the final landform within that mine closure plan is geotechnically stable. Would you agree that, from your expertise, that would include that pit stability concern that you have – it's a geotechnical stability point?

Dr McAlpine: Yes, in terms of a plan – the words in the plan – yes.

Mr Leckie: And that mine closure plan is required to be prepared six months from commencement of the consents and updated every three years. I'm just putting that to you – that's condition C115. The bond conditions go on to require, at C123, that the works required by that mine closure plan are included in the annual bond assessment. Given that those works that we've talked about are included in the annual bond assessment, would you agree that your concerns over premature abandonment would be addressed if there was money available to ensure that the closure activities were able to be carried out in the event the applicant – to use your words – abandoned the site?

Dr McAlpine: Not entirely because I think premature abandonment presents a whole raft of difficult issues with respect to the mine now – is the underground mine for example safe to re-enter, which is – happens and it's happening at a mine – in the Arcadia mine which – I happened to be in Australia a couple of months ago when there was a relatively small earthquake and that mine is currently closed and it hasn't been indicated when it might re-open. I'm also not aware of a – not aware of but it may exist – a mine closure plan for Macraes which had reported suspension to underground operations about two years ago and it's unclear as to the current status of that mine. So the consequences of not being able to fully implement the closure plan can leave a region with potentially mine voids which had been planned to be sealed or managed upon closure but are no longer safe or possible to enter and therefore you could create a permanent sump of very effective interconnecting channels of – that will fill with water and mine-affected waters and really can't be pumped out, can't be drained, can't be backfilled. So in that respect technically that's where I'm concerned that a situation that there is no bond – no bond big enough to address the problem.

Mr Leckie: So taking that Macraes' example where you were concerned because there wasn't a mine closure plan - - -

Dr McAlpine: Sorry, I'm not aware that there has been a mine closure plan.

Mr Leckie: Where you're not aware that there's a mine closure plan, you'd accept that provided the applicant in this case complies with the condition here requiring a mine closure plan, that would be a very different situation, wouldn't it, because there would be a mine closure plan in place?

Dr McAlpine: As I said before, I'm not worried about what's on pieces of paper, I'm talking about the actual feasibility of covering a remediation – there is no remediation you could argue for a mine that is abandoned prematurely through a force majeure event.

Mr Leckie: Thank you. No further questions.

Mr Muir: Thank you. We'll take the lunch – a rather late lunch adjournment now for half an hour.

Luncheon adjournment

Mr Muir: Have we lost Mr Randal too or is he on the way? No word from him.

Mr Macdiarmid: I think he's on his way back.

TOPIC 4: ELF DESIGNS

Mr Muir: Right. What do the section 53 invitees' appointed experts want to say about ELF design? We'll start with you Dr McAlpine? Is this a subject that you intend to address us on?

Dr McAlpine: It is not a subject that I participated on the - - -

Mr Muir: Yep, right. We'll go to Mr Emmerman – sorry Professor Emmerman.

Prof Emmerman: It's okay. I don't have anything to add on this subject.

Mr Muir: Right, very good. Mr Pizey.

Mr Pizey: Nor I sir.

Mr Muir: Right. This sounds promising. Why did we have this on the board? Right. Dr Matuschka or Mr Torvelainen?

Mr Torvelainen: No, not from me.

Dr Matuschka: No.

Mr Muir: Right.

Mr Macdiarmid: Nothing from me. I think we covered this in the slope design part of things to be honest. Yeah, I have no concerns.

TOPIC 5: SHEPHERD'S SEEPAGE SUMP

Mr Muir: I should go to lunch more often. The Shepherd's seepage sump. This is definitely an area where I expect there's going to be an element of cross-pollination with what we've discussed before. Are we talking about performance of it, size of it, location of it, factors of safety in relation to it. What is the issue here? Who should I invite for the section 53 invitees to start? Professor Emmerman, did you want to comment on this?

Prof Emmerman: No thank you.

Mr Muir: No. Dr McAlpine?

Dr McAlpine: I think we've kind of covered the landslide risk which is my major concern and I'm not sure that I've got anything further to add just with respect to the seepage sump. Obviously it would be something that's very susceptible to landslide risk, even a very moderate landslide.

Mr Muir: Mr McDiarmid, did you have any comment on this?

Mr Macdiarmid: Nothing from me on this.

Mr Muir: Mr Pizey?

Mr Pizey: No sir, thank you.

Mr Muir: Right. Dr Matuschka, we don't need to touch base with you on this either?

Dr Matuschka: No.

Mr Muir: Right, okay, thank you. My goodness.

Ms Gepp: Sir, could I just note one thing on this. I don't have a question. I just note that when this was discussed in the joint witness statement, Professor Lottermoser's first flush of run off commentary is touched on. So I just wanted to note that just because you had expressed an interest in that issue yesterday.

Mr Muir: Yes, and I tried to develop that issue for the purposes of our water experts and there's nothing further that you wanted to put to anyone.

Ms Gepp: I've got nothing to ask sir.

Mr Muir: Right.

TOPIC 6: SILT DAM AND PROCESSES AND THE PLANT PLATFORM

Mr Muir: Silt dam and processes and the plant platform. Dr Matuschka?

Dr Matuschka: No, no comments.

Mr Muir: Right. Mr Torvelainen?

Mr Torvelainen: No comments.

Mr Muir: Thank you. Is this an issue that you wanted to engage with Dr McAlpine?

Dr McAlpine: No. The – only in the extent that this is yet another item of the infrastructure that I think provided the main input to the discussion that we had in joint witness statements around mining-induced seismicity. So again, it kind of relates to – these are – particularly the plant processing platform and so forth. There's a lot of civil engineering buildings which are built in accordance with the Building Code. One of the potential shortcomings of the Building Code as it relates to regulations around not building on an earthquake – sorry, a fault is that effectively mining subsidence and mining-induced seismicity triggers unknown fracturing which is, by definition, faulting, and which does result in displacements, horizontal and vertical, of the foundation rock. So I think this niceness – preciousness about that is that the Building Code is – would seem to me to provide inadequate redress of this risk. So it's all very well and good to not put a building over a fault but it's rather loosely described as to what – exactly where that fault is, whether it's the surface trace of it which – sometimes faults don't actually have quite a surface trace, that's where it intersects at ground level – and which part of the fault do you not build over, since most faults travel through the earth's crust at quite some angle. So I think there is some discussion from memory that, you know, there was – if you were asking the question exactly does it affect things that are built according to Building Code, does the risk of mining-induced seismicity affect things according to the Building Code. The answer is yes it does because the earthquakes don't care what the Code says. They'll go whether they were there – they'll trigger whether they were there before or not. So I would argue possibly that there's a shortage, in my view, of the strict regulatory controls around buildings within mining sites because it does not necessarily protect them from these sorts of ground movements we've been talking about in mining-induced.

Mr Muir: Well, Dr Matuschka, this issue of the plant platform considerably closer to the Rise and Shine pit, perhaps the area of greatest generation of mining-related seismic activity, a lot closer than up on the TSF a kilometre away – a concern to you?

Dr Matuschka: Not from a ground vibration point of view. The issue that's been raised is the potentially – the mine-induced seismicity creating some movement of the ground or subsidence which would create a fracture in the earth's surface underneath the platform or silt dam. To me, it seems quite hypothetical. I'm unaware of any examples where that's occurred. So I'd say it's an extremely low risk scenario. I couldn't completely dismiss it but I'm unaware of that mechanism resulting in faulting of the ground surface beneath a building structure.

Mr Torvelainen: Mr Torvelainen. Just a comment is that the process plant is still a notable distance from the pit and underground, and off the top of my head I would say it's over a kilometre away and maybe one and a half kilometres away. So it's quite a distance. And so if there was this effects around micro-seismicity and stress relaxation, we would have to propagate a long way which seems feasible.

Mr Muir: Dr McAlpine?

Dr McAlpine: I just comment to that. I mean what brought it to my attention was – and again it comes back to benchmarking against Macraes and I'm sorry if it makes it seem as though I'm anti-mining or anti-Macraes because I'm not. But they're the – my interest in Macraes peaked when I first – first aroused when I looked – visited the visitor centre in [inaudible 00:13:16] I think and then went back sometime later and not only had the road been – the public road between [inaudible 00:13:27] the area been diverted considerably further away from the pit because it was undergoing land movements, but also the old visitor centre and the whatever it was – the facilities that were hosting the visitor centre, the buildings and parking and offices and plant and so forth had also been dismantled and removed away from an area of ground disturbance. So this creep that can – there's the creep from – which is usually a close sort of unravelling of the structures by the pit margin and what I just described there is an example of that at Macraes. The – I have – so that's certainly a major risk and one that can be well documented – sorry, well, you know, many, many examples of it. In terms of the distance that induced seismicity occurs, it's generally considered that induced seismicity can also trigger natural earthquakes by activating faults that were previously unknown or – particularly if they're unknown – and generally from Australia I've seen examples where they often talk about mining-induced seismicity. Again, not the blasting and the shaking and so forth – the unloading of the rock material such that the earth – the upper crust is more likely to shake. It's not uncommon for features to exist up to 30 kilometres or triggered events to be up to 30 kilometres from the mine.

Mr Torvelainen: In terms of the shaking hazard from micro-seismicity, I see that the process plant designs are a much higher level in terms of having to design for the tectonic seismicity in the area and that's much more notable magnitude earthquakes and so the process plan infrastructure will be designed well in excess of the shaking loading that we could expect from a micro-seismicity event. Or further – it would trigger something else, like there was secondary effects on other faults, it is designed to take those loads.

Mr Muir: What about the silt dam?

Mr Torvelainen: So the silt dam has – it's actually one of – it's actually located effectively above the underground so it is in an area of relatively high potential for fracturing of the ground. What I would note is that the dam wall is – the majority of it – is buttressed by the Shepherd's service corridor valley infill. The application presents a remaining height of the wall. If I just try and put it into context for you. The whole height of the wall of the dam might be 16 metres high conceptually and then I think the application has the height that protrudes above the valley infill downstream is about seven metres. If there's any issues in that area, it's very easy for us to – for the applicant to buttress that dam and so I don't see a situation where we end up not being able to keep that area in control.

Mr Muir: Mining-induced seismicity could result in a spontaneous failure?

Mr Torvelainen: No. So I think that what I'm saying is that it's an earth embankment and it's also a silt pond so most of the time the water level is low in it so it's actually only in flood conditions that it's full, and the majority of the embankment is buttressed and so the water level is below that level of that buttressing and so the risk is very low.

Mr Muir: And if the risk were to come to pass, what would typically occur would be a silt sludge that would emanate from that area?

Mr Torvelainen: No, I don't believe that that can occur because the silt sits at the bottom of the pond and the – that's well below the level of the Shepherd's service corridor valley infill. That is downstream. That's below that level and so - - -

Mr Muir: It's - - -

Mr Torvelainen: - - - it's buttressed similar to a TSF and so overall the – even if there was some differential settlement there because of – just from pure subsidence from the underground mining, it's controlled because it's buttressed.

Mr Muir: Professor Emmerman, did you have any comment on this issue?

Prof Emmerman: Not on the silt pond. I realised I have some comments on the ELF so if we could come back to that later I'd appreciate it.

Mr Muir: Right, okay, well let's just back up then to the ELF. Did I miss you on the ELF, Professor Emmerman?

Prof Emmerman: No, you didn't. I was just thinking about physical stability of the ELF. Then I looked at the joint witness statement and saw we also talked about leachate collection.

Mr Muir: Okay, well, we'll come back to you on that. Let's just close out this issue first.

Prof Emmerman: That's fine.

Mr Muir: And you had no comment on that. Mr Pizey?

Mr Pizey: No comment from me sir.

Mr Muir: Right. And Mr Macdiarmid?

Mr Macdiarmid: No comment from me.

Mr Muir: Right. Very good. Was there any cross-examination on this topic?

Ms Gepp: No sir.

Mr Muir: No, no. And Mr Randal? Yes.

Mr Leckie: And I forgot Mr Randal.

Mr Muir: Mr Leckie.

CROSS-EXAMINATION BY MR LECKIE:

Mr Leckie: Sorry Mr Randal. Just one line of questions for Mr McAlpine again. You mentioned in an exchange regarding your visits to the Macraes mine, which was in the context of mining-induced seismicity – it's the afternoon - mining-induced seismicity, just to confirm you haven't presented any evidence, have you, that that road and the visitor centre were moved because of that, have you?

Dr McAlpine: No I haven't. My original statement does include a couple of photographs to illustrate an area where considerable fractures have appeared in time over – and they extend for a couple of hundred metres away from the edge of the pit. That particular location is right by the point where the visitor – it was in fact on that illustration there's a pair of aerial photographs with a time lapse in them. In the top corner of that pair of photographs is in fact – was the main highway between Hyde and Macraes and that – the top photograph – the one – I think it was in 2017 from memory – that road was open and those fractures and so forth were not visible to my eye but I wasn't looking for them at that stage, I was having a – just generally interested in stuff. And then subsequently the aerial photographs from two years later show that fractures have grown – yeah 2019 – that road is closed in that particular photograph and was moved back by probably in the order of 400 metres or so forth. The facilities I was talking about were just off to the south of that photograph – there's a carpark and so forth. And that – in fact, since 2019 that area went – underwent further very considerable slippage and became quite broken and disturbed so at some point – it may have been in the original plan to move the road and to close that particular bunch of facilities, but I suspect it was a reactive situation because of the developing, unpredicted ground rupturing.

Mr Leckie: So that's an assumption you're making?

Dr McAlpine: It is.

Mr Leckie: Thank you.

Mr Muir: Professor Emmerman, we're going to double-back to you now on ELF design. There's been some discussion about slope design. Do you want to take it beyond that?

Prof Emmerman: No, I don't have any comments on slope design. I have some comments on the controls on seepage from the ELF.

Mr Muir: Very good, thank you.

Prof Emmerman: You're ready?

Mr Muir: The floor is yours.

TOPIC 4: ELF DESIGNS (PROFESSOR EMMERMAN)

Prof Emmerman: Okay, thank you. So I was quite surprised reading the application where the application gave examples of a successful collection of seepage from waste rock piles. And there were four examples given – the Fero Mine complex and Myra Falls in Canada, Resolution Copper in the USA and McArthur River in Australia. Those were the four examples that were given. Resolution Copper doesn't count because it's not going to open for another 10 years and it's not going to have any waste rock.. It's going to be a [inaudible 00:24:23] caving operation, so that's not an example at all. Fero Mine complex is not encouraging – that's regarded by the government of Canada as the largest and most contaminated site in Canada, so I'm not encouraged by that. Myra Falls in Canada and McArthur River in Australia – they both have very extensive records of contamination and I give references to that in my original expert report. And so I do not find this terribly encouraging. If I were on the Panel, I would be asking can you give some positive examples – examples of this kind of collection of seepage from waste rock piles that has actually worked, that has not produced contamination of surface water and ground water. That's what I would be asking. In the absence of any kind of positive examples, I'd be asking well, could we be realistic based upon past history, could we be realistic about what kind of surface water and ground water contamination do we expect to see. This is my concern – this kind of lack of positive examples of these kinds of control measures.

Mr Muir: Perhaps it's unfortunate, Professor Emmerman, that you didn't join us yesterday and that the full suite of applicant's experts on this subject is not present today. But perhaps Dr Weber, since you have been here for both days, did you want to comment on that?

Dr Weber: I can only talk to my area of expertise of course and maybe provide general comment about some of those if that works.

Mr Muir: Yes, if you wouldn't mind please.

Dr Weber: So for the engineered landforms, a key component of managing the effects [inaudible 00:26:25] is to ensure you control that seepage. And I talked yesterday about avoiding diffuse loss of seepage and trying to concentrate [inaudible 00:26:34] toe seepage to one or two points so that any control used different management processes. My comment on that is, that's part of the detailed engineering design to make sure that water comes out or you collect it and that has been included in those – in that early understanding. In regards to the loss of the water – basal seepage – down into the underlying bedrock, there was hours – a long time that was considered and discussed yesterday on that by the hydrogeologists in regards to how that could be monitored so through performance monitoring. I now am stepping outside my area of expertise but in regards to how they could have interception trenches, I think we talked about secondary - - -

Mr Muir: Yes, secondary primary.

Dr Weber: Did we go to tertiary?

Mr Muir: Well, do we have a possibility of tertiary, before we got to passive.

Dr Weber: And I think the conversation was that there was, if I remember, over a kilometre of real estate to monitor and ensure that was captured. Based on my understanding of what was said, and of course not my area of expertise, that it will be constrained. I can't say further than that.

Mr Muir: I know. I appreciate that it's not precisely your area of expertise. But can any of the – can any of the experts called by the applicant address Professor Emmerman's criticism of the examples that were used, essentially saying there is no precedent – there's no precedent for adequate collection of contaminated – contaminated leachate if I could call it that from the TSF to ground or surface water?

Dr Matuschka: I could give an example. The Waihi gold mine has two tailings storage facilities and it has a much more adverse scenario that this – the Bendigo site because it's not constrained in a valley. But there's – as far as I'm aware – been no exceedance of ground water quality downstream of that facility. And that includes quite significant quantity of potentially acid-forming rock within – forming the embankment. Also at Macraes, the main tailings dam – the oldest tailings dam – has been quite successful in intercepting seepage. There's no significant contamination that I'm aware of downstream of that. There's an underdrainage system and seepage collection drains upstream and downstream, and underneath the embankment it has a big seepage collection sump and it has a – just a primary single line of ground holes across the gully. And I'm involved in a number of projects in Australia where they have had seepage out of the – from the facilities but it's not uncommon over there to have seepage recovery well systems and they've been quite successful in limiting migration of seepage further downstream. So there are examples I think where it's successful and there's mitigation measures that can be put in place to manage if there is any bypass.

Mr Muir: I wonder, Professor Emmerman, whether you'd had any personal experience of exposure to a facility that I've referenced a couple of times in the course of these proceedings in the Napa Valley. The McLaughlin Mine. Again, I can only indicate what I can read and that is that its seepage collection systems have performed, it seems, very satisfactorily from a mine of probably some multiples the size of this. I don't know whether you're familiar with that example at all?

Prof Emmerman: I've never – I've heard of that mine. I've never studied that mine. I'm kind of curious if that mine was analogous and a positive example why that mine wasn't listed in the application.

Mr Muir: Yes, well, I just mentioned it for the fact that (a) it occurs within a very well-established viticultural area of international repute, (b) it is in a semi-arid environment, (c) it is in a relatively contained valley system and (d) it produced I think about three times the size of gold that is anticipated to be recovered from this mine. Look, I'm not a geologist or a geotechnical engineer. I just wondered whether you'd had any exposure to it because I had read about the satisfactory performance of its seepage collection systems.

Prof Emmerman: No, thank you, I have not looked at that evidence – that documentation.

Mr Muir: Right?

Mr Mulliner: Professor Emmerman, could I just clarify – is your concern here that the applicant's pretext or my understanding of the application in that they will capture all of the seepage or – is that your concern or is your concern that they will be able to capture some of the seepage?

Prof Emmerman: Well, I think all of it makes sense in theory, on paper. I mean, lots of things look good on paper. If I was evaluating a project, I'd always say can you give me an example, can you give me 10 examples, can you show me where this has worked in the past. I was just quite shocked when I read the application and I saw four examples, one of which was completely irrelevant and three which were disasters, so that gave me some pause.

Dr Weber: Professor Emmerman, Paul Weber here. I just wonder whether those examples were provided – and I don't know where those examples came from [inaudible 00:33:33] that information whether they were provided to demonstrate specific systems rather than an overall issue that had gone on in the project, so yes, you might be struggling to understand the context but surely there must have been [inaudible 00:33:53].

Mr Muir: I presume so if what is described as disasters are disasters completely unrelated to the adequacy of seepage collection they could remain valid comparisons for the purposes of our discussion today.

Dr Weber: Could I make one more clarification. Dr Matuschka mentioned the Waihi gold mine. I was recently engaged by the Council up there to review the application on behalf of the Council and I went through all that documentation and it is – they have a robust management system for the potential effects of acid rock drainage, acid [inaudible 00:34:20] drainage so I was comfortable with that process and I've got a long history of experience in dealing with water, so that also gives me comfort. Always hard for a new project when you're starting up because you can't demonstrate because you're talking up what you will do. So we always fall into that situation. Thank you.

Dr McAlpine: May I just have a comment?

Mr Muir: Yes.

Dr McAlpine: I was yesterday morning at the back listening in to ground water because it's so interconnected. I'm not an expert for ground water but I would just like to pass on the report that I talked about with respect to the analysis of rock failures and so forth at Macraes does include some photographs and description of zones that were mined with shallow shafts and then subsided. And there's an excavation through that piece of geology, if you like to call it, where some old, very early but modern – well, modern in terms – 1990 or something like that – shafts were driven through the schist rock and have collapsed. Now we're in a subsidence zone – a zone that is expected to be affected by subsidence – I think two metres of subsidence or so forth I remember reading somewhere – at Bendigo because of the collapse of mine stopes and so forth. The Macraes example – the photographic example is a very graphic example – picture of how the schist has crumbled and broken because it's not a ductile rock so if you have subsidence it's obviously got to break in a brittle fashion and crack down. So I perhaps would just highlight that report I mentioned now a couple of times one of the post-factor analysis of Macraes has been very relevant for this topic but also for your ground water.

Mr Mulliner: That's outlined in your original evidence?

Dr McAlpine: Only the reference because I was aware that there was a reference and to be honest it was after my – it's reference is reference number 17 I think it was – yes – in my recent statement. I did not have time to go back to that reference in the time I had available to produce my statement so I hadn't realised that it had so much importance to this.

Mr Mulliner: I'm struggling a little bit on the context here.

Dr McAlpine: Seepage pit – so this relates to the integrity of the – or the permeability of the schist at the surface from the basement of the seepage pit and how, if it is within a zone of expected subsidence because of the collapse of mine shafts – stopes, sorry – beneath it, then this document illustrates how where subsidence has occurred through that mechanism the schist has fractured and broken become very highly permeable.

Mr Mulliner: Okay. Who's best from the applicant to address that? So you're talking about stopes failing.

Dr McAlpine: Yes, yes. If I'm correct, there's an estimation that the maximum subsidence expected as a result of the settling of the mine is two metres at surface. That's my understanding.

Mr O'Bryan: Could I say something there?

Mr Muir: Yes.

Mr O'Bryan: There's a factor of 10 you missed out there. .2 metres. And that was a very conservative estimate. In some of these things, we're conflating issues where there's been a phenomenon and we're saying that that is directly applicable here. I think before we go too far down that track, we should just take a step back perhaps and consider that we're, in most cases, dealing with different situations. Even from Macraes to Bendigo, there are differences. I'll just leave it at that.

Mr Muir: Yes, thank you, very good. That was Dr O'Bryan.

Mr Torvelainen: Mr Torvelainen. I'd also – my understanding is that the stopes are being paste backfilled in the underground and so that reduces the subsidence compared to the situation at Macraes which isn't paste backfilled.

Mr Muir: Thank you. Is there any other expert that wishes to contribute to that topic? Is there any cross-examination on that topic? No. Could I ask any of the experts, obviously including you Professor Emmerman, is there any issue that we have not addressed today that, with the benefit of the discussions that have been had, we should have? Professor Emmerman?

Prof Emmerman: I would just like to come back to landslides a bit. Landslides – one thing that concerns me is this concept that the wet tailings are going to act as a buttress against landsliding. And I have never heard of such a thing. I have never heard of any mining project where someone has said wet tailings will act as a buttress against landsliding. This is another case where I'd say can you give me an example of where this has been successful in the past.

Mr Muir: I don't think that we should elevate it beyond the point that was being made by Dr Matuschka. I don't think that he put it any higher than it might – that it would have possibly some effect. Dr Matuschka?

Dr Matuschka: Yes, I think it's well-known that when you retain water or any other fluid or substance against a landslide, it extends below the level – that it does have some confining effect. It does provide some restraint as compared to not having anything there at the toe of the landslide. There is a competing effect which is acknowledged that it will rise the level of ground water at the toe of the landslide but you can't overlook the fact that the water pressure or tailings pressure in tailings exerts a higher pressure than tailings – than water because it has a higher density – probably 50 per cent greater. So that does have a beneficial factor and that's well-known if you're in the field of analysing landslide stability. There is a restraining effect.

Mr Muir: It sort of makes – to the non-educated eye, that sort of makes sense Dr Emmerman, do you accept that? Professor Emmerman.

Prof Emmerman: I guess I'm really concerned about whether this has any significant effect and whether this is anything anybody would depend on. Otherwise, yeah, I mean in theory it makes sense. I just never heard of anybody depending on this.

Dr Matuschka: It's quite common when there are landslides to buttress the toe of the landslide, that's a common form of mitigating or reducing the potential for – or providing a stabilising effect on a landslide – is providing a buttress. And the tailings are effectively doing that. They're providing a buttress – it's a weak buttress but it does have a positive effect in terms of providing some restraint. We consider that when we're analysing the stability of the landslide and that will be documented in the building consent application.

Mr Muir: Any other issues that you think, Professor Emmerman, we have omitted?

Prof Emmerman: No, it's fine. I think – no, I think we've covered everything that I had in mind.

Mr Muir: Thank you very much. Could I just have a check in please with Mr Macdiarmid – is there anything that ORC wanted us to review today that has not been?

Mr Macdiarmid: I think we've covered everything. Just for the record, I agree with the buttressing effect of the tailings on the landslide.

Mr Muir: Yes. Dr McAlpine?

Dr McAlpine: I would like to address one point in my initial statement of evidence that when I wrote it I thought was a relatively minor issue – like a third priority and certainly way below mining-induced seismicity – and I'm prompted to do so by something you mentioned earlier which was reference to this very strong emotional response or feelings that there are about a tailings dam. My background is more in petroleum-induced environmental effects and some work has been done and I was – had an input to that which was looking at the harm caused to communities through the anxiety of things like, in my case, fracking, compared with the actual physical harm that was produced by the activity itself. So the measurable harm in terms of anxiety, visits to the doctors, social cohesion and so forth. The work was eventually published just as I think an unpublished master's thesis but I have spoken to it at the university when I give an address. The emotional aspect of the tailings dam is – we will all probably have a perception of why it's so unwelcome. Some people will think it can collapse and wash away their homes and houses. I'm absolutely confident that that is not the risk in the case of Bendigo where it is buttressed and so forth. I completely agree that that is totally – total red herring. But it is something that you see through social media and so forth that people are alarmed and concerned about.

The other I think key aspect of the anxiety is that this is a poison. It's a poison that is stored and in fact it's wrong to call it stored, it's – probably the closest word is dumped because "store" in resource management terms and in the dictionary is to hold onto something for later use, and that is not the intention. So there is a dump of material that is threatening, through seepage and so forth, environmental harm.

I think it's – I would like to observe that I'm – two other things. So what makes a dam safe to a community? In the New Zealand Society of Large Dams, the definition of a safe dam is one that is acceptable to regulators – other things as well but it included the community. The statement that to be a safe dam, its definition is it has to be safe to the community. In the GISTM, there is a – not in the definitions but in the description around the community and what the community deserves, there is a very detailed prescribed process for the global community to be involved in every stage of the dam's lifecycle, right from the definition concept select phase, right the way through into abandonment post-closure. And that is meaningful engagement, which we have – engagement in the community between the applicant and the community – but also a two-way development of the actual plan itself. So I think – I wanted to touch on that because we did have it on our agenda as what are the comparisons between the GISTM requirements and the New Zealand requirements with respect to what makes a dam safe. And I think it's [inaudible 00:49:50] it behoves the proponent of a project to be absolutely quite clear that they are, you know, hands and feet involved with the community in developing the project rather than saying "this is what we're going to do and this is how we're going to do the engineering so the engineering is up to scratch".

The other – following on from that if I may, which is actually more specifically the point I made in my initial statement, was that the option I'm surprised that I haven't seen considered is that increasingly now gold tailings, by-products and so forth are being mined – effectively recovered – reworked. In the past it was reworking of all mine pits and so forth.

Mr Muir: That's what $5,000 an ounce does for you?

Dr McAlpine: But the most efficient way of reworking it is not after it's been left for 50 years and so forth, it's at the point of production. And I think for this project to satisfy its stated objectives of being modern and leading edge – or maybe not leading edge but [inaudible 00:51:28] of good mining practices. I would think that there is an opportunity here by addressing that reworking which is also removal of the toxic elements of critical minerals such as arsenic, you actually no longer have a toxic tailing, you have a relatively benign and safe tailing. So I think that's one aspect of the mitigation of the harmful effects or potential harmful effects of the tailings dam that has not been explored and given the number of – small number of minerals which are on the critical minerals list and which are highly valuable, there is an opportunity there that perhaps it could be – whether it's caught in consents or what I don't know – but certainly should be looked at and I think that would go a long way to helping with the restoration of the risks and uncertainty and the anxiety that is affecting the community.

Mr Muir: Thank you. Is there anything there Dr Weber that you wanted to respond to?

Dr Weber: Yes thank you. I might just [inaudible 00:52:58] back – apologies but just back to this morning's conversation about tailings firstly and putting them in a variety of different places. From my perspective, that just increases your risk because then you're spreading tailings across multiple facilities. I'd much rather see them contained in one place. There's a very good engineered design where we know, except for this bugbear of seepage, it all comes out to one point. That gives me confidence to manage it. If it's put in the other satellite pit I'd have – I'd have to do a lot more work and I would also see it as a higher risk so I would – from a geochemistry perspective, I would be not enthusiastic about that.

Just in regards to some of the other points raised by Dr - - -

Dr McAlpine: Alex. Call me Alex.

Dr Weber: I've forgotten your last name Alex. Trying to catch the value as it comes out of the pipe. Gold has its point at that time of processing. So when I went to [inaudible 00:54:10] in the late 1990s, they were reprocessing tailings then. The grade then was one gram per ton.

Mr Muir: And we're at four here?

Dr Weber: I'm not sure of the grade here.

Mr Muir: So certainly a lot higher grade than that? And higher grade overall than Macraes.

Dr Weber: Yes, one gram per ton, the purpose of the story is they were reprocessing because it had already been milled up and it was easy to get, even though no other projects were higher, this is, you know, 25 years ago. Since then, they've also gone back and remined that again at .3 grams a ton because it was economic to do so. So if there's any product, and I don't know what the product is that's going out of the tailings storage facility, it may actually be economic in 50 years' time or 100 years' time and you're not going to chase that now, you'll chase it in the future. So I acknowledge that it is a future resource and so within a facility like that, there may be benefit in the future. That's beyond the scope of this project because no one can opine on that.

Mr Muir: I think Dr McAlpine was trying to sort of tie the sort of – what I understood as sort of like easy – you're taking the easy pickings of a higher grade ore that's not been processed to its greatest potential and in the course of doing that, you could have done a lot more about the things that worry the community. Is that right?

Dr McAlpine: Yeah, that's absolutely correct. I mean, from my understanding, and one of the difficulties in making the statement I've just made, is that I found it difficult to see in the applicant's documentation exactly the thing that you were saying you didn't quite know – what is the chemistry of the tailings as they come out of processing after the maximum gold has been extracted. But I pointed out from some of the tables and so forth that there's 20 per cent less – or there's only 20 per cent of the gold that comes out of the refractory after the initial treatment, before it goes to the storage pit – 80 per cent of the final last remaining gold is [inaudible 00:56:37 – background noise] so it's a very, very low gold grade [inaudible 00:56:39 – background noise] because gold is so overwhelmingly valuable but I'm really talking about the other much more abundant, in terms of quantity, abundant elements such as arsenic, which is really very – quite abundant in the [inaudible 00:57:01].

Dr Weber: So you could do a desulphurisation process. So you could look at, you know, removing the arsenic [inaudible 00:57:09] and the other sulphides and all those other sulphides are in my reports. But then what do you do with that? Where are you going to put all that? That would have to go into another facility and we know the tailings facilities manage these products. You don't get a [inaudible 00:57:25] oxygen increase in the tailings. It's diffusion through the top and there's going to be a cover system put on top to minimise that. So for this project I don't see a real benefit of separating out those sulphide minerals, unless there was value to do so of course, which is maybe what Alex is talking about. Do you put that somewhere? But that's a lot of effort for a future value that might not be realised for a very long time. Other than that I didn't really have any other comments.

Mr Muir: Yes, thank you. Mr Pizey, any matters that you wanted us to consider before we close this session?

Ms Buxeda: Hello, Mr Chairman, this is Ms Buxeda speaking.

Mr Muir: Ms Buxeda. Yes.

Ms Buxeda: Hello. Mr Pizey's connection has dropped off. He is able to continue to watch us, however he has text me clear instructions that he has nothing else to raise here. He is happy with the topics that have been dealt with.

Mr Muir: Thank you very much Ms Buxeda. Now, I've lost my place completely. Any issue which the experts called by the applicant consider that we should address before we close? No. Any counsel – any matters? No. Very good. I thank you all very much for another – from our perspective and we've been talking about this all day – very valuable session. I know that I sound repetitious for the perspective of counsel, but we are extremely grateful to the quality of the experts that have been appearing before us for the last six days and today is yet another example of not only their intelligence, competence, but also their high degree of professionalism in their inter-relationship with others of their same discipline to produce a result which is and has been very useful to us as a panel. Thank you very much indeed. I don't know that I'll be saying the same of all the economists.

??: Can I just [inaudible 00:59:53] that New Zealand drew with Iran.

Hearing concluded