Board of Inquiry into the McCrae landslide

Before: The Chairperson,
Ms Renée Enbom KC

County Court of Victoria,
250 William Street, Melbourne, Victoria

Wednesday, 7 May 2025 at 10.00am

(Day 1)

Mr M. Costello KC with Mr A. Di Stefano and Ms A. Kittikhoun appeared as Counsel Assisting.

Ms K. Evans KC with Ms E. Peppler and Mr C. McDermott appeared on behalf of the State of Victoria.

Ms K. Foley SC with Ms E. Bateman, Mr C. Viney and Dr W. Phillips appeared on behalf of the Mornington Peninsula Shire Council.

Ms D. Siemensma appeared on behalf of South East Water Corporation.

CHAIRPERSON: Good morning, all. This is the first public hearing of the board of inquiry into the McCrae landslide. My name is Renée Enbom, and I have the privilege and responsibility of being the chair of this board of inquiry. This hearing is being held on the lands of the Wurundjeri people of the Kulin nation, and I wish to acknowledge them as traditional owners. I would also like to pay my respects to their elders, past and present, and Aboriginal elders of other communities who may be here today.

Ms Jones, will you please now read into the record the order in council establishing this board of inquiry.

MS JONES: The Governor in Council, on the recommendation of the Premier, under s53(1) of the Inquiries Act 2014 appoints Renée Enbom KC to constitute a board of inquiry to inquire into, report on and make any recommendations considered appropriate in relation to the terms of reference specified in this order. This order comes into effect on the date it is published in the Government Gazette.

The objectives of this board of inquiry are to determine the causes of the McCrae landslide; determine the adequacy of measures taken to prevent and minimise landslides and landslips in the McCrae area, including reviewing responses to the November 2022 and 5 January 2025 landslides and landslips in the area to the extent that this information is available and relevant to the McCrae landslide; and identify measures to be taken for the prevention or mitigation of the risk of similar landslide events to the McCrae landslide occurring in future in the McCrae area.

Terms of reference. Having regard to the objectives set out above, you are required to inquire into, report on and make any recommendations considered appropriate in relation to the following terms of reference: (a) the causes of the McCrae landslide; (b) the actions (including any inaction) and decisions of connected parties, including actions taken to prevent or mitigate landslides and landslips in the McCrae area, and actions and/or decisions taken that may have contributed to causing the McCrae landslide (including, without limitation, approving and issuing permits, and undertaking building, road, water or other works); (c) the adequacy of any risk assessments

undertaken to determine the likelihood and severity of landslides and landslips in the McCrae area before the McCrae landslide; (d) the adequacy of preventative and mitigative measures taken before the McCrae landslide, including actions that could have been but were not taken by connected parties; (e) any barriers to the implementation of measures to prevent or mitigate landslides and landslips in the McCrae area that existed before the McCrae landslide occurred; (f) the regulatory framework, including the responsibilities, powers, duties and functions of all responsible authorities in relation to the prevention and management of landslides and landslips in Victoria; and (g) identify any measures for the prevention or mitigation of the risk of similar landslide events to the McCrae landslide occurring in future in the McCrae area.

CHAIRPERSON: Thank you, Ms Jones. On 14 January this year a landslide occurred in a residential part of the coastal town of McCrae, which is located within the Mornington Peninsula Shire Council. The landslide followed two previous landslides in the area, one on 5 January this year and the other in November 2022.

The 14 January landslide sent one man to hospital with serious injuries. I acknowledge the trauma that he has experienced. I also acknowledge the distress suffered by the family whose home has sadly been reduced to rubble. Four months on and their collapsed home still sits to the side of Point Nepean Road. They lost their home, a home that they worked hard over many years to be able to purchase to enjoy with their family and friends, and there is currently no clear path forward in respect of their property.

I acknowledge the significant stress that the landslide has caused to other residents. Many residents were compelled to leave their homes and to leave their belongings behind at short notice. Some residents have not been able to return home since the earlier landslide in November 2022. Two and a half years on and those residents are still not able to go home and they do not know when they'll be able to do so.

Shortly after the establishment of this inquiry I visited McCrae and I had the opportunity to speak to many of the residents. They are a community motivated to assist

this inquiry in whatever way they can. I thank the residents who attended, and I thank them for the assistance that they have provided and continue to provide. It is time to find the answers to the important questions being asked by the McCrae community.

I am determined to make findings as quickly as possible as to the cause of the 14 January landslide. The work of the inquiry must be undertaken with care, but it must also be undertaken with speed, given the number of landslides that have occurred in the area and the ongoing impact on residents. I am determined to make recommendations as quickly as possible as to the measures that need to be taken to prevent or mitigate the risk of another landslide. Those residents who have not returned home must be able to do so safely. Those residents who are now back in their homes need to feel safe.

The work of the inquiry will be undertaken with care and speed, and in a manner that is fair and decent. I ask those organisations who are engaging with this inquiry to adopt the same approach. This inquiry is not an opportunity for grandstanding. It is not a place for litigation type strategy. It is a place for finding answers in the public interest.

This is the first of several hearing blocks to be held. This week the inquiry will hear some initial evidence from experts. One of the experts has been working for many months on trying to determine the cause of the landslide. He will assist the inquiry with evidence as to the work he's undertaken to date, and the nature and timing of the further work that is proposed. The inquiry will also hear some initial evidence from representatives of the Mornington Peninsula Shire Council and South East Water. Next week affected residents will give evidence. As I said earlier, there will be further hearing blocks at which more detailed evidence will be given by expert witnesses. Shire and South East Water representatives will also be required to give further evidence in a later hearing block.

Finally, I encourage anyone who is attending today or watching remotely to contact the inquiry if they have information which they believe may assist. Contact details are on the inquiry's website.

Now, before counsel assisting commences, I'll take

appearances from counsel assisting and those parties granted leave to appear.

MR COSTELLO: Madam Chair, I appear with Mr Alexander Di Stefano and Ms Angela Kittikhoun as counsel assisting.

CHAIRPERSON: Thanks, Mr Costello.

MS FOLEY: Madam Chair, pursuant to leave that's been granted on 17 April, I appear on behalf of the Mornington Peninsula Shire Council with my learned friends Ms Bateman and Mr Viney and, today appearing with me Dr Phillips.

CHAIRPERSON: Thank you, Ms Foley.

MS EVANS: Madam Chair, I appear with Ms Peppler and Mr McDermott for the State of Victoria, specifically, Madam Chair, the 15 entities that were granted leave from the board of inquiry through correspondence on 2 May.

CHAIRPERSON: Thank you, Ms Evans.

MS SIEMENSMA: Madam Chair, I appear on behalf of South East Water. We have also been granted leave to appear.

CHAIRPERSON: Thank you. Mr Costello.

MR COSTELLO: Thank you, Madam Chair. Madam Chair, as you are aware, since the inquiry was established there have been a power of work undertaken by those assisting you and by many parties interested in the work of this inquiry. While public hearings of the type we begin today are a very significant aspect of the work of the board of inquiry, a great deal of work occurs outside of public hearings. That work is underway and will continue beyond this hearing block.

Your counsel and solicitors assisting have sought to be judicious in issuing notices to produce documents and in requesting witness statements from relevant entities. The terms of reference which have now been read into the record limit and focus the work of the inquiry, and the reporting deadline necessitates that decisions be made with a view to efficiency.

If the slides could be put up now, please, and I could have slide 2. While that comes up, Madam Chair, can

I mention that up to the point of this hearing you have caused 20 notices to produce to be issued to various parties, which has resulted in, at least at the start of this week, around 1,300 documents being produced. Some of those documents are short. Others are not. A number of them are expert geotechnical and engineering reports, some of which include annexures with the results of scientific testing. All documents produced to the board of inquiry will be carefully scrutinised by those assisting you.

Things have rather moved on from even the start of the week, and since then we have received an additional 1,610 documents, most of them overnight, which we're now in the process of reviewing.

As you have already mentioned, Madam Chair, you and those assisting you are concerned to ensure that the local community most directly affected by these events, their friends and family are given full opportunity to participate in the work of the inquiry, and in so doing have their opinions both heard and considered, and have the effects of these events upon them recorded and acknowledged.

The board's engagement with the local community has been constant. In particular, on 9 April, shortly after the inquiry was called, you, members of the board of inquiry staff and members of the counsel and solicitors assisting teams travelled to McCrae in order to meet with community members and to view so much of the site as was available.

In order to ensure that the community is aware of the fact of the inquiry and their ability to participate in its work, 1,400 flyers have been distributed to the local community and advertisements have been placed in newspapers and online.

Since then, the inquiry has had a number of telephone calls with community members and 32 public submissions have been received as at 5 May, some of them from local residents. A number of local residents will give evidence in this hearing block. On behalf of the legal team assisting you, can I thank the local community for their very active engagement, which has materially aided the work of the inquiry.

Could I turn then to some uncontroversial facts. McCrae is a suburb on the Mornington Peninsula in Victoria. It's situated 59 kilometres south of the Melbourne central business district and two kilometres from Rosebud. It's located within the shire of Mornington Peninsula local government area and is home to over 3,000 people, as at the most recent Census.

During the course of this inquiry, Chair, you will hear much evidence about geotechnical matters and the underlying geology of the McCrae area. The site of the 2022 and 2025 landslides is underlain by Quaternary raised coastal deposits comprising of siliceous and calcareous sand, shell beds and mud islands at the base of the escarpment. At the elevated terrain, that is behind the escarpment, the landscape is underlain by Paleozoic granodiorite and granite.

The relevance of soil types to landslide risk is a matter I will address through evidence later today. Topographically, McCrae can be defined by its near continuous coastal escarpment. Along the toe of the escarpment is a low coastal plain featuring small low-lying dunes.

The McCrae area, as you mentioned, Madam Chair, has experienced several significant landslides in recent times, and there are three landslides referred to in the terms of reference. In fact, there were two landslides in 2022 and two in 2025. In the following section of my opening address I will canvass the key facts concerning the two landslides that occurred in 2022 and the two that occurred in 2025.

The key dates are as follows. In 2022 an initial landslide occurred on Monday, 14 November at the rear of 10-12 View Point Road. In the early hours of the following morning - that is, Tuesday, 15 November 2022 - a subsequent landslide occurred at the same location. In 2025 the initial landslide occurred in the evening of Sunday, 5 January. On the morning of Tuesday, 14 January a subsequent, more severe landslide occurred at the same location, this time completely destroying the dwelling at 3 Penny Lane.

Whether or not it's correct to describe the general area within McCrae as landslide prone, it's certainly the

case that landslides are not unknown in the area. A significant landslide occurred in the general area in July 1952. That landslide, which destroyed eight homes, appears to have occurred near Anthony's Nose, which is an escarpment located between Dromana and McCrae, approximately two kilometres north-east of the site with which this board of inquiry is concerned. The 1952 landslide was triggered by significant rainfall. 1952 was a significantly wet year throughout Victoria. In July 1952 rainfall was the highest on record for the southern parts of Victoria.

The region within Victoria that received the highest-on-record rain included the McCrae area. Although the Anthony's Nose landslide in 1952 is two kilometres from the site of the events with which this board of inquiry is concerned, it is of some relevance in understanding the geological and slope conditions, and the effect or potential effect of significant water on those conditions.

Can I return now to the 2022 landslides. As I mentioned, it's important to note that two separate landslides occurred, the first on 14 November. If we can bring it up, Madam Chair, I'd like to show you a diagram of this area. I think there's a difficulty with the IT system.

CHAIRPERSON: Would you like me to stand the matter down briefly while we investigate?

MR COSTELLO: I think that might make it more efficient, if you wouldn't mind.

SHORT ADJOURNMENT

MR COSTELLO: Chair, I apologise for the delay.

CHAIRPERSON: Not at all.

MR COSTELLO: The problem has been remedied, happily. If I might just quickly traverse some of the ground I went over. These are some facts and figures in respect of the community engagement that the board has undertaken since it was established, and some of the data concerning documents obtained and witness statements received and prepared by the board. As I mentioned, overnight the number of documents obtained in response to notices to

produce has more than doubled.

If we could move to the third slide, please. This is just an identification of the McCrae area within, first, the greater Melbourne area and the Bellarine Peninsula, and then within Mornington Peninsula and McCrae as it sits in connection with Arthurs Seat.

If we move to the next slide, please. I mentioned, Madam Chair, the underlying geology of the region and, having I think pronounced each of the difficult words correctly the first time around, I'm not going to try and do it a second time. But the map on that slide relevantly also shows the Selwyn Fault, which is a very significant geological feature of the region and of this particular area where the slide occurred, and you will hear some evidence about the Selwyn Fault and its significance in the geology of the region during the course of these hearings.

If we move to the next slide, please. This is a topographic map of the precise area where the slide occurred. As I mentioned, topographically the suburb is most significantly defined by its near-continuous coastal escarpment, and along the toe of the escarpment is a low coastal plain featuring small low-lying dunes. You can see there the topography from the blue lines of the hill that is the hill in question, here top of the hill being View Point Road and the bottom of the hill being Point Nepean Highway

If we could move to the next slide, please. As I mentioned, there were in fact four landslides that this inquiry must give consideration to. The 2022 landslides are to be given consideration in connection with their relevance to the 2025 landslides. We are not called upon to make findings as to the independent cause of the 2022 landslides, but you will hear evidence about those matters.

If we could move to the next slide, please. You'll recall, Madam Chair, I mentioned the 1952 landslide that occurred near Anthony's Nose two kilometres from this site and that it was a significant event not only for McCrae but for the whole of Victoria in that eight homes were destroyed.

Next slide, please. Rainfall is one of the most significant factors necessary to consider in connection

with landslides and, as I mentioned, 1952 was an historically wet year. You can see the dark blue shading on the map there is indicative of highest-on-record rainfall, and the entire Mornington Peninsula and a significant portion of Victoria beyond that is shaded in dark blue there.

Next slide, please. So we move now to the 2022 landslides, and if I could have the next slide. What's identified on that map is the affected landslide area. The yellow dotted line takes in 10-12 View Point Road, which is at the top of the hill, and the area to the left of the red arrow is the area where the landslide in 2022 - or landslides, rather, in 2022 occurred.

If we could move to the next slide, please. In 2022 there were site inspections conducted by a senior principal from Stantec. That is a firm of geotechnical engineers. They inspected the site on the afternoon of 15 November 2022. There was also an inspection by another consulting engineering firm, Logocon, on 24 November 2022. Those inspections included visual non-invasive investigations, and you'll hear some evidence later today, Madam Chair, about the difference between invasive and non-invasive investigatory techniques in connection with landslide investigation. Independent observations were made. In addition there were discussions with local residents with a view to seeking anecdotal information that might bear upon a proper assessment of the causal factors of the landslide.

If we move to the next slide, please. Still here in connection with the 2022 landslides, in particular the first of them, the reports of the geotechnical engineers engaged in relation to that landslide suggests that an initial landslide occurred on the afternoon of 14 November; it occurred at the rear of 10-12 View Point Road on the upper slope; it was categorised as a translational landslide - that is in contrast to a rotational landslide, and Mr Paul will give evidence about the difference later today - and it was considered a landslide that was moderate to rapid in nature. Moderate to rapid means that the earth moved in the order of metres per hour to metres per minute.

If I could have the next slide, please. Of potential relevance, the owners of unit 3/613 Point Nepean Road reported hearing a loud noise at the back of their property early in the morning of 14 November, they think at

approximately 6.30 am. However, they did not identify anything visually at that time that indicated that a landslide had occurred.

Next slide, please. In the early morning of 15 November 2022 the second landslide occurred. This landslide manifested as a debris flow from the middle part of the slope down to the toe, resulting in and impacting on 3 Penny Lane. Debris also flowed into the backyard of unit 3/613 Point Nepean Road. This landslide, in contrast to the first, was considered very rapid to extremely rapid, meaning that the earth moved in the order of metres per second. Inspection of the failed slope indicated the displaced soil was sand. Several properties were evacuated after the 15 November 2022 landslide, including 2 Penny Lane, 3 Penny Lane, unit 3/613 Point Nepean Road, 10-12 View Point Road and 14-16 View Point Road.

If I could have the next slide, please. Madam Chair, this image depicts the location of the initial landslide on 14 November. You can see 10-12 View Point Road to the top left of the image at the top of the hill. The subsequent debris flowed down the hill on 15 November. That's evident from the middle of the image of the slide. The arrows give you an idea of the impact and effect of each landslide, the first landslide being smaller and settling at about the middle of the hill, and the second landslide, the earth travelling further from the middle of the hill towards the base.

If we could move to the next slide, please. This image depicts the subsequent debris that impacted the slope leading down to Penny Lane from View Point Road. It shows the view looking up from the base towards 10-12 View Point Road.

If I could have the next slide, thank you. This is an image of debris flow from the 15 November 2022 landslide. It was taken by the owners of unit 3/613 Point Nepean Road from their garden. As you can see, Madam Chair, the debris flow has damaged the rear of their property but thankfully did not impact the home itself.

One of the residents of unit 3/613 Point Nepean Road took this image of the escarpment on the morning of 15 November 2022 following the landslide. The image indicates the presence of significant water flow down the

escarpment at that time. You can see from the image that the debris looks like mud, is largely sodden and that there is open water towards the base of the flow.

If I - thank you. I mentioned once already that rainfall is an important consideration in connection with investigating causal events leading to landslides. On 14 November 2022, that is the date of the first landslide, 80 millimetres of rain was recorded by the Bureau of Meteorology rain gauge located at the Rosebud Country Club, which is three to four kilometres away from the site. According to that data, that was the highest single day of rainfall at that rain gauge since February 2005.

More generally, the monthly precipitation for October and November 2022 was much higher than previous years dating back to 1927. The precipitation for November 2022 was triple the historical average.

If I could have the next slide, please. A land survey was conducted of the slope by GJ Martin Consulting Land Surveyors on 11 November 2022, and a drone topographical survey was conducted by CivilTest on 2 December 2022. The two surveys by GJ Martin and CivilTest have been overlaid in this graph to estimate the extent of the earth flow on 15 November 2022. The red line highlights the loss in volume to the face of the escarpment following the two landslides in 2022, and the dotted blue line is a projection of the pre-landslide hillscape.

One of the matters of relevance to which your attention is specifically drawn in the terms of reference, Madam Chair, is the fact of extant legal proceedings and their relevance to the matters that this board is charged to inquire into. There are current proceedings on foot before the Building Appeals Board relating to the 2022 landslides, including with respect to emergency and building orders issued by the Mornington Peninsula Shire Council following the 15 November 2022 landslide and proposed rectification works to stabilise the escarpment and eliminate danger to life and property.

There are also current proceedings on foot before the Victorian Civil and Administrative Tribunal regarding the 15 November 2022 landslide which were commenced by the owners of 10-12 View Point Road against the shire council.

Last week the Building Appeals Board delivered a determination in proceedings issued by the owners of 10-12 View Point Road, and found that the emergency order and building orders issued to them by the shire council were invalid. Proceedings issued by the owners of unit 3/613 Point Nepean Road in the Building Appeals Board are still awaiting determination. The solicitors and counsel assisting are giving active consideration to the matters raised in those various proceedings.

If I could have the next slide, please. If I could return now to the 2025 landslides. As you know, Madam Chair, the first was on 5 January and the second was on 14 January. The 5 January landslide occurred in the evening, and the 14 January landslide occurred at approximately 8.30 am.

If I could have the next slide, please. This is an aerial image of the landslide site before the - thank you. This is an aerial image of the landslide site after the 14 January 2025 landslide. You will note the significant debris. Could we just go back one slide, please; thanks. You'll note the significant debris, and evident at the bottom of the slope is the destroyed property at 3 Penny Lane in the centre of the image.

If we move to the next slide. There are side-by-side before and after images of the relevant site, the first before being before either of the 2025 landslides and the second being after the both of them.

If we could move to the next slide, please. Madam Chair, you know 3 Penny Lane was destroyed in the second 2025 landslide. It was a three-storey house built in 1999. It sat on an 828 square metre block. It had four bedrooms, two bathrooms and two parking spaces. It had only been purchased by the current owners, Nick and Kelly Moran, in 2023.

Madam Chair, you will hear evidence from the Morans that 3 Penny Lane was a much-loved holiday home for them and for their immediate and extended family. Nick, Kelly and their children spent the June 2023 school holidays and the September 2023 holidays at 3 Penny Lane, and they often spent weekends at the property, more often than not with extended family and friends.

In the weeks leading up to 5 January 2025, 3 Penny Lane was rarely vacant. Nick, Kelly and their children were often there and, when they were not, various friends and family stayed at the premises.

If I could have the next slide, please. The property at 3 Penny Lane was built on a slope that runs roughly from beach level at Point Nepean Road and Penny Lane to the top of McCrae hill on View Point Road, and you can see the property there with the white box around it. To the left of the shot you can see two houses at least on View Point Road. The second house, that is the house without the flat roof, is 10-12 View Point Road, which sits almost directly above 3 Penny Lane.

Could I have the next slide, please. On 5 January at approximately 7.30 pm the initial landslide impacted 3 Penny Lane, McCrae. Kelly Moran and her daughter were inside the property when the first 2025 landslide occurred.

Could I have the next slide, please. The property sustained structural damage to the rear. It's approximated that 20 to 25 tonnes of material struck the dwelling, causing moderate damage to the external walls and structural piers. The external wall of the centre of the dwelling was deemed unsafe and unstable. The undoubted source of the landslide was upslope towards 10-12 View Point Road.

Madam Chair, you will hear evidence next week from Kelly Moran as to her experience being in the property at the time of the 5 January landslide. You'll hear that Ms Moran heard a large rumbling sound, which she thought was thunder, and then the whole house began to vibrant. She observed the rear of the second floor of the property being pushed into the house where her and her daughter were standing. Once the vibration stopped she saw that the laundry door and laundry cupboards had been pushed into the hallway of the home, completely blocking all access to the bedrooms in that part of the house.

Next slide, please. A number of properties were affected by the 5 January landslide, including 10-12 View Point Road, 3 Penny Lane and 607-609 Point Nepean Road, which is located downhill, further downhill of the landslide activity. There were not emergency orders issued to evacuate residents at that time.

If we move to the next slide, please. It should be noted that rainfall data indicates that there was no rainfall in the month of January preceding the 5 January landslide. That puts the 5 January landslide in a categorically different position to the 2022 landslides and of course the 1952 landslide. More specifically, the graph on the right of the slide shows zero millimetres of rain as at 5 January 2025.

Could I have the next slide, please. The first rainfall event of the year in McCrae was on 7 January 2025. You can see there, Madam Chair, a recording of 14 mms on 7 January. There was also rainfall on 13 January, 9 mms, which is on the moderate to light side.

If I could have the next slide, please. Temperature data indicates that the weather preceding the landslide was hot and dry in the McCrae area. The graph here - the map here, rather, indicates that the maximum temperature for the first week of January 2025 was between 24 and 27 degrees.

If I could have the next slide, please. Despite the lack of rain, water flow was observed after the landslide. A significant portion of the head scarp was saturated in the week of the 5 January landslide. A measurable flow of water of 0.15 to 0.2 litres a second was observed to be flowing down the hill. The seepage was observed at the point between the surface soils and the underlying natural soils.

Could I have the next slide, please. Following the 5 January landslide, Nick and Kelly Moran vacated 3 Penny Lane and removed various items from the property over the coming days. They also attended at the property to meet with various representatives from the shire council and from their insurer. They did not receive a formal evacuation order, though it was plain that they could no longer remain in the premises and came to that conclusion themselves.

The residents of 10-12 View Point Road and 607-609 Point Nepean Road also remained in their respective properties during this period and were not formally evacuated.

Can I have the next slide, please. Madam Chair, you are not called upon to make recommendations or findings in connection with the immediate response to the landslide, but it is worth at least noting that the Victorian State Emergency Service were on site within two hours of the landslide. On that day and over the coming days the Victorian SES were focused on diverting water out of the 3 Penny Lane property and assisted the owners in moving and removing furniture from the property.

South East Water switched off water to 3 Penny Lane shortly after the landslide. Between 5 and 14 January representatives from and on behalf of the shire council, including building surveyors and geotechnical engineers, attended at the property, and representatives from the owners' insurer were also on site at various times and engaged in discussions with some of the other parties on site.

If I could have the next slide, please. On 14 January at approximately 8.30 am a subsequent landslide destroyed the dwelling at 3 Penny Lane. The collapse shunted the house towards 607-609 Point Nepean Road. It did not impact the building on that property except for some distortion to a rear retaining wall. The source of the landslide was upslope at 10-12 View Point Road.

Next slide, please. Subsurface water was observed during a geotechnical engineer's visit. That water was discharging from points near the initial landslide area towards the rear of 10-12 View Point Road. The following day approximately 9 millimetres of rainfall occurred in the area.

Next slide, please. This photograph shows exposed material at the landslide site. Some of the exposed material in the gully is observed to be dark in colour, whereas material exposed in an adjacent slope appear to be pale brown and sandy. The characteristic of soils of those colours is a matter of inquiry.

If I could have the next slide, please. While failure mechanisms were not able to be identified immediately, it was concluded that the landslide transitioned into a rapid debris flow, with runout extending its reach to below the properties. It is acknowledged that 2 Penny Lane acted as a barrier to slow and stop the debris.

Could I have the next slide, please. A total of 19 properties were originally evacuated on 17 January 2025. Madam Chair, you can see, although it may be a little hard to identify the precise addresses, that this map sets out the addresses of each of the relevantly affected properties, some of which I have spoken of already. You can see at the base of the hill 3 Penny Lane, which is sat behind 607-609 Point Nepean Highway, and directly behind 3 Penny Lane is 10-12 View Point Road on the one side and 6 View Point Road on the other.

Of the 19 properties originally evacuated on 17 January 2025, 11 had emergency orders lifted on either 14, 20 or 21 February or 15 April. Those residents have been allowed to return to their homes, with the exception of course of 3 Penny Lane. Eight properties still remain in the exclusion zone, with residents unable to return to their properties.

Finally, Madam Chair, I must mention that a Mornington Peninsula Shire Council worker was on site at the time of the 14 January 2025 landslide. He was one of a number of Mornington Peninsula Shire Council officers and staff who had attended from time to time at the property. He was the only person on site at the time of the 14 January landslide, and as a consequence of being in attendance at the site at that time he sustained serious injuries as a result and was taken to hospital. Of course our thoughts are very much with him.

Madam Chair, those are the factual matters connected with the 2022 and 2025 landslides that I wanted to outline. At this point I intend to move to a different topic, namely erosion management overlays, and I'll then return in some sense to the factual matters I've addressed to identify current lines of inquiry.

CHAIRPERSON: Thanks, Mr Costello.

MR COSTELLO: Erosion management overlays are something that you will hear a significant amount of evidence about in the course of this inquiry. An erosion management overlay is the principal planning control for landslide risk in Victoria. Although named "erosion management overlays", they are directed to erosion, landslip and other degradation, and have firmly within the core of their

purpose prevention of landslides.

Erosion management overlays are part of the Victorian planning scheme. In general terms, the regulatory scheme is as follows. Each local government area has a unique planning scheme. That planning scheme will, amongst other things, identify the extent to which an overlay applies to particular land identified with precision by a map.

Overlays complement but are separate to zoning. Overlays are a method of applying additional subject matter-specific planning controls, for example, with respect to heritage preservation, flood, bushfire or, in the case of an erosion management overlay, landslide management. Not all land in a given local government area will be subject to an overlay, while some land may be subject to various overlays, including an erosion management overlay.

The overlay information will indicate if a planning permit is required for the construction of a building or other change to the land, and sets out the requirements for subdivision and building works that apply in addition to the requirements of the zoning. An overlay may specify information that must be submitted with an application for a planning permit.

In broad terms, if an erosion management overlay applies to land it can trigger the requirement for a planning permit for buildings and works, including for types of developments that are ordinarily exempt from planning permits under statewide controls.

In addition, any application that would ordinarily require a planning permit - to take as one example, a subdivision application - in respect of land affected by an erosion management overlay, that application will be required to demonstrate that the objectives of the overlay are met.

Where an erosion management overlay applies it is likely to have practical consequences, such as requiring additional stabilisation work in respect of the site or the preparation of specific geotechnical hazard and risk assessment reports, ordinarily to be prepared in accordance with the Australian Geomechanics Society guidelines.

There are erosion management overlays within the Mornington planning scheme. Somewhat unusually, the Mornington scheme does not apply a single overlay to identified areas but applies six distinct overlays, the most recent of which was introduced in January of this year. It appears the more common practice in local government areas in Victoria is for there to be a single erosion management overlay in a local government area. That is not to say that there is anything inappropriate about the method employed by the shire here. Indeed, it may be that a multiplicity of erosion management overlays is a better system designed to suit site-specific conditions. These are matters that we will consider in the course of the inquiry.

For present purposes, I simply note that the method employed by this council is not the universal method employed throughout Victoria.

Madam Chair, can I take you now to parts of the Mornington Peninsula planning scheme. Could I have document INQ.003.0001.0002. INQ.003.0001.0002. This particular document I think might be in the court book in more than one place, so I might have another document ID I can give. Perhaps I'll try another ID. Can I try INQ.0003.0001.0004. I think they're being moved across into the hearing book. That's fine.

Madam Chair, I know you wanted to take a morning break. Would now be the appropriate time or would you prefer me to continue?

CHAIRPERSON: We can do it now.

MR COSTELLO: All right. Thank you.

SHORT ADJOURNMENT

UPON RESUMING

CHAIRPERSON: Mr Costello, don't be alarmed by me standing. I'm going to stand from time to time due to a back injury.

MR COSTELLO: As long as you're happy for me to keep standing, Madam Chair, I've got no objection to it.

I was in the thick of describing in a general sense the erosion management overlay system and how it sits within the broader regulatory regime in respect of planning in Victoria:

I now want to go a little more specifically to some of the particularity of the Mornington planning scheme. Just to acquaint you, Madam Chair, with some aspects of it, this is a topic that I'll take up with Mr Paul, but at least it seems sensible to do it at least in an introductory sense now.

If I could have on the screen, please, INQ.0003.0001.0001. This is a version of the Mornington Peninsula planning scheme. As you would be aware, Madam Chair, planning schemes within local government areas are not irregularly updated for a variety of reasons. This particular version that is on screen was updated on 19 December 2024. That's shortly before the first 2025 landslide. As I mentioned, there has been a subsequent amendment to the scheme that is of at least tangential relevance here in that at the time of this scheme there were five erosion management overlays in place in the shire, a sixth was added in January 2025, but I needn't go to the specificity of that for my current purposes at least.

So this document sets out the planning scheme for the whole of the local government area, and in that sense deals with a great number of topics that are outside the terms of reference of this board of inquiry but, relevantly, deal with erosion management overlays.

If I could please go to page 85 of that document, and if that could be blown up a little bit. Thank you. You will see here, Madam Chair, this is clause 13.04 of the scheme, and it is addressed to erosion and landslip. It identifies the objectives as being to protect areas prone to erosion, landslip and other land degradation processes, and underneath that it identifies strategies, namely identify areas subject to erosion or instability in planning schemes, and, when considering the use and development of land, prevent inappropriate development in unstable areas or areas prone to erosion, promote vegetation retention, planting and rehabilitation in areas prone to erosion and land instability. So that is the general objective and the general strategies.

If we could then move to the next page, please. This is a more specific example directed to Mornington and Flinders, and you'll see there that this particular policy applies to land affected by two of the what at this time were five but now six overlays in place. You will see that the strategy identified is to encourage development on land that presents the least risk to property and life. Beneath that there are policy guidelines. Those policy guidelines direct that developments should avoid soakage pits and absorption trenches, significant cut or fill of slopes, the removal of vegetation, including the removal of roots of any felled vegetation, and locating buildings on the public land east of The Esplanade in Flinders.

There's then something more specific in relation to land in proximity to Tanti Creek, and you'll see the third bullet point: development should be discouraged if a geotechnical hazard and risk assessment shows that the development has a loss of life risk for the person most at risk that exceeds 1 in 100,000 per annum. This is a topic I will take up with Mr Paul and ask him to explain the concept of loss of life risk, the concept of person most at risk, and how these calculations are done so as to identify who is the person most at risk and what the chances of a loss of life of that person are.

Then you'll see there's more specificity set out in the table below, the far left column being the likelihood of risk, with an indicative value of approximate annual probability, and then there are gradations of risk from catastrophic through to insignificant.

If we could then move to internal page I think it's 755. Yes, thank you. We're now in that part of the planning scheme that concerns the particular erosion management overlays. You will see identified is, in the second line under "Purpose", "to protect areas prone to erosion, landslip and other land degradation or coastal processes by minimising land disturbance and inappropriate development". There's then the objectives and statement of risk. There's then a statement regarding buildings and works. Relevantly, a permit is required to construct a building or to construct or carry out works, including works of the kinds identified there, two specific and then one by reference to a schedule. I needn't trouble you with VicSmart applications. That's an expedited process for

simple planning applications of an eligible kind.

You'll then see at the foot "Vegetation removal", where an EMO applies a permit is required to remove, destroy or lop any vegetation, save for those exceptions to the general principles set out in the three bullet points below.

If we go over the page you will see that there is a lengthy table of exemptions. Yes; thank you. Now, most of these exemptions are not of particular relevance in the domestic setting, although some of them are. You'll note, for example, planted vegetation, potentially noxious weeds, an exemption in respect of surveying.

Then if we go over the page you'll see there set out a list of considerations required to be taken into account in the assessment of an application, including whether buildings or works are likely to cause erosion or landslip.

Now, as I mentioned, the particular scheme within the shire sets out at this point in time five and now six erosion management overlays that start with EMO1 being the overlay that applies in respect of areas of least risk and imposes the slighter controls through to areas more prone, to which there are significantly greater restrictions on the potential use of the land and additional hurdles that need to be met in order for any permit to be approved.

If we could go forward in the document to about page 765. Thank you. If we could go, sorry, one back. You'll see here by way of example, Madam Chair, this is concerned with EMO4. The objectives are stated below, and then the statement of risk says that, "Areas susceptible to landslide have been identified to occur along the coastline, creeks and steeper sloped inland parts of the Mornington Peninsula. Inappropriate use and development, including vegetation removal, can exacerbate the risks of landslide to life, property and environment associated with these areas. Problems may include restricted usability; structural stability; cracking and rising damp. Changes in drainage patterns or the water table could also contribute to further instability with associated risks to water quality and the protection of indigenous flora and fauna."

And then beneath that there are permit requirements. Permits are not required in the particular circumstances

set out in the three bullet points there: where the building height isn't to be increased, there's no ground disturbance or no changes to stormwater runoff. If one is in a circumstance where any of those things will be affected, then under EMO4 you are in a permit application process, and the application requirements are set out there in clause 4 of schedule 4.

This, Madam Chair, gives you an idea of the types of impositions imposed upon landowners in connection with the development and use of their land in circumstances where an EMO applies. You will see that these steps are required to be undertaken to the satisfaction of the responsible authority, and the first is a site-specific geotechnical hazard and risk assessment, and that report needs to be prepared by a suitably qualified geotechnical engineer or engineering geologist with experience in landslide risk management. So this isn't a document that can be prepared by any civil engineer. Experience in the subspecialty of geotechnical engineering with specific experience in landslide risk is necessary.

There are then prescribed aspects of the report that must be included, and you'll see it includes a history of the land use; geological and topographical information; the findings of a detailed inspection of the site; analysis of an historical sequence of aerial photographs; an inventory of the location, nature and extent of individual landslides in the area sourced from the shire's landslide inventory or other relevant historical documents; an assessment of likely groundwater levels, including responses to rainfall events, and at least three boreholes dug to a minimum depth of five metres.

If we could go over the page, there's then reference to further essential aspects of the geotechnical report, including standard penetrometer testing; application of geotechnical testing by an accredited soil laboratory; the development of a geotechnical model, including the identification of geomorphic processes; and a computer slope stability assessment. That's just one aspect of the permit process here, and you will see that in the bullet points they're under there are others, including geotechnical hazard assessment; if the land is affected by the further EMO, EMO5, there are additional requirements of a qualitative risk assessment in accordance with the Australian Geomechanics - sorry, quantitative risk

assessment of the site in accordance with the Australian Geomechanics Society's guidelines, and a variety of other things.

So you can see from this, Madam Chair, that depending on the nature of the particular land in issue the types of regulatory burden the land are subjected to can vary and it can become quite an onerous process to be able to make a change to the buildings on land, even if that change would in ordinary circumstances be of a fairly standard type. What is recognised by the application of an erosion management overlay is that the susceptibility of sites to landslide and landslip necessarily means that a higher degree of investigation is necessary. But not only that. The design of works needs to be conducted so as to mitigate against any risks and perhaps even in the circumstance of a particularly well-designed building operate to reduce the risk that would otherwise have been present.

Although as at December 2024 there were five EMOs in place within the shire, perhaps surprisingly, particularly given some of the history of this particular land, there was no erosion management overlay in respect of the land the subject of the landslide here, and that remains the case.

If I could just show you briefly another document. The ID is INQ.0003.0001.0003, and if that could just be zoomed in to the extent you can. It's a little difficult to see, but this map serves a few purposes, Madam Chair. The first is you can see from the shaded portions of the map that the application of the erosion management overlay to particular areas is fairly precisely defined, and areas immediately adjacent to each other may be the subject of different erosion management overlays.

What this map also demonstrates is the fact that there is no erosion management overlay in respect of the land at the site here. You'll see starting at about a quarter of the way up from the left-hand side and moving diagonally across the screen is the Mornington Peninsula Freeway. It's on the side of the freeway to the top left of the photograph where this landslide occurred and, as you can tell from this map, the whole of that area is unaffected by any environmental management overlay.

The imposition of an erosion management overlay

requires a lengthy process of mapping, consultation, local government approval and ultimately ministerial approval in order for the necessary planning scheme amendment to come into force. It appears that it is not, at least in its ordinary form, a decision that can be taken with haste. No doubt that reflects the potentially significant restraints on the rights of owners of land affected by an erosion management overlay.

However, in the course of this inquiry and not just in its public hearings we will consider the efficacy of the environmental overlay mechanism generally, whether an overlay ought to have applied in respect of this land and whether the fact of an overlay would likely have altered the course of the events as they occurred. That is to say we will consider both the shire's actions in respect of the land at McCrae and more generally the policy questions arising in respect of landslide prevention. If that map could be brought down now, thank you.

Can I turn then, Madam Chair, to the future work of the board of inquiry. We have to date identified a number of avenues of enquiry that we are pursuing, some of which will be pursued in this hearing block and others which will be pursued later, all of which will be pursued outside the work of the hearings. Those assisting you have not formed any view on whether or the extent to which any of these issues in fact contributed to the 2025 landslides.

In general terms, the avenues of enquiry currently being pursued are as follows: the effect of building works on View Point Road; the removal of vegetation from the top of the cliff; the adequacy of stormwater diversion; the role of natural springs in this area; and the role of damaged infrastructure and in particular a burst water main. Might I briefly outline each of those avenues of enquiry.

The first two avenues of enquiry are not connected with water but, rather, concern anthropogenic factors, namely building works and vegetation removal. As to building works, it's not in dispute that a retaining wall was installed at the rear of the property at 10-12 View Point Road in around December 2020. No permit was issued for those works. Generally, a building permit is required for retaining walls more than one metre high. The evidence of the property owner will be that the retaining wall was

less than that height and, given that and that no erosion management overlay applied to the land, no permit was required.

In November 2022 a reinforcement wall was built 30 metres in front of the original retaining wall to structurally strengthen the original retaining wall. It does not appear that those works increased the height of the wall but, rather, were directed to ensuring the efficacy of the original retaining wall. The shire was not advised of the fact of those works at the time they were performed.

Related to those works is the fact that some of the colluvium, that is the loose sediment at the base of the slope following the landslide, might be capable of being described as fill. You'll hear some evidence today from Mr Darren Paul, a geotechnical engineer engaged to assist the board, that the addition of fill at the top of a slope can affect landslide risk.

The second non-water-related line of enquiry, although as, you'll hear from Mr Paul it does have a relationship to water, is vegetation removal. Some vegetation was removed from the property at 10-12 View Point Road in December 2020. The property owners have described the removal as being limited to dead vegetation and invasive weeds, coupled with the trimming of some large plants at the request of a neighbour. As I have already said, we have formed no view on whether any of those matters contributed to the landslide. But both matters are at least capable of having contributed to the landslide in that they could assist in creating the conditions necessary for a landslide to occur, even if they were not causal, and on that basis we're under an obligation to fully explore them, and we will.

There are then three water-related potential causes. What will become clear from the evidence of the two geotechnical engineers who will give evidence in this hearing block is that, in the absence of other obvious factors such as major earthworks or an earthquake, a probable causative factor is water. I will adduce evidence from Mr Paul on this later today.

Put briefly, the extent of water in the soils of a hill increases the magnitude of the risk of a landslide

occurring. A variety of factors can contribute to soil saturation levels. Here, there are two lines of enquiry. The first concerns stormwater diversion. Madam Chair, you will hear from Mr Dane Pope, the geotechnical engineer engaged by the shire, that he concluded that one of the most significant, perhaps the most significant, contributing factor to the 2022 landslide was the very significant, indeed historic, rainfall in the days before those landslides occurred.

One method of reducing the amount of water absorbed by a hill is by stormwater diversion infrastructure. That infrastructure serves to channel the water through safer paths and away from the at-risk areas. Those assisting you are considering the extent and sufficiency of the stormwater infrastructure in and around the area of the landslide. That infrastructure serves to divert both rainwater and springwater.

That brings me to natural springs. It is well known that the area in and surrounding the landslide area here has a number of natural springs. Such springs are common, particularly in areas of granite rock. One local resident who will give evidence next week will describe a flow of water that appeared to originate and emanate from a spring under two properties located at 1 and 5 Prospect Hill Road between May 2014 and December 2020. He will explain that the flow was intercepted and diverted down a stormwater drain on Prospect Hill Road and into a culvert at the top of View Point Road, and that the culvert was continuously overflowing. He will describe an increasing saturation of the hillside and in particular at the location of the November 2022 landslides, and he will give evidence that the continuous flow did not stop even during dry periods.

It appears that in mid-2023 new stormwater drains and kerbs were installed on View Point Road. There is evidence to suggest that those works had the effect of reducing the volume of water seeping into the hillside. We are in the process of requesting further information from the shire about the mid-2023 works and about stormwater diversion in the area more generally. It's unlikely that we will fully explore those matters in this hearing block. However, they remain an active line of enquiry.

The final avenue of enquiry in connection with water is whether a burst water main may have triggered or

contributed to the McCrae landslide that occurred on 14 January. I'll refer to this as the burst water main theory. Shortly stated, the thesis is that water leaking from a water main located south of the Mornington Peninsula Freeway could have travelled through the stormwater system and trenches surrounding local water infrastructure all the way to the escarpment.

Excess water was observed in McCrae both before and after the landslide. In the months before the landslide approximately from mid-November local residents observed excess water on the streets uphill of Penny Lane, namely Waller Place, Charlesworth Street, Coburn Avenue and Prospect Hill Road. The water, we have been told, roared in the stormwater drainage system. It emerged through the roads. It pushed up and cracked the asphalt. It created potholes. It flowed down the streets. It saturated nature strips, and it leaked into the kerbs.

Shortly after the landslide of 5 January, water was seen flowing out of the escarpment above the Morans' property. The flow of water was constant. The water continued to flow on the day of the 14 January landslide and for weeks thereafter. The source of the excess water in McCrae was not immediately obvious to local residents. As I have mentioned, there had been no major rain events in the months leading up to the landslide. Days after the landslide South East Water, the local water authority, advised residents that the water was not coming from its network.

That created a mystery. Consequently, at the end of January, Mr Kevin Hutchings and Mr John Bolch, both of whom are the members of McCrae Evacuees Residents Group, which has the acronym MERG, were tasked by that group to try and locate the source of the water. MERG was a group formed in late January by local residents affected by the McCrae landslide for the purpose of sharing information and providing mutual support.

The enquiries of Mr Hutchings and Mr Bolch, both of whom will give evidence in the course of this hearing block, led them to a water main pipe located south of the Mornington Peninsula Freeway near the corner of Bayview Road and Outlook Road. The area around that water main revealed significant signs of saturation. Trees had fallen over, vegetation had been stripped back and the sandy

topsoil around the main had been washed out.

There does not appear to be any real doubt that the water main had burst or that South East Water attended the site to effect repairs on or about New Year's Eve. In the months following the landslide the excess water appears to have dried up, the road surfaces have been repaired, there are no visible flows of water on the road surfaces and the nature strips are no longer sodden.

To test the burst water main theory, the McCrae Evacuees Residents Group has sought to obtain further information from both the shire and South East Water in connection with the maintenance and conditions of water infrastructure in McCrae. The evidence of Mr Bolch and Mr Hutchings is that to date they have not received substantive responses.

The board of inquiry has also sought and obtained a variety of information from South East Water. That information is being assessed. Some of it will be adduced in the course of this hearing block.

Now, I should note, Madam Chair, that while I've addressed the three water-related causes independently it is entirely possible that each played a role and that they were related to each other. The potentiality of the three identified potential causes operating symbiotically will become apparent in the course of the evidence over the next few days.

That brings me to the evidence that you will hear today and tomorrow. The evidence at least towards the start of this hearing block will be of a technical kind. I will soon call Mr Darren Paul, a highly regarded geotechnical engineer with considerable experience in landslide prevention and investigation. Mr Paul's evidence will be directed to the subject matter of landslides generally, including the preparatory factors necessary for landslides to occur, the controls that can be imposed to mitigate landslide risk, the factors most likely to cause landslides, and the broad topic of landslide investigation.

It is intended that Mr Paul will continue to work with the board of inquiry as a technical consultant and adviser. In that capacity he will assist the board to properly understand and consider technical evidence, and will advise

on useful paths of enquiry.

Tomorrow you will hear from the geotechnical engineer engaged by the shire, Mr Dane Pope. Mr Pope is known to many of the affected local residents in McCrae by reason of his work in connection with the landslides. He continues to be engaged by the shire and has produced a number of reports concerning the events in both 2022 and 2025.

After Mr Pope's evidence you'll hear from two of the shire's senior officers, Mr Bulent Oz, who was the acting chief executive officer of the shire at the time of the 2025 landslides, and Mr David Simon, who is a senior officer within the shire's planning function. I expect that that evidence will take until the close of tomorrow.

If it's convenient to you, Chair, I will outline the witnesses that will follow Mr Simon tomorrow because those submissions will be partly driven by timing considerations.

Madam Chair, they are the matters that I wish to traverse in the course of my opening. If you have no questions, I propose to call the first witness.

CHAIRPERSON: I don't, Mr Costello, but thank you for your very detailed and helpful opening. Is Mr Paul in the hearing room? Mr Paul, if you could just move to the witness box.

<DARREN ROSS PAUL, affirmed:

<EXAMINED BY MR COSTELLO:

CHAIRPERSON: Mr Paul, Mr Costello will ask you some questions, and after Mr Costello has finished others at the Bar table may wish to ask you some questions. They'll need to seek leave before they do that.

MR COSTELLO: Mr Paul, could you state your full name for the record?
A. My name is Darren Ross Paul.

Q. And your occupation?
A. I'm an engineering geologist.

Q. And your current role?
A. Current role is technical director of engineering

geology at WSP.

Q. And what is WSP?
A. We're an engineering - a global engineering consulting firm, multi-disciplinary consulting firm.

Q. I see. And do they deal only with geotech engineering?
A. No, not just geotech engineering, but other disciplines of engineering as well.

Q. I see. And could you explain to the chair the types of geotechnical work that you have undertaken in the course of your career?
A. Yeah. So, Madam Chair, by - I'm an engineering geologist, so I specialise in the interaction between the built environment and the ground, and my role is to understand how the ground might respond to what happens in the built environment. So part of that is looking at what we call geohazards where the ground might affect the built environment, including landslides, and so my specialty for the last 25 or so years has been in landslides and specifically in landslide planning controls and preventions. I've worked on most of the erosion management overlays in Victoria over that time, but also in landslide response, repair work, mitigation. For example, I worked on the Bongong landslide that happened up at Falls Creek just recently. So my specialty is in landslides. Not exclusively what I do, but it's most of what I do.

Q. All right. You say your specialty is in landslides but it's not all that you do. Sticking with landslides for the current moment at least, are landslides a common occurrence in Victoria?
A. There's - the interesting question is what we - how we define "common". Over my career the frequency of landslides in Victoria has changed and changed in response to climate. So, for example, between 2020 and 2022, when we had three consecutive La Nina events and it was much wetter, frequency of landslide went up, and that rate is the highest I've seen in my career. Historically, we've had high rates of landslides in the 50s and high rates in the late 80s and 90s. It tends to go with what the climate is doing. Then we had a drought from 2000 to late 2010s where we didn't have too many. Is it a common occurrence? You know, common enough that it needs attention might be the way to answer that.

Q. Now, could you just outline in general terms some of the prior work that you've done in connection with landslides, perhaps to begin with not dealing with the more discrete topic of erosion management overlays, but concerning either landslide mitigation of a non-planning kind or landslide investigation?
A. Yeah, that's right. So an area I specialise in is landslide risk assessment, and the process of landslide risk assessment involves understanding a location, understanding the landscape, understanding the processes occurring in that landscape, and then relating those processes to what the risk from landslide might be to perhaps a particular development. So most of my work in landslide would be some form of development is proposed, is there a risk from landslide to this development and, if there is, how serious is it and how might we mitigate it. So that would be the bulk of what I do.

Now, that process involves a whole lot of stages. You have to go out and gather information about the terrain and you have to gather evidence. You have to undertake investigations, which might include mapping of boreholes or, you know, sometimes remote sensing or geophysics. There's a whole raft of techniques. Then we have to pull all that evidence together, interpret what's going on in the landscape and interpret what the landslide processes might be, what are the factors that make the area susceptible to landslide, what are the factors that might trigger a landslide, and then once we've got a model, we call it - a model refers to an understanding of the processes, understanding of the ground - then you've got a basis upon which to design controls and design mitigations, and that would be the next step, to then say, "We need to design controls to prevent this undesirable event." Maybe that's designing drainage, maybe that's designing retaining walls. It's designing something to mitigate the risks that were identified. And that would be the process we would go through to, say, mitigate landslide risk in a particular development or location.

Q. Thank you. Is it accurate to describe geotechnical engineering as a subspecialty of civil engineering?
A. Yeah, that's reasonable, yes.

Q. And is there a further subspecialty then of geotechnical engineers that work in the landslide area?

A. Yes.

Q. All right. And how does one come to do that type of work? Is there a professional qualification that you need to seek or is it a matter of experience?
A. It's a matter of experience at the moment. There's a whole story behind it, but Professional Engineers Australia and the Australian Geomechanics Society are in a process of developing registration for specialisation in particular fields of geotechnics, one of which might be landslide. There's nothing in place at the moment. So currently it's through experience, and then if you are a chartered - registered Victorian engineer or chartered engineer, an obligation that goes along with that, that you operate within your area of expertise. So the protection we have for people who are non-competent acting in the landslide area is that we need to check they're chartered or registered, and therefore they're bound to operate in their area of expertise.

Q. You mentioned two professional bodies then. One is the general professional body for all engineers?
A. Yes.

Q. And you also mentioned Geomechanics specifically, and you may have heard in the course of my opening in the section dealing with erosion management overlays there was some reference to some guidelines that that body has put forward. Could you just explain to the chair what that body is, how one becomes a member of it and the type of work that it does?
A. Yeah, so the Australian Geomechanics Society - and I'll pre-empt that I'm formerly the chair of the Australian Geomechanics Society - is a technical body that sits under Engineers Australia, and the way Engineers Australia are framed is their technical societies hold the body of knowledge. So the Australian Geomechanics Society hasn't got a role in sort of lobbying or trying to sway policy. The Australian Geomechanics Society's role is they're the technical body of knowledge. So we provide continuing professional development and training in the technical field of geotechnics. That's what we do. And our role is limited to that. If it goes above that - say if the Geomechanics Society wanted to convey an opinion, that would sit with Engineers Australia who would do that, that lobbying. So it's purely a technical society. So as part of that we develop technical guidelines that are used in

industry. One of those is the Australian Geomechanics Society guidelines for landslide risk management, which I imagine we'll hear about through the inquiry. So that's sort of what we do.

Q. Thank you. Can I ask you a further question in connection with that, which may be very obvious to you but I want to make sure that everybody that is in the room and is watching this has some familiarity with the different technical words. So you were speaking about the Australian Geomechanics Society and you also mentioned geotechnics in the course of your answer then.
A. Yes.

Q. Perhaps you could explain what geomechanics is as opposed to other areas within civil engineering, and whether there is any difference between geomechanics and geotechnics?
A. No, essentially there is no difference. "Geomechanics" is the name of the society. If I'm honest, it could be updated. But it essentially means the mechanics of the ground, hence a landslide being related to that. That's, you know, the mechanics of the ground.

Q. Aside from landslide, has the Australian Geomechanics Society produced technical guidelines for other areas?
A. Yes, landslide - it would be the main one historically that it has been involved with. Not so much producing standalone technical guidelines, but sitting on, say, Standards Australia committees to develop standards. So it's important to note that the guidelines for landslide risk management are not an Australian Standard, they're a standalone guideline. But the Australian Geomechanics Society has members on Australian Standards committees for things like, say, earthworks or foundation design. They do that.

Q. I see. And does that mean that as things currently stand there is no Australian Standard that is directly related to landslide risk mitigation?
A. No, there's no Australian Standard, no.

Q. And is there any particular reason you're aware of as to why that's the case?
A. It's a topic that's debated. It was put together as a guideline originally, I think probably because with landslide risk management it's difficult to be as

prescriptive as what a standard is. So, for example, a standard for designing building foundations will be very specific about the redundancy in the foundation and what you have to do to test them and it's quite specific, whereas in landslide risk management, where we're dealing with different sites, all different characteristics, it's difficult to be as specific.

Q. Yes.
A. But it's - a question that's open for debate is should it be a standard, but currently it's a guideline.

Q. All right. We'll come back to the guidelines perhaps a little bit latter. Can we start perhaps at a higher level of abstraction on the question of landslides and where and how they might occur. You have explained to me that there are preparatory factors that are in effect the conditions necessary for a landslide to occur. So is it the case that a landslide will invariably occur wherever there is a cliff at some point in time?
A. No, that's not necessarily the case. An example I might use is if we looked at the terrain, say, to the east of Melbourne up in the Dandenongs, no cliffs up there. You won't find a slope up there steeper than about two horizontal to one vertical. But if I go out to the west of Melbourne I might well find, you know, some cliffs. If I go down to the Great Ocean Road I'll find some cliffs.

Now, the reason we see that is because of the type of rock or soil, and different rock or soil has different strength attributes and can stand at different angles and will be unstable at different angles. So it's related to the geology.

Q. I see. Okay. So you mentioned two things there that I want to explore. One was the angle of the slope, and you mentioned two to one?
A. Yes.

Q. Now, do you want to explain the measurement of angles of slopes and the relative effect that a slope angle has in connection with the possibility at least of landslide?
A. Yes. So in a general sense the steeper the slope the more susceptible it might be to sliding. But that threshold at which it becomes unstable is different depending on characteristics like the water in the soil and the type of ground you're dealing with.

Q. All right. Let's talk then about the geological conditions that are perhaps more prone to landslide than others.
A. Yes.

Q. So particular types of soil and rock will be less stable than other kinds; is that a fair description?
A. Yes, that's fair.

Q. All right. Can you just explain to the chair in general terms perhaps by reference to some areas in Victoria that you're aware of some of the different types of geology that are found and how that geology relates to landslide risk?
A. I'll try to summarise this. We could go into a lot of detail here. So in Victoria or in Australia in general we have a very old landscape. It's eroded down a long way. Go back 15,000 years ago and we had an ice age. All around the world the sea levels were dropping and the landscape is getting incised and eroding down; you're cutting down the channels. As those channels cut down, the sides of the valleys sort of slide in.

So if I look at, say, up in Yarra Valley, the Yarra River has cut down through the terrain. And as it's cut down, slopes have slid in and slid in. Now, if we go up to the Yarra Valley we find landslide deposits all over that area. Now, they are landslides that happened under different conditions than they did today, but there's landslides all up over that valley. It's material that's moved before. It's material that's been disturbed before. And so it's prone to being disturbed or moved again with further landslides.

If I go out to, say, the west of Melbourne where I've got valleys that have cut down, they've cut down through more rocky type material which hasn't been able to slump in. So we see the cliffs stand. When we go down to the bottom of the valleys we don't see the colluvium. So there's this difference in how the different materials, different grounds respond to those processes.

Now, if we go to the coastal area, which is more relevant to here, the sea levels were higher about two metres or so 6,000 years ago. And that's caused the back of the coast to regress and cut back. Go around the

Victorian coast you'll see things called shore platforms. If you've ever been down to Inverloch, for example, you'll see these big flat rocks and shore platforms which are remnant from when the sea level was higher and cutting back the coast. The sea level has dropped. Now, as that coast has been cutting back it gets eroded, it slides, it gets eroded and it slides. The sea has retreated. Now, we have these kind of relic landslides that are there. So that soil is sitting close to the steepest angle it can, called the angle of repose.

It's a bit like if you've got a pile of sand and you've poured it out. It's going to sit in that angle of repose. It has been cut back and it's slipped. And that's fine; it can sit there. But it's now susceptible. If we actually change the character or change the forces acting on that, that's where we have the potential to trigger a landslide. So we've got lots of areas where landslides have happened before, and we have disturbed soil in Victoria, and that's a function of the geological history.

But then we also have areas where slopes have been cut back by anthropogenic means through earthworks and that type of thing that have disturbed it and, again, that is a factor that gives us preparatory factors for landslide. So everything we see as landslide susceptibility is generally a function of the geological history and what sea levels were doing or what water was doing in the past and how soils have eroded in the past and weathered and are now a function of the anthropogenic history and what humans have done to change the natural landscape.

A long-winded answer. But, to sort of put one more thing on to that, because the Australian landscape is so old and it's cut down and eroded and we've got the landscape we've got, one of the key things for landslide control is to leave it. The less we disturb the landscape, the less chance we might trigger landslides. When we interfere with the natural flow paths, we interfere with the natural slope angles, that's where our susceptibility can go up. A lot to go through there.

Q. No, that's very useful. Thank you. Can I perhaps bring you on the topic of geology to this area?
A. Yes.

Q. Are you aware of, in general terms, what the

geological conditions including soil and rock types are in this area?
A. Yes.

Q. All right. Could you explain those, please?
A. Yes. We've got the geology map. We can talk to the geology map.

Q. If we could bring Mr Paul's slides up, please?
A. It's 8.

Q. Did you say 8?
A. Yes, number 8.

Q. Could we go to slide number 8, please?
A. The geology map. Next one.

Q. Is that the one you're after?
A. No.

Q. Can you see it on the screen in front of you?
A. That's the one.

Q. Is that on the screen in front of you as well?
A. No, the screen is blank.

Q. Okay. I apologise for that.
A. I'll look up here. So this is a geology map of the McCrae area, and I'll just point out a few of the features on it. When we describe geology we like to talk from the oldest rock up to the youngest rock in the sequence in which it was formed naturally. The red is granite, and that's Arthurs Seat. You've been up to Arthurs Seat; comprised of granite.

Then you can see the contours. They slope down towards the top left, and we can see the sort of yellowy material just adjacent to the granite. That is a Pleistocene dune. If you've ever been down to, say, Barwon Heads or Cape Schanck around the coastline of Victoria we see these cemented dunes or cemented sands that are old and sort of greater than 20,000 years, maybe 100,000 years old. Old cemented dunes, that's what we have there.

And then there's this dashed sort of line, triangular line, adjacent to that. And then on the other side of that line we've got what's sort of the current beach and

dune sands. Now, that line through there, that's the Selwyn Fault, which I've labelled there, and that's a major fault that goes up the east side of Port Phillip Bay.

So in a general sense what we've got here is this granite that's really old, like, it's 300 million years old. Then we've got these Pleistocene dunes that might be no more than sort of 100,000 years old. Then we have the Selwyn Fault. Now, the material on the right has been uplifted. Port Phillip Bay is what we call a sunk land. It's land between faults on either side that has sort of sunk down because those faults have moved with the relative offset.

So everything on the right-hand side of that has been pushed up through tectonic activity or through faulting, and that's why we've got the Selwyn Fault. Sometimes you get a big earthquake on the Selwyn Fault. But that's why we have the slopes there. It's because of the offset of the fault. So we've got granite. Clinging onto the edge of the granite we have this cemented sand, and then we have this slope which is a clear escarpment on the landscape, and then we have the beach down here. I hope that's enough detail. There's quite a lot we could go into about that.

Q. No, that's very useful, thank you. Is it fair to say that as you travel from the coastline further inland up to Arthurs Seat you're moving more into the territory of granite rock as you get up --
A. That's correct. You're moving up into granite. That is why Arthurs Seat is there, because it is granite, it is harder. It has not only been uplifted; it's less resistant to erosion, and so there it is.

Q. Just for the avoidance of doubt, the fact of the Selwyn Fault - people may have heard of fault lines in connection with geology and earthquakes, for example, but the fact of the Selwyn Fault here that's of historical interest because it has affected the geology but isn't of direct relevance to a landslide in fact occurring; is that correct?
A. Well, I'd say the Selwyn Fault there is the reason we have a slope.

Q. Yes.
A. That's the reason we have a slope.

Q. Thank you. Now, are you familiar with the gradient of the slopes in this terrain?
A. Yes, and we've got contour on there to illustrate.

Q. And, in general terms, you were describing I think did you say in the Dandenongs rarely more than two to one?
A. Yes, two to one is about the maximum natural slope.

Q. I see. And what type of range are we talking about in this area?
A. It's slightly steeper.

Q. I see.
A. So up on the granite it's a bit less. But you can see where the contours get really dense down on that escarpment. That is getting a little bit steeper than two to one down there. You can see the very stark difference. It sort of almost looks like a different shading, but that's the close contours.

Q. All right. It might be worthwhile here - I'm taking you slightly out of order, but if we could go to the second slide. If might just be useful to get some of this terminology down.
A. Yes.

Q. Sorry, the one after that; the third slide. It might be useful if we try and get some of this terminology understood, otherwise I'll start using the wrong terms. This is a diagram of a landslide that has in fact occurred; is that correct?
A. It's a generic diagram for the purposes of communicating the nomenclature.

Q. But in this diagram there has been a landslide; it's not a cliff?
A. Yes.

Q. All right. Can you just explain what are the sort of central features of the diagram here insofar as they have relevance to the landslide that occurred in McCrae?
A. Yes. So these are terms that will come up through the inquiry. On the top left there we see zone of depletion and zone of accumulation. So there is a zone where soil has come from in the act of a landslide. It has then travelled and it has been deposited somewhere. So it's moved from the zone of depletion and it's moved to the zone

of accumulation. That's an important thing. When we talk about landslides we want to define where's this stuff come from, what's the area in which the landslide originated and what are the factors that have caused that, and then where's that debris travelled to.

You might hear terms like the foot or toe of the landslide, referring to the base of it where the debris has got to. And at the other end you might hear terms like scarp or main scarp or head scarp, which is referring to the top of it, where materials come from, and you usually see a steep, quite sharp-breaking slope towards the top. They're the key terms I think to get out. Perhaps on the next slide there are probably two more terms that are useful.

Q. I mentioned in the course of my opening - if we just go one page further - that the landslide here was a translational landslide.
A. Yes.

Q. Could you explain to begin with what that means and how it contrasts with a rotational landslide?
A. Yes. Here's a slide just generically - we categorise types of landslides. Now, with a categorisation like that - this is sort of a discrete categorisation. You can get in between things and it's a bit more of a continuum. But we can characterise a rotational landslide. You can see the surface under that landslide is sort of a deep circular type shape. On the translational landslide that surface is a more linear shape.

What factors might determine whether we get a translational or rotational landslide lie in the type of ground, lie in the geology. So a uniform clay material, for example, where it's all kind of the same clay might be more rotational. A sandy material might be more translational, or a material or ground in which you've got various layers might be more translational. So the type of landslide relates to the ground.

Q. Thank you. Are there any other features of this particular slide that you wanted to point out to the chair?
A. No, they're probably the relevant ones. In this particular hearing, rockfall and things are not relevant. Perhaps it might be worth mentioning debris flow, as that might come up, or perhaps the bottom one in the middle,

earthflow, which refers to a situation where as a landslide occurs that debris is fluid enough, it's got enough water in it and it can sort of flow like a fluid. So an earthflow or a debris flow is that type of landslide. You may hear that come up.

Q. I don't want to get to water yet, but while we're dealing with geology and rock type is it fair to say that particular types of rock are more likely to have water pass through them through cracks and fissures than other types of rock?
A. Yes, absolutely, and you could add rock or soil. So it's what we call the hydraulic conductivity of the ground is what is the ease by which water can be transmitted through that ground, and that's a function of the permeability.

So, for example, if I had a gravel material, we use gravel for drainage, and if I had a clean gravel with lots of pore spacing between it water can flow through that very easily. If I had clay, water cannot flow through that very easily. So the type of soil and its permeability will transmit water in different volumes and rates.

Q. I see. Sticking with rock rather than soil for present purposes, we established earlier that as you move up from the bay into the hills we're in granite territory. What's the position with water passing through granite?
A. That's right. So a granite like Arthurs Seat has soil and rock. So the top of it is weathered rock, and that weathered rock is a soil. You may be familiar with granitic sands. Sometimes we take granitic sands; it's good for making bars and the like. So you'll have a more impermeable soil over the top.

And then under that in the rock that rock will usually be jointed, which means it's got defects and discontinuities. Those defects and discontinuities, if they are open, that can transmit water. We call that fracture flow. So we can get water to flow through fractured rock, and that can be more permeable than soil and certainly more permeable than low-fractured rock.

Q. Thank you. So we're dealing here with what I think you call preparatory factors; is that right?
A. That's right.

Q. Preparatory factors being those factors that need to be present in order for a landslide to occur?
A. Yes.

Q. And so far we've dealt with geological factors. Is there anything else that you want to say in connection with geological preparatory factors before we move on?
A. More generally about preparatory factors, they are the features in the landscape that make it susceptible to landsliding, in the broad sense. We distinguish them from the causal factors which is some event, usually, that has happened to cause the landslide. But if you don't have a slope that's susceptible to landslide that trigger wouldn't drive the landslides. You need both.

Q. Yes.
A. So, the preparatory factors, it's the geology. We have talked about the slope angle, but also things like vegetation.

Q. Right.
A. In general, a slope with more vegetation on it can't absorb water as readily. The water pressure cannot build as readily in the slope because the trees are taking water out through evapotranspiration and the vegetation is helping water run off better. So more vegetation you would reduce your susceptibility. But the degree of vegetation I would describe also as a preparatory factor.

Q. All right. Let me just ask you a couple of questions in connection with vegetation. So to an untrained mind in these matters one might think that the significance of vegetation is that root systems bind the soil and therefore keep it more stable; is that correct?
A. That's partially correct to an extent. If you had a soil that's fully grassed with small roots in it, that will have some effect of holding it together. But for particularly larger landslides the main benefit from vegetation is they keep the ground dry. They help prevent water pressure building up through evapotranspiration for one and through allowing water to run off. Think about a vegetated slope with lots of leaf litter and vegetation. The water that gets on to that slope is more likely to run off than soak in.

Q. Yes.
A. If it does soak in, the roots are pulling out the

water and helping keep it dry and helping keep a state of partial saturation, which we might get into later as well.

Q. All right. That probably leads fairly naturally into groundwater conditions. So you've mentioned water now in connection with vegetation and also in connection with some of the geological conditions, including the capacity of different soils to hold water or for water to pass through them. Is it fair then to say that the extent to which soils are saturated is a significant factor in whether or not a landslide is likely to occur?
A. Yes, particularly in Victoria.

Q. Why particularly Victoria?
A. So other areas I work on landslides, for example, Papua New Guinea, New Zealand, we would find in those areas one of the main triggers is earthquake because they're sited in active areas. We don't have earthquake of the same magnitude or extent in Victoria. So our landslide triggers would usually be a change in what we call the pore water pressure. A change in the water pressure in the ground would be the main trigger of landslides in Victoria.

The other trigger might be anthropogenic means, perhaps earthworks or changing the loading on a slope through anthropogenic means. For natural landslides, it would be a change in water pressure in the soil.

Q. All right. Let's deal with water pressure generally and with water. You mentioned water pressure and I think you said pore pressure.
A. M'hmm.

Q. Perhaps you could explain those concepts to the chair?
A. Yes.

Q. And the significance of them in this area of discourse.
A. Okay. So a soil is comprised of three constituents. It has solid particles. Then in between the solid particles that's what we call the pores, and the pores contain water or air in varying proportion. If the pore is completely full of water, we call that saturated. If there's completely no water in there, that would be dry. Most natural soils have water and air.

When you have water and air you build surface tension

in those pores, and that helps pull the soil together. So, if you build a sandcastle, you can't build a sandcastle out of dry sand, you can't build it out of saturated sand. You need to have partially saturated sands. So those pores have water and air in them, and that has an effect of binding the soil together. What we call effective cohesion. It's helping to pull the soil together. So it gives it strength. Now, when we lose that by saturating the soil we lose that effective cohesion, we lose that strength.

So one of the main mechanisms of landslides in Victoria is we have partially saturated soils and then those pores become saturated, we lose strength, we have a landslide. So an example people might be familiar with: road cuttings. Where I live up near the Dandenongs we have got road cutting up there that have been cut 120 years ago. They're standing very, very steep. But then we get a big rain come through and you come out the next morning and there's soil on the road and the cutting has slumped. That's happened because it's standing there because it's holding this negative pore pressure, we call it, or suction. Then it's lost that suction because it's got wet and it's come down. So think about it like pouring a bucket of water on a sandcastle.

The finer the soil particles the more that effect in general. So think about gravel with lots of big pore spaces in between it. You pour water on it, it goes straight in. That's not going to build up any suction because the water can just come straight into it. But as we get finer into sands we do build suctions; we can make sandcastles. And get finer again into clays and we can build even more suctions.

If you have a clay soil, to sort of lose that suction and lose that pore pressure takes a long time because the water can't get in to fill that air and displace that air easily. It takes a long time. So that's why I say cuttings up in the Dandenongs that have been there for 120 years, they're only sort of failing now. That's the kind of timeframes it takes for water to infiltrate.

Q. You mentioned pore pressure and you mentioned suction.
A. M'hmm.

Q. Are suction and pressure relevantly the same thing

here or is there some subtle difference?
A. Yes, they are. So when I talk about suction I'm talking about a negative pressure, actually negative pore pressure. So when we sort of talk generally about change of pore pressure we might have a soil with a negative pore pressure and, through the introduction of water, that pore pressure rises. Now, it doesn't have to necessarily become positive before we lose strength but, if it were to become positive, then we would lose all that suction strength.

Q. I see. And so you've already described that different soil types will in effect have a capability of holding different amounts of water depending on that soil type?
A. M'hmm.

Q. So, a granite soil, water will pass through whereas other types of soil will be more likely to hold the water within the soil; is that fair?
A. That's right. So that's going back to the permeability and the transmissivity. So we're talking about slightly different things. The ability of the soil or rock to transmit the water through it for it to basically flow through versus the capacity of that soil to absorb the water and how that changes the pore pressures.

Q. I see.
A. Slightly different.

Q. Relevant to this question of permeability in respect of soil and rock is natural springs?
A. M'hmm.

Q. Is this how natural springs in effect are developed, through water passing through rock fissures?
A. That's right, yes. So, for a spring, in essence you need a recharge area which is elevated. So you've got somewhere that water is raining, and water is getting into the ground at a higher elevation. It's infiltrating the ground, and then it finds sort of permeable ground it's able to flow through. Maybe that's fractured rock. It will flow through that. But then, because the slope sort of trends down, that water might infiltrate in. It might then not be able to penetrate further vertically because there's some more impermeable layer there or the rock joints close up. It's going to take the path of least resistant, which then might be to come out sideways and emerge in the slope. That's generally how a spring --

Q. So a spring is not, for example, necessarily fed from an Artesian basin; it can be fed from elsewhere?
A. Absolutely, yes. For example, the foot of Mount Dandenong has springs all around it. All up the coast of Mornington Peninsula there's quite a few springs that I know of and I've been involved with, some that have flowed years ago, some that flow now. They don't all flow continuously.

Q. I see. So some of them will flow intermittently depending on the extent to which what water is in the recharge area?
A. Correct, essentially in response to rainfall is what will cause it. But then there's other factors. Human intervention has sort of changed where springs flow now. But in principle, yes, we have rainfall perhaps further inland which then the water will pass through the soil and it will emerge where that - we call it an aquifer - permeable sort of ground it's flowing through emerges.

Q. Is an aquifer a build-up of water?
A. An aquifer describes strata in the ground that more easily transmits water.

Q. I see. And how does all of this relate to the concept of a water table?
A. Okay. So let's say we start drilling down through the ground we might have partially saturated material, maybe there's potentially to see a bit of saturated material but then we go back into partially saturated material, but eventually it will get to a point where it is saturated and it is saturated - if you continue going down and it remains saturated. The water table is that point at which the ground is now saturated, if that makes sense.

Q. Yes.
A. So the pores are full of water. You don't expect air in those pores. That's the water table.

Q. It might be useful at this point if I direct you to I think it's the fifth slide. It should be - sorry, yes, that one; thank you.
A. No, that one or the --

Q. Let's start with that one and we'll go to the other one, because you can see here - I should ask you where has

this come from?
A. This is from a paper by Arja. It is a technical paper about - it's actually about landslides in granite published by a professor from the University of Singapore, I think he is from. A technical publication.

Q. I see. So this isn't a diagram that is descriptive of the area in McCrae?
A. No.

Q. This is either descriptive of somewhere else or it is generic?
A. It's generic.

Q. I see. Thank you. Just before we finish, there's a line there for the groundwater table, and there's a saturated zone and an unsaturated zone and that's what you were just talking about?
A. Exactly. So below the groundwater table that's saturated. The pore spaces are full of water. Above that the pores are part water, part air.

Q. All right. Can you just explain to the chair the other features of this diagram insofar as they're relevant?
A. So this is talking about how a landslide might develop in an unsaturated soil. It's saying essentially for that to happen you need water to infiltrate and displace the air that's in those pores, it's saying water can infiltrate down maybe the tension cracks in the top and the rain can bring this down; the loss of vegetation, because vegetation we talked about before brings the water out through evapotranspiration; loss of vegetation might mean more water gets in than is pulled out by the vegetation; or we might have what's called a wetting front where it saturates up on the surface and, the more rain that gets on it, it saturates and it can't flow off quick enough and the water keeps infiltrating in.

The Bogong landslide I worked on recently this was the mechanism. We had three years of rain, three years of La Nina, and over that type the water just kept - it sort of infiltrated that wetting front, just kept advancing and kept advancing into the soil. We're losing saturation until we get to a tipping point where the strength is reduced sufficiently to cause a landslide.

Q. I see. And before we break I might just take you to

the next slide as well which relates also to this. This is another diagram. This one I think I'm correct to say comes from a report of Mr Pope, the geotechnical engineer engaged by the council; is that correct?
A. That's correct.

Q. And so this is descriptive of what?
A. So this is what's called a model. I heard mentioned before in the opening statement about we're putting a model together. When we investigate a landslide that's the goal: get a model together that communicates what's happening, what are the mechanisms and the processes in the ground. So, what has been communicated here, the purple down the bottom is granite, I believe. The pink above it is this weathered granite I talked about. So this is a more impermeable material in the pink. The dash line down the bottom is the water table, so below which it's saturated.

What this is saying is if water comes down through that top browny coloured material, which might be sand, for example, it's able to seep into that fairly readily because it's a sand and it's got open pores and water can get in. But then it can't keep sinking down too far because it hits this barrier, this more impermeable material. So it's going to take the path of least resistance and it's going to migrate sideways. So it has infiltrated in there.

The source of water could be rainfall, could be a pipe, could be whatever; the ground doesn't care where the water comes from. The water seeps in and then it flows along that, and you can see where it says "seepage" it's coming out of the face. That's a spring. The term we use is "perched water" because it's water that has seeped into this impermeable barrier and then it perches there. It can't go further and it flows out. So that is what that is illustrating, potential flow paths in ground with soils and rocks of different conductivity. Does that make sense?

MR COSTELLO: Thank you. Madam Chair, would that be a convenient time?

CHAIRPERSON: Yes, it would. We'll adjourn now for lunch and resume at 2.15.

LUNCHEON ADJOURNMENT

UPON RESUMING AT 2.15 PM:

CHAIRPERSON: Thanks, Mr Costello.

MR COSTELLO: Thank you, Madam Chair. Continuing with Mr Paul, and perhaps if we could have Mr Paul's slides back up on the screen whenever convenient, and if we go to the second slide. Is there one before that? No, sorry, could we go to slide number 2; pardon me, that's my fault. Yes, that one. Thank you. Mr Paul, we've been talking through preparatory factors that are relevant to making conditions susceptible to a landslide, and so far we've dealt with geology, slope angle. Immediately before the break we were dealing with the question of water in the soil. Are you comfortable that you've said for now what you would like to say in respect of those three matters?
A. Yeah, I think we just summarise it, that the factors that make a slope susceptible to landslide are in the main the type of rock or soil, the angle of the rock or soil is on, to some extent the amount of vegetation on the soil, and the water in the soil.

Q. Yes, thank you. The fourth point on this first slide is the previous history of landslides. How does that relate to the question of preparatory factors?
A. Okay. So some types of landslides what we call reactivate. So the landslide might move a little bit and then it might stop and then it might move a little bit and it might stop, and so it reactivates. So if you can identify there's a landslide in that landscape we know that's a susceptible area. A landslide's happened there before, it may move. Now, there are some types of landslides where, you know, we've had a zone of depletion and the soil might move away from the zone of depletion and go somewhere else, and the site had gone and the event's happened and it can't repeat. But one thing we look at is has there been a landslide before, what can that tell us about the potential for a landslide there again.

Q. I see. Thank you. You're generally aware, are you, of some of the histories of landslides in this particular area?
A. Yes, yes.

Q. And to what extent are you aware of those matters?
A. So I've done works all up that side of Port Phillip Bay, and, you know, not just the McCrae area, but there's landslides in different parts of the escarpment. Say,

we're looking at this escarpment in McCrae. There's a similar escarpment, say, in Mornington, further up, there's a similar escarpment in Frankston. And so there are known landslides all the way along. When I say "known", we've got records going back to the 1860s of landslides sort of on an escarpment in Frankston. It's a fairly simple matter to do a search of historical newspapers and records and archives to learn what landslide had happened in the past. In the McCrae area we've got good records of landslides in the 1950s, and then the more recent in the last few years.

Q. I see.
A. So we know landslides happen in this area.

Q. All right. Well, then that might deal for now at least with the preparatory factors. Can I move then to a different topic, which is controls, by which I really mean what are the mechanisms available to mitigate the risk of landslide occurring. You may have heard in part of my opening I had something to say about erosion management overlays. No doubt they're one control. Would you describe them as the principal control in Victoria?
A. Yeah. So the erosion management overlay's about prevention, in a sense. So it's about identifying where do we have the susceptible areas, where do we have these preparatory factors, let's delineate those areas with those factors and then put controls in place to ensure, as the scheme says, appropriate development in those areas from which the risk of landslide is manageable.

Q. Yes. At the commencement of your evidence I asked you to explain to the chair some of the work that you had done in connection with geotechnical engineering generally and your specific work in connection with landslides but I said "not dealing with EMOs at the moment". Let's come to EMOs now. In the course of your daily work do you regularly give advice in connection with EMOs?
A. Yes. Like, almost every day.

Q. All right. Could you explain the type of work that you're engaged to provide in that process?
A. Yeah. So initially in development of the EMO. So undertaking the work to identify the susceptible areas and to recommend where the planning control should be.
I advise on what the planning - when you presented the schedules for Mornington before, I advise on what to put in those schedules. I didn't do that for Mornington, but I've

done that for six or so - seven or so other local governments around Victoria, and once that's implemented I have a role on behalf of councils to peer review planning applications that are made under the erosion management overlay, because councils generally don't have geotechnical people on staff with the skills. So if, for example, a landslide risk assessment is done in connection with a planning application, they'll send that through to me to undertake review on behalf of council of that application.

Q. I see. So based on the work that you've done before you feel comfortable giving evidence in connection with the EMO process generally?
A. Yes, yes. Yeah, sure.

Q. All right. Thank you. Can I perhaps zoom out a little bit before we come back to EMOs and delve into the specifics of them. I would describe EMOs as a form of planning control; is that a description you'd be comfortable with?
A. That's right, yes.

Q. And they're a creature that exists by virtue of Victorian legislation. Are you aware at least in general terms if there are equivalents in other states?
A. Yes, very much so. There are equivalents in Queensland, in New South Wales. They reside at local government level in Queensland and New South Wales, and of course not every local government area has landslide issues or a control. Tasmania has landslide controls at state levels. The Tasmanian planning scheme is at state level. South Australia has less formal controls, and Western Australia doesn't have too much at all, at least that I'm aware of, which reflects the landslide risk I think in those states.

Q. I see. At least then along the eastern seaboard there is something that's broadly equivalent to an EMO in New South Wales and Queensland; is that right?
A. Yes. Not called EMO. Only Victoria calls it EMO. It's called landslide planning controls in other areas.

Q. I see. But they are each controls at the planning level?
A. Correct, yeah.

Q. Okay. Thank you. So could we perhaps get a little

more specific into EMOs. You have one slide in your pack here, I think it's slide number 9, that's relevant to EMOs.
A. Yes.

Q. In fact, if we go one slide earlier than that even. All right. So here you've outlined some content concerning EMOs. Could you just give your own description of the purpose an EMO is intended to serve?
A. Yes. So this is under the Victorian planning provisions, which of course link into the local government planning schemes. So the purpose of the EMO is to - it's probably twofold. It's to protect the land from erosion, and in Victoria we put landslide under the umbrella of erosion, which it is. It's soil moving from one place to another. So it's to protect the land from erosion, but it's also to protect development from erosion and/or landslides.

Q. I see.
A. So it's important to note that, whilst it's called an erosion management overlay, landslide sits under it, and we've been campaigning for a while to get the name changed because it's not clear that erosion encompasses landslide, but it does.

Q. I see. Do you have a general recollection of when the EMO process came into the planning scheme in Victoria?
A. Yes. So initially - I started my career in the late 90s, and it was my boss working for the Shire of Lilydale at the time in the 80s, and in the Shire of Lilydale in the 80s and up the Yarra and some of those shires around there they'd had landslide issues, they had houses destroyed. So it was the early 90s when the Shire of Lilydale introduced, as far as I'm aware, the first planning control in Victoria for landslide. The first erosion management overlay was the early 2000s, which was the Shire of Yarra Ranges after they merged with - they did an amalgamation in the late 90s, and then the Shire of Yarra Ranges put an erosion management overlay control which built on the Lilydale one, and that's the first I sort of know of it being an erosion management overlay in the context it is now. But there'd been really a preceding plan and control.

Q. Thank you. Are you generally aware of when EMOs came to be used in this local government area, that is Mornington?
A. Yes, only in the context of I attended the job to

perform it and lost. It was around 2008, 2009 when that occurred.

Q. Okay. So could you explain to the chair the process for developing an EMO and putting it in place, and the extent to which geotechnical advisers like yourself are involved in that process?
A. Yes. Okay. So the key thing is developing the mapping. So we need to identify areas susceptible to landslide. So we need a criteria. There's got to be a criteria for this land is in or out of the overlay. So work has to be done to develop the criteria. The best evidence we have to put a criteria together is what's happened before, and it's a sort of basic principle of geology to look to processes that have occurred in the past and how could those processes occur in the future.

So step 1 of developing the erosion management overlay is what we call a landslide inventory, and it's just essentially a database of all of the landslides we can find and that we can learn happened historically in that area. Now, we identify it from historical records. Things like council maintenance records are useful, things like newspaper articles are useful. But perhaps the main source now is using sort of digital terrain models, so - are you familiar with LiDAR models, where we can get quite detailed images of the landscape, and from those detailed images of the landscape identify landslides there.

Going back before LiDAR, which has probably been the last 15 years it's been in common use, you'd try and do the same thing from hard copy air photos, and it wasn't as precise. So now we can get a really good inventory of where are all the landslides. Once you've got all the landslides identified and recorded attributes about them - so what geology have they happened in, what slope angle have they happened in, what are the terrain attributes around it - you then run a process of identifying what are the characteristics in common. So we might learn that we only see landslides in this volcanics geological unit on slope angles steeper than 20 degrees, and that might become a criteria. So then we say if we have slopes, whether a landslide has happened or not, steeper than 20 degrees in this volcanics unit we'll put a plan overlay on, and the evidence is what's happened before. So that's essentially the process of getting the mapping together, and that's called a susceptibility map.

Now, the AGS guidelines we mentioned earlier set out guidance on how to do it. So it's not - we have an industry standard. It's not a standard - it's an industry guideline with best practice on how to produce the susceptibility map which becomes the overlay. So there's that step 1, put the mapping together, and that's a very important step

Then it's put the planning provisions against that by developing the schedules to the erosion management overlay, and then we start having to look at, okay, in this particular terrain what type of things might cause a landslide. Maybe inappropriate earthworks might cause a landslide in that area, and maybe we've got historical evidence of that happening, so we need planning controls around earthworks. We're going to limit the extent of earthworks. We're going to require geotechnical advice if we propose earthworks in this landslide-susceptible area. Drainage or water-holding structures, things like dams, we know that a dam can cause water to get into the soil. We will specify in the scheme we want planning controls around dams or pipes or tanks or things that could cause water to get into the soil. Vegetation removal can be a factor that makes a slope more unstable. The schedule will have information about or require planning permits for vegetation removal.

So that's the thing. So, if you can think of it, the mapping is here is where all the preparatory factors are, and then the schedule is about when we develop in those areas how do we limit the potential for one - for a causative factor.

Q. Yes.
A. And that's a broad way of thinking how the EMO works.

Q. Thank you.
A. Make sense?

Q. Yes. I've got questions for you in connection with both the mapping and the schedule. Obviously from what you've just said, mapping's absolutely core to having an effective EMO. You've got some examples in your slides. Perhaps if we could go to slide number 12, I think it is. It might be 11, actually. Yes, 11, thanks, the one before that.

A. Yeah, 12 - the one - yes.

Q. So this is an example of a map in connection with the EMO, is it?
A. Yes, this is actually the Shire of Lilydale mapping which became the Yarra Ranges EMO. So, yeah, it's from the Yarra Ranges EMO from early 2000s, this map.

Q. All right. And what does this map tell us in general terms?
A. Okay. So it's indicating susceptibility, landslide susceptibility. We can see it's got these areas marked M2, that is medium susceptibility, and there might be areas marked H, which will be high susceptibility. But it is zoning the ground based on its susceptibility to landslide.

Q. Yes.
A. Now, that - - -

Q. I see, on the left-hand side of the map there there's a shape and it has an "M1" in it, and within the shape there's a smaller shape that's got an "M2" in it. Is that what you're talking about?
A. That is right. So what that indicates is that polygon has been given a label M1 susceptibility. That correlates in this case to medium susceptibility. The numbers relate to different geology types. What this is really showing us is these are the areas susceptible to landslide.

Q. I see. And how was a map like this put together?
A. So back then the metropolitan board of works topographic maps - which were these big hard copy sheets that were produced in the 1960s and were put together using aerial photography, photogrammetry techniques with aerial photography. Now, if the criteria here was a geology and a slope angle to say this is susceptible to landslide, someone would sit down with a scale rule on those contours to work out the angle, and then a state-published geology map to know the geology, and then the combination is the susceptible or not. So that's how it was done back then.

Q. I see. Is it still done in that way now?
A. No, we don't do it that way anymore.

Q. All right. What's the usual method for mapping now?
A. Yeah, so now we have LiDAR information.

Q. Is that the next slide?
A. That's the next slide. So just to show you the contrast of how much better of the appreciation we get of the terrain - - -

Q. If we could just go one slide forward, please.
A. So this is showing - this is from Silvan, actually. So you can see on the left there - you know, even to a non-trained eye you can clearly see a different signature or texture in the terrain within the red polygon compared to outside of it. So that's a landslide inside. The reason for the hummocky, bumpy terrain there is because it's been affected by a landslide. Outside of it, where the slopes are smoother, that's not been affected. So we can be quite precise using this as to areas that have been affected by landslide. They're far more precise than what you could have with those old maps.

Q. Right.
A. When LiDAR came along, you know, it was sort of towards 2010, absolute game changer for our industry.

Q. So as a matter of practicality how does this work? One orders the LiDAR maps for the particular region?
A. Yeah. They're sourced from a different area, but the Victorian State Government has very extensive LiDAR libraries now. LiDAR is undertaken for many purposes other than landslide identification.

Q. Yes.
A. So there's quite a lot of good LiDAR data available. Most of Victoria is covered.

Q. Then who is the person or what is the profession of the person that would then interrogate the photos and insert the polygons like this?
A. Yeah, that would be an engineering geologist or perhaps an engineering geomorphologist.

Q. I see.
A. Because they're a science - somebody with the earth science background and earth science skills.

Q. So do you do this particular work?
A. Yes, I do that. Myself and my team do that particular work.

Q. All right. By your training, you can pick the terrain that's landslide - previously landslide affected?
A. Yes.

Q. And is that what you're looking for? Is it limited to terrain that has been landslide affected, or are you looking also at terrain that may not yet have suffered a landslide but could suffer one?
A. So the multi-step process. So first of all we're just saying where have landslides occurred, and doing an activity like this, and then we go to that process of based on where they've occurred where else do we have similar terrain attributes, where could they happen in the future, that's when we develop the susceptibility map.

Q. I see. And in terms of going through this process with a client, local government area, for example, how does it ordinarily work? Do you identify those areas, produce the polygons, and then is there a discussion with the local government area? Do they typically have expertise within their own staff that would want to discuss this work with you?
A. Yeah, they do, but we're usually relied upon to identify this is where the landslides are. They wouldn't - generally the councils don't have people to, you know, say "you haven't done that right" or to scrutinise that. It sometimes gets peer reviewed, so the council may engage their own consultant to review our work.

Q. I see.
A. But most of the discussions with the council might be around things like, "This particular land is administered by Parks Victoria. It doesn't belong in our planning." Essentially, "Take it out." Because when we do this work land status boundaries are irrelevant. We map it all up, and then it might need to be refined to, say, take some areas out, and we'd get advice from council for that.

Q. I see. So in the way that the process evolves, though there is some discussion, ultimately the areas that are the subject of an EMO are areas that have been identified by a trained professional as being at-risk areas?
A. Yeah, or the word we use is susceptible.

Q. Susceptible areas?
A. It's getting the terminology - risk is a different concept to susceptibility. So susceptible to landslide.

Q. Does this type of LiDAR map tell you anything about the degree of susceptibility?
A. Yeah, it can.

Q. To a trained eye, looking at one as opposed to the other can you say one is more likely to have a landslide than - one area than another area?
A. We can. That's what this is actually showing. So you can see there's landslides mapped on the left and the right. You can see on the left much more pronounced. That's telling me that that landslide's probably moved more recently, you know that it's moved, the ground's been deformed and there hasn't been time for that deformation to sort of smooth out with further erosion, whereas the one on the right has. So I would say the left is more active. I'd expect reactivation of the landslide on the left would be more likely than on the right.

Q. I see.
A. But that doesn't mean it can't, the one on the right. It doesn't mean it's not susceptible. It's just less susceptible.

Q. Yes, I see. I'll ask you another question about the mapping before we get back to the schedules. I think on the next slide you have a map dealing with slope angle?
A. Yeah.

Q. Yes, here. Perhaps if you could just explain to the chair what we're all looking at on this slide?
A. Yeah. So what I'm just showing is how we can manipulate the LiDAR data. So on the left is what's called a hillshade, which is - it simulates the sun shining from a particular direction and sort of simulates shadows and it gives you an appreciation of the morphology of the terrain. The one on the right, the pixels are coloured based on the slope angle. So you can see the red is a steeper slope, the blue is flatter. So that second part of the process once we've worked out the criteria for inclusion in the EMO, on the right there we can quite accurately say if the criteria is that it's a slope steeper than 20 degrees we can quite accurately know where that is, and so we would do something like that on the right and then that would feed into what our EMO mapping becomes.

Q. And this is relevant in part because, as you explained

when we were dealing with the preparatory factors, slope angle is one of the tells, if you like, about the degree of landslide susceptibility?
Yes.

Q. Is that a fair way of putting it?
A. Yeah, absolutely, yes.

Q. Okay. This mapping, this is all done for a number of purposes but ultimately in aid of preparing what I think you described as a landslide inventory; is that right?
A. Yeah, that's right. So the initial mapping, where are landslides, where have they occurred in the past, that's the landslide inventory.

Q. Yes.
A. Then the next phase, the susceptibility mapping, is given the landslide inventory, given where landslides have happened in the past, where can they happen in the future.

Q. I see.
A. And that's the susceptibility map. It's both mapping, I guess.

Q. So the first stage of the mapping is the trained eye identifying those areas where there has in fact been a landslide?
A. Yes.

Q. But then there is a second layer of judgment brought to the next stage, which is in the light of the now known information as to landslide history what are the degrees of susceptibility of areas within the mapped region?
A. That's right, yeah, yeah.

Q. I see. If we could just move to the next slide, please. I think this is the final map that you've included in your slides.
A. Yes, yes.

Q. So this is speaking about an area - I think an update to an area that exists within a landslide inventory; is that correct?
A. Yes, that's right. This is just to illustrate the benefits we get from the LiDAR information. So on the left - that's the red polygon there on the left - is a landslide that was mapped prior to the LiDAR information,

and you can see on the right, you can pick the change in texture there, with the LiDAR information it can be far more precise. You know, we can identify quite clearly that isn't one landslide, it's two sort of separate ones that are a bit separated. So that just is to illustrate what we can go from then to - - -

Q. I see.
A. - - - with the better digital terrain information.

Q. So, to make sure that I properly understand this at least, on the left on this example there would have been a single landslide placed in the landslide inventory?
A. Yes, yes.

Q. And it was a landslide that occurred somewhere within the polygon on the left?
A. Yes. Yes, in fact that sort of whole polygon.

Q. The whole polygon?
A. That whole polygon's a landslide --

Q. Is a single landslide?
A. Yes, that's right.

Q. Thank you. And then, although that polygon's been placed over what I presume is a LiDAR map --
A. No, that would have been - no, that was placed on - so the earlier map we looked at, the contour plan --

Q. Yes.
A. -- that was produced on the basis of that.

Q. No, sorry, I understand that.
A. Yes.

Q. It was produced on the basis of that, but for the purpose here it's been placed over a LiDAR map?
A. Yes.

Q. So that is in fact a LiDAR map there?
A. That is correct.

Q. In fact it's the same.
A. Yes.

Q. Then LiDAR comes along?

A. Yes.

Q. Somebody takes another look at it and instead of a single landslide they identify, what, four?
A. Yes, that's right. There's two there and another one off to the side, correct, yes.

Q. And those areas identified as landslides on the right-hand side they're not lines that are descriptive of where an EMO might be placed. This is the earlier step of just identifying where landslides have occurred to create a landslide inventory?
A. That's right, yes.

Q. Thank you. Did you say that LiDAR came in 10 or 15 years ago?
A. I first started using it about 2007.

Q. I see.
A. But that was for an oil company with some good funding. I didn't start using it in Victoria - it would have been sort of early sort of 2010s time, yes.

Q. I see. And has the quality of LiDAR maps even in that period improved?
A. Yes. Yes, a lot. So some of the earlier Victorian stuff which was done as part of sort of climate change studies around the coast and sea level rising impacts was around 2007, and it's got a very coarse resolution or pixelated a lot. But with latter technologies the pixelation is much, much finer. Much better detail, much better imagery.

Q. So that's the mapping process of the EMO.
A. M'hmm.

Q. You then mention schedules?
A. M'hmm.

Q. So is the general process develop an inventory, identify susceptibility?
A. Yes.

Q. And then move into preparing schedules?
A. Correct.

Q. Now, is a professional like yourself involved in the

schedule aspect of EMOs, or does that then go off into a different area of local government and doesn't involve somebody with your expertise?
A. Very much I'd usually prepare the first draft of the schedule, but I'm preparing it from the point of view of what type of development should be exempt because, you know, it's unlikely to be at significant risk from landslide. So I help out with the list of exemptions, what type of development should not be exempt because that's going to - you know, perhaps a clear risk or cause landslides. So that's our domain to look at that. But then it also is going to go into the planning scheme, so I need to work with planners, who can put it in the right format and include all the right words that it can be in the planning scheme. So I'd usually start a first draft and then work with the planners at the council to refine it.

There's then - any new amendment to the planning scheme, it goes through various checks and third party checks and checks at state government level, and there's opportunity for the public to comment. There's planning panel hearings. There's quite a few steps that it goes through before us having the draft schedule and the final that's implemented.

Q. Yes, okay. I might just call up a schedule. If we could please go to INQ.0003.0001.0001. This is a document that I went to in the course of my opening. This is the Mornington Peninsula planning scheme. Now, you haven't done particular work in connection with this scheme; is that right?
A. I've peer reviewed some reports prepared in support of a planning application of a third party reviewer, but I've had no involvement in the development of the scheme.

Q. I see. I might just show you a schedule so we can all be clear quite what it is that we're talking about. Perhaps if we could go to page 765. Could we go one page earlier, sorry. My maths must be out. All right. Thank you. Is your screen working now?
A. Yes, I can see that. It's a little blurry, but I can see it.

Q. I might just get it made a little larger, thank you. All right. Hopefully that's a little clearer. Is this an example of the type of schedules that you're speaking of?

A. It is an example of. Mornington Peninsula's schedules are a little bit different to a lot of the other ones in Victoria.

Q. All right. Why don't you start by describing what you might call a more ordinary schedule, and then we can move from there into the differences between those and a Mornington Peninsula schedule?
A. Yes. So Mornington Peninsula is the only one that has different controls in different areas. So you mentioned at the start EMO1, 2, 3, 4, 5, 6, and each one of those is quite different in what it requires. Yarra Ranges puts more back onto the geotech engineer who assesses that development, right? They are the ones who decide the level of severity. We mentioned the reason for EMO1 to 5 is there's different levels of susceptibility and it describes what should be done. What other ones in the state do is allow the geotech practitioner to decide that on a case-by-case basis. So it doesn't say, "You must do this number of boreholes or this particular work." It says, "You as a geotechnical practitioner need to use your expertise and competence to assess the risk of this particular development.' So the EMO is a bimodal thing. You're in or you're out. There's no 1 to 5, right? So it puts - more of these application requirements of what you must do is more to the discretion of the practitioner doing the work.

Q. I see.
A. So there's been about four recent amendments across Victoria. What there's been a move towards is taking the requirements for what the geotech practitioner has to do, how they have to investigate, pull that out of the planning scheme and it's been put into what's called an incorporated document. The reason for that is there was concerns that there was too much language in here in the schedules that was technical and wouldn't be understood by the public. So everything that was in here that was really for the geotech engineer who was going to go out and assess the site got pulled out into a separate related document. So that's been how Yarra Ranges, East Gippsland, Towong, Yarra Ranges have all done - done it that way now.

Q. I see. So at the heart of the process connected with schedules in those types of areas there is a degree of discretion vested in a geotechnical professional?
A. That's right. Yes. Try not to be too prescriptive in

here. So, for example, if it says in the schedule, "You must go do four boreholes at 10 metres," well, every site is different, every development is different, the geotechnical conditions at every site are different. So the move is towards, well, don't prescribe that because that might not be appropriate everywhere, leave it to a geotechnical professional to decide how deep the boreholes need to be and how many there needs to be. That's - that different sort of concept.

Q. And a professional faced with those sorts of questions in connection with the particular proposed development or a particular permit application, would they have regard to some sort of objective standards or criteria like the AGS guidelines, or do the AGS guidelines not speak to that level of specificity?
A. No, it does. So in those other schedules it says that the practitioner must undertake an assessment in accordance with the AGS 2007 guidelines. Now, the AGS 2007 guidelines that don't get to that level of "you must do this particular work", it again allows the practitioner to on a case-by-case basis determine what's the appropriate type of work and level of work that needs to be done.

Q. I see. So appreciating then that you haven't had in-depth involvement with the Mornington Peninsula planning scheme, but insofar as you understand it how does the way that this scheme deals with erosion management overlays differ from what you've described as the more general method?
A. Yeah, much more prescriptive is the way I'd put it. It says, "You must do computer analysis." Very prescriptive. It says, "If you are an EMO5 you must do ..." Other planning schemes won't say that. They'll say, "If you in the EMO you must engage a geotechnical practitioner to assess the risk on your site." It won't say how they have to assess it. It says, "You must assess it in accordance with these guidelines," and that's the main difference.

Q. I see. And might one reason that this method's been adopted rather than another one be a reflection of the fact that there are a broad range of conditions that have been identified as being susceptible in different ways and therefore it's easier in a way to be more prescriptive in relation to specific areas?
A. Could be, but that's the basis of the different EMO

schedules. It's where we have greater susceptibility let's require a more onerous assessment.

Q. Yes.
A. And that makes sense, that's logical. I think that's how it's evolved. It was put in place late 2000s, and that would have been one of the first two or three in the state, and I think since then we've learned a lot and things have evolved. But that's still sort of similar to what it was in 07/08.

Q. Does the AGS, either generally or through its guidelines, have anything to say as to a preferred method of scheduling an EMO?
A. No. The guidelines speak more generally. It will talk about, you know, factors for landslide, it will talk about good development, poor development on landslides, but not to that level of detail as to what type of investigation should be done.

Q. Yes.
A. It has some information in there about - you know, more generally, you know, these are the sorts of investigation you might do, but not to the specific level of, you know, how big the boreholes have to be, for example.

Q. So then when you're involved in helping to prepare a schedule in another council area that perhaps adopts the more common method of vesting discretion in the practitioner, is what you're seeking to do primarily by the schedule identify the triggers for a permit application, or is it more than that?
A. That's in essence I guess broadly, you know, what - if we're going to develop in a landslide susceptible area, what type of development or what aspects of a development could either cause a landslide or create a landslide risk. We've got to look at both. So things like earthworks might cause a landslide, but if we have a site where we know there's potential for a landslide to occur and we stick a house in front of it we're putting the development at risk from a landslide. So there's the two elements that need to be looked at.

Q. All right. Is part of this connected with what might be described as good hillside practice?
A. Yes.

Q. All right. Can I show you a slide. I think it's number 10, although I don't think I've got one right yet, so we'll wait and see. If we go back to the slides, thank you. If we could go to slide number 10, please. Bingo.
A. It's a bit blurry.

Q. This is a slide that you asked to be included in your slide deck. Could you explain to the chair what this slide is telling and how it relates to EMOs?
A. Apologies it's so blurry, but this is a slide that appears in the back of the AGS 2007 guidelines, and its purpose is to communicate to the public what's good and poor practice on a hillside with, you know, nice pictorial examples. So, in essence, what we're trying to achieve with an EMO is to ensure that development in the landslide susceptible area is on the left; it's the good hillside practice. So that's the development controls that will be in the EMO. So if you look at the one on the right, things like large fill, there's a big fill there, we don't want to put large fills onto the side of the slope with potential to slide. We want to have good drainage controls. We don't want foundations of the type that have got slabs that require us to make a big excavation into the slope to form a level area. We want it up on stilts. So that's what the intention of this is, and I sort of put it in there to try to communicate what's the point of the EMO. The point of the EMO is that our development is on the left good hillside practice less susceptible to the consequences of landslide.

Q. We might come back to the AGS guidelines in a minute, but they were the questions that I immediately wanted to ask you in connection with EMOs. But before I move to a different topic is there anything else about EMOs that you think it's important that the chair understand?
A. I hope that's it. If I think of anything - - -

Q. If you think of anything, you let me know and - - -
A. - - - later I'll sort of come back to it. But I think that in essence sums it up, we're trying to achieve good hillside practice.

Q. Thank you. So that was connected with EMOs which - as we discussed, for a planning control. So far as your profession is concerned, are they the sole and exclusive planning control in respect of landslide risk?

A. In Victoria they are, as a regulatory control.

Q. Yes.
A. Okay? So let's say we didn't have an EMO and under the building requirements you're required to get a soil report done if you were to build a house. Now, if a competent geotechnical practitioner went out there to do a soil report, they might notice a landslide hazard and raise it and ensure it's designed for whether there be an EMO or not. But there's nothing requiring them to do that.

Q. Yes. And I suppose, similarly, it's possible that there might be discretionary powers in local government, if they're aware of a particular site, to seek additional information or satisfaction in connection with a permit?
A. That's right. That happens too. So I've had sites, say, that are not in the EMO but, for example, involve really extensive earthworks, that even though it was not in the EMO, that the earthworks were so extensive the council had some concerns whether that might cause some instability, they've got discretionary powers to say, "We want a geotech assessment for this, please." That sometimes happens.

Q. So that's planning controls. Is the other principal form of control what you might call building or engineering controls?
A. Yes, that's right. So that's sort of what we've touched on here, is if you were in the EMO and we know there's a susceptibility to landslide in that, what do we do and how do we develop the building to ensure that we can manage the consequences or manage the potential for landslide to occur, and that's what we might call engineering controls.

Q. And in your professional practice you've already said that you're involved advising local government authorities in connection with the development of EMOs. Do you ever do work on the domestic building owners' side where they are seeking to obtain a permit for works in an EMO area? Is that work that you do?
A. I've done it occasionally. The bulk of my work is in reviewing it for councils more so than working for the landowner.

Q. Yes.
A. But I have done it - - -

Q. So you haven't just been involved in the development of EMOs; you've been involved on the council side assessment of permit applications?
A. Correct.

Q. Is that right?
A. Assessment of permit applications, yes.

Q. And the circumstances in which that arises is there's an EMO in place, there's an application for particular works to be undertaken, the landowner's obliged to comply with the EMO requirements that may well include, for example, someone in your profession producing a report and submitting it to the council?
A. Correct.

Q. And then you're called in in those circumstances to evaluate the merit of the report; is that how it works?
A. Correct, yes.

Q. I see. And are you aware of circumstances where a permit has been denied on the basis that it's simply too risky for any works to be done?
A. Yes. Oh, yes. Yeah. They usually end up in VCAT, but yeah. Yeah.

Q. I see. Now, in terms of building or engineering controls, some of those are presumably connected with the physical integrity of the building?
A. Yes, in a sense that's right. So you see an image there. If we've got ground that's got potential to move, you could take an approach of can we put engineering in to stop it moving, which is not - it often isn't feasible on the scale of a residential block if the landslide is way bigger than your block.

Q. Yes.
A. So then the control might be, well, can we design the building to accommodate some movement, like it's a flexible structure like the one on the left there.

Q. Yes.
A. In extreme cases, there's some case where the building is designed that if the ground moves underneath it it can be relevelled. So there is various controls, and it really is a case-by-case, site-by-site assessment as to what you

would do.

Q. Does it often involve appropriate controls put in place to divert water?
A. Absolutely. The greatest benefit - you know, given in Victoria it's the water that would most likely trigger a landslide, then engineering controls to manage water are probably the best value mitigation you can put in place.

Q. I see. Does that mean that building controls are necessarily bespoke, or are there standard applications as well?
A. In a landslide context, for an application coming through under an EMO they're bespoke because the particular development has its own attributes. It's on a site with particular attributes. So if we were wanting to manage groundwater or manage water on a particular site we need to understand how deep is the groundwater, where's the groundwater coming from. We've got to answer all those questions, which would then feed into what's the appropriate design to manage that groundwater. There's no kind of sort of generic way to cut it. It really involves understanding the detail of that development.

Q. And so all of this must necessarily mean that proposed works in an area subject to an EMO become very expensive?
A. Well, I would say they're usually more expensive than if you were not an EMO, usually. Of course there's many cases where it's not. You might draw a parallel with, say, bushfire controls. If you are in a bushfire area you have a higher standard of building with non-flammable material, so, yes, it costs more to build there. But it's not always the case, right? Controls don't have to - aren't necessarily expensive. Drainage controls aren't usually that expensive. If you were trying to hold the soil back with piles or soil nails or something like that, that is expensive. So that would be more expensive. So I'd sort of say, yes, generally, but not exclusively.

Q. You mentioned soil nails now?
A. Mmm.

Q. That's probably not a term that most people would understand. Could you explain when a geotechnical engineer might require that soil nails be used in connection with a particular development and what it is that they do?
A. Yes, okay. So I suppose a little bit more generally

about controls.

Q. Thanks, yes.
A. Yes, building controls. So we know that we've got preparatory factors related to the soil strength. We've got causal factors related to water getting into it. So we can address these things. So if we've got soil strength is a control, well, we can strengthen the soil, and there's ways we can do that mechanically. Soil nails are effectively steel rods that are drilled into the soil and, you know, in a general sense they give it greater strength so that it's more resistant to - if it did get the trigger of a water pressure change, it's more resistant. We've strengthened it. And there's other ways we can strengthen it. We can put piles into it and concrete into it, and there's various ways.

The other one is keep the water out, which is drainage. There's various forms of drainage. We can install subsurface drains. In some cases - there's spots on the Bellarine Peninsula where we put boreholes down and actively pump water out of the ground or we put drains in to prevent the water getting in in the first place. So you can look at the controls in sort of broadly a couple of - or engineering controls broadly in that we can make the ground stronger or we can keep the water out of it, and ideally we do both.

Q. I see. Perhaps to round off on this topic of controls, we've mentioned a number of times the AGS guidelines and you've mentioned your own involvement with that organisation and I think in connection with the guidelines themselves?
A. Yes, we're revising the guidelines at the moment, and I'm the chair of the committee revising the guidelines.

Q. All right. Well, you're well placed then perhaps to explain the reason the guidelines were developed and the extent to which they are ordinarily referred to in an EMO process?
A. Yes. So it goes back - sort of the first publications in Australia on landslide risk management sort of go back to the mid-80s, various technical papers that did that. It was in the 90s that it started getting a bit more momentum to develop into a guideline. But then in 1997 the Thredbo landslide happened, which very much heightened awareness. Following the inquiries and commissions and the coroner's

report into that there was funding, and AGS got funding from Emergency Management Australia, and that sort of kick-started it.

So the first version of the guidelines came out in 2000. There was a revision in 2003; another revision in 2007. Each one, I guess, once it gets put out and people practice with it, improvements are identified and it's been changed a few times. It hasn't changed since '07. But with things like, you know, LiDAR technologies and changes that have been since 2007, in fact overdue, it's going through an update now. So that's how it's involved over time.

Now, the status of it, as I mentioned earlier it's not a standard, it's a guideline. So there is no, you know, to the same standard as Australian Standard; it's normative; you must perform your work to it. It's a guideline. However, for all practical purposes it may as well be a standard because in the schedules to the planning schemes it will say, "You shalt do it in accordance with AGS 2007 guidelines." So it represents the best practice to do this work that we have in Australia, and practitioners are required to follow it if they're providing a report that's under an EMO or under a planning scheme. I think most practitioners would be in a position that if you didn't follow what's the recognised best practice guidelines you'd be putting yourself at risk by not doing so. So, whilst it's not a standard, you know, it almost operates as if it is.

Q. In the schedule that I was showing you before to the Mornington scheme there's reference to quantitative risk assessments of the site being conducted in accordance with the - and then I quote - "practice note guidelines for landslide risk management, Australian Geomechanics Journal, volume 42, number 1, Walker, Davies and Wilson, March 2007." Are they the guidelines you're talking about?
A. Yes, that's one. That's actually referencing a chapter of the guidelines.

Q. I see. And the guidelines deal with mapping?
A. Yes, they do.

Q. Do they deal with mapping in both senses of the inventory and susceptibility?
A. Yes.

Q. Do they deal with risk assessment more generally?
A. Yes, they deal with risk assessment.

Q. And do they deal with the types of controls that might be imposed in particular conditions?
A. Yes, to a lesser extent. Yes, to a lesser extent. So it's mainly about sort of assessing the risk and understanding what could happen. But it doesn't get into the specifics of, "Here's how you design a retaining wall." It just might say, "A retaining wall might be a suitable solution." It doesn't get into more detail.

Q. I see. When do you expect the update of the guidelines to be completed by?
A. Our target is for the first draft in April '26, and I'm not going to commit to that. That's our target.

Q. Can I ask you something about the timeline of EMOs.
A. Yes.

Q. Is the mapping the thing that takes the longest?
A. No, it's the regulatory side of it takes longer. So putting the mapping together would take, let's say, six months or something like that, depending on the size of the area we're looking at. Some government areas are bigger than others. The amount of information available, it might take six months to produce a map. It doesn't take too long to produce a schedule, and that's because there's quite a few of them out there and there's good precedent to draw from.

But then once we have our first draft, "Here's the mapping and here's the schedule," there's community consultation, there's consultation with Planning Victoria, there's planning panels and hearings, and there's a protracted process of giving people the opportunity to comment. We may refine it, change it. So the time between, "Here's our first draft and here's the implementation" can take years. I've had some that's taken two years. I'd typically say it takes about a year, unless there's a ministerial intervention. The minister can intervene and fast-track it. But otherwise it's more than a year usually from draft to implementation.

Q. How long does the mapping typically take?
A. About six months, as a general. It varies. Like,

I did one for the alpine resorts; did a small area. Didn't take as long. If I'm doing it for all of East Gippsland it's going to take longer.

Q. Is that really a function of the availability of the particular practitioner?
A. It's the function of - yes, well, I suppose it's two. It's a big area. So there's lots to look at. We've got to scan all the LiDAR over a particular area. I guess to some extent it's a function if we've got more people to do it we'll get it done quicker. But I say it's really a function of how much data you've got to go through, how big is the area you've got to scan. So it takes the longest.

Q. So it's still a very heavily manual process at that level that requires a person with appropriate training, skill and experience to actually turn their eyes to every part of every map?
A. That's how we do it, yes. That's how we do it now. I would say that there are - you know, there are parts of the world now where AI techniques are being used to do that instead. That's sort of been coming for a little while. But the ones we have done in Victoria have been done manually, and they involve not just looking at a screen and identifying from the LiDAR but we also go out and ground-truth and that adds time as well. We don't just say, "We'll take what we see on the LiDAR for certain." We go out onto the site and check that what we've interpreted from the LiDAR is consistent with what we see on the ground.

Q. I see. So there's a physical inspection process to some degree?
A. Yes, that's right. That is part of it.

Q. Okay. I might come back to that in a moment, but just to stay with the maps for now. Are the LiDAR maps expensive?
A. No, I have never had to pay for them. The ones we use are owned by the Victorian State Government. They would be expensive if we wanted to buy them from the State Government. But if we're working for a local government they get it from --

Q. The State makes them available?
A. The State makes them available to the local government.

Q. I see. So the cost of the mapping process is in effect the cost of the expert?
A. Yes, that's right. There's really no cost to it.

Q. I should just seek to properly understand the degree of on-the-ground checking. Is that in connection with the inventory or susceptibility or both?
A. Both.

Q. I see.
A. Both. Usually go out multiple times, yes.

Q. I see. And you'll go out for spot checks? You wouldn't check the entire area?
A. No. So we might have mapped a whole series of landslides, and we'll selectively go out on the ground and make sure that what we've seen in the LiDAR, understand the landslide on the ground and understand has our mapping been reasonable. Then later on in the process, once we've got a susceptibility map and we've identified areas that we think could be susceptible to landslide, we want to go out on site and say - as a manner of validating the criteria we've come up with, go out on site and have a look as well. So you go out at multiple stages in the process.

Q. I see. Two further questions in connection with EMOs. The first is this is a process triggered by a permit application. Once an EMO's in place --
A. Yes.

Q. -- the EMO becomes relevant if there's an application for a landowner to do something.
A. Yes.

Q. And that, I suppose, reflects the fact that the works, either in the doing of them or once done, might increase the susceptibility of a particular slope to landslide; that's the basic theory, is it?
A. Just to sort of pick up on the terminology. It's that the development could be at risk. So I go to the point and say we might put a development there that doesn't change the susceptibility. It's just as likely for a landslide to happen. But by putting a development there and perhaps putting people at risk of that landslide we then increase the risk. So the risk is the likelihood and the consequence. So, our development, we potentially could

change the likelihood with poor drainage or earthworks, but we could also change the consequences because we're putting valued assets or people in an area where landslides could occur.

Q. But as a matter of reality is the case that, even in an area in which there is an erosion management overlay in place, there could be no works undertaken in that area and a landslide can still occur?
A. Yes.

Q. And that happened here?
A. Yes, absolutely.

Q. And in those sorts of circumstances you're not aware of any obligation on the part of the local council or anybody else to be doing anything actively to manage landslide risk; it's all triggered by permit? That's how the process works?
A. Yes, and in that sense it's triggered by a permit. But, to sort of add to that, local council also has responsibility for emergency management.

Q. Yes.
A. So if a landslide occurred, EMO or not, if that was presenting a risk to public safety then council would have an obligation to address that.

Q. Thank you. Is there any requirement for EMOs to be updated?
A. There's no requirement that I know of that says they must be updated; not that I'm aware of.

MR COSTELLO: I see. Thank you. Madam Chair, I'm going to move to another topic now. Mr Paul's been in the box for an hour. Would that be a convenient time to have a short break?

CHAIRPERSON: Yes. Let's give him a 15-minute break, and give some others a 15-minute break. We'll resume at 3.30.

SHORT ADJOURNMENT

MR COSTELLO: Thank you, Madam Chair. Mr Paul, having confidently told you that I was moving to another topic, there's one last question concerning EMOs that I wanted to raise with you. Could I perhaps call the Mornington

Peninsula planning scheme back up. Thank you. Could the second bullet point perhaps that starts, "If any of the land" - no, the next one down, sorry. If we could just blow one up. It starts, "If any of the land is also affected". Yes, thanks.

This comes from the schedule that I was discussing with you earlier, and you'll see here there's a particular requirement in connection with land affected by EMO5 for a quantitative risk assessment of the sites in accordance with the practice note guidelines for landslide risk management. What's involved in the preparation of a quantitative risk assessment?
A. Okay. So what we're trying to achieve with a quantitative risk assessment is an estimate of the probability of loss of life for that particular development. It's a probability of loss of life. That probability then gets compared to a criteria. So we're kind of saying, "Look, we think the probability of somebody might be killed is one in 10,000. The minimum we're going to allow as, say, Mornington Peninsula Shire as the regulatory authority is one in 100,000. Therefore, that's not acceptable."

The process by which a practitioner would undertake that assessment is initially develop our model, identify what the landslide hazards are, what could happen on this site, what type of landslide, how big might it be, how far might it travel. So that all comes out of that model. Then we look at what's the probability of the landslide happening; what's the probability of the debris travelling to somewhere a person might be; what's the probability a person might be there at the time; and what's the probability they might be impacted.

So they're called conditional probabilities, but you string together what is the probability of all the things that have to happen between a landslide getting triggered and someone getting killed. That's how you come up with the probability of loss of life, which then gets compared to a criteria. So that's the process.

Q. Is this also a circumstance in which one is not only looking to the probability of a loss of life but a probability of loss of life of the most at-risk person?
A. Yes. That's the next level of detail. So let's say you've got a house and there's four people living in that

house. The calculations become more difficult if one person is there for eight hours a day, one person is there for three, they're not there on the weekend. You can take your calculation of probability to a really sort of detailed level. We find that level of detail is not necessary.

So a simplified way is to say, "Well, of all the people in that house, let's pick the person who's at the highest risk," and we call them the individual most at risk. Usually that would be the person who is there the most, or maybe they're the person who is in a particular part of the building that is the one that is going to likely be impacted. So, instead of trying to assess the probability of somebody getting killed given all the pattern of usage of the building, we just do it for the individual most at risk. We get the probability of loss of life of the individual most at risk. Then the most commonly used criteria - in fact I think all of the Victorian planning schemes, the criteria they will use is the probability of loss of life to the individual most at risk must not exceed, and it will either be one in 10,000 or one in 100,000.

Q. I see. Thank you. That document can come down from the screen, thank you. We've dealt now with preparatory factors and with controls, the relevance of the AGS guidelines. Can I move to a different topic now, which is causal factors.
A. M'hmm.

Q. These are the particular factors that might result in a landslide occurring; is that a fair description?
A. Yes, I would use the word "trigger"; trigger the landslide.

Q. Thank you. And what are the most common causal factors?
A. Okay. So it's things like - so something has to change, is sort of more generally. You've got a slope that's sitting there. We know it's susceptible to landslide. But something has to change in that slope for it to actually slide.

Q. Yes.
A. Now, that could be a change in the water pressure. That could be a change in the loading. It could be

surcharge loading placed - a bunch of fill, for example, placed on the top. It could be earthworks, for example. We change the loading by removing soil that's buttressing the base of the landslide. It could be an earthquake. So that would be the most common. In Victoria I would say almost overwhelmingly it will be a change in the water pressure that's the thing that triggers it. So we find most landslides in Victoria will happen in response to large rainfall events or some means of water getting into the ground, mostly; not exclusively, but mostly.

Q. All right. And that gets us back to the concept that you explained earlier about pore pressure?
A. That's right. Yes, that's the change. So water gets into the ground causing the pore pressure to increase, therefore causing the soil to lose strength, causing the landslide.

Q. Yes. When you talk about soil strength here you're talking about the likelihood or capability of the soil to hold in its present location; is that what you mean by soil strength?
A. Really I'm talking about - I suppose that's an extension of it in a way, but we're really talking about the internal soil strength. We're getting a bit detailed perhaps. Soil gets strength from a number of mechanisms. It gets strength from the friction between the particles. So if you've got some dry sand and poured it into a pile it would adopt a cone. It is getting strength from the friction between the particles. If you have something like a clay there's electrostatic attraction between the particles sort of pulling it together. That's giving it strength. That's why clays are plastic and sands are not. Then the third one is what we call the apparent cohesion which we talked about earlier of the negative pore pressure. The air and the water partially pulling it together. So soil gets strength from those three things.

Now, the friction is always the friction. The particles are still going to be the same friction between each other. What we call the cohesion, which is the electrostatic attraction, that's kind of the same. The thing that can change is the water content. When we change the water content we change the strength. Makes sense?

Q. That's very useful; thank you. In terms of changing the water content the obvious example is rainwater?

A. M'hmm.

Q. Do others include what I think you referred to earlier as hydrogeological features?
A. Yes. The source of the water would be, I guess. Rainfall or perhaps there's some aquifers, water migrating through the subsurface and causing an area to become wetter.

Q. Yes. You mentioned perch water earlier?
A. Yes.

Q. Is that relevant to the question of the pore pressure?
A. Yes, it is. I guess there's no limit to the sources of what the water could be.

Q. Yes.
A. Some of the more common ones would be rainfall infiltration and rainfall migrating into the soil, or the diagram we showed where soil stays wet for a long time and a wetting front builds through, or it might be - it can be the groundwater table rises for some reason and that causes the soil above the groundwater table to become wet.

Q. Yes.
A. Or it could be leaking services leaking water into the soil. You can probably invent some more. A leaking tank. The water has to come from somewhere.

Q. Yes. So there are natural water sources?
A. Yes.

Q. Or then there's human caused factors which might include excessive irrigation?
A. Yes. Yes, could be.

Q. Could include broken infrastructure that's leaking water in?
A. Yes.

Q. And all of those are relevant in terms of - sorry, all of those are relevant because they have the capability, in fact likelihood, of affecting the pore pressure in a way that will make the area more susceptible to a slide?
A. Yes, or I would say the way I would frame it is it has the potential to trigger the slide. So the area is already susceptible. Water getting into the soil causes the soil

to lose strength. We now that if soil loses strength it's unable to hold itself up. It's internal shear strength is reduced, and then it can slide.

Q. I see. You're now going to assist the board of inquiry in its investigations into the causes and, from what you know of the geological conditions of this site and what the site was used for, that is it's a residential setting, does that mean water is a very clear line of enquiry from a geotechnical perspective?
A. I would say for this case water would seem to almost certainly be involved, and water will almost certainly be the trigger, and a line of enquiry is what might the source of water be.

Q. Thank you. Can we talk then a bit about landslide investigation. In your professional career have you been involved in landslide investigation?
A. Yes.

Q. That is post event?
A. Post event, yes.

Q. It seems from some of the material that's been provided to the board of inquiry that there are a number of reports that seem to usually be done in this connection. I just want to ask you about them and tell me if it's the ordinary sort of process for an investigation. There's one category of report that appears to be really a factual investigation rather than a causal analysis; is that an ordinary step?
A. Yes. In simple terms the first thing we've got to do is gather the evidence before we make any interpretation and scrutinise the evidence. So the factual report is essentially the evidence that's been gathered so far.

Q. I'll come back to the types of enquiries one would make to do it, but just stay on the current topic. What's the next step? Is it then interpreting that evidence to determine cause?
A. That's right, yes. Of course there's no limit to how much evidence we might get. There's a question there about how much do we want to get. But, that's right, once we've got that evidence we would use that to put our model together. The model is essentially a hypothesis. "Based on this evidence, how do we think this happened? How did this landslide occur?"

Now, that's not a bad way to think of it as a hypothesis, and it should always be subject to further testing. Once we get our first model together, we might think, "Okay, this is what we think has happened, but there are a few more tests we might be able to validate to test that hypothesis." Then once we've got that model together and we've developed what we think is the sort of leading hypothesis, "This is what caused it," that then puts you in a position to be able to make some decisions about how you go from there; mitigation or whatever you might want to go from there.

Q. Another type of report that sits separately from the mitigation idea that you've just mentioned is a risk to life report.
A. M'hmm.

Q. And that seems to be bear some similarity to what we were just talking about in connection with the report required by the schedule in that there's the risk to life analysis. Is that a report commonly done post event?
A. It is. Yes, it is. It can be done before or it can be done after. Now, in this circumstance once we've got all that evidence together and we've got an idea of what might be happening, perhaps the next step might be, "Given what we know about this landslide, what risk to life does it present?" That might then inform decisions to evacuate or whatever the action might be.

Just to give you another angle on that, immediately after a landslide there will be a position where emergency services needs to get on there. There needs to be rapid decisions made on the risk to life, like, straightaway. Now, you don't have time to go and do a whole bunch of investigation and put a model together. You're making on-the-go decisions, which is absolutely necessary under emergency conditions. So, for that, the same process is sort of followed but just in a more rapid way.

Q. Do you mean methodologically the same process?
A. Yes, methodologically. So we're still saying, "What could happen here? For example, could that landslide get bigger while people are there? What's the likelihood of that? What will be the consequences of that?" If that's unacceptable, we would have to take some action.

Q. And how does one determine what the risk tolerances are? Is that just the decision of the particular local government area or is there some guidance about that from AGS or elsewhere?
A. Yes, the AGS guidance is it is the appropriate regulatory authority. So in the planning context that's the council. If it was an emergency response context, it might be the police or the SES or whoever's got control on the site.

Q. I see.
A. But it's the relevant regulatory authority.

Q. All right. And then you mentioned design mitigation. Is that ordinarily part of the process that the person who's done a causal inquiry will be involved with or does that typically go off to somebody else?
A. That's right. So you've got your model together. We've identified what could trigger the landslide. Now, we want to develop. We need to design mitigations that prevent as far as practical that trigger occurring; or, if that trigger were to occur, reduce the consequences as far as practical, and that's the process of getting to an acceptable level of risk.

Q. Yes, thank you. Now, in terms of landslide investigation I suppose that scale is important?
A. M'hmm.

Q. That is, whether you are looking at things in the immediate scale of the area directly affected or if you're extending the scale more broadly than that. How does a professional like you go about determining the causes of a landslide and at what scale do you commence your investigations?
A. Yes, it's like anything, not to focus in or sort of focus in on the tree and miss the forest. So in gathering that evidence we want to take a very wide view first. The principle to work on is to take a far field view and narrow it down to near field. Regionally, what's the geology in this region? What processes are occurring elsewhere in the area? You might be looking at, "Okay, we've got Arthurs Seat up behind. We've got granite. What could be happening there? What might be happening with groundwater," and looking at it at large scale. At that point you're starting to build your models and hypotheses and what could be happening.

Then you start getting to near field. "Here's what I think is going on. If I go do some boreholes there and some boreholes there, that's going to help confirm whether that model I put together at far field is right." So you're then zooming into the next level. We might be saying, "We think we've got some sand over granite, and maybe the water's coming down through the sand, for example." So we'll go do some boreholes through the sand just to check if there is. But, in principle, far field and near field; big picture then the detail in the process.

Q. And when you're doing far field enquiries are you concerned at that level about geological conditions or are you only concerned with geological conditions closer to the site?
A. You're still concerned with geological conditions; it's just the scale you're considering them out.

Q. I see.
A. I could say, "Here I've got this whole lump of granite," or I could say at a next level down, "Here I have this granite and there's residual soil in a part of it and there are joints that are a metre apart." You can look at something in a big picture or you can hone in.

Q. Looking at things in the big picture, is one in a better position to do that in circumstances where there's an EMO because there's already mapping that's been done that might be relevant to the enquiry?
A. Yes, that's right. So we call it our desk study. So going in and doing that far field view you're trying to pull as much information out that exists. So if I was to do a landslide investigation the first thing I'm looking at, the landslide inventory, what data, what evidence, what other landslides are known to have occurred here. I'm looking at the geology map; what's my understanding of the geology. What landslide susceptibility has been mapped in this region before. So I'm looking well beyond the scale of my particular site. Eventually I'll get to looking specifically at the site, but I'll start off by understanding what's happening regionally.

Q. I see. And then you've mentioned the importance of investigations into water. What type of investigations would one typically undertake in that regard?
A. It's a hydrogeological model. I'm trying to

understand where water is getting into the soil, where water is getting out of the soil, what the depth to the water table is. Putting together - similar to a geological model, we're putting a hydrogeological model together. Where is water in the soil; where is it coming from; where is it going to.

Q. Yes, I see. And so once you've done your far field and near field investigations you've developed a model or a concept which is an explanation as to how you think this or what you think triggered this landslide?
A. Yes, what are the factors that caused it.

Q. And then is the next step that it's necessary to somehow test that model?
A. Yes. Usually, yes.

Q. And how is that done in reality?
A. So that might be we go to that next level. We might do what we call intrusive investigation, things like boreholes, things like excavations. We're actually looking into the ground. We might install instrumentation to monitor and measure what the groundwater is doing. We might do that in different locations. So that's how you would test the model.

Q. I might get you to comment on some particular types of testing that can be done by reference to one of Mr Pope's reports in a minute. But, before we get to that, all of this necessarily is an informed opinion as to the trigger and it must carry within it some risk of error. How does one deal with levels of certainty in these types of investigations?
A. Yes, it's a good question. There's always uncertainty because we cannot - we don't have x-ray vision to be able to look at everything under the ground and know everything that's going on. When we do try to see what's underground we can do boreholes at discrete locations with lots of spacing between them. There is always uncertainty. And there's different ways of dealing with that uncertainty.

So one approach might be to bound it, to say, "Well, we don't think the situation could be any more extreme than this based off what we know." There could be some range in between. "We can't be any more extreme than this." And we could take that as our sort of basis, conservative basis, to say, "Not worse than this. Probably isn't quite this

bad, but it's not worse than this." If we take that as our basis, we'll be in a conservative position. That might be one way to deal with it.

Another way is to take what's called an observational approach, sort of continue learning as you go. So you recognise it's uncertain, design a mitigation and say, "Let's say, for example, we're going to install soil nails in this site as our mitigation." As we install those soil nails we will look at the material coming out of the holes. We will check it's consistent with our assumptions. And over here we'll have a contingency to address that if we come across it. That's a bit more of an aggressive way.

Or we can take a risk based or probabilistic approach to say, "We think the truth sort of lies somewhere in between here and here, and there's a probability distribution that's kind of more likely to be this, less likely to be that." So we might try to operate it at the 25th percentile or something like that and we'll say, "We'll assume it to be here relative to what we know," if that makes sense. So there's various ways to deal with uncertainty, but it's always there.

Q. I suppose that data collection in any landslide investigation necessarily has some sort of time element involved in it. There's the time to actually conduct the tests. But presumably, given environmental conditions change on a day-to-day basis, there must be some level of time that needs to pass in order for results to be meaningful?
A. Can be. So if we're trying to understand a time-dependent process then you might need to be measuring or monitoring, you know, over a time scale that's consistent with that process. So if, say, we were concerned about changing water conditions and those changing water conditions in the ground occurred in response to rainfall events or occurred in response to above average years of rainfall, to really understand that you would have to monitor over the time in which that process is going to change or fluctuate. Often that's not possible. So you need to in that case perhaps make an assumption.

So, for example, to go to somewhere else, an infrastructure project I'm working on at the moment, we have to have a basis of groundwater level to produce the

design. But what's uncertain is what that groundwater level will do in the future in response to climate change and those sort of things. So the approach there is to say, "We've measured the groundwater level here, but we're going to say in the next 100 years feasibly the worst it could get is here." So that will be our design basis, and we account for that uncertainty. Even though we haven't got the measurements, we have to make an assumption about what it could be in an extreme or future case.

Q. Yes, I see. I might just take you to a report of Mr Pope. It's MSC.5007.0004.0078. Madam Chair, this is a document described as McCrae landslide evacuation order area, geotechnical factual report, dated 9 April 2025 prepared by Mr Dane Pope, who is an employee of PSM Consulting Services Pty Ltd. I haven't tendered any of the other documents that I've referred to. They can all be tendered in a batch at the end.

CHAIRPERSON: Yes.

MR COSTELLO: I think I'm right to say this is in fact an exhibit to a witness statement that will be tendered. So this is finding its way into evidence one way or the other.

CHAIRPERSON: Yes.

MR COSTELLO: How would you prefer me to do it?

CHAIRPERSON: If you could tender all of the documents that you referred to in your opening as a bundle. This document can be tendered at the same time as the witness's report is tendered.

MR COSTELLO: Thank you.

CHAIRPERSON: As the witness's witness statement is tendered.

MR COSTELLO: Witness statement is tendered.

CHAIRPERSON: Yes.

MR COSTELLO: Yes, thank you; we'll do it that way. Mr Paul, you know that Mr Dane Pope has been engaged by the Mornington shire council in connection with both the 2022 and 2025 landslides?

A. Yes.

Q. And I assume that the pool of geotechnical engineers with experience in landslides in Victoria is sufficiently small that you're at least aware of each other, if you don't know each other?
A. Yes, yes. It's a fairly small pool.

Q. Do you know Mr Pope?
A. I do know him, but I don't know in great deal. I've never worked with him, for example.

Q. All right. So this is a factual report that he's prepared in connection with the 2025 events. I thought it might be easier to ask you questions connected with landslide investigation by reference to this report rather than more generally. If we could move to I think it's page 8; it's 0085. Actually if we could go one page earlier; thank you.

This is Mr Pope undertaking a factual investigation without identifying causes. You can see here that the third heading in the report is entitled "Geotechnical investigation", and he talks about the period that the investigation was carried out, and the types of investigations that were done here in those first six bullet points. Site walkover is obvious enough. He then mentions geotechnical drilling. If we go over the page you'll see here is a more detailed section on geotechnical drilling where he talks about vertical boreholes being drilled, using a track mounted geoprobe 7822DT drilling rig. What's the purpose of, in general terms, geotechnical drilling in connection with a landslide investigation?
A. Gathering evidence to understand the mechanism and to feed into his model.

Q. And is geotechnical drilling connected both with ascertaining soil type and groundwater?
A. It can tell us about soil type, and then we can put instrumentation into the borehole to tell us something about groundwater.

Q. And in the heading 5.2 there concerning groundwater you can see that he speaks about all eight boreholes were completed by installing either VWPs or standard piesometers?
A. Standpipe, yes.

Q. Is VWP initialisation that you're familiar with?
A. Yes, it's a vibrating wire piezometer, but it's measuring pore pressure.

Q. I see. So it's one type of piesometer?
A. Yes, an instrument for measuring pore pressure; yes.

Q. I see. And that's the standard tool for measuring pore pressure?
A. Yes, I would say it's standard. It's not the most basic one. It's got a level of sophistication to it but, yes, very common.

Q. And as a general proposition is it important to leave piesometers in the ground for a reasonable period so as to ascertain affluxions in pore pressure?
A. Yes. As soon as you've installed them there's a requirement to wait a little bit of time because the process of drilling itself introduces water into the ground. Water is used in the drilling process. So you have to allow for that to dissipate, which might be days or weeks. It's not a long time. Then if you want to know what the natural fluctuations in the soil moisture in the ground you've got to leave it there as long as you think those fluctuation cycles might run for.

Q. And is there anything in the AGS guidelines that gives one guidance about the timeframes necessary in order to obtain statistically valid datasets?
A. No, they're just guidelines; wouldn't get to that detail.

Q. So this is a question for the particular expert?
A. Yes.

Q. Applying their professional training and skill to determine how long you need to leave the piesometers in the ground and have a result that will be worth having?
A. That's right. And that expert will be under all sorts of pressures as to when their report is required, which will be another factor. You don't get the luxury to leave it for as long as you prefer.

Q. Over the page he mentions non-destructive testing, and this was something that you may not have heard it but I mentioned non-destructive testing in the course of my

opening. What's non-destructive testing and what's it used for?
A. Basically digging a hole. However, it's dug with a particular piece of equipment, which is a vacuum excavation, and you use it to minimise the risk of damaging a service. So if you were just to go in there with backhoe and dig away you'd risk impacting a service. But, non-destructive, it's essentially a giant vacuum and you vacuum the soil out rather than dig it out.

Q. And you're vacuuming the soil out, what, so that you can do lab analysis of the soil?
A. Yes. You can take observations of the soil or perhaps samples of the soil.

Q. I see. And then the second one there is - perhaps 6.1.2 in the paragraph underneath it could be blown up. It says "RD". He speaks of two hand auger holes being excavated to a depth to identify, and then is it re-in drains?
A. Reln drains.

Q. Reln drains. What's a Reln drain?
A. Reln's a brand, actually. But it's what some people might call an agi-pipe. So it's a slotted plastic pipe with holes in it that you would put in a trench filled with gravel, and its purpose is to drain water out of the soil.

Q. I see. A lot of this is directed to ascertaining groundwater levels. Apart from particular site investigations which we'll come to in this context in a minute, is there publicly available data about groundwater in particular locations?
A. There is. So a bore that's put in for the purpose of extracting water from the ground, even if it's just to extract water for a test but, more specifically, if you're extracting water for watering stock or whatever, any bore has to be registered through Southern Rural Water in this area. That information has found its way into a database, which is called the Visualising Victoria's Groundwater database, and you can access that information. There's thousands of boreholes in there. The level of information varies. What's in the database in respect to a particular borehole, particularly older ones, can be very limited. And it's luck of the draw whether there happens to be one in your area of interest. But there is a public database as a matter of course you would look into if you were

interested in the groundwater.

Q. Is the publicly available borehole data less likely to be useful in a heavily residential area?
A. It could be useful. It's just you might have less chance that there is actually data.

Q. Sorry, you're quite right. That's what I mean. Is it less likely that there would be useful data?
A. Yes, it would be less likely, I'd say, you'd find it.

Q. Thank you. If we could go over the page, please. This is still in connection with groundwater. There's talk about NDT holes. Then at section 7 he gets to cone penetration testing. Could you explain cone penetration testing, please?
A. Yes. This is where this whiteboard has been sitting. I've been waiting for my chance. So it's a probe that we stick into the ground. So it's a probe with a cone on it, which is why it's called cone penetrometer testing. You push that into the ground, and it goes down. What's in here is a load cell which measures the resistance on the end. So as it goes in we can measure, essentially, how hard the ground is, how much resistance we get on the end. Then it's got through here a sleeve, and it's measuring the friction on the side. Of course more friction, it will receive more load than less friction. So you get this information. You get the resistance. You get the friction.

But it also usually has a sensor, either up here or down here, which measures the pore pressure. But you have to be very careful because the pore pressure it is measuring is the pore pressure in response to pushing this into the ground. So when you push this into the ground you're causing all that soil to displace around here. You drive something in the ground, that soil doesn't come out the top. It's getting compacted and pushed around the probe. That causes the pore pressure to elevate. It's like getting a sponge or something and squeezing it. The water pressure will rise.

But it tells you the response. So what that is useful for is if we cause the pore pressure to rise around the cone and then it suddenly dissipates quickly that tells me it's permeable. It tells me that water was able to dissipate quickly. If it causes the pore pressure to rise

and it stays risen, it tells me it's low permeability. So from this test we can understand the different layers. We can say is it sand, is it clay, what type of material is it, and we can understand something about the permeability. And you get a continuous profile.

Q. I see. So in that respect - well, does a piezometer measure only water level or does a piezometer tell you pore pressure as well?
A. Okay. So a piezometer --

Q. Could I ask you to use black pen?
A. Sorry.

Q. Apparently for those watching at home they can't see it in the green pen?
A. I'm glad they're interested. So we drill down a hole. There's different types of piezometer. We drill down a hole and we insert PVC plastic pipe into the hole, and then in that pipe there are slots in the end. Those slots allow groundwater to go into that. Once that groundwater goes in, if the pressure out here is higher then the water in that pipe will rise up to whatever the pressure is at that point. That doesn't mean there's groundwater here. It just means the pressure of that groundwater will cause the water to come up, and then we can measure - it gives us an idea then of the pore pressure down here. So that's a standpipe. This sits in a borehole. The pipe's in a borehole. If we're interested in the pore pressure at this depth, you seal it by putting tight clay material down there. So we are measuring the pore pressure at that spot by allowing it to rise up.

The other form, a vibrating wire, I'll add here. It's an instrument on a cable, and then it sits down the bottom at the depth we're interested in. Then we seal it in, and all this is sealed up, and it's directly reading the pressure. The reason it's a vibrating wire is because it's like a little guitar string. As you change the pressure, the frequency it vibrates at is different. Then you can measure that frequency change up the top, and that is related to the pressure. So different instruments but they kind of give you the same thing. This doesn't give you the in situ pore pressure. These do. Makes sense?

Q. Yes, thank you. I'm sorry if I have been depriving you of the opportunity to do your drawings. I should have

asked you to draw a hill at the start of my opening. Obviously, given the centrality of water as a potential trigger, is it important to ascertain the source of the water?
A. Yes. If eventually where we're going to is how are we going to manage the water, then you need a basis to which to pair your design. Where are you going to put your drains? What type of drains? How big do they need to be? So, to get to that point where you can design a mitigation, absolutely you have to know where the water is, how is it flowing, how much. So that's kind of essential design input to designing mitigation.

Q. I see. If we can go over the page, please, in fact if we could go two pages forward to 0089. You can see here at 8.1.2 that Mr Pope sampled surface water on 20 January. It was done, sorry, not by Mr Pope. It was done in the presence of some of his staff, but by JBS&G. And the sampling was conducted at five locations for field water quality testing and laboratory testing. Is laboratory testing of surface water an ordinary and usual test that would be used in a landslide investigation?
A. Yes, absolutely. And what the purpose of doing that is to try to understand where the water has come from and to. So you could match the chemistry of the water where you're seeing it coming out to the chemistry of some water that's getting in. That's perhaps evidence to link the two.

Q. I might then be getting close to trespassing beyond your area of expertise, but if we go a long way forward in that report to page 0263, using the Bates numbering. Could we go back, thanks. Could we go to 0263 on the Bates. Thank you. Then go to one forward. So this is an appendix to the report, and it's said in the part of the report I just took you to that surface water samples have been taken from five sites. You can see the sites indicated here each with an SW notation. You can see there - I think you familiarised yourself with the map of this area, Mr Paul; is that correct?
A. Yes.

Q. So you can see that SW05, that is down towards Point Nepean at the bottom of the slope near the affected Penny Lane property, and the other four surface water samples were taken up high on the slope at View Point Road. And they were then sent off to JBS&G for testing.

If we could move to 0270. It looks as though this testing was done by Eurofins, and you can see it's addressed to JBS&G. Can you see there that the column starting from the right are SW4, 3, 2 and 1? And unfortunately SW05 is over the page, but I'll take you to that in a moment. Just using the data that's blown up for you there, a testing of the water is done and the levels of different chemicals and minerals are recorded in respect of each of the five sites. Now, is water chemistry something that geotechnical engineers with your subspecialty are interested in in landslide investigation?
A. Yes, something we're interested in and I must say we would get a - there are people specialised in this who I would bring in to help. But absolutely we would be interested in.

Q. Would that be you would bring in a chemist?
A. Yes, it would be somebody with the skills in groundwater chemistry, which might be a hydrogeologist with skills in chemistry. It could be a chemist. They tend to come from different backgrounds, people who work in soil water chemistry. Yes, somebody with that skill set.

Q. Presumably to a trained eye levels of particular chemicals such as fluoride or chloride will immediately be indicative of something?
A. Yes, that's a common one is if we're looking, "Did this water come out of mains," you know, there's fluoride usually in mains water and that's one of the things you might look for to see whether it's got fluoride in it as evidence that it might have come out of the mains.

Q. Can you see the third test is conductivity?
A. M'hmm.

Q. Do you have an understanding of what conductivity means in this circumstance?
A. Yes. So it's the electrical conductivity of the water. In general the more ions in it, which is essentially the more saline it is, the higher conductivity.

Q. More salt means more conductivity?
A. Yes, more salt means more conductivity.

Q. And can you see here that on conductivity there's something dramatic - well, whether it's dramatic or not you

can tell me based on the unit of measurement, but at least there's a significant difference between the conductivity of SW01, for example, and SW02, 3 and 4?
A. M'hmm.

Q. They're all at or above 400 and SW01 is at 140?
A. Yes.

Q. And to a geotechnical engineer like yourself does that tell you anything?
A. You could say, well, we would have to check, but if that is a salt content or a conductivity higher than you would get out of rainwater it's telling us it has to have spent some time on the ground, travelling through the ground, to pick up the dissolved ions it's got in it.

Q. Thank you. If we could just go over the page for a moment. You'll see there there's the column for SW05. Now, can you see the conductivity level for SW05 there?
A. Yes, 1,200.

Q. So that is far above that for SW02 to 4, and almost 10 times for SW01. Does that tell you anything about that particular sample?
A. Without being conclusive, it could be evidence it's been in the ground longer. It's had to pick up these ions from somewhere, which could be from it flowing through the ground.

Q. I see. It might be, for example, that water that has travelled through the earth a greater distance might end up with a higher conductivity?
A. Could do, yes.

Q. And are there any other particular markers that you would look for to determine whether or not it's likely that water has passed through the earth to any significant degree?
A. None of the others. Bicarbonate alkalinity is CoCo3, which appears down the bottom. So that's carbonate. To pick up that it has to flow through something that has carbonate. Carbonate we mean shells, limestone, that sort of material. So that might be indicative of flowing through, for example, the dune deposits we have there, the Pleistocene dunes that we showed on the geological map, have carbonate in them. So to see carbon in the groundwater would be consistent with perhaps it flowing

through a soil that we know has carbonate in it.

Q. I see. And the reading there for bicarbonate alkalinity is 190.
A. M'hmm. And that seemed higher --

Q. Is that milligrams a litre?
A. Yes, milligrams per litre.

Q. I can tell you, but you can't see it because you're on the other page, that for SW01 that same reading was 41, for 2 it was 79, for 3 it was 95, and for 4 it was 93. So at this level it's about double the others?
A. Yes. So that might indicate it flowed through the ground or that ground with carbonate in it for a longer distance to pick that up.

Q. All right. If I was to present this data and the balance of the testing to a chemist with particular expertise in water and soil, would you expect that they would be able to analyse these results and draw conclusions?
A. Yes. The extent of the conclusions and the level of uncertainty would be there of course but, yes, absolutely. That's what they do.

Q. I might just ask you two further questions, Mr Paul, and then I'll let you go. If Mr Paul's slides could be brought back up. The final slide that you included in your slide deck concerned Thredbo?
A. Yes.

Q. That's obviously a particularly famous example of a landslide and a landslide investigation within recent Australian history. What's the map that you've put here?
A. That's a map from the coronial report on the left - I can talk to it if you like - and that's a photograph of the landslide on the right. That's better, yes. I can explain the reasoning.

Q. Yes, please.
A. So I just put this in because it just helps when we're talking about all these landslide concepts to put it in the context of a case study just as a means to help convey the issues that are relevant here. So we talked about preparatory factors. In Thredbo there were a number of preparatory factors.

The landslide originated on the road, which was a cut to fill. So the preparatory factor was we had a fill there. The second preparatory factor, that fill was on a very, very steep slope. The lodges that were impacted sat below that steep slope. So those were the preparatory factors: the ground was this fill, which the investigations after suggested wasn't particularly well compacted, and the steep slope.

The causal factor found by the inquiry was there was a pipe. That pipe was an asbestos pipe that was in the slope. Because that fill was able to consolidate, it wasn't well compacted, it caused the pipe to break. That pipe leaked water into this fill, over what's thought to be a period of several months, causing the fill to become wet and causing the landslide to come down destroying one lodge and a fair bit of another.

One thing that continually surprises me with Thredbo, if you look at the scale here, you can see here the width of the scar and even to some extent on the right when you look up to the top it's not that big. The volume of soil that came down is not great, but it was enough, being saturated to get momentum up when it flowed and to cause such damage that it killed 18 people and knocked down two buildings.

So that just distinguishes these preparatory factors - fill, the steep slope - and the causal factors being the water getting into the slope; and then the consequences arising because we had development in this location that could be impacted by it. So I just sort of put that up there to help understand these concepts.

Zone of depletion up the top. That's what this map is sort of showing. It's depleted up the top and where it deposited down the bottom. Those little arrows are actually showing where elements of the building went from and to. That's what's being communicated there. A lot of good information in the coronial report.

Q. Thredbo is an example of a landslide, the trigger for which was water?
A. Correct.

Q. And the source of the water was?

A. A pipe.

Q. It was a burst pipe, was it?
A. Yes, it was a burst pipe. Not so much a burst; it was thought to have leaked more slowly over time allowing water to accumulate over time in the soil, they think maybe a few months. They don't know for sure when the leak began.

MR COSTELLO: Thank you, Mr Paul. Madam Chair, I have no further questions for Mr Paul.

CHAIRPERSON: Thanks, Mr Costello. Are there any applications for leave to cross-examine the witness? No. You're lucky, Mr Paul.
A. That's merciful, isn't it.

CHAIRPERSON: Thank you for your evidence today, which I found to be very helpful. You're excused from this hearing block, but we will need you back during a subsequent hearing block?
A. Yes, understood.

CHAIRPERSON: And the solicitors assisting the inquiry will be in touch with you.
A. Excellent. Thank you very much.

<THE WITNESS WITHDREW

CHAIRPERSON: Mr Costello, let's deal with the exhibits. I'll mark the bundle of documents that you went to in your opening as CA1.

EXHIBIT #CA1 BUNDLE OF DOCUMENTS IN OPENING

CHAIRPERSON: Given that Mr Pope hasn't yet prepared a report, I'll mark --

MR COSTELLO: A witness statement.

CHAIRPERSON: A witness statement, I'm sorry, I'll mark his report exhibit CA2. Can you just give me the title of his report?

MR COSTELLO: Yes. It is "McCrae landslide, evacuation order area geotechnical factual report, 9 April 2025", and the Bates number is MSC.5007.0004.0078.

CHAIRPERSON: Thank you. That will be exhibit CA2.

EXHIBIT #CA2 REPORT OF MR POPE, MSC.5007.0004.0078

Do you want to tender Mr Paul's slides?

MR COSTELLO: Yes, I think we should.

CHAIRPERSON: I'll mark those CA3.

EXHIBIT #CA3 MR PAUL'S SLIDES

CHAIRPERSON: That deals with the documents referred to today.

MR COSTELLO: It does. Would you like a photograph taken of the whiteboard and would you like me to tender the photograph?

CHAIRPERSON: Yes, please.

MR COSTELLO: Perhaps if that could be CA4?

CHAIRPERSON: Yes.

MR COSTELLO: I see your associate is attending to it now. So I'm sure that will be uploaded to the court book immediately.

CHAIRPERSON: Thank you, Ms Moore.

EXHIBIT #CA4 PHOTOGRAPH TAKEN OF WHITEBOARD

CHAIRPERSON: Are there any other matters today?

MR COSTELLO: Not for today, thank you.

CHAIRPERSON: We'll resume tomorrow at 10.15 rather than 10 o'clock, and then we'll return to a 10 am start the following day and next week.

MR COSTELLO: Thank you, Madam Chair.

AT 4.23 PM THE HEARING ADJOURNED UNTIL THURSDAY, 8 MAY 2025

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