**PARADISE DAM COMMISSION OF INQUIRY**

*Commissions of Inquiry Act 1950*
*Section 5(1)(d)*

**STATEMENT OF JONATHON REID**

| | |
|---|---|
| **Name of Witness:** | **Jonathon Grant Reid** |
| **Date of birth:** | [redacted] |
| **Current address:** | **C/- of SMEC**<br>**Level 5, 20 Berry Street**<br>**North Sydney NSW 2060** |
| **Occupation:** | **Dam Safety Engineer** |
| **Contact details (phone/email):** | Simon.Scott@smec.com<br>[redacted]<br>Matthew.Smith@clydeco.com<br>[redacted] |

I, **Jonathon Grant Reid,** Engineer, make oath and state as follows:

**Background**

1. I am a civil engineer, with over 25 years of experience in geotechnical dam safety assessment.

2. This statement has been prepared based on my answers to questions presented by Jane Menzies (Counsel assisting the Commission) in a teleconference on 6 February 2020. Not all discussion traversed within that teleconference has been included in this statement. Annexed hereto and marked **JR-1** is a copy of the Transcript of the teleconference that took place on 6 February 2020.

3. I have worked on and designed dams my whole career. My expertise is mostly with earthen embankment dams, but I also have experience with geotechnical issues for all manner of structures.

4. I also have expertise in writing dam safety emergency action plans for different authorities, and in writing the ANCOLD guidelines for emergency action plans.

5. I am also an experienced risk assessor, specialising in the detailed risk assessment of dams.

6. Attached to this statement and marked **JR-2** is a copy of my resume.

**Involvement with the Paradise Dam Technical Review Panel (TRP)**

7. I first became involved with the Paradise Dam TRP in mid-2019. I was selected to be on the TRP after tendering and being interviewed by SunWater for the position.

8. My role on the TRP was to review the consultant's work from a dam safety and risk management perspective.

9. I was involved in the drafting of the three TRP reports in 2019. I drafted certain sections and added comments to other sections of all three reports.

**TRP Report 1, 2019**

10. I reviewed and added to the section titled Risk Assessment Update, which was drafted by Peter Foster. I adopt the content of that section as it stands. The opinions expressed in that section of the report are ones honestly held by me.

11. That section of the report discusses the TRP's assessment of the factors of safety and the conversion to a probability of failure.

12. There is not a lot of published material available on which to complete probabilistic analyses of structural elements, because there are too many unknowns and complexities involved. These analyses are largely based on experience and are often done in a workshop setting. There are no real guidelines in this regard for roller compacted concrete (**RCC**) dams, so the expertise of all the TRP members, designers and owners

is brought into these analysis workshops. As a group, the workshop participants then decide on the probability of failure.

13. When dams are built, engineers and dam designers use standards-based design, which is basically where the design meets the design standards which are in the published documents, like ANCOLD and ICOLD documents.

14. In Australia, experts in my field have gone back and looked at old dams (not built to modern standards) with a view to upgrading dams to current standards. This can be extremely expensive. Water authorities were looking at big expense to upgrade dams to meet standards-type design criteria, and that is when risk-based criteria evolved.

15. Dam safety experts undertake risk assessments to look at a particular dam or portfolio of dams to understand how 'safe' their dams are and whether remedial works are required or justifiable based on ANCOLD risk guidelines and industry precedent. Where remedial works are required, the risk assessment can also provide dam owners with timing so a strategy can be created to incrementally lower the risk of a dam or their portfolio and delay costs.

16. To undertake the risk assessment, dam safety experts assess all plausible failure modes, like stability and overtopping, erosion and piping and other factors, for the dam using a probabilistic analysis, and that creates a probability of failure. We look at the consequences, such as the loss of life, economics, and others, and combined with the probability of the failure, this determines the risk of the dam. The risk of the dam is then evaluated using ANCOLD societal and individual risk to life criteria.

17. For example, in TRP Report 3, there is a graph on page 14 titled Figure 7.1, which represents the results of the societal risk evaluation. Societal risk criteria are simply a measure of society's aversion to mass fatalities. On the Y axis is the annualised probability of failure and on the X axis is the number of fatalities resulting from the failure mode. There is a black line going through the middle, which is labelled the "ANCOLD limit of tolerability for existing dams". The other lines represent different kinds of risk assessments on the dam. For example, the "Paradise Dam Existing" line, July 2019, basically starts with a loss of life of about over 100 to approximately

130. Then there is a cumulative annual probability which is approximately between 1 $x10^{-3}$ and 1 x $10^{-4}$ that 130 people will lose their lives by a dam failure.

18. The "Paradise Dam Existing" line is generated by analysing all plausible failure modes for all the different loading cases. For example, in normal operation and flooding it is the water level in the reservoir. All the different water levels that can occur, from the dam being empty to the probable maximum flood, are then considered and the probability of failure for each of those water levels (grouped into partitions) is assessed. This is done for water load and seismic load. All the results are put in a table and they are ordered from highest loss of life to lowest loss of life, and then each of those probabilities of failure are totaled. The starting point is the highest loss of life, and the cumulative probability of failure for that loss of life totals to $10^{-3}$ to $10^{-4}$ in the example described above. Then the next step across to the left is for scenarios leading to a lower loss of life. The sum of probabilities that could result in the lower loss of life are added and this is continued all the way to the left side of the graph (PLL = 1). That is the risk profile.

19. If that risk profile line goes above the ANCOLD limit of tolerability, the risk of the dam is unacceptable, as labelled in that box in the top right of the graph. If the risk profile line goes below the ANCOLD line, then the risk of the dam is in ALARP (as low as reasonably practical) region.

20. This assessment is used to plot the probability of failure of a dam and the consequences which combine to show the risk against the societal evaluation criteria. This is used to advise the dam owner whether:

    a. there is an unacceptable risk which needs work,

    b. the risk is close to the limit and the dam needs work; or

    c. the risk is below the limit of tolerability and the justification for the works are assessed using the ALARP principle.

21. If the dam is below the limit of tolerability, further analysis is done to see whether or not the remedial works are justified. Below the limit of tolerability is ALARP, and that

is about justifying whether the cost to do the work is commensurate with the risk and the reduction in the consequences.

22. Societal risk criteria, such as shown in Figure 7.1 in TRP Report 3, is only one of the two ANCOLD risk to life criteria. Societal risk criteria is often the 'face' of the risk assessment and is often the more critical criteria, however all dams must also satisfy the Individual risk criteria. The Individual risk criteria aims to ensure the risk of a dam is no greater than the background risk faced by a person in their everyday life. Simply, the total annual probability of failure for an existing dam cannot be greater than $1 \times 10^{-4}$ for any person likely to be affected by the dam break.

23. The risk assessment is a good tool for dam owners to understand what work is required to get their dams to a socially acceptable level.

24. When the analysis of the dam is done, the factor of safety is not going to change uniformly. The analysis can plot the position when the dam is starting to be distressed, for example, it is starting to 'bend' in the downstream face, and when it does that, concrete does not bend, and so it will crack. Once the dam has moved enough to develop tensile stresses in the upstream face of the dam, it will crack. Once that cracking happens, there is a direct injection of water into those cracks. Then there is an immediate uplift component directly into the dam and then that can accelerate to failure rapidly. So the factor of safety might plot as "good", "good", "good", "good", then "bad".

25. The TRP also reviewed the options for remedial works put forward by GHD. The TRP report notes with regard to option 3 that, "Until the geotech investigations catch up with the sophisticated analytical models ... in the view of the TRP [it] is a work in progress ...". As far as I am concerned, that is still a work in progress.

**TRP Report 2, 2019**

26. I prepared parts of section 5 of this report and reviewed that section in its entirety. The opinions expressed in that section are ones I honestly hold.

27. The TRP noted at the end of the first paragraph in section 5 that "CRA [Comprehensive Risk Assessment] is still largely based on assumptions from the previous design phase

and requires updating". As far as I am concerned, those assumptions still require updating before the CRA could be completely justified.

28. The second paragraph goes on to discuss the option of lowering the primary spillway crest by 10 metres and notes "this creates a significant risk reduction relevant to the existing dam risk profile and plots marginally under the tolerable risk line in a region where risks are tolerable if they satisfy the ALARP principle." This means, by just lowering the spillway crest level, without anchoring the dam or increasing the stilling basin base and length on the primary spill, or any other works, the assessment will come in just below the limit of tolerability.

# Commission of Inquiry
PARADISE DAM

***OATHS ACT* 1867 (DECLARATION)**

**I, Jonathon Grant Reid, do solemnly and sincerely declare that:**

**(1) This written statement by me dated 19 February 2020 is true to the best of my knowledge and belief; and**

**(2) I make this statement knowing that if it were admitted as evidence, I may be liable to prosecution for stating in it anything I know to be false.**

**And I make this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.**

**.....Signature**

**Taken and declared before me at** Melbourne **this** 19 **day of** February **2020.**

**Taken By .....**

~~**Justice of the Peace / Commissioner for Declarations**~~ **/ Lawyer**

# Annexure JR-1 to the statement of Jonathon Grant Reid declared on 19 February 2020

This is the Annexure marked "**JR-1**" referred to in the statement of Jonathon Grant Reid declared on 19 February 2020.

Date: 19 February 2020

Signature: 

Name:

Address:

Title/position:

David Angus Saunders
Solicitor
Practitioner number P0029286
c/- SMEC Australia Pty Ltd
Level 20, Tower 4, 727 Collins St,
Melbourne VIC 3008

JR-1

**PARADISE DAM COMMISSION OF INQUIRY**

*Commissions of Inquiry Act 1950*
*Section 5(1)(d)*

**TRANSCRIPT OF INTERVIEW OF JONATHON REID**

**Thursday, 6 February 2020**

| | |
|---|---|
| **Name of Witness:** | **Jonathon Reid** |
| **Date of birth:** | |
| **Current address:** | |
| **Occupation:** | |
| **Contact details (phone/email):** | |
| **Statement taken by:** | **Jane Menzies (Counsel Assisting)** |
| **Also present:** | **Matthew Smith - Observer**<br>**Simon Scott – Observer**<br>**Brock Morgan – Observer**<br>**Rachael Murray – Observer** |

MS MENZIES: Jonathon, to provide some background - you may be familiar with what we're looking at, but just so you have some context about where you sort of fit in to the Commission's picture - the Commission was set up late last year in light of some of these technical reports, particularly what GHD has done in the last couple of years, and obviously the Technical Review Panel has had a part to play in that. We're looking at the structural and stability issues that have been identified in engineering reports over the last few years, and we have been asked to identify the root causes of those problems, and those causes - and I am referring to the terms of reference - we're directed to consider design, construction and commissioning issues, as well as a range of other things.

So we are really faced with a rear-facing task; we're looking back in time at what has gone before, so it is a slightly different focus to what engineers, GHD and the TRP have been doing, because that's necessarily focused on how we fix these things in the future.

So in any event, having said all of that, because of your role on the Technical Review Panel, we have been looking closely at those reports and we are hoping the discussion today can just help us better understand what those reports say and what your contribution to those was.

So unless you've got any questions about that, we'll kick off.

MR REID: No, that's fine. Let's go.

MS MENZIES: Okay. An easy one to start with. Can you tell us what your qualifications are and what your background in dams is?

MR REID: Yes, I've got obviously a degree in civil engineering. Basically, started off as a geotechnical engineer, and within a couple of years was brought in to the dams team of what was a company that was eaten by GHD a couple of years later, and have pretty much been 25 years in the dams field, working obviously around Australia and overseas.

MS MENZIES: And what was that company that you started out with before it was taken over by GHD?

MR REID: Geo-Eng. So G-E-O hyphen E-N-G.

MS MENZIES: Great. Thank you. So that's quite some experience, 25 years. What have you particularly been involved in? And the point of the question is, how did you get onto the TRP? What expertise do you bring to that panel?

MR REID: Yes. I suppose my primary expertise has been more the geotech, geological, foundation parts and more earthen embankment design - is one of my key strengths.

Primarily, for the TRP I've been brought on as the reviewer of the risk assessments. So going through the career of dams and slope stability and other issues, I sort of got involved in risk assessments pretty much after the Thredbo disaster, and I've sort of been involved in risk reviews of sort of geostructural elements

pretty much since then. So a good - nearly, I suppose, nearly 20 years now.

Yes, so primarily, my role is - I'm not a concrete dams expert by any means. Obviously I've got strengths in the geotech and the foundation; also got strengths in anchoring. I've done a bit of anchoring work, which is more the remedial side of things. And then primarily I'm on this as the reviewer of the risk.

MS MENZIES: Yes. Did I hear you correctly before when you said "geostructural elements"? Is that what you said.

MR REID: Yes.

MS MENZIES: Can you just explain exactly what that means?

MR REID: Yes. Basically, it's the interaction between, obviously, you know, structural elements like dams, tunnels - you know, buildings, retaining walls, et cetera - with the earth.

MS MENZIES: Great. Thank you. So we had had a look at your background online. There is not much to be found about you, Jonathon, but we had seen that you were --

MR REID: I'm staying under the radar.

MS MENZIES: You are. We saw that you were involved in an ANCOLD committee that seemed to be focused on emergency management and emergency plans.

MR REID: Yes.

MS MENZIES: So what has that involved?

MR REID: Basically, I suppose, yes, one of the things that you do. You know, a lot of the work that we do in Australia is obviously management of existing dams, dam safety. Emergency management is obviously a critical part of sort of the ongoing management of a dam. I've been involved in writing a lot of dam safety emergency plans for authorities in and around Australia and also some dam safety emergency sort of scenarios and testing of these things. So I'm on the working group to write the guidelines, basically. Virtually every dam with sort of significant or greater consequences is pretty much required to have a dam safety emergency plan across Australia, so we're just putting into place guidelines for people

writing those, just to basically tick the appropriate boxes, I suppose, in what a dam safety emergency plan should have.

MS MENZIES: Yes. And you said that you are not an expert in concrete dams, but it seems you are writing guidelines for all sorts of different types of dams. So are the principles largely the same?

MR REID: Yes, pretty much. I mean, I've obviously been involved in concrete dams and concrete structures, so there are obviously synergies going across there, but, you know, most of my work is designing embankment dams and not concrete gravity or RCC dams.

MS MENZIES: Is that of any significance, though, in terms of - I mean, are there people who are specific safety experts on RCC or concrete dams?

MR REID: Yes, I mean, we have our specialties. Sort of in our group, basically, Francisco, who you have spoken to, is probably more the concrete guy, and I'm more the earthen embankment guy.

MS MENZIES: Yes, I see.

MR REID: Obviously we cross paths and we understand bits of it, but I'm not going to definitely count myself as the RCC guru.

MS MENZIES: No, but in terms of safety, the principles, whether it's a concrete or an earthen embankment dam, are largely the same; is that correct?

MR REID: They are similar. There are obviously slightly different analyses and slightly different design criteria requirements, but, in general, yes, they are pretty much the same.

MS MENZIES: Okay, thanks for all of that. When did you first become involved with the TRP?

MR REID: I suppose it would have been mid last year.

MS MENZIES: Okay. We sent you through - we sent them through Simon, but I understand you received them - the three Technical Review Panel reports from last year?

MR REID: Yes.

MS MENZIES: Do you have those with you?

MR REID: I do.

MS MENZIES: So can we turn to the first one then, please. It is dated - well, it came out after the workshop in May 2019.

MR REID: Yes.

MS MENZIES: So a couple of basics in this one, if you could just turn to page 18 of the document.

MR REID: Yes.

MS MENZIES: So that's the signature page. Everyone's signatures are on there, including yours, but the report has a "Draft" watermark. Are you aware of why that might be?

MR REID: No. I assume it was just left there.

MS MENZIES: Yes, okay. And as far as you know, this is the final, agreed, signed-off report, despite the "Draft" watermark.

MR REID: Yes.

MS MENZIES: And just confirming, you might see that date above Francisco's signature; it's got the year 2016.

MR REID: Yes.

MS MENZIES: Is that correct?

MR REID: No.

MS MENZIES: So I presume the date should say 2019; is that correct?

MR REID: Yes, I would say so. I would say it is a hangover from Peter Foster's original template.

MS MENZIES: Yes. Okay, no problem. Thanks very much. With those basics out of the way, so we had gathered that you were probably focusing on risk assessment, in light of what we could see about your qualifications.

MR REID: Yes.

MS MENZIES: The page prior to that is page 17, and it has a section there called "Risk Assessment Update". Can you see that?

MR REID: Yes.

MS MENZIES: Did you prepare that section?

MR REID: I didn't prepare all of it. Peter Foster prepared part of it and I made comment - and I added to it.

MS MENZIES: I see. But you would agree with the content of that section as it stands now?

MR REID: Yes.

MS MENZIES: I just had a couple of particular questions about some of the content in here. So under that heading 3.6, the second paragraph down - if you need to read it, please just let me know - right at the start it talks about "conditional probabilities for failure for each lake level were based on the analysis done by Sunwater", and then the next sentence:

> *This appears to map the probability of failure to the sliding stability safety factor. The TRP are unaware of the source and domain for which such mapping is valid.*

Can you explain what that mapping is? What are you talking about there?

MR REID: So basically when we do these analyses we are calculating factors of safety. Obviously when we are doing a risk assessment we are talking about probabilities of failure. So it's the way that you convert the calculated factors of safety to a probability of failure.

MS MENZIES: And I think it is safe to say you should assume that there is minimal technical expertise at the other end of the line. Can you explain how do you that in layperson's terms?

MR REID: It is actually not easy. It is largely based on experience. There is not a lot of guidance to make a probabilistic analysis of structural analyses, because there are just too many unknowns and complexities involved. So we've got one or two sort of

guidelines that sort of give us a probability of failure for a factor of safety of, say, 1, and a probability of failure for a factor of safety of, say, 1.5, and we've basically put in what we call shape curves to estimate - you know, to basically interpolate factors of safety of 1, which is basically essentially meaning that you are near failure, to 1.5, which is a common safety standard, and anything below 1 and above 1.5, and obviously in between we've kind of got a curve that relates that factor of safety to a probability of a failure.

MS MENZIES: And is that a dam-specific curve or is that a dam type - you know, say you have a curve for RCC or you have a curve for an earthen embankment dam? How does that work?

MR REID: Yes, there is a particular one - a particular reference that we use for embankment dams. It is not great but it's all we've got, so we use it. We don't really have anything for concrete dams or concrete elements, but we kind of used a similar sort of thinking. So, generally, these sorts of relationships need to be basically determined in sort of a workshop type arrangement. So we basically do it for each individual assessment. We will look at factors of safety and we will look at, you know, what has gone into those calculations and how much we know, and then we will basically usually, as a workshop and as a group, come up with a probability of failure. So unfortunately, like a lot of things in dams, there is no published or written or standardised documentation that we use, so sometimes we have to just go to a collective group discussion and an agreement on these things.

MS MENZIES: Yes, I see. So you have factors of safety and they are set out in ANCOLD guidelines and what-have-you. What difference - like, what does the probability of failure tell you that the factors of safety don't? Why do you do that process?

MR REID: So basically when we are doing dams in this day and age we do two things: we do standards-based design, which is basically where you do a design to meet, you know, design floods, design earthquakes, factors of safety, et cetera. They are basically all the things that are in the published documents, like the ANCOLD documents and ICOLD documents, et cetera. So they are design standards that we are supposed to meet.

Australia is probably one of the leaders. We stopped building dams so we started looking at our old dams and whether or not they were safe, and when you go back and you look at old dams, obviously

they weren't built to modern standards, and to upgrade them to current standards can be extremely, extremely expensive. So water authorities were looking at, you know, big bills to upgrade dams to meet standards-type design criteria, and that's when risk-based criteria started becoming involved.

So we started doing risk assessments to look at what are the main risks in each of - like, you know, a dam owner might have 20 or 30 dams, so, looking at what are the main risks that we need to tackle immediately on these dams, and then looking at particular dams, okay, what is the key failure mode of that dam? And to give dam owners a way of knowing whether or not their dam is safe enough or not, we basically got the ANCOLD risk guidelines, which basically we assess all the things like the stability and overtopping, erosion and piping and all the rest, of the dam using a probabilistic analysis, and that creates, obviously, a probability of failure. We look at the consequences, the loss of life, economic, et cetera, and then we've got what we call societal and individual risk evaluation criteria, which we can plot the probability of risk of a dam and the consequences on this criteria and we can tell them, "No, your dam is unacceptable risk, you need to work on it", "It's close to the limit so you need to work on it", or "It's below what we call the limit of tolerability, so, it is in the 'unacceptable' region", but then we do further analyses to see whether or not the remedial works are justified to do. So it is a tool - it is a good tool for dam owners to be able to work out how much work - well, what work is required to get their dams to basically a socially acceptable level.

MS MENZIES: Yes. And is that where - I mean, I don't know if it is just a dam-specific reference, but the phrase - I don't even know if I'm saying it the right way. ALARP - "as low as reasonably practicable"?

MR REID: Yes, ALARP. Yes, I didn't use that. "As low as reasonably practicable". So once you are below the limit of tolerability - so above the limit of tolerability is unacceptable risk and you have to do something. Below the limit of tolerability is ALARP, so you need to basically justify whether the cost to do the work is, you know, commensurate with the risk - the reduction in the consequences, basically.

MS MENZIES: Okay. This is jumping around a bit but it ties into what you were just discussing, I think. In the third report, so maybe if you could bring that up --

MR REID: Yes.

MS MENZIES: -- on page 14 there is a graph, and I understand this is taken from GHD's work. Do you have that chart in front of you?

MR REID: Yes.

MS MENZIES: Is this what you are talking about?

MR REID: Yes. That's the ANCOLD societal risk criteria, basically.

MS MENZIES: Can you just explain what this is showing and how it works and what you use it for, et cetera, please?

MR REID: Yes, okay. So figure 7.1, for example?

MS MENZIES: Yes.

MR REID: So the basis of the graph is you have got your annualised probability of failure on your Y axis, and on your X axis you've got the number of fatalities resulting from that failure mode. And so, as I was saying, you've got that black line sort of going through the middle there, which is labelled the "ANCOLD limit of tolerability for existing dams".

MS MENZIES: Yes.

MR REID: And obviously you have these other lines representing different sort of risk assessments on the dam. So if you look at the "Paradise Dam Existing" line, July 2019, you will see it basically starts with a loss of life of about over 100 to 130-odd.

MS MENZIES: Yes.

MR REID: And then, basically, there is a risk which is about between 1 to 10 to the minus 3 and 1 to 10 to the minus 4 that 104 people will be killed by a dam failure. So basically, what you do to generate that line, which is the "Paradise Dam Existing" line, is you analyse all potentially different failure modes for all the potential different loading cases - so for normal operation and flooding it's basically the water level in the reservoir, so you look at all the different water levels that can occur from basically the dam being empty to, you know, your probable maximum flood - and you reassess the probability of failure for each of those what we

call basically partitions. So we break that up into segments and we analyse each segment of the water load and what the probability of failure is for all the different failure modes, and we do it obviously for seismic as well. So all those little points are basically put in a table and they are ordered from highest loss of life to lowest loss of life, and then each of those probabilities of failure are then added up, so it is cumulative. So, basically, that's why you sort of generate that line. You start off with the highest loss of life, and the cumulative probability of failure for that loss of life is up around that 10 to the minus 3 to 4, and then you go to the next sort of step across to your left, and that's a lower loss of life for a different scenario, and then you keep going up, adding the different probabilities that could result in that loss of life, et cetera, et cetera, until you basically get across to, you know, the left side of the graph.

MS MENZIES: I see.

MR REID: So that's basically your risk profile.

MS MENZIES: Okay.

MR REID: And if that little line goes above that ANCOLD limit of tolerability, you will see in that box in the top right, that's unacceptable.

MS MENZIES: Okay.

MR REID: And if you plot below that line, you are in the your ALARP region.

MS MENZIES: Thank you. That's a really helpful explanation. Then we were back at report number 1 in that section 3.6. So you have explained the basis upon which you map that probability. The rest of that paragraph then talks about:

> *... this type of mapping will fall down as a base cracking mode becomes dominant and can be affected by small changes in lake level ...*

And then we are talking about peak sliding factor of safety greater than 3 to less than 1. I don't really understand what the rest of that - what that is talking about. Are you able to explain that?

MR REID: Yes, this is mainly Peter's words, but I can give you the

basis for it. As I said, we basically generate a curve of this probability versus factor of safety, and when you actually do the analysis of the dam, the factor of safety is not going to change uniformly. You are going to get to a position where the dam is now starting to be distressed, it's starting to, if you like, bend downstream, and when it does that, concrete doesn't like to bend, so it will crack. And once you get that cracking, you have basically got direct injection of water into your cracks, so you've got an immediate uplift component directly into your dam and then that can accelerate to failure really rapidly. So it might be factor of safety is "good", "good", "good", "good", then "bad".

MS MENZIES: I see. Okay.

MR REID: So you just have to be careful of that change.

MS MENZIES: Okay. So that is what that is saying - the factor of safety can change really, really rapidly as a result of small changes in the lake level, is that what you are talking about, once you get to the critical --

MR REID: Yes, once you have basically - yes, it has moved enough that it starts to crack and you start to get tensile stresses in the upstream face. Well, then you start getting water injected straight under your dam or into your dam.

MS MENZIES: Okay, thank you. Further down that page, the second-last paragraph on the page, so you are talking about how option 3 plots and how option 2 plots, but then the last sentence says:

> *Until the geotech investigations catch up with the sophisticated analytical models ... in the view of the TRP [it] is a work in progress ...*

MR REID: Yes.

MS MENZIES: So that was back in June last year. Is that still the case?

MR REID: Yes. Yes. We haven't updated it much since we started.

MS MENZIES: Yes, okay. So the work that is being done on the dam - you may have seen there was some legislation put into parliament I think this week about the spillway lowering works. So

that work has been done while things are still a work in progress; is that correct?

MR REID: That's correct, yes.

MS MENZIES: Okay. I have no more questions out of report number 1. If you could open report number 2, please, and go to page 15.

MR REID: Yes.

MS MENZIES: So there is a section there, section 5. Did you prepare section 5 or did you contribute to it?

MR REID: Yes, I prepared section 5.

MS MENZIES: Yes. And so I think this is just the point we were just making. The end of the first paragraph says the risk assessment - "CRA is still largely based on assumptions from the previous design phase and requires updating" - that's what we were just talking about, isn't it?

MR REID: Yes. Yes.

MS MENZIES: You may have already done this, based on what we have talked about, but I had a question about the second paragraph under that heading, where you are saying "Option 3", "base case", and you are talking about the primary spillway crest only, no other work:

> *... this creates a significant risk reduction relevant to the existing dam risk profile and plots marginally under the tolerable risk line in a region where risks are tolerable if they satisfy the ALARP principle.*

What is that all about?

MR REID: Actually, I think the second paragraph was Peter's addition.

MS MENZIES: Okay.

MR REID: But, again, I understand what you are saying, because I obviously review this before it goes out. So, basically, obviously the existing is well above the limit of tolerability, so unacceptable. Option 2, the remedial works, is still well above

the - well, basically dips in and out above the line, so it is still unacceptable. Option 3, the 10 metre lowering, by just lowering it, without anchoring or increasing the spillway, the ceiling, base and length on the primary spill, or any other works, gets you just below the limit of tolerability.

MS MENZIES: Yes. And is this a reference - when we are talking about this, we're talking about where something's plotting on a chart. Are you talking about the charts I took you to before, or is it that more basic --

MR REID: Yes.

MS MENZIES: Yes, okay.

MR REID: Yes, yes. They are called the FN charts - "F" being frequency, "N" being number - of deaths, basically.

MS MENZIES: Right. That's a bit grim. So it's --

MR REID: It can be.

MS MENZIES: It is not those charts that are simply plotting the ANCOLD factor of safety - you know, they have that dogleg in them where you are going from "usual", "unusual", "extreme" --

MR REID: Yes.

MS MENZIES: You are not talking about that; you are talking about these other ones we talked about before?

MR REID: No. Yes, that's an input into the risk assessment.

MS MENZIES: Yes. I see. Okay, great, thanks. I don't have anything - oh, actually, so the next section, section 6, called "Option Scoping", were you involved in that at all?

MR REID: I wrote the first part of it, yes. That's where my anchoring stuff comes into it.

MS MENZIES: I see. Right, okay. I should have asked this for report number 1 as well. Other than the bits I've taken you to, did you make any other particular contributions to those reports?

MR REID: Yes, in report number 1 I contributed to the geology

review. It was basically started by Peter and then I added in a number of paragraphs.

MS MENZIES: Okay. Sorry about this, I should have done it before. Can we go back to that, report number 1.

MR REID: That's okay.

MS MENZIES: Can you just point to where your particular contributions were?

MR REID: So in section 3.2 "Geology", the second paragraph and the third paragraph are mine.

MS MENZIES: Yes, okay.

MR REID: Hang on, I need to count paragraphs - 4, 5, 6 - so the seventh paragraph, so the one that says, "There appears to be little borehole information", is mine; and the paragraph underneath that is mine.

MS MENZIES: Yes.

MR REID: And then - I've lost count, where are we up to? 9, 10, 11 - paragraph 12, "The geotechnical investigations have recognised the need to further develop an engineering geotechnical model".

MS MENZIES: Yes.

MR REID: So those last two paragraphs on the bottom of page 7 are mine.

MS MENZIES: Yes. And they seem to be making this - would you agree that they are making the point about, "We need more work here"?

MR REID: Yes, absolutely. Yes, the geological assessment has been ongoing throughout our whole - the whole TRP component.

MS MENZIES: And in your experience, is the state of geological mapping unusual? So would you expect more - this sort of work to have been done in the initial design phase or is this fairly orthodox, the amount of information that's available?

MR REID: To be honest, we haven't been exposed too much to what

the original investigation results and that were. We're predominantly being shown what GHD have been doing, and GHD have brought in a lot of construction mapping that has been done, and GHD are basically - through this process is obviously doing more investigations and starting to bring in all the information they've got. So it has been a continuous sort of process of updating with what information they get.

MS MENZIES: Okay. All right. And so nothing else in report number 1?

MR REID: Let me flick through. I put in bits and bobs here and there. What section is that? In section 3.3, "Dam Stability", if you go to page 12, about the fourth paragraph down, "Material strengths for the Plaxis model have been developed using Hoek Brown" - that paragraph was me.

MS MENZIES: Yes.

MR REID: And the bottom paragraph on page 12, "If defect sets are found to occur", that was also me.

MS MENZIES: Okay. All right. So these things look like they are sort of --

MR REID: Oh - yes, basically, as I said, I usually come in on the end of everyone writing, unless everyone is slower than me, which is unusual, and I just add in comments and, you know, some of my areas of expertise. So this was before we had John Young. So he came in, sort of took over more the geotech side of the review role.

MS MENZIES: I see. Okay. So unless there are any other passages in report 1, can we do the same for report 2, please, which is - John Young's contributing by then, but --

MR REID: Yes. I think I put in - I mean, it was basically finished by the time I got it and, as I said, I just recognise my role more as to absorb everyone's views and to make sure that is brought into the risk assessment, so I just put in comments which were obviously read by the guys but didn't really result in much change --

MS MENZIES: Yes, I understand.

MR REID: -- to the document.

MS MENZIES: So it is mostly that section 5 and part of section 6.

MR REID: Yes, it's pretty much - 5 and 6, yes, were my only real contributions.

MS MENZIES: Great. That's fine, thank you. And that takes us to, then, report number 3, dated 9 December. We've already talked about those charts, which has been really helpful, and then I wondered whether you had a part in the section - section 5, which starts on page 11? Maybe not. This is --

MR REID: Yes, I wrote both paragraphs.

MS MENZIES: Okay. I don't have any questions, it's more just understanding your contributions to the report.

MR REID: Yes.

MS MENZIES: Are there any other sections in this that you have prepared?

MR REID: And the "Trial Anchor Scope", section 3 - I think I put in the third paragraph, or the bottom paragraph on page 8.

MS MENZIES: I see, yes.

MR REID: I don't think - yes, I did put in that one but I don't know if I put in any more. No, just that paragraph, yes.

MS MENZIES: Okay. Because, as I mentioned at the outset, we are doing this sort of rear-facing job where we are looking more at the original design and construction, commissioning, sorts of issues, so a lot of your work has seemed to have focused on the assessing the risk of what is proposed to be done. So I don't have any other questions. Is there anything else that you can think of that might be relevant to talk about in light of what we are looking at particularly?

MR REID: No, not really. I think you hit the nail on the head. I'm sort of more making sure that the remedial works, you know, hit the right marks, is my primary role on this.

MS MENZIES: Okay, great. Thank you again so much for your time. We will prepare a draft statement, just reflective of what we have

discussed today, and we will send that through to you. Please feel free to make changes. It is your statement, so that is no problem. Otherwise, have a nice day. Thanks for your time, Jonathon.

MR REID: Thank you.

MS MENZIES: Thanks, everyone.

MR REID: No, too easy. Thank you.

MS MENZIES: Thank you all very much.

**THE INTERVIEW WAS ADJOURNED ACCORDINGLY**

# Commission of Inquiry
PARADISE DAM

## Annexure JR-2 to the statement of Jonathon Grant Reid declared on 19 February 2020

This is the Annexure marked "**JR-2**" referred to in the statement of Jonathon Grant Reid declared on 19 February 2020.

Date: 19 February 2020

Signature: 

Name:

Address:

Title/position:

**David Angus Saunders**
**Solicitor**
**Practitioner number P0029286**
**c/- SMEC Australia Pty Ltd**
**Level 20, Tower 4, 727 Collins St,**
**Melbourne VIC 3008**

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# Jonathon Reid

Technical Principal Engineer Dams / Geotechnical

## Professional Overview

Jonathon has over twenty-five years of experience in the fields of geotechnical, dams and tunnels engineering. He has broad experience in the design of dams, tunnels, retaining structures and associated infrastructure. Jonathon has been involved in all facets of small and large scale civil projects from feasibility studies, through the varying design stages to works supervision. He has led many multi-disciplinary design teams on varying geo-structural projects. He has also worked on many construction projects as client representative or with the contractor to complete temporary works designs, manage QA and ensure all works meet the design intent. He is an accomplished risk assessor specialising in quantitative risk analysis of geotechnical hazards to validate design requirements, construction risks and prioritise works for clients' portfolios.

## Relevant Project Experience

**Sepik Development Project**
**Dates**: 2019 – On-going
**Client:** Conservation and Environment Protection Authority, PNG

Member of external technical review panel for CEPA reviewing the Frieda River Project. Review of 185m high, asphaltic core dam design for the hydroelectric, integrated storage facility in Sandaun, East Sepik Provinces of north-west PNG.

**Eraring Ash Dam Liquefaction Review**
**Dates**: 2019 – On-going
**Client:** DFACS NSW

Independent review for NSW government on risk of Ash Tailings Dam, particularly from seismically induced liquefaction. Risk from dam has resulted in closure of government facilities downstream of dam.

**Paradise Dam Spillway Improvement Works**
**Dates**: 2019 – On-going
**Client:** SunWater

Member of technical review panel responsible for risk assessment components of the Paradise Dam Improvement Works. The works involve remedial measures to stabilise the 52m high RCC dam and control scour at the toe of the spillway in flood.

**AROWS Pre-concept Design Review**
**Dates**: 2018 – On-going
**Client:** Power and Water Corporation

Internal reviewer for geotechnical investigations and pre-concept design for the Adelaide River Off-stream Water Storage (AROWS). AROWS is a scheme being investigated to augment Darwin's water supply. The project consists of two main embankment dams (~40m high) and a number of saddle dams to create a 300 GL storage in a natural occurring basin. Review included staged options, dam type, spillway arrangements, pumped intake and outlet.

### Years of Industry Experience:

25+ years

### Qualifications and Memberships

- B Eng Civil (Hon), Monash University, Melbourne, 1994
- Member of Engineers Australia and Australian Geomechanics Society (AGS)
- Author and co-author of 5 papers for ANCOLD and NZSOLD conferences and bulletins
- Member ANCOLD working group to develop DSEP guidelines

### Key Skills and Competencies

- Experienced leader in the design of dams, tunnels, landslide mitigation and associated civil infrastructure
- Versatile geostructural engineer experienced in a range of civil industries
- Solid background in geotechnical site investigations and laboratory testing
- Respected risk assessor

### Professional History

2016 – Present | SMEC
Principal Engineer Dams / Geotechnical

2002 – 2015 | GHD

1996 – Feb 2002 | Geo – Eng Pty Limited

**Eurobodalla Dam Detailed Design**
**Dates:** 2017 – On-going
**Client:** Eurobodalla Shire Council

Design Lead for detailed design of the Eurobodalla Southern Storage, an off-stream storage required to increase water supply security for the region. The dam is to be staged with a 37m high, Stage 1 earth and rockfill embankment that is to be raised to 50m high in Stage 2. The design includes spillway, outlet tower, river pump station with 20m deep shaft and all associated pipework and power supply.

**Keepit Dam Stage 2 Upgrade**
**Dates:** 2017 – On-going
**Client:** WaterNSW

Design representative during construction for placement of world's largest 91 and 65 strand anchors to stabilise 54m high, concrete gravity Keepit Dam. Design lead for remedial works to a number of monoliths that were found to have been substantially cracked during the original construction.

**Urannah Dam Feasibility Review**
**Dates:** 2018 – On-going
**Client:** Huston International Consulting Services

Design lead for prefeasibility and option review for new ~80m high dam on the Broken River near Mackay to develop a preliminary business case in accordance with the Building Queensland Guidelines. Review found RCC, CFRD and E&R dam options all viable with similar costs. Scheme includes spillway with total discharge capacity of 16,000m3/s and 1,660GL reservoir.

**Thwake Multi-Purpose Water Development Program**
**Dates:** 2016 – On-going
**Client:** Ministry of Water and Irrigation, Kenya

Dam design reviewer of feasibility and concept design and dam design lead for detailed design of the Thwake MWDP scheme. Thwake MWDP is a multi-purpose dam for water supply, hydropower generation and irrigation development on the Athi River in Kenya. The scheme consists of an 80m high, 1.5km long CFRD embankment, spillway with total discharge capacity of 11,500m$^3$/s and 688 GL reservoir. Works on the dam commenced in 2018 with completion expected 2022.

**SRWRA Dam**
**Dates:** 2018 - 2019
**Client:** Water Utilities Australia

Concept design, detailed design and construction phase services for new 600ML off-stream storage to supply recycled water to the McClaren Vale region of SA. Design lead for all phases of new high consequence embankment dam.

**Deep Creek Reservoir**
**Dates:** 2018
**Client:** **Suburban Land Agency**

External reviewer of new 20m high embankment dam on Deep Creek in Whitlam, Canberra. Dam required to control water quality from new suburban development before entering the Molonglo River.

**Porgera Water Supply Option**
**Dates:** 2018
**Client:** Porgera Joint Venture, PNG

Feasibility design and cost estimate to increase water supply to Porgera Mine. Review required development of water sources to increase the existing storage capacity from 667ML to 3,300ML. Water sources included new dam sites upstream and downstream of the existing storage, raising of the existing concrete diaphragm and gabion dam, reinstatement of lined CIP pond and groundwater options.

**Swansea Dam Upgrade**
**Dates:** 2017 – 2018
**Client:** TasWater

Independent peer review for Swansea Dam upgrade. Swansea Dam had issues with excessive foundation seepage and sand boils at the toe on first filling and has not been able to be filled beyond 15% storage capacity. Responsible for review of investigations and design of upgrade works for TasWater.

**Glenlyon and Callide Dam Design Review and Risk Assessment**
**Dates:** 2018
**Client:** SunWater

Dam safety review and risk assessment of Glenlyon Dam, 62m high earth and rockfill dam. Completed detailed risk assessment and erosion analysis of stilling basin. Dam safety review of 37m high earth and rockfill Callide dam. Technical lead for review of embankment and spillway.

**Backwater Dam Review**
**Dates:** 2018
**Client:** Ramu NiCo Management (MCC) Ltd, PNG

Third party reviewer of new water storages at the Ramu NiCo in PNG. Mines regulator in PNG required a third party review of new HDPE lined, rockfill dams for water supply to hydro mining.

**Corin Dam Design Review and Risk Assessment**
**Dates:** 2017
**Client:** Icon Water

Dam safety review and risk assessment of Corin Dam, 74m high earth and rockfill dam on the Cotter River, ACT. Technical lead for review of embankment and spillway. Completed detailed risk assessment and erosion analysis of stilling basin.

**Retarding Basin and Service Basin Risk Assessments**
**Dates:** 2017 – 2018
**Client:** Melbourne Water, North East Water, Gippsland Water

Safety review and risk assessment of 13 retarding basins and 17 lined service basins in built urban environment. Technical lead for review and analysis, concept designs, detailed designs and construction phase services.

**Connolly and Storm King Acceptable Flood Capacity Assessment**
**Dates:** 2017
**Client:** Southern Downs Regional Council

Risk assessor to determine required AFC based on detailed risk review of High C, earthfill with concrete core wall Connolly Dam, and High A, concrete gravity Storm King Dam. Storm King Dam was recently post-tensioned anchored, risk review found further works not necessary despite large increase in flood requirements.

**Glenorchy System Risk Mitigation**
**Dates:** 2016 & 17
**Client:** TasWater

Reviewed options to lower operating levels on the three Extreme consequence dams of the Glenorchy system above Hobart. The three dams consist of 36m high CFRD Knights Dam, 27m high, earthfill with concrete core wall Limekiln Dam and 20m high puddle core Tolosa Dam. Reviewed the effects on the consequences and probability of failure to determine operating level that appropriately mitigates the dam risks.

**Nam Mang Upstream Feasibility Assessment**
**Dates:** 2016
**Client:** VC Invest Inc. Laos

Dam design reviewer of Nam Mang Upstream Hydropower Project. Review of concept arrangement for 195 GWh p.a. scheme consisting of 80m high earth and rockfill dam and 384GL reservoir on the Nam Mang River in Laos. Responsible for review of investigations, dam type selection, dam arrangement and embankment design.

**Callide Valley Flood Mitigation Study**
**Dates:** 2016
**Client:** Department of Energy & Water Supply

Pre-feasibility design of options to mitigate floods in the Callide Valley, Qld. Works reviewed options to raise 37 m high Callide Dam up to 5m, including lifting 6 x 11 m high, 12 m wide gates. Raise 25 m high Kroombit dam a further 8m and construct a new 25 m high dam on the South Kariboe Creek site.

**Myponga Dam Safety Review**
**Dates:** 2016
**Client:** SA Water

Reviewed the stability of the rock abutment of 48 m high concrete arch dam with concrete gravity flanks and gated spillway.

**Murree Landslide Risk Projects**
**Dates:** 2016 new 500 bed hospital
**Client:** Ministry of Tourism, IDAP, Pakistan

Geotechnical and landslide mitigation reviewer of 4km cable car route and new 500 bed hospital in landslide prone hills in Murree, north of Islamabad, Pakistan.

**Scrivener Dam Risk Assessment**
**Dates:** 2016
**Client:** National Capital Authority

Risk assessor and reviewer of detailed risk assessment of Scrivener Dam, a 33 m high, concrete gravity structure with gated spillway and earthfill flanking embankments. Reviewed current risk profile and risk reduction options.

**Eastern Ash Landfill Project**
**Dates:** 2014 & 2015
**Client:** Energy Australia, Yallourn.

Manage concept and detailed design of all civil works required to complete the new facilities to manage ash waste from the Yallourn Power Station. Works include substantial mine batter stabilisation, dam remedial works, new return water basin, flood design and all associated pipework, pump stations, power supply and access roads. Critical path project for the mine and high risk as works were completed on historic land slip areas that impact neighbouring towns, roads and services.

**Bright Water Security Storage**
**Dates:** 2011 to 2015
**Client:** North East Water

Managed design and construction phase services of new 520 ML storage on difficult foundations consisting of deep alluvial foundations previously dredged for gold.

**Witts Gully Dam Upgrade Project**
**Dates:** 2014 & 2015
**Client:** Energy Australia, Yallourn

Managed review, concept, detailed design and construction of upgrade works to stabilise Witts Gully Dam. The 17 m high dam was located on liquefiable materials that were removed and the dam stabilised by a berm with filters and a foundation relief well system.

**Anchor Testing**
**Dates:** 2015
**Client:** Goulburn-Murray Water

Technical advisor to G-MW for testing program of all post tensioned bars and anchors in their portfolio (Cairn Curran, Yarrawonga, Goulburn, Laanecoorie, Buffalo).

**Alphington Sewer Project**
**Dates:** 2010 to 2015
**Client:** Pipelines Alliance / Melbourne Water

Temporary and permanent works design leader for 1.6 km long, 1500 diameter sewer and 1.6 km long, 900 diameter sewer replacement. Involved in design of all aspects of tunnelling, launch and receival shafts, permanent manholes (5

m dia., 20 m high) and syphon crossing of the Yarra River. Job Manager for construction phase services to Melbourne Water, construction being completed by Lend Lease.

**Westconnex Stage 2 Tender Design**
**Dates:** 2014/2015
**Client:** TunneLink (Ferrovial Agroman, Ghella and McConnell Dowell)

Tender design of all portals and shafts for **$17 billion Sydney** road project. Shaft designs include contiguous pile walls, segmented precast rings, diaphragm walls and rock support. Portal design included anchored pile walls, soil nail walls and rock support for ramps and tunnel entrances in deep, saturated sands to shallow, poor quality rock below residential and commercial development.

**Mt Bold Dam Safety Review and Detailed Risk Assessment**
**Dates:** 2012 -14
**Client:** South Australia Water

Completed detailed risk assessment on Mt Bold Dam, a 58 m high arch with gravity abutment, extreme hazard dam. Conducted failure modes workshop for very complex dam.

**Coliban Water Portfolio Risk Review**
**Dates:** 2012 to 2013
**Client:** Coliban Water

Completed portfolio risk review of 13 higher hazards dams in Coliban's dam portfolio. Included dam design review, detailed risk assessment and concept design options for all dams. Strategy report was completed outlining works priorities, capital expenditure and program for staged reduction of risk profile.

**Todd River Concept Remedial Design**
**Dates:** 2012-15
**Client:** South Australia Water.

Completed detailed risk assessment on Todd River Dam, a 22 m high puddle core dam. The risk assessment looked at reducing operating levels of this High C hazard dam to meet acceptable risk criteria. Included a detailed review of business risk to SA Water.

**Apollo Bay Raw Water Storage**
**Dates:** 2011 to 2013
**Client:** Barwon Water / Alliance

Completed functional / option review of new 250 ML storage for Apollo Bay in Victoria. Chosen site (by others) has extremely difficult foundation conditions including very soft alluvial soils and slopes with remnant landslides and extremely low residual shear strengths.

**North West Rail Link Tender Design**
**Dates:** 2012
**Client:** Bouygues / Boulderstone Joint Venture.

Designer and design reviewer of station boxes and service shafts for the **$8.3 billion NWRL**. Completed design for Cherrybrook Station, an open, deep basement excavation which also incorporated the launch facilities. The Cherrybrook site is within well-known landslide prone area. Reviewed designs of other station boxes which included multi-strand anchored pile walls, soil nail walls and rock support. All stations located within dense urban development.

**Sturt River Dam Decommissioning**
**Dates:** 2011 to 2014
**Client:** South Australia Water.

Completed detailed risk assessment on Sturt River Dam including decommissioning options that involved reduced operating levels and enlarge outlet works to reduce consequence category and lower risk to acceptable levels.

**Portfolio Risk Review**
**Dates:** 2010

**Client:** Central Highlands Water

Reviewed current risk status of all Central Highlands significant and high hazard dams to aid prioritisation of studies and remedial works to reduce the risk to life profile for the organisation.

**Cotter Dam Enlargement Project**
**Dates:** 2009
**Client:** BWA / ACTEW.

Completed site investigations for saddle dams for project as well as investigations for borrow sources.

**Dam Safety Review and Detailed Risk Assessment**
**Dates:** 2009
**Client:** Gippsland Water.

Completed dam safety review and detailed risk assessment on Moondarra Dam, Buckley's Hill Reservoir and Pine Gully Reservoir, all high hazard embankment dams. Also involved developing concept designs, detailed design and construction services for remedial works using risk based criteria.

**Melbourne Main Sewer Replacement**
**Dates:** 2009
**Client:** Melbourne Water.

Detailed design of Yarra River crossing of the 1.8 m diameter Melbourne main sewer pipe. Design involved reviewing wet and dry coffer dam options for construction of pipe through soft river sediments. Final option included steel protective sleeve supported on precast pipe saddles and steel tubular piles. Wet design option chosen so required to be placed underwater with the use of divers.

**Yallourn Mine Geotechnical Risk Assessment**
**Dates:** 2008
**Client:** TRU Energy

Undertake a desk top review of all geotechnical risks at Yallourn Mine. Responsible for review of all dams, ashing facilities, river diversion and flood levees.

**Lake William Hovell Dam Safety Upgrade Project**
**Dates:** 2008
**Client:** Goulburn-Murray Water.

Completed remedial design for main and secondary embankments including reconstruction of upper portion of dam and raising of crest. Designed spillway wall raising and stabilising against earthquake with passive and active anchors. Revised risk assessments including detailed assessment of spillway erosion issues. Provided dam design services throughout construction.

**Tarago Dam Safety Upgrade Project**
**Dates:** 2007
**Client:** Melbourne Water

Upgrade of the 34 m high, 38 GL capacity Tarago Dam to return it to the Melbourne water supply. Completed geotechnical investigations for remedial design to reconstruct upper portion of dam.

**Newlyn Dam Interim Upgrade Works**
**Dates:** 2007
**Client:** Goulburn Murray Water

Design of interim works for the 12 m high, 3300 ML capacity Nelwyn Dam.

**Cairn Curran Dam Safety Upgrade Project**
**Dates:** 2007
**Client:** Goulburn-Murray Water.

Completed remedial design for main and secondary embankments including reconstruction of upper portion of dam and raising of crest 1.0 m. Completed 3-D post liquefaction stability assessment. Responsible for site QA, dam safety and ensuring works completed to design intent.

**Mokau Hydroelectric Project**
**Dates:** 2007
**Client:** King Country Energy.

Job manager for embankment concept design for new hydroelectric scheme. Include preliminary advice during approvals process and concept design for 45 m high dam. Completed design and cost estimate for earth and rockfill embankment, gated spillway, diversion works and associated infrastructure. Assisted in concept design of RCC option.

**Moondarra Dam Raising Feasibility Study**
**Dates:** 2007
**Client:** Gippsland Water

Completed review of original design, concept designs and preliminary estimates for works to upgrade and raise the 41 m high, 30 GL capacity Moondarra Dam. Completed cost estimates for range of increased levels to enable assessment of most effective option.

**Eildon Dam Improvement Project**
**Dates:** 2004 to 2006
**Client:** Goulburn-Murray Water/Eildon Alliance.

Senior geotechnical and structural designer for this multi-award winning project. The upgrade of the Eildon embankment included reconstruction of upper portion of dam and raising of crest 5.3 m in earthfill and with a concrete parapet wall. Involved in structural design and stabilising of spillway with 253 multi-strand anchors. Design Representative and member of Alliance Management Team during site works. Responsible for site QA, dam safety and ensuring works completed to design intent.

**Alpine Village Geotechnical Risk Assessment**
**Dates:** 2002 to 2004 & on-going to 2016
**Client:** Falls Creek, Mt Buller, Mt Baw Baw, Mt Stirling Resort Managements.

Completed quantitative / qualitative risk assessment for nearly 100 sites in alpine resorts. Responsible for the management and co-ordination of all planning approval processes, geotechnical investigations, design, tendering, tender appointments, contract management, project management and supervision of large number of varied remedial works. Works included extensive groundwater depressurisation of large landslide prone areas with 1,200 m of horizontal drains installed. Multiple civil stabilising projects involving anchoring rock faces, steel pile and precast panel retaining walls, large gabion retaining walls to 10m height, concrete cantilever walls, concrete gravity walls and large ornamental grouted rock rubble walls. Also responsible for setting up groundwater and ground movement monitoring programs and on-going surveillance.

**Hazelwood Ashing System**
**Dates:** 2002
**Client:** Hazelwood Power Station

Detailed design of new 492 ML storage and remedial works for existing 178 ML storage for the Hazelwood Power Station ashing system. Managed the geotechnical investigation and completed stability assessments for the new embankments. Completed design, drawings and documentation for works. Involved in works supervision.

**Dartmouth Regulating Dam FSL Raising**
**Dates:** 2002
**Client:** Southern Hydro.

Completed design review of dam including stability assessments for all extreme loading cases. Detailed design and drawings of crest modifications of 24 m high concrete gravity dam for installation of steel hydroplus fuse gates, the first such project of its type in Australia.

**Crusoe and No.7 Reservoir Upgrade**

**Dates:** 2001
**Client:** Coliban Water

Completed the geotechnical investigation and stability assessments for Crusoe and No.7 dams. Involved in detailed design of remedial works.

**Risk Reduction Measures**
**Dates:** 2001 - 2018
**Client:** North East Regional Water Authority

Produced and managed the production of DSEP's and O&M's. Involved with setup of dam safety program. Completed investigations, dam safety reviews of major dams. Completed detailed design and construction phase services at most of dams.

**Rocky Valley Dam FSL Raising**
**Dates:** 2000
**Client:** Southern Hydro Partnership

Involved in the preliminary phase of the raising of the FSL of Rocky Valley Dam. Included was assessment of works required in raising and approval process with Department of Infrastructure. Involved in Technical Advisory Group (TAG) meetings and production of planning permit and other legislative referrals.

**McKay Power Station Stability**
**Dates:** 2000 to 2006
**Client:** AGL Hydro.

McKay Power Station is located on a large landslide that is constantly creeping downhill. Responsible for formalising monitoring program, investigations, design remediation options and instigating several stages of works to increase the stability of the slope.

**Moochalabra Dam Raising**
**Dates:** 1999
**Client:** WA Water Corporation.

Completed design for raising the reinforced rockfill, Moochalabra Dam 12.0 m and constructing new 120 m wide unlined spillway. Undertook risk analysis on need to line spillway chute, pioneering rock erosion analysis in Australia.

**Glen Mervyn Dam Raising**
**Dates:** 1998
**Client:** WA Water Corporation.

Completed design to raise Glen Mervyn Dam. Involved in the raising was reconstruction of the spillway crest using a labyrinth type structure, addition of a floating offtake, modifications to the outlet works and other ancillary works.

**Asset Register, Maintenance and Management Plan**
**Dates:** 1997
**Client:** Southern Hydro Ltd

Work included the development of a list of all civil infrastructure assets broken down into maintainable items with an accurate list of technical details. A list of preventative maintenance tasks and capital works was then developed for each item and input into computer maintenance management system used to forecast, plan and issue all maintenance jobs. An operating manual was developed for running the system.

**Dam Safety Reviews**
**Clients:** Goulburn-Murray Water, Loy Yang Power, AGL, Water Corporation (WA), SA Water, Goulburn Valley Water, North East Water, Coliban Water, Gippsland Water, South Gippsland Water, TRUenergy, Barwon Water, Western Water, TasWater, SunWater, Icon Water.

Completed Dam Safety Reviews on Lake Mokoan, Loy Yang Settling Pond, Loy Yang High Level Storage, Rocky Valley, Eildon Regulating, Mt Beauty Regulating Dam, Glen Mervyn, Bundaleer, Barossa, Sturt River, Malmsbury, Buckley's Hill, Moondarra, Pine Gully, Old Inglewood, Yallourn Twin Ash Ponds, Little Bass, Deep Ck, Battery Creek, Stawell No.7, Stawell WW, Marengo, Allens, Cruckoor, Hartwichs, Callide, Glenlyon, Corin, Myponga, Scrivener and others.

**Detailed Risk Assessments – Individual Dams**
**Clients:** Goulburn-Murray Water, Loy Yang Power, AGL, Water Corporation (WA), SA Water, GWMWater, North East Water, Coliban Water, Gippsland Water, TRUenergy, Barwon Water, Melbourne Water, Bega Valley, TasWater, SunWater, Southern Downs, Icon Water.

Completed or reviewed detailed risk assessments and involved/facilitated workshops on Loy Yang High Level Storage, Eildon Regulating, William Hovell, Mt Beauty Regulating Dam, Bundaleer, Barossa, Sturt River, Mt Bold, Todd River, Malmsbury, Ben Boyd, Yellow Pinch, Tilba, Buckley's Hill, Moondarra, Pine Gully, Evanswood, Nil Gully, McCall Say, all Coliban Water Dams, St Arnaud Winter WWTP Storage, Horsham Winter WWTP Storage, Toolondo Reservoir, Moora Moora Reservoir, Highton, Marengo, Swansea, Glenlyon, Knights, Lake Victoria, Limekiln, Tolosa, Connolly, Storm King, Kennington, Beischer, numerous service basins and retarding basins.

**Routine Dam Safety Monitoring, Annual & Comprehensive Inspections**
**Clients:** Numerous.

Led inspections and routine monitoring of numerous dams including variety of outlet tunnel configurations and hydraulic structures for many authorities and private industry around Australia. Works include; condition assessments, design reviews, risk assessments and remedial work designs where required.

**Dam Emergency Exercises**
**Dates:** 2005
**Client:** Goulburn Murray Water, Southern Rural Water & Sydney Catchment Authority

Involved in development of exercise methodology to test DSEP's. Developed scenarios, acted as co-ordinator at dam site for exercise and facilitator in debrief. Aided in report on exercise outcomes. Summarised in ANCOLD paper

**Small Dam Design and Construction Phase Services**
**Client:** Multiple.

Involved in design review and construction phase services for new ponds and remedial works. Apollo Bay Raw Water Storage, Seaspray Raw Water Storage, Dutson Downs WWTP, Nhill WWTP Winter Storage, Dales Road Winter Storage, Daylesford WS, Cobden WWS1, Jack Fisher Dam, Lake Victoria, Tongala WW Reuse, Mansfield Dam, Annuello / Bucks / Schools / Campbells / Ryans Irrigation Dams, Lamattina, SRWRA Storage, Bright WWTP, Retarding basins

**Geotechnical Investigations**
**Client:** Numerous.

Conducted investigation of foundations and ground conditions for many civil projects. Responsible for organisation of drilling, supervision, insitu testing, logging, sampling, organising laboratory testing and report writing. Investigations for all types of ground conditions, using many drilling techniques, often in areas with very difficult access.

**Operation and Maintenance (O&M) Manuals**
**Client:** Goulburn Murray Water, Wimmera Mallee Water, North East Water, Liverpool City Council

Completion of an Operation and Maintenance (O&M) Manual for Eildon Dam, which was used as the template for all G-MW dams, also set-up document for Eppalock Res. and Yarrawonga Weir. Completion of O&M's for retarding basins (LCC), Rocklands Reservoir (WMW), McCall Say, Loombah, Springhurst and Nil Gully (NEW) and Moondarra (GW). The manuals consist of detailed step by step procedures for the operation of the dam, a schedule of maintenance tasks, dam safety monitoring routines and general information on the dams.

**Dam Safety Emergency Plans**
**Client:** Loy Yang Power, Hazelwood Power, Yallourn Energy, South Gippsland Water, North East Water, Liverpool City Council, Southern Hydro, Gippsland Water

Completion of a Dam Safety Emergency Plan (DSEP) for Witts Gully Dam (YE), five for NEW, generic docum ent and 14 specific documents for SGW, five documents for LCC, Hazelwood Cooling Pond, Dartmouth Reg Dam (SH) and Moondarra Dam (GW). The DSEP's identifies possible failure modes of the dam, impacts from the dam failure, threat levels, response actions and evacuation procedures.

**Dam Break Analyses and Consequence Assessments:**

**Clients:** Melbourne Water, Hazelwood Power, Yallourn Energy, Gippsland Water, South Gippsland Water, North East Water, Liverpool City Council, Southern Hydro, Water Corporation (WA).

Completed dam break and inundation mapping for various scenarios. Assessed impacts of dam break as per ANCOLD guidelines.

Technical Reviewer - Tunnels
**Client:** Various.

Reviewer of various aspects of temporary and permanent works for tunnelling projects. Technical reviewer on shafts for Woolloongabba Sewer Project, pipe rehabilitation of Ord River Irrigation Project, asset review of water authority and power generation company's tunnels.