BEFORE THE COMMISSION
APPOINTED BY THE OTAGO REGIONAL COUNCIL

UNDER	the Resource Management Act 1991 (RMA)
IN THE MATTER	Of an application RM18.004631
BY	**PIONEER ENERGY LIMITED** **Applicant**

BRIEF OF EVIDENCE OF ANTONY WILLIAM JACK

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BRIEF OF EVIDENCE OF ANTONY JACK

INTRODUCTION

1. My name is Antony William Jack, I am a Civil Engineer at Pioneer Energy Limited. I have held this role since 2011. In this role I am responsible for Dam Safety, oversight of civil infrastructure maintenance, hydro and wind generation investigations and development, project management, and oversight of resource consent compliance and processes.

2. I have been responsible for the development of this application on behalf of Pioneer Energy Limited.

3. I hold BE Civil (hon), Diploma of Civil Engineering, NZCE(Civil), CPEng, CMEngNZ.

SCOPE OF EVIDENCE

4. In this evidence I will address the following:

    a. History of Lake Onslow.

    b. Description of the Lake as a storage reservoir.

    c. How Pioneer operate Lake Onslow, relative to the consented parameters.

    d. Reasons for the application and intentions for the operation of the Lake moving forward.

    e. Modelling carried out as part of the application

    f. Personal observations of Lake Onslow

    g. Response to items raised in s42A Staff recommending report and supporting evidence.

HISTORY OF LAKE ONSLOW

5. The original stone dam at Lake Onslow was built in the 1890’s for mining. In early 1982 a new dam was constructed at Lake Onslow by the Otago Central Electric Power Board, which raised the levels of the lake by approximately 5 meters and drowned the original dam.

6. The purpose of the new Dam was to provide secure and reliable seasonal storage for generation of electricity. The dam also improved security of supply for the Teviot Irrigation Company which holds permits to take water for irrigation purposes from the Teviot River.

7. Lake Onslow provides water to 5 separate power stations on the Teviot River with a combined generation potential of approximately 16MW, producing approximately 93GWh per year or enough power for approximately 13,000 households.

8. Pioneer Energy Limited sought and obtained resource consents from the Otago Regional Council in 2006for the take, damming and discharge of water at Lake Onslow. Since obtaining those consents Pioneer has exercised those permits in accordance with their terms and Pioneer’s generating requirements.

DESCRIPTION OF THE LAKE AS A STORAGE RESERVOIR

9. Lake Onslow has a total storage capacity of approximately 46.5 million cubic meters of water and has a surface area of approximately 1000 hectares. The operational range of Lake Onslow under Pioneer’s consents is 5.2m. The effective operating storage is approximately 34 million cubic meters. The remainder of the stored water is held below the level of the original dam.

HOW PIONEER OPERATE LAKE ONSLOW

10. The storage available in Lake Onslow is used to provide a secure supply of water for electricity generation throughout the year. Effectively PEL use the storage available to compensate for periods of low inflows. If used judiciously Lake Onslow allows PEL to manage generation commitments for 2 consecutive dry years. ‘Dry years’ are

characterised as years where the outflow exceeds the inflow over a 12-month period and result in a net lake level drop.

11. PEL operate Lake Onslow and the downstream generation as part of an overall portfolio of generation. The way PEL provides power into the NZ energy market is through a combination of presold kWhrs or “Hedges” and the remainder at “Spot”. The annual ratio between hedge vs spot is based on historic annual generation volumes and the seasonal trends. The Teviot River hydro generation is a significant portion, approximately 45% of PEL-owned generation portfolio. The storage available on Lake Onslow provides a secure source of water to meet PELs hedge commitments when Teviot inflows are lower than long term average. The storage also allows PEL optimise returns when spot prices are higher which would generally coincide with increased electricity demand.

12. To meet forward generation commitments PEL must manage the storage so that there is sufficient water available to generate at the required output in late summer when storage levels are traditionally at their lowest.

13. Figure 1 shows the level of Lake Onslow relative to spillway crest for the period 2006 to 2022. It can be seen that there is a large variation in the year-to-year water levels, but the overall trend is for the lake to be lowest in autumn and highest in spring. Figure 1 also shows that the lake level tends to fall steadily as the storage is utilised and then often refills rapidly, often due to a sequence of storms. Figure 2 shows the long-term lake level since construction in 1982. Figure 2 Lake Onslow level 1982 - 2022 shows significant variability in minimum level that Lake Onslow reached from year to year, but also demonstrates that the lowest levels (1990-91, 2004, 2008, 2022) had low inflows in the previous year that did not replenish the lake storage.

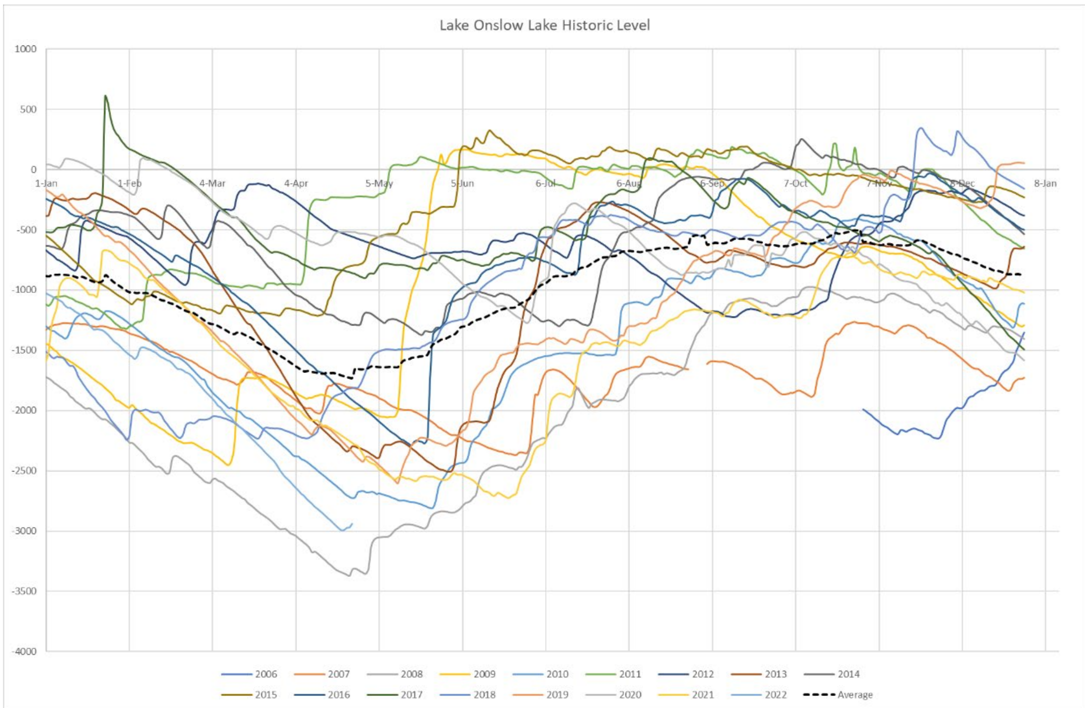

Figure 1 Lake Onslow level 2006 – 2022

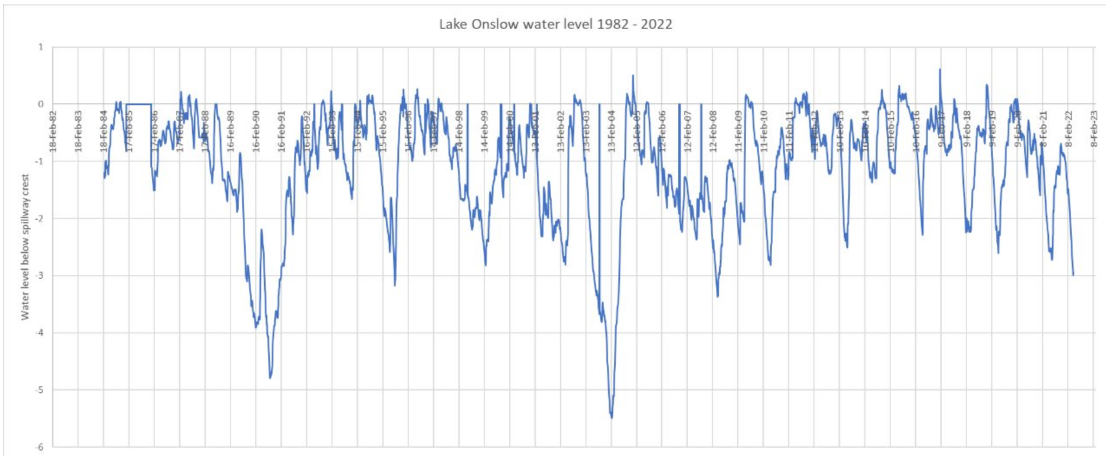

Figure 2 Lake Onslow level 1982 - 2022

REASONS FOR THE APPLICATION

14. PEL has identified that there is an opportunity to both manage the lake better to meet forward hedges and to optimise opportunities for generation to meet high demand periods. Currently the restriction of not lowering Lake Onslow more than 200mm/wk affects PELs ability to manage downstream generation by inhibiting its ability to respond to short term periods of high demand and to maintain levels of generation as the lake lowers.

15. PEL operate Lake Onslow in order to maximise the value of the water available from storage. To achieve this PEL reduces outflow from Lake Onslow when inflows into the catchment downstream of Lake Onslow support the required generation. This enables Pioneer to retain as much water in Lake Onslow as possible to provide for future demands. In periods of reduced inflows or low demand PEL also "cycle" the generation on the Teviot Scheme over the 24hr day, this is achieved through the adjusting flow from Onslow to increase generation at periods of peak demand and reduce outflows for low demand periods. Generation cycling is usually based on a day/night generation profile.

16. As Lake Onslow lowers the surface area decreases, as a result the lake level will change more rapidly if there is a constant discharge. The effect of this is that as the lake lowers PEL must reduce the discharge from the lake to avoid exceeding the drawdown limit. The effect of this is reduced generation. Figure 3 shows the maximum effective average outflow from Lake Onslow with respect to depth below crest for both the current 200mm/wk restriction and the proposed 400m/wk drawdown. Figure 3 clearly shows that as the lake lowers PEL must reduce discharge from the lake to avoid exceeding the maximum drawdown rate. Figure 4 shows the effect that lake level has on effective ramp rates at different outflows. Figure 3 and 4 have been calculated assuming that the inflow into Lake Onslow is

0.75m^3/s which is the approximate inflow for February and March in a dry year.

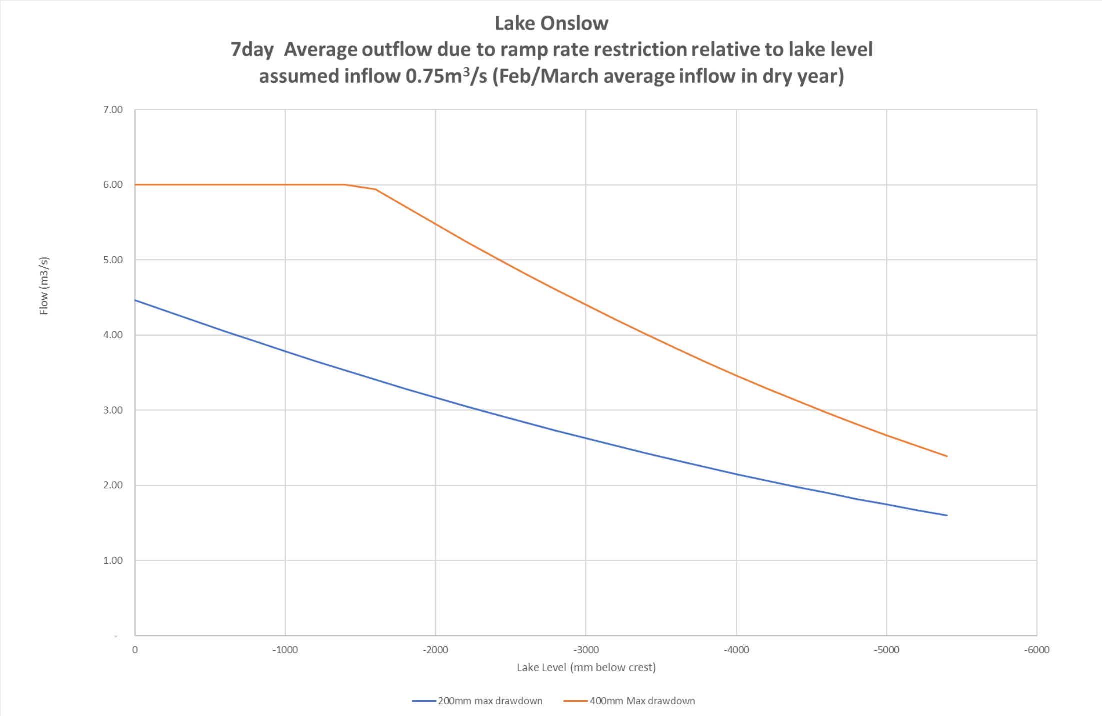

Figure 3 Lake Onslow average outflow wrt to ramp rate and lake level

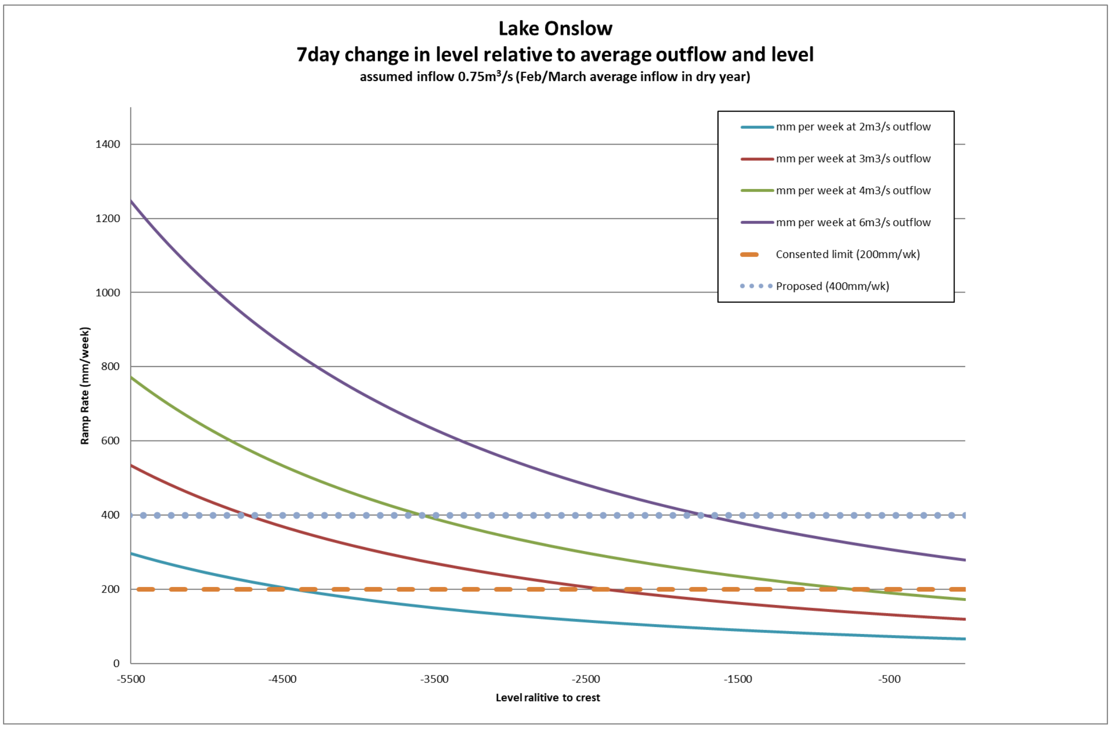

Figure 4 Lake Onslow Ramping rate wrt outflow and lake level

17. PEL has identified that there is potential to increase generation to meet system demand by increasing generation over relatively short

periods. If the discharge from Lake Onslow is at a level that is approaching the current drawdown limit PEL would potentially exceed the limit. Alternatively, would PEL need to reduce generation within the 7-day period to ensure that lake level did not reduce by more than 200mm for that week, therefore reducing the generation level that can be achieved over that period. Having the ability to increase the level of drawdown would afford PEL an ability to respond to increased electricity demand without compromising its ability to meet forward generation commitments. This situation is most likely to arise when Lake levels are already lower and drawdown rates are compromising the amount of water that can be taken for generation. This means the drawdown rate becomes the primary restriction during dry years when lake levels are already low due to low inflows. These periods are when the ability to rely on the storage is most important for PEL.

18. Lake Onslow and the Teviot scheme is one the largest generation systems owned by PEL. Increased flexibility within that system would also allow PEL to increase short term generation from the Teviot and to offset lost generation resulting from “outage” of other assets as a result of maintenance works or breakdown.

19. Pioneer Energy Ltd (PEL) has no intention to change the overall operating regime of Lake Onslow. The intention is to continue to use the reservoir for seasonal storage to supplement lower inflow periods during summer, thus allowing the reliable generation of electricity that is injected into the local network and at times into the national grid. It is not in PEL’s interests to draw down Lake Onslow at significantly higher rates than present as excessive consumption of the available stored water would leave PEL unable to meet its forward generation commitments, be it later in the season or in subsequent years should winter inflows do not provide sufficient volume to refill the reservoir. Therefore, the operation of Lake Onslow is inherently conservative and will continue to be so.

20. PEL need to be inherently conservative because of the need to meet its forward commitments and the consequences of not doing so. If

PEL cannot provide electricity supply to meet its hedged commitments it is required to purchase supply on the wholesale market and sell it at its contracted hedge price. Inevitably this would mean PEL pay a considerably higher price than it would be entitled to recover for its hedged supply, resulting in significant economic losses for the company. The increased drawdown rate allows for more flexibility and better risk management but using too much at any stage will offset future storage.

21. The current restriction of lake level drawdown means that at lake levels lower than about 1m below crest PEL is unable to take the consented maximum flows and at lower levels is effectively restricted to much lower rates of take due to the increased draw down rates that occur at lower lake levels. This means that PEL is unable to react to demand and utilise the installed generation capacity within the Teviot system. Generally, it is in late summer that national hydro-storage is operating at low levels and that there is maximum demand on the electrical system. It is during this period of high demand that short term peaks in demand warrant increased generation. The restriction in the ramping rate level has a significant impact on the average allowable take when the lake is at lower levels which tend to coincide with late summer and periods of high demand. It is this issue that the proposed amendment seeks to address.

22. Any Change to Lake Onslow will likely be indistinguishable from the historic variability of Lake Onslow which have resulted from variable inflows and national generation demands. Those factors will continue to be highly variable.

MODELLING

23. To support this application, I have prepared a spreadsheet "model" to quantify what Lake Onslow would have looked like, in terms of lake level, if it had been exercised to the full extent allowable under 2001.475 & 2001.476.V1. The "model" considered the inflow into the lake, the storage vs depth relationship of Lake Onslow and the allowable discharge in accordance with 2001.475 & 2001.476.V1.

24. The model does not seek to provide a definitive solution to what Lake Onslow would have been if the consents were full exercised. This would be impossible given the number of variables that would have occurred over the past 16 years. Instead, the model is intended to demonstrate significant difference between what might have occurred given the consent limitations and the magnitude of change if the proposed variation was in effect. The model also shows a comparison of the actual historic record for the period.

25. There are no monitoring sites recording the inflows into Lake Onslow. Therefore, the inflows into Lake Onslow must be derived from other sources. There are two options for this:

    a. Inflows can be calculated using the storage/depth relationships and discharge flow from the Lake. This method was not used because the discharge flow record from Lake Onslow has known inaccuracies and is incomplete.

    b. Use a synthetic hydrograph derived from nearby catchments that have similar hydrological patterns. Two data sets for synthetic hydrographs have been obtained. Firstly, a synthetic hydrograph developed for the Electricity Authority to model inflows into Lake Onslow for the purpose of modelling national energy storage. This dataset is based off inflow into Lake Waipori, which is approximately 40km southeast of Lake Onslow. A second dataset was supplied by NIWA that has been prepared for MBIE in their assessment of Lake Onslow for the NZ Battery Project. The second data set is based on the flows in the Taieri River at Canadian Flat, which approximately 10km East of Lake Onslow and in the adjacent catchment.

26. I analysed both data sets and the Waipori derived data set was found to have approximately 50% higher volume for the period 2007 – 2022 than the dataset derived from the Taieri River. When applied to the model using the Waipori dataset created significant differences

between the simulated lake levels and actual lake levels, refer Figure 5 below.

27. The Taieri dataset correlated much more closely to the actual historical lake level, particularly in terms of trends. i.e. simulated increases in lake level occurred at the same time as the actual historic record. It was concluded that the Taieri derived data set as supplied by NIWA/MBIE was a better representation of the actual inflows into Lake Onslow for the period.

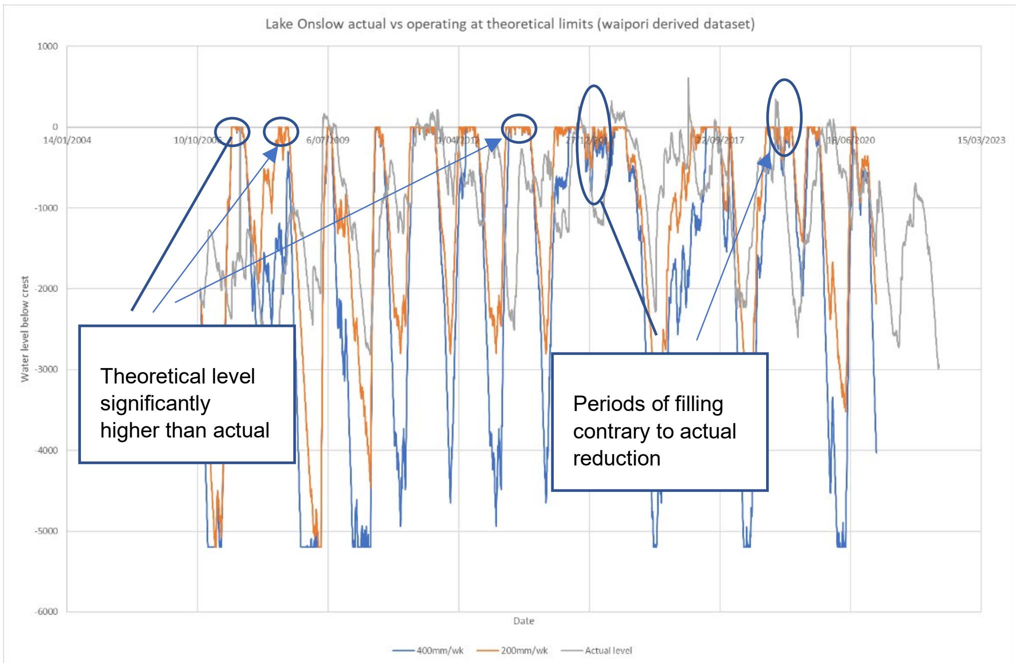

Figure 5 Lake Onslow Model using Waipori Dataset identifying areas of poor correlation

28. A check on the validity of the Synthetic inflows derived from the Taieri River has been carried out to confirm they are generally in agreeance or realistic with actual lake inflows. To validate the inflows the period from 1/6/2013 to 1/8/2013 have been selected as this period coincides with a period of inflow that did not cause the lake to overflow. If the lake had overflowed during the period, the total volume would not have been determinable. The total volume of inflow calculated from the synthetic inflows was compared with the calculated change in volume based on the volume/depth relationship from the historic Lake Onslow level record considering that the

outflow for the periods was between 2m3/s and 3m3/s. It was found that the theoretical inflows exceeded the "actual" volume change by a factor of 78%, suggesting that the synthetic inflows are a higher estimation than the actual inflows for the same period. However, allowing for some error in the volume/depth calculations and error in the inflow and outflow record it was concluded that the Taieri derived dataset was a reasonable, if not conservative, approximation for inflows in the absence of another source of information.

29. I am in agreeance with the review undertaken by Tiago Teoceira & Lobo Coutinho of Babbage that the inflow hydrograph calibration correction is around 0.68 based of the period discussed above. I also agree that this single period of consideration could be expanded to include other periods to determine if it is an aberration or if it is representative of the overall dataset. To confirm the correction factor two further periods have been considered. The period from 21 May 2016 to 28 June 2016 has been evaluated with the correction factor calculated to be 0.64 based on change in volume being calculated at 12,974,000m^3, outflow 4,588,000m^3 based on the measured outflow over the period. Likewise, the period 12 May 2019 – 30 October 2019 was evaluated and the correction found to be 0.61. It must be accepted that there are likely to be errors in outflow and volume calculations but the range of correction factors,0.61-0.688, indicates that the Taieri based inflow hydrograph will overestimate the inflows into Lake Onslow by 45%-64%. I agree that the 0.688 correction factor used in Mrs. Pritchard's s42A assessment of effects is reflective of the likely actual inflows into Lake Onslow

30. The Babbage review of the model has highlighted that the model does not consider direct rainfall on the lake or evaporation. I agree that this could be included and have considered this from a sensitivity perspective if it is likely to provide a substantially different answer. The Lake Onslow catchment is approximately 126km^2. Lake Onslow when full has an area of 10km^2 so represents approximately 8% of the total catchment. Furthermore from 2013 to 2021 the average annual rainfall recorded at Lake Onslow was 616mm whilst mean

average pan evaporation in Roxburgh is 1120mm/yr (Groundwater Allocation of the Ettrick Basin, December 2006, Otago Regional Council). Any allowance for direct rainfall on the lake will be within the margin of error of any of the variables used in calculating the model and is not considered to be significant.

31. Key assumptions that have been made in preparing the Lake Onslow water level model

    c. The analysis starts 1/11/2006 and assumes the lake is at 1991mm below crest level, this is the actual lake level recorded on that day.

    d. The outflow is the lesser of $6m^3/s$ or the flow that will result in a reduction in lake level of 200mm/wk (or 400mm/wk)

    e. The depth/volume relationship determined by OCEPB as shown on drawings 2W/01S/018 dated 3/1985 is valid.

32. The model demonstrates, see Figure 6 and Figure 7, that the actual utilisation of Lake Onslow has historically been significantly less than that permitted under 2001.475 & 2001.476.V3. The model also shows what that environment would have looked like if the increased ramp rate had been applied. It can be concluded from the model that the impacts of the increased ramp rate on the existing environment would have been largely indistinguishable. Table 1 provides a summary of the percentage of time the lake level is below certain levels for both the existing and proposed ramp rate limits.

Table 1 - Modelled Percentage of time level below levels if consents fully utilised

Level water below	200mm/wk	400mm/wk
-2500	92% (100%)	95% (100%)
-3000	84% (99%)	91% (99%)
-3500	70% (96%)	84% (98%)
-5000	21% (60%)	47% (77%)
Note figures in Brackets () are calculated for an inflow correction of 0.688		

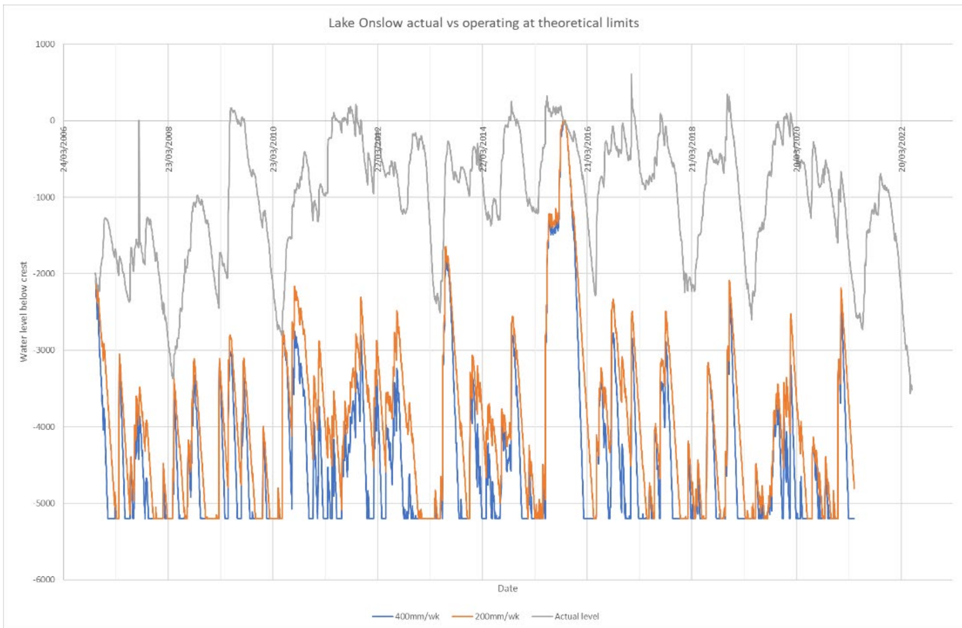

Figure 6 Lake Onslow actual Vs operating at theoretical limits (unadjusted inflows)

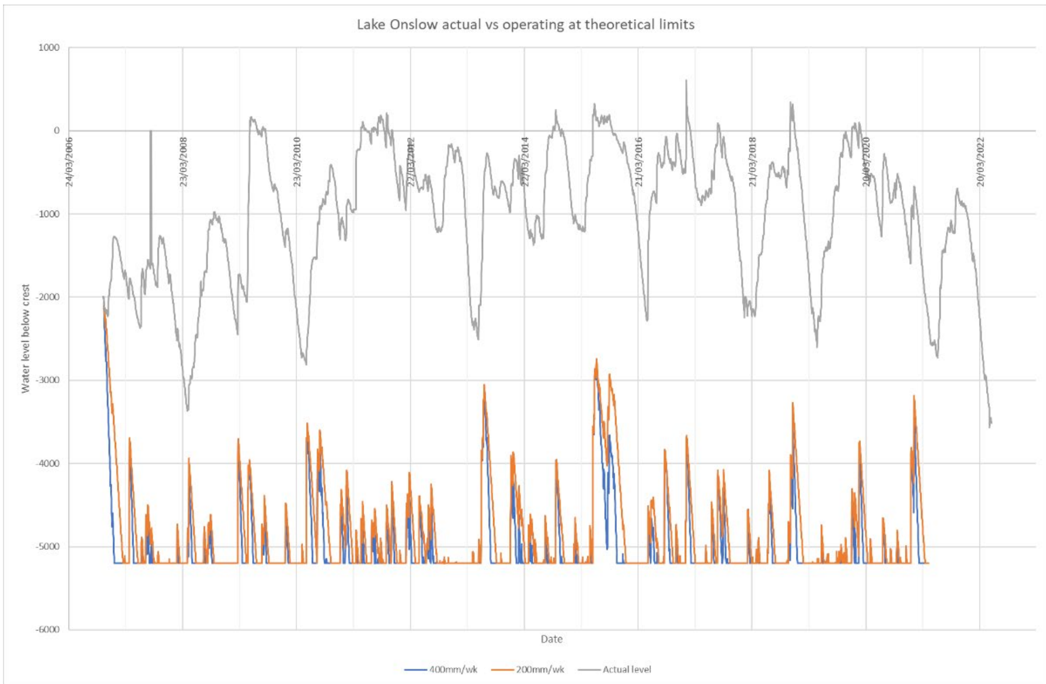

Figure 7 Lake Onslow actual Vs operating at theoretical limits (inflow correction of 0.688)

PERSONAL OBSERVATION OF LAKE ONSLOW

33. Over the past 10 years I have regularly visited Lake Onslow for asset and dam safety inspections. I have also been a member of a number of 4WD clubs over the past 20 years that would pass through the Lake Onslow basin a couple of times per year. I am familiar with the area.

34. On Queens Birthday public holiday 2022 Lake Onslow was the lowest it had been in the past 14 years with the water level 3.5m below crest. The day was fine and sunny so took my children fishing at Lake Onslow. During the day we fished from the shore covering a distance of approximately 1.5km starting at the boat ramp and heading east and south. We also fished the area north of the bridge crossing the north arm. During the time that we were at the lake, approximately 5 hours, the only other users of Lake Onslow were 2 small jet boats that launched from the concrete boat ramp. These boats headed to the northern end of the Lake, returning a few hours later following the shore in a clockwise direction. They did not appear to be fishing, instead traveling at speed. The exposed flats around Lake Onslow

generally had shallow mud that left an impression when walked on but was traversable. In areas that were low laying and clearly wet the mud was deeper, with some areas up to 300mm and capable of trapping inattentive gumboots. Generally, these areas could be avoided. 2 fish were caught from the shore. I found very few other lake users there on 6 June 2022 but found few issues or impediments in the recreation I went there for despite the lake being at the lower level.

35. Figure 8 – 14 show photographs of shoreline areas at lake level 3.5m below crest.

Figure 8 Lake Onslow for a distance, water level 3.5m below dam crest

Figure 9 Lake Onslow Boat Ramp (-3.5m)

Figure 10 Lake Onslow, Boatramp in use (-3.5m)

Figure 11 Lake Onslow area of rocky shore near huts

Figure 12Lake Onslow - Broad flats south of huts (-3.5m)

Figure 13 Lake Onslow showing huts and Boat Ramp (-3.5m)

Figure 14 Lake Onslow North Arm - area of softer mud

RESPONSE TO ITEMS RAISED IN S42A STAFF RECOMMENDING REPORT AND SUPPORTING EVIDENCE

30 In Section 13.2.2 of the s42A Mrs Pritchard suggested a potential condition to install 3 rocky areas on the shoreline as these may provide some minor ecological benefit as suggested in para 63 of Mrs Coates evidence. The suggested condition does not provide any indication of the magnitude of these possible rocky areas. Mrs Coates also does not give any indication of the scale that would be required to provide any meaningful or measurable benefit should they be installed. Given Lake Onslow has a surface area of 1000ha and a shoreline in the order of 30km, even if the proposed rocky areas represent a small portion of the shoreline perimeter the total area of introduced rocks may be several hectares. Undertaking such an addition of rocky area to Lake Onslow would require significant civil works including quarrying to source the rock, trucking to transport the rock and formation of tracks to gain access to allow the installation to take place. The civil works alone would come at a significant financial cost. In light of the conclusions that effects of the change in draw down rate are insignificant I do not consider the proposed conditions are justified.

31 I can confirm that PEL accept the recommended amendments to Water Permit 2001.475 Condition 15 (signage), with a suggested change to the recommended wording. With regards to sub-condition (c) PEL has no jurisdiction to dictate procedures for boat stranding and nor does PEL have the resources or expertise to render advice or assistance to boat users who fail to navigate the known hazards associated with Lake Onslow. As a result, I suggest the requirement to provide advice on boat standing procedures be removed. As an alternative the sign could advise that the NZ Coastguard recommends all boats carry 2 forms of communication that will work if they get wet.

Signed:

Antony Jack

Pioneer Energy Limited

Date: 21 June 2022