From: Natasha Pritchard
To: Jason Augspurger
Subject: FW: s92 response RM18.004
Date: Thursday, 5 April 2018 2:57:00 p.m.
Attachments: image001.jpg
20180405 17367 Ross Dungey s92 response.pdf

Hi Jason,

Please find attached the further information for the Pioneer application.

When you have had a chance to review, let me know if you have sufficient information to provide technical comment on the application.

Cheers
Natasha

From: Hilary Lennox [mailto:Hilary@landpro.co.nz]
Sent: Thursday, 5 April 2018 1:27 p.m.
To: Natasha Pritchard
Subject: s92 response RM18.004

Hi Natasha

Hope you're keeping well! Please find attached a response to you email dated 15 February regarding consent application RM18.004.

Let me know if any further information is required.

Cheers

Hilary

Hilary Lennox

Lake Onslow. Supplementary Information

Potential effects

1. Water quality effects from increased water level fluctuations, sediments and nutrients in the lake and river.
2. Water quantity effects downstream of Lake Onslow (on Teviot River and dams).

Impacts in the Teviot Catchment.

1. Extensive land development in recent years has seen the removal of tussocks from large tracts of the Teviot catchment. This leads to increased runoff carrying sediment and nutrients.
2. Cattle damage on tributaries and the Teviot River from trampling and crushing of riparian margins is an additional source of fine sediment and nutrients.
3. There has been commercial harvest of lobster from Otago high country lakes (Onslow, Poolburn, Manorburn) in recent years with unknown effects on fish populations for which lobster are a major food item. Studies on the Teviot fish population indicate that trout are on a less than full food ration, hence small average size. It is not until they reach a critical size at which they can switch from an insect diet to a fish/lobster diet that they can get past that restriction and grow to normal sizes. If a major “large item” food source is limited then it follows that there will be adjustments in the fish population structure and perhaps reduced average size.
4. Forestry developments in the Teviot catchment will be having an effect on both water quality and quantity.
5. Hydro schemes such as Horseshoe Bend have resulted in a residual river section through a steep gorge which may have resulted in a net loss of trout habitat. Monitoring indicates that for the remaining river there have been no adverse effects from the operation of the Horseshoe Bend hydroscheme on the Teviot River.

Background.

1. The proposed variation is to increase the allowable draw down rate from 0.2 to 0.5m per week.ie 1.2mm/hr to 3mm/hr.
2. The operating range remains unchanged.
3. Drawdown is balanced against keeping the lake full enough to provide for irrigation.
4. The frequency of use of the proposed drawdown rate depends on market demand and how often there is a dry year(< expected rainfall).
5. There is a maximum discharge of 6 cumecs from Onslow which will limit how often the proposed change could be exercised.
6. PEL plans to utilize the extra capacity in late summer.
7. Analysis by PEL indicates the faster drawdown rate would have been utilized in two of the last 5 summers.
8. An increased drawdown rate would increase flows in the Teviot River and may result in an increase in the time lower level lake shore line is dry in late summer.

9. Lake Onslow comprises approximately 1/3 of the total catchment, there is a further 1/3 of the catchment from Lake Onslow down to Horseshoe Bend the tributaries of this reach usually contribute 1 cumec to the Teviot River.
10. There are potential effects on fish, invertebrates, and water quality.
11. Based on 21 years of regularly visiting the Teviot River for various PEL aquatic surveys there has been very little change to the stream channel below Horse Shoe Bend and Bridge Huts Bridge from large floods that over top the Onslow dam.

Information sources.

1. Flow data. PEL records and advice. NIWA
2. Fish surveys, 1998-2017
3. Invertebrate surveys, 2012, 2013, 2015
4. Algae surveys, 2007-2018, visual inspection 5x per summer
5. Horseshoe bend sediment investigation, 2013
6. Teviot and Horseshoe Bend environmental investigations, Cawthron Institute.

Operating Regime

The allowed operating range of Lake Onslow is 5m but the scheme is typically operated within a 2.5m range. The maximum allowed instantaneous discharge from Onslow is 6 cumecs in winter and 3 cumecs in summer. This is the maximum that Horseshoe Bend can operate at. Given the maximum of 6 cumecs the release of additional water is likely to have the effect of reducing the range of flows for a given period (late summer) although the range over a season is likely to remain similar. As the increased draw-down would be used in late summer, flows in the Teviot River would increase at a significant time for aquatic biota in general where annual late summer stressors typically apply. The additional flow would relieve those stressors.

The summer/winter operating regime of the river is unlikely to change significantly from what was experienced historically, pers com A Jack, PEL. The proposed variation will allow PEL to maintain higher flows in the river in dry years by not placing as much restriction on the amount of water that can be released as the reservoir level lowers. The current consent effectively restricts the amount of water that can be released in late summer. It may mean that lake levels remain lower for longer than at present if rainfall does not eventuate to refill the lake. This should not result in any change compared to recent historical lake levels as it does not equate to more shoreline being exposed to wave action but simply a different section of shoreline.

A key point with regard to the proposed change is the frequency with which it is applied, if it were several times a year every year then an effect may be expected if that were a substantial change from historic use patterns. But since it would be utilized occasionally, 2 of the last 5 late summers, pers com A Jack, PEL. Most of the changes are expected to be positive. Given the likely timing of exercising increased draw down any effect (positive or negative) that there maybe, is likely to be subtle and difficult to detect.

Potential Effects.

1. There would be increased summer flows in the Teviot River when faster drawdown is exercised. It is widely accepted among fish ecologists that the amount of habitat available at late summer low flows creates an annual bottleneck to production. This results from a reduced wetted area and elevated temperatures and a range of other related adverse consequences. As a generalization any additional water/habitat at this time of the year will alleviate this bottleneck so the effects of increased flow on the Teviot River are positive. This could be mediated for example by adverse effects such as widely fluctuating flows that resulted in alternative inundation and drying of the stream bed. This is unlikely given the shape of the Teviot River channel, the minimum flows and the limits on maximum rate of discharge.
2. The Teviot River channel tends to be "u" shaped so that even a large change in flow results in very little change to wetted area.
3. An increased draw down rate does not directly equate to more fluctuations in lake level, it is simply that water could be used more quickly on occasion. The lake will still need to be recharged(rainfall) and this will limit how often the faster drawdown can be applied. There is potentially an increased sediment load as lake bed is exposed more rapidly; but this seems unlikely as faster draw dawn means base level is reached sooner so the intervening sediments between top level and drawdown level spend less time in shallow water and potentially being worked by wind/wave action. A faster draw down rate should not therefore result in more sediment suspended around the lake shore or supplied to the Teviot River. Nutrients would be similar so overall there could be a lowering of sediment and nutrient input to lake and river if faster drawdown results in less wind/wave working of shorelines.
4. The potential effect of lower lake levels reducing fish habitat in late summer is mitigated the behavioural response of trout to increased water temperatures in shallow water. They currently avoid these by moving to deeper(cooler) water, which is where knowledgeable anglers seek them in late summer.
5. Disturbance of fish is unlikely to be an issue because in summer fish tend to move into deeper channels to avoid warmer temperatures and back into shallow as temperature falls over-night or with weather change. If there is less wind working/wave action then the water will possibly be clearer overall which may allow greater light penetration with positive benefits to productivity.
6. Water quantity effects downstream of Lake Onslow (on Teviot River and dams).
   An Increase in intensity, frequency, and duration of fluctuating flows seems unlikely as more water is released because it is within the existing range as set by minimum and maximum discharges, see table 1 below. Except when there are flood events, flows will tend to be near 3-4 cumecs over summer, therefore water used around specific high value periods equates to a steadier flow. However when the stored water is used a more stable period of lower river flows, while the lake refills, is likely to exist, and there should be an extended period of reduced fluctuations. According to the Cawthron IFIM study this would provide better ecological conditions.
7. The release of additional water from the increased drawdown is much less than the recently experienced flood flows. Even these flows which left a debris line about 2m above the normal water level and washed out the water level recorder at Bridge Huts didn't produce any river bed scouring that was noticeable on recent (summer 2017-18) visits. The only damage to the river bank was at 1 location where the large

mats of floating vegetation, that result from cattle trampling the bank, was rolled back by the flood in mid-summer. The maximum change the variation to draw down would equate to is between the FRE2 and FRE3 flows that are required under consent number xxx to flush out algae and these are well below bed movement flows. Gravel size particles are very limited in the Teviot River and even those locations (Horseshoe Bend to the bridge) used for spawning did not show any gravel movement with the recent flood events of November and February.

The greatest expected change (from a proposed increase in allowable drawdown rate) is additional flow in late summer in the Teviot River, where it will most likely have a positive effect. Additional flow in winter may mitigate stressful cold water effects on small trout while additional flow in summer is likely to mitigate warm water stressful effects.

Table 1, stream flow parameters under different scenarios with the maximum discharge of 6 cumecs.

Season	**Time**	**Minimum**	**Maximum release**	**% increase**	**Median**
Winter	Day	5.9	0.1	1.7	4.5
	Night	2.7	3.3	122	4.5
Summer	Day	3.0	3.0	100	2.5
	Night	1.7	4.3	253	2.5

Existing Studies

Evidence of trends from existing studies on the aquatic ecology (1998-2108) is that habitat is stable or improving in the Teviot River.

Under the current regime, surveys (listed above) have shown,

1. a significant increase in winter invertebrate density,
2. variable summer invertebrate density but within the established range,
3. elevated MCI scores for both summer and winter since the scheme was commissioned, Dungey 2015.
4. a small but steady increase in mean fish length, Dungey 2017

Hayes and Strickland (1999) reported on an IFIM analysis of the effect of fluctuating flows which they calculated may reduce food producing habitat by approx. 26% with the effect worse in winter than summer. But subsequent density assessments suggest no significant adverse change in invertebrate abundance. There is variation in invertebrate density but it has generally increased since commissioning of the Horseshoe Bend project.

These points are shown in the figures below showing winter and summer invertebrate densities and MCI scores for 3 sets of surveys over 16 years.

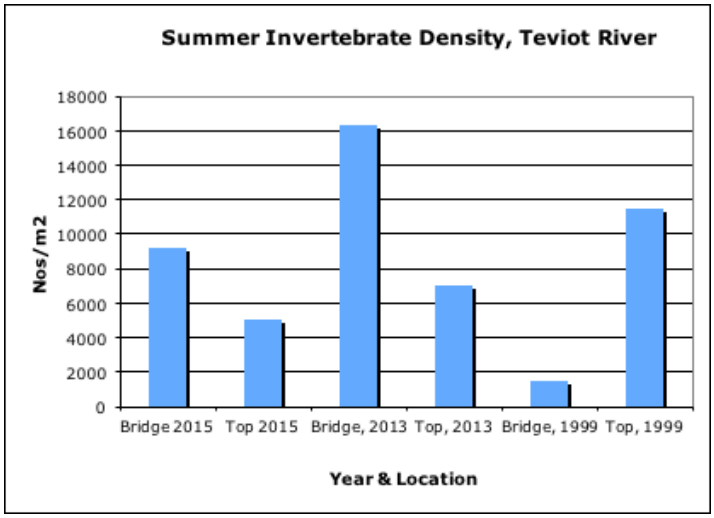

Figure 1 , Teviot River summer invertebrate density.

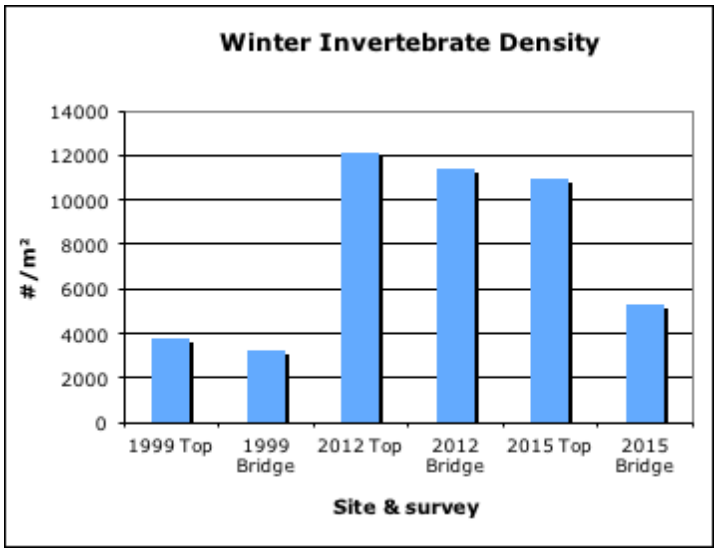

Figure 2, Teviot River winter invertebrate density.

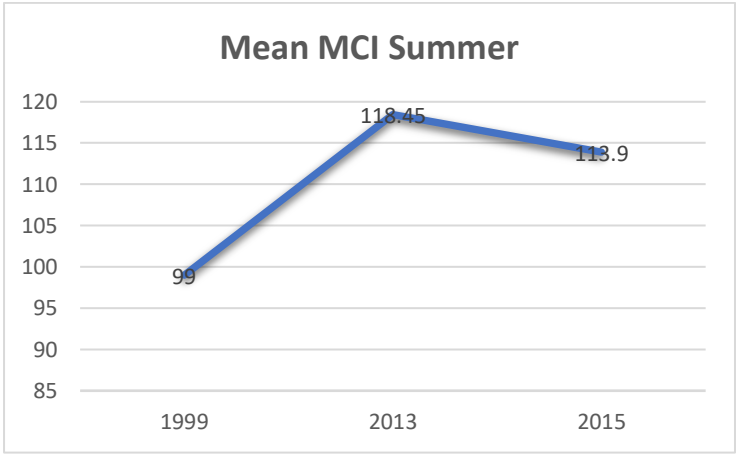

Figure 3, Mean MCI scores for Teviot River summer invertebrates 1999, 2012, 2015

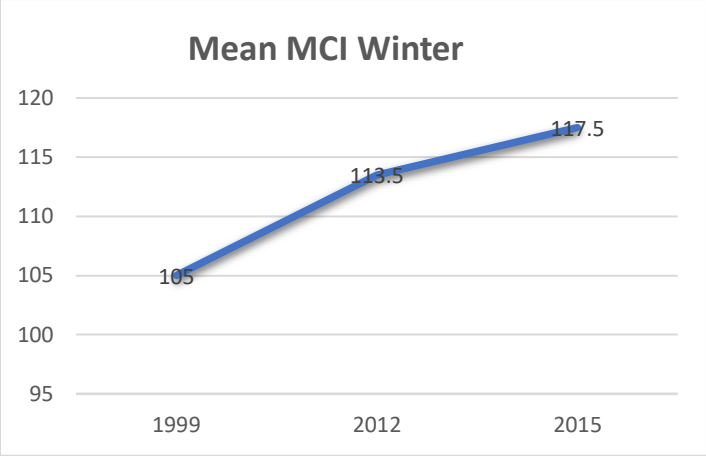

Figure 4, Mean MCI scores for Teviot River winter invertebrates 1999, 2012, 2015

These studies are all against a background of no noticeable change in streambed or riffle/pool structure during the years of observation.

As agricultural intensity increases in the Upper Teviot catchment nutrient supply is likely to increase. It is possible that the observed increases in invertebrate densities in the Teviot are in response to these changes which may therefore mask any subtle effects the scheme hydroscheme may be having. The annual algae monitoring was instituted in 2007 to alleviate concerns about algae by Fish and Game (2001.477, consent brief No. 2.) . A slight increase in productivity may be desirable (given the less than full ration estimate) but the algal growths give an indication of the likely response to elevated nutrient levels and they could reach or exceed desirable levels. The MFE guidelines have been exceeded at individual sites on some previous surveys giving an indication of the potential for proliferation of algae.

Annual PEL Sponsored Fishing Competition.

PEL sponsors an annual fishing competition that provides fish lengths from a sample of angler caught Teviot trout, currently there is a 21 year dataset. The length of the data set and the consistent trend add integrity to what a simple sampling regime can show. The gradual increase in mean length (182-204mm, approximately 10% increase) and the reduction in the numbers of small trout, suggest increased food availability rather than reduced availability. Under the current regime food production seems to have been enhanced slightly rather than reduced although the reasons for this change are unclear. What is clear is that the scheme is not having a significant adverse effect.

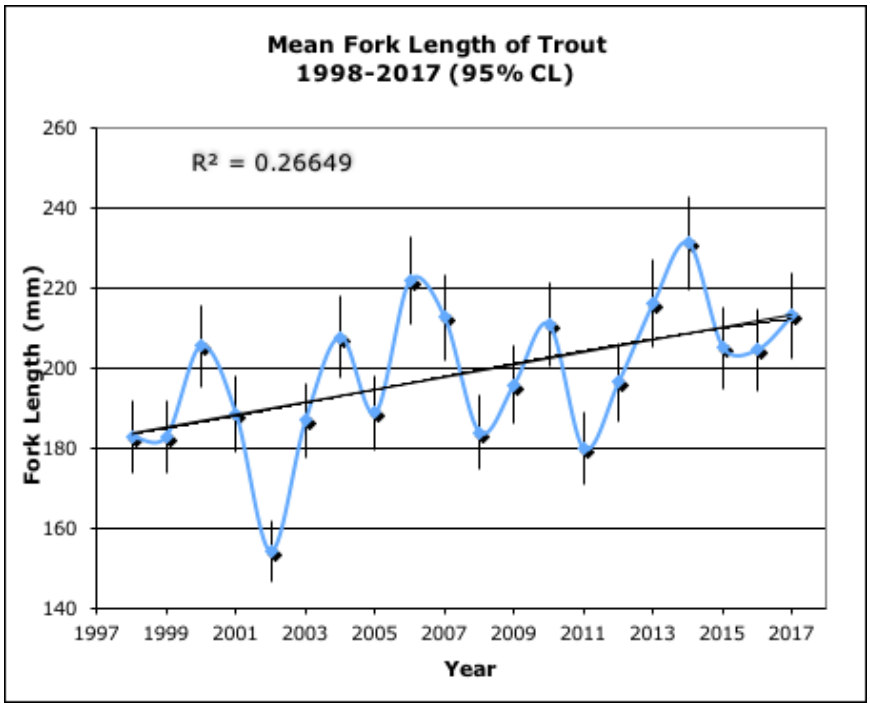

Figure 5, mean length of angler caught Teviot trout, 1998-2017.

Horseshoe Bend Sediment Study.

A survey of the extent of sediment accumulation at the head of the Horseshoe bend impoundment was undertaken in 2013. This survey noted there was no sediment accumulation developing a delta where the Teviot River enters the Horseshoe bend impoundment. Sediment sources tend to be in the fine category (mud, silt) and largely washed through the system at the existing rate of supply. Any increase in fine sediment input however has the potential to be damaging to the aquatic biota. It seems unlikely that an increased draw down rate would alter sediment inputs and that land development and cattle damage to riparian zones would be a more likely source of fine sediment.

Algal Monitoring

Each summer since 2008, 5 assessments of the extent of algae cover and filament length have been conducted as part of PEL consent conditions. These show varying levels of algae, figure 6, but the consent requires flushing flows to be supplied if MFE guidelines for filamentous algae are exceeded. Low levels of algae and large mid to late summer flood events (for example January 2017, November 2017, February 2018) have superceded any such flushing events so far. None of the years in figure 6 coincided with a drier than average year but show wide variation in algal filament length. A change to draw down rate will not alter the effect of the large flood events that currently seem to control algae growth in the Teviot. It is possible that elevated flows could provide more stable flows and therefore enhance algae but the change in draw down rate is expected to be an occasional event in some years, not a regularly occurring scenario.

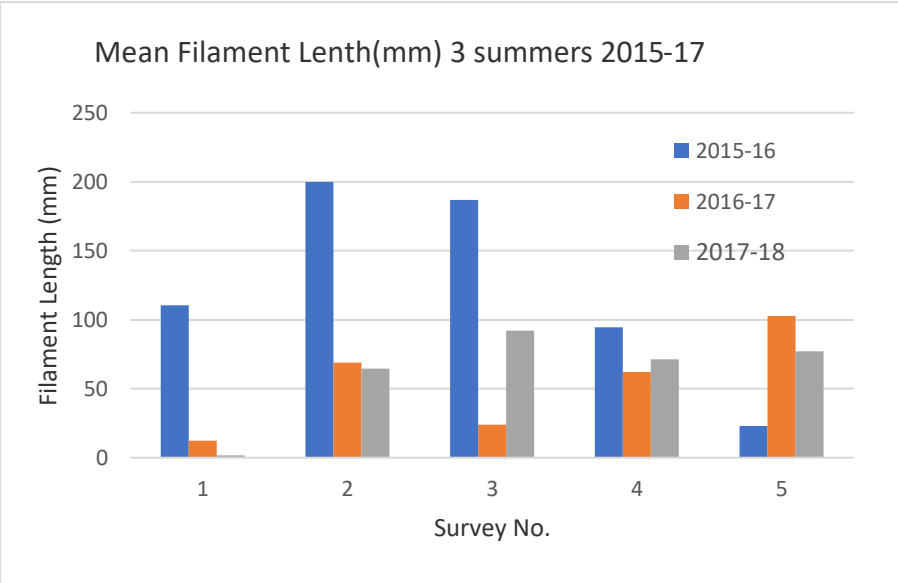

Figure 6, mean green filamentous algae filament length over 3 summers.

Summary.

There are no anticipated adverse effects on water quality in Lake Onslow as the proposed change does not alter the existing operating range and would not therefore expose new shoreline. Effects are further moderated by the requirement for recharge which is solely rainfall.

The expected effects from an increase in draw down rate and therefore release into the Teviot River are that late summer stressors related to lower flows are likely to be alleviated when the additional discharge occurs.

The variation is a small change and given the monitoring indicates a positive trend over recent years, no adverse effect is anticipated.

Monitoring Options.

While the indications are there will be little change, monitoring may be of value to check for any response to a change in the drawdown regime. The invertebrates present provide a summary/review of environmental conditions in the preceding months/years. We have previous surveys to compare with. A possible monitoring regime would be to repeat the invertebrate surveys on Teviot River to confirm existing conditions and then repeat 3-5 years after the proposed draw down regime has been implemented and operated.

If fish populations were of concern then some sampling of Onslow trout may be of value, this would however be difficult to interpret as recent commercial harvest of lobsters in Central Otago Lakes will have had an undetermined/undefined impact on this major food group for trout. Observed changes in the fish population statistics would be very difficult to attribute to a specific cause such as changed draw down rate against the background of the harvest of a historically available food source.

There is the possibility that increased draw down may alter reworking of sediments and nutrients in the sediments. Once suspended by wave action they may flow to the Teviot River at a different rate than is currently the case. Some water quality monitoring, initially under existing conditions and then post an increased draw down rate may show if there is any change (in nutrients and sediment) that could be attributed to the rate of draw down change. There is no baseline data available so this would need to be established.

References.

Dungey R 2013; Horseshoe Bend Small Hydro Lake Sedimentation Investigation. Monitoring Condition 10, Consent number 97319. Report to Pioneer Energy Ltd.

Dungey, RG 2013. Teviot River Invertebrate Monitoring. Report to Pioneer Generation Ltd.

Dungey RG 2015; Winter 2015 Invertebrate Monitoring & Comparison with 2012 & Baseline studies. Report to Pioneer Generation Ltd. Alexandra Ross Dungey Consulting Ltd.

Dungey, RG 2017. Teviot River Fishing Competition, sponsored by Pioneer Generation Ltd, Report to Pioneer Energy Ltd.

Dungey, RG 2017. Teviot River Algae Monitoring. Report to Pioneer Generation Ltd.

Hayes J, Strickland R. 1999, Effects of the proposed Horseshoe Bend Hydroelectric scheme on fish and aquatic invertebrates: an IFIM analysis. Report to Central electric. Cawthron Report No. 507.

Ross Dungey Consulting
March 2018