

**IN THE MATTER**

of the Resource Management Act 1991

**AND**

**IN THE MATTER**

An application by **MAJAC TRUST** to vary parts of the Buller River Water Conservation Order relating to the Gowan River.

***HEARING BEFORE  
A  
SPECIAL TRIBUNAL  
IN  
NELSON***

***TO VARY THE BULLER RIVER  
WATER CONSERVATION ORDER***

***NOVEMBER 2005***

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***STATEMENT  
OF  
EVIDENCE  
OF  
PETER SWAN***

1. My name is Peter Swan. I am a Consulting Engineer and Director of Peter Swan Ltd Consulting Engineers. I have practised as a Principal in consulting engineering design practices for the last 30 years.
2. My professional qualifications and memberships are Bachelor of Engineering Civil from Canterbury, member of the Institute of Civil Engineers and member of the Institute of Professional Engineers of NZ.
3. My experience covers a wide variety of civil engineering design works including roading, drainage, bridging and water retention structures and structural engineering design works for commercial and industrial buildings. It also includes 2.5 years engineering construction and project management experience on the Tokaanu Power Project penstocks, powerhouse and tailrace canal.
4. Peter Swan Ltd has prepared preliminary designs for a low impact run-of-river hydro electric development for the Majac Trust on the East Bank of the Gowan River.
5. The proposal to construct a Run-of-River hydroelectric development involves:
  - Constructing an intake structure on the east side of the river complete with screens stilling basin and control gates.
  - Constructing a headrace canal and head pond on terraces alongside the river
  - Constructing a penstock from the head pond to the power house
  - Constructing a 10m by 18m power house at the foot of a high terrace adjacent to the river
  - Constructing a tailrace from the power house to the river
  - Build a new HT transmission line to join the existing 110kV line near the outlet of Lake Rotoroa into the Gowan River.
6. A summary of the salient features of the proposal are:
  - The scheme is proposed on the east bank of the Gowan, entirely on land owned by Majac Trust.
  - The intake will be a side-entry design built into the right bank of the river and will involve minimal interference with the natural flow of the river.
  - No water will be taken from the river during low flows until the natural flow reaches 9.00 cumecs. Operational requirements dictate that the flow will be allowed to increase above 9 cumecs up to approximately 12.5 cumecs before a minimum flow for operation

of approximately 3.5 cumecs can be diverted, resulting in the flow in the diversion reach not dropping below 9 cumecs.

- When the naturally occurring instantaneous flow of the Gowan is more than 9 cumecs the scheme would divert some of the water from the Gowan into a canal which would carry the water along the east bank for a distance of 4.00km and deliver the water via a penstock through a head of 54.5m to a turbine and generator. The water would discharge via a tailrace to rejoin the Gowan.
- The intake will be located 2.2km downstream of the road bridge, which crosses the Gowan at the outlet of Lake Rotoroa.
- The outlet will be located 3.5km upstream of the confluence of the Gowan with the Buller River.
- The whole of the development will be designed to minimise any visual impact on the environment and will be extensively landscaped after construction. Most of the canal is on land currently planted with pine trees, which will entirely screen the canal and powerhouse from rafters by the time they are constructed.
- Drawings of the proposed development are included in appendix B.

7. The Buller River Water Conservation Order has effect over the Gowan River as one of its tributaries. The Order currently provides for removal of water from the Gowan. Application has been made to vary the Order so that sufficient water can be extracted for hydro generation without adversely affecting the river.

8. This proposal provides that no water would be taken from the Gowan when the naturally occurring flow rates are below 9.0 m<sup>3</sup>/s. At flow above 9.0 m<sup>3</sup>/s, as set out in 6 above, it is proposed to divert water for hydro purposes with a river management programme as follows.

Natural River Flow (cumecs)	Divert for Hydro (cumecs)	Modified River Flow (cumecs)
4.5	--	4.5
9.0	--	9.0
13.5	4.5	9.0
18.0	9.0	9.0
22.5	13.5	9.0
27.0	18.0	9.0
31.5	20.5	11.0
36.0	23.0	13.0
40.5	25.5	15.0
45.0	28.0 (maximum)	17.0
49.5	28.0	21.5

54.0	28.0	26.0
58.5	28.0	30.5
63.0	28.0	35.0
67.5	28.0	39.5
72.0	28.0	44.0
76.5	28.0	48.5
81.0	28.0	53.0

This diversion is illustrated on the attached Charts in appendix B.

9. The Gross hydraulic head proposed for the plant is 55.0m, being the difference between the head pond level at 434m and the tailrace level at 379m. Losses due to intake screen and gates, outlet losses etc are estimated at 0.50m leaving a net head available at the turbines of 54.5m. The flow rates proposed involve diverting a maximum of 28m<sup>3</sup>/sec of water from the river for hydro generation. On this basis the maximum gross power output at the turbine shafts is 14.00MW.

The efficiency of conversion of this energy to electrical energy varies according to the water flow with a maximum of 97%, giving the maximum electrical power output at the powerhouse is 13.6MW. There will be transmission losses, which will reduce this to around 13.0MW of metered power production.

Normally the plant will operate unattended. Mechanical components for the scheme include:

- A low velocity fine pitch intake safety and debris screen 28.0m long x 2.80m high
- Two radial gates, 4.50m wide by 2.80m high, to control flow into the canal.
- Hydraulic vertical lift, wheeled penstock intake gate 4.0m wide by 4.0m high.
- A penstock intake screen and screen cleaner.
- Steel penstock which trifurcates to three penstocks at the Power House.
- Three horizontal Francis or Turgo Turbines with synchronous generators housed in a 12.0m x 18.0m Power House building.

From an analysis of the river flow records, the cumulative output available from the scheme is approximately 60,000,000kW hr of electricity in an average year This could vary up or down by 25% in any particular year.

10. The intake has been designed and positioned at a point on the river, which will minimise alteration to the existing topography. The intake is a

side-entry construction on the east bank of the river located at the downstream end of a deep pool on a stable bend in the river. The river bank is two metres to six metres high at this point with large boulders and rocks typically 0.2m to 1.0m in diameter embedded as an agglomerate.

The intake structure will be a reinforced concrete vertical wall of varying height up to 4.0m and curved in plan to a shape similar to the natural riverbank. The abutment between the wall and the bank will use the boulders set in concrete to provide a natural transition. The overall length of the wall is approximately 100m. The concrete finish on the wall facing the river will be "exposed aggregate" to blend with the naturally occurring gravels and stones which make up the river bed.

A stop bank will be constructed at the downstream end of the intake structure. This will be formed and landscaped in a similar appearance to the naturally occurring river terraces.

The intake structure will not be visible from the road. It will be visible from the opposite bank of the river and will appear as a long, low exposed aggregate concrete surface similar in height and form to the existing river bank and terraces and blending with these at each end. The intake screens will be visible as a fine louvered rectangular opening in the surface of the wall. The structure will be evident as a small intrusion in the scale of the landscape and the visual effect will be minor.

The scheme uses the river bed to maintain the water level in the existing deep pool at the intake. The intake wall is aligned to the natural river bank so as not to intrude into the natural flow of the river. There is no plan to change the river shape or bed but some of the boulders may be anchored in place with concrete to stabilise the bed at a uniform level. The natural course of the river will not be affected after construction and the effect of setting of these rocks will be minor.

The intake will require a temporary diversion of the river flow during the construction. This will be done at a time of seasonal low flow and will reduce the width of the river by approximately 15%. The effect of this will be short term and minor and will not impede the natural flow. Rafting will still be able to occur safely during the construction phase.

The Gowan River has a relatively uniform flow regime and a stable riverbed. However movement of the riverbed over time may require periodic minor rearrangement of the bed material in order to maintain the water level in the deep pool. It is anticipated that this maintenance work will be infrequent and minor and will not impede the natural flow or affect safe rafting during maintenance works.

11. The intake structure allows water to enter the stilling basin, which leads to the headrace canal via an intake screen.

This intake screen acts as a safety barrier, preventing rafters, kayakers, swimmers and any particles of debris greater than 25mm from entering the canal.

The screen is constructed from 50 x 8mm horizontal stainless steel bars with 25mm gaps mounted on a supporting frame. These bars run parallel with the flow of the river and are designed to have no protruding parts which will impede the main river flow or stop floating objects from passing on downstream in front of the face of the screen. The velocity of water passing through the screen to the stilling basin and canal is at all times well below the velocity of the main river flow. Accordingly, should a rafter come into contact with the screen the river flow will carry the raft on down the main river.

12. The intake gates are radial type gates which have all hydraulic load transferred through the trunnion (pivot) bearings. A hydraulic lifting system has been selected for raising and lowering the gates.

The selected intake gate for the preliminary design consists of two radial gates, each 4.5 m wide by 2.8 m high. Features of the gates include:

- The gates provide precision control of flow.
- Un-powered gravity closure of the gates is provided, ie. they are fail safe.
- The gates are designed to provide control of water level and isolation of the canal up to the maximum design river flood level.
- The gates will be low maintenance with self-lubricated trunnion bearings, long lasting coating systems, with all exposed embedded components fabricated from stainless steel.
- Power will be from an external mains supply with provision for an emergency generator supply.
- The hydraulic powerpack will be a single tank for the two gates with independent pumps and valves for each gate.
- A battery and battery charger is included to provide backup DC power to the Intake PLC (Programmable Logic Controller), transducers and gate control solenoid valves. In the case where mains power is lost, data from the intake can still be supplied to the powerhouse and gate closure can be undertaken if necessary.
- The gates' pier and side walls are extended upstream to provide support for a road bridge for crossing the canal.
- Stop log slots are provided upstream and downstream of each gate to allow isolation of each gate for any major maintenance.
- The hydraulic system is filled with bio-degradable oil to minimise impact in case of an oil leak.

13. Accurate positioning of each gate requires accurate input data, accurate information on the actual gate position and accurate control of gate movement.

The primary input data will come from pressure transducers measuring river levels and flows to ensure the water is diverted for hydro in accordance with the approved river management programme. Several gauging points will be used and the data from these will be averaged to provide the input data. Irregular information, which does not fit within prescribed limits due to a fault will be ignored. These gauging points will be regularly calibrated. Secondary input data can also be used to operate the gates.

Accurate information on the actual gate position is by position feedback devices installed on the gate. These devices provide a signal proportional to the relative position of the gate. Tilt transducers will be used for this, which are high precision electronic levels. For gate application the transducer is housed in a waterproof stainless steel case and is bolted to the gate arms near the trunnion. With no exposed moving parts and the ability to armour the signal cable, the transducer is relatively impervious to the external environment and vandal damage.

Raw data from the transducer requires conversion to gate opening in metres, which is performed by an algorithm programmed in the Intake PLC.

Accurate control of the gate movement is achieved in the design of the hydraulic system supplying hydraulic oil to the ram(s). This control is achieved with a proportional hydraulic control valve in the hydraulic circuit, providing smooth operation with near infinite control on flow rate up to maximum flow. A balancing system is included in the gate actuation system to balance the movement of the two rams.

14. Overall control of the scheme will be by the scheme computer based SCADA (supervisory control and data acquisition) system, which communicates with all the various individual scheme control systems. The SCADA system is also the human interface method (via a PC) for high level monitoring and control, either locally or remotely.

The powerhouse turbine and generator will be supplied with their own dedicated direct control system that will interface with the SCADA system.

A Station PLC will control and collect data from all the systems related to the powerhouse and associated structures.

A separate Intake PLC will be located at the intake. This PLC will be responsible for controlling the intake gates as well as providing data and alarms to the Station PLC.

The Intake PLC will communicate with the Station PLC via the telemetry system for exchange of data and alarms via a fibre optic cable buried

in the canal bank.

Telemetry between the various transducers and the Intake PLC is typically 4 - 20 mA communication loops hard-wired into the Intake PLC.

Water level transducers (separate from the river level recorder) will be placed upstream and downstream of the intake screens and downstream of the intake gates. The transducers will be installed in stilling wells.

Flow measurement through the gate will be calculated by the PLC based on the gate position, and water levels immediately upstream and downstream of the gate. Calibration of flow vs. these three parameters will be undertaken during commissioning of the gate with the use of a temporary flow measurement system.

15. The first section of the tailrace canal is an extension of the Power House construction and will be below ground level. The tailrace continues as a below ground cut-and-cover construction across the valley floor to within 150m of the river.

The tailrace emerges from below ground into a head wall and side wall rectangular concrete section for a further 50m. A security screen is provided at the exit point from the below ground construction.

The rectangular concrete section becomes progressively trapezoidal over a further 50m as the tailrace approaches the river, forming a more natural cross section.

The final 50m to join the river is formed using river stones embedded in concrete, with a cross section similar to the natural river bed.

The re-entry point to the river is on the inside of a bend. Any rafting is likely to be on the outside of the bend and the effect on rafters of the confluence of the tailrace with the river will be minimal. The appearance of the tailrace at this point will be a broad fan of water similar to other tributary stream confluences.

The tailrace will be almost entirely below ground in pine plantations. It will be visible where it joins the main river flow from the opposite bank and will appear as a natural river channel.

The effect of this construction in the scale of the natural landscape will be minor.

16. Flow data for the Gowan River has been recorded consistently over the period 1934 to 1991. This data recording was carried out by the appropriate Government Department or other authority throughout this

period and most recently by NIWA. These records are in the public domain and have been regularly checked for accuracy throughout this period. A summary of these records showing monthly mean flows, is provided in Appendix A. This data provides the basis on which the flow regime for the power generation has been developed.

The recording station at Lake Rotoroa was removed in 1991 and records were not kept for the period 1991 to 2004. In September 2004 the recording station at Lake Rotoroa was re-established by NIWA and records are being kept in an identical manner to the earlier records.

Levels are recorded at 15 minute intervals. These levels have been calibrated by gauging the river at the bridge and the flow recorded gave good correlation with the earlier river flow calibration. This new data is presented on Chart #1 in Appendix A.

In addition to re-establishing the original recording station in September 2004, a new recording station was established downstream from the lake recording station, adjacent to the proposed hydro intake site. Levels are being recorded at this site in an identical manner to the lake site and this provides correlation between the changes in level relative to flow, which occur at the intake site and at the lake site. This data is also presented on Chart #1 in Appendix A.

Chart #2 in Appendix A plots the levels at both recording sites against the flow.

In addition to these two gauging stations a further three temporary markers have been established in the diversion reach below the Intake gauging site. Water levels have been measured at these three temporary markers and compared with the levels measured at the intake site. Changes in level with flow at these temporary markers is less than a 10% variation of that recorded at the intake gauging station as the river gradient is steeper. This data is recorded on Chart #3 on Appendix A. Accordingly, we are confident that modeling of changes in level with flows based on data from the intake gauging station represents the maximum changes in the diversion reach.

17. The proposal to construct a hydro scheme will divert some of the river flow from the natural river channel into the intake, head race canal, head pond, penstocks, powerhouse and tailrace and then return this water to the natural river channel.

It will be seen from Appendix A that the river flows change naturally hour by hour and day by day. It is a very dynamic situation and the whole ecosystem sustained by the river is subject to these changes. The records from 10 September to 20 October 2004 show that the flow ranges from 13.5 cumecs to 59 cumecs during the period. The flow ranges from 13.5 to 34 cumecs during one 4 day period, from 33 to 59 cumecs during another 3 day period and from 35 to 59 cumecs during a single day. Accordingly the size of the proposed changes to the flow

of the river caused by diverting some of the water to a hydro scheme are similar to the naturally occurring changes.

Chart #4 plots the gauge depth and flow at the intake site against the natural river flow and the flow in the diversion reach, if the proposed taking of water for hydro purposes was to occur. Comment can be made on the effects of the proposed changes for the river flow in the diversion reach as follows:

- There will be no effect on the hydrology of the river for naturally occurring flows up to 9.0 cumecs as no water will be diverted in this range.
- For naturally occurring flows in the range 9.0 - 45.0 cumecs there will be reductions in the flow over the 4.5km section of the river of between 30% and 60% and the reduced flow will be in the range 9.0 – 17.0 cumecs and above. These resulting reduced flows are no different from naturally occurring flows other than in their frequency and distribution throughout the year.
- For naturally occurring flows in the range 45.0 – 80.0 cumecs and above there will be reductions in the flow over the 4.5km section of the river between 30% and 60% and will be in the range 17.0 – 52.0 cumecs and above. These resulting reduced flows are no different from naturally occurring flows other than in their frequency and distribution throughout the year except that it will have the effect of reducing peak flows, i.e. maximum flows for this section would be 52.0 cumecs and above, not 80.0 cumecs and above. This reduction is likely to lessen flood damage and lead to a more stable riverbed.
- There is an effect on the hydrology of the river under this proposed regime on a particular day, but it is minor compared with the annual cycle of ebb and flow in the river.
- The effect of opening and closing the intake gates will result in a rate of change to river levels which is more rapid than the changes which occur naturally. However, these changes will be gradual and can be compared with the filling of a normal domestic bath which at 40mm/minute would rise in level at a rate approximately 3 times as fast as the rate of rise in river level in the diversion reach proposed during the closing of the intake gate at 12mm/minute.

18. Operation of the Intake Gates:

- The opening and closing of the intake gates will be controlled to a very gradual rate of change. Typically it would take 30 minutes to restore full flow in the diversion reach in the event of a rafter requiring full flow. This equates to a maximum rise of approx. 350mm and a maximum rate of rise in the diversion reach of approx. 12mm per minute.

- Under normal operating conditions the rate of change of flow would be incremental and synchronous with the natural ebb and flow of the river and as such changes experienced by a rafter would not be discernibly different from natural changes in the river flow.
  - The lack of rafting activity on the Gowan as a result of the danger from overhanging willows means that closing of the gates for rafting is likely to be an infrequent occurrence.
  - By comparison with some rivers, the Gowan has Lake Rotoroa to buffer the effect of flash flooding and accordingly the natural changes in flow are more gradual than on other rivers. This will avoid the potential for flash flooding to combine with changes in flow to the opening and closing of the intake gates.
  - Changes in river levels in the diversion reach can be managed and mitigated by controlling the rate of change in the opening and closing of the intake gates. The overall rise and the rate of rise proposed is such that rafters will have ample time to respond in safety to any variation in the flow of the river. Should any adjustment to the rate of rise be considered appropriate, this can be readily achieved by reprogramming the PCL controls.
19. The proposal for providing ongoing protection to rafters who wish to use the Gowan is to have full flow of the river available on demand via a 24 hours manned telephone monitoring service and telemetric control system, as follows:
- A notice will be displayed at launching points adjacent to the outlet of Lake Rotoroa and on the riverbank.
  - Rafters may use the phone, which will be permanently connected, to dial the 24-hour alarm monitoring company, which will receive a call at any time.
  - The monitoring company will phone the automatic hydro control centre and enter a code to initiate a shutdown of the plant and restore full river flow in the diversion reach.
  - The operation of the hydro scheme will be controlled by a Programmable Logic Controller (PLC), which will continuously monitor the following:
    - *River levels and flows at intake and tailrace.*
    - *Head pond and canal levels.*
    - *Gate positions at intake and head pond.*
    - *Turbine performance data.*
    - *Generator performance data.*

- *Synchronous function.*
- *Time clock.*
- National grid power conditions.
- The PLC will respond to changes in the river conditions and in particular will shut down the system in a controlled manner in the event of a signal from a monitoring station, ie. River flow has dropped below 9 cumecs.
- The PLC can be remotely controlled via a phone line and modem by entering codes in the event that a decision is taken to start or stop the plant and in particular to have full river flow restored in the diversion reach when requested by rafters.

20. This proposed hydro scheme would change the natural flow of the river through the diversion reach as described above. Rafters will be free at all times to either raft through the diversion reach at the reduced flow or have full flow restored at their discretion.

APPENDIX A  
GOWAN RIVER  
FLOW DATA

# APPENDIX B

## GOWAN RIVER

### PROPOSED RUN-OF-RIVER HYDRO-ELECTRIC DEVELOPMENT DRAWINGS