APPENDIX B: JADE WATER VALUE MODEL

1. This appendix gives a short overview of the assumptions and limitations of the marginal water values produced in JADE (Just Another DOASA Environment) and used in the weekly trading conduct reports. See more detailed documentation.

2. JADE (Just Another DOASA Environment) is an implementation of the Stochastic Dual Dynamic Programming (SDDP) algorithm of Pereira and Pinto.[1] JADE is nearly identical to DOASA in terms of model inputs and outputs but is written using the Julia modelling language JuMP.

3. DOASA was developed by researchers at the Electric Power Optimisation Centre (EPOC) for the New Zealand electricity market.[2] A version of DOASA has been used by EPOC for analysis of the New Zealand electricity market for many years, and SDDP is a well-known and widely accepted modelling tool for hydro-thermal optimisation in electricity systems. DOASA gives a consistent measure of the opportunity cost of water. The DOASA model seeks a policy of electricity generation that meets demand and minimises the expected fuel cost of thermal generation and value of lost load.

4. There is a three-step process we use to obtain the expected marginal water values:

    a. The first step is to run an infinite horizon version of the JADE model, using the cuts that define the water value in this model as the end of horizon cuts of the model in the second step (ensuring to use the infinite horizon cuts from week 52 as the end of horizon cuts of a model run in week 1). This model is ideally run at the beginning of a calendar year or when there is a major change to the system (such as new generation or large amounts of load entering or exiting).

    b. The second step, run weekly, is to obtain a policy based on a 52-week finite horizon run of JADE. Before we run this step, we update our forecasts of demand, fuel costs, outages, etc. based on available information. The actual reservoir storage will be the initial storage.

    c. Using the policy from step 2, we then run simulations using the same inputs from step 2 and historical inflows. Depending on the historical inflows, the simulation will release water based on the policy defined in step 2 and will give prices each week based on the marginal offer price of generation. The marginal water values of week 1 are then averaged across all simulations to represent the marginal water value of each reservoir (assuming week 1 is the current JADE week).

5. The following are some of the limitations of the assumptions in the JADE model:

    a. Load is based on forecasts for future periods and recent periods where reconciled data is not yet available.

    b. Forecast plant and HVDC outages are based on current POCP data.

    c. The estimated thermal fuel costs used in JADE may not accurately represent what hydro generators face, in terms of thermal generator offers. Hydro generators must

[1] M V Pereira and L M Pinto, “Multi-stage stochastic optimization applied to energy planning,” Mathematical Programming 52, (1991): 359–375.
[2] Electricity Authority, “Doasa overview”.

manage their storage levels within the context of volatile thermal fuel prices and availability, and the thermal fuel cost estimates may not perfectly represent these.

d. Non-dispatchable plant, such as wind, is modelled as having constant power output instead of stochastic power output.

e. Some hydro station head ponds and major reservoirs are governed by complex resource consent rules. The model limits used in JADE are necessarily somewhat simplified and may not accurately reflect the actual flexibility of these limits.

f. Inflow probability distributions are based on past inflow sequences.

g. JADE does not directly model stagewise dependence (ie, from week to week) of inflows eg, if it was wet last week, it's more likely to be wetter this week as well. However, JADE approximates this effect by an approach called Dependent Inflow Adjustment (DIA), which artificially increases the variance of historical inflows when generating the cutting planes.

6. Prior to 8 June 2022, we reported the average water value over all of New Zealand from JADE rather than the water values for individual reservoirs (for the weekly trading conduct reports and the post implementation review of the trading conduct provisions). This was because we were using a version of JADE that was the same as the DOASA configuration that was used by EPOC. Since receiving JADE (an open source version of DOASA) we have altered the model somewhat for our purposes. See our assumptions, inputs and configurations. As part of this alteration, we can now produce water values by reservoir (albeit still with the caveats as set out above). In our trading conduct reports we now therefore report water values for:

   a. Manapouri
   b. Hawea
   c. Pukaki
   d. Tekapo
   e. Taupo