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CORPORATE FINANCE & TREASURY EXPERTISE

A Preliminary Assessment of the Economic Benefits of Project Aqua

Appendix AM to Project Aqua: Assessment of Effects on the Environment

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1. Summary

Aqua is a relatively cheap and efficient way of meeting New Zealand's future electricity requirements. Our preliminary national Cost-Benefit Analysis (CBA) of Project Aqua, based on the Ministry of Economic Development's (MED) forecasting model, indicates net gains to New Zealand's overall economic welfare of around $600m if Aqua proceeds.

The gains from proceeding with Aqua arise in particular from:

- the benefits to New Zealand businesses and households from wholesale electricity prices being around 5% to 10% lower than they would otherwise be;

- the benefits from prices being lower in related markets, most importantly wholesale gas prices being around 6% to 18% lower than they would otherwise be;

- the producer surplus[1] achieved from Aqua; and

- the reduced risks of shortages in electricity supply, especially in the South Island, and the associated reduced risks of blackouts.

Offsetting these benefits somewhat are the lower overall surpluses for electricity generators (and other related energy producers, most notably gas producers) if Aqua goes ahead. With wholesale electricity and gas prices some 5% to 18% lower, electricity and gas producers overall will make lower surpluses if Aqua goes ahead (than they would if Aqua didn't go ahead).

The table below summarises our preliminary assessment of the benefits and costs and the overall net impact on the economy of Aqua proceeding.

Table 1: Estimated Net Benefits if Aqua Proceeds

(Expressed in Present Values, March Yr 2003/04)	Benefits $M	Costs $M
i) Benefits to consumers from lower electricity prices	$1,136	
ii) Benefits to MEL from Project Aqua	$55	
iii) Lower returns to non-MEL producers of electricity		-$592
Net Benefits ($M)	$599	

[1] Consistent with conventional applied welfare economics, producer surplus is defined as the difference between the amount the producer receives for the good or service and the cost of producing it. The benefits to consumers are calculated as the gains in consumer surplus – i.e., the difference between the costs to the consumer of the good or service and the amount the consumer is willing to pay for it.

The economy benefits if Aqua proceeds because lower electricity and other energy (particularly gas) prices enhance the position of energy-using producers (and thus the overall international competitiveness of New Zealand's industries) and because households benefit from lower electricity and gas prices, having increased disposable income to spend elsewhere.

The net overall benefits of proceeding with Aqua are equivalent to a one-off gain of around 0.5% of the total Gross Domestic Product (GDP) of the economy. On a per-household basis, the net benefits are equivalent to a one-off gain of around $500 for every household in New Zealand. Conversely, if Aqua doesn't go ahead, the net costs are equivalent to a one-off net loss of around $500 for each and every household.

The MED model that underlies this analysis assumes a carbon tax of $15/t$CO_2$. With the exception of the impact of this carbon tax on Aqua's producer surplus, the above estimates make no allowance at this stage for the intangible costs and benefits (e.g., the other environmental and social costs and benefits) associated with Project Aqua. However, the economic benefits of around $600m indicate the necessary magnitude of the net environmental and social costs (after mitigation effects) if they were to justify not proceeding with a project that is otherwise in the overall national interest.

2. National Cost-Benefit Analysis

National CBA is a well established and internationally recognised means for assisting social decision making[2]. National CBA has been used by the World Bank since at least the 1950s as a means of ranking investment projects. Further, nearly all Western industrialized countries have protocols covering the application of CBA to a broad range of public investment opportunities or specific program areas.[3]

Under CBA the costs and the benefits of alternative projects are assessed over the life of the projects. The costs are the opportunity costs of the extra resources a project employs and the benefits are the outputs of the project at values that indicate consumer utility. These values are typically estimated from the willingness of consumers to pay for the project's extra goods and services. Often the output value and the opportunity costs are closely proxied by market prices. In other cases estimation is required. The criterion of cost-benefit analysis essentially mimics that which economists term economic efficiency. The costs and benefits in a CBA analysis are the extra costs and extra benefits resulting from the project. In the case of Aqua,

[2] For an introduction to CBA, see for example "Cost Benefit Analysis, Concepts and Practice" by A. Boardman, D. Greenberg, A. Vining and D. Weimer, Prentice Hall, 1996 and "Cost-Benefit Analysis" edited by R. Layard and S. Glaister, Cambridge University Press, 1994.

[3] In the USA, for example, every major regulatory initiative (costing over $US100,000) must be accompanied by cost-benefit analysis of the impact of the regulation. In Canada, a Federal-Provincial government agreement requires that all river flood control agreements have to be determined to be engineeringly sound and economically viable, with economic viability determined by CBA.

CBA is conducted by comparing the costs and benefits of the project against the costs and benefits of the counterfactual of no Aqua investment.

Any investment entails costs and benefits occurring over time. The net benefits – benefit minus cost - at each date into the future are discounted to a particular date to obtain the project's net present value at that date. Any project with a positive net present value should, with limited exceptions, be accepted as an investment that will enhance social welfare. Sensitivity of the result to key assumptions can be undertaken to assess the robustness of the result to variations in these assumptions.

Several important features of CBA should be noted:

- future benefits and costs are discounted at an appropriate discount rate to reflect the higher value that is placed on consumption today versus deferral of consumption into the future;

- no distinction is made in a national economic assessment regarding which individual New Zealand residents enjoy or suffer changes in welfare – the criteria is the total welfare of all New Zealand residents independent of its distribution. In the case of Aqua, the benefits are widely spread across all households and businesses (as consumers of electricity), while some of the costs (e.g. some adverse environmental effects) are primarily borne by the local region; and

- environmental and social costs and benefits can in principle be taken fully into account. Where such costs can be identified and quantified they can be included directly in the calculation of net national benefit. Where such effects can be identified but not quantified an implicit maximum value for the bundle of these sorts of net costs that enables a positive net present value may be inferred from the analysis.

3. Cost-Benefit Analysis of Project Aqua

Project Aqua involves the possible construction of hydroelectric stations on the lower Waitaki River. The proposed scheme consists of a 60km canal system on the south bank of the river, incorporating a cascade of six power stations. As currently envisaged, the project would result in additional electricity generation of around 3,000 GWh p.a. being brought on-stream on a phased basis from late 2008 at the earliest.

An assessment of the economic impact of Aqua involves assessing the differences in the national benefits and costs between the following two scenarios:

a. the case where Aqua is constructed and delivers electricity; and

b. a situation where Aqua is not constructed and the electricity that would have been provided by Aqua has to be generated from other sources.

The principal benefits and costs to the economy associated with project Aqua (as summarised in table one above) are:

Benefits

i. the impact of Aqua on New Zealand electricity consumers: in particular the benefits of Aqua to New Zealand businesses and households from prices for electricity being lower than they would be if Aqua was not constructed together with the benefits from the associated greater consumption of electricity. This benefit is referred to as the gain in "consumer surplus";

ii. the change in the overall surplus of MEL if Aqua goes ahead. The impact of Aqua on MEL comprises a gain from the surplus achieved from Aqua itself and a partially offsetting reduction from the lower surplus (due to the lower prices) achieved from other (non-Aqua) generation operated by MEL; and

Costs

iii. the surpluses of electricity producers other than MEL that are foregone (as a result of lower prices) if Aqua goes ahead.

The overall net economic impact of Aqua is the sum of the above benefits less the sum of the above costs. Each of these benefits and costs is considered in turn below.

4. Benefits of Aqua

4.1 Benefits to Consumers of Lower Electricity Prices

The cost of generating electricity in New Zealand is generally expected to rise over time as relatively cheap sources of generating electricity (e.g., Maui gas) are depleted and higher cost sources of electricity are required. For example, the MED model projects that wholesale electricity prices (in $2002) in New Zealand will increase from 5.6c/kWh in 2005 to 7.4c/kWh by 2025 even if Aqua goes ahead.[4] Similarly, Energy Link, who are independent forecasters, project the Benmore price to rise by around 20% in real (i.e., inflation adjusted) terms by 2013. If Aqua proceeds, the need to construct and bring into commission generating plant with higher unit costs than Aqua will be able to be delayed. Electricity prices will be lower than they would otherwise be as a result.[5]

[4] The analysis in this report uses the MED model forecasts as the MED model has been used to examine the impact of Aqua. The MED model's forecasts are considered the best source of information as MED is an independent government agency and is not influenced by the commercial interests of a particular energy market operator. It is understood that MED's unit cost estimate for Aqua is based on MEL's unit cost estimate.

[5] The estimates in this analysis assume that prices are lower as a result of Aqua only until 2030.

Figure 1 **Wholesale Electricity Prices**

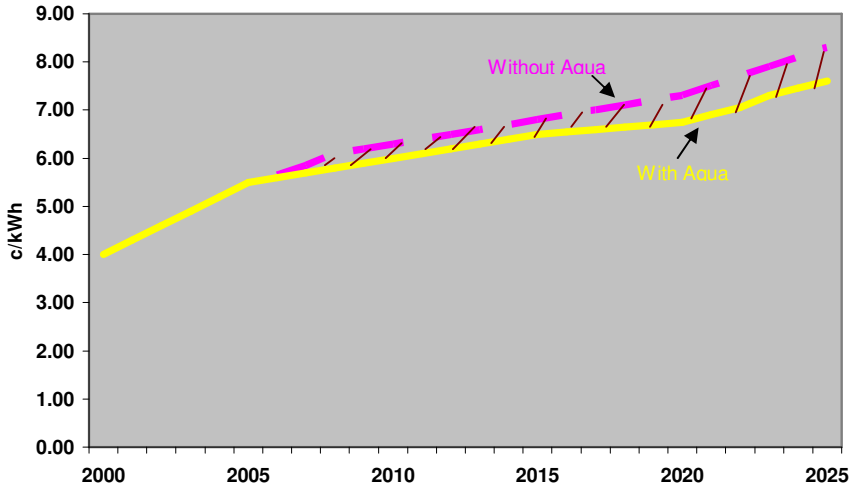

Figure 1 above provides the MED model's estimates of the impact on wholesale electricity prices if Aqua proceeds. The MED model estimates that wholesale electricity prices would be around 10% lower by 2020 if Aqua proceeds.

The lower electricity prices will impact beneficially on the economy in several ways:

- lower domestic electricity prices will mean households have more disposable income to spend on other goods and services;
- lower industrial electricity prices enhance the position of energy-using New Zealand producers (which will mean the international competitiveness of NZ industries is improved – resulting in greater profits and employment opportunities in NZ companies); and
- to the extent businesses pass on the lower electricity costs they face, the prices of other goods and services in the economy are likely to be lower than would otherwise be the case, with a lower overall rate of price inflation in New Zealand as a result.

The overall benefits to consumers – as measured by the gain in electricity consumer surplus associated with Aqua - are estimated at around $1,136m.

4.2 Benefits to New Zealanders from Lower Gas Prices

While Aqua proceeding will affect many prices, the most important price effect, other than on the electricity price itself, will be on the gas price. The price of gas will be lower if Aqua proceeds as less gas would be needed for electricity generation

purposes. The MED model estimates that the amount of gas used for electricity generation would be around 16PJ (23%) lower in 2020 if Aqua proceeds. Wholesale gas prices would, as estimated by MED, be around 12% lower by 2020 as a result.

However, to include also the benefits (and costs) arising in the gas or any markets other than the electricity market itself would be double counting. In national CBA, the economic welfare effects of changes in markets other than the one directly affected can, under standard assumptions, be shown to be reflected in the estimates of consumer and producer surplus arising in the market directly affected.[6] Therefore, we have not made any separate allowance in our estimates of overall net economic welfare for the impact of Aqua in the gas market or in markets other than the electricity market.

4.3 Net Gains to MEL from Aqua

The other principal benefit associated with Aqua is the increased surplus MEL is expected to make as a result of Project Aqua. At MEL's estimated unit cost of 4.5c/kWh, Aqua is the lowest cost major new generating option available in the MED model. With wholesale electricity prices projected by the MED model to be around 6 to 8 c/kWh if Aqua goes ahead, we estimate Aqua would generate an economic surplus of around $391m on a stand alone basis.[7]

On the other hand, however, if Aqua goes ahead MEL will forego profits that it would have made from the higher wholesale electricity prices that would occur if Aqua doesn't proceed. Based on the MED model's estimates of the price path if Aqua doesn't proceed (figure 1 above), we estimate the foregone surplus for MEL on its non-Aqua generation capacity at around $336m.

The overall net increase in producer surplus for MEL if Aqua proceeds is estimated to be around $55m.[8]

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[6] For a formal analysis of this point, refer to Just, R., D. Heuth and A. Smitz (1982) "Applied Welfare Economics and Public Policy, Prentice – Hall. See in particular chapter 9 and Appendix D.

[7] The Project Aqua unit cost estimates include an allowance for the AC transmission grid capital costs and subsequent AC grid connection charges associated with Aqua. Transmission losses have also been allowed for in our analysis by taking Aqua's output as 90% of the estimated generation of the Aqua project. The unit cost does not allow for any capital cost associated with any HVDC upgrades. Analysis undertaken recently indicates the link will need to be upgraded at some stage between 2008 to 2020 to ensure dry year security of supply to the South Island (whether Aqua proceeds or not). If this is correct, then from the perspective of national CBA, Project Aqua is neutral to the need for an HVDC upgrade.

[8] Note that this producer surplus estimate does not equate to the commercial impact of Aqua on MEL. The increase in producer surplus of $55m noted above takes into account the opportunity cost of the around $1.1bn ($2002) expected to be invested in the project, as well as the effect on surpluses that would be achieved by other MEL generation capacity in the absence of Aqua.

5. The Costs of Aqua

The principal economic costs of Aqua relate to the lower returns electricity producers other than MEL are expected to make if Aqua proceeds. If Aqua goes ahead, electricity producers other than MEL will forego profits as a result of the lower path for electricity prices. The foregone surplus of non-MEL producers is estimated to be around $592m.[9]

This foregone producer surplus needs to be deducted from the benefits of Aqua noted above when estimating the overall impact of Aqua on economic welfare.

6. Environmental, Social and Other Impacts of Aqua

The environmental and social costs of Project Aqua are likely to include costs arising from:

- ◊ impacts on the physical environment (e.g., the loss of braided river and degradation of water quality);
- ◊ impacts on the ecosystem (e.g., on fish and bird life); and
- ◊ impacts on people and communities (e.g. the disruption to the local community during the construction phase).

The estimates of the net economic impact of Aqua in this report make no allowance for the above intangible effects of Project Aqua. It is likely to prove very difficult to place a reliable economic value on many of the environmental and social impacts. For example, while some methodologies for placing a value on the loss of wetlands and braided river have been developed overseas, the results are inevitably subjective and contentious. Nevertheless it may prove possible to place values on some of the effects and it would be worthwhile investigating the feasibility of applying such methodologies to the Aqua project.

One major environmental benefit of Aqua that can and has indirectly been taken into account, at least partially, in the national CBA is the impact of Aqua on the nation's net emissions of greenhouse gases.[10] Dialogue estimate Aqua would result in

[9] This estimate takes into account the higher cost of gas used for electricity production if Aqua does not proceed. The cost of gas-fired generation if Aqua proceeds will be lower than if such generators had to pay the gas price that prevails if Aqua does not proceed.

[10] The MED forecast of electricity prices that are used in this CBA assume a carbon tax of $15/tonne of CO_2 is imposed by the government. The resulting higher electricity price profile increases the producer surplus associated with Aqua. The higher price profile reflects, at least to some extent, the value to society of the reduced greenhouse gas emissions if Aqua proceeds.

greenhouse gas emissions well under 1% of the emissions from a gas-fired combined cycle plant generating an equivalent amount of energy.[11]

A further effect of Aqua is the regional economic benefits that are derived, especially during the construction phase, from the project. However, care needs to be exercised in recognising regional benefits in a national cost-benefit analysis. Benefits to one region may simply arise at the expense of costs to another region. Similarly, regional multiplier effects also need to be treated with considerable caution and no allowance has been made in the estimates in this CBA for such effects.

Finally, Aqua could have effects on the overall risk management (and in particular dry-year risk) in the electricity system. Aqua could bring two risk-management related benefits:

- by increasing supply in the South Island, Aqua decreases the risk of an electricity shortage in the South Island at a time when South Island demand is expected to be growing significantly; and

- by adding extra generating capacity to the Waitaki system, Aqua permits increased output from the existing storage upstream on the Waitaki.

However, these risk-reduction benefits to the system as a whole are expected to be relatively small and Aqua does not in itself add any extra hydrological storage. Further, Aqua would increase the overall dependence of the electricity system on water.

7. Sensitivity Analysis

The sensitivity of the results presented in this report was evaluated by examining the impact of alternative values for the key assumptions underlying the analysis. The assumptions tested (refer table 2 below) were the discount rate, the unit cost of Aqua, the forecast profile for electricity prices, the impact of Aqua on electricity prices (the "electricity price gap"), the responsiveness of the demand for electricity to the price of electricity (the "electricity price elasticity") and the impact of Aqua on gas prices (the "gas price gap").

[11] "Aqua Comparison of GHG Emissions", report of 29 January 2003, by Murray Ellis.

Table 2: Scenario Summary	Benefit of Aqua	Change from Base Case
Base Case:	$599M	
Lower Discount Rate (from WACC-0.5%)	$709M	$110M
Higher Discount Rate (from WACC+0.5%)	$481M	-$119M
Aqua Unit Cost +10%	$524M	-$76M
Aqua Unit Cost -10%	$675M	$76M
Electricity Price +10%	$714M	$115M
Electricity Price -10%	$485M	-$115M
Electricity Price Gap +30%	$610M	$11M
Electricity Price Gap -30%	$588M	-$11M
Electricity Price +10% & Gap +30%	$725M	$126M
Electricity Prices -10% & Gap -30%	$474M	-$126M
Electricity Price Elasticity +300%	$599M	$0M
Electricity Price Elasticity -100% i.e Zero	$599M	$0M
Gas Price Gap +30%	$651M	$52M
Gas Price Gap -30%	$548M	-$52M
Worst Case	$310M	-$289M

As can be seen from table 2 above, the estimated net benefits of Aqua are most sensitive to the discount rate, the price path for electricity and the unit costs of Aqua. For example, a lower discount rate (corresponding to a reduction in the real post-tax weighted average cost of capital (WACC) of 0.5%) increases the net benefits of Aqua by around $110m.[12] Conversely, if a 0.5 percentage point higher discount rate is used, the net benefits of Aqua decrease by around $119m. If electricity prices are 10% higher (lower) than assumed in the base case, the net benefits of Aqua increase (decrease) by around $115m. On the other hand, if Aqua's unit cost of production increases (decreases) by 10%, the net benefits of Aqua decrease (increase) by around $76m.

Overall, the sensitivity analysis indicates that the conclusion that there are significant net benefits from Aqua is quite robust. Even if a "worst-case" scenario is constructed where Aqua's unit cost is 10% higher, a higher discount rate is used, electricity prices are 10% lower than projected by the MED model, and the effect of Aqua on electricity prices is only 60% of what the MED model forecasts, Aqua still is estimated to provide net benefits of around $310m.

8. Conclusions

Project Aqua is one of the most important potential development projects for New Zealand over the next few years. If it goes ahead, the project will have a significant impact on the pattern of resource use, especially in terms of the costs of construction and the impact of the project on energy and other prices in the economy.

National cost-benefit analysis is a generally accepted methodology for evaluating the overall net benefits (or costs) of major projects. Our preliminary estimates indicate

[12] A discount rate of 10% real pre-tax (reflecting our estimate of the WACC in the electricity generation sector) has been used in the base-case analysis.

potentially significant net benefits to the economy of around $600m if Aqua goes ahead.

The principal benefits of Aqua arise from the lower electricity and gas prices that are expected to result if Aqua goes ahead. These benefits are only partly offset by lower profits accruing to suppliers of electricity and other energy sources, particularly gas.

There is inevitably considerable uncertainty at this stage around estimates of the national costs and benefits of Project Aqua. Nevertheless, the conclusion that Aqua provides significant benefits to the economy appears quite robust to reasonable changes in the key parameters underlying the analysis.

Other than the impact of Aqua in reducing greenhouse gases, these preliminary results do not take into account the environmental and local community impacts of Aqua. However, the net negative effect of such impacts would have to be substantial to justify not proceeding with a project that would otherwise appear to be in the national interest.