No 8 Limited – Response to DOC further information request

28 August 2018

1. Construction Methods

> *To fully understand the construction footprint of the proposed access tracks and whether the footprint is feasible in that environment, please provide a concept design which includes a detailed description of the construction methods and footprint of the proposed route of the access tracks and penstocks, desander, tailrace and power house. This information should also show where the access track would deviate from the penstock route. This information must be prepared by an appropriately qualified person (civil engineer) with input from a geotechnical expert in relation to this specific site.*

A route will be provided as per SNZHB8630 with no structures, lookouts, signs, etc. The path would be a route used during construction and then would remain in place for public users that know the location. There would be no track formation however, there would likely be a marked line that gets naturally formed from walking.

> *This is very relevant in assessing the effects on flora/ecological values for the reasons noted in item 6 below.*

> *Please provide an assessment of effects from the construction methods utilised at each part of the access track/penstocks.*

Ecology New Zealand assisted No.8 Limited to re-align the previously proposed route to take advantage of a more sensitive corridor with less impact on significant trees. This has been achieved through the assessment of high aerial lidar mapping which has provided detail into tree heights for the subject penstock area. As recommended within the Wildlands EA, the alignment of this pipeline will be refined during installation under the supervision of an experienced ecologist to enable the avoidance of significant trees, and in any instance where avoidance cannot be achieved, the selection of which tree to be pruned or felled can be recommended based on multiple significance factors (e.g. threat status, structural integrity, fauna habitat).

Please refer Ecology NZ -McCulloughs Creek Hydropower Scheme Supplementary Ecology Report [ENZL, 2018], Section 3.0 and Attachment A.

2. Risk to Public

> *In your application you propose signage and fencing to mitigate risks to the public however there is no assessment of what the risks are. There is no detail on what areas are proposed to be fenced.*

Fencing, locked gates, security systems with cameras and signage prevent unauthorised access to the powerhouse, switchyard and adjacent areas. All other parts of the project (which do not pose a risk) will not be fenced and accessible to public.

Please provide an assessment of the risks to the public in and around the proposed structures and methods proposed to mitigation those risks.

Please refer to risk matrix in Appendix A which outlines risks and mitigation measures which includes risks of members of the public. The mitigation measures include:

- A fire protection system is proposed with passive measures (e.g. fire-rated construction materials and methods), active measures (e.g. sprinklers, venting, fire-fighting equipment) and operational measures (e.g. plans, systems and training for fire prevention and response.
- Fences, locked gates, security system and cameras installed around powerstation and high voltage equipment. Public safety in and around the operational area and structures will be managed under a Safety Plan developed in conjunction with DOC.
- Fences, locked gates, security system and cameras installed around powerstation and high voltage equipment.
- Head gates to prevent water flows in event of pipe burst. Foundation design, evacuation plans, drills. Emergency Management Plans in place
- Health and Safety plan developed for workers, under Worksafe NZ. Training for first aid, working at heights, confined space.
- Bunds arounds transformers to contain spills, oil separators used where required, biodegradable greases used in turbine.

3. Freshwater

The Department's freshwater specialist has stated that the effect of hydrological alteration and potential fish passage issues have not been adequately assessed. Further survey work for aquatic values present and more accurate hydrological data is required.

Please refer ENZL, 2018, Section 5.0 to 8.0.

3.1. Freshwater Biodiversity Surveys

a. Aquatic macroinvertebrate sampling should be undertaken at a number of sites within the abstraction reach to determine the extant macroinvertebrate composition and community structure.

b. Targeted macroinvertebrate sampling should occur in a range of habitats along the abstraction reach such as; seepage areas, lateral pool habitat, etc… which are most likely to harbor rarer macroinvertebrate taxa of greater conservation value.

c. Malaise trapping should be undertaken at a number of sites along the abstraction reach to complement the above. This is needed to positively identify many of New Zealand's aquatic invertebrates to species level (IDing to species often requires adults).

d. Fish surveys should be repeated at a number of sites within the affected reach at a more appropriate time of the year (i.e., as recommended in Joy et al. [2013]). Addition survey methods (e.g., Gee's minnow traps, fyke nets, spotlighting) should also be *considered to complement electrofishing surveys (to provide an increased level of certainty).*

Please refer [ENZL, 2018], Section 5.0 to 8.0.

3.2. Hydrological Information

Further hydrological data should be collected from the abstraction reach, especially over the summer to autumn low-flow period, to provide greater accuracy and certainty of the hydrological estimates (especially low flow indices such as MALF).

An assessment should be undertaken to determine how flow measured near the proposed powerhouse site compares with that at the point of take (e.g., simultaneous flow gaugings at both sites).

A flow recording station was installed on McCullough's Creek during March 2017 near the proposed powerhouse site (at approximately the 110-m elevation contour). Data is still being recorded and will continue to be used to update the hydrological record.

The MALF estimate for the intake site is based on 12 months of continuous data collected at the NIWA recording station and supported by gauges on the Poerua and Hokitika River. The estimate of MALF was performed by hydrologists and scientists at NIWA. Please refer to NIWA - McCulloughs Creek Low Flow Estimation, John Porteous July 2018.

The intake site flows are estimated based on the proportion of the catchment areas of the recorder site (7.66 km^2) to the intake site (4.40 km^2). According to NIWA, the MALF at the intake site is estimated at 0.336 m^3/s or 336 l/s.

3.3. Assessment of Effects on Freshwater Biodiversity Values

a. The proposed activity represents a large-scale diversion (diverting >50% of estimated average flow and increasing low flow duration significantly [at the intake]). A more detailed assessment should be undertaken to provide more certainty around the flow alteration effects on aquatic biota (once the surveys mentioned above have been undertaken). Technical method selection to determine ecological flow requirements should follow the values and risk-based framework described in the Beca (2008) 'Draft Guidelines for the Selection of Methods to Determine Ecological Flows and Water Levels'.

Additional in-field surveys will be conducted across the project area outside of winter months. These surveys will aim to validate and refine ecological assessments undertaken by Wildlands and desktop investigations undertaken in this report. The following works are likely to occur:

- Supplementary fish surveys throughout McCulloughs Creek.
- Investigation of natural fish passage barriers.
- 1D habitat modelling across the impact reach (SEFA methodology to be used);
- Supplementary aqautic macroinvertebrate surveys using recommend practises for hard bottom stream systems.
- Herpetofauna surveys across the project area

- Bats should be confirmed present or absent across the project area by means of acoustic surveys across the McCulloughs Creek catchment; and
- Avifauna surveys should be undertaken by means of representative 5 minute-bird-count methodologies across all habitat types on site.

[ENZL, 2018]

b. An assessment should be undertaken to determine the potential effects of the abstraction on fish passage throughout the abstraction reach.

To assess impact further an assessment of all perceived barriers within the lower reach will be undertaken. Barriers will be identified and defined as either velocity barriers or height barriers. This assessment will be further supported by the 1D modelling. To ensure that the hydropower scheme is not affecting population distribution it is recommended that a five-year monitoring programme is implemented after construction is completed. [ENZL, 2018].

c. Further detail is needed on the additional outlet at the intake weir that is proposed to "allow fish to pass the weir, both up and downstream during low flows".

Fish passage around the weir structure will be facilitated by the secondary channel indicated within figure 6 of Wildlands EA. It is expected that the construction of the Coanda style weir will result in a small pool developing behind the weir. This pool will then divert the remaining 252L/s base flow through the secondary channel. This flow will provide sufficient wetted margins for koaro to ascended around the weir. In periods of higher flow additional flow, on top of the base flow and upper abstraction limit, will be diverted through the secondary channel and over top of the weir. To ensure koaro are traversing the secondary channel during the operation instream monitoring will incorporate monitoring above the weir system to confirm the fish passage. [ENZL, 2018].

d. Potential fish injury/mortality rates (e.g., descaling, impingement) need to be assessed relative to the depth of water over the bottom of the screen.

The potential for fish injury and mortality due to interactions with the fish screen is considered low as the Coanda screen is designed in a way that sweeping velocity carries fish instantly off the screen. There is a potential this methodology may occasionally result in skin abrasion. The current research however shows promising results on salmonid passing over the screens without any major effects on the individuals. As part of the live monitoring koaro caught around the intake site will be additionally monitored for signs of injury potentially associated with the Coanda screen. [ENZL, 2018].

e. More detail is needed regarding operation of the intake to ensure minimum flow in the abstraction reach (as well as sufficient water depth over the weir) is maintained.

The design of weir is such that the environmental flow is met via an uncontrolled outlet. The height of the outlet is set to ensure that at least 252 l/s is diverted through the outlet (but not over the weir). Only when flows increase in the river and the water level rises, does water flow over the Coanda weir, and is utilised by the project at flows between 60 l/s and 600 l/s. Up to a flow of 312 l/s, all water is released downstream. A small notch in the weir will allow water to flow over the rock banks, allowing Koaro to navigate at very low flows.

f. Fish (especially migrating kōaro larvae and elvers) would likely be attracted to the tailrace outfall, and this effect needs to be assessed.

To mitigate the potential misdirection, it is proposed to disperse the flow discharge through several discharge points reducing the volume entering the stream at any one point along the stream system, blurring a specific point source. This is intended to reduce the flow trigger that may result in species being drawn to the discharge point(s). At present, it is impossible to accurately estimate the level of effect the tailrace discharge will have on misdirecting migrating species, although it is expected to be minor. Further surveys will confirm the population utilising the upstream habitat and confirm the effects. [ENZL, 2018]

g. Hydropeaking-related effects need to be assessed. Operational shutdown periods etc. can lead to hydropeaking-related effects (stranding and displacement due to down- and up-ramping, respectively).

The effect on the impact site with regards to hydro-peaking is considered to be minimal if not non-existent. This is due to the natural status of the stream system being a fast response system. Over the 388 days of flow recording, the stream volume dropped greater than 600 l/s over an hour on over 68 occasions, with the highest drop being >2,900 l/s. This likely means that species present within the impact reach are well-adapted to rapid flow changes. To mitigate any further impacts, abstraction or shut down will occurs in half an hour step down/ step up increments. [ENZL, 2018]

h. Clarify inconsistencies in the EIA (section 4.1), about how much water will be abstracted versus how much will be retained as residual flow in the 2.8-km abstraction reach. For example, statements such as the following appear erroneous "This represents an average change of flow of 250 l/s at the intake location, or a 25% reduction in average flow", considering the next paragraph states "The current design flow represents 54% of the average flow".

No.8 has since collected significantly more hydrological data since the issue of the AEE, so there are minor updates based on that updated information. Based on data collected at the site, the average flow rate at the gauge site is now estimated to be 1,200 l/s (from 1,108 l/s) and 710 l/s at the intake site.

The project is estimated to use an average of 352 l/s for operation with the turbine able to operate in a flow rate range of 60 l/s to 600 l/s. During operation, the average flow rate in this 2.8-km abstraction reach would reduce from:

- An average of 1,207 l/s to 856 l/s at the gauge location, and
- An average of 710 l/s to 358 l/s immediately downstream of the intake.

This represents an average flow reduction of 50% immediately below the intake and 29% immediately upstream of the powerhouse. Below the powerhouse where water will be returned to the river, the reach would see no change in the hydrological regime and maintain its natural state.

3.4. Application under Freshwater Fisheries Regulations 1983

The requirement to make Permit application will be assessed after the proposed spring visit to undertake further ecological sampling. If there are no trout species in affected reach, this may not be required.

4. Fauna

> *The Wildlands Consultants' report (August 2017) states in the introduction on page 1 of the Ecological Assessment - , "Potential effects on birds, lizards, bats, and the marine ecosystem were not assessed". It is noted that previous Department correspondence during the pre-application phase in June 2016 set out the requirement to provide an AEE which included flora and fauna survey. This is still required and should include an assessment of the values and potential effects on birds, bats and lizards and any methods to avoid, remedy and mitigate these effects. Specifically;*

Please refer [ENZL, 2018], Section 4.0.

4.1. Birds

> *A number of nationally 'Vulnerable', 'Critical', 'Recovering' and 'At Risk' bird species are likely to be present in the area under application. Without bird surveys being undertaken there is insufficient data to assess this application for effects on birds.*

Please refer [ENZL, 2018], Section 4.3.

4.2. Bats

> *There is the potential for long tailed bats to be present in the area. If they are in the area there is the potential risk of them being killed, injured or displaced. The information is insufficient to assess the effects on bats because there is no survey provided on bats at the site.*
>
> *Please provide an assessment of effects on bats including an assessment of the values, potential effects from the proposed scheme and any methods proposed to avoid remedy and mitigate these effects. This assessment would need to include a bat survey in the application area. A bat survey needs to be done in the correct conditions (temperature >7 degrees) between the period of September to May to assess the likelihood of risk to bats. The survey should have an adequate number of survey nights in optimum conditions and follow DOC's best practice surveying guidelines:*
>
> *http://www.doc.govt.nz/getting-involved/run-a-project/our-procedures-and-sops/biodiversity-inventory-and-monitoring/bats/*
>
> *The Department strongly recommends a radio tracking study is done and that you should follow the overview diagram of the Bat Management Framework included in attachment 1 below.*

Please refer [ENZL, 2018], Section 4.1.

4.3. Lizards

> *A lizard survey over the application area by a Department approved lizard specialist is required to assess the area. It is likely that there would be a range of lizards in the area. However, it is impossible to accurately state the likely nature and size of lizard populations in the project footprint without proper survey. As lizards require specific habitat and are not evenly spread through the landscape, clearing areas could potentially harm a high number of lizards. This could cause ranging effects.*

Please refer [ENZL, 2018], Section 4.2.

5. Flora/Ecological Assessment

5.1. Below ground effects on the forest

> *You have proposed mitigation measures you would carry out to minimise the above ground impacts on the indigenous forest but have not provided any mitigation measures for the below ground impacts (i.e. the tree roots).*
>
> *In your application, you have provided an image (Figure 15) on page 20 of your EIA as an example of the proposed penstock access track. This clearly shows a benched track of 1.5m width. To build such a track, you would have to cut through at least the upper soil layer, causing potentially significant damage to tree roots in the process. You have not addressed this potential impact in your application, nor have you given any indication of mitigation measures in relation to it. Please assess this.*

A route will be provided as per SNZHB8630 with no structures, lookouts, signs, etc. The path would be a route used during construction and then would remain in place for public users that know the location. There would be no track formation however, there would likely be a marked line that gets naturally formed from walking. Frame Group has advised that all grades are acceptable for walking, with max grade approximately 70%.

Potential below ground impacts are exclusively linked to the construction phase of the project and are limited to the establishment of the powerhouse and lower penstock. The greatest extent of vegetation clearance for the project is associated with the creation of the GRP/Steel Penstock and HDPE pipeline corridor. The potential for below ground forest impacts are largely avoided in these areas by their above ground nature. Given that these structures do not require benching to be installed, below ground impacts are further mitigated.

The second area where below ground impacts are anticipated to occur is at the powerhouse. The powerhouse will be located at the lower extent of the McCulloughs creek valley and within an area of riparian vegetation. The construction of the powerhouse will require enabling works consisting of vegetation clearance and benching to enable the building platform. Given the contiguous nature of the surrounding vegetation in this area, a degree of below ground impacts will occur as it can be expected that roots from surrounding retained trees will overlap into this works area. Trees in this area are classified as between 2.5 – 10m in height with no significant specimen trees in the direct vicinity.

The removal of vegetation will be undertaken by trained and experienced individuals and in a manner which causes no unnecessary damage or disturbance to any retained vegetation and their root zones.

During the establishment of the powerhouse, the lower penstock supports and cableway, a works arborist will be contracted to supervise and guide these works. The role of this works arborist will be to ensure that below ground root impacts are appropriately managed (e.g. through root retention, selective pruning and protection). The guidance and supervision of the works arborist would be most beneficial where below ground impacts are expected in the rootzone of significant mature trees (e.g. >50 cm DBH and/or >25 m in height) which will be retained.

5.2. Containment of soil while building penstock track

> *The terrain in the upper part of the proposed penstock route is very steep and a large amount of spoil would have to be removed to build a track of the dimensions specified in your application. The Wildlands Consultants environmental impact assessment included the following statement:*
>
> *"Construction of the access road, pipeline and penstock will produce substantial amounts of cleared material (rocks, soil and vegetation) that must be disposed of. Inappropriate disposal of this material (e.g. dumping it on indigenous vegetation outside the corridor) could greatly increase the size of the designated construction footprints and result in more than minor adverse effects on indigenous vegetation."*
>
> *This impact has not been adequately addressed in your application, as there is no information as to how the risk of spillage of rock and soil downhill from the penstock would be mitigated.*
>
> *It seems unlikely that you would be able to contain spoil and cut plant material within the specified width of the track. If you were not able to do so, this would cause adverse effects on the indigenous vegetation in the area, as the area of affected forest would be much larger than specified in your application. It is expected that this information will be addressed in your construction methodology and footprint requested in point 1 above.*

The track shown in the AEE is indicative and intended to typical dimensions of the pipeline in comparison to the forest and track. However, the proposed track for the McCulloughs Creek hydropower scheme will not require benching for pipe installation and minimal forest clearance. A reference is the Inchbonnie Project, where the penstock in the upper steep sections is located in between significant flora with flexible pipe.

Ecology NZ mention:

"The proposed pipeline corridor will prioritise the retention of vegetation during construction and will synonymously deliver provision of foot access into the site. This associated foot access will cater for contractors with backcountry experience to undertake required construction, routine maintenance and monitoring checks between the powerhouse and intake. It is envisioned that the foot access track will be naturally formed and maintained over time from routine walking.

As specified under the Standards New Zealand Handbook 8630:2004 (Tracks and Outdoor Visitor Structures), the corridor would not be subject to factors such as maximum grades, the provision of steps, minimum walking surface widths, or contain structures such as boardwalks, guardrails or viewing platforms. The surface of the route would be left in a natural state and not require formation through means such as scraping or benching."

5.3. Clarification around area of impact

> *Throughout the application it is stated that the temporary cableway to be built to service the penstock installation would follow the exact path of the penstock, thus minimising damage to forest. However, when examining the maps in Appendix A of the application, these clearly show that the cableway would not follow the exact path of the penstock track, thus potentially increasing the impacted area substantially. Clarification is needed around the exact location of the cableway in relation to the penstock track, and the associated effects. It is also expected that this information will be addressed in your construction methodology and footprint requested in point 1 above.*

An additional penstock alignment option has been provided as part of work with Ecology NZ. This allows significant trees to be avoided. The cableway position has been simplified, however, the alignment is essentially in the same position, so visual effects will not change. Please refer [ENZL, 2018], Section 3.0.

The cableway is installed at a significant height above the canopy in places. This allows a degree of freedom, where the payload can be winched to either side up to 50 m to allow the pipe to be installed in its correct position.

5.4. Weeds

> *The application states you would clean all building materials entering the site to reduce the risk of weed invasion. Please clarify how you are proposing to clean building products such as concrete aggregate and provide mitigation measures in terms of storage and movement of aggregate around the site to ensure that exotic weed spread would be minimised.*

As part of the original AEE, No.8 Limited identified several measures to avoid or reduce risks of weed invasion. These measures are outlined below, specified for the construction and operational phases.

<u>Mitigation measures during construction include:</u>

- The amount of gravel and artificial building materials (concrete, steel, timber, plastic etc.) brought in for construction of the proposed structures would be limited.
- Vehicles, equipment, and materials entering the site will be sourced carefully and inspected and cleaned thoroughly. All contractors working on site will be made aware of the relevant biosecurity protocols.
- Contractors working on site would be made aware of the relevant biosecurity protocols.

- Monitoring for introduced weeds will be carried out during construction by suitably qualified and experienced persons. The key sites for weed monitoring are the intake site, powerhouse, pipeline/penstock corridor, and access road.

Mitigation measures during operation include:

- Monitoring for introduced weeds will be carried out during operation by a suitably qualified and experienced person. Control of weeds will be implemented in a timely manner by a suitably trained person using the most appropriate methods.
- Helicopter landing areas will be left to regenerate from local seed sources
- Control of weeds would be implemented in a timely manner by a suitably trained person using the most appropriate methods.

5.5. Interpretation around removal of large trees

> *The application states that trees >30cm DBH (Diameter at breast height) would only be removed if not practicable to retain them. This statement, if kept is too open to interpretation, and could lead to the potential removal of significant numbers of large trees. You will need to define what 'not practicable' means or state a maximum number of large trees that would be acceptable to remove.*

The term "not practicable" is a term that is sufficiently certain and enforceable – although what is practical (or not) will be assessed in the particular context in which the issue is raised. In this context, there is some flexibility in the final route choice, which is likely to mean that many of the trees >30cm in the vicinity of the general route can be avoided without undue cost or other major consequences for the project. In such circumstances it would be practical to avoid removal of those trees. Of course, there is a limit to flexibility in route choice, and the ability to "zig-zag" to avoid all trees >30cm. Across the entire route, therefore, it may not be practicable to avoid all trees >30cm.

To assist in guiding what "not practicable" will mean in the circumstances No 8 proposes a process to confirm, for any trees >30cm that are proposed in the final design to be removed to demonstrate that it is "not practicable" to retain them by:

- providing, before their removal, a plan showing the number and location of any trees >30cm proposed to be removed;
- the plan is to be accompanied by an explanation, which might include alternative route explored to demonstrate why it is not practicable to retain the trees >30cm proposed to be removed;
- that may further include an indication of the cost of the alternatives, including construction as well as any implications for functional efficiency, as well as any other relevant matters, such as the health, importance and/or representativeness of any of the trees >30cm proposed for removal.

Further mitigation measures include:

- Removal of vegetation is to be undertaken by trained and experienced individuals and in a manner which causes no unnecessary damage or disturbance to any retained vegetation and their root zones. During the establishment of the powerhouse, the lower penstock supports and cableway, a works arborist should be contracted to supervise and guide these works.

- The role of this works arborist will be to ensure that below ground root impacts are appropriately managed (e.g. through root retention, selective pruning and protection). The guidance and supervision of the works arborist would be most beneficial where below ground impacts are expected in the rootzone of significant mature trees (e.g. >50 cm DBH and/or >25 m in height) which will be retained.

6. Need for Project (Submissions to DOC)

The overall need for McCulloughs Creek Hydropower project is to ensure that the West Coast and the NZ electrical grid are supported into the future. The project is beneficial because it is:

- Provides clean, renewable, efficient energy
- Is diverse in terms of location and hydrological regime,
- Provides significant winter energy
- May benefit from climate change due to increased West Coast Rainfall[1]
- Provides the West Coast with net positive energy, reducing reliance on other areas

Recently, there have been several publications which reinforce the need for the McCulloughs Creek Hydropower Project. For example, Transpower's Energy Futures report[2], which addressed a range of electricity supply, demand and future technology scenarios, concluding "New Zealand cannot wait for solutions to be developed and deployed overseas before importing them and will need to be near the leading edge of energy innovation to manage winter demand and dry years. New Zealand must invest resources in innovation and adopt new technologies, as it relates to energy development, because it does not have the luxury of time to follow the lead of others."

The report makes several recommendations, all supporting the approach of the McCullough Creek Hydropower Project, outlined below.

> *Electrification will significantly decarbonise the New Zealand economy - New Zealand's international advantage lies in its ability to generate clean, renewable electricity. As New Zealand and the world increasingly focus on the pressing challenge of limiting greenhouse gas emissions, New Zealand will generate electricity from renewables and electrify other parts of its economy that are currently using fossil fuels – particularly stationary industrial energy and New Zealand's light and heavy transport fleets.*
>
> ***Electricity demand in New Zealand will double by 2050*** *- As the New Zealand economy electrifies in pursuit of the most cost-efficient and sustainable energy sources, electricity demand is likely to more than double from ~40 terawatt hours (TWh) per annum today to ~90 TWh by 2050. Electricity demand as a percentage of total delivered energy demand is estimated to increase from 25 per cent in 2016 to 61 per cent by 2050. Meeting this projected*

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[1] http://www.mfe.govt.nz/publications/climate-change/climate-change-projections-new-zealand

[2] Transpower TE MAURI HIKO – ENERGY FUTURES // WHITE PAPER 2018

demand will require significant and frequent investment in New Zealand's electricity generation portfolio over the coming 30 years.

The transport future is electric - *Electric vehicles (EVs) are expected to reach 40 per cent market share by 2030 and 85 per cent by 2050. EVs will be cheaper to run, cheaper to buy, cheaper to maintain, and will have a longer lifespan than internal combustion engine vehicles. Heavy land transport is also expected to electrify, but there is more uncertainty behind this assumption.*

Demand will be met by renewable generation and new technologies - *New Zealand's electricity sector will meet demand through the use of new technologies and require a wide mix of renewable energy technologies, consisting of grid-connected generation (primarily wind and hydro), plus a range of distributed technologies (primarily solar and batteries).*

A renewable future is the most affordable - *A renewable future based on New Zealand's abundance of renewable energy resources is likely to offer the lowest-cost energy future for consumers. New technologies, particularly solar photovoltaics (PV), batteries and smart appliances, will all decrease in price and place more control in the hands of consumers.*

Winter and peak demand is still the biggest challenge to solve - *None of this will be easy. While this report focuses on a base case scenario and reviews a number of other possible scenarios, the challenge in the future is similar to that which the energy sector currently faces. How, with low energy storage options, does the system reliably meet demand peaks, particularly in dry years and cold winters? New Zealand's current winter and peak-demand challenge is exacerbated under this report's scenarios, with substantially growing demand being met from increasingly intermittent energy sources.*

Distribution is critical - *While multiple new technologies will play their part in New Zealand's energy future, all parts of the system will need to be fully functioning to realise their potential. New generation will be both grid-connected and connected into local distribution networks. The national grid and local electricity networks will need to ensure sustained investment in their assets is sufficient to connect and reliably distribute new forms of energy. For the national grid, it is expected multiple new grid connections will be required from increasingly intermittent energy sources. Local networks will similarly need to consider how their assets will handle increasing peak loads, greater solar PV, and battery penetration and the charging of EVs.*

6.1. Climate Change

In 2016, MfE released a report on Climate Change which addresses expected changes in New Zealand's climate (temperature and many other climate variables) out to 2120. The report draws on climate model simulations from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report.

The most significant parts of this assessment with respect to the McCullough Creek Hydropower Project are those related to rainfall. Of primary importance is the expected increase in rainfall on the West Coast rainfall and reduction in rainfall in hydropower dominate areas, such as Canterbury and Otago. Climate change may play a beneficial role for generation on the West Coast. The conclusions regarding precipitation identified in this report are:

i. The most common pattern of annual precipitation change shows the largest increases in the west of the South Island and the largest decreases in the east of the North Island and coastal Marlborough.

ii. Annual precipitation changes are small in many places, partly due to inter-model variability, but also to seasonal compensation, eg, in Hawke's Bay, models predict an increase in summer rainfall but a decrease in winter.

iii. The largest projected changes in precipitation occur on the West Coast in the winter season, with area-average increases of up to 40 per cent under RCP8.5 by 2090.

iv. The number of dry days per year increases over time in many places, especially in the North Island. Conversely, the 99th percentile rainfall amount on rain-days increases in most places, especially in the South Island.

6.2. Existing blackout risk

Currently, there are periods where the electrical gird is near limits. In the event of a dry year the gird may suffer from blackouts. Therefore, new, reliable electricity sources are required. For example, electricity market commentator and hydropower engineer, Bryan Leyland reports[3]:

On the morning of the 25th July Transpower issued a warning notice saying that there was insufficient generation available and blackouts were possible. For this to happen in a year when the hydro lakes are full and the South Island was exporting nearly 800 MW to the North Island is a strong indication that we do not have enough reliable generating capacity. Wind generation was low – 690 MW of wind capacity was producing 11 MW – but this should have been expected.

Another problem was that the Huntly coal-fired power station was not generating – probably due to the fact that the peak periods were quite short and it is impractical to run it for only an hour or so.

Had the lake levels been low there would have been a risk of rotating blackouts to conserve the remaining hydro storage.

On the evening of the 24th July the peak demand was 6512 MW – more than 100 MW above Transpower's predicted maximum demand. Although it was cold in the South Island, Auckland was not unusually cold. During peak demand periods on the 24th and 25th, electricity prices were in excess of $1/kWh – about 15 times normal. The power system was close to its limits.

[3] Energy News - LETTER: Is our electricity supply at risk? Bryan Leyland.

McCulloghs Creek Hydropower Project Risk Register

Item Number	STEP 1 - RISK IDENTIFICATION				STEP 2 - RISK ASSESSMENT BEFORE TREATMENT				STEP 3 - RISK MITIGATION STRATEGY	STEP 4 - RISK ASSESSMENT AFTER MITIGATION		
RI	**Risk Category**	**Activity**	**Risk**	**Potential Consequences**	**Likelihood (1-5)**	**Consequence (1-5)**	**Rating (1-25)**	**Is the Risk Significant? Yes/No**	**RISK MITIGATION Elimination Measure, Design Initiative or Control**	**Likelihood (1-5)**	**Consequence (1-5)**	**Rating (1-25)**
0001	Operation	Station evacuation	Where required, people must be able to get out of a hydropower station safely.	Injury/death of employee.	3 - Possible	4 - Major	**12 - High**	Yes	Two independent ways to exit. If one route becomes inaccessible, an alternative emergency escape route is always available. Adequate emergency lighting around powerhouse for escapes.	1 - Rare	3 - Moderate	**3 - Low**
0002	Operation	Flooding	Flooding of powerhouse while operators present	Injury/death of employee.	3 - Possible	3 - Moderate	**9 - Medium**	No	Head gates to automatically stop the hydro plant before the water levels become critical. Exit routes clearly marked.	2 - Unlikely	2 - Minor	**4 - Low**
0003	Operation	Fire	Fire in or adjacent to powerhouse and transformer	Injury/death of employee.	3 - Possible	4 - Major	**12 - High**	Yes	A fire protection system is proposed with passive measures (e.g. fire-rated construction materials and methods), active measures (e.g. sprinklers, venting, fire-fighting equipment) and operational measures (e.g. plans, systems and training for fire prevention and response.	2 - Unlikely	2 - Minor	**4 - Low**
0004	Operation	Public Safety	Member of public coming close to electrical equipment	Damage to plant/Injury/death of employee.	3 - Possible	3 - Moderate	**9 - Medium**	No	Fences, locked gates, security system and cameras installed around powerstation and high voltage equipment. Public safety in and around the operational area and structures will be managed under a Safety Plan	2 - Unlikely	2 - Minor	**4 - Low**
0005	Operation	Vandalism	Vandalism of plant, especially electrical equipment	Damage to plant/Injury/death of employee.	3 - Possible	2 - Minor	**6 - Medium**	No	Fences, locked gates, security system and cameras installed around powerstation and high voltage equipment.	3 - Possible	1 - Negligible	**3 - Low**
0006	Operation	Earthquake	Earthquake shaking causing penstock rupture, shaking, collapse of slopes and structures.	Damage to plant/Injury/death	4 - Likely	4 - Major	**16 - High**	Yes	Head gates to prevent water flows in event of pipe burst. Foundation design, evacuation plans, drills. Emergency Management Plans in place	4 - Likely	2 - Minor	**8 - Medium**
0007	Operation	Workplace accidents	Accidents while working in confined space, heights, or around equipment	Injury/death of employee.	3 - Possible	4 - Major	**12 - High**	Yes	Health and Safety plan developed for workers, under Worksafe NZ. Training for first aid, working at heights, confined space.	2 - Unlikely	2 - Minor	**4 - Low**
0008	Operation	Oil spills	Bunds arounds transformers to contain spills	Pollution or contamination	2 - Unlikely	2 - Minor	**4 - Low**	No	Bunds arounds transformers to contain spills, oil separators used where required, biodegradable greases used in turbine.	2 - Unlikely	2 - Minor	**4 - Low**