KNOWLEDGE-BASED WATER QUALITY IMPACT ASSESSMENT FOR PROPOSED WIND FARM

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ABSTRACT

Palmerton North City Council (PNCC) entered into a partnership agreement with Might River Power to develop a wind farm within the Turitea Reserve in the northern Tararua Ranges. Nearly two thirds of the proposed turbine sites are located within or adjacent to the Turitea catchment, drinking water source for Palmerston North City. The Minister for the Environment called in the application which had sites for up to 104 turbines in the final layout submitted to the Board of Inquiry.

A detailed Water Quality Impact Assessment was carried out on behalf of PNCC for the hearing to meet their obligations to proactively manage risks to its water supply. The findings of the assessment challenged the construction methodology of the wind farm, and lead to significant changes in the design. These included exclusion of all spoil sites and siltation ponds from the water supply catchment, deletion of all works on steep farmland that drained directly to the Lower Dam where the water supply intake is located, and a balanced view on the risks of not understanding the reservoir dynamics. This process also identified gaps in the reservoir baseline water quality data and implemented a programme to complete it.

KEYWORDS

Catchment, risk assessment, drinking water quality, Turitea, wind farm

1 INTRODUCTION

1.1 BACKGROUND

Following a Reserve Management Plan change allowing the generation of electricity in the Turitea Reserve Palmerston North City Council, here forth PNCC, entered into a partnership agreement with Mighty River Power to investigate and develop a wind farm within the Turitea Reserve in the northern Tararua Ranges.

Known as the Turitea Wind Farm, the proposed development would be visible from Palmerston North City on south-eastern skyline. It extends onto adjoining farmland and consists of up to 105 turbine locations, within which a maximum of 104 turbines are planned depending on final turbine type selected. The majority of the 61 sites planned within the Turitea Reserve are located within or bordering on the water supply catchment for Palmerston North City.

Mighty River Power lodged resource consent applications in 2008 and in December of that year the Minister for the Environment, Hon Nick Smith, called in the applications and referred them to an Independent Board of Inquiry. Public hearings were held from July 2009 to March 2010, and as at the time of writing this paper the Board of Enquiry is yet to release a draft report and decision.

This paper describes the water supply water quality impact assessment carried out on behalf of PNCC that was submitted as part of PNCC's independent evidence. The assessment covers risks pertaining to public health and water quality of the Turitea Catchment as a water supply source but excludes ecological impacts as these were assessed separately.

Figure 1 below depicts what the proposed Wind Farm might look like from Massey University, just south of Palmerston North.

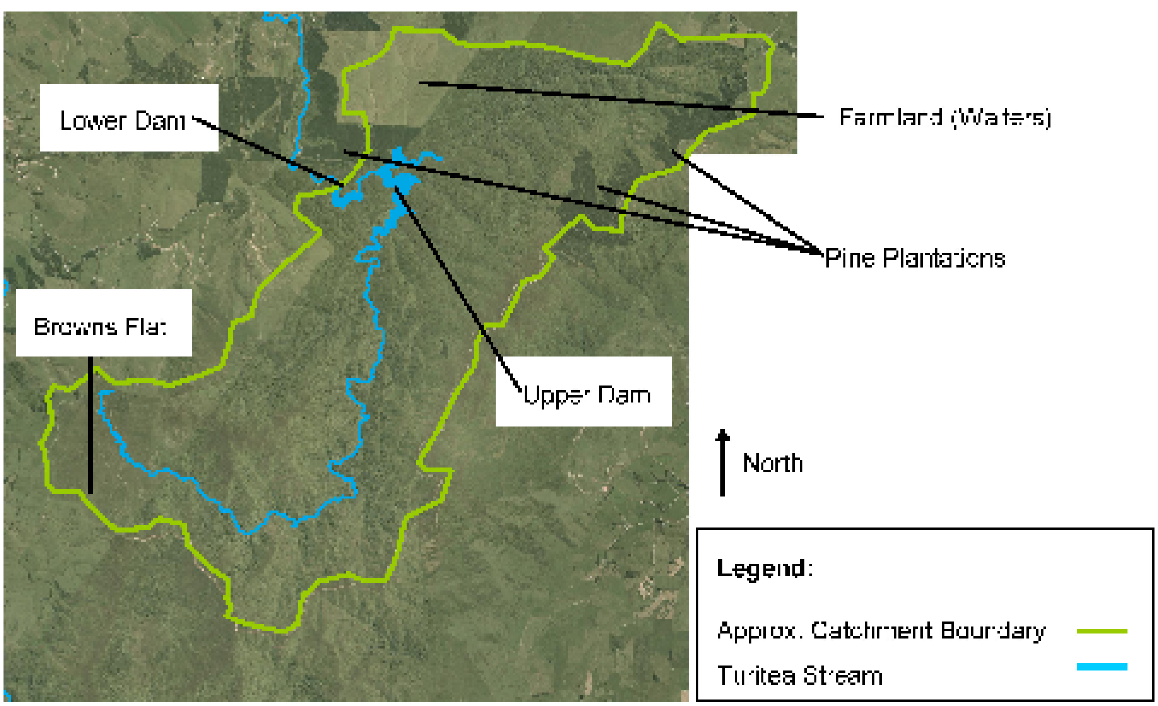
Figure 1: Photomontage of Turitea Wind Farm from Massey University

1.2 OVERVIEW OF PALMERSTON NORTH WATER SUPPLY

1.2.1 WATER SOURCES

The primary water supply for Palmerston North is derived from surface water from the upper catchment area of the Turitea Stream, approximately 2,400 hectares as shown in Figure 2 below. The Turitea catchment source is supplemented by five bores located in the city which are only consented to take less than half the total average demand. Effectively, the bores supply less than the current minimum winter demand.

Figure 2: Turitea Water Supply Catchment



The Turitea Stream is dammed by the Upper and Lower water supply Dams. Above the Upper Dam there are two easily identifiable streams, the Main Turitea Stream and Little Turitea Stream as well as numerous unnamed tributaries. The intake for the water treatment plant is located at the Lower Dam, which stores approximately 280 ML, or about 10 days at average daily demand. The water level in the dam is maintained operationally by flows from the Upper Dam, which stores approximately 1,680 ML, or about 60 days at average daily demand.

1.2.2 CATCHMENT CHARACTERISTICS

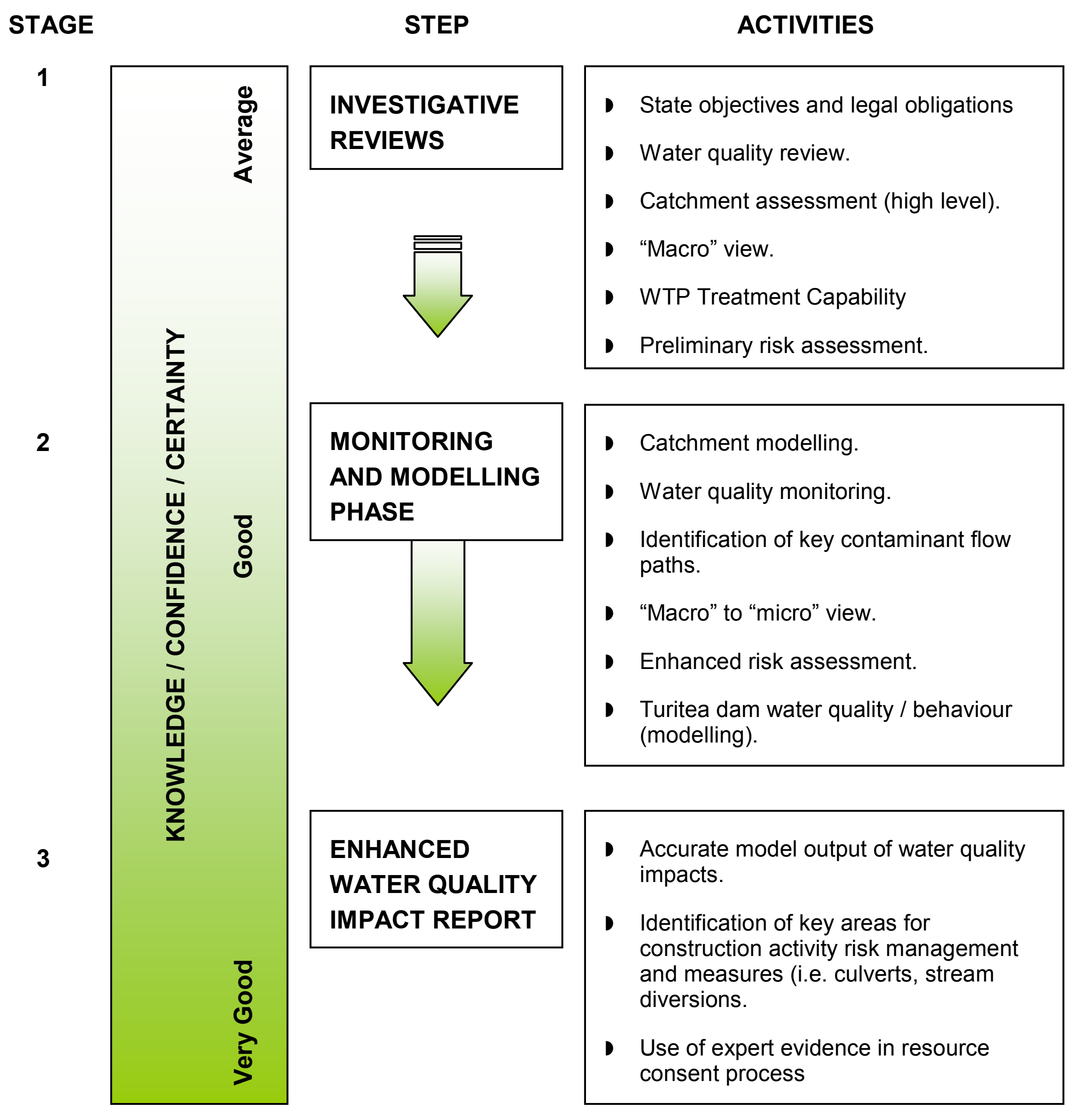
The majority of the catchment area lies above the Upper Dam, has native bush and scrub cover with some sections of adjoining pine plantations and includes approximately 200 ha of relatively flat pasture known as Browns Flat. The Lower Dam has a small area of native bush and pine plantation draining into it as well as a minor stream running from the adjacent sheep farm to just below the Upper Dam face.

The topography is typically steep and the elevation varies from approximately RL 620 m at its highest point down to RL 115 m at the intake for the water treatment plant. Approximately 90% of the catchment is local purpose reserve consisting of native bush and small pine plantations. Administered by PNCC, this area is fenced and access is restricted to permitted hunters, Department of Conservation (DOC) staff and PNCC staff. The remaining 10% of the Turitea catchment is privately owned and is used for sheep farming.

2 WATER QUALITY IMPACT ASSESSMENT METHODOLOGY

Figure 3 below shows a flow chart of the adopted water quality impact assessment methodology.

Figure 3: Water Quality Impact Assessment Methodology



The methodology was based around: collating and reviewing the existing knowledge of the water source and treatment plant; review of the wind farm design; preliminary risk assessment; knowledge gap analysis; monitoring and modelling; and identification of specific construction activity risk management and measures.

As the water quality impact assessment was to be included in PNCC's submission of expert evidence for the public hearings a methodology was chosen that could provide knowledge-based, and thus defendable, outcomes that would help PNCC meet their public health duties for the Palmerston North water supply.

3 DISCUSSION AND RESULTS

3.1 LEGISLATIVE REQUIREMENTS

3.1.1 RESOURCE MANAGEMENT (NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER) REGULATIONS 2007

A number of regulations in the National Environmental Standards pertain to an introduced activity in a catchment upstream of a drinking water supply abstraction point. These regulations impose limitations on the permitted activity and set triggers for imposing conditions on the resource consents and are summarized in the standards explanatory notes:

"The purpose of the regulations is to reduce the risk of contamination of drinking-water sources by requiring regional councils to consider the effects of certain activities on drinking-water sources when…including or amending rules in a regional plan in relation to permitted activities (Regulation 10).

The regulations also require regional councils and territorial authorities to impose a notification requirement on certain resource consents in the circumstances where an event occurs that may have a significant adverse effect on a drinking-water source (Regulation 12).

Under the regulations, different criteria apply for granting resource consents or writing permitted activity rules depending on whether the drinking water concerned currently meets the health quality criteria or does not meet the health quality criteria. These terms are defined in regulations 4 and 5 with reference to the Drinking-water Standards for New Zealand 2005, a Ministry of Health publication, and the Water Information New Zealand database maintained on behalf of the Ministry of Health (currently by ESR (Environmental Science and Research))"

3.1.2 HEALTH (DRINKING WATER) AMENDMENT ACT 2007

Risk management practices in New Zealand have been formalised in the legal requirements dictated by the Health Act for reticulated community water supply owners and operators to complete a Public Health Risk Management Plan. This was first announced by the Ministry of Health in 2001 to address the high degree of noncompliance to DWSNZ (1995 & 2000). This was largely due to costs of monitoring and inflexibility of the compliance process. It was recognised that dogmatic water quality monitoring often did not deliver value or benefit to smaller supplies.

The Health Act 1956 was amended by the Health (Drinking Water) Amendment Act in October 2007 and aims to protect public health by improving the quality of drinking-water provided to communities. The main duties of the Act which apply to suppliers above a certain size include the obligations to take all practicable steps to comply with the (previously voluntary) drinking water Standards, and introduce and implement public health risk management plans for the water supply, if serving more than 500 people (Ministry of Health 2010).

Though there are links to the Drinking-Water Standards for New Zealand 2005 (Revised 2008) (DWSNZ 2005) as outlined in Section 3.1.1 above the National Environmental Standards are scarcely referenced in DWSNZ 2005 as this was not a priority at the time. The National Environmental Standards were originally proposed in 2002, after significant consultation including debate on the rationale for two controlling Ministries, Environment and Health, and risks of disconnect in the regulatory forum.

Historically, management of water supplies in New Zealand relied heavily upon monitoring the quality of the water that was produced and supplied to the customers and then comparing the results against the Drinking

Water Standards for New Zealand for compliance. Whilst monitoring will still play an important part in public health management, Public Health Risk Management Plans (PHRMP) have been introduced to reduce the likelihood of contaminants entering the supply in the first place; or being reintroduced; or escaping the barriers designed to reduce them.

In order to prevent contamination of any water supply there should be barriers to prevent contamination of the raw water, remove particles from the water, kill germs in the water and prevent contamination after treatment. As the proposed Turitea Wind Farm is partly located in the water supply catchment the first priority is the protection of the raw water quality and then secondly, understanding the treatment capability of the water treatment plant to produce water that is safe for the public to drink. In order to carry out the preliminary risk assessment hazardous activities and/or events related to the construction, operation and decommissioning phases were identified and the existing water quality was characterised to understand the susceptibility of the receiving waters to a hazardous activity or event.

As part of the documentation forming a PHRMP a Catchment Assessment is required to be undertaken. This is a survey of the area from which raw water for a drinking-water supply is obtained to allow potential contaminant sources to be identified, and the risk they present to the raw water quality is evaluated (Ministry of Health 2008).

PNCC has completed a PHRMP and the water supply currently meets the health quality criteria. In 2010 the catchment status has been down graded from secure due to the uncontrolled areas of farmland within the catchment but due to the treatment capability of the plant the source and plant grading remained unchanged as an “A”. PNCC is working towards attaining these areas and converting the farmland to bush.

Approval of the Turitea Wind Farm development would be a significant change in the catchment activity and PNCC would be required to revise the PHRMP risk assessment and improvement schedules. In anticipation of this the water quality impact assessment for the Turitea Wind Farm was formatted in a way that helps meet the reporting requirements of the Public Health Risk Management Plan.

3.2 ANTICIPATED NEGATIVE IMPACTS ON HYDROLOGY AND WATER QUALITY

Due to the nature of wind farms there are a number of potential negative impacts on the water quality during construction, operation and decommissioning.

For construction sites adjacent to sensitive waterways, water quality may be impacted by changes in hydrology, erosion and siltation caused by either:

- Careless construction practices;
- Clearing activities;
- Road construction;
- Pooling of water;
- Unplanned stockpiling and disposal of spoil;
- Earthworks;
- Unstable excavations;
- Contamination from temporary washroom and toilet facilities;
- Contamination of reservoir by cement or other concrete batching, waste or sediments; and
- Change of trophic status of the reservoir due to uncontrolled waste runoff (including increased phosphate and nitrogen loadings) during construction and operation. This can lead to oxygen depletion in the reservoir and killing of fish and aquatic habitat.

Each impact was classified using the following definitions:

- Direct: Environment is affected directly due to project activities, or
- Indirect Environment is affected indirectly due to a change of another environmental element as a result of project activities.
- Primary: Impact on environment is major due to project activities, or
- Secondary: Impact on environment is minor due to project activities.
- Temporary: Impact on environment is temporary due to project activities, or
- Cumulative: Impact on environment is cumulative due to project activities.
- Reversible: Impact on environment is reversible within a foreseeable time, or
- Irreversible: Impact on environment cannot be reversed.
- Short-Term: Impact on environment is short term and will recover within a foreseeable time, or
- Long-Term: Impact on environment is long term and permanent, or will not recover within a foreseeable time.

Table 1 contains a summary of the potential impacts, which have been listed according to their mitigation priority from high to low for general reference, and form the basis of prioritising specific risks identified in the catchment risk assessment.

Table 1: Potential Impacts During Construction and Operation

Anticipated Impacts During Construction & Operation	**Direct / Indirect?**	**Primary / Secondary?**	**Temporary / Cumulative?**	**Reversible / Irreversible?**	**Short-Term / Long-Term?**	**Mitigation Priority**
Soil erosion, water pollution, and impacts on groundwater caused by construction of access roads, culverts, bridges and earthworks.	Direct	Primary	Part temporary / part cumulative	Partially Reversible	Partially Long-Term	**High**
Soil erosion and water pollution from borrow pits and disposal sites.	Direct	Primary	Temporary	Partially Reversible	Short-Term	**High**
Impacts on groundwater level variation at cut and fill areas.	Direct	Primary	Cumulative	Irreversible	Long-Term	**High**
Permanent alteration of drainage patterns.	Direct	Primary	Cumulative	Reversible	Long-Term	**High**
Change of reservoir water quality and trophic levels.	Direct	Primary	Cumulative	Irreversible	Long-Term	**High**
Water and soil pollution from uncontrolled disposal.	Direct	Primary	Temporary	Partially Reversible	Short-Term	**High**

Anticipated Impacts During Construction & Operation	Direct / Indirect?	Primary / Secondary?	Temporary / Cumulative?	Reversible / Irreversible?	Short-Term / Long-Term?	Mitigation Priority
Disposal of maintenance wastes.	Direct	Primary	Temporary	Partially Reversible	Short-Term	**Medium**
Wastewater and garbage from construction sites and camps.	Direct	Secondary	Temporary	Reversible	Short-Term	**Medium**
Continued excavation and earth moving for maintenance.	Direct	Primary	Temporary	Partially Reversible	Short-Term	**Low**

3.3 EXISTING WATER QUALITY DATA

3.3.1 REVIEW OF AVAILABLE WATER QUALITY DATA

Available water quality data was reviewed in order to better characterise the susceptibility of the receiving waters to a contamination event prior to carrying out the risk assessment.

The historical water quality data covers numerous sampling periods from 2004 onwards and underwent a multidimensional review. This included scrutinising not only the measured parameters and frequency but also the location and seasonal timing. The purpose of this is to determine whether or not a water quality baseline can be established from the data.

Due to the complexity of reservoir water quality and trophic levels it is important to take representative samples of all the main elements. This includes taking samples from the two main tributary streams, the reservoirs at different depths, the Lower Dam inflow, upstream and downstream of the intake, raw and treated water and reservoir floor sediment samples.

It was found that PNCC's water quality data has been collected to mainly meet monitoring requirements for the water treatment plant and is sufficient for PNCC's current water source risk profile. Though modified as a result of the algal bloom in 2006 (Taylor, 2006) the monitoring programme is limited in that it does not create a complete picture of the raw water baseline quality because there is insufficient information on reservoir stratification, nitrogen and phosphate levels. Just as important as the nutrient loads are the flows and these have seldom been gauged upstream of the intake.

3.3.2 PRE-CONSTRUCTION WATER QUALITY MONITORING PROGRAMME

In order to help complete the baseline water quality data the existing algae trigger levels monitoring programme that targeted seven surface locations around the Upper and Lower dams was expanded to include stream samples, sediment samples, and strato samples. Flow gauging was begun in three locations, the Turitea Stream just upstream of the intake, and the two main tributaries feeding the Upper Dam. Also in addition to the increased sampling and gauging, bathymetry surveys of both dams were carried out for comparison with the original design dam water depth/stored volume relationships.

It is expected that this data will be used prior to the wind farm construction to carry out water quality modelling, especially as preliminary data indicates that both phosphorous and nitrogen levels are in excess of guideline values for upland streams in New Zealand as highlighted in Table 2 below.

Table 2: Comparison of Water Quality with Guideline Values for New Zealand Upland Streams

Name	Upland sites, >150 m Guideline	Location [1]	Measured		
			Minimum	**Maximum**	**Median**
Total phosphorus (mg/l)	0.026	Site 1	0.018	0.090	0.031
		Site 5	0.015	0.060	0.025
		Site 8	0.018	0.030	0.020
Dissolved reactive phosphorus (mg/l)	0.009	Site 1	<0.005	0.030	0.007
		Site 5	<0.005	0.032	0.010
		Site 8	<0.005	0.007	0.006
Total nitrogen (mg/l)	0.295	Site 1	0.260	0.930	0.543
		Site 5	0.116	0.420	0.260
		Site 8	0.208	0.320	0.300
Nitrate-N (mg/l)	0.167	Site 1	0.000	0.356	0.070
		Site 5	0.001	0.169	0.049
		Site 8	0.016	0.178	0.114
Ammonia-N (mg/l)	0.010	Site 1	0.005	0.028	0.013
		Site 5	0.005	0.017	0.012
		Site 8	0.007	0.047	0.016

[1] Site 1: Little Turitea Stream. Site 5: Main Turitea Stream. Site 8: Turitea Stream between the Lower and Upper Dams.

The initial monitoring time frame is until the time at which a decision is made regarding the wind farm development. At which point, the pre-construction programme may be extended depending on whether sufficient data has been captured. A construction monitoring programme would then be implemented but the details of this are yet to be finalised.

3.4 HISTORICAL WATER TREATMENT PLANT PERFORMANCE

In order to understand how water quality might be affected two known recent events in the Turitea water supply catchment that have a bearing with regard to the wind farm development were investigated. These were an algal bloom in February 2006, as pictured in Photograph 1 below, and pine plantation harvesting from September 2006 to September 2007.

Photograph 1: Algae Bloom in Upper Turitea Dam, February 2006

The historical water quality data was used to assess the water treatment plant performance during these events.

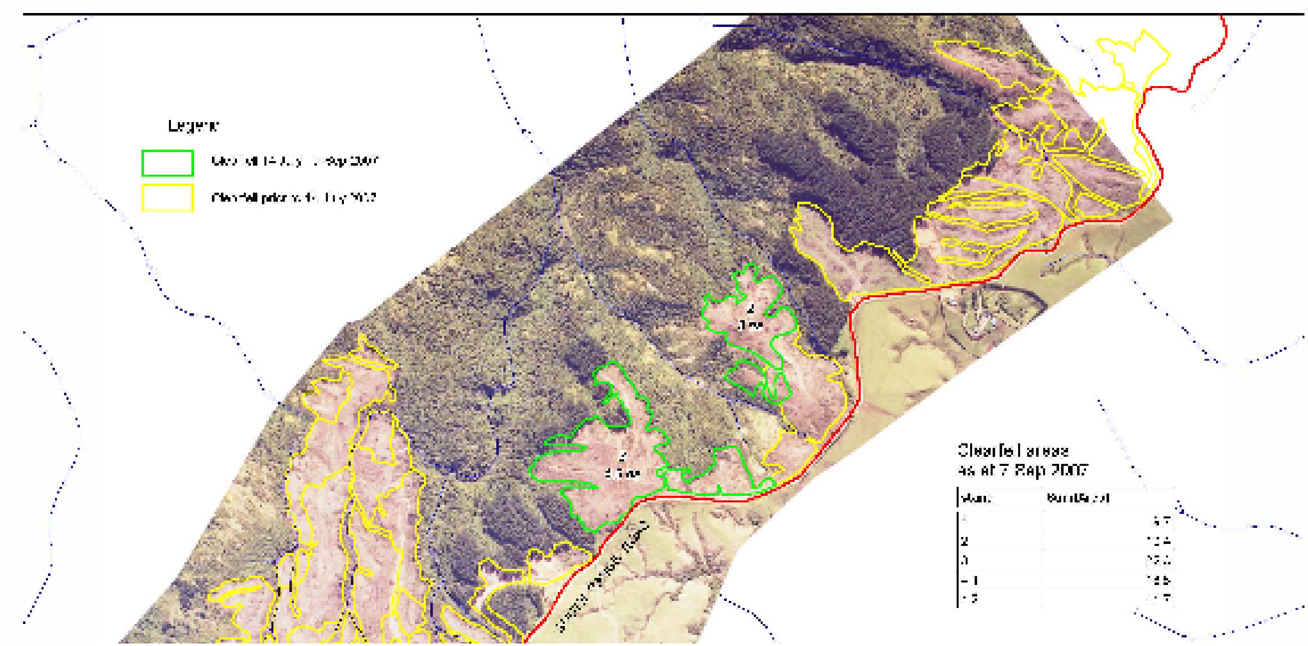
Early in 2006 an algal bloom developed in the Turitea dams. It was unexpected and was the worst in the known history of the supply. The exact cause of the bloom is unknown but is likely to be a complex combination of all or some of the following factors: elevated summer water temperatures; top dressing fertiliser runoff; sunshine hours, wind, and over population of Perch.

In response to the algal bloom PNCC implemented an ongoing monitoring program in order to predict changes in water quality that might lead to another algal bloom. PNCC also installed a Powdered Activated Carbon (PAC) dosing plant and continuously dose with PAC regardless of algal levels. PAC provides a pragmatic, low cost solution, compatible with the existing plant facilities and with the current state of knowledge of the algal link. Doses are applied downstream of coagulant addition and flocculation and prior to clarification. The PAC dosing rate is able to be increased if the risk of an algal bloom is elevated as detected from the water quality monitoring.

PAC is successfully proven to remove algal cyanotoxins and whilst none were detected at the time of the bloom the dosing had favourable results on taste and odour precursor removal, and consequently reduced customer complaints. It is strongly recommended to maintain the PAC dosing during the construction and operation of the wind farm.

Within the period September 2006 to September 2007 some 66 hectares of pine plantation owned by PNCC within the eastern bounds of the Turitea water supply catchment were harvested. The area lies along South Range Road, which runs south along the ridgeline from Pahiatua Aokautere Road and is bounded by farmland (outside the catchment) and by native bush and scrub within the catchment. The pine trees were clear felled in two phases as shown in Figure 4 below.

Figure 4: Extent of Pine Plantation Harvesting In Turitea Water Supply Catchment



The remaining pines in this area are to be felled to allow for a number of turbines to be built so it is important to review the effect the felling had on water quality at the time. The area drains into the Little Turitea Stream, which was monitored during the harvesting period by PNCC. Table 3 contains raw water turbidity, nitrate concentration and dissolved reactive phosphate results from this monitoring program. Included in italics are typical water quality parameters from other sampling results outside the felling period.

Table 3: Water Quality Parameters During and Outside Pine Harvesting

Raw Water Turbidity	**No. of samples**	**Min**	**Mean**	**Max**	**95 %**	**Standard Deviation**
Turbidity (NTU) during forest harvesting	181	0.88	2.38	11.5	4.79	1.43
Typical raw water turbidity (NTU)	*156*	*0.73*	*2.46*	*9.73*	*5.76*	*1.63*
DRP (mg/L) during forest harvesting	156	0.01	0.01	0.03	0.01	0.01
Typical raw water DRP (mg/L)	*154*	*<0.005*	*0.009*	*0.082*	*0.016*	*0.01*
Nitrate levels (mg/L) during forest harvesting	156	0.001	0.05	0.38	0.21	0.07
Typical raw water Nitrate levels (mg/L)	*148*	*<0.01*	*0.07*	*0.30*	*0.19*	*0.05*

Due to ground disturbance turbidity is the main indicator that runoff has reached the water in the dams and as shown in Table 3 above the results indicate there was no significant difference between the turbidity, DRP and nitrate levels during or outside the deforestation activities of September 2006 to September 2007.

Inspection of the felled areas revealed some key reasons why turbidity levels were little unchanged. These include a significant amount of undisturbed bush between the cleared areas and any free flowing streams, the area is relatively flat and the stumps were left in the ground.

The remaining pines are in the same location so it is expected that runoff water quality reaching the Little Turitea stream would be similar provided that at a minimum the same felling practises are used.

As expected, during this period the treated water turbidity never exceeded 0.15 NTU. This is well below the most constringent DWSNZ (2005) requirement that for continuous monitoring the turbidity does not exceed 0.30 NTU for more than five percent of the time over the compliance monitoring period. All-in-all pine harvesting in the upper reaches of the catchment is very unlikely to propose any risk to water quality and public health but these results cannot be transferred to felling of the pine plantations around the water supply intake.

3.5 POTENTIAL CONTAMINANT PATHWAYS

3.5.1 DETAILED REVIEW OF TURITEA WIND FARM ACTIVITIES

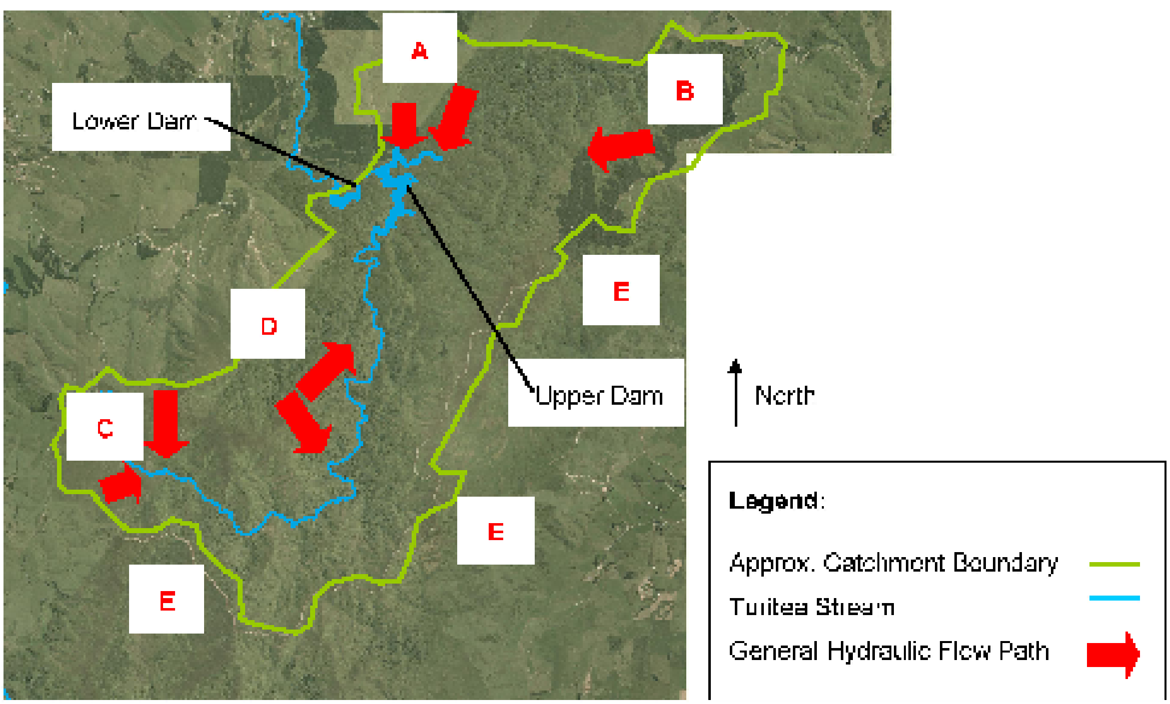
Mighty River Power's Assessment of Environmental Effects (BECA 2008) was firstly reviewed in regards to the scale and layout of the wind farm.

When determining potential negative impacts from a development with such large scale earthworks it is important to define risks by the receiving environment where possible. To not do so would lead to an overly simplistic and potentially homogenous risk assessment.

In geographically defining the risks the distinguishing qualities considered included the proximity of the turbine sites to the water intake, Lower or Upper dam, the extent and type of vegetation clearance, and whether existing roads are upgraded or new roads built. Peripheral activities with the potential for landscaping to cause runoff to flow into the catchment included construction and operation of concrete batching plants, road upgrades, spoil sites, trenching of transmission lines and sub-station construction.

Figure 5 below shows the four geographically distinct areas, A to D, that were identified for these planned works within the catchment. In addition to the above, a number of other activities, area E, were identified that could impact on the Turitea catchment surface or ground water quality as they are in proximity to, or on the catchment boundary.

Figure 5: Works Located Within or Adjacent to Catchment



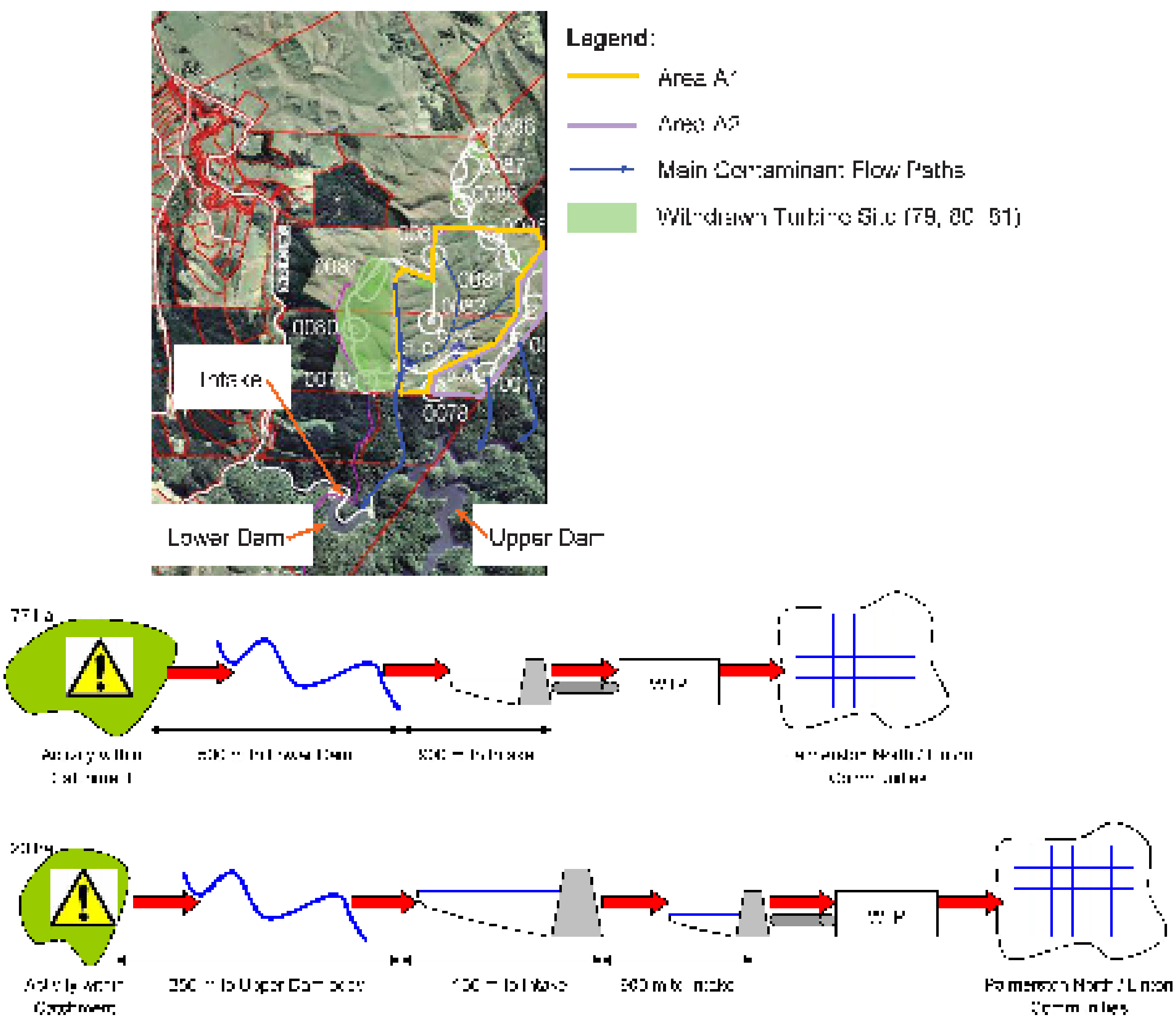
Several field inspections were necessary understand each environment and determine their proximity to the nearest waterway, and thus begin to understand the likely behaviour of any contaminant during transit. A summary of the findings from each area is given below. It should be noted that this assessment was carried out on the original AEE layout and then updated following the first revised layout in January 2009. Nine turbine sites were removed due to their proximity to permanent dwellings and for ecological concerns. The following sections contain summaries from the updated assessment completed in February 2009.

3.5.2 AREA A: FARMLAND WITHIN NORTH TURITEA CATCHMENT

As shown in Figure 6 below the farmland in Area A is divided into two hydrological areas by a ridge. Area A1: The largest area of farmland, approximately 77 hectares, drains to the Lower Dam via a minor tributary (stream flows unknown) of the Turitea Stream. The distance from the edge of the farmland to the WTP intake at the Lower Dam is approximately 1.4 km. Area A2: The second area of farmland is much smaller (approximately 20 hectares) and drains to the Upper Dam via native bush and/or gullies and minor tributaries to the Turitea Stream, the closest point being just 250 m from the Upper Dam water body. The distance to the WTP intake is approximately 1.3 km.

Area A1 is grazed by sheep and is relatively steep with a stream flowing through the middle of it. In the original design access to sites 70 to 81 was via a new track running down one site of the sub-catchment, crossing the stream with a culvert and then back up the other side. These three sites were removed by MRP due to being within 1km of households. Proximity to the stream in the farmland that drained directly to the Lower Dam was not cited as a reason, however further benefits of their removal included no longer any need for the culvert crossing and reduced earthworks as sites 82 and 83 would be accessed from the track between sites 85 and 86 to the north.

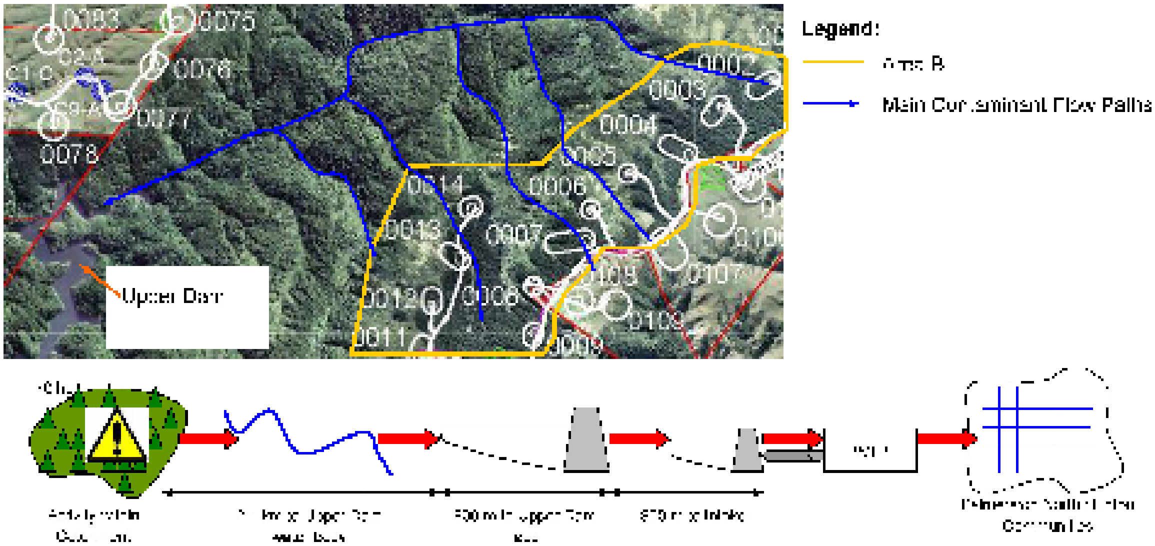
Figure 6: Site Plan of Works Located Within Catchment and Contaminant Flow Paths – Area A



3.5.3 AREA B: PINE PLANTATIONS WITHIN NORTHEAST TURITEA CATCHMENT

An area of pine plantation of 114 ha is to be felled in Area B, refer Figure 7 below, to allow for the wind farm construction.

Figure 7: Site Plan of Works Located Within Catchment and Contaminant Flow Paths – Area B

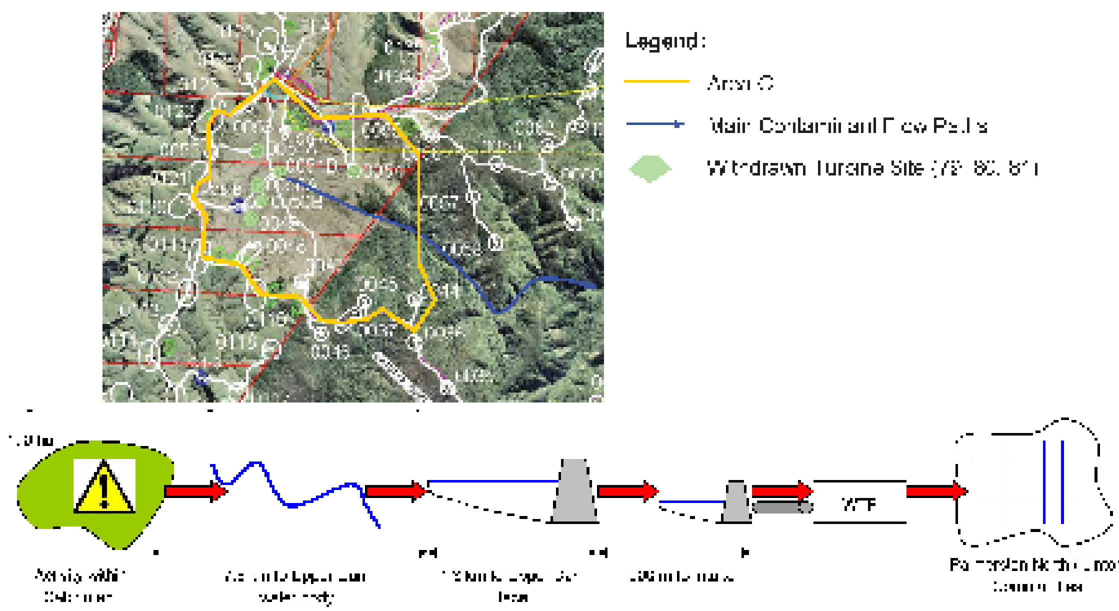


70 ha of this area are within the Turitea catchment and will be re-vegetated, involving 60 ha of managed natural regeneration and 10 ha of planting. The area drains to the Upper Dam via a series of steep sided gullies, native bush and minor tributaries to the Turitea Stream, the closest point being 2.1 km from the Upper Dam water body. It is a further 800 m to the face of the Upper Dam and then 900 m again to the water supply intake.

3.5.4 AREA C: FARMLAND (AT BROWNS FLAT) WITHIN SOUTH TURITEA CATCHMENT

The Upper reaches of the catchment at Browns Flat (approx. 170 ha of farmland) are defined by distinct ridgelines. The works closest to the Upper Dam water body are approximately 7.5 km away. Then from there is a further 1.3 km to the face of the Upper Dam and then 900 m again to the water supply intake. The six sites in Figure 8 below were removed due to likely adverse impacts on the ecology of the sensitive wetland area.

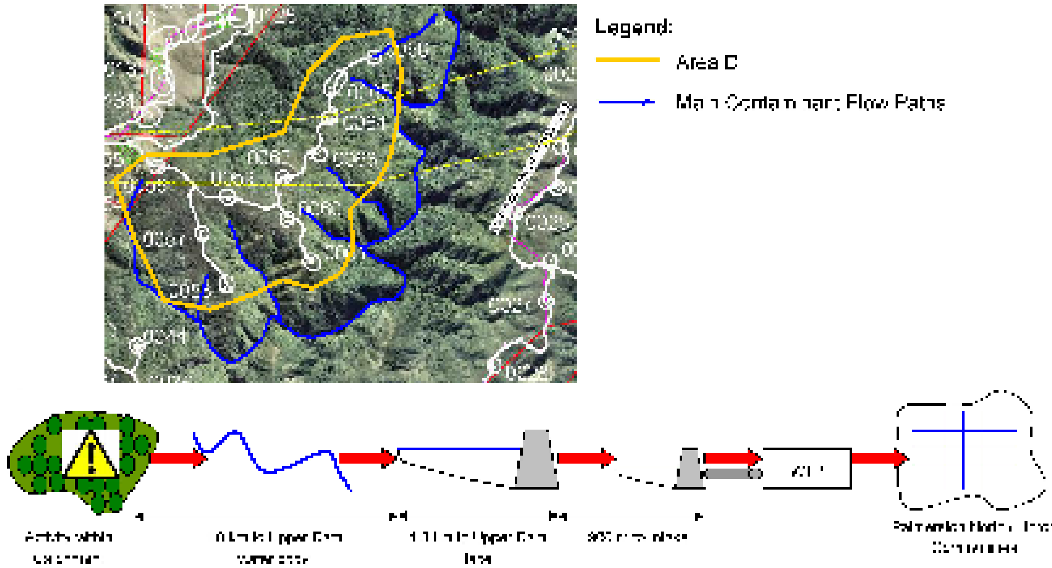
Figure 8: Site Plan of Works Located Within Catchment and Contaminant Flow Paths – Area C



3.5.5 AREA D: WORKS CENTRALLY LOCATED WITHIN THE TURITEA CATCHMENT

As shown in Figure 9 a ridgeline covered with scrub within the central Turitea catchment has also been selected for the turbines sites.

Figure 9: Site Plan of Works Located Within Catchment and Contaminant Flow Paths – Area D

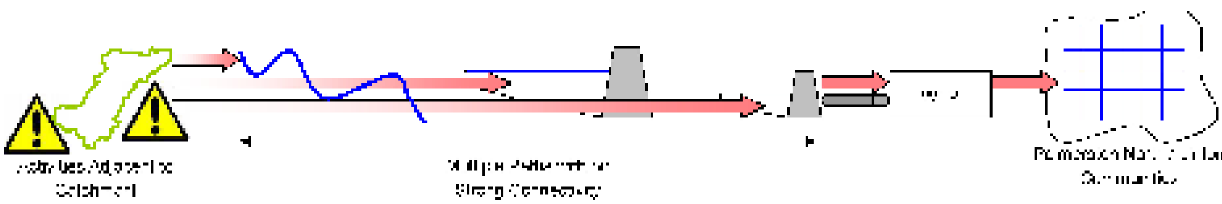


The closest turbine is approximately 1.8 km to Upper Dam water body, which is, again, a further 1.3 km to the face of the Upper Dam and then 900 m again to the intake to the WTP.

3.5.6 AREA E: WORKS PROPOSED ADJACENT TO THE TURITEA CATCHMENT

As depicted in Figure 10 below there is no strong connectivity between adjacent works and the catchment.

Figure 10: Site Contaminant Flow Paths – Area E



3.6 RISK MANAGEMENT AND MITIGATION MEASURES

3.6.1 RISK MANAGEMENT – LESSONS FROM A CONTRACTOR

In developing risk management and mitigation measures a specialist contracting division for the delivery of major civil projects including wind farms was interviewed in regards to their lessons. The following comments were made by the contractor:

- The contractor has consistently experienced what they claim to be unnecessary costs and programme delays due to restrictive consent conditions due to lack of contractor input at the pre-consenting phase. This lack of contractor input has also contributed further to delays caused by the Resource Management and Environmental Court processes.

- The level of environmental controls in the consent conditions has been continually increasing for each successive wind farm.

- Contractors involved in wind farm construction will inevitably engage subcontractors due to the scale of the physical works, thus potentially increasing the risk of consent breaches. It is recommended the civil contracts with subcontractors have a mix of lump sums, measure and value, and risk allocation. This way, a commercial incentive is provided for both parties to deliver the project exceeding all Key Result Areas.

- This applies in particular to environmental Key Result Areas. For example, if subcontractors are able to charge per item for maintenance of silt ponds, silt fences etc as required, then subcontractors are less likely to neglect these important structures, and thus more likely to ensure an event is contained.

- The Civil contractors are the most experienced and efficient in developing solutions to the civil pavement construction and the interface with these other areas.

- The Tararua and Ruahine ranges are susceptible to severe weather events, thus restricting the amount of earthworks that can be completed during summer construction months.

3.6.2 REVIEW OF PROPOSED RISK MANAGEMENT AND MITIGATION MEASURES

The risk management and mitigation measures described in the Assessment of Environmental Effects (AEE) were reviewed and correlated with the water quality impact assessment outcomes to determine any risk management gaps in the AEE.

MRP's proposed risk management/mitigation measures are all considered standard and typical for construction purposes in New Zealand but did not include the following:

- Avoid locating turbine sites, roads, sub-stations, pylons and associated earthworks from water supply catchment where practicable;

- Locate all spoil sites outside water supply catchment area;

- Bund turbine sites and grading of roads along catchment ridges so that runoff or oil spills drain away from water supply catchment;

- Where silt fences are required these should be doubled or even tripled to provide multiple barriers to heavy rainfall events that are likely to occur even during summer construction periods in the Tararuas;

- Liaise with farmers to ensure stock are well away from parts of the Turitea reserve perimeter where fences will be dropped or access gates left open;

- The AEE suggested natural sedimentation may occur in the reservoir but there was not sufficient baseline water quality data to determine the behaviour of the water bodies; and

- Ensure ongoing PAC dosing at the water treatment plant.

Included in the AEE is a Water Quality Management Plan. The general provisions of this were deemed to be well conceived and pragmatic, especially the intention to carry out visual inspections of works as the primary tool for "confirming the adequate protection of water quality". The plan allows Horizons Regional Council and PNCC to have rights to unannounced audits of Mighty River Powers documentation, records and procedures. However a number of key observations and recommendations were made:

- As mentioned in Section 3.3.2 baseline water quality data is incomplete but the AEE only recommends monitoring at three stream sites despite the size of the Upper Dam which has dozens of tributaries.

- Use of 'visual inspections' as described in the plan may be limited in identifying contamination emanating from discrete events in Area A due to the short distance to the Lower Dam and water supply intake and should be detailed further.

- Negative impacts upon the water treatment plant operation are mentioned with a mechanism for financial redress in the resource consent but such "negative impacts" are left undefined. The objectives set out in the AEE are to have only a minor increase in sediment reaching the dam water bodies and minimal sediment reaching the water treatment plant. Increased sediments would increase coagulation chemical costs et cetera but such impacts may be subtle and difficult to attribute to development activity alone, more so if there is incomplete baseline water quality data and reservoir turnover mechanisms are poorly understood.

Reasonable contingency plans are identified in the AEE to respond to the following events: marked plume in watercourse or reservoir and other evidence of sediment reaching a watercourse; hydrocarbon or cement spill or discharge; or rubbish or other debris identified.

3.6.3 GROSS POLLUTANT MONITORS

One preventative option is to locate a gross pollution monitor on the major surface waterways to the reservoirs. This option is not inexpensive and but is sometimes the only way of knowing if a pollution event has occurred. Pre-treatment in the tributaries is not recommended and is generally not practised in New Zealand. The reasons for this, apart from the relative expense, are: the disturbance of the waterway during construction (undesirably increasing turbidity etc); accessibility restraints for installation (including power source) operation and maintenance; and the feasibility of designing it to capture both solids and hydrocarbons, which require different treatment technologies.

3.7 LIKELIHOOD, CONSEQUENCE AND RISK LEVEL SCALES

In populating the water quality impact assessment table the possible adverse effects were identified for each of the construction, operations and maintenance, and decommissioning project phases. For each of the Areas A to E in Section 3.5 the likelihood, consequence and risk level was determined separately for each hazardous event. Risks were only grouped for those areas with the same outcome in order to condense the risk assessment table. What this allowed was the ability to identify specific areas of the wind farm development that had risks inadequately addressed. It also identified a number of risks that will be confirmed with more certainty once water quality modelling has been carried out.

The likelihood, consequence and level of risks were assessed using the DWSNZ 2005 scales contained in Table 4 to 6 respectively. These scales were adopted to allow for easy insertion of the assessment into the Public Health Risk Management Plan if the wind farm consents are granted.

Table 4: Likelihood Scale

Likelihood Ranking	Probability / Frequency
Rare	Has never occurred before, and expected to occur less than once every 10 years.
Unlikely	Has never occurred before, but expected to occur every 5–10 years.
Possible	Has occurred before. Expected to occur every 2–5 years.
Likely	Has occurred more than once before. Expected to occur every year.
Almost Certain	Occurs like clockwork. Occurs every week, month, or season.

Table 5: Consequence Scale

Consequence Ranking	Description
Insignificant	No illness expected in the community.
Minor	Very few of the community ill.
Moderate	Some of the community ill
Major	Most of the community ill.
Catastrophic	All of the community ill. Anticipate some deaths.

Table 6: Risk Matrix Significance Scale (Level of Risk)

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost certain	Medium	Medium	High	High	Very High
	Likely	Medium	Medium	Medium	High	High
	Possible	Very Low	Low	Medium	High	High
	Unlikely	Very Low	Very Low	Low	Medium	High
	Rare	Very Low	Very Low	Low	Medium	Medium

3.8 HEARING AND CAUCUSING OUTCOMES

MRP's hearing evidence was provided to the Board 1 May 2009. Submitters had an additional three weeks to provide their evidence after this date and followed by a further two weeks for MRP to provide additional evidence in response to their evidence. As part of PNCC's evidence statements were prepared on the following:

- Water quality and treatment matters in relation to the public health management of the Turitea Water Supply (Chris Taylor); and
- Potential impacts of the proposed wind farm development on water quality within the Turitea Catchment, upstream of the water supply reservoirs (John Male).

The public hearing began 6 July 2009, during which a number of caucuses occurred between the respective experts on certain matters. The purpose of the caucusing was to determine areas of agreement and more importantly, areas that an agreement could not be reached.

During caucusing the following key areas of alterations to the AEE were agreed:

- Silt ponds should be outside the water supply catchment to eliminate "wave" risk to ponds, i.e. material or object falling into pond causes a wave to over top and erode the side of a siltation pond, not only emptying contents but also accumulating debris on the way down;
- Spoils sites to be located outside the water supply catchment;
- Sediment deposition in reservoir was agreed volumetrically to be less than a minor risk;
- Sediment is unlikely to be a problem during operation of wind farm if runoff is distributed and controlled as proposed in the AEE;
- Nitrogen estimates were agreed in principle on relative change;
- Algal blooms exist currently and are infrequent;
- Inspections and audits need to be openly available to both MRP and PNCC; and
- Effects on long term operating costs are not required in the consent application as this is already covered in the MRP/PNCC partnership.

Not all areas reached agreement including:

- The number of silt fences in series –recommended minimum of two versus one in AEE;

- It was agree that full understanding of reservoir dynamics needs quantitative measurement but whether this was required for projects effects was not agreed on during caucusing;

- The main concern with the reservoir dynamics was that base phosphorous load had not been established and there was no data to establish the best estimate of phosphorous runoff during construction to determine whether or not the load will have a significant bearing on the ecological response of the reservoir, and thus, water quality;

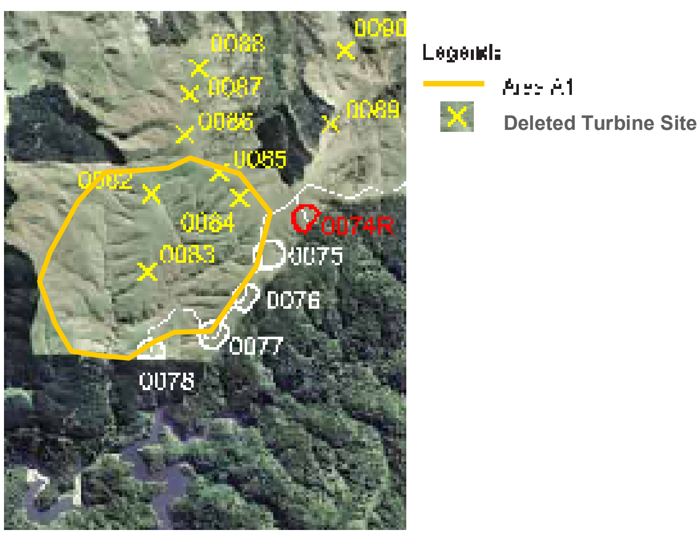
- The timeframe of the hearing did not allow for completion of baseline water quality sampling let alone carry out reservoir water quality modelling prior to the Board retiring to make a decision. Thus, following on from the above, an adaptive management plan was put forward on behalf of PNCC to better ensure the development design or construction practises are altered if the risk of an adverse impact on the reservoir water quality is higher than anticipated in the current AEE; and

- Whether PNCC should have involvement in the sign-off of the sediment and erosion management plans. Though partly covered in the existing partnership agreement there are strong reasons to do more than the standard consent approach due to PNCC's legal obligations under the Resource Management (National Environmental Standards for Sources of Human Drinking) Regulations 2007 and Water Health (Drinking Water) Amendment Act 2007.

The revised water quality impact assessment in February 2009 had identified that Area A1 had an unacceptable high risk due to the steep hillsides, short grass cover and close proximity of two turbine sites to the stream that drained directly into the Lower Dam. With all earthworks progressing downhill there was no easy way to protect the earthworks or construct silt ponds without the risk of sediment runoff into the Lower Dam.

This unacceptable risk was acknowledged by MRP and the remaining two turbine sites were removed, thus eliminating all construction activities from Area A1 as shown in Figure 10 below.

Figure 11: Deleted Turbine Sites in Area A1



4 CONCLUSIONS

By using a knowledge-based Water Quality Impact Assessment methodology PNCC was able to meet their obligations to proactively manage risks to its water supply as set out in the Resource Management (National Environmental Standards for Sources of Human Drinking) Regulations 2007 and Water Health (Drinking Water) Amendment Act 2007. The methodology proved to be systematic, defendable during the public hearings and ultimately proved its usefulness through influencing a number of significant changes in the proposed Turitea Wind Farm layout and construction methodology. The assessment:

- Drew upon construction best-practises in New Zealand and the experience of contractors who have built wind farms on the Tararua range to the north of the proposed Turitea Wind Farm;

- Furthered the understanding of the baseline raw water quality data and water treatment plant capability. It identified information gaps in the baseline data and implemented a cost-effective flow gauging and water quality monitoring program that can be used to not only detect an increased risk of algal bloom but also carry out reservoir water quality modelling if required;

- Took generic risks and hazardous activities to a further level of detail by scrutinising the wind farm design, determining potential contaminant pathways and re-categorising the risk level for specific locations and activities.

The resulting risk assessment was compared with the AEE to determine any discrepancies. These issues were caucused and a number of points of agreement and disagreement were brought back to the Board of Inquiry. Two significant changes in the wind farm design that were agreed on were:

- Exclusion of all spoil sites and siltation ponds from the water supply catchment; and

- Deletion of all works on steep farmland that drained directly to the Lower Dam where the water supply intake is located.

The main point of disagreement was whether or not the reservoir dynamics were understood enough to give an accurate assessment of project effects. It was however agreed that there needs to be quantitative measurement of the reservoir dynamics. Due to the Board of Inquiry retiring to make a decision on the wind farm prior to sufficient data being available from the enhanced water quality sampling programme it was strongly recommended the Board consider an adaptive management plan be adopted. This would allow for changes in the construction methodology and potentially the wind farm design in order to deal with risks to the water quality in the Lower and Upper Dams, especially associated with algal blooms.

Public hearings were held from July 2009 to March 2010, and as at the time of writing this paper the Board of Inquiry was yet to release a draft report and decision.

ACKNOWLEDGEMENTS

Chris Pepper and Bruce Lawrence of Palmerston North City Council for permission to publish findings of the Water Quality Impact Assessment.

John Male and Chris Taylor for provision of additional supporting material given as expert evidence on behalf of Palmerston North City Council during the public hearings.

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