IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF resource consent applications by TrustPower Ltd to the Bay of Plenty Regional Council regarding the ongoing existence, operation, and maintenance of the Matahina Hydroelectric Power Scheme

STATEMENT OF EVIDENCE OF DONALD ROBERT TATE

1. QUALIFICATIONS AND EXPERIENCE

1.1 My name is Donald Robert Tate. I am a Director of Riley Consultants Ltd, a consultancy with specialist expertise in Geotechnical and Water Resources Engineering.

1.2 My academic qualifications and professional memberships are:

- Bachelor of Engineering (Civil) Auckland University 1984.
- Chartered Professional Engineer.
- Member of the Institution of Professional Engineers NZ.
- Member of the New Zealand Geotechnical Society.
- Member of the New Zealand Society on Large Dams (Committee Member).
- Member of the New Zealand Society on Earthquake Engineering.

1.3 I have 26 years' experience in civil and geotechnical engineering; specialist areas include water retaining structures, such as dams, and similar structures.

1.4 I have provided advice to various clients throughout New Zealand on safety aspects of dams, detention dams, and stopbanks. I have had extensive experience in the design and safety review of stopbank structures and, in particular, identification of possible modes of failure and assessment of probability of failure. These studies have been carried out in Canterbury (Ashley and Waimakariri Rivers), West Coast (Grey River), Manawatu (Manawatu River and major tributaries), and in the Bay of Plenty (various sections of Whakatane and Tarawera Rivers, Reids Canal and at Matata). In 2004, I was a member of a review panel appointed by Horizons Regional Council to investigate the causes of the multiple stopbank breaches which occurred on the Manawatu, Oroua, and Rangitikei Rivers, with extensive flooding of residential areas and the Manawatu rural area due to the breaches. Each of the breach sites was physically inspected.

1.5 I am familiar with the stopbank system on the Rangitaiki River/Reids Canal through my involvement with previous geotechnical investigations on the Reid Canal. Also, I have undertaken annual inspections of the Matahina Earth dam on a number of occasions.

1.6 I confirm that I have read and am familiar with the Code of Conduct for Expert Witnesses in the Environment Court Consolidated Practice Note (2006). I have approached the preparation of this evidence in the same way that I would for the Environment Court. I agree to comply with the Code of Conduct.

2. PROJECT BRIEF

2.1 I have been engaged by TrustPower Ltd (TrustPower) to provide evidence with respect to the existing stopbank system on the Rangitaiki River downstream of the Matahina Hydro Electric Power Scheme (HEPS) and, in particular, the costs sought to be apportioned to TrustPower for the river management costs associated with the Rangitaiki Tarawera Rivers Scheme (RTRS).

2.2 My evidence will cover:

- General background on stopbank integrity and the risks associated with stopbanks.
- The design and contribution of the stopbanks on the Rangitaiki River and their performance in flood events.
- Review of the costing information provided by the Bay of Plenty Regional Council (BoPRC), particularly with respect to the cost sought to be apportioned to TrustPower.

2.3 I have been asked to focus on the stopbanks themselves, rather than the wider river management associated with the operation of the HEPS which is covered in more detail in the evidence of other witnesses (Mr Levy and Dr Toan).

3. STOPBANK INTEGRITY AND RISKS ASSOCIATED WITH STOPBANKS

3.1 A stopbank is a particular form of water retaining structure in that it only retains water for a short time in a flood event, when the floodwater exceeds the height of the riverbanks. They are constructed of local soils and have a grass covering. A stopbank breach can be defined as the uncontrolled release of the river floodwater which the stopbank is designed to retain. The breach leads to flooding of downstream areas as the water escapes through the gap created. As demonstrated in the Manawatu and Bay of Plenty floods in 2004, stopbank breaches often lead to very large areas being flooded.

3.2 A stopbank can be breached by various mechanisms or modes. For most schemes the most common mode is overtopping when the flood level rises above the stopbank crest. As the water flows down the landside batter slope the grass cover is washed out as the velocity increases. The flowing water then attacks the exposed soil, at or near the toe. The erosion increases, working back toward the river until the crest is lost and the remaining soil is washed away. A stopbank can sometimes resist overtopping for some time depending mostly on the depth of floodwater over the crest and the standard of grass cover.

3.3 The next most common breach mode for most schemes is undermining by river erosion. This mode can occur before the river level reaches the stopbank crest. Where a stopbank is located close to the river channel itself, the river erodes laterally, and the river side of the stopbank loses support as the foundation is washed away. The process continues until the entire stopbank cross section loses support and the stopbank crest drops and is overtopped.

3.4 Other failure modes include internal erosion of the stopbank and/or foundation, and slope instability. In most schemes these failure modes are much less common than overtopping and undermining in the New Zealand context. However in the Bay of Plenty river schemes a number of internal erosion failures have occurred. These modes occur by groundwater seepage eroding the soils, most commonly loose permeable sands within the foundations of the stopbanks. Soils in the Bay of Plenty commonly include lenses of permeable sands; as such stopbank failures by internal erosion are a greater risk than most other schemes in New Zealand. As a comparison, multiple breaches of stopbanks occurred in the 2004 Manawatu floods. Almost all of the failures there were due to overtopping, and none conclusively due to internal erosion.

4. STOPBANK DESIGN AND CONSTRUCTION

4.1 In New Zealand there are no specific published guidelines or regulations delineating a design standard for stopbanks. The recently updated Building Act 2004 and draft regulations include in its scope flood detention dams, but stopbanks are specifically excluded. Typical practice for stopbank systems is to delineate a design flood (i.e. a flood event which the system is designed to contain). This design flood varies typically in New Zealand within a range of 20 to 100 year standard, with a 100 year standard most common for major rivers. A freeboard allowance above the design flood is also typically applied, which is the vertical difference between stopbank level and the design flood level.

4.2 Within the Bay of Plenty region there are major stopbank systems on the Tarawera, Rangitaiki, and Whakatane rivers. From the early 1970s to 1985 the Bay of Plenty Catchment Commission completed the Rangitaiki-Tarawera major scheme; informal banks were in place before that time.

4.3 The stopbanks were constructed to a standard shape using locally obtained materials. Typically they did not include specific foundation treatment such as cut-off trenches, toe loading or specific drainage features. It is not known if specific geotechnical investigations or input to design was carried out, but is probably unlikely. This is not unusual in my experience for most New Zealand stopbank schemes built in similar time periods.

5. PERFORMANCE OF STOPBANKS

5.1 Historically and in operation of the RTRS, there have been problems with seepage and internal erosion in a number of different areas. Internal erosion failures are also referred to as ground heave failures. A ground heave failure is a subset of internal erosion failures. The ground heave mechanism is caused by groundwater seepage in a permeable material in a flood, and the seepage pressure exceeds the weight of the overlying soil on the landward side of the stopbank. The ground then 'heaves', allowing water to escape, erosion of soils to initiate and ultimately erosion works backwards towards the riverbank. Various mechanisms can then lead to breaching of the stopbank. Most commonly, collapse of the stopbank into the erosion hole occurs and then floodwater overtops the crest, or the erosion hole extends all the way to the river water and there is gross enlargement of the erosion hole. There have been stopbank breaches on both the Tarawera River and Rangitaiki stopbanks (three on the previous informal Tarawera stopbanks and the Sullivans Breach on the Rangitaiki River in the major flood in 2004). Seepage areas have also been recorded on the landward side of the stopbanks in flood events on all three stopbank systems. These seepages have not led to a stopbank breach because erosion did not initiate.

5.2 The seepage and internal erosion problems have been largely caused by seepage within the foundation of the stopbanks, rather than seepage through the stopbank material itself. This is based on reported observation made in flood events about these stopbank systems. Analytical groundwater modelling I have been previously involved with supports these visual observations. In this region the volcanically derived soils in the stopbank foundations are susceptible to these problems because they are both permeable (allow significant amounts of water to seep through them) and are light and erodible. These internal erosion issues have created problems with other types of water retaining structures in volcanic materials in New Zealand, for example collapse of several hydro electric canals and small dams.

5.3 BoPRC have an ongoing programme of investigating seepage related risks and implementing improvement works, particularly after the Sullivans breach in 2004. At the time of the Sullivans breach in 2004 some seepage protection works in the vicinity of Edgecumbe had been undertaken at three separate sites following the 1998 flood, as reported in the Opus 2007 report on Edgecumbe Urban and Rural Flood Hazard. The length of stopbank treatment was not reported, but would be small relative to the overall length of the stopbank system on the river.

6. IMPACTS OF THE MATAHINA SCHEME ON STOPBANK SECURITY FROM INTERNAL EROSION FAILURE

6.1 I consider in the following the potential impacts on the stopbanks themselves, as opposed to the river banks. In general terms, stopbank breaches only occur in significant to extreme flood events (i.e. with the floodwater a significant proportion of the stopbank height). Some occur in over design events (overtopping) and sometimes at a flood level less than the design flood of the stopbank.

6.2 For an increase in stopbank failure risk due to the Matahina HEPS operation, the flood levels would need to increase or be sustained for a much longer time. This is because seepage pressures through the stopbank itself or the stopbank foundation would be greater or sustained for a longer period, leading to a greater risk of a stopbank breach.

6.3 I understand that in significant flood events (where flood water rises above the riverbank and is up against the stopbanks), there is minimal attenuation from the reservoir. Therefore, there should be no increase in failure risk to the stopbanks in significant flood events due to the presence of the Matahina HEPS. I note that the independent report on the 2004 stopbank breach (Sullivans Breach) concluded it was due to internal erosion within the foundation, and that the Matahina Scheme did not have any influence on the failure.

6.4 Mr Philpott in his report considers the lack of sediment passing downstream of the Matahina dam is reducing the natural deposition of silts on the riverbanks. He considers this silt provides a sealing layer to the riverbanks and reduces the risk of piping and heave failures. I agree that a silt layer will provide some benefit in reducing the potential for reducing groundwater pressures and hence the overall risk of a seepage induced failure assuming that the silt remains in place.

6.5 However the silt as a recently deposited material will be loose and quite likely to be moved in a flood event. For design purposes the presence of such a material is not usually relied upon in managing the risk of seepage.

6.6 I also note that the river berm in places may have been used as a borrow area, thus removing existing silt in any case. This was the case at the Sullivans breach site and is discussed in the independent report. The report concluded that the use of the river berm as a borrow area may have slightly accelerated the failure but did not cause the failure.

6.7 I have reviewed Dr Toan's analysis on ground heave. I consider that the analysis methodology and results obtained are sound. As with any assessment on a long stopbank system only a limited number of cross-sections can be analysed. In my opinion the analyses carried out are sufficient to make valid extrapolations because the analyses carried out show conclusively there is no issue of ground heave. Thus further analyses are unnecessary.

6.8 I have considered whether the weakening of any silt layer on the river bank due to regular flow fluctuations may exacerbate the internal erosion risk to the stopbanks in flood events. As the peak water level corresponding to the maximum flow fluctuation is still well below the top of the river bank the effect can only be confined to seepage within layers well below the stopbank. Problems due to ground heave and internal erosion typically occur in layers at shallow depth within the stopbank foundations and the internal erosion risk cannot be influenced by this effect even if it did occur. Furthermore it is not sound practice to rely on the presence of such a material in managing the risk of seepage.

7. LATERAL EROSION RISK TO STOPBANK

7.1 The mechanism of lateral erosion is discussed earlier in my evidence. The key mechanisms are (1) drawdown slope failure of the river bank and (2) lateral erosion largely caused by localised high river velocities and scouring effects. The first mechanism of drawdown slope failure occurs when the river bank becomes saturated in a flood event and slumps when the flood recedes. The second mechanism occurs in a flood when the toe area of the river bank slope is eroded or undermined by scouring action, and the slope above loses support causing further erosion.

7.2 Drawdown slope failure does not present a direct threat of a stopbank breach, unless a subsequent flood peak occurs and the slope failure has removed a significant portion or all of the berm between the riverbank and the stopbank toe. This is because the failure occurs when the flood has receded and is no longer loading the stopbank, i.e. the water cannot escape through a breach. The second mechanism is potentially more dangerous, as in a worst case scenario may lead to a stopbank breach during the flood. This mechanism is a common cause of stopbank failure but I am not aware of such a failure in the Rangitaiki River.

7.3 The risk of either mechanism ultimately threatening stopbank security depends on the berm width (distance between river bank and stopbank) and river morphology (aspects such as height/steepness of bank, protective cover (riprap or vegetation), and hydraulics of the river flow). Dr Toan has noted in his evidence that lateral erosion after the 2004 floods largely occurred on the outside of bends, this is similar to most river regimes after significant flood events.

7.4 I agree that the effects of the Matahina HEPS on river erosion are largely based on qualitative judgment. However quantitative assessments such as drawdown analysis of the river banks as undertaken by Dr Toan can be usefully used to supplement these judgments, provided that these analyses are supported by sound judgment.

7.5 I note that rock riprap downstream of Te Teko now protects the most vulnerable points in terms of risk of slumping erosion and hence direct risk to stopbank integrity. I would expect that the increase in risk due to both the present and proposed operating regime at these protected points is negligible. This is because the rock riprap is an engineered solution.

7.6 In my opinion it should be possible with a combination of quantitative analysis and sound qualitative judgment to separate out the effects of river erosion due to the Matahina operating regime, and flood events (exceeding say 2 to 5 year frequency).

7.7 In particular, this could make use of the drawdown analyses of the riverbank, for both the usual operating regime and flood events. This could then feed into a qualitative judgment of the relative effects. Lateral erosion effects are not readily quantified and this would largely remain a qualitative judgment.

7.8 I have reviewed Dr Toan's analyses on drawdown stability of the river bank. I consider that the analysis, methodology and results are sound. For the same reasons outlined in section 6.7 I consider further analyses are unnecessary. In the wider context of river management the effects of vegetative cover is also important as noted by Dr Toan.

8. REVIEW OF THE COST ALLOCATION MODEL

8.1 I have been provided with the spreadsheet calculations undertaken by Watershed Solutions Ltd used for determining the cost apportionment to TrustPower, and the detailed cost breakdown of routine maintenance activities undertaken by BoPRC on an annual basis.

8.2 The routine maintenance activities are split into various river reaches, and a general item covering management activities and tasks associated with the overall scheme. Each works item is split further into categories such as salaries, wages, contractor costs, materials and other miscellaneous items.

8.3 It is only possible to check a few of the larger work items for the reasonableness of the rate and costs. I have checked a few of the more significant costs and rates. For example the most significant cost item for each river reach is rock maintenance. The per tonne or per cubic metre rate is reasonably high in my experience but may well be justified if a cheap rock source is not available and haul distances are significant. For the same rock item, salaries and wages are about 25% of the construction cost. Again this is considered to be at the high end of a typical range and would require justification.

8.4 Of far more significance is the inclusion of particular elements of river scheme costs and the percentage allocation to TrustPower. I note that capital work projects from 2010-2014 are included in the spreadsheet. These elements total $6.4M and include geotechnical strengthening works, floodway widening works and spillway construction. These works appear to be addressing issues associated with flood capacity and seepage/internal erosion. In my opinion none of these are created or exacerbated by the Matahina Scheme and accordingly none of these costs should be apportioned to TrustPower.

8.5 I note that the cost allocation model makes an adjustment for future changes in the peaking and low flow regime denoted by the term annual scaling. This results in a large increase from a baseline of $214,813 in Year 1 to $347,625, which is almost a 60% increase. I can understand the rationale behind this approach, but I consider the approach is very arbitrary and subject to even far greater uncertainty than the baseline calculations. Given that the cost allocation model is based on future actual costs, it does not appear logical or necessary, in my opinion, to make this adjustment at this stage. The evidence of Mr Levy and Dr Toan also concludes that the influence of more frequent peaking on the river system is minor.

8.6 Overall, I consider (subject to the above qualifications) that the actual cost components within the costing spreadsheet are reasonable. My brief has not included a detailed review of the % apportionment (25% within spreadsheet), nor a detailed assessment of the river erosion management effects, but has included consideration of flood and capital expenditure aspects.

9. CONCLUSIONS

9.1 The stopbank construction on the Rangitaiki River system is considered typical of similar schemes throughout New Zealand. However, the foundation soils of the stopbanks are problematic and particularly prone to seepage and internal erosion problems. They are much more prone to this type of issue than most other schemes in New Zealand.

9.2 In line with most stopbanks constructed in a similar time period only limited attention appears to have been paid in the stopbank design to potential seepage issues. After several historic seepage observations and in particular the major breach in the 2004 flood, BoPRC have investigated these issues on an ongoing basis and specific works have been planned. Also major capital works to improve flood capacity are planned.

9.3 I concur with Dr Toan's analyses on ground heave and drawdown stability, and his overall conclusion that the proposed operation of the Matahina HEPS under the revised operating regime would not worsen the ground heave or piping risks, nor affect inland stability

9.4 In my opinion the major capital works (geotechnical strengthening work and floodway/spillway improvements) are not related to any increased risk arising from the presence and operation of the Matahina Scheme and no cost allocation for these works should be apportioned to TrustPower.

Donald Robert Tate
27 June 2011

10. REFERENCES

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