IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications to the **WAIKATO DISTRICT COUNCIL** and **WAIKATO REGIONAL COUNCIL** by **WEL NETWORKS LTD** for resource consents to authorise the establishment, operation and maintenance of 28 wind turbines for the generation of electricity and associated activities near Te Uku

STATEMENT OF EVIDENCE OF MARK THOMSON MITCHELL

1. INTRODUCTION

Qualifications and experience

1.1 My name is Mark Thomson Mitchell and I am a Chartered Professional Engineer with a Consulting Geotechnical and Environmental Engineering Practice based in Hamilton. I hold the degrees of Bachelor of Engineering (Civil) from Auckland University [1966] and Master of Science in Civil Engineering from Purdue University, USA [1968]. I am a member of the Institution of Professional Engineers, New Zealand, the American Society of Civil Engineers and the NZ Geotechnical, Geological and Geophysical Societies. I am also a member of the Association of Consulting Engineers, New Zealand.

1.2 I have practised as a specialist consulting geotechnical engineer in Hamilton for in excess of 25 years and my career has also included a number of years of part time and full time lecturing in a variety of civil engineering subjects for the Civil Engineering Department at the Waikato Polytechnic.

1.3 My consulting engineering practice, which operates under the name of Mark T Mitchell Ltd, covers primarily the Waikato-Coromandel-King Country areas and our clients include City and District Councils, Government organisations, private companies and individuals. The practice specialises primarily in geotechnical, geological and environmental engineering.

1.4 I am familiar with the general geology of the Raglan – Te Miro area and with the geotechnical and environmental aspects of building foundations, road construction, rock quarrying, earthworks development and land stability, both in this area and also elsewhere in the greater Waikato area.

1.5 I am also familiar with day-to-day control of earthworks and stormwater runoff within environmentally sensitive areas, and my consulting practice regularly reports and advises on these aspects of construction.

1.6 My evidence should be read in conjunction with that of Roger Burchett who describes the activity proposed and that of Tony Keyte who describes civil engineering issues.

Expert Witness Code of Conduct

1.7 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Note 2006 [2006] NZRMA 357. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Project involvement

1.8 In March, 2005 I was retained by WEL Networks to advise on the geotechnical aspects of the WEL Wind Park. That involved an initial site inspection of the site, which was followed by my staff carrying out a series of approximately 34 test bore holes and associated field and laboratory testing, with each of the proposed wind turbine sites tested in this manner.

1.9 The results of this testing form part of my Geotechnical Investigation Report for the project, which is dated 31 July, 2007 and is attached to the AEE. A series of A3 colour Site Plans for each of the Turbine locations was prepared following that report. These Site Plans are based on localized aerial photograph/contour plans which show the general location of the turbine, the bore hole location and the approximate location of the access road. I have not attached copies of these Site Plans to my evidence because of the number and size of them, however I have copies available if the Committee wishes to see them.

1.10 Subsequently, I carried out a geotechnical review of rock quarrying operations at the Te Mata quarry. It is intended that Basalt rock from that quarry will supply roading and concrete aggregate for the WEL Wind Park project.

1.11 Test drilling was carried out at the Te Mata quarry. From this data, together with my review of general quarry operations, I prepared a Management Plan for future quarry operations. That report is dated 13 September, 2006.

1.12 I have determined that there is sufficient rock available within the Te Mata quarry site to supply the Wind Park project. Also there are available areas of rock that will need to be removed in order to provide the general road access to the site, termed the *Primary Access Road* and also access to some of the Turbine sites. Rock from those areas will be used to supplement rock from the Te Mata quarry.

Purpose and scope of evidence

1.13 Against that background, the purpose of my evidence is to outline the geological and geotechnical aspects of the site. I will also indicate procedures that will be followed to insure that the turbine foundations and site road works are constructed upon soil or rock that is stable both during and following the construction works. In that regard, my evidence will address the following matters:

(a) Site geology (sections 3 and 4);

(b) Geotechnical aspects of the project site (section 5);

(c) Land Stability (section 6);

(d) Requirements for further site investigations (sections 7 and 8);

(e) Engineering control of earthworks (section 9);

(f) Response to submissions (sections 10 and 11);

(g) Proposed conditions (section 12);

(h) General conclusions (section 13).

2. EXECUTIVE SUMMARY

2.1 The following evidence covers the geological and geotechnical aspects of the site and provides an outline of procedures that will be followed in order that the turbines and access roads are founded upon stable ground.

Site geology

2.2 The basement rock is “greywacke” and exposures of this rock occur in the base of the valleys. The valley sides, which are relatively steep, are comprised of younger

sedimentary rock, with outcrops typically consisting of limestone and sandstone. These rocks are capped with hard basalt volcanic rock which is mantled with a clay cover that is typically about 4 metres thick.

2.3 At many turbine locations, basalt rock is located within a few metres of ground surface. Where this occurs, it is likely that this rock will be exposed by excavating the overlying clay soils so that the size of turbine foundations can be reduced due to the strength and bearing capacity of basalt.

Active and inactive faults

2.4 Although faults are present in the general area of the project site, the site is within an area of low seismicity and therefore the turbine foundation design will be governed by wind effects rather than by earthquake effects.

Land stability

2.5 Over the majority of the site, the soils are comprised of fine grained silt and clay. Soil tests show that these soils have high shear strengths. Those tests also show that the soils will need to be air dried before being compacted in a structural earth fill, due to their higher than their best water content for compaction, termed the *optimum water content.*

2.6 The valley sides are typically steeper than 25 degrees to the horizontal and by Environment Waikato definition, these parts of the project site lie within an area of "high erosion risk". However the sedimentary and volcanic rocks that underlie the surface soils of these slopes are generally stable and the *high erosion risk* relates only to the soil cover in most of those situations.

2.7 The plateau area where the turbines will be located has been farmed by the Van Houtte family for in excess of 100 years. Also the location of the Primary Access Road to the site was originally the only route between Raglan and Hamilton. Therefore the land where the proposed earthworks will be undertaken has been cleared of bush for in excess of 100 years. This enables areas of stable ground and also areas of past instability to be clearly visible to a geotechnical engineer or engineering geologist.

2.8 Similarly, locations of groundwater outflows that are likely to result in land instability are well-established and readily recognised when the site is inspected during winter.

2.9 On this account, it is possible to plan the locations of access roads, soil dump sites and turbines so they are well separated from areas of past instability. While some allowance needs to be made of potential climate change, it can be assumed, in general terms that where land has remained stable for the past 100 years, it will continue to do so in the future, provided there are no adverse changes to the local environment.

2.10 The turbine sites are to be set back from the edge of these steeper slopes and will therefore not be affected by the high erosion risk soils. The alignment of the access roads will generally follow the ridge lines and thus also avoid the areas of high erosion risk. However some roads will sidle across the steeper slopes and site-specific designs will be required for those areas to ensure that the stability of the road alignments is improved so that an acceptable safety factor is obtained.

2.11 Stormwater runoff will be managed appropriately to ensure that stability will be enhanced and erosion minimised. These matters will be addressed in a management plan.

2.12 I recommend that following commission of the project, regular site inspections of the site be undertaken by an experienced geotechnical engineer and a report submitted to WEL Networks following each inspection that outlines any remedial drainage or other land stabilising work that might be required.

Supplementary site investigations

2.13 Sufficient information has been obtained via test bore holes to ascertain that there are suitable foundation conditions at each turbine site. However, further investigations are necessary in order to obtain adequate geotechnical data for the final design of foundations, roading, embankment filling, excavation cut faces and soil disposal fill sites. Slope stability investigations and studies are also required to be carried out for land surrounding the turbine sites, along the local and main access roads and also for the soil disposal sites. This work is planned to be undertaken during the design phase of the project.

2.14 Further tests will also be required for the purposes of determining road pavement design, verifying road alignment and testing for the presence of rock suitable for road construction. Where such rock is to be used for road construction, a rock extraction management plan will be prepared.

Earthworks and construction

2.15 Earthworks will be required at each turbine site. A management plan will set out measures to be undertaken to control sediment and erosion. An Earthworks Specification will be prepared and will set out required soil density, water content range and shear strength. Appropriate measures will be undertaken to ensure that land disturbance is kept to a minimum.

Approvals

2.16 The site development and construction work at the site will require Building Consents from the District Council for various parts of the project. Because some of the work involved needs to be completed before other work can commence, it is critical that systems are put in place so that progressive approvals are able to be granted while the designs of other parts of the project are being undertaken.

Officer's Reports

2.17 The Waikato District Council (WDC) has commissioned Tonkin & Taylor to undertake a review of the geotechnical aspects of the project and a set of possible conditions has also been prepared by Council staff as part of the Planning Report. I provide comments on both these reports.

Submissions

2.18 Issues relating to land stability and erosion will be addressed by undertaking earthworks in a manner that is sensitive to the specific nature of the ground and developing an appropriate management plan. The only work to be undertaken in the high risk erosion are parts of the internal roading network.

2.19 The rainfall data collected by Mr Wells will be invaluable in planning for stormwater management.

2.20 There only blasting expected to occur is in order to widen the Primary Access Road between Te Mata Quarry and the plateau and also parts of the cross-plateau road. The access road is separated from the more populated areas and blasting on the plateau will be limited due to the presence of the Telecom Tower.

Conditions

2.21 I have recommended conditions which address:

(a) Management plans for rock extraction, earthworks construction and control of runoff

(b) Provision to undertake minor earthworks during the design phase of the project.

(c) That the design and construction of the works that relate to earthworks, slope stability and slope stabilization be the responsibility of the Project Geotechnical Engineer and that work be peer-reviewed by another consultant.

(d) I recommend the deletion of the currently proposed Consent Condition that require the final design of all earthworks for the total project be completed and then submitted to Council staff for review over a 3-month period be deleted. Instead I proposed that the Conditions provide for an on-going, project-focused and independent engineering peer review process for all engineering work on the project.

(e) I also recommend that the Conditions include a provision for parts of the construction works to commence while the design of other parts of the work is still being undertaken

Conclusion

2.22 The proposed turbine locations are situated in stable ground areas. Any land instability issues can, and will be, addressed through design and the development of management plans. In my view, the proposed Wind Park is well suited to the Wharauroa Plateau site.

3. SITE GEOLOGY

3.1 In this section of my evidence, I will outline the general geology of the site.

3.2 The wind park site is situated on top of the Wharauroa Plateau, extending a total of 5.5km from Turbine Site No. 29 at the Northern most point to Turbine Site No. 2 in the South.

3.3 The basement rock that underlies the plateau area consists of hard sandstone/conglomerate and siltstone, with outcrops of this rock occurring in the lower parts of the valleys. These rocks are of the Jurassic Age, which was formed about 150 million years BP (before present) and are of slightly younger age to the common “greywacke” rock which occurs within the Hakarimata range above Ngaruawahia, but has the same appearance. This rock does not occur within the

elevated (upper Plateau) part of the site and will not be encountered within the site development work.

3.4 This basement rock is overlain by sandstone, siltstone and limestone of the Glen Massey Formation and which were deposited in the Oligocene period, about 30 million years BP. These rocks are exposed around the flanks of the Plateau and also within the mid-height to lower part of the valleys. Rocks of this formation are more obviously exposed in the Te Mata area, to the southwest of the Plateau. There were no exposures of this rock type at any of the Turbine locations. However rock of this type may be encountered during site excavations for some of the turbines where the capping basalt rock layer is absent.

3.5 The strong capping rock that has produced the general plateau-type topography is a basalt volcanic flow of the Okete Volcanic Formation. This formation is relatively young, being between about 2 to 4 million years old and has erupted from multiple vents within the area, and is a similar age to Mt Pirongia to the southeast and Mt Karioi to the west.

3.6 At many of the turbine sites, this basalt rock is located within a few metres of ground surface. In situations where this occurs, it is likely that the excavations for the turbine foundations will be deepened so as to expose this rock. By this means, the size of the turbine foundations can be reduced as the basalt rock is stronger and has a higher bearing capacity than the overlying soils.

4. ACTIVE AND INACTIVE FAULTS

4.1 In this section of my evidence, I will discuss the presence of faults within the general area of the project site.

4.2 The closest known active fault in the vicinity of the project site is the Turi Fault, which is located offshore to the south-west of Kawhia.

4.3 This fault has a design maximum magnitude M_{max} of 7.2 at a depth of 15km and recurrence interval of 1,600 years. The site is therefore located within an area of low seismicity. Consequently, turbine foundation design will be governed by wind effects rather than by earthquake effects.

4.4 An inactive fault, termed the Van Houtte Fault is located in the north and northeast of the study area. This fault has downthrown the geology to the north and uplifted, to expose, the older, Jurassic-aged sediments of the study area.

4.5 Seismic design of tower structures will not be influenced by potential movement along the active fault on account of its distance from the site, nor by that of the inactive fault.

4.6 Weaker and more jointed rocks will generally be associated with fault lines on account of the deeper weathering that is associated with historic faults. However neither of these faults occur within the project site area and therefore there will be no necessity to review turbine locations in relation to past fault traces.

5. NEAR-SURFACE SOIL CONDITIONS AND INFLUENCE UPON STABILITY

5.1 In this section of my evidence, I will discuss the influence that the soil conditions will have upon site earthworks and land stability.

5.2 The earthworks for the project will involve primarily those soils that occur within a few metres of ground surface apart from the earthworks that will be associated with the construction of the primary access road from the Te Mata quarry where there will be a significant gully fill. The test holes that have been drilled at the turbine sites indicate rock to be present at less than 10 metres below ground level at most of the sites. The actual depth of rock at each of the turbine sites is described in my geotechnical investigation report that is included in the AEE.

5.3 The majority of the site where earthworks construction is proposed contains a soil mantle overlying rock, with the soils comprised of fine-grained, SILT and CLAY. These soils have resulted from in-situ weathering of volcanic ashes originating from the eruptions of Mt. Pirongia and Mt. Karioi and other volcanic cones and vents. Some soil layers have also developed from the in-situ weathering of the underlying basalt flow features.

5.4 The soil cover over the areas varies from a few to several metres but reduces to be non-existent over the more steeply inclined gradients. The rock type that is present within these steeper areas where the soil cover is thin or absent, generally consists of soft siltstone or soft sandstone.

5.5 Soil tests that have been carried out on the near-surface, weathered ash-origin, fine-grained soils show these soils to have moderate to high shear strengths. This means that when an excavation is made into these soils, a steep cut batter slope will be relatively stable in the short term, but will tend to fritter back if not stabilised by hydro-seeding or similar.

5.6 The natural water contents of these soils are typically 4 to 12% above their plastic limits. This means that the soils will need to be air-dried for up to 1 and 2 days to

reduce their water contents by a similar range in order for them to be compacted without the soils being excessively wet or dry of the optimum water content. The term *optimum* refers to the water content at which the earth fill is more readily able to be compacted.

5.7 Therefore structural site earthworks will need to be carried out during dry summer conditions, so as to allow the soils to dry out before being compacted in a structural earth fill. It is probable that the soil water contents even during summer dry months will be at least 4 percent above optimum water content.

5.8 Also because of the particular characteristics of weather conditions in the plateau area, which are not always conducive to best practice earthworks construction, design changes during the course of the earthworks will be necessary. For example, if the construction program requires soil to be removed and compacted into a disposal area within a given time frame, and wet weather prevails, a design change will be required. That design change must be the sole responsibility of the Project Geotechnical Engineer. I have proposed Resource Consent Conditions that will provide for on-site design changes to be reviewed and approved by means of an on-going engineering peer review process.

6. LAND STABILITY

6.1 In this section I will discuss the general slope stability aspects of the site.

6.2 A dominant feature of the plateau area is the steep-sided valley slopes that dissect the project site into a series of ridges. These valleys have been formed by downcutting of streams through the softer siltstone rocks until the harder greywacke-type rock is reached. At the top of these steep slopes, the typical rounding feature that commonly occurs at the top of hill slopes is absent, with instability of the upper part of the hillside being prevented by the hard volcanic capping rock, but with a potential for near-surface erosion to occur.

6.3 The effect of downcutting by the streams is that the lower parts of the steep sided slopes are typically in a state of marginal stability. The gradient of many of these slopes is in excess of 25 degrees and therefore lie within the Environment Waikato classification of these steeper slopes being defined as a “high risk erosion area”. That classification does not distinguish between whether the material underlying the near-surface soil cover is soil or rock. Nor does the definition of “high risk erosion area” apply to land that has a slope gradient of less than 25 degrees wherein the majority of the earthworks will take place.

6.4 Of particular relevance is the fact that the plateau area where the turbines will be located has been farmed by the Van Houtte family for in excess of 100 years. Also the location of the Primary Access Road to the site was originally the only route between Raglan and Hamilton. This means, that unlike much of the steeper topography within the Waikato area, the land where the proposed earthworks will be undertaken has been cleared of bush for in excess of 100 years. Thus slope instabilities that have resulted from bush-clearing and exposure to wider variations in wetting and drying have now had ample time to occur. Thus areas of stable ground and also areas of past instability and locations of groundwater outflows are now clearly visible to a geotechnical engineer or engineering geologist.

6.5 On this account, it is possible to plan the locations of access roads, soil dump sites and turbines so they are well separated from areas of past instability. While some allowance needs to be made of potential climate change, it can be assumed, in general terms that where land has remained stable for the past 100 years, it will continue to do so in the future, provided there are no adverse changes to the local environment. In fact, the drainage of all areas will be improved over the course of the wind park construction and this will result in an improvement of the stability of ground that is affected by the wind park construction

6.6 The turbine sites have been selected so that they are set back from the top of the steeper slopes a sufficient distance so that soil erosion and slope stability will not be an issue. Earth fill disposal sites will also be located away from these areas. This requirement will necessitate relatively long haul distances in removing the upper softer foundation soils from the turbine locations in order to secure earth disposal fill sites that are located on stable ground away from the steeply sloping areas.

6.7 The road alignments to the turbine locations will generally follow the ridge centrelines and that will enable appropriate setback distances from the top of the steeply sloping areas to be maintained. Where the road alignment runs along a narrow ridge feature, it will be necessary to lower the road level through that area so as to provide a wider road base.

6.8 In some areas, however it will be necessary to construct the roadway by sidling across the steeper slopes, rather than running along the ridge line. In those situations, the road will be formed primarily as a cut, with any fill on the outer edge retained by a suitable type of retaining wall.

6.9 During the Design Phase of the project, the extent of all turbine sites, access road routes and soil dumps will be pegged by the Project Surveyors. Geotechnical

engineers and engineering geologists will then closely inspect all sites and landslip hazard maps will be prepared to indicate the presence of all ground that has the appearance of past instability. These inspections will also take place during winter so that groundwater outflows may be mapped.

6.10 The final earthworks design of the project will take into account all of these features.

6.11 Particular care will be adopted in carrying out works near the edge of the steeper slopes so that any loss of loose soils over the edge of the steep slope does not occur. A site management plan will be prepared during the design phase of the project that will outline the procedures to be followed in this regard.

The site management plan will also include reference to water table construction, sediment control devices such as frequency, location and size and other matters that the earthworks contractors are to follow to ensure that adequate slope stability is maintained both during and following completion of the project.

6.12 The water tables and other drainage features associated with the project earthworks are to be constructed so that all stormwater runoff from cleared ground is directed into sediment control devices. From there, the treated water is to be directed to locations where land stability will not be affected.

6.13 As the site becomes progressively rehabilitated and grass becomes established, the sediment control devices will not longer be required and they will then be removed, but with the drainage measures maintained.

6.14 These procedures will ensure that the areas of disturbed land will be at least as stable as at present. Also, with drainage measures established, the potential hazard related to uncontrolled discharge of stormwater over the steeper slopes that presently exists will be removed. Thus the general slope stability of the project site will be enhanced and the erosion potential minimised.

6.15 After the sites have been commissioned, it is recommended that all turbine sites undergo an annual inspection by an experienced geotechnical engineer for the first three years and every five years thereafter. Following each inspection, it is recommended that a report be presented to WEL outlining any remedial drainage or other land stabilising work that might be required.

7. SUPPLEMENTARY SITE INVESTIGATIONS – PLATEAU AREA

7.1 In this section of my evidence, I will discuss some of the site investigations that will be carried out during the design phase of the project.

7.2 At each of the proposed Turbine locations, a test bore hole has been drilled in order to provide preliminary data of the foundation soil and rock strata. The soil and rock information that has been collected and which is reported in the AEE has identified that suitable foundation conditions occur at each of the turbine sites.

7.3 However this single test hole will not provide adequate geotechnical data for the final design of foundations, such as determining the optimum foundation depth and method of foundation construction.

7.4 It is expected that a common design of the foundation pads will be adopted, but with minor variations depending upon the local soil conditions. For example, where the rock level is close to the ground surface, the overlying soils will be completely removed and the foundation pad situated either directly upon the rock surface, or upon a thin layer of compacted basecourse. Where the rock level is deep, only the upper soils will be removed, with the effect of the replacement compacted basecourse layer being to increase the bearing capacity of the supporting rock and soil. Either option will provide an adequate foundation support to the turbine foundations.

7.5 The reason for not having the requirement for all turbines to be founded on rock is so that the volume of soil to be removed and transported to fill disposal sites is kept to a minimum.

7.6 Slope stability investigations and studies will also be required for each of the turbine sites and these will follow on from the mapping of landslip hazard areas referred to above.

7.7 Therefore in order to assist in construction planning, it will be necessary to carry out further test bore holes, or alternatively excavate a series of test pits in order to determine subsurface conditions below the full extent of the foundation pad footprint.

7.8 Along the access road alignments, bore hole or test pit excavations will also be carried out prior to the road formations in order to determine geotechnical data for pavement design and also to verify that the selected road alignment is clear of any area that either has been, or is likely to be affected by slope instability.

7.9 During the Design Phase of the project, all-weather access to all turbine sites will be required. The plateau area is frequently covered in cloud and driving over the site, even in farm bikes can be hazardous unless all access routes are clearly defined. For this reason, it is recommended that the Consent Conditions allow for the construction of these all-weather, metalled access tracks and/or intial road formation be constructed prior to the earthworks design being approved.

8. SUPPLEMENTARY SITE INVESTIGATIONS – PRIMARY ACCESS ROAD

8.1 The Primary Access Road from the Te Mata Quarry up to the Plateau area will also be subjected to geotechnical investigations prior to the commencement of the upgrading of this road. This road generally follows the old route between Raglan and Hamilton but that road was abandoned (apart from for farm access) in excess of 90 years ago and thus is narrow and in a poor state of repair. The test holes along this route will primarily be directed at the review of slope stability of planned cuts and fills, but with test drilling also carried out in areas where rock that is suitable for road construction is present.

8.2 The completion of the upgrading of this Primary Access Road is a priority as it is critical to the overall project, being the main supply route for the rock that will form the base to all of the project roading and turbine foundations. Parts of this road are currently unsafe for vehicle traffic on account of its clay surface, narrow width, poor drainage and unsuitable alignment. For this reason, the consent process relating to this road upgrade will need to be separated from other earthworks consents to enable these works to commence as soon as the Resource Consent for the project is granted.

8.3 A rock outcrop has been identified at a location midway up the Primary Access Road that will provide suitable materials for the road pavement and turbine foundations. A separate Management Plan – Rock Extraction will be prepared during the early stages of project design so that rock extraction and crushing is able to commence while the Primary Access Road is being upgraded.

8.4 The Site Layout Plan that forms part of the Rock Extraction Management Plan will show the boundaries for the planned rock extraction, the proposed depths of excavation and the planned locations of the mobile crushing plant and stockpiles. A separate Site Plan showing the proposed site rehabilitation will also be included in this Management Plan.

9. EARTHWORKS CONSTRUCTION

9.1 In this section of my evidence I will discuss issues that relate to the physical site preparation works.

9.2 Construction involving earthworks will be required at each of the turbine sites and for all access roads. It is also expected that soil disposal sites will be required, within which surplus and unsuitable soils will be placed.

9.3 Prior to the commencement of earthworks in any area, a sediment control Site Plan will be prepared as discussed in the evidence of Mr Keyte, which will shows the locations of the extent of earthworks proposed and the sediment control devices. Also detailed will be any erosion protection required, such as within the drains that flow out from the sediment control devices.

9.4 The extent of the earthworks will be pegged and its location checked on site by the Project Geotechnical Engineer before earthworks is commence in any particular area. This is to ensure that land disturbance is kept to a minimum.

9.5 Within all areas that are to be disturbed, the topsoil layer will first be removed and stockpiled in a readily accessible location, again as discussed in the evidence of Mr Keyte. Where filling is to be placed, either as a structural fill or within a soil disposal site and the ground slopes at an angle in excess of 1 vertical on 8 horizontal, the site will be excavated into a series of near-level benches in order to key the new filling into the original ground.

9.6 An appropriate Earthworks Specification will be prepared that will set out the required soil density, water content range and soil shear strength for the high strength structural fill, the engineer-controlled fill and the soil disposal site filling.

9.7 Periodic and systematic soil testing will be carried out on all filling to ensure that it is compacted to the specified degree of compaction.

9.8 Wherever practical, the general fill batter design will be graded to suite the return of the site to grazing, which is approximately 1 vertical on 4 horizontal slope. However in steeper topography, this gradient is not practical and the steeper gradient of 1 vertical on 3 horizontal should be used. Where site constraints require a steeper fill batter a structural fill will be used and this will enable the fill slope to be steepened to 1 vertical on 1.5 horizontal, but subject to satisfactory foundation conditions.

9.9 A design temporary cut batter slope of 2 vertical on 1 horizontal will be used in order to minimize the extent of soil disturbance, but subject to local soil conditions present. Following the erection of the towers, the road width will be reduced and during this process the slope gradient of the more critical cut batters will be flattened through buttressing the bottom of the slope in the former water table location. Permanent cut batters will be 1 vertical on 1 horizontal in clay soils and steeper in rock cuttings.

10. OFFICERS REPORTS

10.1 I have read the Geotechnical Review of the project that has been commissioned by Waikato District Council and which is presented in a report prepared by Tonkin & Taylor Ltd (TT) dated 04 October, 2007. I have also read the Draft Consent Conditions dated 5 November 2007 that have been prepared by Waikato District Council.

10.2 I recommend that for this project, there be a different approach to the building consenting process for earthworks and other geotechnical-related items than that which have been proposed by TT and has been presented in the Draft Consent Conditions. Those conditions require that before any on-site earthworks can commence, the final earthworks and groundwater design for the entire project to be completed and then submitted to Council for a 3-month review. Only after that 3-month review can any work on the project commence.

10.3 It is accepted that such pre-approvals may be appropriate for items where the general public are involved, such as noise, traffic and off-site roading, but for on-site works, where no public are involved, a total-project pre-approval of final designs is inappropriate.

10.4 I am also concerned that, because of the complexity of the earthworks and other geotechnical related aspects of the project, the Waikato District Council and Environment Waikato may not have the resources to carry out the review of the initial design and of the many variations in the design that are likely to occur over the duration of the project.

10.5 On a project that covers some 25 kilometres of access roads and includes 28 individual turbine sites and associated access roads, the finalisation of the complete earthworks design, stability analyses, together with the location of minor details such as locations of subsoil drains some 3 months before anything can happen on the site is, in my view, unworkable.

10.6 I contrast the effect that these requirements will have on the project timing and duration with the construction program that was achieved and the timing of the geotechnical investigations of the Te Apiti Wind Farm which is located on the north side of the Manawatu Gorge. That project consisted of 55 turbines, 21 kilometres of access roads and 1,000,000 cubic metres of earthworks and is thus in this context is about double the size of the proposed Whauraroa Wind Park.

10.7 I understand that the Te Apiti Wind Farm geotechnical work did not commence until 2003 and continued through to 2004. However, construction commenced in November 2003, while the geotechnical investigations were still underway. The first turbine was commissioned in July 2004 with all 55 fully commissioned by October, 2004. It appears in that case that the geotechnical-related design work was not required to be completed and reviewed before any construction work could start on the project. In contrast, the conditions proposed by the Council would require all geotechnical design work to be completed 3 months prior to the start of any construction.

10.8 For all of these reasons, I therefore recommend that the Consent Conditions provide for progressive approvals for the geotechnical-related aspects of the project.

10.9 I also propose that the Consent Conditions take into account that this is a project where the general public are excluded from accessing the site. This project differs from the normal type of project where Council has some responsibility to the general public (individual and community) safety and welfare. For this project, it is WEL Networks Ltd (WEL) who requires assurance that the roads and turbine foundations will remain stable rather than the Council.

10.10 It is my professional opinion that the final responsibility for all engineering matters, including geotechnical should rest with the experienced engineering consultants that have been employed by WEL.

10.11 Furthermore, because of the size of the project, it is appropriate for WEL, the project owner to commission experienced engineers to peer review the design work of their consultants as well as decisions taken in the field as the construction work progresses, so that on-site decisions can be made on a day-to-day basis. This is particularly important for geotechnical aspects of the project, where weather conditions can have a significant influence on how earthworks are managed.

10.12 This form of peer review of project design and construction management is currently a requirement for dam construction in New Zealand. For that work, since

it is very specialized, a group of experienced dam engineers has been established for the purpose of peer-reviewing dams that have been designed by other consulting engineers. But earthworks design is more general than dam design and it would be in order for an experienced geotechnical engineer from one consulting organisation to peer review the work of the design geotechnical consultant.

10.13 I would also like to comment upon the TT recommendation that a separate Groundwater Management Plan be prepared.

10.14 I have noted previously that much of the plateau has been in its present, grass covered state for some 100 years and that locations of groundwater outflows are now clearly visible to a geotechnical engineer or engineering geologist. My paragraph 6.9 also refers to inspections that will take place during winter so that groundwater outflows may be mapped, along with all areas of slope instability that are located near the proposed works.

10.15 Some items that are referred to under the Groundwater section of the TT report, such as the need to install drainage along and near access roads and turbine locations, are fundamental to the earthworks design process. Where there is a need to install drainage, it is normally designed and installed as part of the earthworks design and construction work. So the suggestion of having a Groundwater Management Plan to separate out items that are normally part of the earthworks design is unnecessary in my opinion.

10.16 The TT report also recommends that as-built plans of all drainage works, including subsoil drains are provided to the Council. However this compilation of as-built plans is a normal procedure for drainage works that include subsoil drains as provision has to be made to clean drains in the future and does not need to be spelled out in a Resource Condition.

10.17 It is therefore my opinion that taking out subsoil and surface drainage from the Earthworks Management Plan and placing them into a separate document termed a *Groundwater Management Plan* is not warranted and may cause confusion as to what actual drainage measures are required in areas where cut and fill earthworks are also involved.

10.18 During the Design Phase of the project, vehicle track access to each of the turbine sites and to the proposed rock extraction areas will be required. This work will involve some minor earthworks to be undertaken to enable further site investigations are to be undertaken, such as test drilling and the excavation of test

pits and trial excavations to take place. A Consent Condition is required to enable this work to be undertaken prior to the general approval of earthworks design and commencement of earthworks construction.

10.19 After the sites have been commissioned, it is recommended that all turbine sites undergo an annual inspection by an experienced geotechnical engineer for the first three years and every five years thereafter. Following each inspection, it is recommended that report be presented to WEL outlining any remedial drainage or other land stabilising work that might be required.

11. ISSUES RAISED IN OTHER SUBMISSIONS

11.1 I have read the submissions that relate to earthworks, land stability and the diversion of stormwater away from earthworks areas. I also note the concerns expressed by nearby land owners in relation to their experience in working in land that is within a high risk erosion area.

11.2 It is accepted that where earth cutting and filling is carried out in a manner that does not take into account the sensitive nature of the ground and the effect of concentrated flows of stormwater runoff, it is likely that problems with soil erosion and land instability will arise. For this reason, during the design phase of the project, a Site Management Plan document will be prepared that will form part of the specification that all earthworks contractors will be required to adhere to.

11.3 Also, all earthworks and stormwater control will be undertaken under the direction of the project geotechnical or civil engineer to ensure that the Management Plan requirements are enforced on a day-to-day basis.

11.4 A number of the submitters refer to work to be carried out in high risk erosion areas. However the actual earthworks that are planned to be carried out in a high risk erosion area are confined only to minor parts of the primary access road and of the road across the general plateau area. The majority of the land that will be disturbed during the site development is located on land that has a slope that is less than 25 degrees and is therefore outside of the land that is defined as a high risk erosion area by Environment Waikato.

11.5 I have taken particular note of Mr Wells comments relating to rainfall, and his experience of collecting rainfall records over the past 32 years. While it is my understanding that there are variations in the micro-climate from one side of the plateau to the other, I expect Mr Wells' will be particularly useful in the planning of site drainage works over all parts of the site.

11.6 With regard to blasting and associated vibrations I do not envisage that any blasting of rock will be required at the turbine sites, nor on the access roads. This is on account that none of the test holes encountered rock in the immediate vicinity of ground surface.

11.7 However blasting will be required to widen the primary access road to the site and also to establish a higher level rock extraction, or borrow site in the general vicinity of that road. That area in particular, being on the south-west side of the plateau, is well separated from the more populated areas.

11.8 Some minor blasting will also be required in order to widen the existing cross-plateau road. But that area is in close proximity to the existing Telecom tower and this will limit the size of detonation used.

12. PROPOSED CONDITIONS

12.1 It is recommended that the Consent Conditions reflect the concerns that I have pointed out in my evidence. The key points are as follows:

(a) Ability for minor earthworks, such as access and/or initial road formations to be carried out during the Design Phase of the project.

(b) Provision to be made for progressive approvals for work to be carried out, rather than a single approval of the earthworks design for the complete project.

(c) All geotechnical and groundwater related design and construction to be under the direct control of the Project Geotechnical Engineer. Before work is to commence on any part of the project, design drawings, together with Producer Statements are to be submitted to Council. After the completion of each construction phase of the project, Producer Statements are also to be submitted to Council.

(d) The Producer Statements submitted to Council are to consist of the standard, IPENZ-approved PS-1 Design, PS-2 Design Review, and PS-4 Construction Review.

(e) Peer reviews are to be carried out for all geotechnical-related work on the project by an experienced geotechnical engineer who is employed by WEL and is from a separate geotechnical consultancy from than that of the Project Geotechnical Engineer. The peer review engineer shall provide the

PS-2 Design Review Producer Statements for all design and as-built construction works.

(f) The requirement for a Groundwater Management Plan to be deleted and instead all groundwater-related design and construction requirements incorporated into the Earthworks Management Plan.

13. CONCLUSIONS AND RECOMMENDATIONS

13.1 The results of my geological and geotechnical investigations have revealed that many of the proposed turbine sites are situated in locations where rock lies at reasonably close to the ground surface. This will enable those turbines to be founded directly upon rock. Elsewhere the turbine locations are situated in stable ground areas.

13.2 The access roads to the turbine locations will generally follow ridge areas and thus will avoid the high risk erosion areas for the most part. Where these roads sidle across or are adjacent to the steeper ground areas, particular measures will be undertaken to ensure there are no adverse effects upon the local environment.

13.3 The primary access road will pass through an area of rock that will need to be excavated in order to form the proposed new road alignment. It is planned that rock extracted from that location will provide some of the basecourse materials that will be required in the site road construction.

13.4 These factors indicate that the proposed Wind Park is well suited to the Wharauroa Plateau site.

Mark T Mitchell
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