

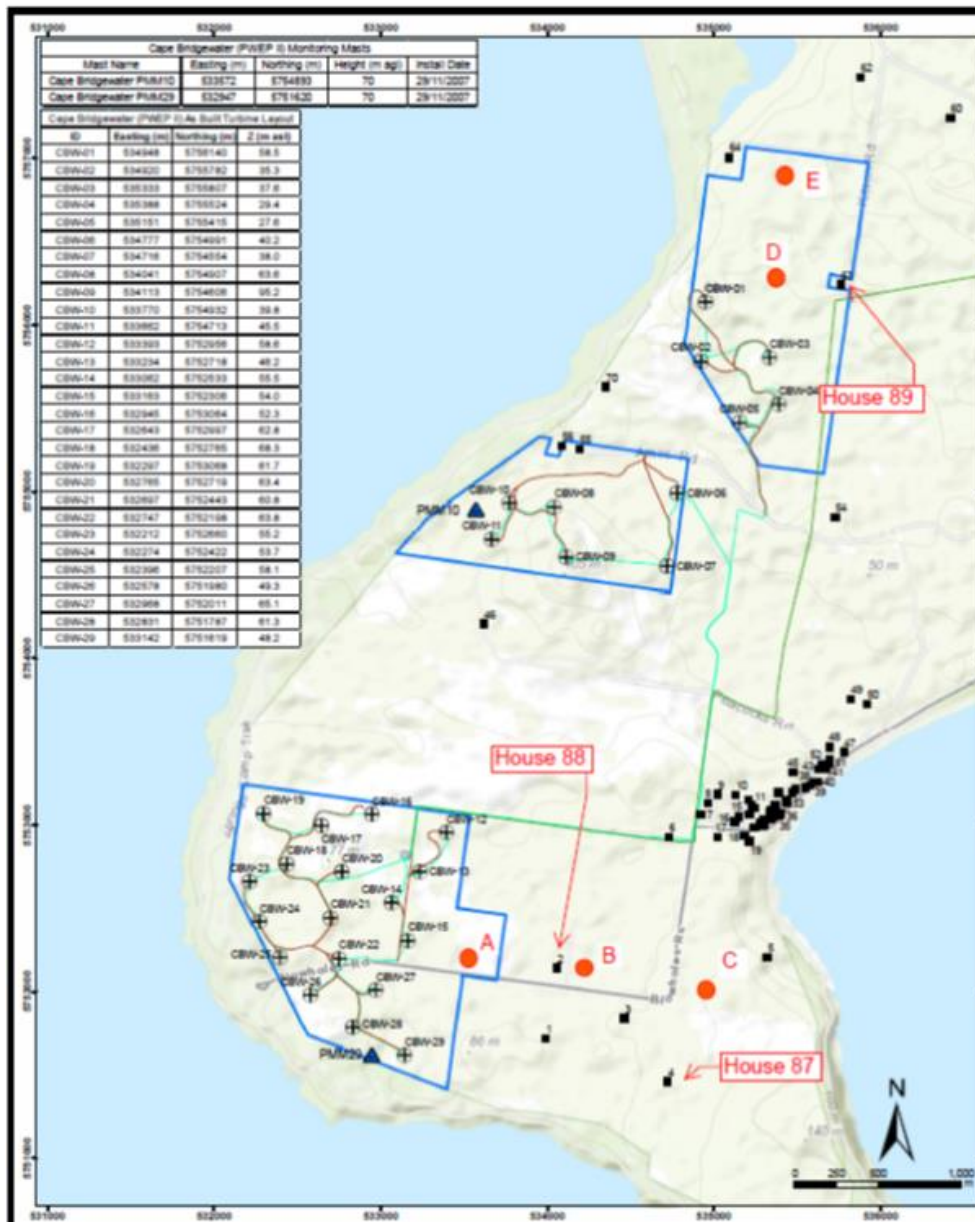
# PRELIMINARY FINDINGS

# Brief

- A complying wind farm still generates complaints
- Look to apply my theories/concepts as to other parameters that may be giving rise to complaints – not just dB(A) or 1/3 octaves.
- Look to inside noise and vibration measurements using full spectrum analysis
- Small sample (3 houses) subject to 6 years of exposure

# Concept for Investigation

- Need to correlate noise levels with observations of residents.
- Have access to an abandoned residence.
- Other houses given over for two nights of continuous monitoring
- Monitoring for 6 weeks and then expanded to 8 weeks to take advantage of a two week shutdown
- Start with SA EPA method for Waterloo Wind Farm but modified to involve residents input and feedback (every 2 weeks)
- Proposed further examination of narrow band data
- Have full access to wind farm data



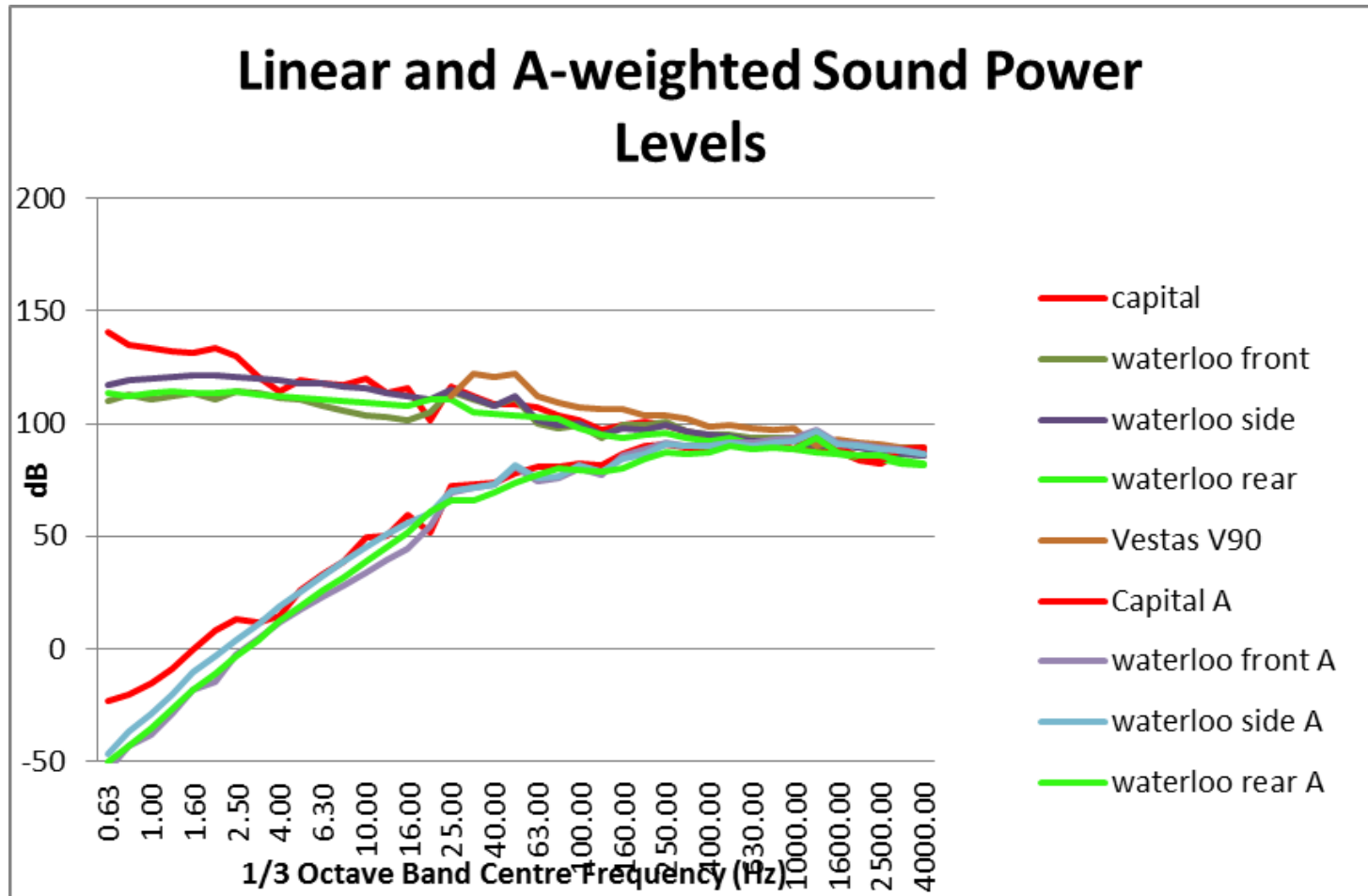
# Initial Findings

- Discussions revealed different impacts on residents – broken down to noise, vibration and sensation to be reported on a 1 – 5 severity scale.
- Developed a method of graphically displaying results where blue is noise, green is vibration and red is sensation
- When plotting power output of wind farms the initial assessment could not correlate results with observations except for showing changes
- Found residents were just reporting changes they noticed in their perceived impacts. MAJOR FINDING
- Changed reporting to give regular (1 – 2 hr) observations not just changes
- Plotting the observations versus the power output of the wind farm found correlation with some of the various acoustic indices INSIDE the dwellings.
- High sensation levels related to turbines just starting, change in power levels by say more than 20% (either up or down) and when wind exceeds maximum power output and blades are being de-powered.
- Correlation of external background level versus power output but no correlation of observations with the external dB(A) level.
- Issue of ambient noise from waves on cliff/ocean and wind direction is relevant in data.

# dB(A)

- Applied externally to dwellings
- Determined in 10 minute increments
- Is an averaged value of all the measurements by way of a regression line that plots the background level versus the hub height wind speed
- At times individual levels may have their value adjusted is special audible characteristics such as tones and modulation – but not enough to influence the averaged level.

# Weighting Influence



# Investigations into wind turbine noise by others

## External Measurements only

- Limited to just dB(A)
- Limited to just regression lines
- Includes 1/3 octaves (different lower frequency limits)
- Includes dBG
- Limited to only external measurements
- Look at modulation
- Look at infrasound (as noise)
- Includes narrow band resolution
- On off testing (short shutdowns)

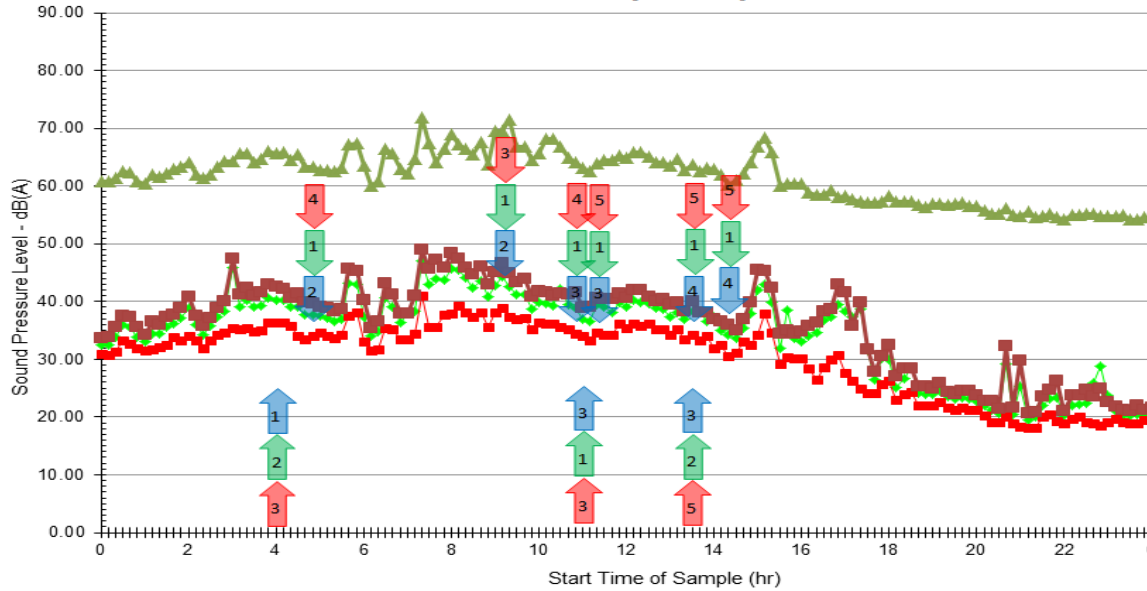
## All of the above with measurements for internal locations

- Other acoustic parameters
- Vibration measurements
- Look at building response
- Look at infrasound (as pressure only)
- Cross correlation of internal and external measurements



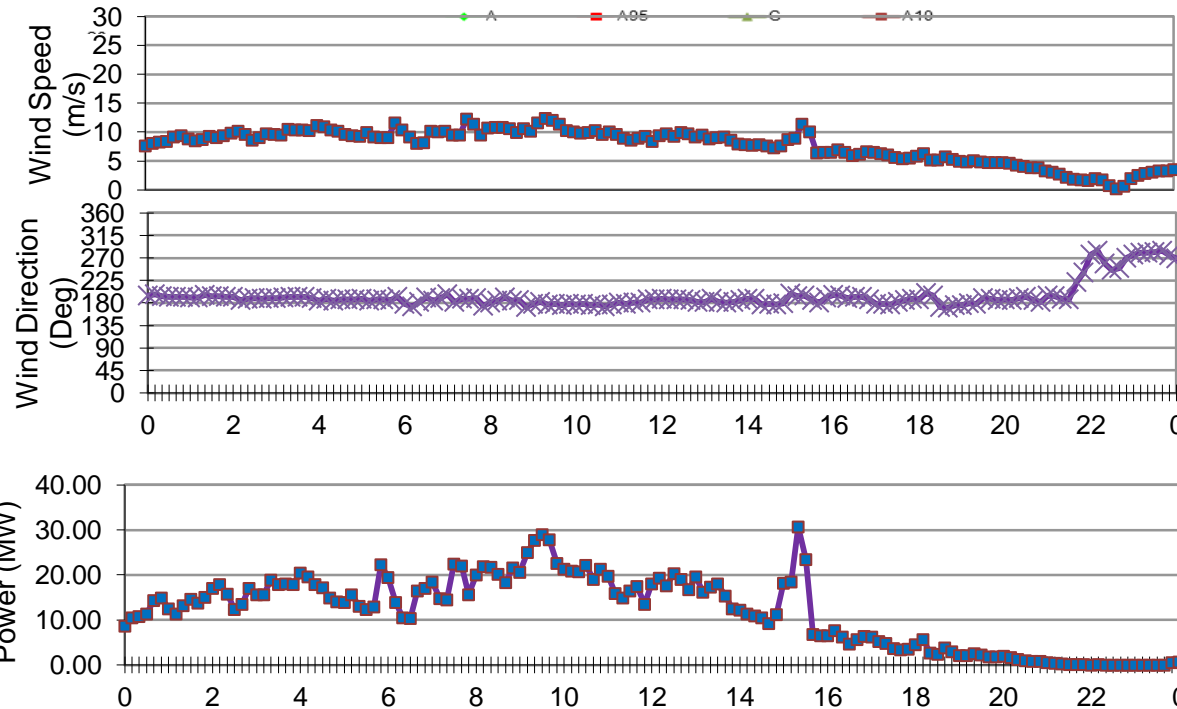
# Ambient Measurements

Wednesday, 28 May 2014



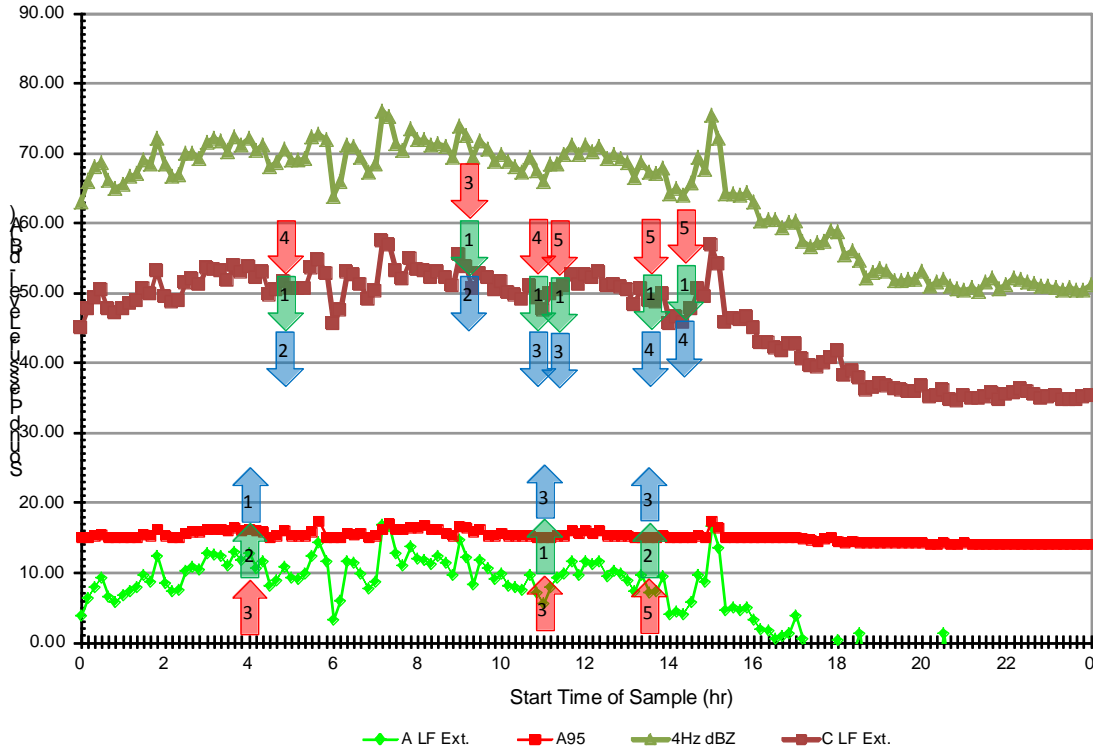
# External Measurements

Blue – noise  
Green – vibration  
Red - Sensation



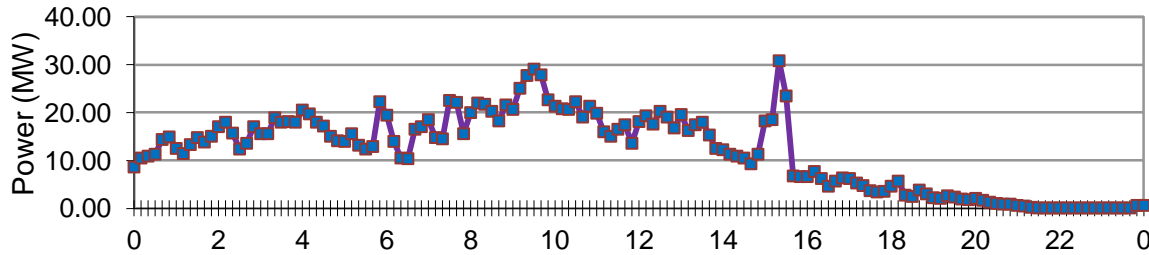
# Ambient Measurements

Wednesday, 28 May 2014



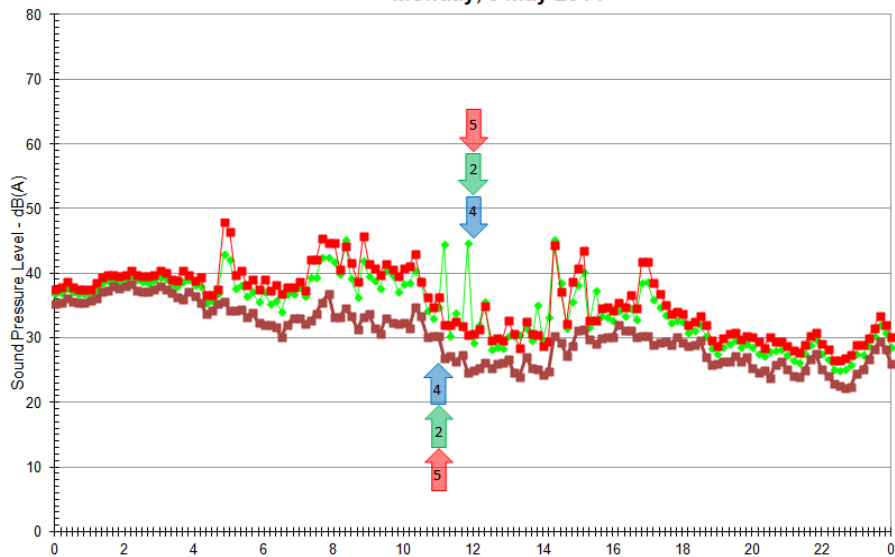
# Internal Measurements

Blue – noise  
Green – vibration  
Red - Sensation

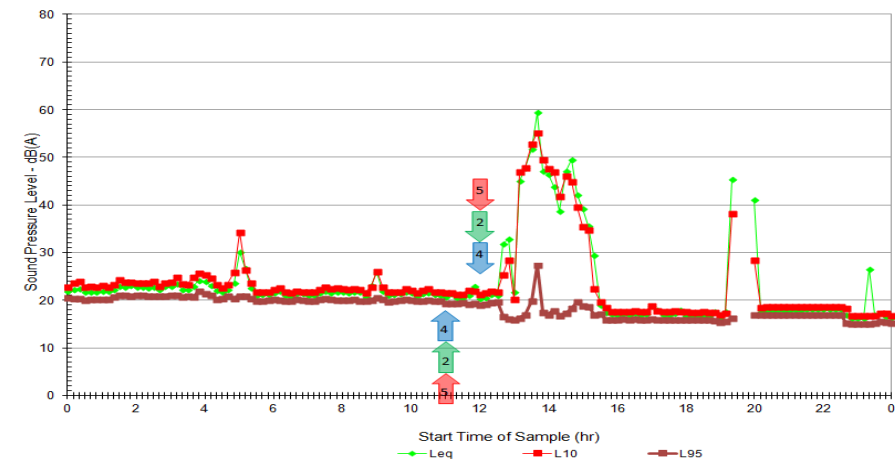


# Ambient Measurements

Monday, 5 May 2014



Outside

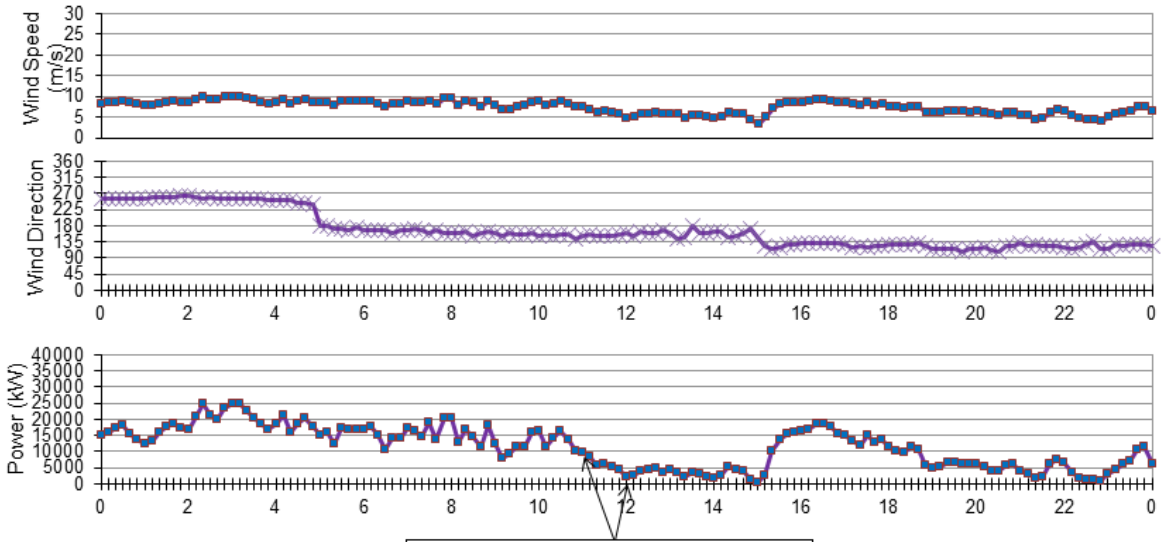
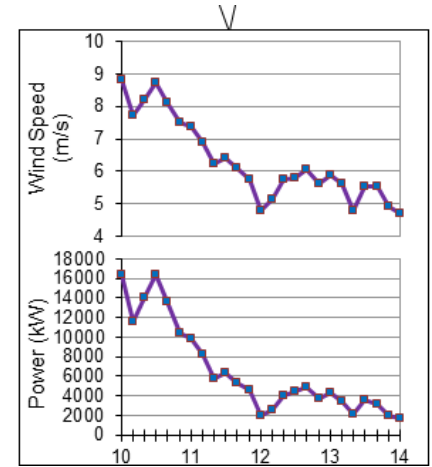
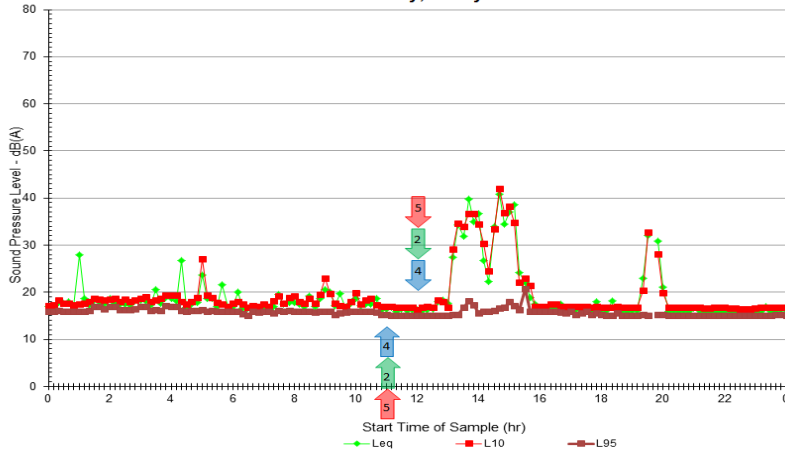


Living room

# Ambient Measurements

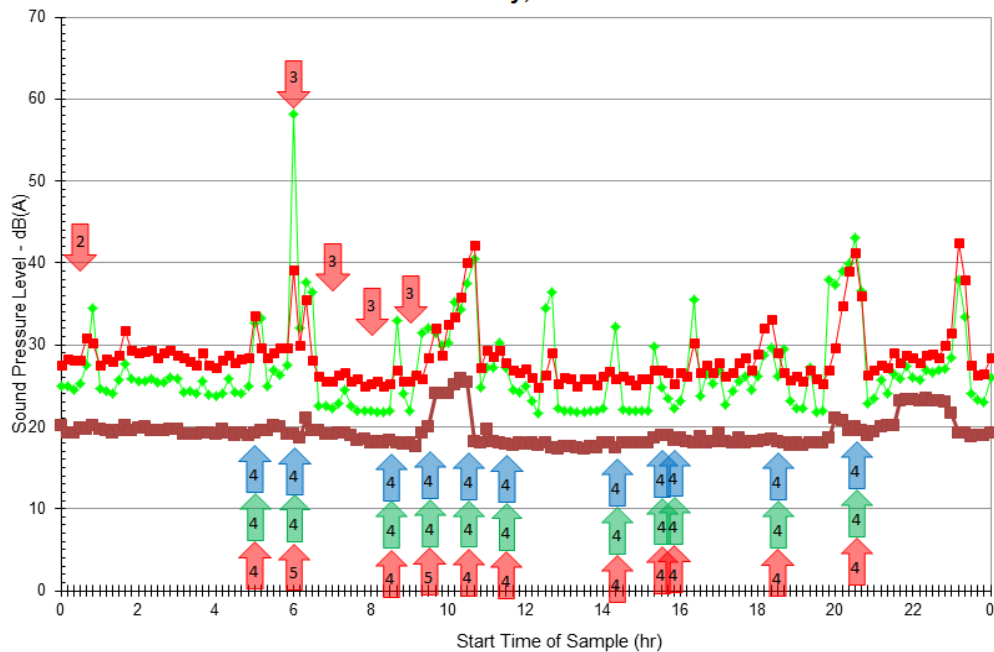
Monday, 5 May 2014

Bedroom

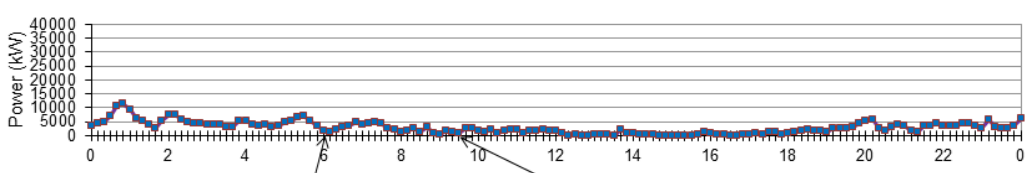
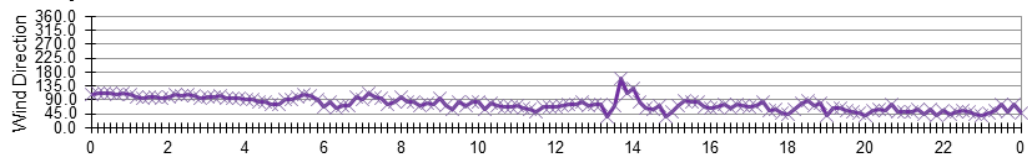
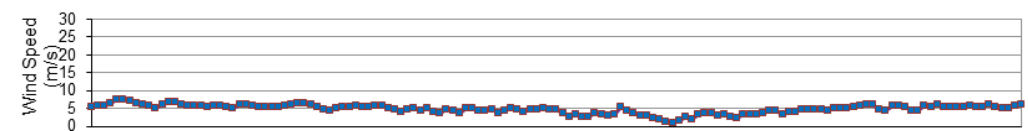


# Ambient Measurements

Sunday, 8 June 2014

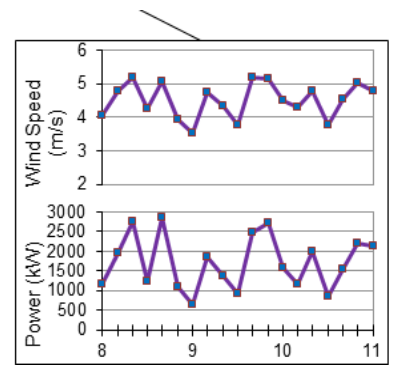
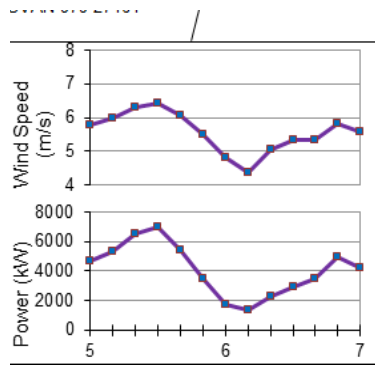


—◆— Leq    —■— L10    —■— L95



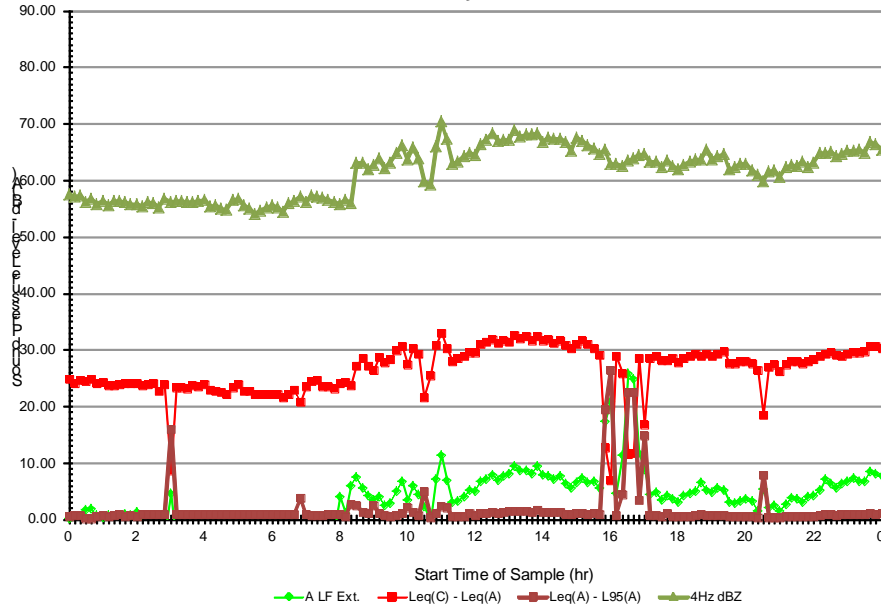
Cape Bridgewater  
SVAN 979 27164

House 88 Inside



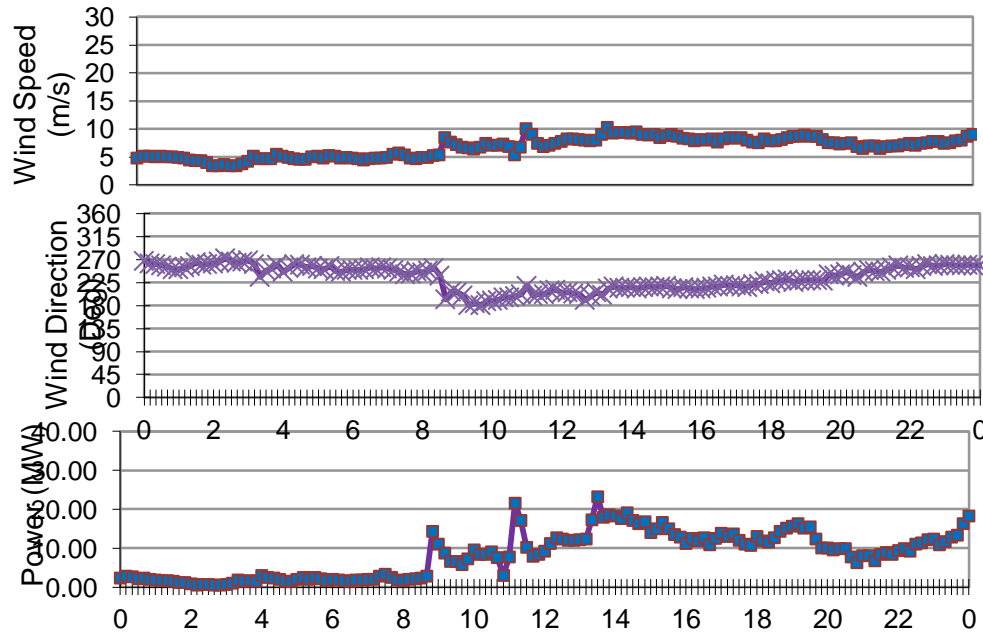
# Ambient Measurements

Tuesday, 3 June 2014

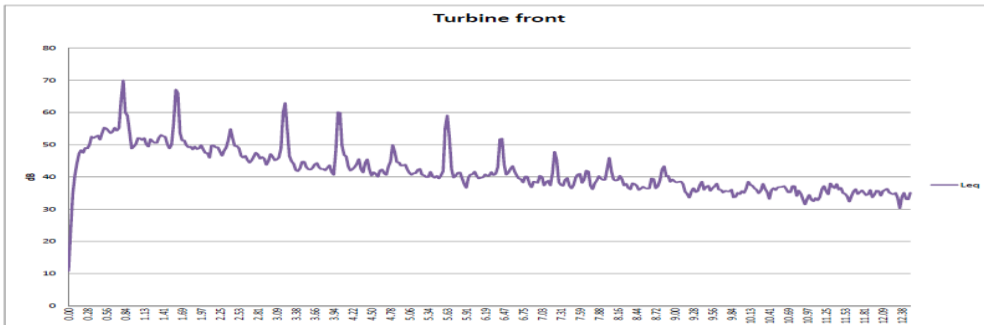
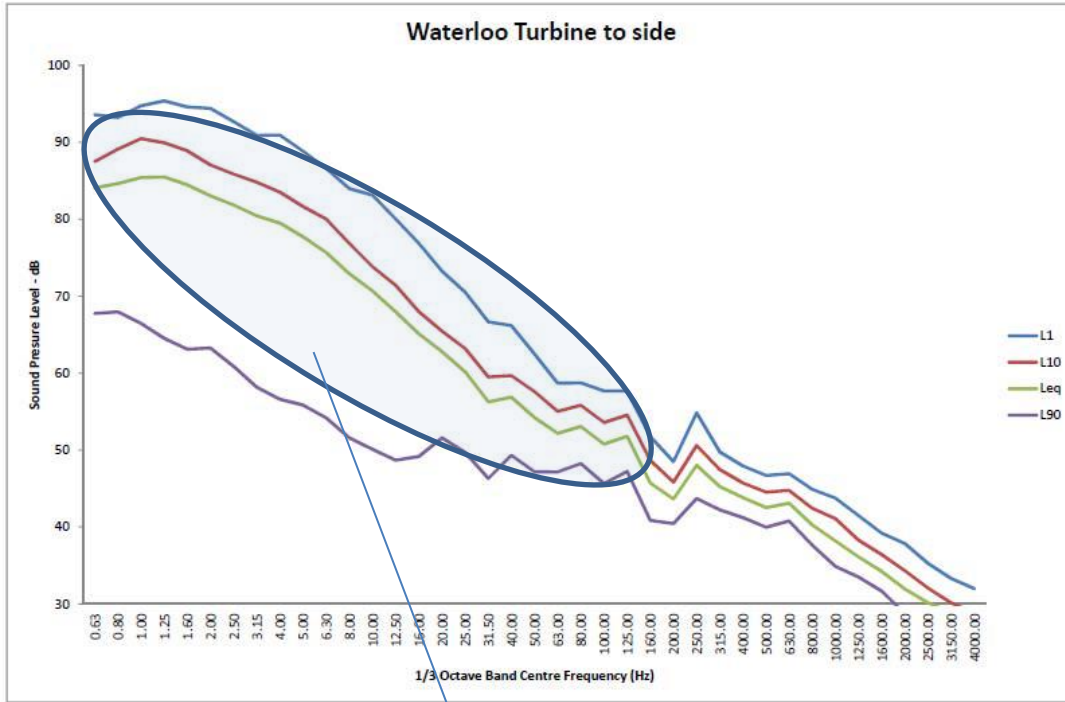


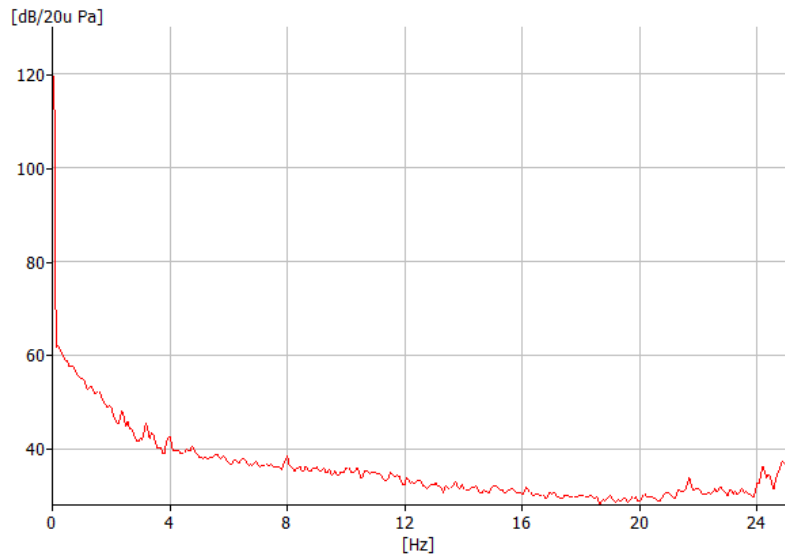
Modulation Check

Inside  
dBC- dBA Leq  
dBA Leq – dBA L95



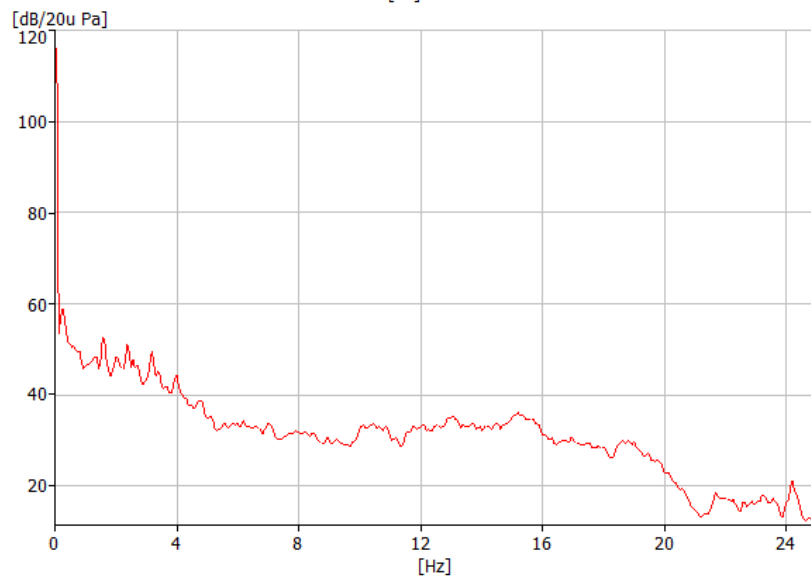
# Finer Resolution





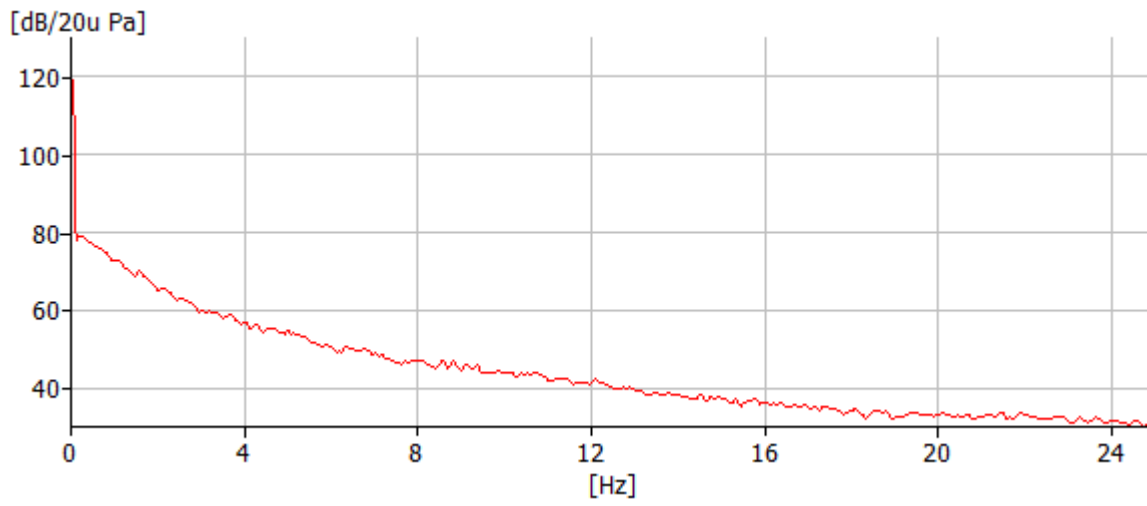
10% power output

outside



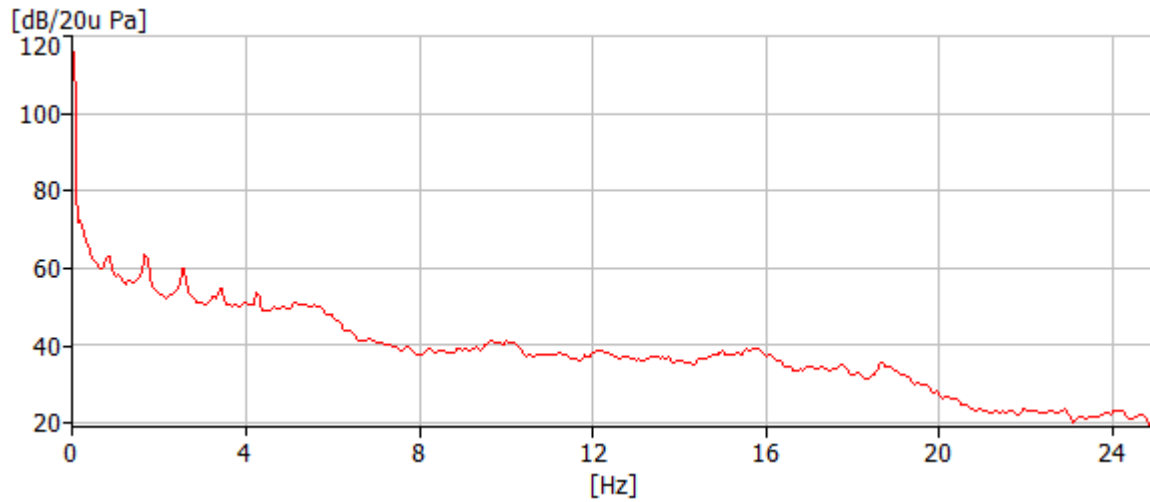
Inside





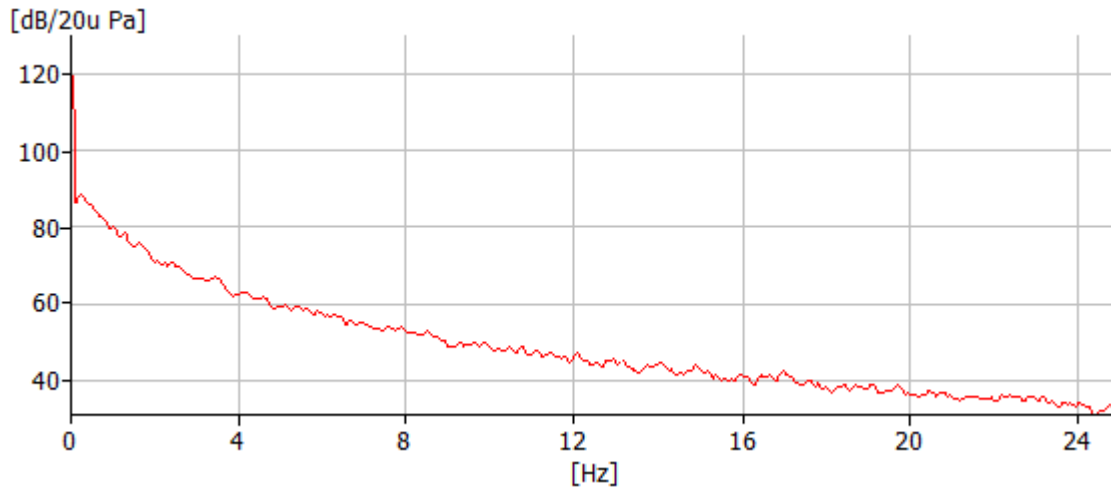
100% power

Outside

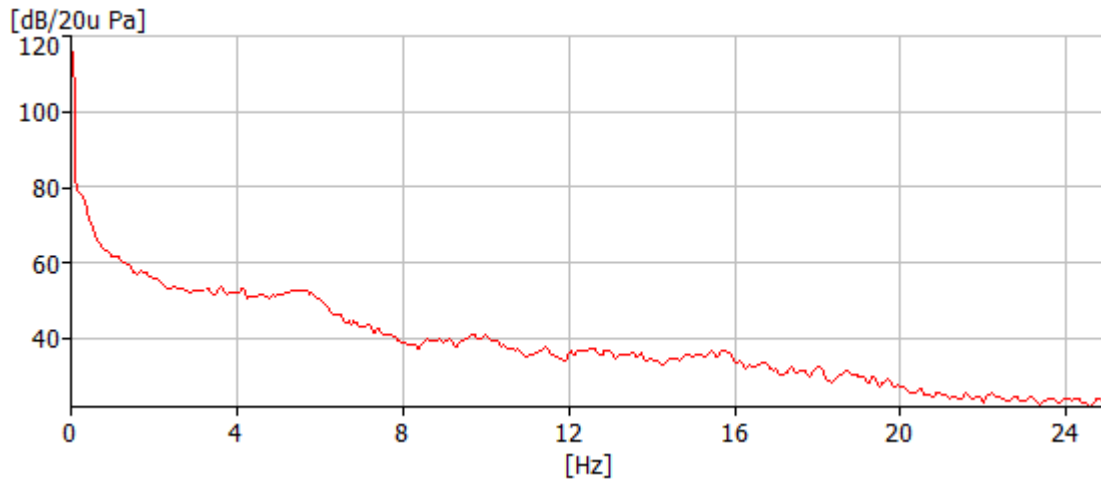


Inside

Shutdown – equivalent wind  
to maximum power

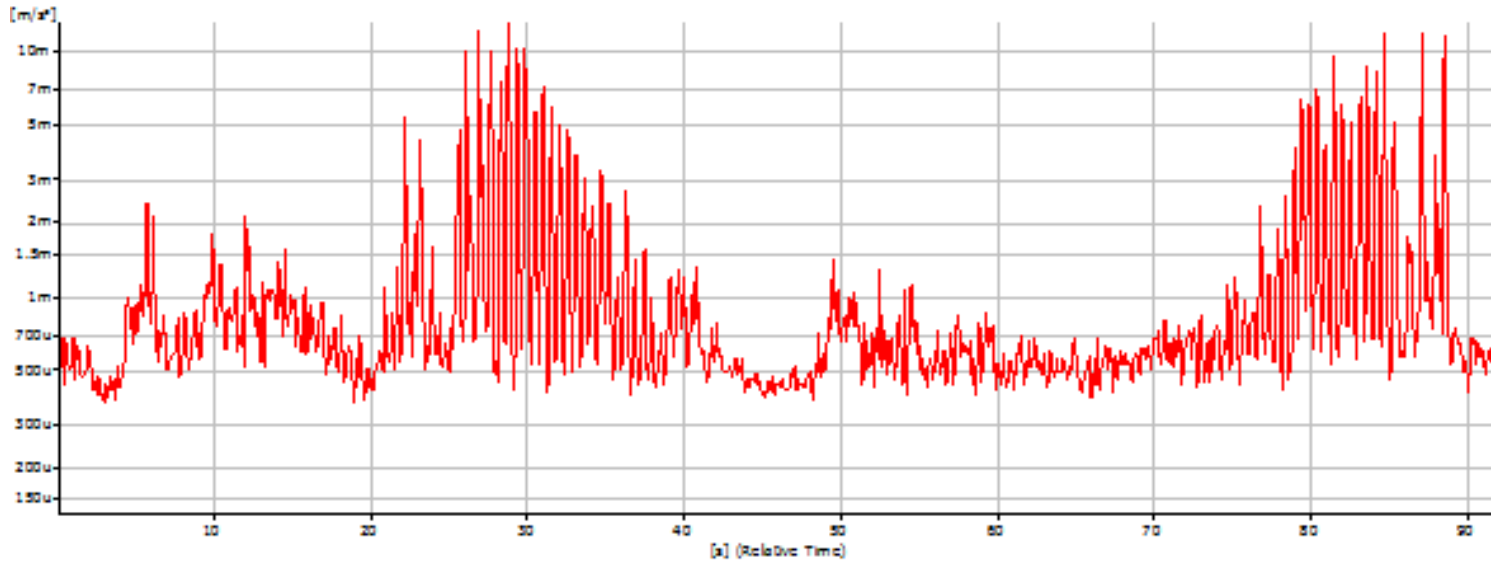


Outside



Inside

# Vibration in ground external to house



# Preliminary Findings to Date

- The use of dB(A) noise levels external to a dwelling have no correlation with internal noise levels or impacts that residents identified as occurring as a result of the wind farm.
- With the wind farm not in operation the residents indicate that noise, vibration and sensation are all at low severity ratings although there was one resident who clearly has a greater sensitivity than the other residents and is able to identify instances of noise, vibration and sensation that are above a threshold level.
- However those instances are of short duration and are not of a constant impact.
- There is a direct correlation with the external dB(A) level and the power output of the wind farm.
- There is correlation between the power level of the wind farm versus the dB(A)LF level determined inside residential dwellings.
- Where the dB(A)LF exceeds 20 dB there is a corresponding identification of noise in the diary observations.
- Where the internal measurements reveal the dB(A) L95 is above 20 dB(A) together with the dB(A)LF above 20 and the same time dB(C) above 50dB and the 4 Hz 1/3 octave band above 50dB then there is a higher degree of noise and sensation which would be deemed by the residents as unacceptable.
- The higher levels of sensation occur with the qualification of the above indices and also exhibit a noticeable drop in the dB(C) Leq minus dB(A) Leq together with an increase in dB(A) Leq minus dB(A) L95. This may provide a simple tool to identify the need for examination of modulation of characteristics. However it is noted that there are some limitations in normal noise loggers to provide accurate results of the dB(A) Leq and dB(A) L95, due to the noise floor of instrumentation used.

# Preliminary Findings to Date

- At none of the house has the dB(G) been above 85 and therefore if that level has taken as the hearing threshold of infrasound then there is no audible infrasound in any of the houses
- The presence of the wind turbine signature, which is related to the blade pass frequency and multiple harmonics of that frequency, is readily identified inside dwellings and at times outside dwellings.
- The wind turbines signature does not exist when the turbines are not operational.
- The use of 1/3 octave band information to compare infrasound generated by turbines and the infrasound in the natural environment does not contain the required information to identify any difference. When supplemented by narrow band analysis of the infrasound region the results clearly show that the natural environment of infrasound has no such periodic patterns.
- Electrical interference/surges in mains + very strong winds has created problems with some data collection.
- The significant amount of data that is available from the monitoring will require further time for detailed analysis in view of issues that have been raised by the residents during the course of the monitoring and the findings to date.
- Analysis of vibration measurements around an inside houses is yet to be undertaken.
- Basic material is to be presented looking at the pitch angles etc. during certain time periods for further analysis by Pacific Hydro and its turbine suppliers.
- The resident's observations and identification of sensation separately to vibration and noise indicates that the major source of complaint for the operation of the turbines would appear to be related to sensation rather than noise.