Responses to Technical Issues Raised at the June 6, 2011
Falmouth Board of Selectmen Meeting

Abutters and other speakers raised questions at the June 6 meeting on the technical aspects of Falmouth's wind turbines. The Town and its consultants prepared these brief responses and provided a chronology of responses to residents' inquiries.

Flicker

Wind turbines have the potential to create shadow flicker at the wastewater treatment facility property and in other areas at certain distances and directions beyond the property boundaries. Shadow flicker will occur under certain conditions of sunlight intensity, time of day, and wind speed and direction, which are predictable in occurrence and duration. The Town's consultants modeled for potential occurrence for shadow flicker using a variety of assumptions and simulated conditions. The receptor location selected for the modeling was on Ambleside Drive in Falmouth, MA. The calculations are worst case scenarios using maximum shadow calculations based on the position of the sun, the location of the turbine and the assumption that each day is clear and sunny, the rotor is always perpendicular to the viewer position and the rotor is always turning.

The results of the modeling indicate the expected number of shadow flicker hours per year for the Ambleside Drive property, which are summarized below.

Shadow Flicker Results per Turbine, hours per year[1]

	Worst Case Greenhouse Mode	Worst Case Unidirectional Mode	Real Case Greenhouse Mode	Real Case Unidirectional Mode
Wind I	41:06	37:04	11:42	10:33
Wind II	53:44	46:43	18:07	15:43
Total Hours Per Year	94:50	83:47	29:49	26:16

[1] This first scenario was performed in omnidirectional or "greenhouse" mode, which assumes that the shadows produced as a result of sunlight passing through the moving blade at the receptor location would be visible in all directions (i.e., there are no walls or ceiling that would obscure the view of the shadows). This scenario was also performed in a fixed unidirectional mode, which assumes that the shadows produced would be visible in only one direction such as where the windows on a building are located. The second modeling scenario was based on "real case" average daily sunshine hours per day per month, derived from nearby weather station data. This scenario was also performed both in omnidirectional "greenhouse" mode and fixed unidirectional mode.

Under "real case" conditions (i.e., taking into account historic local weather patterns), flicker at the Ambleside Drive location occurs 26 hours, 16 minutes per year. This includes 10 hours, 33 minutes per year from Wind I and 15 hours, 43 minutes per year from Wind II.

Mitigation Strategies: The wind turbines for this project are capable of being programmed to operate (or cease operation) based on inputs that include time of day, wind speed, and/or rotor direction. It may also be possible, with the manufacturers engineering support, to integrate the output signal of a pyronometer (a device used to measure sunlight intensity), to also control the turbine operation to minimize flicker impacts, while maximizing the output of the turbine. Simpler and potentially less costly mitigation methods include window blinds or shades. Landscaping can also be used to minimize shadow flicker impacts.

Infrasound and Low Frequency Sound

Infrasound is defined as sound with a frequency too low to be detected by humans under normal conditions. These frequencies range from about 17 hertz, the limits of human hearing, to as low as 0.001 hertz. A sound wave that is 1 hertz has a period of one second. The normal range of human audibility is around 20 to 20,000 Hz. Low-frequency sound is *audible* sound, usually defined in the range of 20 Hz to approximately 200 Hz. Various researchers have conducted numerous studies to determine whether the wind turbines create unacceptable levels of low frequency noise and infrasound. To date, no validated scientific studies have shown that there are any perceptible adverse effects from infrasound from wind turbines in communities at distances such as in Falmouth. Low-frequency sound from wind turbines can be audible when background noise levels are low enough.

As an example of the research that is being done, a major wind energy developer recently commissioned a scientific study of its wind turbine fleet.[2] The study consisted of three parts: (1) a worldwide literature search to determine unbiased guidelines and standards used to evaluate low frequency sound and infrasound, (2) a field study to measure wind turbine noise outside and within nearby residences, and (3) a comparison of the field results to the guidelines and standards. Wind turbines from two different manufacturers were measured at an operating wind farm under controlled conditions with the results compared to established guidelines and standards. The paper presents the results of the low frequency noise and infrasound study.[3]

Sound levels from Siemens SWT 2.93-93 and GE 1.5sle wind turbines under maximum noise conditions at a distance more than 305 meters (1,000 feet) from the nearest residence meet the low frequency and infrasound standards and criteria published by several independent agencies and organizations. At this distance the wind farms met numerous standards for

[2] **Low frequency noise and infrasound from wind turbines,** Robert D. O'Neal, Robert D. Hellweg, Jr and Richard M. Lampeter), Noise Control Engineering Journal, March-April 2011, © 2011 Institute of Noise Control Engineering.

[3] Since the paper reported on low frequency and infrasound emissions, potential annoyance from other aspects of wind turbine operation were not considered, and must be evaluated separately.

indoor levels (including residences and hospitals) and thresholds for annoyance from low frequency sound and beginning of rattles; met standards in other countries around the world; have no audible infrasound to the most sensitive listeners; and might have slightly audible low frequency noise at frequencies at 50 Hz and above, depending on other sources of low frequency noises in homes, such as refrigerators or external traffic or airplanes.

The authors concluded – in conjunction with an extensive literature search of scientific papers and reports – that there should be no adverse public health effects from infrasound or low frequency noise at distances greater than 305 meters (1,000 feet) from the wind turbine types measured: GE 1.5sle and Siemens SWT 2.3-93. In size, these turbines are comparable to or larger than the Falmouth Vestas V82 turbines, and they are also comparable in noise emissions.

Aerodynamic Amplitude Modulation

When a wind turbine is audible, the sound sometimes (but not always) has a swish, swish character, fluctuating about once per second as the turbine blades pass through the air. The regular fluctuating character has been described as "amplitude modulation," or sometimes "aerodynamic amplitude modulation." Since this characteristic of wind turbine sound has been described, some articles have been written about it by acoustical professionals and others. There is an indication in some research that regular fluctuating noise of this kind may be more annoying to some people than randomly fluctuating noise such as road traffic, or steady noise. However, to date, no standard guidance or consensus among acoustical professionals has emerged about how amplitude modulation sound from wind turbines should or could be handled differently in studies of noise effects from wind turbines. Turbine noise emissions continue to be assessed by the overall A-weighted equivalent (or energy-average) sound level. This metric, which emphasizes the louder sounds, is used widely around the world to assess the effects of noise on people from all kinds of noise sources, ranging from power plants to highways to aircraft.

Safety

The Town has an incident notification plan to notify first responders. The fire and police departments have had an opportunity to become familiar with the site layout and the existing turbine. Town staff who work on the wastewater treatment plant site and police and fire department personnel have participated in a 12-hour safety class conducted by Vestas. The Fire Department has an incident plan. The turbines have sensing devices to shut the turbine down if ice formation is detected as an issue. The Town can implement voluntary shut down of the turbine if climatic conditions pose a threat. An example is the shutdown last summer due to hurricane warnings.

Chronology of Siting Public Process – Notices and Updates to Abutters

When Falmouth's Wind Turbine project began, it included notifications by letter and surveys sent to abutters within 900 feet of the property line of the Wastewater Treatment Facility, including multiple addresses on Blacksmith Shop Road, Ambleside Drive and Ridgeview Drive. Where appropriate, Post Office Boxes were used for mailing. The distribution list covered an area three times the normally required notice area for permits. The documents and events listed below were part of the public siting process:

- 2004 Wind Survey
- April 2004 Notice of Meeting
- April 8, 2004 – Wind Forum
- 2004 Wind Field Trips, 30 participants
- January 7, 2005 – update to abutters
- January 27, 2005 – update of test balloon
- April 5, 2005 – notice of anemometer study
- March 26, 2007 – project update
- April 22, 2009 – project update and contact information
- April 5, 2010 – project update and notice of Wind II
- August 25, 2010 – Andersen request to Building Commissioner for cease-and-desist
- September 24, 2010 – Building Commissioner denies request
- October 4, 2010 – Andersen appeal of Building Commissioner denial filed with ZBA
- December 2, 2010 – ZBA opens public hearing process for Andersen appeal
- February 17, 2011 – ZBA appeal decision rendered
- March 3, 2011 – ZBA files notice of appeal denial
- March 21, 2011 – Appeal of ZBA denial filed with Barnstable County Superior Court

Chronology of Town Manager/Board of Selectmen Responses to Abutter Inquiries

The Town has responded to abutter complaints, requests for information and other inquiries, since Wind I began operation. Below is a summary chronology of key communications and responses.

2010

April 6 – Wind I begins operation at Blacksmith Shop Road wastewater treatment facility; Town Manager's Office begins receiving complaints from a limited group of abutters and implements

a policy of responding to each communication; Town staff also meet with individuals as requested

April – Town notifies Vestas of complaints and restricts turbine operation until conditions can be investigated; Vestas conducts maintenance on the turbine and it is placed back into operation.

Early June – The Town authorizes Weston & Sampson to engage Harris Miller Miller & Hanson (HMMH) to conduct a sound study and Regina Villa Associates to assist with communications.

June 10 – Town Manager and Assistant Town Manager meet with a group of 18 abutters, their attorney (Christopher Senie) and sound consultant (Noise Control Engineering) to discuss the proposed scope of work for a sound study and gather input.

June 14 – HMMH, Weston and Sampson, and Noise Control Engineering meet at HMMH offices to review and decide on scopes of work and division of labor/responsibilities for the Noise study.

June 15 – Town distributes Sound Study log sheets to almost 300 residents in the vicinity of Wind I and the future Wind II via mail; the purpose of the log sheets was to attempt to correlate anecdotal information about residents' experiences with monitoring data; NCE collected the log sheets.

June 18 to June 28 – Sound Study data gathering takes place.

Early July – Falmouth establishes a special page on the Town website for Wind Energy Project information where documents are posted; establishes gmail account to collect and log complaints and comments, respond as appropriate and distributes updates and other project information.

July 8 – Falmouth distributes Sound Study Update to almost 300 residents in the vicinity of Wind I and the future Wind II via mail and email.

August 3 – Falmouth posts the Wind Energy Project FAQ describing the project background and benefits and summarizing the sound study and how to stay involved and notifies e-list.

August 11 – The Town posts the sound study raw data and notifies e-list it is available.

September 27 – Town representatives meet with group of 18 abutters and other interested parties to present the Sound Study findings and NCE response; the Town posts the Sound Study Report and notifies e-list.

October 8 – The Town writes to Attorney Christopher Senie detailing proposed mitigation measures and inviting responses.

October 15 – Falmouth receives a response from Attorney Senie deeming mitigation proposals wholly inadequate; the letter does not offer a counter-proposal of acceptable measures.

2011

January 14 – The Town writes to abutter Malcolm Donald responding to his public records request and offering to meet to discuss concerns and sends a similar offer to meet with abutter Barry Funfar; no response has been received from either abutter.

January 24 – MassDEP requests additional analysis and Town authorizes HMMH to proceed.

February 23 – The Town notifies Attorney Senie that the turbine operation will be curtailed during the hours of 12 AM to 3 AM each night in response to abutter concerns.

March 4 – HMMH and Weston & Sampson meet with DEP at SERO in Lakeville to review the noise study results and DEP's data requests.

March 7 – The Board of Selectmen vote to curtail the turbine temporarily at high wind speeds.

March 31 – The Town posts its first annual report on Wind 1 operations and permits, agreements, costs and energy production.

April 26 – The Town posts HMMH's Sound Study Addendum addressing MassDEP's request and notifies e-list that it is available.

June 6 – The Board of Selectmen hold a meeting to hear presentations and collect comments to consider in developing a wind energy facilities operations plan.

June 7 – Falmouth posts June 6 meeting presentations and notifies e-list they are available.

July 11 – Board of Selectmen holds second meeting to continue hearing from experts and residents.

Note: *The Town continues to collect and record complaints and respond to requests for information and other communications from residents and interested parties.*