



# Renewable Energy Research Laboratory

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## Wind Power in Yarmouth: Siting Considerations for a Met Tower, and Fatal Flaws Analysis for a Wind Power Project

*This report was funded by the Massachusetts Technology Collaborative Community Wind Collaborative on behalf of the town of Yarmouth. It was prepared by Sally Wright, RERL.*

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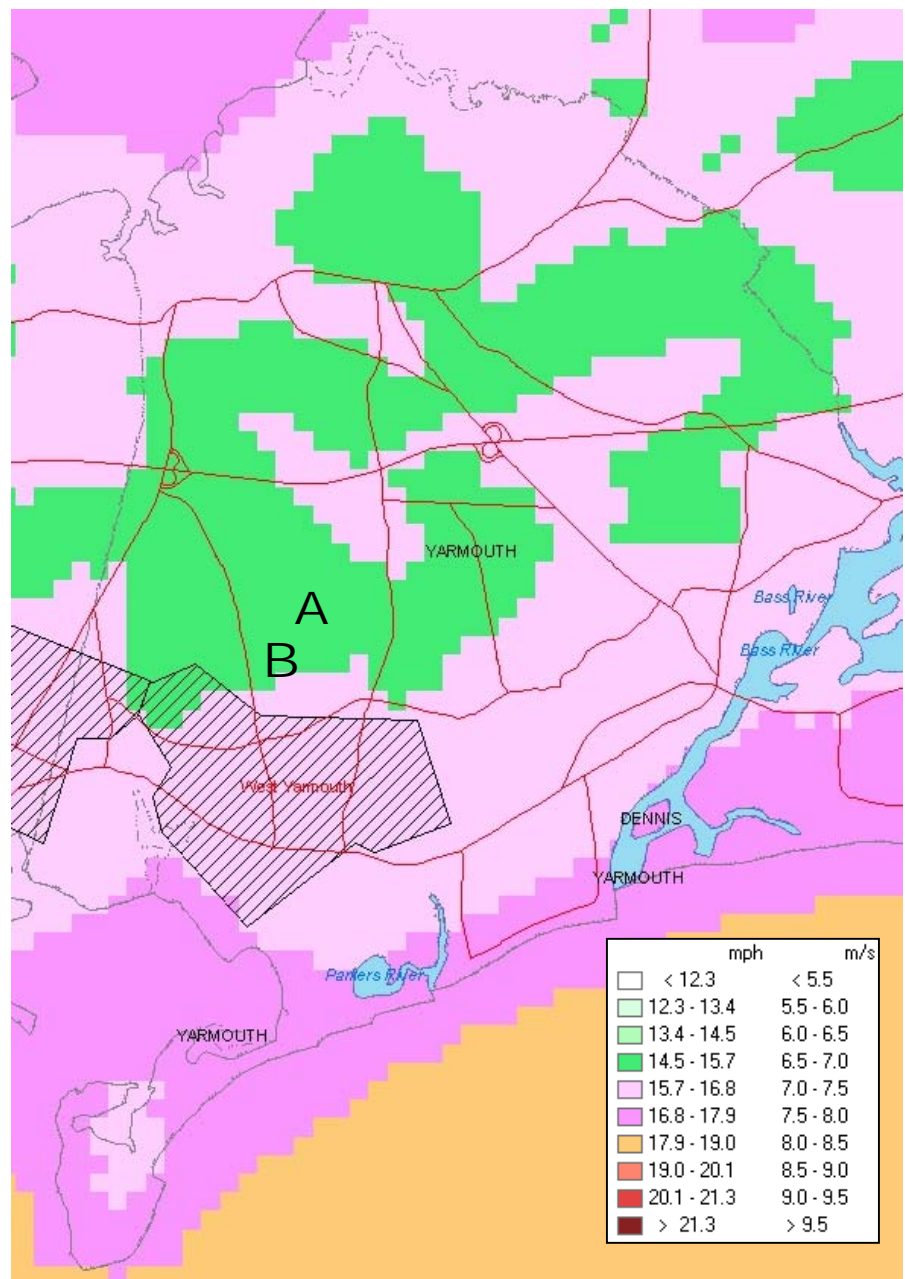
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*Right: Estimated annual average wind speed at 70 meters, in the southern half of Yarmouth.*

*Approximate locations of sites discussed are shown in bold.*

*Sites of primary interest for wind power have a mean wind speed of 6.5 m/s or over, i.e. shown in dark green, pink or orange.*

*(TrueWind Solutions,  
[truewind.teamcamelot.com/ne/](http://truewind.teamcamelot.com/ne/))*





## 1. Introduction

At the request of the Massachusetts Technology Collaborative's Renewable Energy Trust, Sally Wright of the UMass Renewable Energy Research Lab (RERL), Dick Elrick of the MTC, and the Yarmouth Energy Committee visited several potential wind turbine and/or wind monitoring sites in Yarmouth in November of 2004. This report focuses on the siting considerations for wind-monitoring towers (met towers) as well as some of the logistics for met tower installation. Additionally, it takes into consideration a few logistical considerations in a broad "fatal flaw" analysis for potential wind turbine installations. This report is not intended as and should not be considered a wind turbine siting study.

### Note

This document assumes some familiarity with wind power technology on a community scale, as well as wind resource assessment. For an introduction to these areas, please refer to RERL's Community Wind Fact Sheets, which are available on the web at: [www.ceere.org/rerl/about\\_wind/](http://www.ceere.org/rerl/about_wind/). These sheets include information on the following subjects:

- [Wind Technology Today](#)
- [Performance, Integration, & Economics](#)
- [Capacity Factor, Intermittency, and what happens when the wind doesn't blow?](#)
- [Impacts & Issues](#)
- [Siting in Communities](#)
- [Resource Assessment](#)
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## 2. Sites considered

This report focuses on an area of town-owned land that was identified by the Yarmouth Energy Committee for consideration. During the site visit we looked at two locations within this area:

- Near one of the pump houses, at DPW well 13
- Along a dirt road that leads to another DPW well, behind police station.

Following is a listing of site characteristics for these locations. The subsequent pages show an ortho-photo that identifies sites A & B, and a photograph of site B.

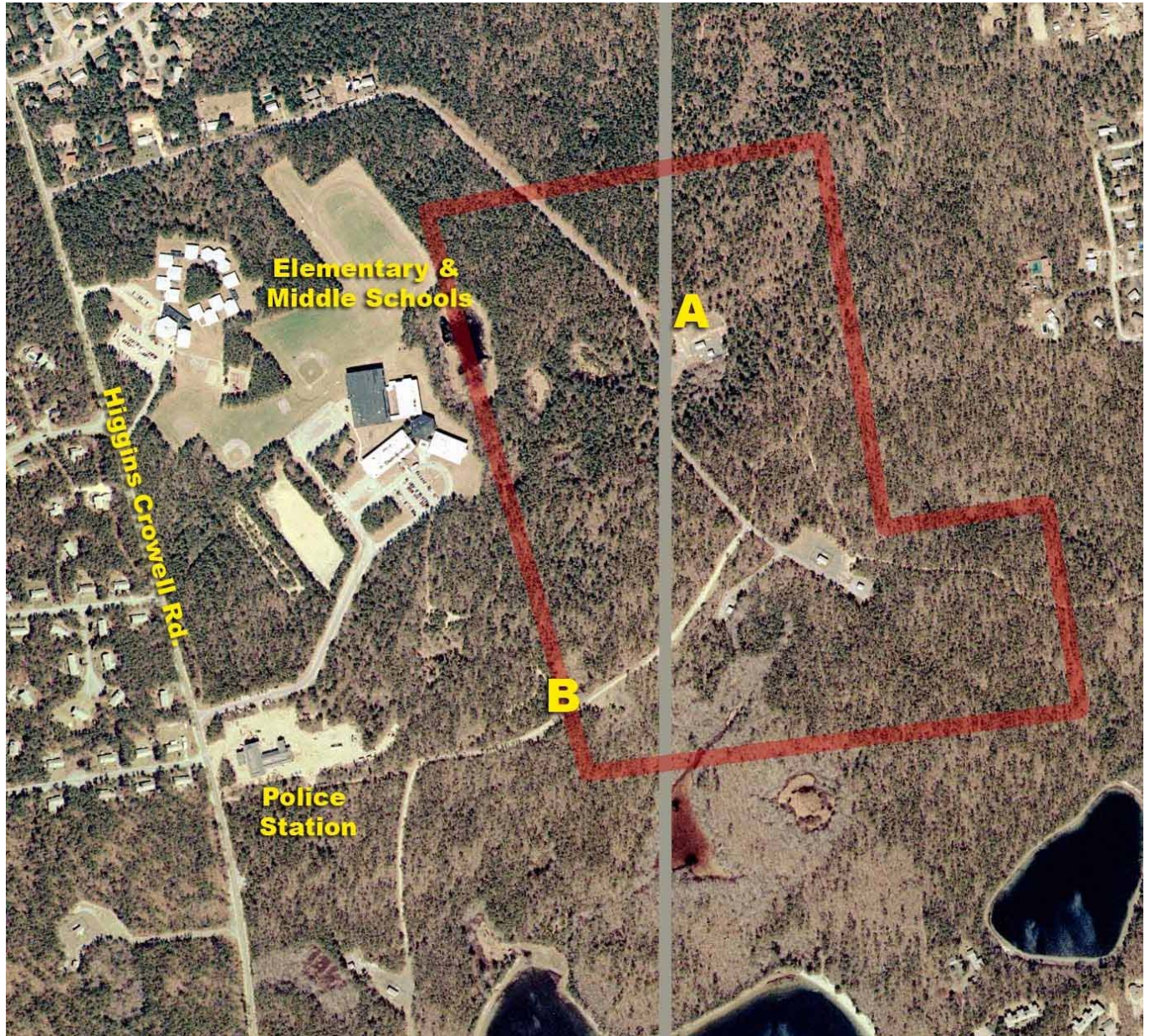
### Site characteristics

Site:	A.	B.
Description of location	Near well head 13	Road behind police station
Owner	Town of Yarmouth	
Location (NAD 27 UTM 19)	Zone 19, 396839 4614025	Zone 19, 396640 4613558
Location (NAD 83, D-M-S)	N41° 40' 23.5" W70° 14' 19.4"	N41° 40' 08.3" W70° 14' 27.7"
Clearing, terrain, obstacles to wind	<p>Flat terrain. The site will need clearing to make room for met tower's guy wires</p> <p>Trees about 40' tall will obstruct wind. For the met tower this results in poorer quality data. For a wind turbine, this reduces energy production and increases expected turbine maintenance.</p>	
Power lines or other obstructions to met tower. <i>(Met tower must be set at least 1.5 x the tower height away from power lines.)</i>	The site must be chosen so that the met tower will be far enough away from existing power lines.	None
Road Access for met tower installation	Good road to site	
Nearby airports	The site is within 1.5 miles of the Barnstable Airport.	
Soil quality for met tower anchors	Possibly quite sandy; may need larger or more anchors than usual	
Security:	The area is in town land that is monitored regularly by DPW staff, but it is also used for recreation.	
Distance to Distribution/Transmission lines	On site	Nearby
On-site electrical loads	TBD	TBD
Electric costs	TBD	TBD
Nearby residential areas:	More than 1,400' away	More than 1,500' away
Other notes	A wind turbine may have to be sited at least 400 feet away from the wellheads themselves. This is not an obstacle but should be kept in mind.	

**Maps:**

Below: Ortho-photograph of the watershed area, marked with the sites A & B.

The red outline indicates the area identified by the town for consideration for wind turbines. This land is town-owned.



## Photo

Below: Photo of Site B



### 3. Predicted Wind Resource

#### TrueWind estimates of annual average wind speed

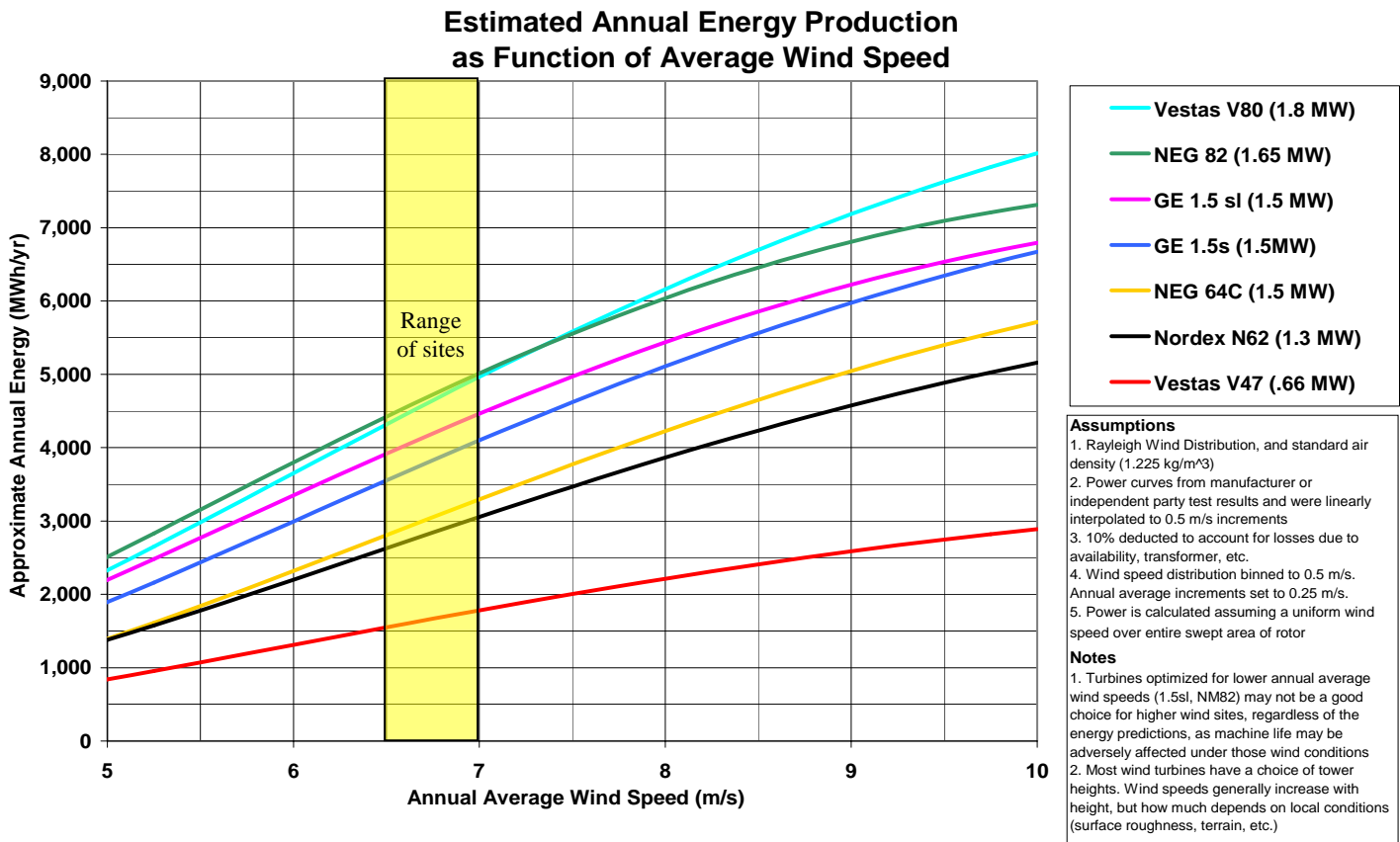
According to the modeled wind speeds in the TrueWind map included on the first page of this report, predicted annual average wind speeds are as follows:

Estimated annual average wind speeds	A.	B.
At a height of 70 m	6.5 –7.0 m/s (14.5 – 15.7 mph)	6.5 –7.0 m/s (14.5 – 15.7 mph)

These TrueWind estimates are used for screening and do not eliminate the need for site-specific anemometry.

#### The importance of wind speed

The feasibility of wind power depends on many factors. One of the most important factors is wind speed. The power in wind varies with the cube of its speed, so small changes or inaccuracies in wind speed will mean big changes in annual energy production. The chart below demonstrates the impact of mean wind speed on wind turbine output at the two sites. Note that *both* axes of this graph, wind speeds and the annual energy, are estimates.



## **Other available wind data**

The Massachusetts Division of Energy Resources (DOER) studied wind in 1995-1997, at the Trash Transfer & Wastewater Treatment Station in northern Yarmouth, and on a radio tower in southern Yarmouth. The first was a 100-foot-tall (30.5 m) met tower, located 2.6 miles to the NNE of the current proposed spot. The annual average of those datasets were 4.5.9 m/s at a height of 30.5 meters. For comparison, AWS TrueWind predicts an annual average of 5.6 m/s at 30 meters height for that location. Thirty-meter met towers are no longer commonly used for collecting wind power data; it would still be useful to measure with a taller tower that will provide more information about shear and higher level winds.

Other anemometry in the area include:

- A met tower at Cape Cod Community College, about 5 miles to the west-northwest
- A set of anemometers, 7 miles to the south at Bishop and Clerks in Nantucket Sound, operated by RERL
- CapeWind's met tower is offshore to the south
- A met tower at Orleans, operated by RERL, about 14 miles to the east
- A met tower at Bourne, operated by RERL, about 18 miles to the west

The data for Orleans, Bourne, Bishops & Clerk, and Yarmouth are available on RERL's website, [http://www.ceere.org/rerl/rerl\\_resourcedata.html](http://www.ceere.org/rerl/rerl_resourcedata.html).

## **Obstacles to wind flow**

All sites have mature trees about 40 feet tall that will cause turbulence and slowing of the wind.

These are important factors in site selection for a wind turbine because they affect the power production.

## **Proximity of anemometry & turbine**

Note that while wind resource assessment directly on the proposed wind turbine site is preferred, it is not required. If wind data are gathered in one spot, but a site for a wind turbine is chosen in another nearby location, then a computer model that considers the wind data and terrain can be used to extrapolate the data from one location to the other. However, as the two sites become farther apart, the level of certainty in the data goes down, and thus the amount of risk in the investment goes up. It is difficult to predict the rate at which the certainty changes with distance, and can only be estimated on a site-specific basis.

Wind Resource data gathered at site B can be used for other sites within the watershed area with reasonable accuracy. So a precise location for a wind turbine within the watershed does not have to be chosen before the met tower is located.

## **Appropriateness of anemometry**

The expected wind resource and the town support are good enough that wind resource assessment is appropriate. The remainder of this report will look at preliminary siting logistics for wind turbines and met towers at and around these sites.

## **Conclusion**

The town representatives preferred site B. They agreed to clear sufficient space for the met tower there. RERL agrees that this is an appropriate place for understanding the wind resource available to a turbine to be placed within the watershed.

The rest of the report will focus will on site B.

## 4. Wind Turbine Siting Considerations

As mentioned in the previous section, it is important to try to measure the wind as close to a potential wind turbine site as possible. Therefore turbine-siting criteria should be taken into consideration when siting a met tower. The purpose of this section is to consider whether there are any “fatal flows” to siting a wind turbine within the watershed.

We stress that a site for a wind turbine has not yet been considered in any depth and siting of a wind turbine is not the intended purpose of this report. Rather, this section is intended to inform the decision of where to measure the wind.

Furthermore, a scale of wind turbine has not been chosen. For the purposes of this discussion, it is assumed that a commercial-scale (660 – 1800 kW) wind turbine will be chosen for the shore sites, but medium-scale turbines may also be feasible.

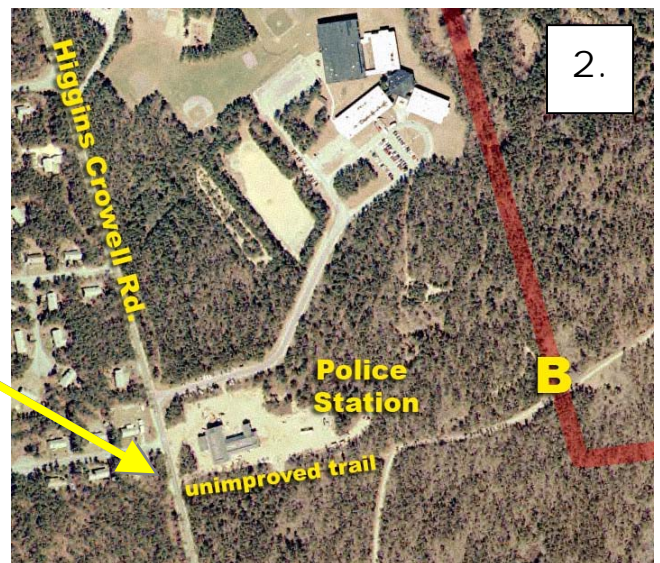
### Transportation accessibility for turbine installation

With blades up to 130 feet long, modern wind turbines require transportation on roads with a fairly large turning radius and only small changes in slope.

Assuming a turbine blade can get onto Cape Cod and onto Route 6 (whether by land or sea), only two turns are tight, as seen in the aerial photos at right.

1. Exit 7 from Route 6 onto Higgins Crowell Road: This turn can probably accommodate a megawatt-scale turbine blade without significant modification but this should be examined more closely
2. Higgins Crowell Road onto the site access road: The beginning of the road to the site includes an unimproved trail. Either that trail or the police station parking lot will be the access road. If the trail is chosen, it will need to be improved, and an adequate radius made at the entrance.

Subsequent phases of study should take a more detailed look at site access.



## Distance to distribution or transmission lines for power distribution:

Distribution-level power is on site at the police station and also within the watershed at the wells. The distance to distribution lines will depend on the exact site chosen for a wind turbine, but it is not prohibitively distant in any case.

## Noise

Noise considerations generally take two forms, State noise regulations, and nuisance levels at nearby residences:

A. Massachusetts state regulations do not allow a rise of 10 dB or greater above background levels at a property boundary (Massachusetts Air Pollution Control Regulations, Regulation 310 CMR 7.10). This sound level is very unlikely to be reached in any case at the sites we examined

B. Aside from Massachusetts regulations, residences must also be taken into consideration. Any eventual turbine would be sited such that it would be inaudible or minimally audible at the nearest residences. At this stage, to check for “fatal flaws,” a rule of thumb can be used: to minimize possible noise impacts, site wind turbines at least three times the blade tip height from residences. Distances from mixed-use areas may be somewhat shorter.

Residences and other noise-sensitive areas lie on the edges of the watershed area, but the watershed is large enough that a turbine or turbines could be sited far enough away, so that noise is unlikely to be an issue here.

## Nearby Airports

The nearest airport is Barnstable Municipal Airport, 1.45 miles from site B.

The FAA requires that any structure over 200' be lit. A Form 7460-1 (Notice Of Proposed Construction Or Alteration) would be sent to the FAA for any proposed wind turbine installation. Any concerns of airport personnel and other air safety regulators would be considered as part of the turbine siting process.

**Right:** Map showing direction from Site B to Barnstable Municipal Airport



## Other Environmental issues

To our knowledge, no endangered species have been identified in this location, although the area is classified as a Natural Heritage core habitat, Coastal Atlantic White Cedar Swamp (see [www.mass.gov/dfwele/dfw/nhesp/twnrpts/yarmouth\\_core\\_habitats.pdf](http://www.mass.gov/dfwele/dfw/nhesp/twnrpts/yarmouth_core_habitats.pdf).)

## **5. Anemometry Installation Logistics**

### **Site Owner Responsibilities**

RERL is pleased to offer wind-monitoring services to the town through MTC's Community Wind Collaborative. The town's in-kind assistance will be needed in several aspects of installing a met tower. The town of Yarmouth would be responsible for security, some minor maintenance, insurance, and permitting. They are described as follows:

### **Security**

The security of the loaned monitoring equipment is the responsibility of the town. The town is expected to protect the site to its satisfaction – e.g. by installing a fence around the tower base if this seems necessary. If the site manager prefers, RERL can place the logger high enough up the pole that a ladder is required to reach it. Additionally, if PV panels are needed for FAA lighting, these would be located near the base of the met tower, and towns typically fence them in.

### **Maintenance**

Met towers have data loggers mounted at the base, to collect the wind data. The data loggers require that a memory card be periodically swapped and mailed back to RERL. Additionally, the person replacing the card would look at the tower and report anything unusual to RERL. A designated town representative (or representatives) will be trained in these simple operations at the time of installation.

### **Liability and Insurance**

The RERL loans industry-standard wind-monitoring equipment under a standard loan agreement. The form can be found at [www.ceere.org/rerl/projects/support/weps/agreement.pdf](http://www.ceere.org/rerl/projects/support/weps/agreement.pdf) or contact RERL for a copy.

The Trust requires that the site owner carry liability insurance for the met tower and name the Trust as an insured party. This requirement is described in the loan agreement.

### **Permitting: Local approval process**

RERL will support the site owner in obtaining any necessary local permits for the temporary monitoring tower (e.g. building permits or zoning variances.)

### **In-kind labor**

Some in-kind labor is needed; some items have already been mentioned in this section. Additionally, the town would need to do any clearing needed. If wiring or fencing is needed for lighting (see notes above), this is provided by the town. The site owner also often provides some in-kind labor during installation.

### **Weather**

The met tower cannot be installed in strong winds, rain, or snow. Additionally, the anchors must be installed before the ground is frozen in order to be properly proof tested.

Note that weather-dependence can make the planning of the project somewhat difficult. Typically RERL sets aside a one- to two-week period ahead of time, then a day or two in advance chooses the exact days within this window.

## **Timing & sequence of events**

Met tower installation can proceed when:

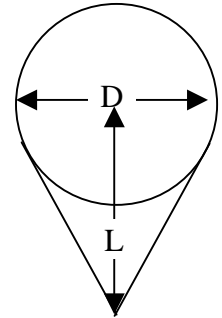
1. The town agrees on a location that is acceptable to RERL and MTC.
2. The site owner secures required permits, if any,
3. A loan agreement is signed and returned to the RERL, and insurance coverage is confirmed,
4. Anchoring systems have been designed, installed and tested, and,
5. The RERL can schedule a work-crew, equipment – and of course good weather!

## 6. Anemometry Siting Considerations

### Space required for a met tower in general

Clearing is necessary both for met tower installation and to reduce ground effect disturbance during data collection. The cleared area is shaped like a circle for the guy wires, with an additional “wedge” in which the tower is assembled before raising. The *minimum* cleared areas for guyed towers are:

Tower Height	Minimum D (Guy diam.)	Minimum L (Space to lay the tower down)	Total Envelope
40 meter (131')	160 feet (49 m)	135 feet (41 m)	215 x 160 feet (66 x 49 m)
50 meter (164')	240 feet (73 m)	165 feet (50 m)	285 x 240 feet (87 x 73 m)



To get a feel for the amount of space needed for a guyed met tower, compare these sizes to a football field, which is 300' x 160'.

In general, a larger cleared area reduces the disturbances seen by the instruments, and improves data quality. Therefore, a cleared area larger than the minimum size is preferred. While it is not necessary to pull stumps, removing as much obstruction and underbrush as possible will facilitate the raising of the tower. Guy-wires will be pulled across this field, and any obstacles that entangle the wires make the job more difficult.

It is also essential that there not be any electric or telephone wires within 1.5 times the height of the tower, i.e. 200 feet of a 40 m tower, or 250 feet of a 50 m tower.

Trees must be cleared at least the height of the trees away from the anchors to eliminate the danger of a falling tree hitting the guys. For example, a 50-foot-tall tree within less than 50 feet of an anchor must be cut down.

### Space availability at the Yarmouth sites

There is adequate space for a met tower at either site A or B, but clearing will be required in both cases.

### Accessibility for met tower installation

All sites are easily reachable by RERL's truck.

### Nearby Airports & FAA restrictions for met towers

The FAA may require lighting on a met tower at this location. An FAA form 7460-1 should be filed for the met tower.

## **Lighting**

The FAA filing will determine if met tower lighting is required.

If lighting is required, either a source of 120 VAC power or sufficient photovoltaic panels and batteries will be needed as an energy source for the light.

The Trust recommends FAA lighting of met towers even if not required by the FAA. This would be left to the discretion of the town and MTC.

## **Distance to power lines (for met tower lighting)**

If lighting is required, 120 VAC power is close enough that we recommend wiring be run to the met tower base.

## **Soil quality & Anchor requirements**

While the soil is probably quite sandy, RERL's standard anchors should be adequate and will be tested on the site.

## **Choice of site**

The town has expressed a preference for Site B, which is agreeable to RERL.

## 7. Conclusions & Next Steps

Preliminary inspection indicates that Yarmouth has sufficient wind speeds to warrant consideration of wind power. To understand this with more certainty requires the installation of a temporary wind-monitoring tower (“met tower”).

### Next Steps

If the town of Yarmouth is interested in pursuing land-based wind power for municipal use on watershed land, representatives should confirm their interest to the Trust. The Trust can then authorize RERL to proceed with wind resource assessment services.

The following are recommendations for next steps in pursuing wind power at this site:

- Met tower size recommendation: a 50-meter should be used to better understand the higher-altitude winds and the wind shear in this forested area.
- FAA: The following forms should be submitted for both a met tower and a wind turbine of the desired size.
  - FAA form “7460-1: Notice of Proposed Construction or Alternation”
  - Massachusetts Aeronautics Commission (MAC) form “Request for Airspace Review”

Forms should be filed for the wind turbine before installing a met tower, in order to understand what restrictions if any the FAA will impose on turbine installation at this location.

The forms are submitted by the town, but RERL will assist the town in filing these forms.

An in-person meeting with a representative of the local airport may also be advisable.

*Time frame*: RERL can fill out the FAA and MAC forms as soon as this proposal is accepted by the town and by the MTC. It can take up to three months for a response.

- Permits: determine if any local permits (e.g. building, zoning, etc.) are required for the temporary met tower. If so, acquire those permits.

*Time frame*: This can begin immediately.

- Clearing for the met tower: Sufficient area will need to be cleared at the chosen site.

*Time frame*: This can begin after receiving positive results from the previous two steps.