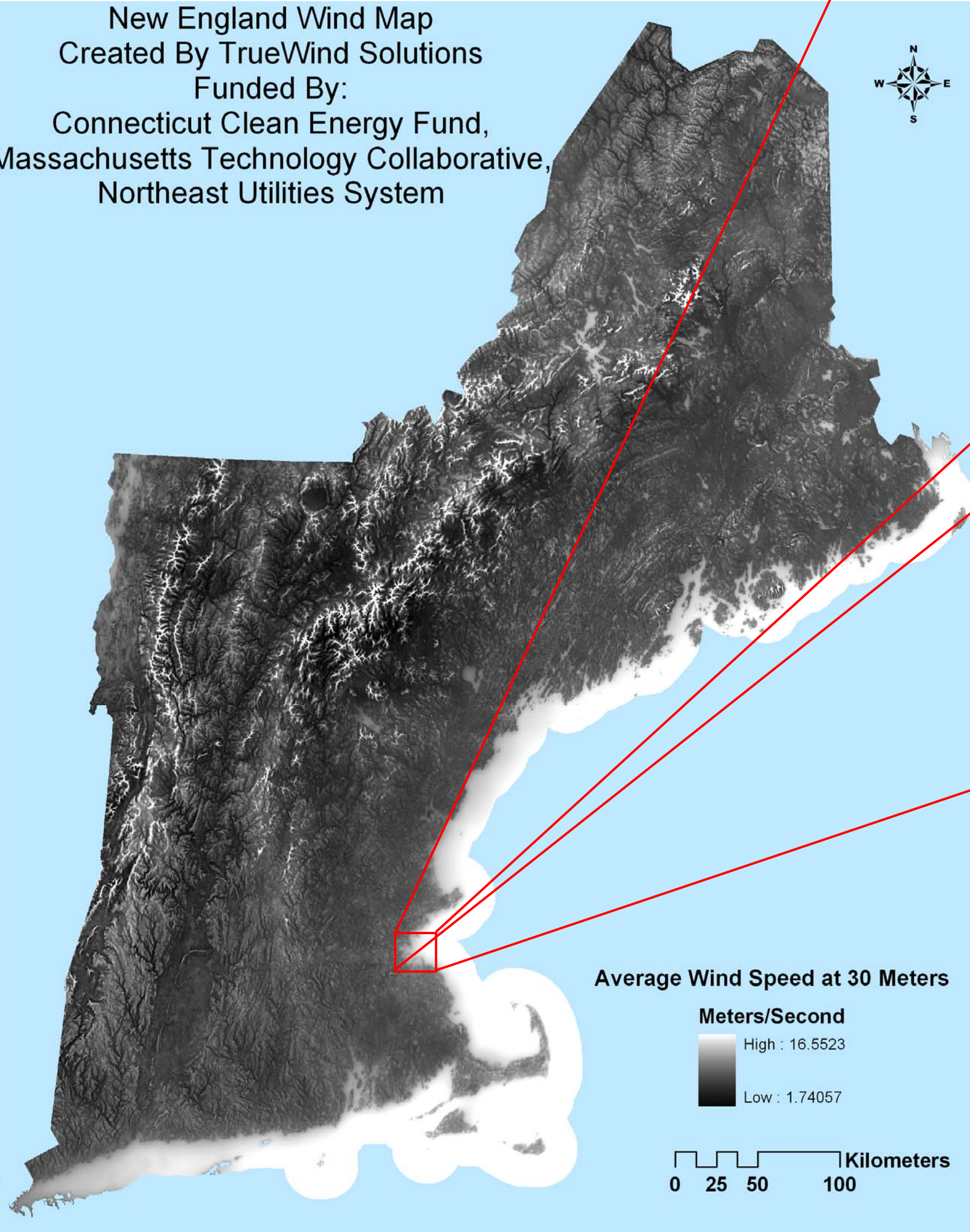


**Introduction:**  
With rising energy costs and continued climate impact concerns, there is a growing need to explore options beyond fossil fuel sources. Renewable energy, such as wind energy, is increasingly in demand. However, despite large gains in global capacity, wind energy still remains fraught with obstacles to greater adoption.

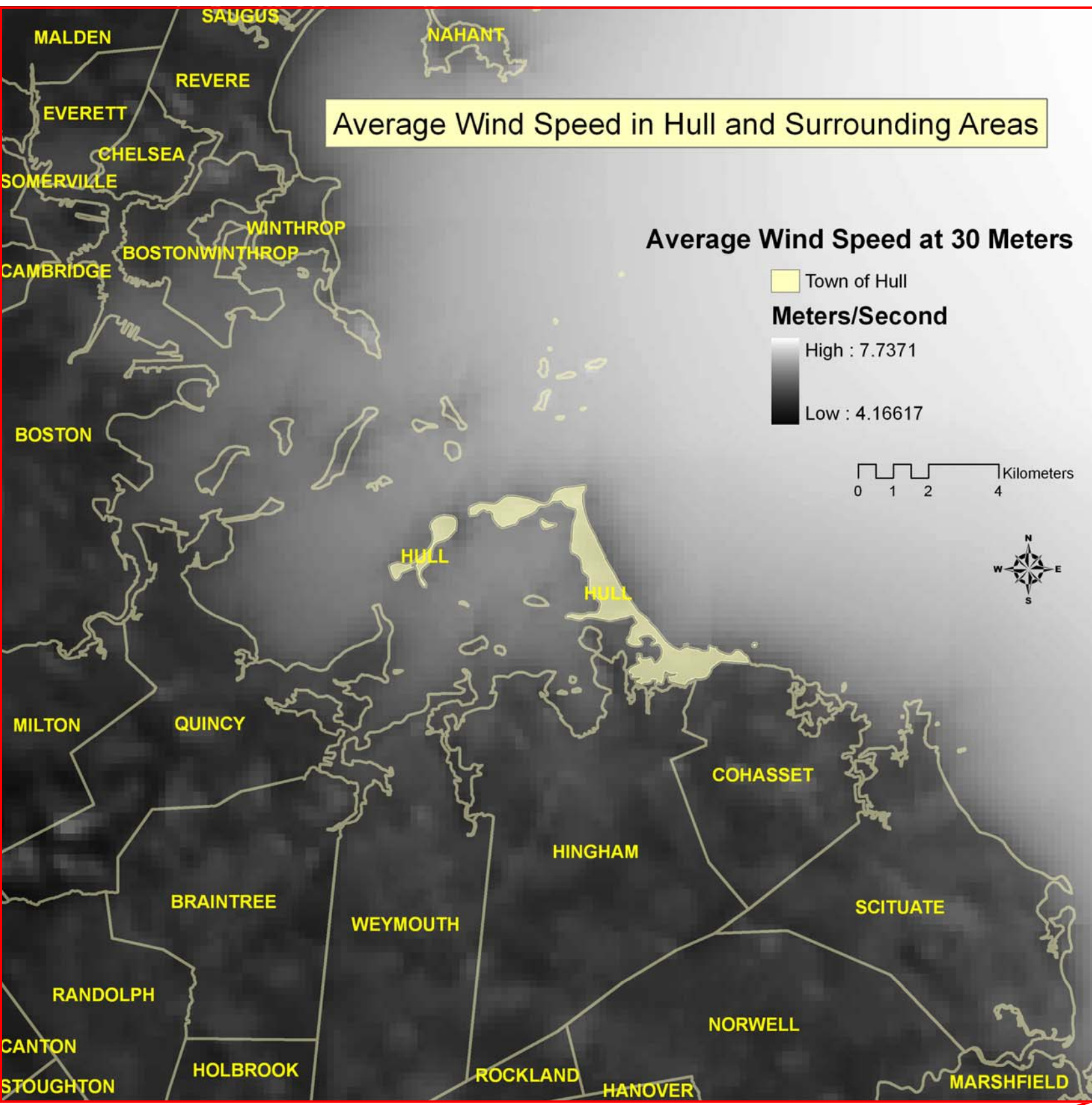
Historically, wind energy was a small scale process until advances in harvesting wind made the concept of large commercial wind projects viable. A return to very modest wind systems may solve some of the hurdles that face wind energy. The idea of “small wind” is finding a rebirth as electricity users are seeking ways to reduce their electric costs from utilities. Generally considered small scale in power generation (less than 100 Kw) and used primarily in customer-sited applications, small wind systems have been used successfully for decades for consumers who found it difficult to be on an electric grid network. Now small wind may be a solution for those who want to augment their dependence to the grid. Though these small wind systems are far from obtaining the same levels of efficiency that large wind farms are capable of garnishing, they have much smaller obstacles to implementation that can result in real gains in a much shorter time than through large commercial production.



# Modeling Sites Suitable For Small Wind Turbines

Jim Moodie  
Department of Urban & Environmental Policy & Planning  
Tufts University  
May, 2007

**Application of GIS:**  
Most research has been initiated by parties concerned with the placement of large wind facilities designed for the production of commercial electricity. As a result of the large impact and considerable investment required in large commercial wind farms, GIS is used by governments, environmental agencies, utilities, private investors, financial corporations, and local authorities to better understand a proposed project. GIS analysis has been used to argue for and against the placement of wind facilities, and is considered a useful tool in multi-party mediation. GIS in conjunction with wind modeling technology is being used by planners to begin the process of discovering untapped wind resources in areas that are too large or poorly studied in order to cut down on the time and expense of field research. Similar GIS analysis could benefit small wind as both a tool for planners to better understand the impacts of potential bylaws aimed at regulating small wind projects and as a means of locating potential sites appropriate for small wind devices.



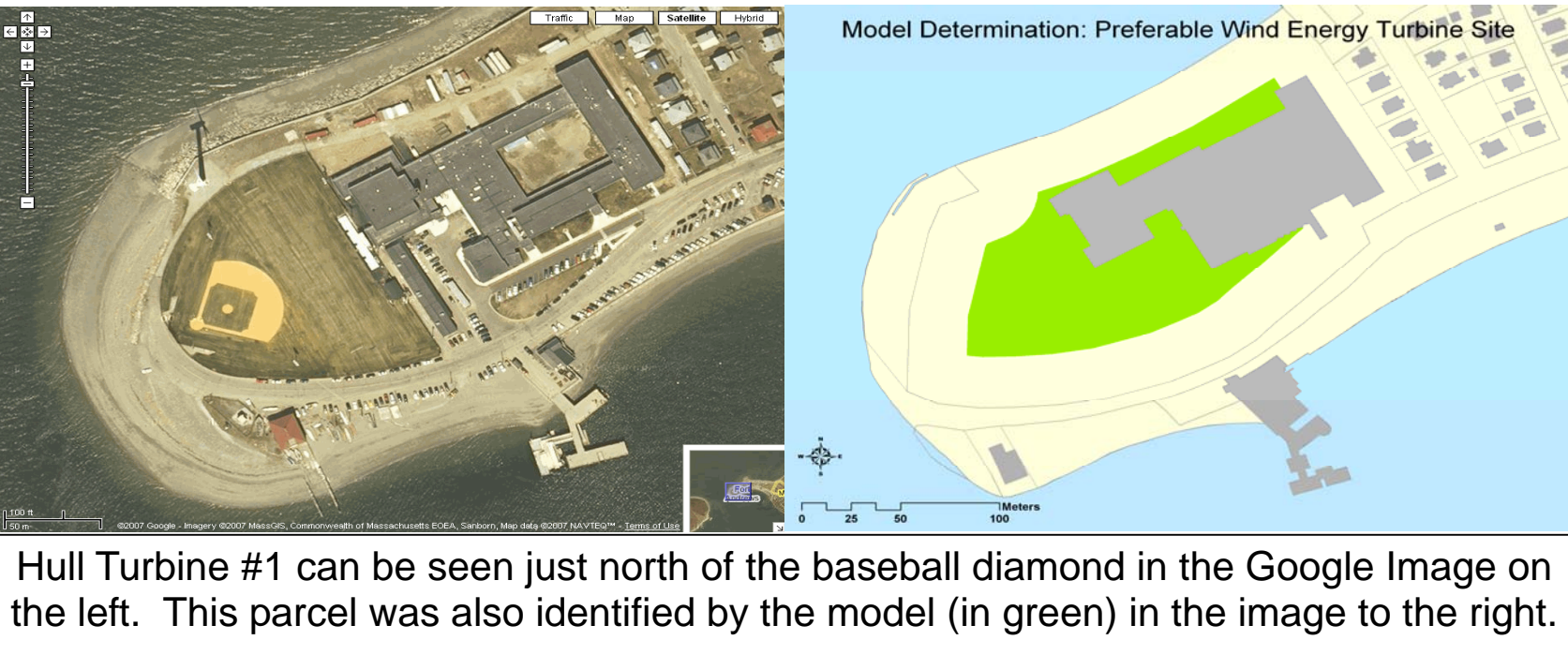
**Considerations Site A Turbine:**  
Currently there are at least three “model bylaws” articulated by organizations within Massachusetts, including The Cape Cod Commission and The Massachusetts Division of Energy Resources. Proposed bylaws governing the siting of wind turbines typically range from requiring a turbine to be setback from all abutting property between one to two times the overall height of the proposed turbine. Further, small wind turbines should not be part of an existing structure to avoid structural and sound pollution concerns.

<b>Sources and Data:</b>
New England Wind Map provided by TrueWind Solutions. Spatial Reference: WGS_1984_UTM_Zone_19N
Town of Hull Parcel and Building Maps provided by the Town of Hull. Projected Coordinate System: NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001_Feet

**Method:**  
A model was created that would allow the ability to change the required offset distances and the proposed turbine heights. With this ability, it becomes easy to quickly generate maps of parcels under varying parameters that are suitable to develop wind turbines on.

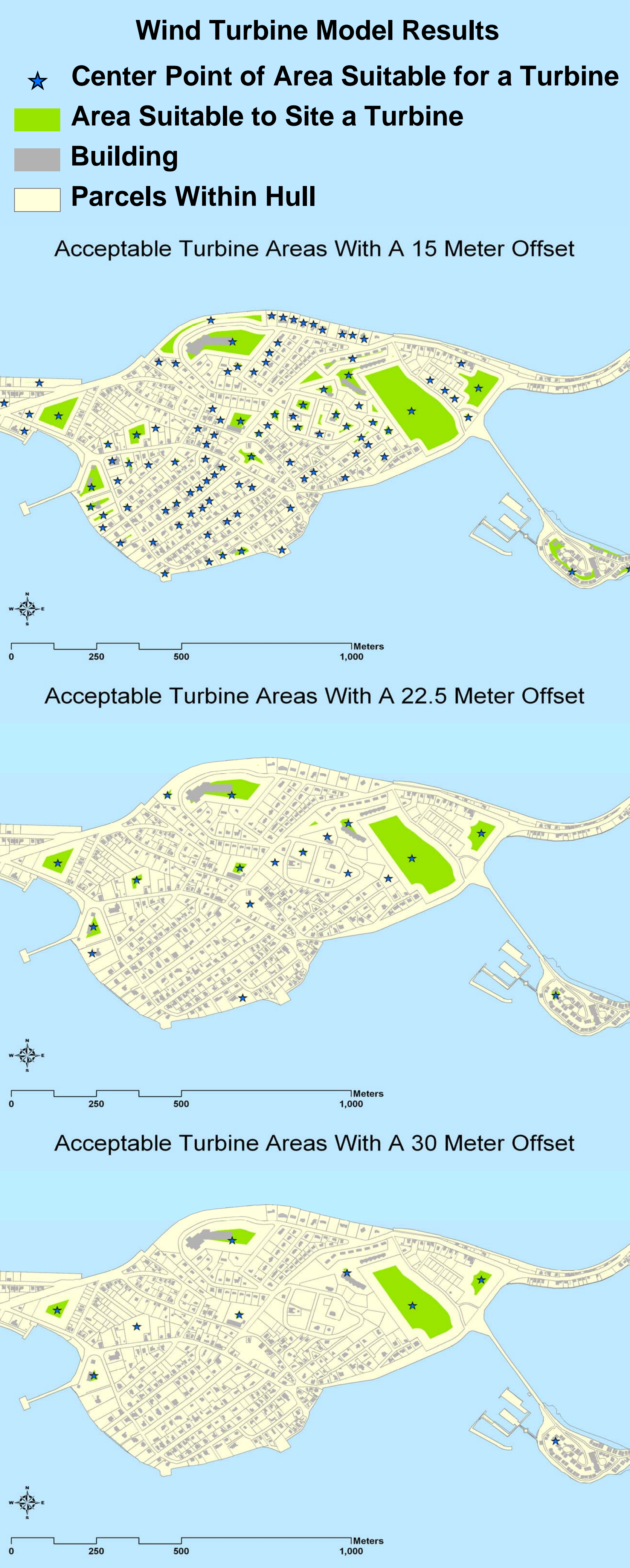
Using parcel and building maps from the Town of Hull, a determination of viable areas for the placement of a wind turbine was conducted by first reducing the parcel areas by the required setback from abutting parcels. From these remaining areas, the footprints of known buildings were “erased.” The estimated wind speed was then extracted from the wind speed resource map (at a height of 30 meters) for the center point of each of the remaining acceptable areas. As the turbine height is a variable within the model, it is necessary for the model to use a known equation to calculate a new estimated average wind speed for the model parameter for turbine height.

**Validation:**  
The model identified areas that are suitable for turbine placement, including Hull High School which has already had a large wind turbine sited near it.



**Results:**  
The model enables easy generation of maps for multiple scenarios. Provided to the right is an example of the model results for forecasting potential turbine placement as result of changing the bylaws that require turbine offsets from adjacent parcels. These three maps detail acceptable turbine placement areas within a neighborhood in Hull when the required offsets are equal to the turbine height, equal to 1 1/2 the turbine height, and twice the turbine height. From the resulting maps we can see that changing the required offset distance from adjacent parcels can have a significant impact on the number of potential wind turbines that can be sited. In this scenario, the Skystream

Required Offset From Abutting Parcels	Potential Number of Turbines With Minimum Average Wind Speed of 5.5 M/S	Estimated Annual Kilowatts Generated at 5.5 M/S From All Turbines Combined
1 Times Turbine Height (15 Meters)	166	796,800
1.5 Times Turbine Height (22.5 Meters)	29	139,200
2 Times Turbine Height (30 Meters)	19	91,200



3.7, manufactured by Southwest Windpower, was modeled at a height of fifteen meters. As the required offsets was increased, the number of viable locations for the turbines decreased dramatically, as did the potential clean energy that could be produced.

**Conclusion:**  
For planners, if the desired outcome is to advance access to clean energy, then restrictive setbacks could greatly reduce the potential power available through small wind construction. Through this model, planners are able to see that slight changes to a proposed bylaw may greatly reduce the likelihood that the goal of the bylaw is achieved.