
# Exploring the impact of the proposed Galloo Island energy project

conducted for the Town of Henderson

submitted by the Nanos Clarkson University Research Collaboration

Project 2016-676, January 2016

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Note: This version of the Clarkson report just has the property value impact part. For the full report see the Town of Henderson website.

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January 20, 2016

Attention: John Culkin, Town Supervisor
Town of Henderson
12105 Town Barn Road
Henderson, NY 13650

Dear Mr. Culkin,

Re: Analysis of the proposed Galloo Island wind energy project

We are pleased to submit the following report on the potential impact of a proposed wind energy facility on Galloo Island which was commissioned, funded, and conducted on behalf of the Town of Henderson.

The report is comprised of the following elements:

- a property value analysis;
- a jobs and tourism analysis; and,
- a viewshed analysis.

Together, the analysis conducted by the research team is intended to support the decision-making process on the proposed project. The research was conducted independently by the project team based on our current understanding of the project and its configuration.


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# 1.0 Executive Summary

The Town of Henderson, New York has been confronted with a challenging development issue. The proposed development of a wind energy facility on Galloo Island has raised concerns by local residents and commercial operators in the Town of Henderson. Uncertainties regarding both social and economic impacts of the proposed development have motivated the Town's leadership to undertake a study of the development proposal's impacts in order to support the local decision-making process

With this in mind, the Town of Henderson has secured the Nanos Clarkson Research Collaboration energy consultant team of experts to assist in determining a series of impacts from the proposed development. The following report provides an overview of property value and economic impacts, as well as a viewshed analysis for the Town of Henderson from the proposed wind energy facility development.

The Galloo Island Wind Energy Facility (henceforth GIWEF) Project was first informally proposed in September 2014 by Albany based Hudson Energy Development LLC under a subsidiary Hudson North Country Wind 1 LLC (henceforth HNCW). Its formal Program Involvement Plan Application occurred in Summer 2015. Its plan comprises 29 turbines located on the privately owned island for an expected 102 MW output. The turbines will be 575 feet high, with blade lengths of 210 feet (Hudson North Country Wind 1, LLC 2015). On Dec. 18, 2015, HNCW sold the project to Apex Clean Energy LLC of Charlottesville, VA.[1]

A key concern of many residents of the Town of Henderson is that the Galloo Island wind facility will negatively impact both property values in the town, as well as economic activity through tourism. These concerns are exacerbated by the fact that the usual benefits which typically accrue to counter potential negative impacts of this type of development, such as payments-in-lieu-of-taxes (PILOTS) or lease payments, are not eligible for residents of the Town of Henderson. As such, the impact of the proposed development on the Town of Henderson is uncertain and requires clarification. This study does not examine environmental benefit / cost impacts for the region as they are beyond the scope of the report as designated by the Town of Henderson.

[1] See "Hudson North Country Wind 1 LLC letter to PSC Secretary notifying of GIWF sale to APEX" at http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=48345&MNO=15-F-0327.

## Key Findings

The Nanos Clarkson Research Collaboration has undertaken a series of analyses, enclosed within the subsequent report, specifically a property value analysis, an economic and jobs analysis, as well as a viewshed analysis. While methodologies (and qualifiers) for the various analyses are highlighted within the report along with report details, the overall general findings can be summarized as follows in terms of the anticipated impacts:

- likely negative land valuations for the Town of Henderson;

These findings are elaborated in more detail within the subsequent report. It should be noted that this study does not examine environmental benefit/cost impacts for the region as they are beyond the scope of the report as designated by the Town of Henderson. Finally, the report includes a series of view-shed analyses for the Town of Henderson in relation to the proposed Galloo Island development. In addition to the enclosed data and documents, the 3-D viewer can be accessed at: http://arcg.is/20Y5VEc in order to provide a more variable tool for analysis and evaluation.[2]

[2] Disclaimer: The Nanos Clarkson Research Collaboration provides analytic services to stakeholders in the energy and environmental arenas and the views and analysis expressed are the authors'. They do not necessarily represent the policies or views of Clarkson University.

# 2.0 Town of Henderson Property Value Analysis in regards to Proposed Galloo Island Facility

## 2.1 Introduction

One concern of many residents of the Town of Henderson is that the Galloo Island wind facility will negatively impact the value of their properties in the town. This section looks at that issue using an analysis of the impacts of the Wolfe Island wind facility in northern Jefferson County. Building on that analysis, the team projected impacts on residential properties in the Town of Henderson.

There are a number of factors related to wind power generation facilities which may result in changes to local property values. For example, both noise and views are often a cause of concern for local homeowners with a potential new project. Wind turbines have become quieter in recent years, but there remain concerns about low frequency noise that dissipates slowly over distance (Bolin, Bluhm, Eriksson, & Nilsson, 2011). In addition, some people raise concerns about health effects, primarily related to noise, although the scientific literature has not found a solid link between the two (Council of Canadian Academies, Expert Panel on Wind Turbine Noise and Human Health, 2015).

Visually, wind turbines are, at the least, large human-made structures that represent a significant change to the landscape. In addition, if wind turbines are improperly sited, there can be more acute visual disamenities such as shadow flicker, when rotating shadows move over a parcel. Flicker is very unlikely to be an impact in Henderson, however, given the relatively large distance of the Town from the turbines. Another visual impact is the array of blinking red lights that sit atop the wind turbine hubs.

Acting counter to these negative impacts are other impacts that may generate a positive effect on property values. These include the benefits from payments-in-lieu-of-taxes (PILOTS) and payments to individual landowners. The first of these would be expected to reduce taxes or increase local public services, or both, while the second would at least have a multiplier effect on the local economy. However, in the case of Henderson, neither of these effects is likely since it is our understanding that Henderson will not be getting PILOT money nor will any Henderson property owners be receiving lease payments. The fact that Henderson landowners may be affected by visual disamenities from the Galloo Island facility, while not receiving any payment as compensation, provides reason to believe that the impact on property values may be negative.

## 2.2 Existing Literature on Property Value Impacts

There exists a growing scientific literature on the impacts of wind turbines on property values. This literature is not conclusive and a main conclusion from a detailed read of this literature is that the specific context and policy parameters matter tremendously in driving property value impacts. Amongst the first studies of this issue are Sims & Dent (2007) and Sims, Dent, & Oskrochi (2008). Neither of these studies finds any significant impact on property values in a study of facilities in the United Kingdom. Unfortunately, these studies are based, on small samples and in areas with significant confounding factors which make interpretation difficult.

The largest studies of wind turbines and property values have been done by Ben Hoen and his coauthors (Hoen, Wiser, Cappers, Thayer, & Sethi, 2011; Hoen et al., 2015). These studies overcome the small sample size problems of many studies in this literature by using a pooled dataset of property transactions nearby to a large number of wind facilities around the country. They also find no significant impact on property values, but an admitted weakness of their study is exactly its strength – by using multiple sites, their estimates represent an average effect that may be hiding significant impacts in particular sub-samples of their data.

Two other more recent papers also find no significant impact. Vyn & Mccullough (2014) looks at a large wind facility in Ontario while Lang, Opaluch, & Sfinarolakis (2014) look at small facilities in Rhode Island. Both studies are carefully done and have reasonable sample sizes. A weakness of the paper by Lang et al. (2014) for the purposes of applying to the Henderson case is the fact that the facilities they study are mostly sites with individual large turbines or a small number of residential-scale turbines, while the Galloo Island facility is proposed to have a larger number of very large turbines.

There have also been a few recent studies that do find significant impacts on property values. Heintzelman & Tuttle (2012) is the first study to report significant negative impacts on property values using data from the areas around three large wind facilities in Northern New York. Importantly, they only find these negative impacts in two of three study areas which brings to the fore the idea that impacts are likely to vary in different areas, and that using large samples of facilities from a large geographic area may be inappropriate.

Sunak & Madlener (2012) find negative impacts using proximity measures and digital viewshed modelling for a region of Germany with a small wind facility with only 9 turbines. Jensen, Panduro, & Lundhede (2014) use similar methodology and a large dataset in close proximity to wind turbines to find significant negative impacts separately from both proximity and view. Finally, Gibbons (2015) focuses on visibility of turbines and finds significant and large negative impacts on property values in the United Kingdom.


**Figure 1: Wolfe Island Study**

Our analysis of the likely impacts of the Galloo Island wind farm on property values in Henderson is based upon an analysis of the impacts of the Wolfe Island wind farm on properties in Jefferson County, NY.[3] Wolfe Island is a Canadian island in the St. Lawrence River near its junction with Lake Ontario. The wind turbines are visible from parcels in Jefferson County, NY, on the island itself, and on the Canadian "mainland". Wolfe Island and the surrounding area is a good case study for application to Galloo Island for a number of reasons. First, the impacted area is in the same county as Henderson, with similar socioeconomics and topography. Second, in both cases the turbines are on islands on the water some distance from the affected properties on the shoreline. Third, no affected U.S. municipalities or landowners receive any compensation as a result of the Wolfe Island facility, meaning that, like in the case of Henderson, there are no confounding factors to counteract any negative impacts from disamenities. While Galloo Island is a U.S. island, it is a part of the Town of Hounsfield, meaning that any compensation paid will be paid to Hounsfield, not Henderson. An important qualification however, in using this comparison site is that while the turbines on Galloo Island are expected to be visible in the Town of Henderson, they are considerably further away from Henderson than those on Wolfe Island are to properties in Cape Vincent.

[3] This analysis is based upon, but not the same as, unpublished work by Heintzelman, Vyn, and Guth (2015). That study looks at properties in both countries whereas the analysis described here focuses only on Jefferson County.

### 2.2.1 Methodology

We use a standard hedonic property value analysis to study the impacts of the Wolfe Island facility. Hedonic analysis goes back at least to Rosen (1974), who posits a model where consumers derive utility from the attributes of a good rather than the good itself. This allows researchers to use consumption decisions by a sample of consumers in a market with differentiated goods, which vary along a number of dimensions, to estimate the consumers' marginal willingness-to-pay for changes in the attributes of the good.[4] This turns out to be an excellent model of property markets since parcels and homes vary along a large number of dimensions, many of which are easily observed by the researcher. In addition, most property markets are reasonably competitive in the economic sense since there are usually many properties for sale at any given time and a number of people simultaneously looking to purchase a home.

With Rosen's (1974) model in mind, hedonic analysis uses data on a sample of sales transactions (generally including price, date of sale, and a number of parcel attributes) to estimate the impacts of individual attributes on price. It uses regression analysis to control for all observable factors, thus allowing for an "all else equal" analysis of how each factor affects price.

There are a few problems that often arise in hedonic analysis which can be controlled using a fixed effects approach. First, is omitted variables bias, which occurs whenever an unobserved variable (say, neighborhood quality) is correlated both with parcel prices, and at least one included explanatory variable. When this happens, the estimated effect of the included variables will be biased and inaccurate. Another, related, problem is endogeneity, when prices and an explanatory variable are co-determined as might happen if, all else equal, wind turbines are more likely to be sited in areas with lower value land. In this case, the analysis may mistake the cause of the siting (lower property values) for an effect of the siting. Fixed effects analysis helps to curb the impacts of both of these issues by estimating fixed "area" effects which control for all factors which are homogeneous across a small geographic area. This reduces the number of omitted variables (and particularly those related to geography) and reduces the scope for possible endogeneity.

One tension that arises when using fixed effects analysis is that the smaller the geographic area chosen for the fixed effects, the more control the analyst has for these problems, but also the less power the analyst has to estimate the effects of included variables. Unfortunately, there is no foolproof way to know at which level to control for these issues. In this analysis we use municipality fixed effects because of the relatively small number of parcels with a view of turbines.

A related problem is spatial autocorrelation which occurs when error terms (variation in prices that is left unexplained by included variables) for transactions nearby to each other are correlated. This can be controlled by allowing for this correlation and calculating standard errors appropriately, which we do by allowing error terms to be clustered within municipalities.

[4] See (Freeman, Herriges, & Kling, 2014) and (Taylor, 2003) for comprehensive descriptions of the hedonic method.

### 2.2.2 Data

Data for this study comes from several sources, as described in Heintzelman, Vyn, and Guth (2015). We use data on 5,631 single-family residential parcels in Jefferson County, NY. Data on NY transactions come from the New York State Office of Real Property Taxation Services (NYSORPTS). This data includes sale price, sale date, and parcel identifying information. Transaction data is then merged with parcel and home characteristics data from the assessment process, also from NYSORPTS. We then bring in parcel shapefile (GIS) data which we acquired from the Jefferson County Assessor's Office. With this spatial data we calculate a number of distance and spatial variables in ArcGIS. Table 1 presents summary statistics for this sample.

With this data in hand, we conducted a preliminary viewshed analysis to identify parcels within five miles of the turbines that had a potential view of the turbines. A pair of students then visited each of these identified parcels to confirm the view from each parcel. The students recorded the number of visible turbines as well as whether or not these views were full or partial. However, given the small number of parcels (26) with a view in our dataset, we simplify the analysis to only focus on whether or not each parcel had any view of one or more turbines. We use a log-linear functional form in following the bulk of the hedonic literature (Cropper, Deck, & McConnell, 1988). We also include year fixed effects to control for sample-wide price trends. Unfortunately, we are unable to accurately control simultaneously for both distance to turbines and view, which is an important limitation.

### 2.2.3 Wolfe Island Results

Results for the hedonic study of the Wolfe Island wind farm are shown in Table 2. The primary variable of interest is the variable representing parcel transactions with a view of turbines, after the turbines were constructed. We see that parcels with a view of the turbines sell for a positive premium (approximately 10%) before the turbines are built, but that this premium is more than eroded by a strong negative impact after turbine construction. The estimated coefficient of -0.164 that describes this effect implies a 15% decrease in property values for homes with a view after the turbines are built. We also calculate a 95% confidence interval for this effect, which tells us that, given the observed data, there is a 95% chance that the true effect is a decrease of between 5.1% and 23.9%. So, while we can't be confident that the effect is exactly negative 15%, we are reasonably confident that there was a negative impact.

Seasonal and waterfront homes both sell at significant premiums while other attributes of the homes have the expected signs. We see a positive premium in the period between announcement and construction for homes with a view, which may have to do with general appreciation for these water view homes. Our spatial controls are not significant but provide important controls for distances to larger communities with shopping and other man-made amenities. Importantly, there is no general post-construction effect across the sample. Instead those affects appear to be limited to those parcels with a view.

### Table 1: Summary Statistics for Wolfe Island Sample

| | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Price ($US) | 139,349.30 | 100,036.80 | 3,500.00 | 2,000,000.00 |
| Parcel w/ View of Turbines | 0.005 | 0.068 | 0 | 1 |
| Parcel Sold between Approval and Construction | 0.216 | 0.411 | 0 | 1 |
| Parcel Sold After Construction | 0.398 | 0.49 | 0 | 1 |
| Parcel w/ View of Turbines AND Sold between Approval and Construction | 0.001 | 0.035 | 0 | 1 |
| Parcel w/ View of Turbines AND Sold After Construction | 0.003 | 0.052 | 0 | 1 |
| Seasonal Home | 0.093 | 0.291 | 0 | 1 |
| Waterfront Home | 0.113 | 0.316 | 0 | 1 |
| Mobile Home | 0.037 | 0.19 | 0 | 1 |
| Lotsize (Acres) | 5.145 | 20.958 | 0.00573 | 391.433 |
| Bathrooms | 1.421 | 0.576 | 0 | 5.5 |
| Bedrooms | 2.992 | 0.938 | 0 | 9 |
| Fireplace | 0.174 | 0.379 | 0 | 1 |
| Air Conditioning | 0.021 | 0.143 | 0 | 1 |
| Quality=2 | 0.128 | 0.334 | 0 | 1 |
| Quality=3 | 0.76 | 0.427 | 0 | 1 |
| Quality=4 | 0.093 | 0.291 | 0 | 1 |
| Quality=5 | 0.001 | 0.03 | 0 | 1 |
| Living Area (sq.ft.) | 1551.206 | 596.219 | 136 | 6074 |
| Age | 69.203 | 51.83 | 0 | 225 |
| Number of Storeys | 1.458 | 0.442 | 1 | 3 |
| Distance to University (Miles) | 15.644 | 7.658 | 0 | 32.4344 |
| Distance to School (Miles) | 2.913 | 2.91 | 0 | 17.9056 |
| Distance to Hospital (Miles) | 10.387 | 6.776 | 0 | 34.0026 |

### Table 2: Wolfe Island Results

| | Coef. | Std. Err. | t | P>\|t\| |
|---|---|---|---|---|
| Parcel w/ View of Turbines | 0.106 | 0.062 | 1.72 | 0.097 |
| Parcel Sold between Approval and Construction | -0.032 | 0.042 | -0.77 | 0.45 |
| Parcel Sold After Construction | -0.034 | 0.057 | -0.61 | 0.55 |
| Parcel w/ View of Turbines AND Sold between Approval and Construction | 0.203 | 0.058 | 3.5 | 0.002 |
| Parcel w/ View of Turbines AND Sold After Construction | -0.164 | 0.053 | -3.07 | 0.005 |
| Seasonal Home | 0.08 | 0.034 | 2.32 | 0.028 |
| Waterfront Home | 0.658 | 0.082 | 8.05 | 0 |
| Mobile Home | -0.209 | 0.051 | -4.06 | 0 |
| Lotsize (Acres) | 0.0005 | 0.0005 | 1 | 0.325 |
| Bathrooms | 0.11 | 0.017 | 6.45 | 0 |
| Bedrooms | 0.003 | 0.02 | 0.15 | 0.879 |
| Fireplace | 0.152 | 0.026 | 5.9 | 0 |
| Air Conditioning | 0.143 | 0.046 | 3.13 | 0.004 |
| Quality=2 | 0.394 | 0.104 | 3.78 | 0.001 |
| Quality=3 | 0.769 | 0.093 | 8.24 | 0 |
| Quality=4 | 0.94 | 0.09 | 10.42 | 0 |
| Quality=5 | 0.698 | 0.108 | 6.45 | 0 |
| Living Area (sq.ft.) | 0.0003 | 0.00003 | 10.8 | 0 |
| Age | -0.005 | 0.001 | -4.9 | 0 |
| Age Squared | 0.00002 | 0.00001 | 3.05 | 0.005 |
| Number of Storeys | 0.07 | 0.031 | 2.22 | 0.034 |
| Distance to University (Miles) | 0.005 | 0.005 | 1.03 | 0.311 |
| Distance to School (Miles) | -0.003 | 0.008 | -0.39 | 0.696 |
| Distance to Hospital (Miles) | -0.011 | 0.006 | -1.69 | 0.102 |
| Municipality Fixed Effects | Yes | | | |
| Year Fixed Effects | Yes | | | |
| R-Squared | 0.4625 | | | |

### 2.2.4 Application to Town of Henderson

The analysis of the Wolfe Island case study provides important evidence suggesting that the Galloo Island wind farm will likely negatively impact property values for those parcels that are likely to have a view of the turbines, although it is again important to note that the Galloo Island turbines will be considerably further away from the mainland than those on Wolfe Island, despite prominent views. The central estimate of the hedonic analysis suggests a likely 15% reduction in property values for homes with a view, after the turbines are built. We now combine the above analysis with the viewshed analysis conducted in GIS to estimate the aggregate effects on property values in the Town of Henderson. To do this we use parcel attribute data on 1,453 single-family residential parcels in the Town of Henderson together with an estimate from the viewshed analysis of whether

each of these parcels will view the turbines. We plug this parcel attribute data into the estimated hedonic model to project two values for each parcel – with and without the turbines. Because our data ends in 2013, this projection is done in 2013 US dollars, as if the homes were selling in 2013, but with the Galloo Island turbines constructed.[5] These estimates are sensitive to assumptions made in the viewshed analysis and, in particular, the assumed height of the forest canopy. For this reason, we calculate two estimates according to a 13m and 20m assumed canopy heights. These projections, aggregated to the town level, are presented in Table 3.

### Table 3: Projected Property Values

| | 20m Canopy Height | | 13m Canopy Height | |
|---|---|---|---|---|
| | Aggregate | Average | Aggregate | Average |
| Projected Value w/ Turbines | $298,950,891.57 | $205,747.34 | $294,918,808.00 | $202,972.34 |
| Projected Value w/o Turbines | $338,816,107.10 | $233,183.83 | $338,109,916.64 | $232,697.81 |
| Projected Change in Value | -$39,865,215.53 | -$27,436.49 | -$43,191,108.64 | -$29,725.47 |
| Projected % Change in Value | -$11.77 | | -$12.77 | |

We see in these projections that the average home is expected to lose between 11.77% and 12.77% of its value if the Galloo Island turbines are built. Importantly, however, this average includes homes both with and without a view. Homes with a view will face the bulk of the value loss. In aggregate, this analysis suggests a total value loss for the Town of Henderson of between $39.8M and $43.2M. These estimates are all calculated using the central estimate of the post-turbine impact for homes with a view from the hedonic analysis of -15%. Because this central estimate is uncertain, our projections are also uncertain. So these estimated aggregate impacts could be considerably larger or smaller in actuality.

While these numbers are large, and suggest a real loss to the people of Henderson, it is important to note that these losses do not affect people's wealth all at once. Instead, for residents who are planning to stay in Henderson for a number of years, they will not actually be significantly affected until such time as they choose to sell. In addition, there is a strong suggestion in the literature (Hoen et al. 2015) that these affects may be short-lived. As people adapt and get used to having the turbines in their landscape, and as many Americans become more familiar with wind energy, negative property value impacts may dissipate.

[5] This is a benign assumption. With additional data on appreciation in values since 2013 we could adjust these numbers to 2015, but this would not affect the relative changes projected to be caused by the turbines.

### Table 4: Projected Effects on Average Parcels w/ Turbine View

| | Baseline Price | Low Estimate | Central Estimate | High Estimate |
|---|---|---|---|---|
| % Effect | | -5.10% | -15.00% | -23.90% |
| Mean | $276,954.50 | -$14,156.35 | -$41,593.40 | -$66,165.92 |
| Median | $221,393.00 | -$11,316.36 | -$33,249.10 | -$52,891.98 |

To illustrate the statistical uncertainty associated with our projections, Table 4 presents projected impacts for parcels with a Turbine view for low, medium, and high estimates of the post-turbine impacts. We calculate the mean and median projected price for the parcels in our Henderson dataset projected to have a turbine view. Using these projections, we use the low and high ends of the 95% confidence interval as well as the central estimate of the impact and apply these to the mean and median prices for this selection of parcels. This analysis suggests that the mean dollar-value impact on homes with a view could be as low as $14,156.25 and as high as $66,165.92. It is worth noting, however that these two extremes are bounds on likely impacts, and are highly unlikely to occur. Finally, the real uncertainty associated with our estimates is likely to be somewhat larger than that suggested by the analysis of statistical uncertainty presented because of the greater distance from Henderson to Galloo Island than from Cape Vincent to Wolfe Island. On its own, our expectation is that this greater distance should make the realized impacts lower in magnitude than the projections provided above.

# 4.0 Viewshed Analysis & Methodology

## 4.1 Introduction

Viewshed analysis is a technique used within Geographic Information Systems software (GIS) for predicting areas on a landscape that will be visible or invisible to observers with known locations and elevations. It uses elevation data in a raster, or cell-based, data format to evaluate the visibility potential of objects on the Earth's surface. The function creates individual line-of-sight calculations from multiple points (wind turbines) to every location in the study area and in the case of multiple points, will add up the values to give a cumulative total of objects visible from each cell across the study area. In the case of the proposed Gallo Island Wind Project, the total number of turbines was 29, so the viewshed values range from 0 - 29.

Visibility of distant objects decreases with distance due to many factors, including meteorological conditions, the curvature of the earth, atmospheric refraction, terrain and physical obstructions and the eyesight of individuals viewing the objects. The parameters considered for this viewshed analysis included terrain obstructions, forest vegetation, earth curvature and atmospheric refraction. An atmospheric refraction coefficient of .013 was used for all viewshed calculations. The curvature of the earth begins to affect visibility of objects at around 3 miles, and the proposed turbines would be completely invisible at a distance of 35 miles over open water.

The study area considered for the viewshed focused on the Town of Henderson, but also included the areas around Galloo Island out to a distance of about 30 miles. Visual impacts of distant objects, regardless of height, rapidly decreases beyond about 15 miles. Distance buffers (rings) were created around the proposed turbines at 5, 10 and 15 miles and are shown in Figures 5 and 6. As can be seen on the map, the majority of Henderson Town is within the 5 - 15 mile distance band. For the purpose of providing visibility information for the entire town of Henderson, the viewshed was run out to a distance of approximately 30 miles, even though the visual significance of the turbines would be very small.

The viewshed (or Visibility) analysis was carried out using ArcGIS Desktop 10.3.1 and the 3D Analyst Extension.

## 4.2 Data Sources and Processing

Proposed wind turbine locations and tower height values were provided by Neil Habig of Hudson Energy Development. Turbine parameters used in the analysis are shown below:

Tower Heights: 110 meters (361 feet)

Rotor Diameter: 130 meters (427 feet)

Blade Tip Height: 175 meters (574 feet)

Total Turbines: 29

Digital Elevation Models (DEMS) were obtained from the United States Geological Survey (USGS) National Elevation Dataset (NED) at a spatial resolution of 10 meters (33 feet). This is the highest resolution data available for the study area. The turbines were plotted on the DEM data to obtain the base elevations of the towers. These values ranged from 76 - 89 meters above sea level (249 - 291 feet). A value of 1.7 meters (5.6 feet) was added to all cells in the study area to represent the approximate height of a person standing on the ground.

Visibility potential depends heavily on vegetation, buildings and local ground conditions. Building footprint data is unfortunately not available for Jefferson County, so the viewshed models do not take existing structures such as houses and commercial buildings into account. The lack of this data will tend to over-estimate the visibility potential of the turbines, especially in urban areas, as buildings will block the view from ground level.

Forest canopy data is available from the National Land Cover Database 2011 (NLCD) at a spatial resolution of 30 meters and was downloaded from the Multi-Resolution Land Characteristics Consortium (MRLC) website. The forested areas were extracted from the NLCD, re-sampled to 10 meter resolution and then added to the heights of the Digital Elevation Model. The forest data does not include the actual heights of the tree canopy, just the presence of continuous forest areas, so assumptions have to be made about the actual heights of the trees. Two forest canopy viewsheds were created, one using estimated canopy heights of 13m and one using forest heights of 20m. The NLCD data does not contain information about individual trees or smaller shrubs, which can also impact the visibility.

Boundary and transportation data for Jefferson County was downloaded from the New York State GIS Clearinghouse.

## 4.3 GIS Methodology and Results

Once all of the data was downloaded and processed into a common coordinate system, the viewshed parameters were applied and the viewshed function was run using the terrain data only, without vegetation. This is known as a denuded or bare-earth viewshed and predicts visibility across the study area without consideration of forest canopy. This method tends to exaggerate the potential visibility but is useful as a reference point (see Figure 9).

To account for the screening effects of forest canopy, NLCD forest areas were added to the DEM elevations for two simulations, one with 13 meter forest heights and another with 20 meter forest heights. The forest areas are then classified as not being able to see any turbines, assuming that observers in these areas would not have a view of the proposed turbines. This could lead to areas

that are classified as zero turbines visible, especially in forested areas that directly face Gallo Island. These visibility maps are shown in Figure 7 and Figure 8.

Additional detail maps are provided at a 1:24,000 scale to show visual impact potential for individual parcels (shown in Figures 10 through 13).

The results of the viewshed analysis were then added to the tax parcel polygons using the Zonal Statistics function. This provided a value that indicates the average number of turbines visible to a given parcel. This step was necessary because parcel size varies greatly across the town and large parcels contain areas that have high and low visibility values. The average turbine visibility values were then used to assess the impacts on property values in section 2 above.

## 4.4 Interactive Map Viewer on ArcGIS Online

The URL to access an Interactive Map Viewer of some of the GIS analyses is at: http://arcg.is/20Y5VEc. Animations of the view shed analysis can be found at: https://www.youtube.com/watch?v=KHNV6SwQHg0&feature=youtu.be.

Some notes regarding the Interactive Map Viewer:

1. The 3D trees are added randomly to all areas considered "Forest" by the USGS. It would be difficult to fill the areas completely with trees because that would take thousands of individual points and would make the product far too cumbersome. The trees are sized to be 20 meters tall. Turbines are 175m to blade tip.

2. All layers can be turned on and off and zoomed into, however the 3D space doesn't allow two base layers to appear neatly simultaneously. So if a user tries to see the USGS topo together with imagery, it can create some strange effects.

3. The resolution of the terrain surface is such that the draped layers (everything else) may not exactly conform to the surface. You may see a tree floating above or cutting under the surface and roads slightly offset. This cannot be altered, as it is due to the native resolution of the digital elevation model, which also comes from the USGS.

Interactive Map Viewer Functionality:

1. Mouse buttons control the view (left = Pan, middle=Zoom, right=Orbit)

2. Environment settings can be changed in upper right (time of year and day, shadows, etc.)

3. Three views were added at ground level and are shown at bottom middle of screen

4. The viewer requires a WebGL enabled browser, which can be confirmed at: https://en.wikipedia.org/wiki/WebGL.

## 4.5 List of Figures

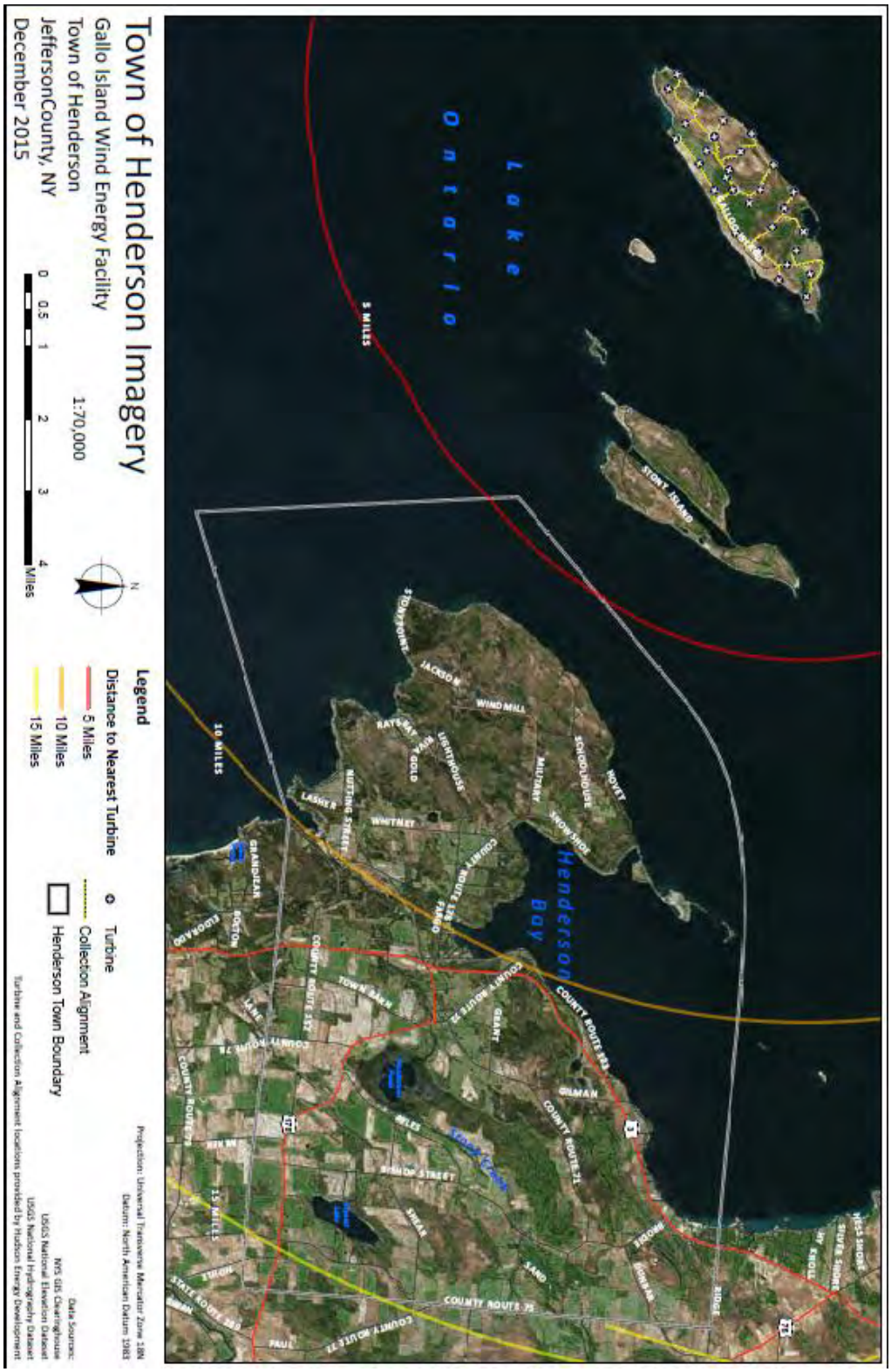


**Figure 5. Henderson Overview with Satellite Imagery**

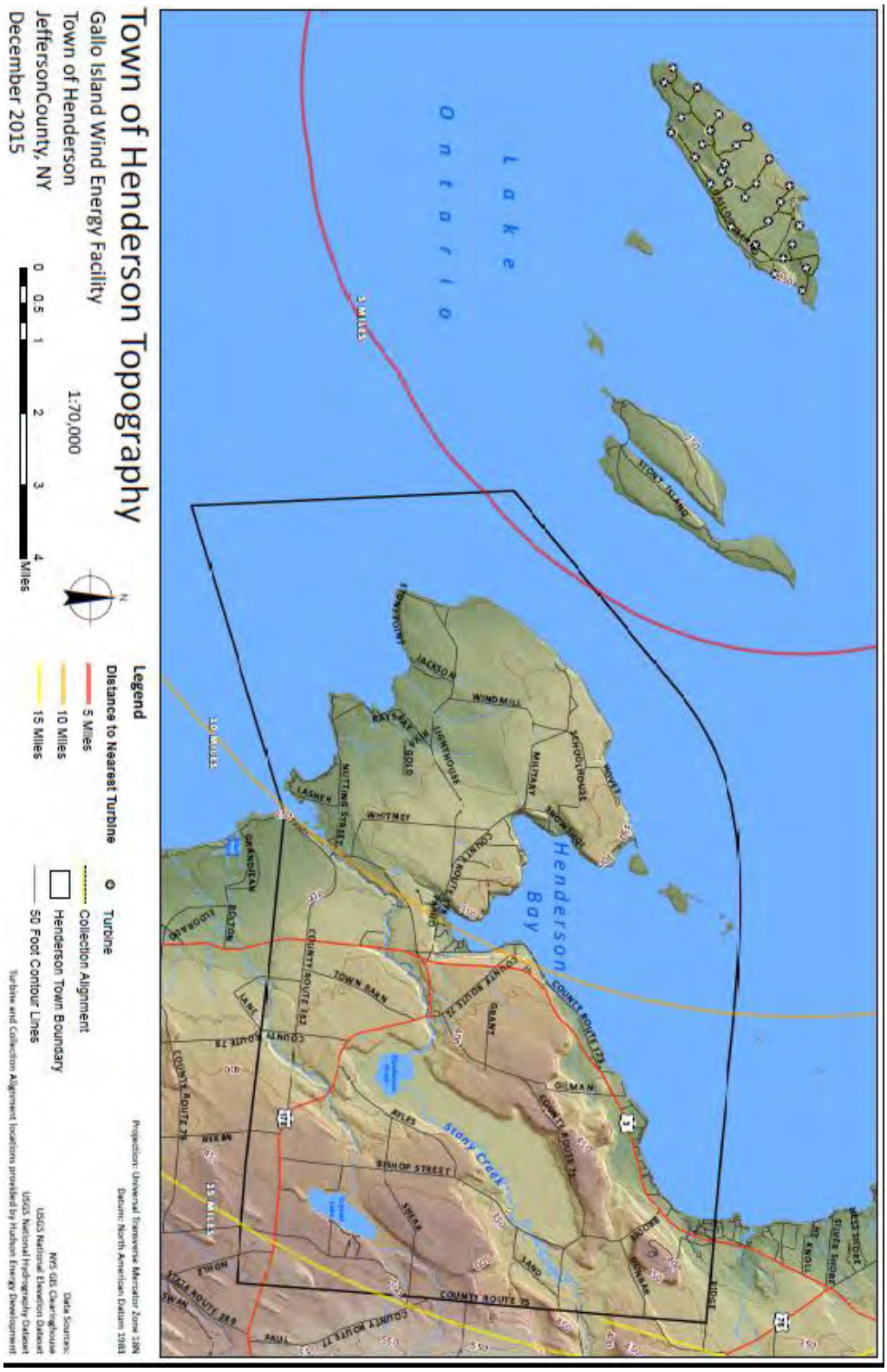


**Figure 6. Henderson Overview with Topography**

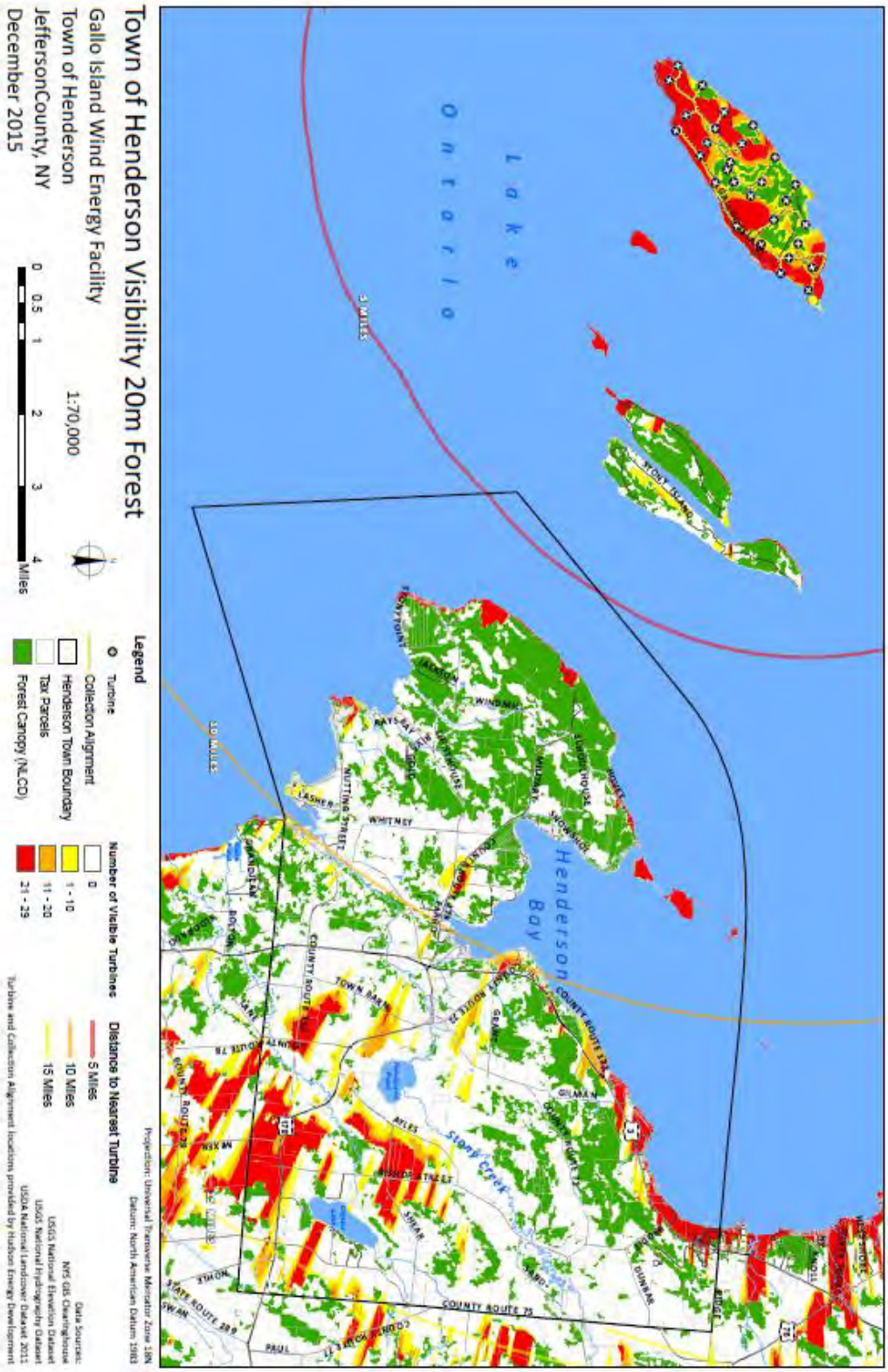

Figure 7. Henderson Town Visibility 20m Forested

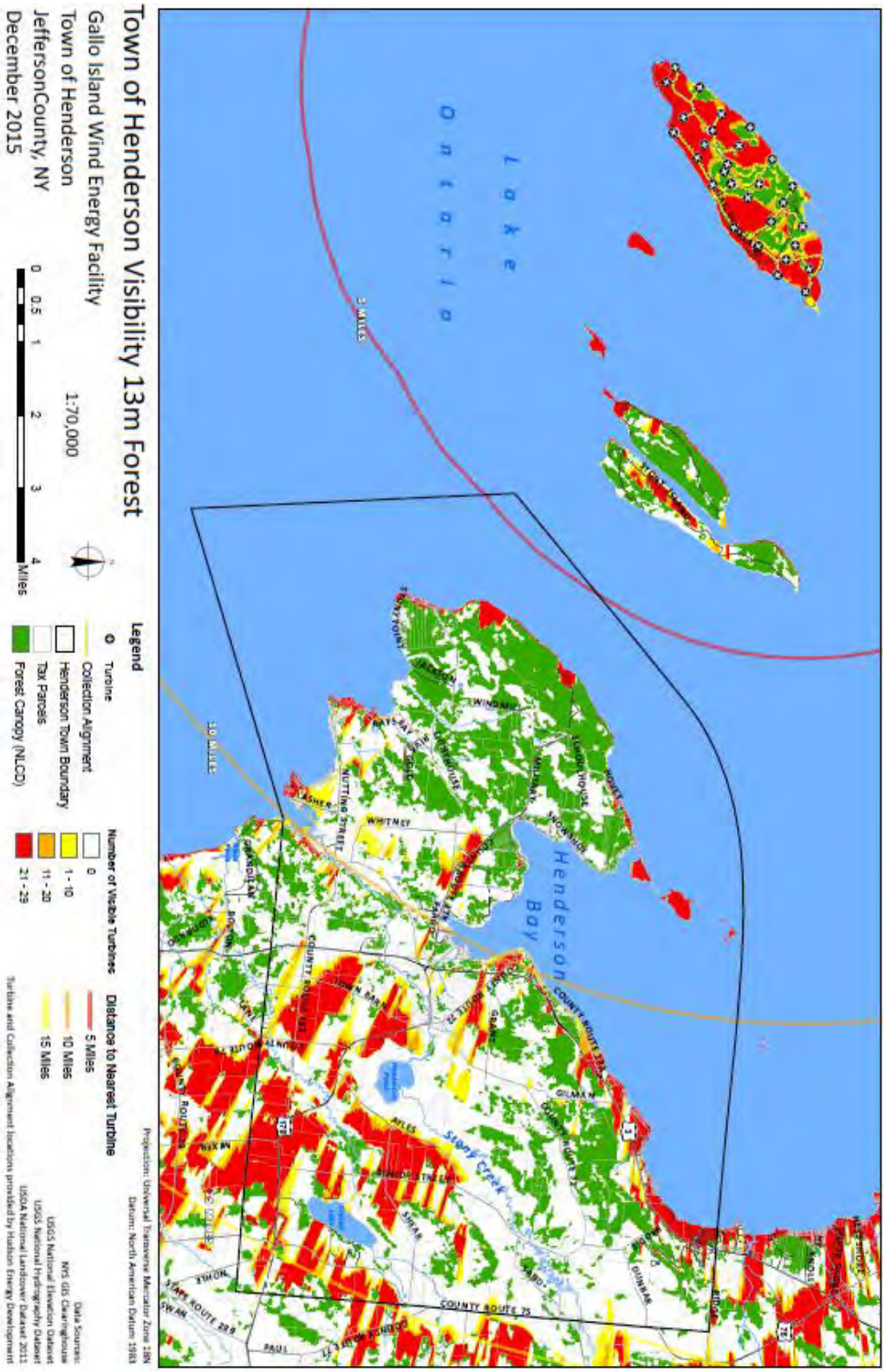


**Figure 8. Henderson Town Visibility 13m Forested**

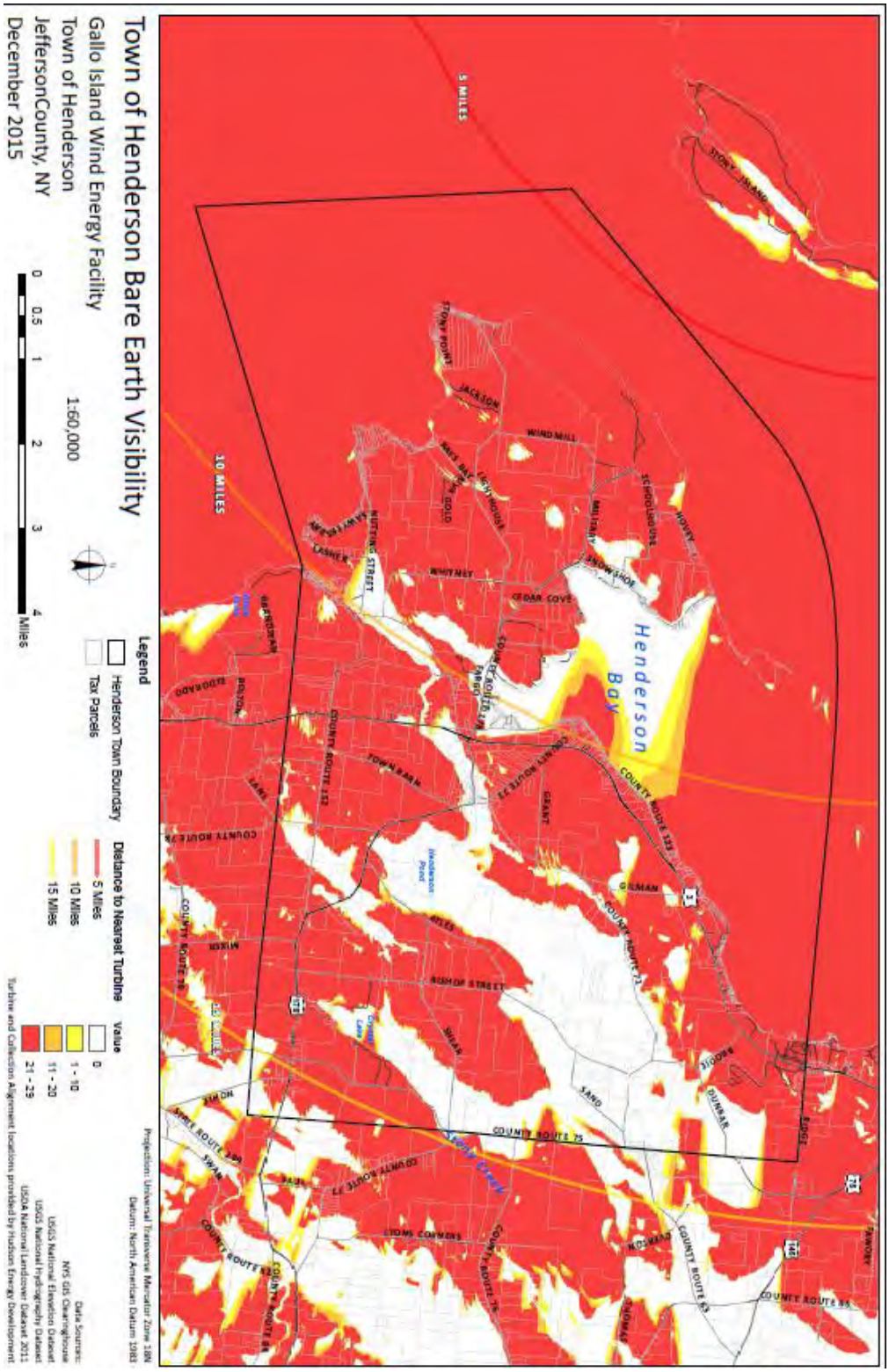


**Figure 9. Henderson Town Bare Earth Visibility**

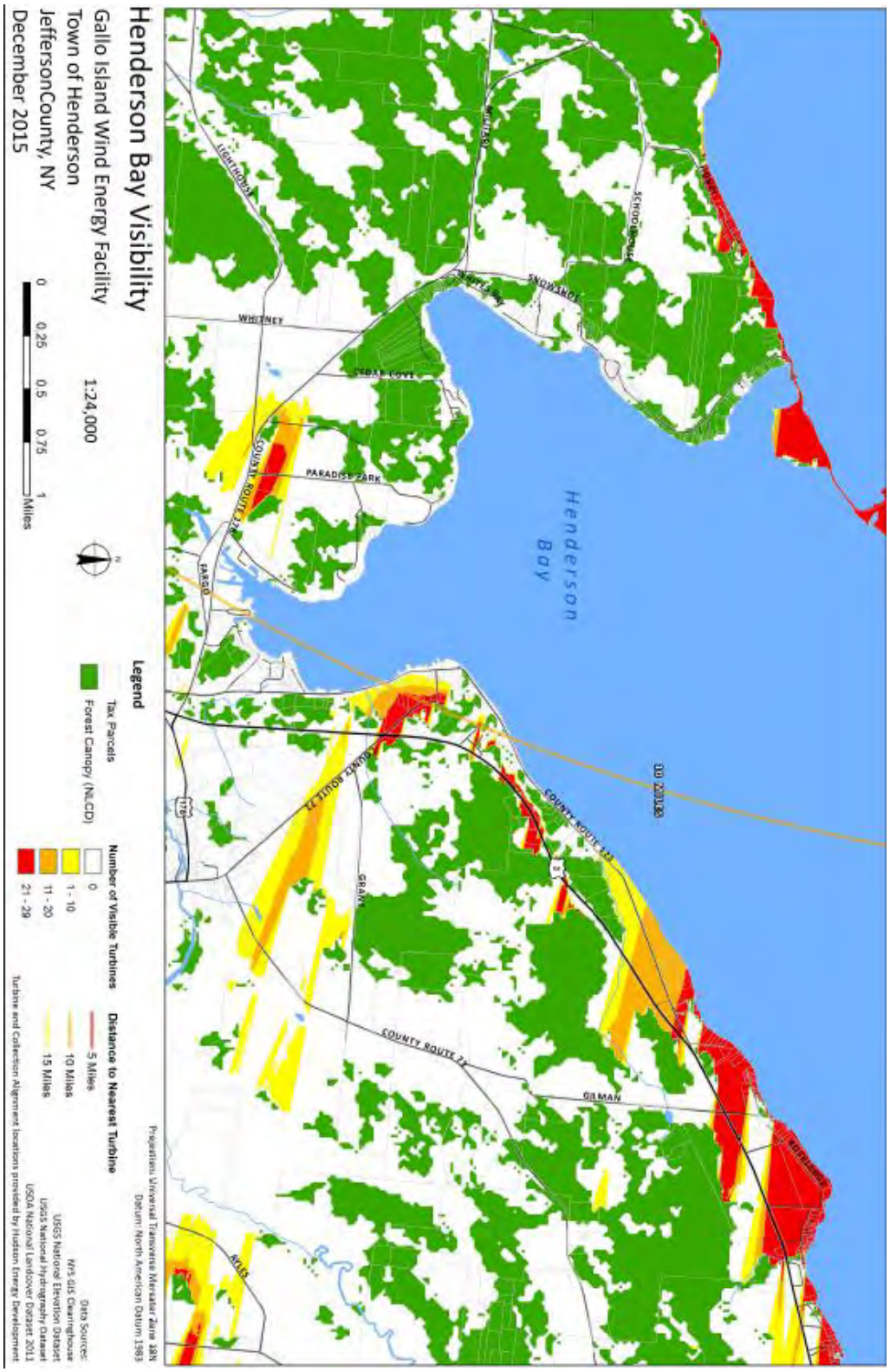


**Figure 10. Henderson Bay Detail**

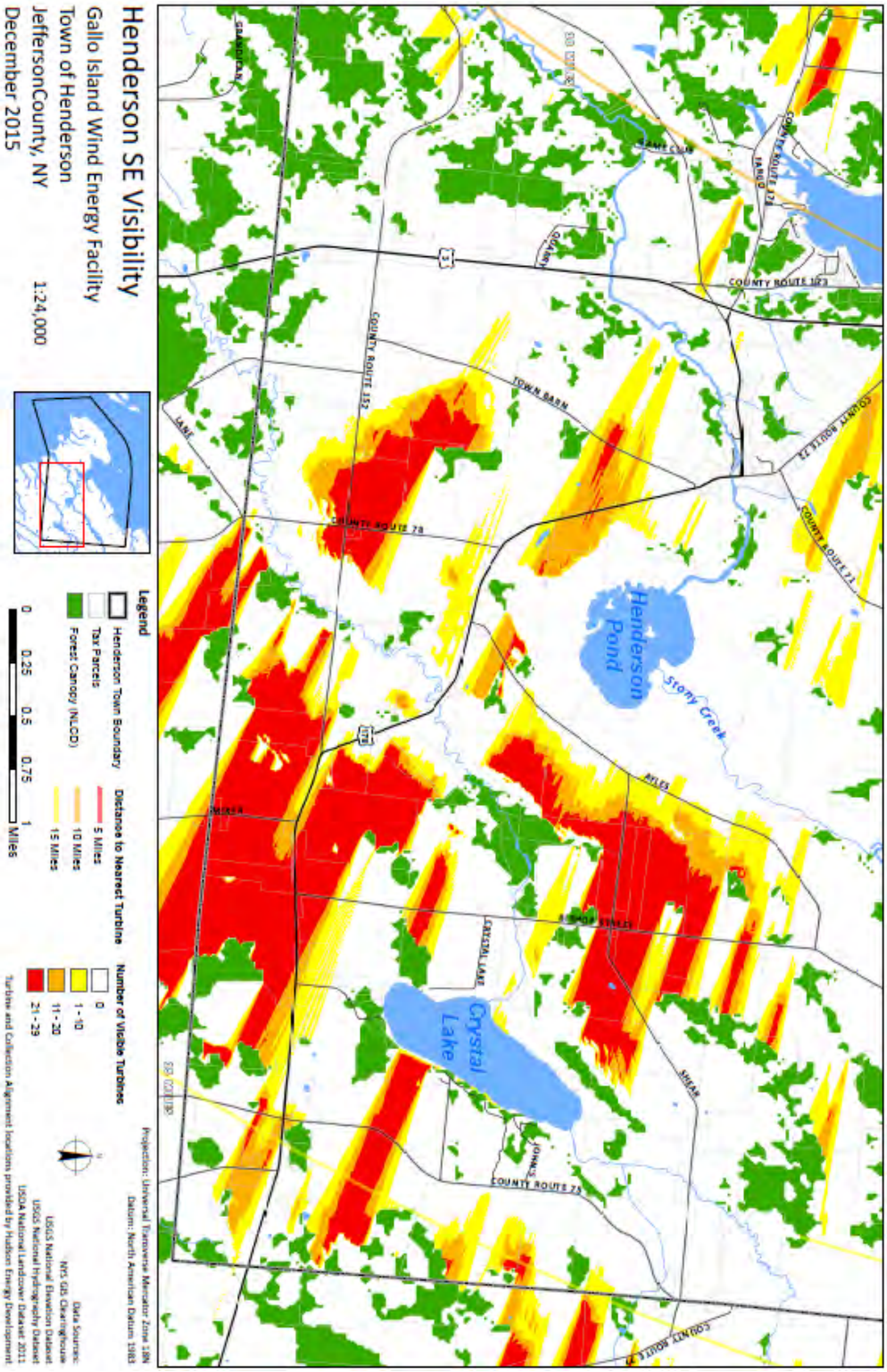


**Figure 11. Henderson SE Detail**

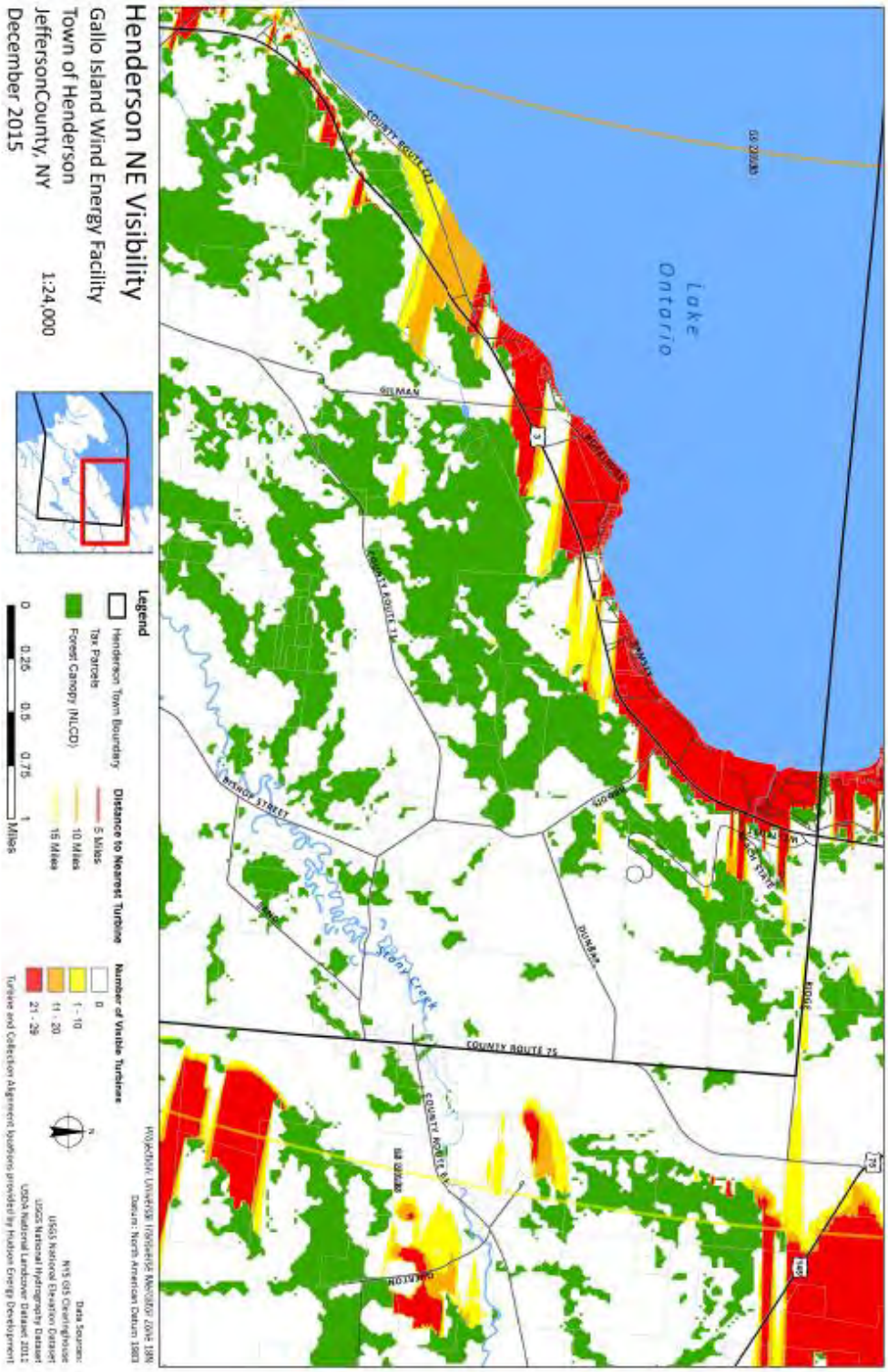


**Figure 12. Henderson NE Detail**

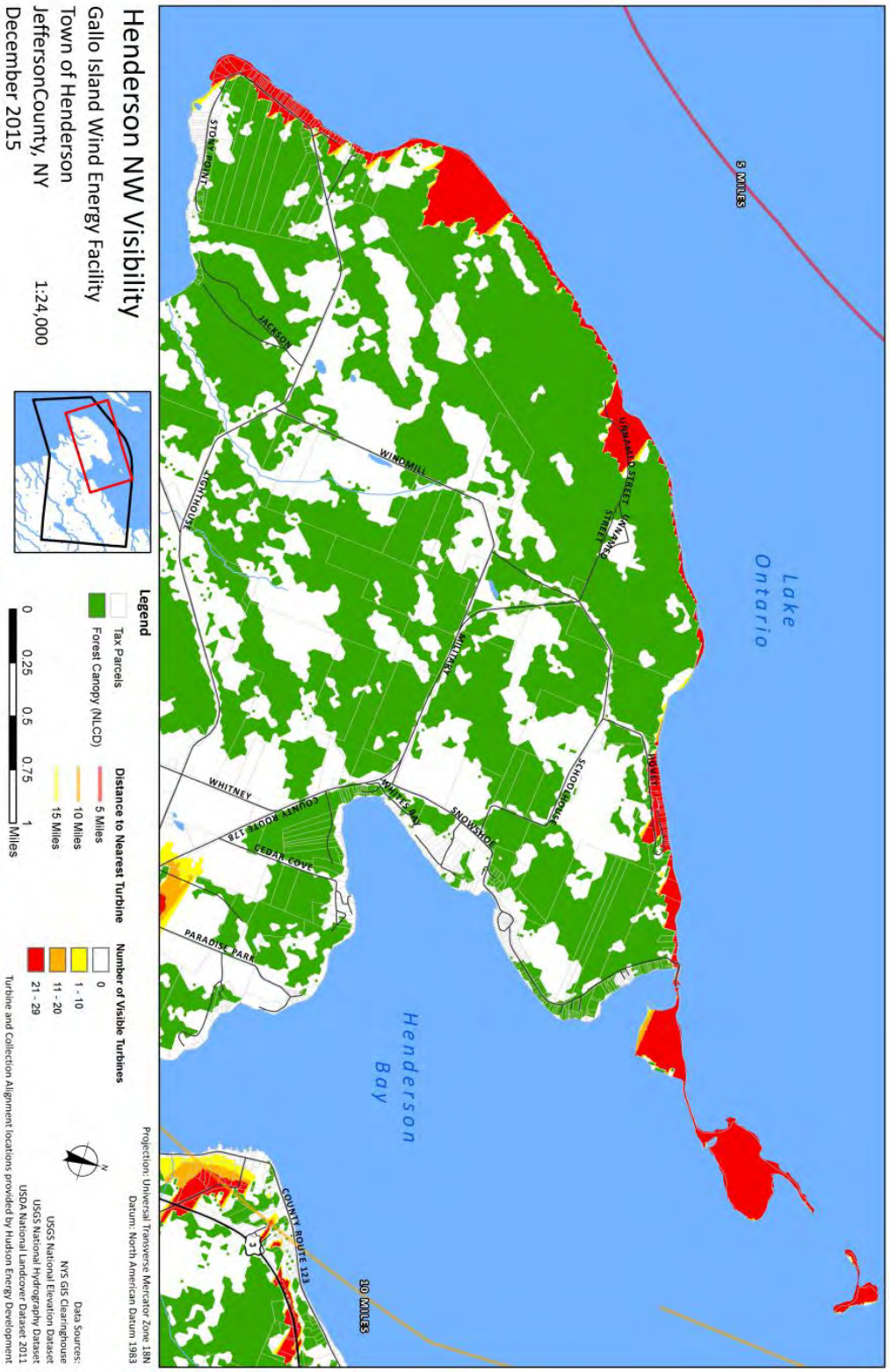


**Figure 13. Henderson NW Detail**

# 5.0 Research Note

The Nanos Clarkson Research Collaboration team has made every attempt to ensure the accuracy and reliability of the information provided in this report. However, the information is provided "as is" without warranty of any kind. The Nanos Clarkson Research Collaboration does not accept any legal responsibility or liability for the public use or interpretation of the data. The data prepared is based on the latest available information in the public domain without prejudice.

The tourism, employment, and economic output analysis used the 31 turbine plan submitted to the Public Service Commission in Summer 2015. The viewshed and associated property valuation analysis was based on more recent plans submitted to the team from Neil Habig at Hudson and received on October 17, 2015. This was considered preliminary and subject to change. We do not expect any significant changes to our general conclusions if there is a minor change to the number or configuration of turbines.

The Nanos Clarkson Research Collaboration, as well as individual team members, shall not be liable for any loss or damage of whatever nature (direct, indirect, consequential, or other) whether arising in contract, tort or otherwise, which may arise as a result of your use of (or inability to use) this report, or from your use of (or failure to use) the information on this report.

# 6.0 Report Summary & Conclusions

The Nanos Clarkson Research Collaboration team has undertaken the preceding analyses based on the best available public data. While the analytical methodologies (and qualifiers) for the various analyses have been highlighted within the preceding report, the overall general findings can be summarized as follows in terms of the anticipated impacts:

- likely negative land valuations for the Town of Henderson;

Finally, the report's series of view-shed analyses for the Town of Henderson in relation to the proposed Galloo Island development are intended as a tool or aid in the planning and decision-making process. Some of the items can be found online in the Interactive Map Viewer identified in the preceding analysis.

# 7.0 References

## 7.1 Property Value Analysis


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