MONTCALM WIND

Welcome

Designing Montcalm Wind:
Best Practices for Safe Siting

Tuesday May 25 | 6:00 p.m.

Follow Montcalm Wind on Facebook @MontcalmWind or visit
www.MontcalmWind.com

Program

- Welcome and Introductions
- Montcalm Wind Overview
- Gathering Wind Data
- Safe Setbacks & Wind Turbine Placement
- The Science of Shadow
- Project Design Goals
- Community Q&A

<u>Question Process:</u>

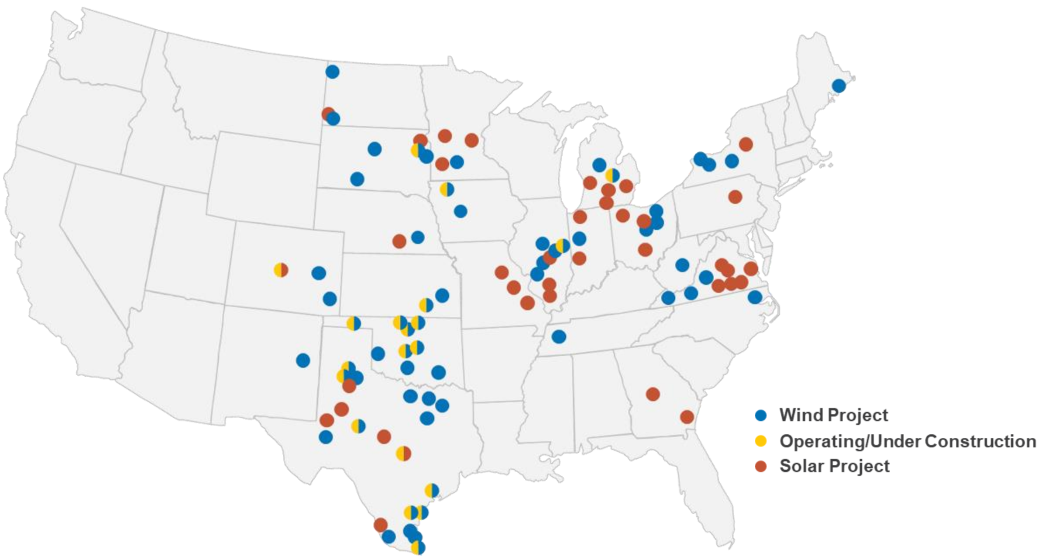
- Zoom Attendees – Open the Q&A window to type in your question for the panelists
- Phone Attendees – Text your question to 989-787-3029

Introductions

- **Albert Jongewaard –** Senior Development Manager, Apex Clean Energy
- **Meagan Denman** – Manager, Resource Assessment, Apex Clean Energy
- **Kent Dougherty** – Director of Project Development, Apex Clean Energy
- **Brian O'Shea –** Public Engagement Manager, Apex Clean Energy

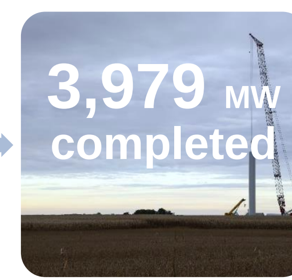
About Apex Clean Energy

Project Portfolio



Our Core Values

By the Numbers



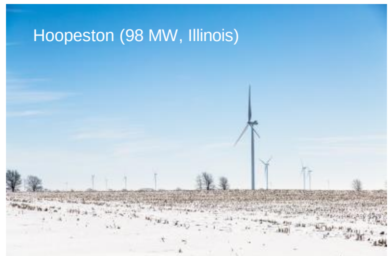
Completed projects power > 2 million homes annually

Working with Communities Across America

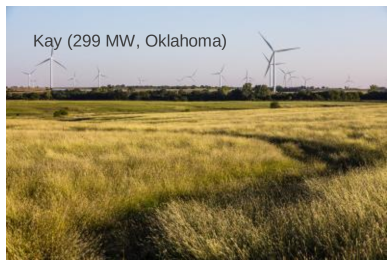
APEX CLEAN ENERGY

Apex Clean Energy has secured financing for over 6 GW of wind and solar projects across the United States, many of which are now operating or under construction. Visit **apexcleanenergy.com/projects** to learn more about these and our other completed facilities.

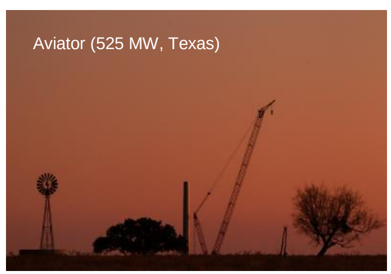

Cotton Plains (50 MW, Texas)


Hoopeston (98 MW, Illinois)


Isabella (385 MW, Michigan)


Kay (299 MW, Oklahoma)


Altavista (113 MW, Virginia)


Aviator (525 MW, Texas)

Industry Awards

AWEA WIND PROJECT O&M AND SAFETY – SAFETY AND HEALTH GOLD ACHIEVEMENT AWARD

2017 Environmental Finance Deals of the Year Awards

2015 PLATTS GLOBAL ENERGY AWARDS WINNER

SUSTAINABLE PURCHASING LEADERSHIP COUNCIL

2016 GREEN POWER Leadership Awards

Commodity Business Awards 2015

Featured Project

Isabella Wind

A community-driven project from the start, Isabella Wind is expected to generate over $30 million in tax revenue for the local community and approximately $100 million in landowner payments.

Project Details

Capacity	385 MW
Technology	136 GE 2.82 MW turbines
ISO / RTO	MISO East
Participants	Over 600 families representing 56,000+ acres
Owner	DTE
Construction Manager	Apex Clean Energy
Asset Manager	DTE

michigan EIBC

2020 Project of the Year

Montcalm Wind Project Overview

Montcalm Wind: Project Overview

A clean economic opportunity for Montcalm County, benefiting local farmers and the entire community.

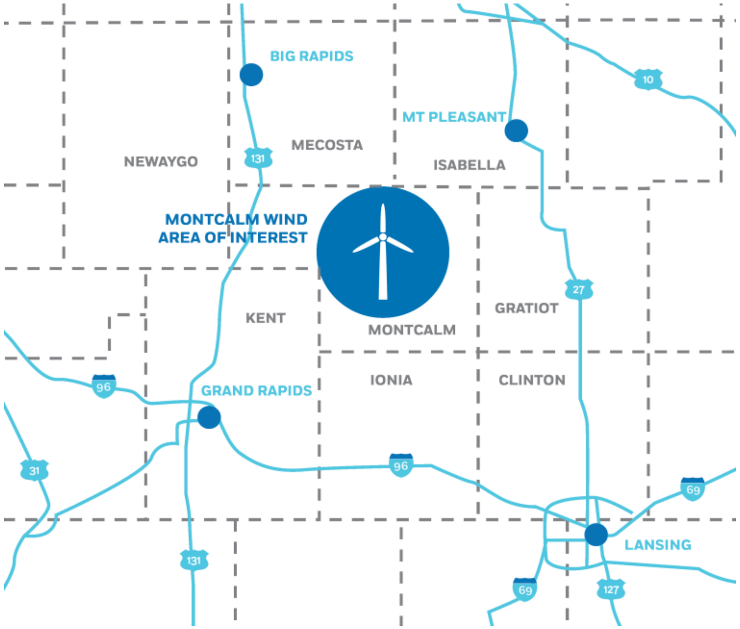
Why Montcalm?

- ✓ Local **familiarity with wind energy**
- ✓ Expansive **agricultural land**
- ✓ Economical **wind resource**
- ✓ Existing high-voltage **transmission** lines

MONTCALM WIND

Project Summary

- **375MW** project
- Up to **75** wind turbines expected, depending on final turbine model.
- Enough energy to power close to **90,000** average Michigan homes.



Project Schedule

- Goal for project completion and commercial operation is **2024**

APEX CLEAN ENERGY

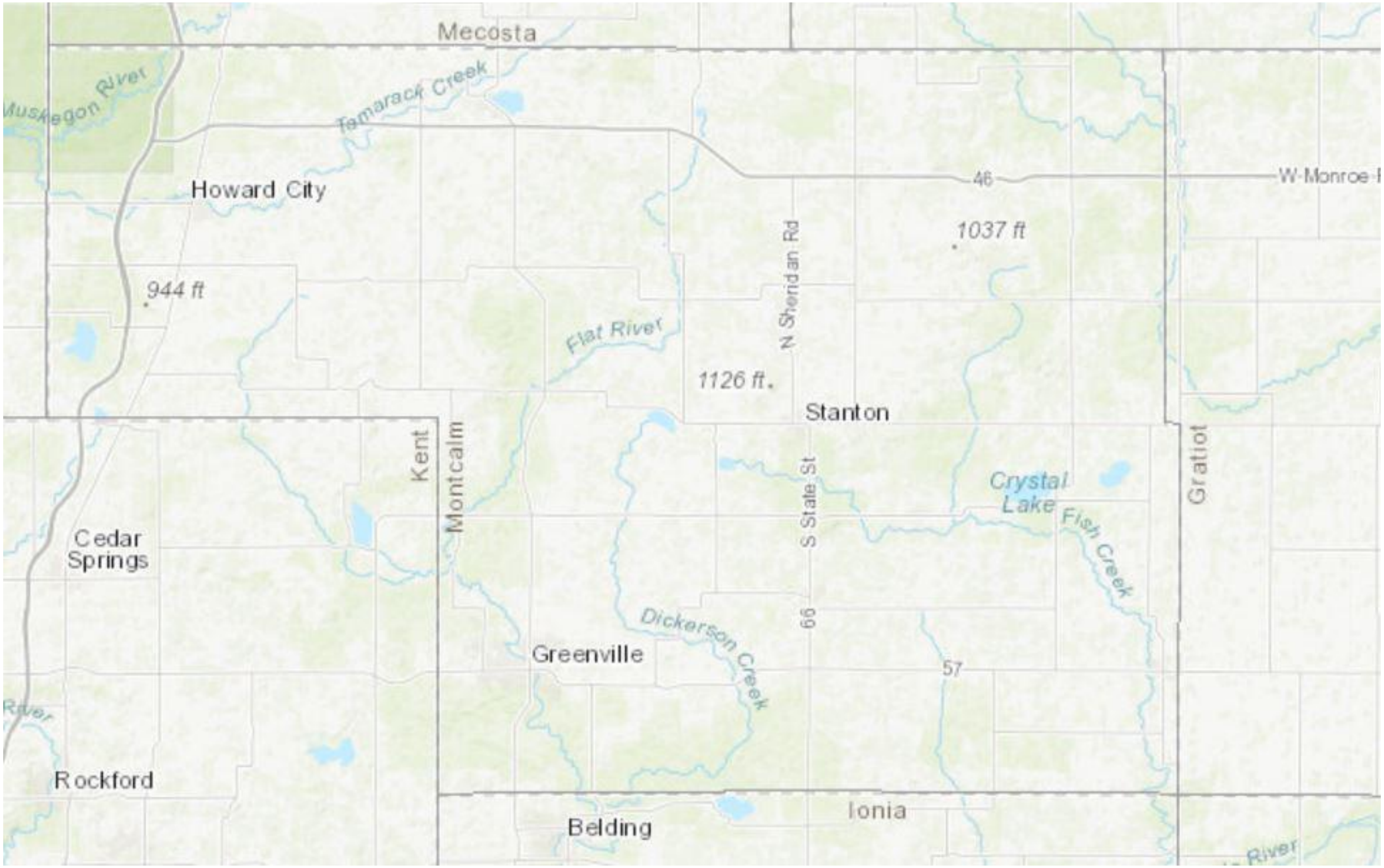
Montcalm Wind: Community-Based Clean Energy

- **Montcalm Wind is for <u>everyone</u>**
- **Community-based model for wind development**
- **Everyone with property can participate**
- **Everyone gets the same opportunity and terms**
- **Participating is <u>your</u> choice. No eminent domain.**

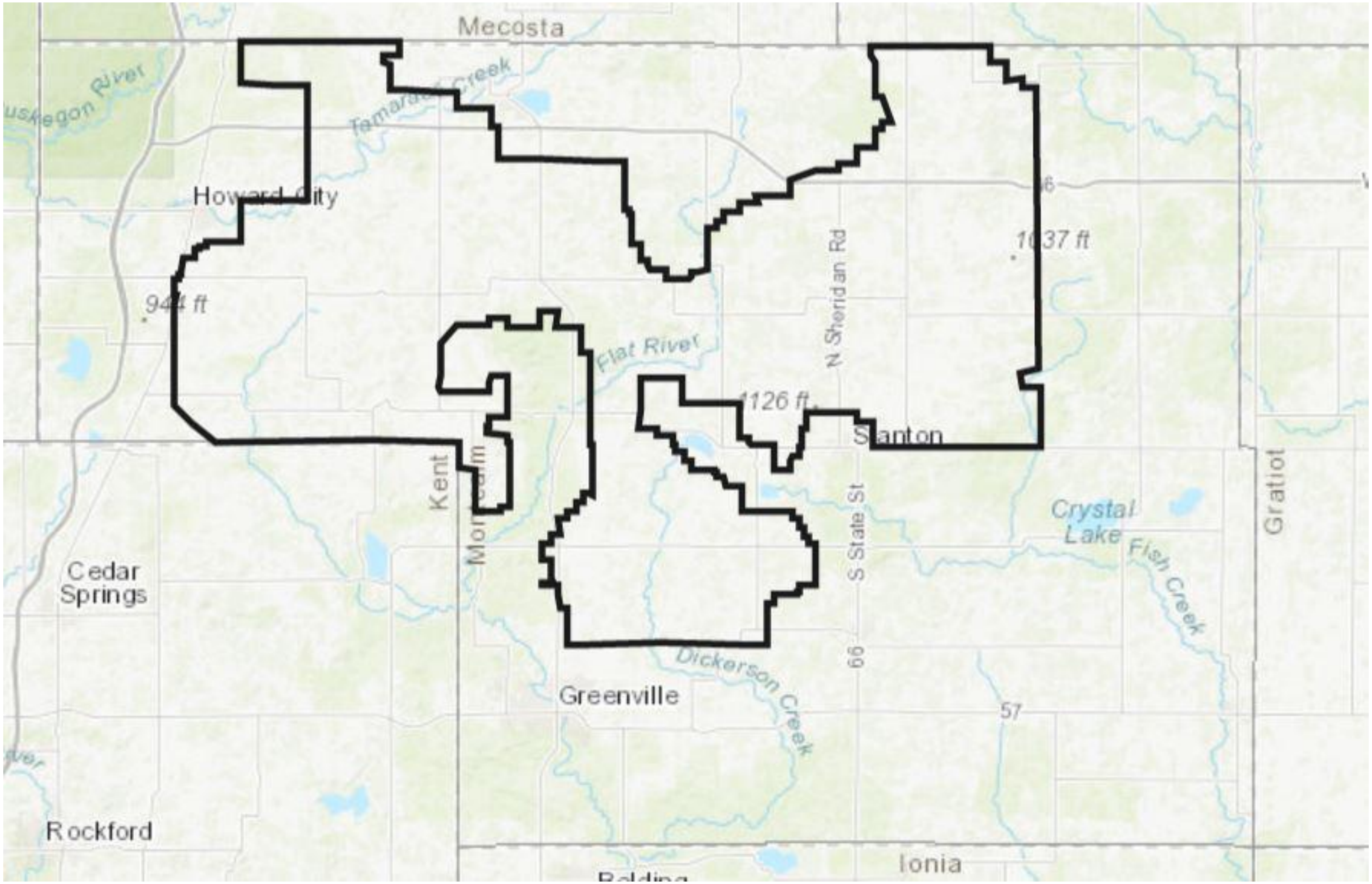
Development Process

- ✓ Interconnection Studies
- ✓ Airspace Studies
- ✓ Community Engagement
- ✓ Wildlife and Environmental Studies
- ✓ Land Leasing
- ✓ Meteorological Towers
- ✓ Township consultations & Zoning
- ✓ Project Design
- ✓ Permitting (zoning, airspace, environmental)
- ✓ Construction
- ✓ Operations

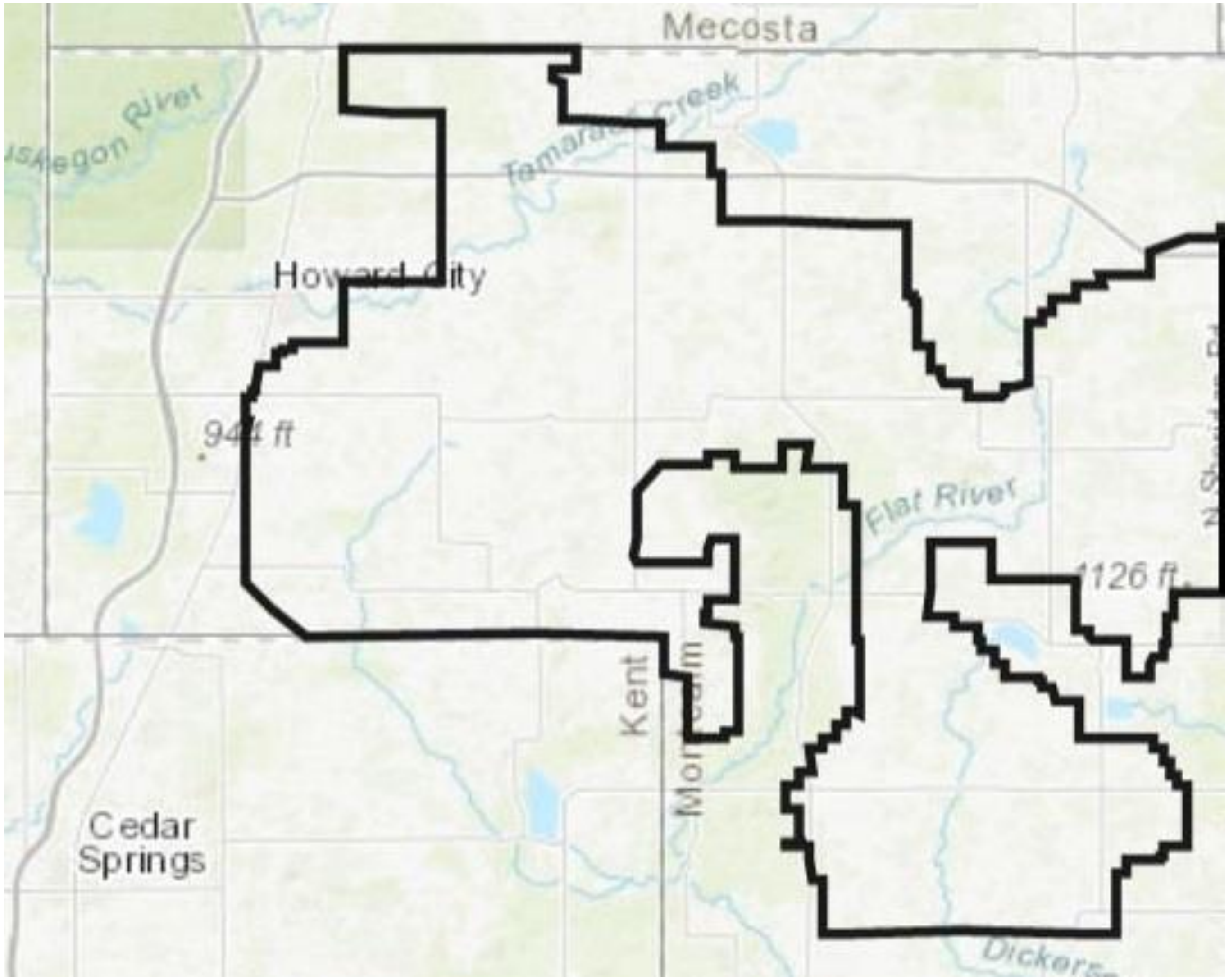
Montcalm Wind: Defining the Project Area



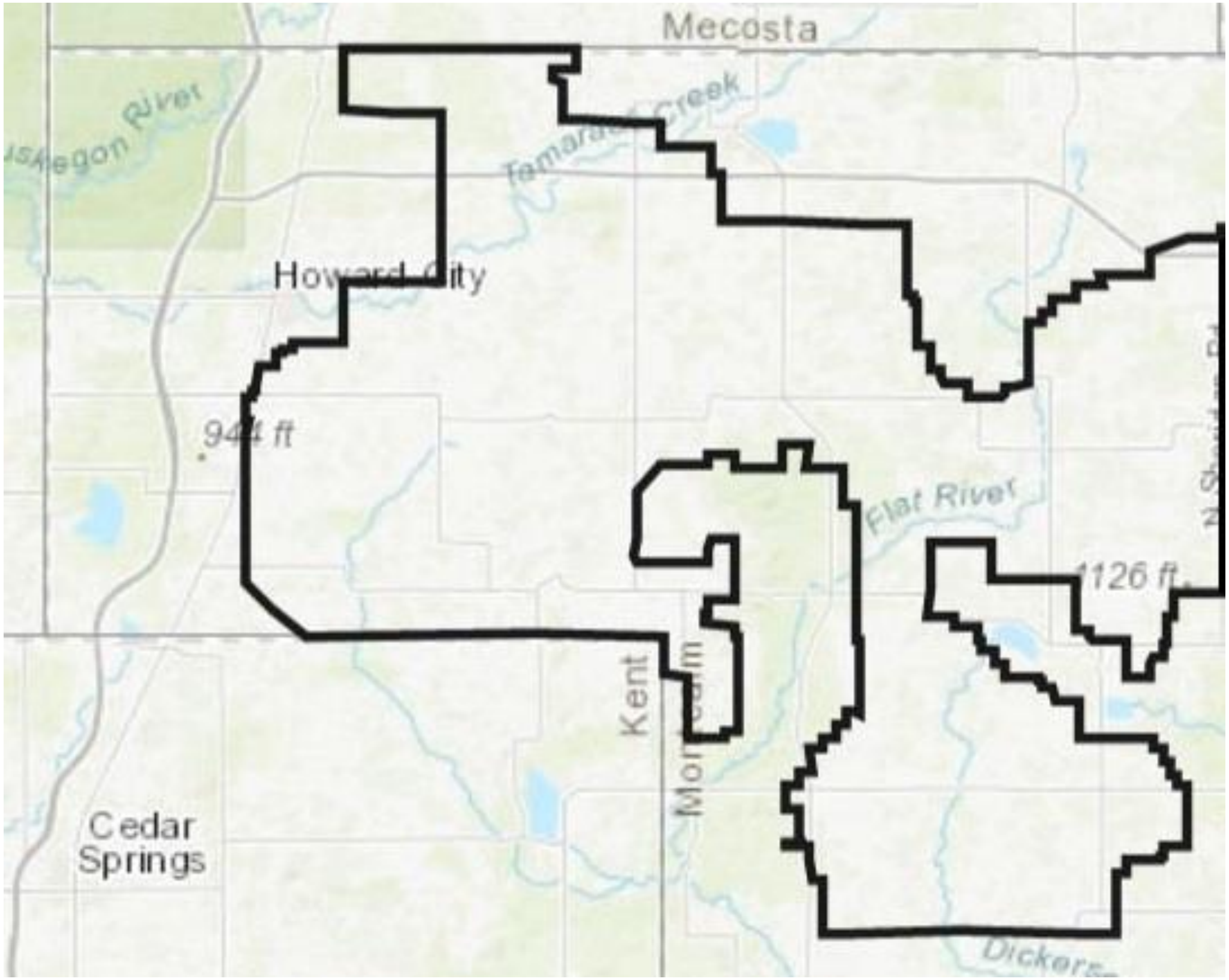
Montcalm Wind: Defining the Project Area



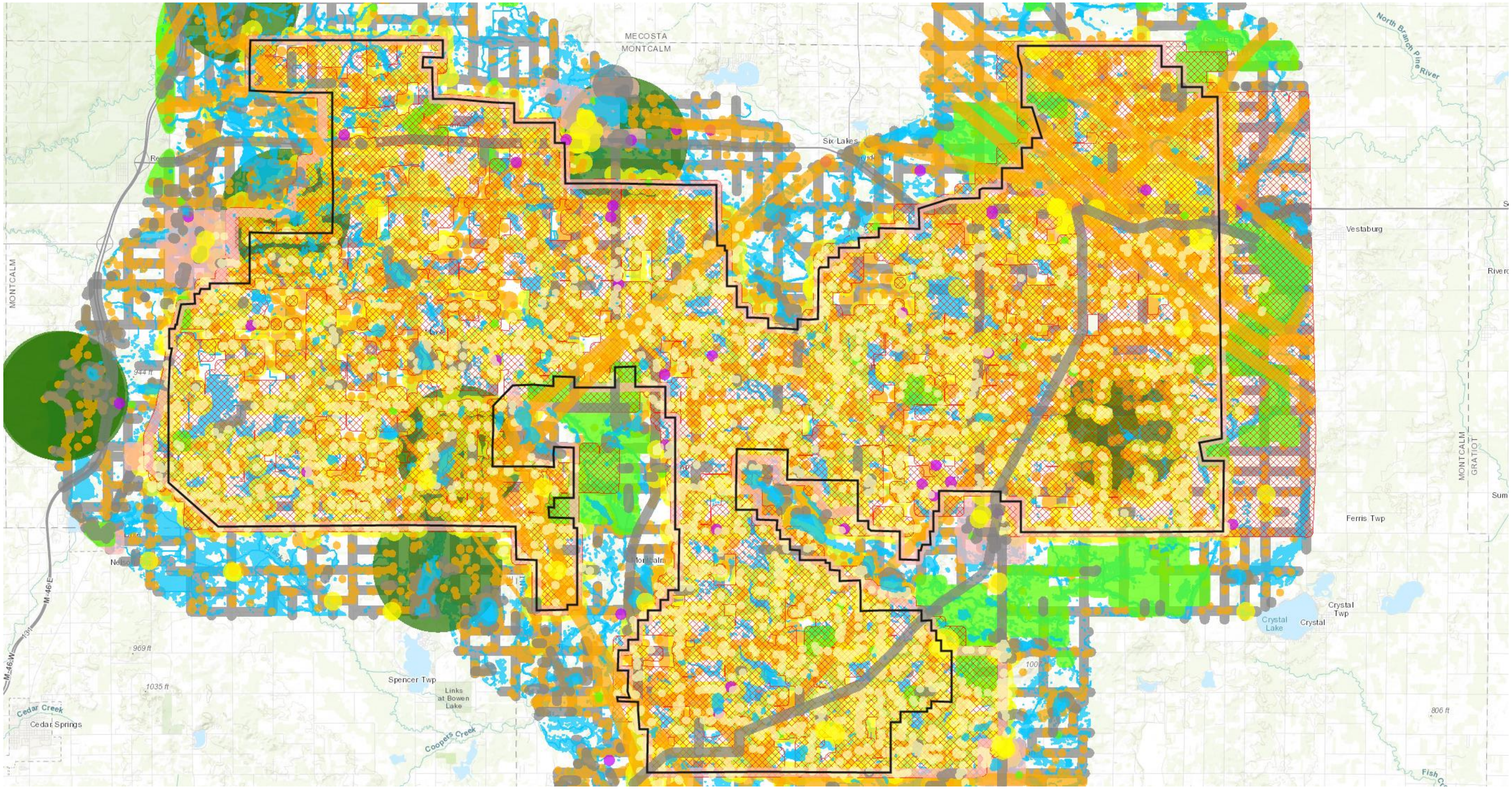
Montcalm Wind: Refining the Project Area



So Where Can a Wind Turbine Go?



Here's where we start

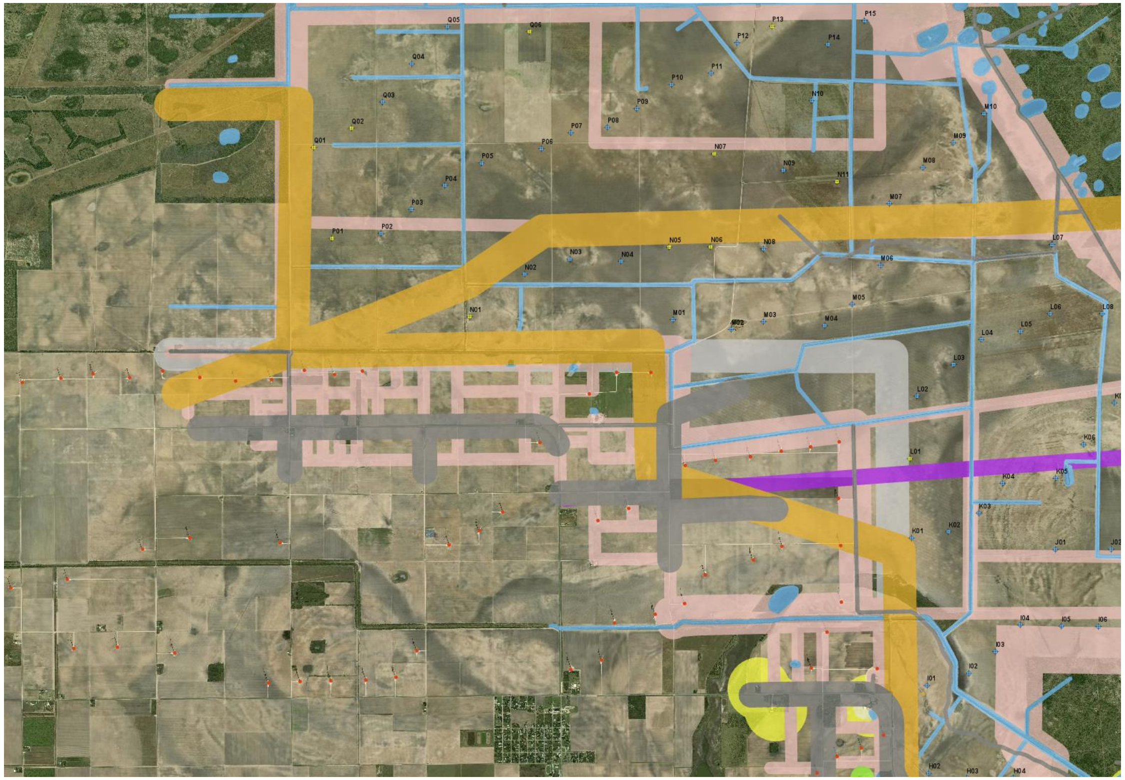


APEX CLEAN ENERGY

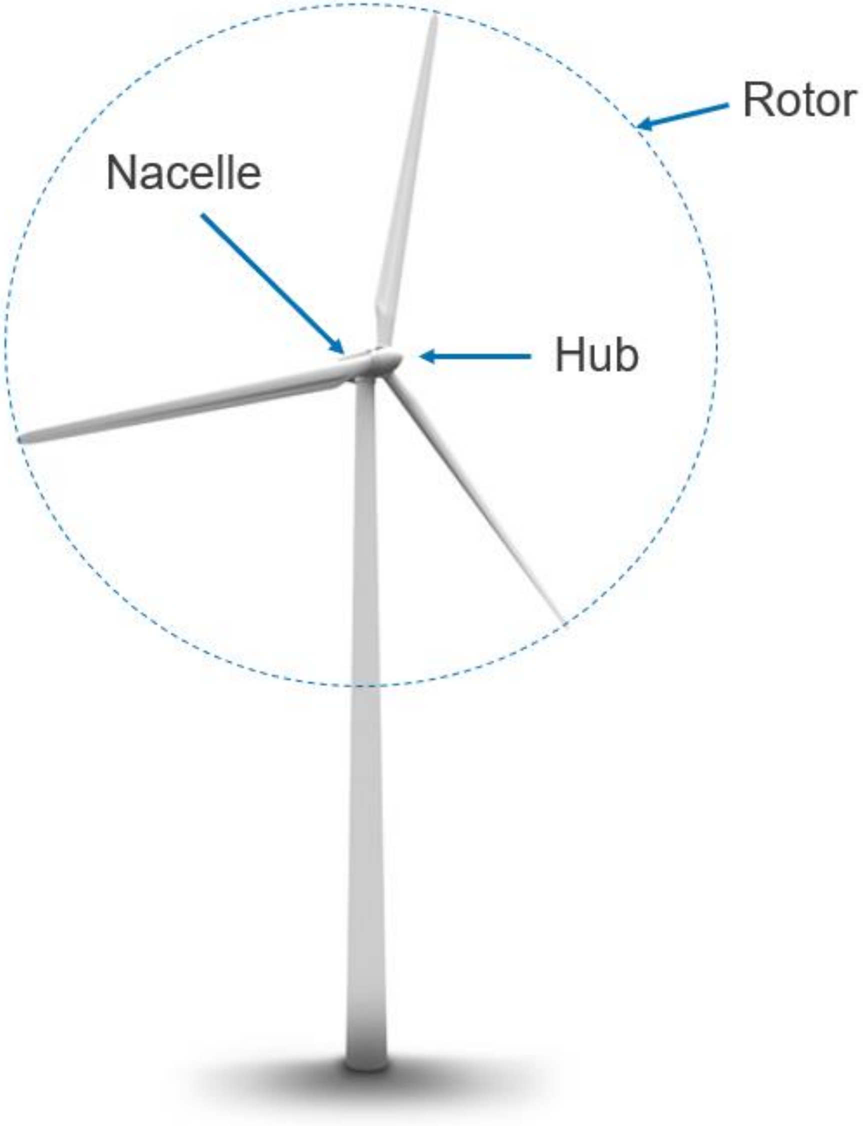
Layout Design

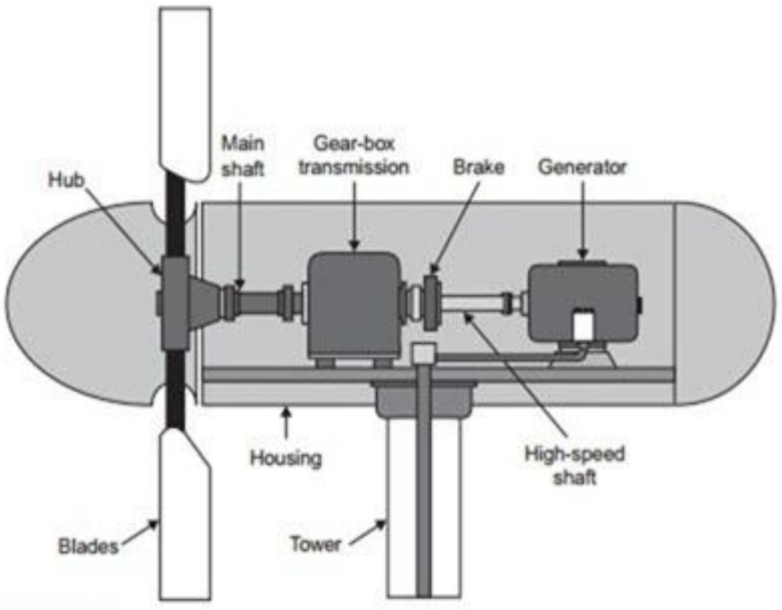
Many factors affect how we're able to design a layout

- Wind Resource
- Terrain
- Physical Setbacks
- Shadow flicker
- Sound
- Turbine models
- Other existing wind farms



Anatomy of a Wind Turbine

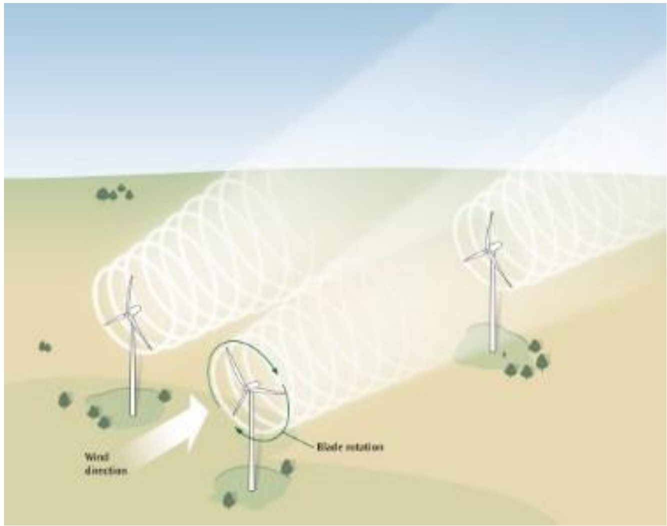


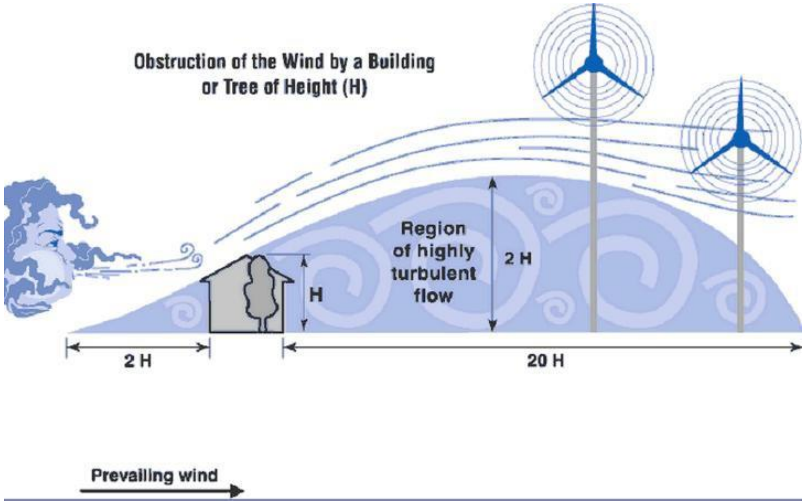


Layout Design: Wind Resource

Finding the Wind Resource

- On-site wind data gathered from multiple meteorological (met) towers.
- Met tower location does not equal turbine location
- Two years of data needed to inform siting process.

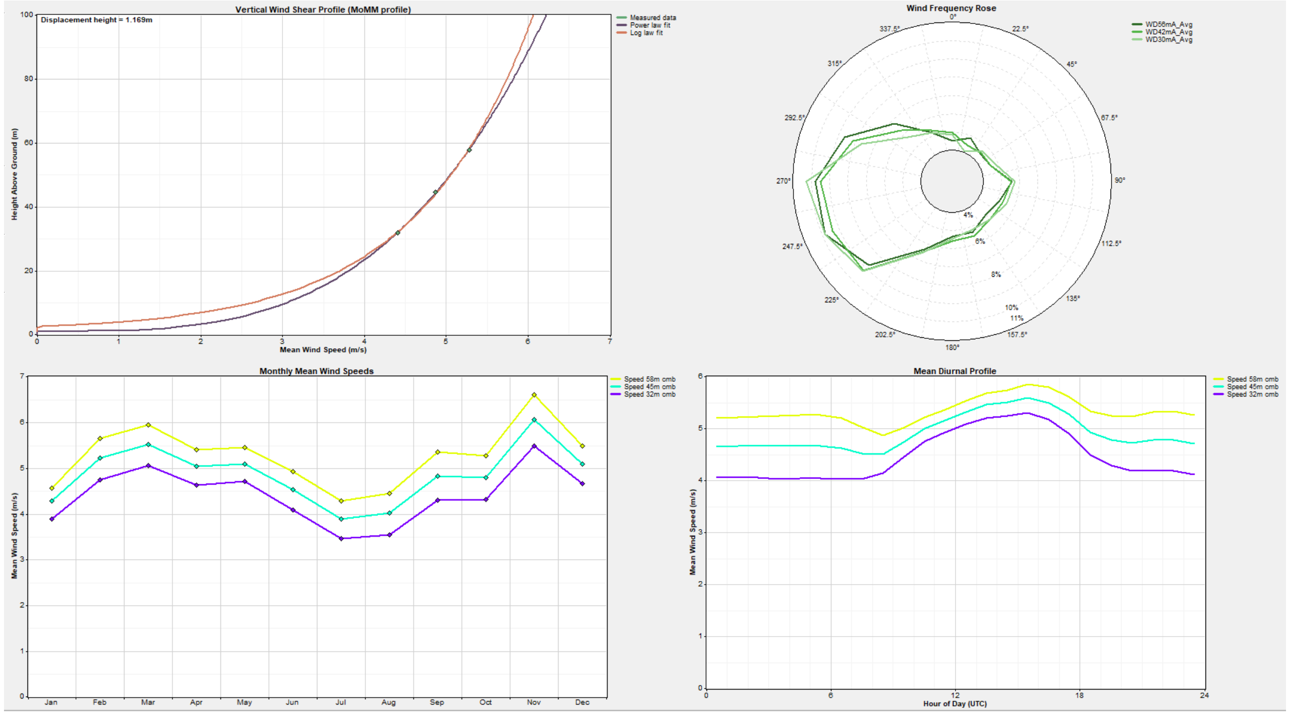




Layout Design - Wind Resource

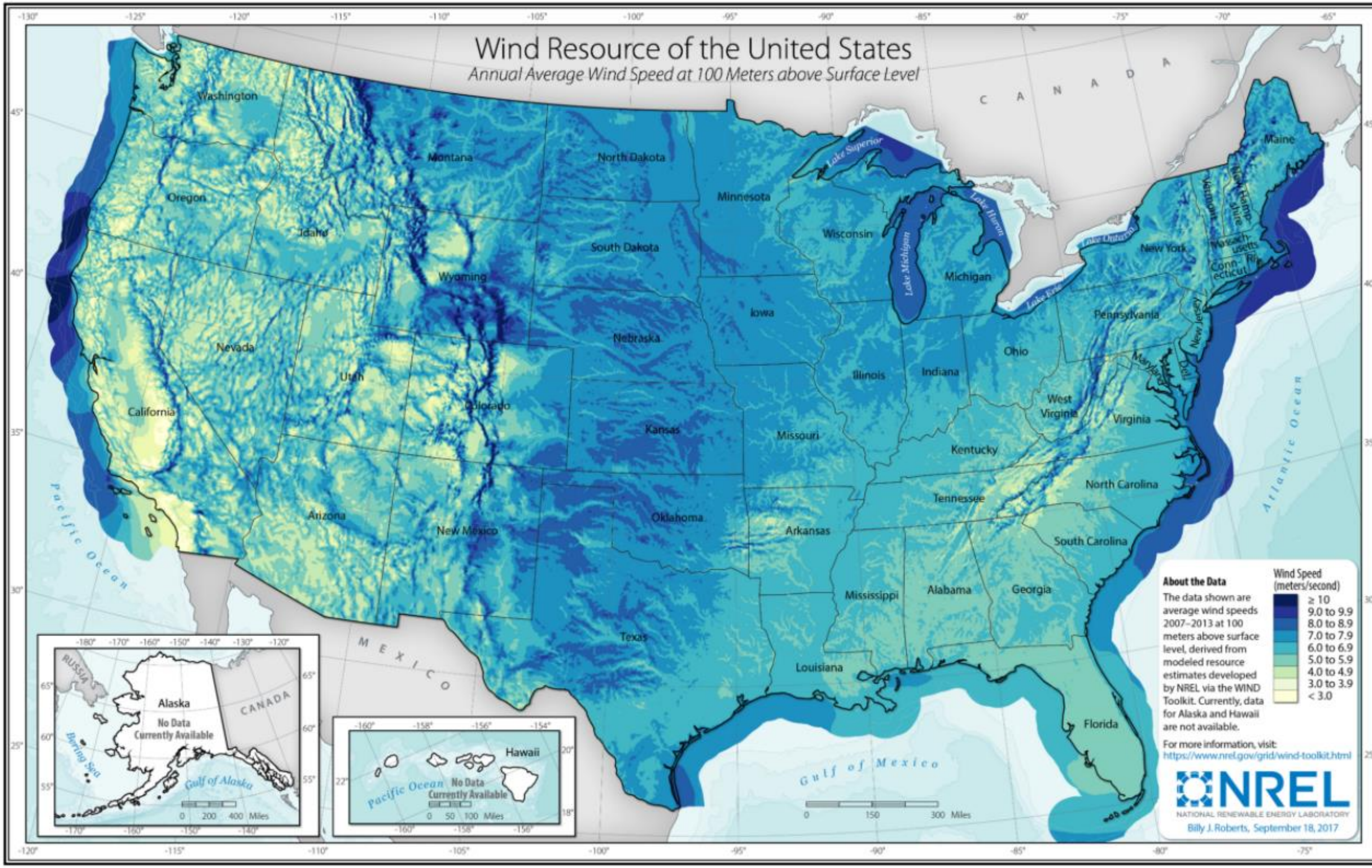
Wind Resource is evaluated by
- On-site data
- Long-term reanalysis products from NASA

Data is cleaned, long-term correlated and extrapolated to turbine hub height



APEX CLEAN ENERGY

Where Michigan Ranks on Wind Energy Capacity



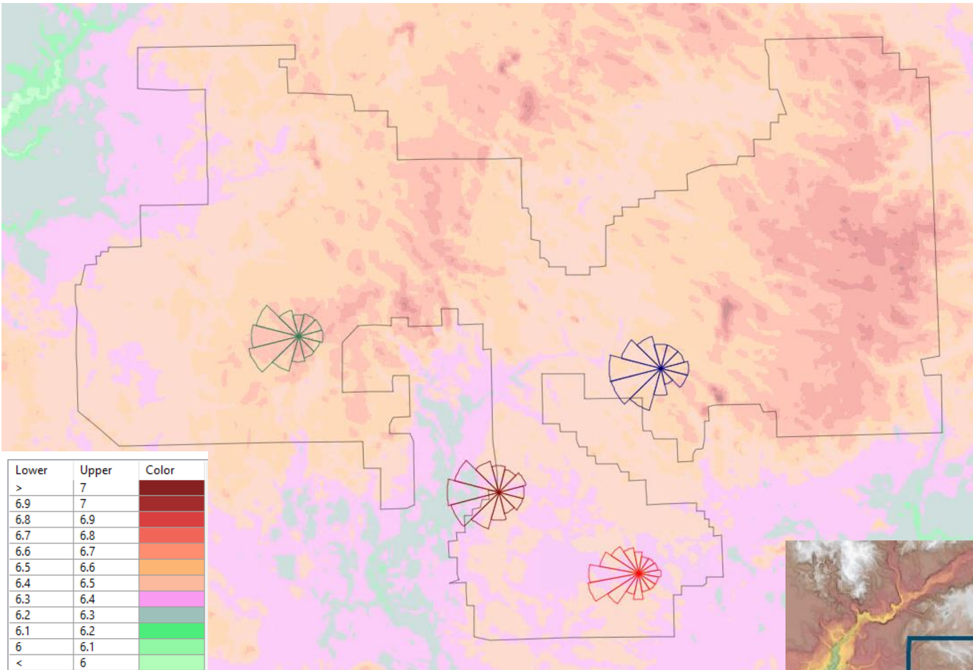
APEX CLEAN ENERGY

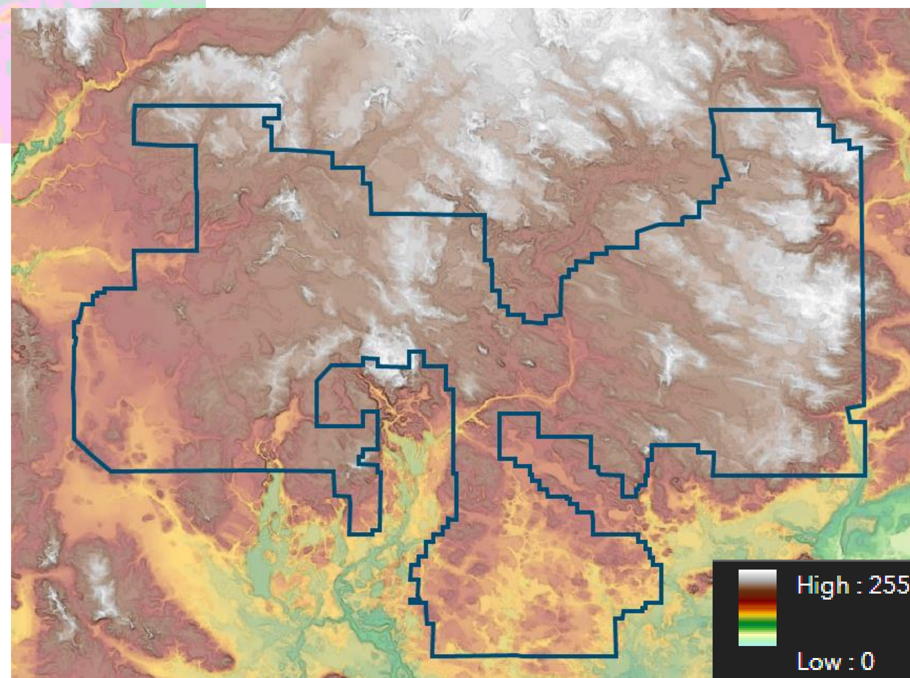
Layout Design - Wind Resource

Elevation and roughness (tree cover) have a large impact on wind speed –

Higher elevation = ↑ Wind

Less roughness (trees) = ↑ Wind

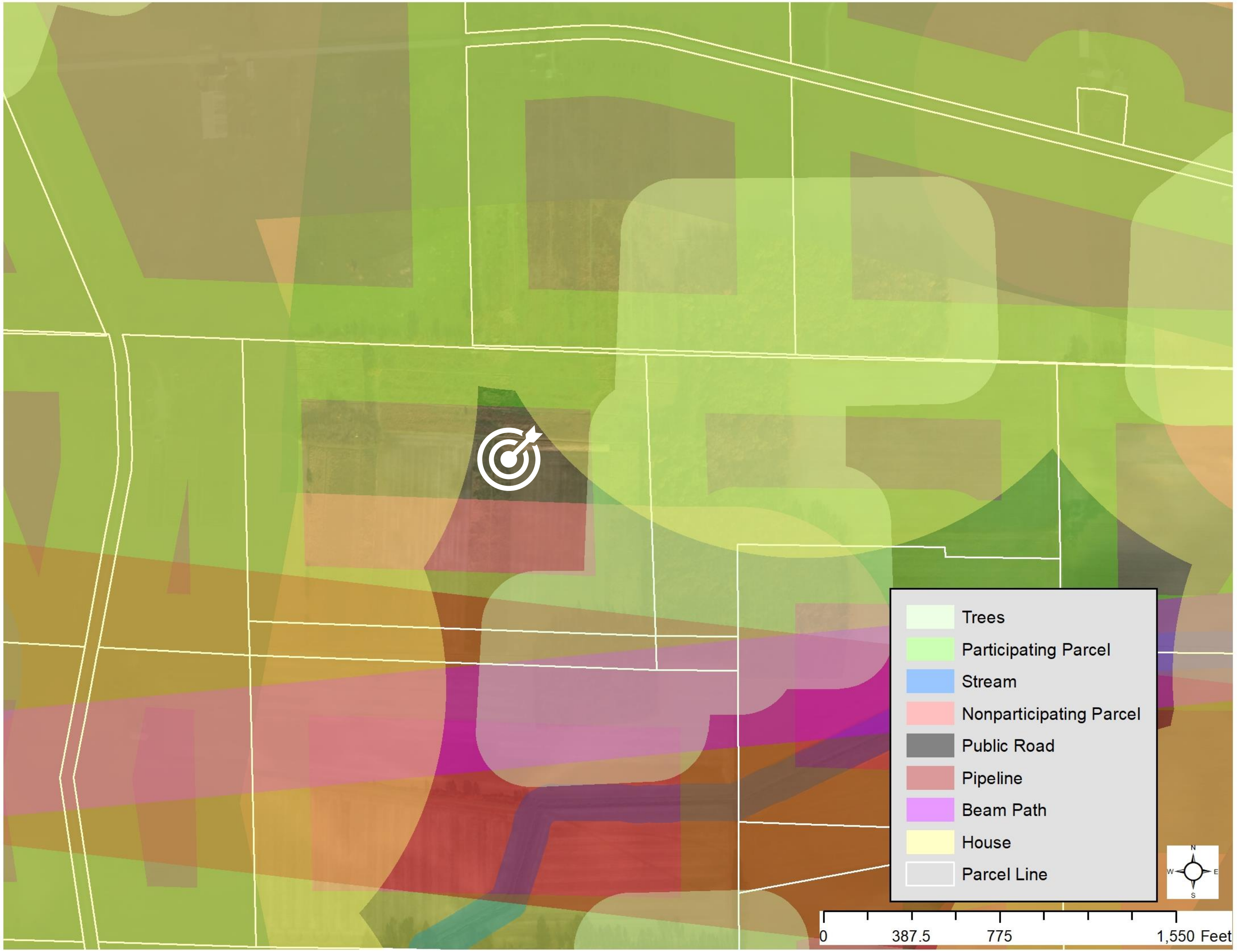




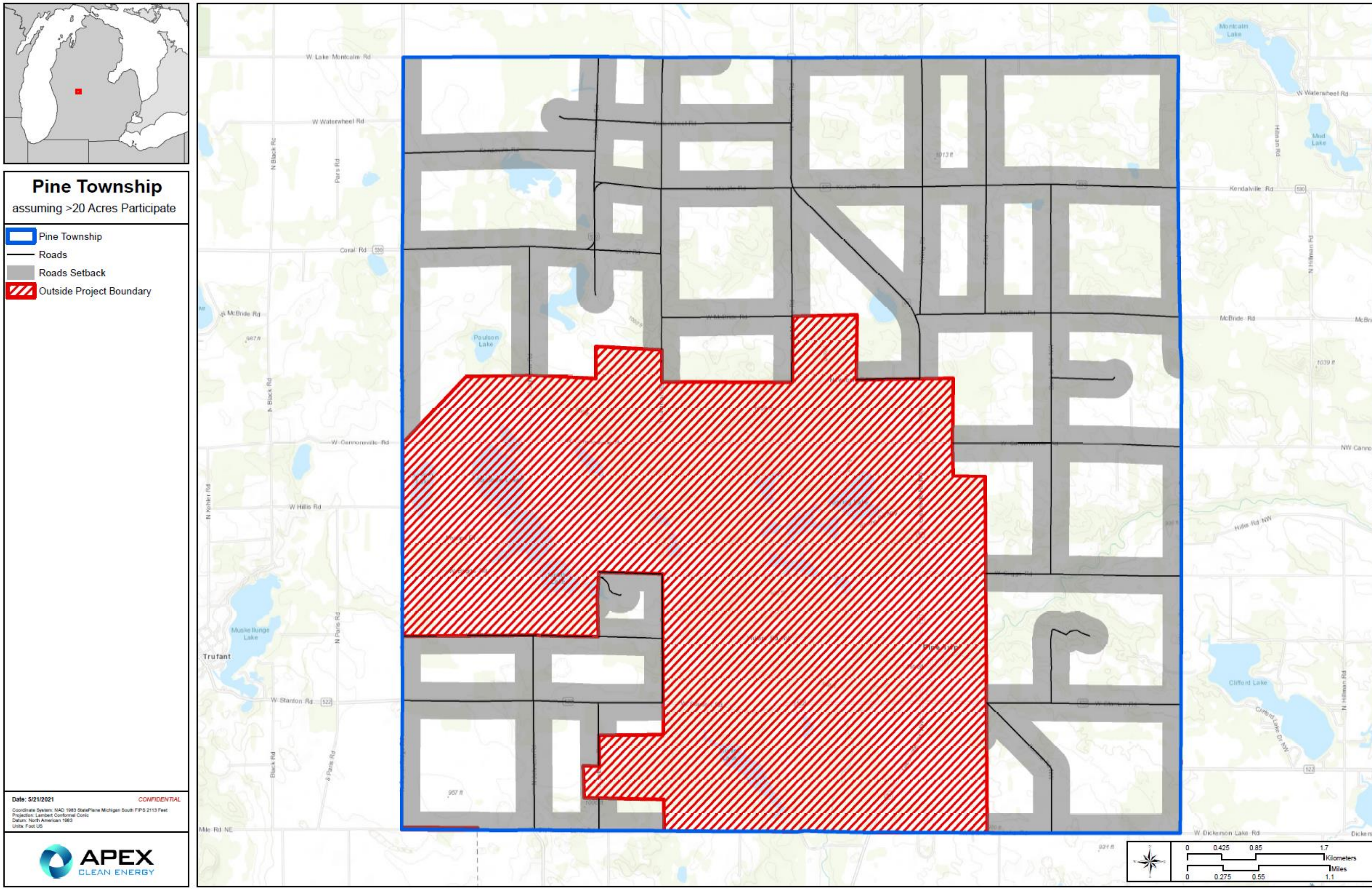
APEX CLEAN ENERGY

Layout Design: Physical Setbacks

Layout Design - Setbacks

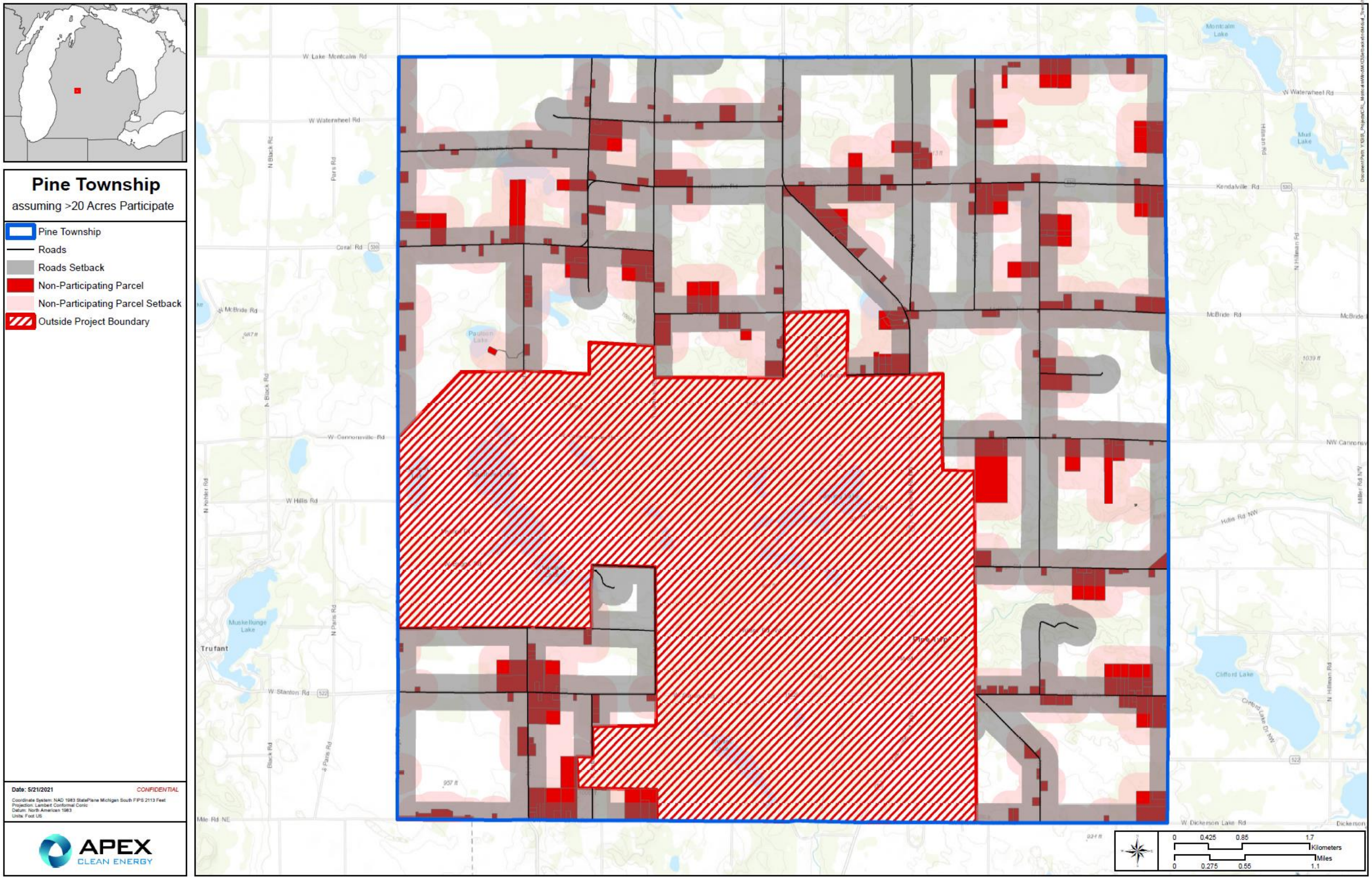


Looking at a Montcalm County Example



APEX CLEAN ENERGY

Assumes Parcels under 20 acres don't participate

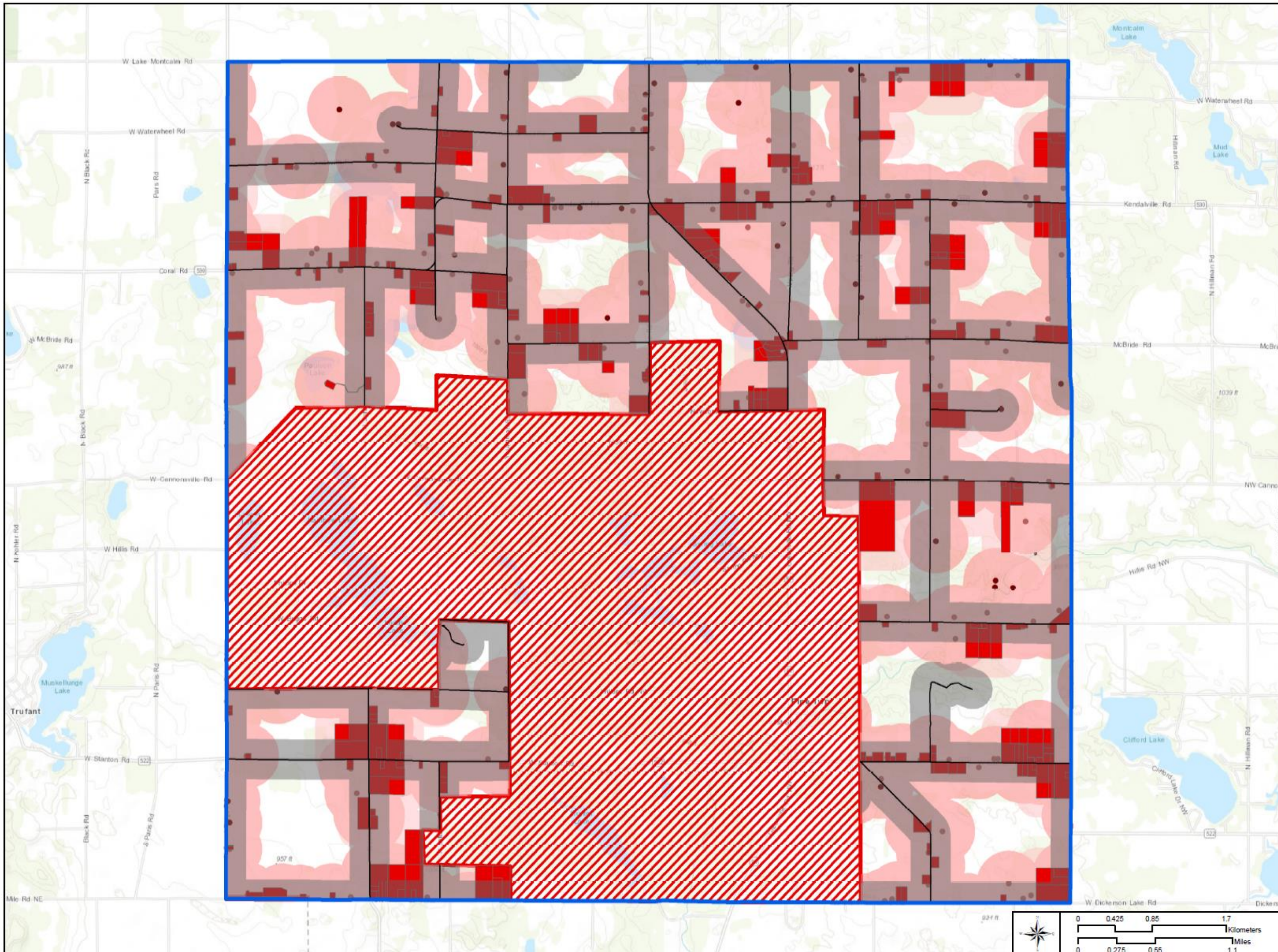


Add House Setback

Pine Township

assuming >20 Acres Participate

- Pine Township
- Roads
- Roads Setback
- Non-Participating Parcel
- Non-Participating Parcel Setback
- Houses
- House Setback
- Outside Project Boundary



Date: 5/21/2021 *CONFIDENTIAL*

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US

Avoid Disrupting Pivot Systems

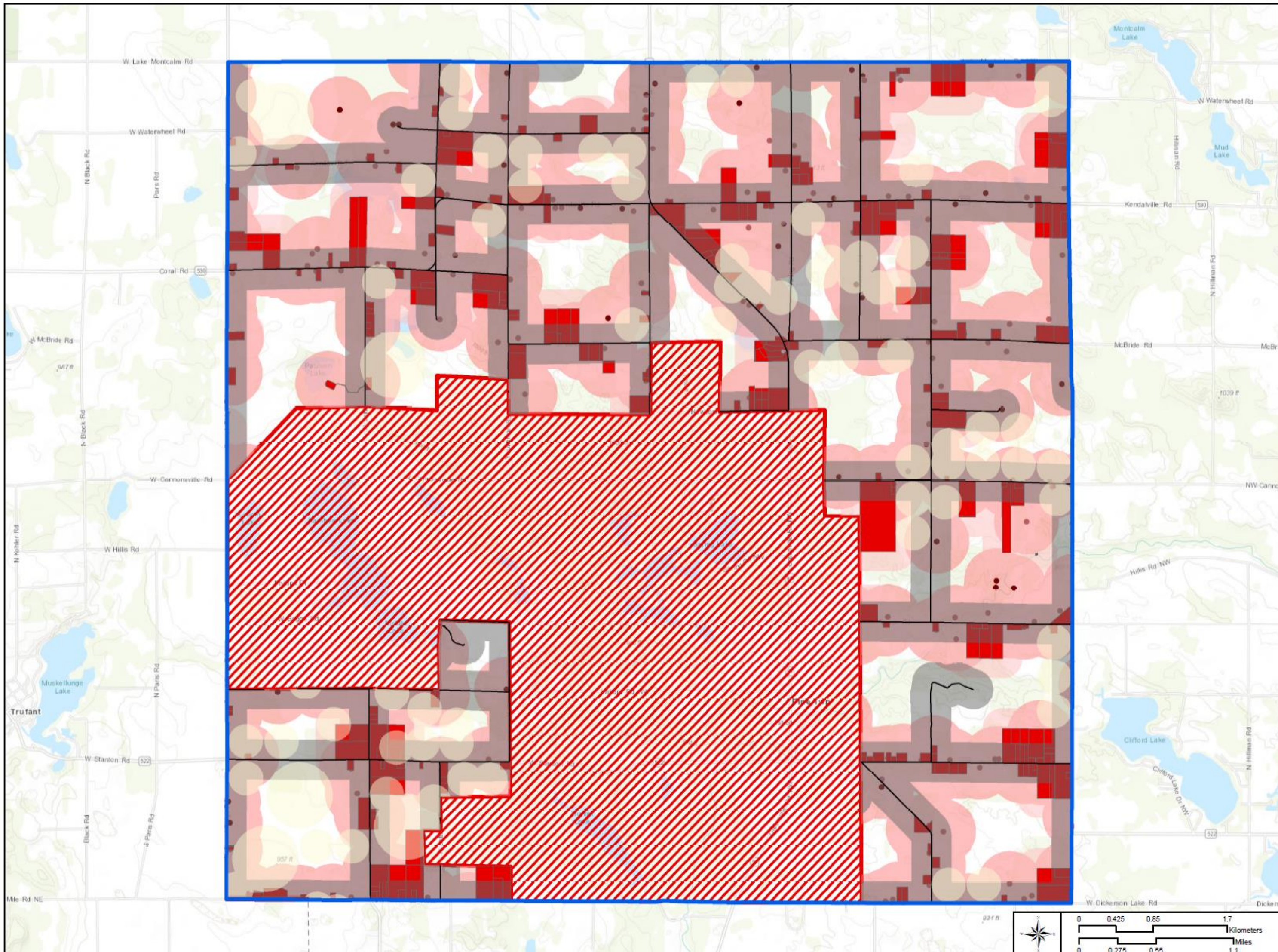
Pine Township

assuming >20 Acres Participate

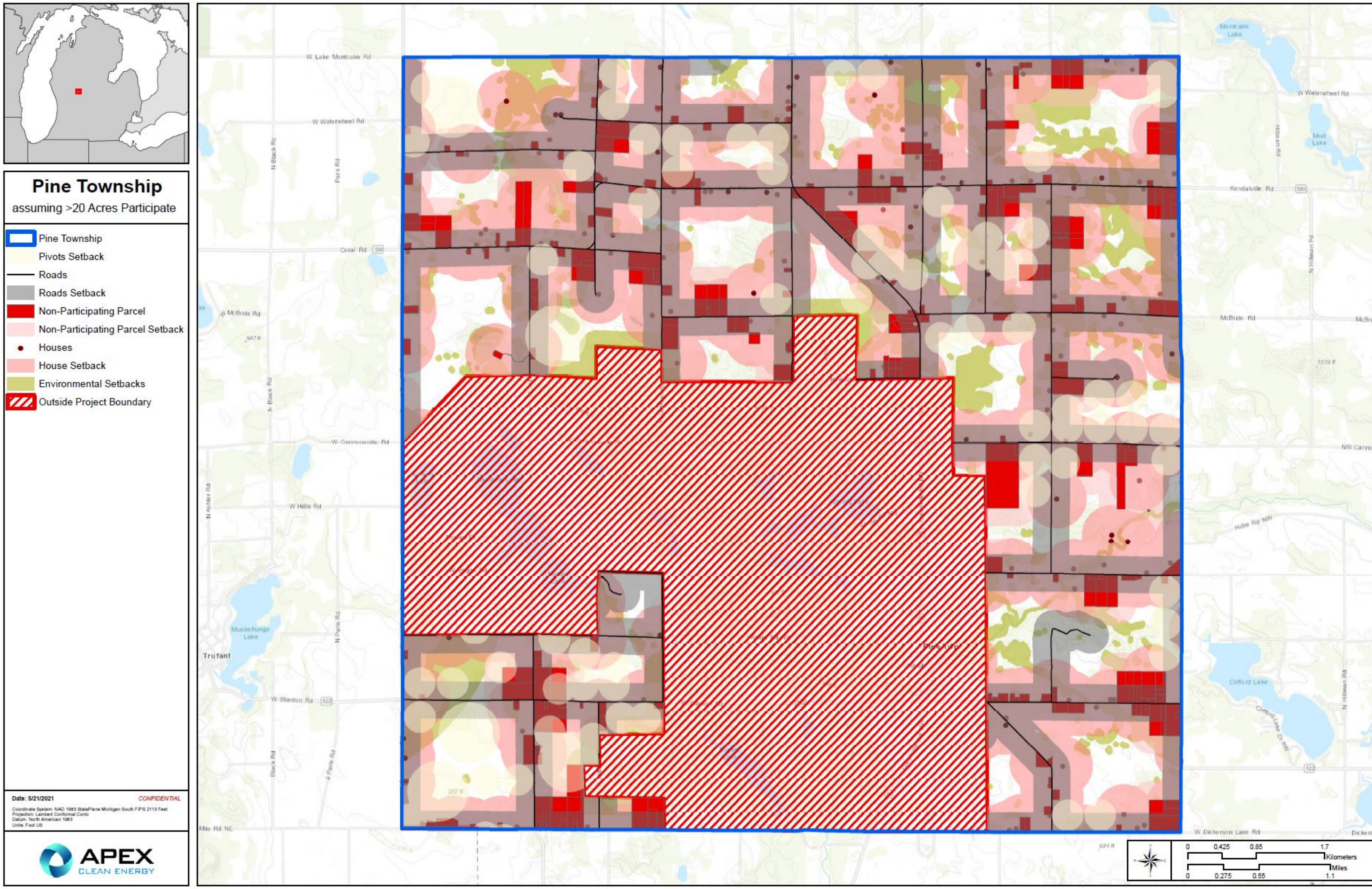
- Pine Township
- Pivots Setback
- Roads
- Roads Setback
- Non-Participating Parcel
- Non-Participating Parcel Setback
- Houses
- House Setback
- Outside Project Boundary

Date: 5/21/2021 *CONFIDENTIAL*

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US



Avoid Wetlands and Environmental Areas



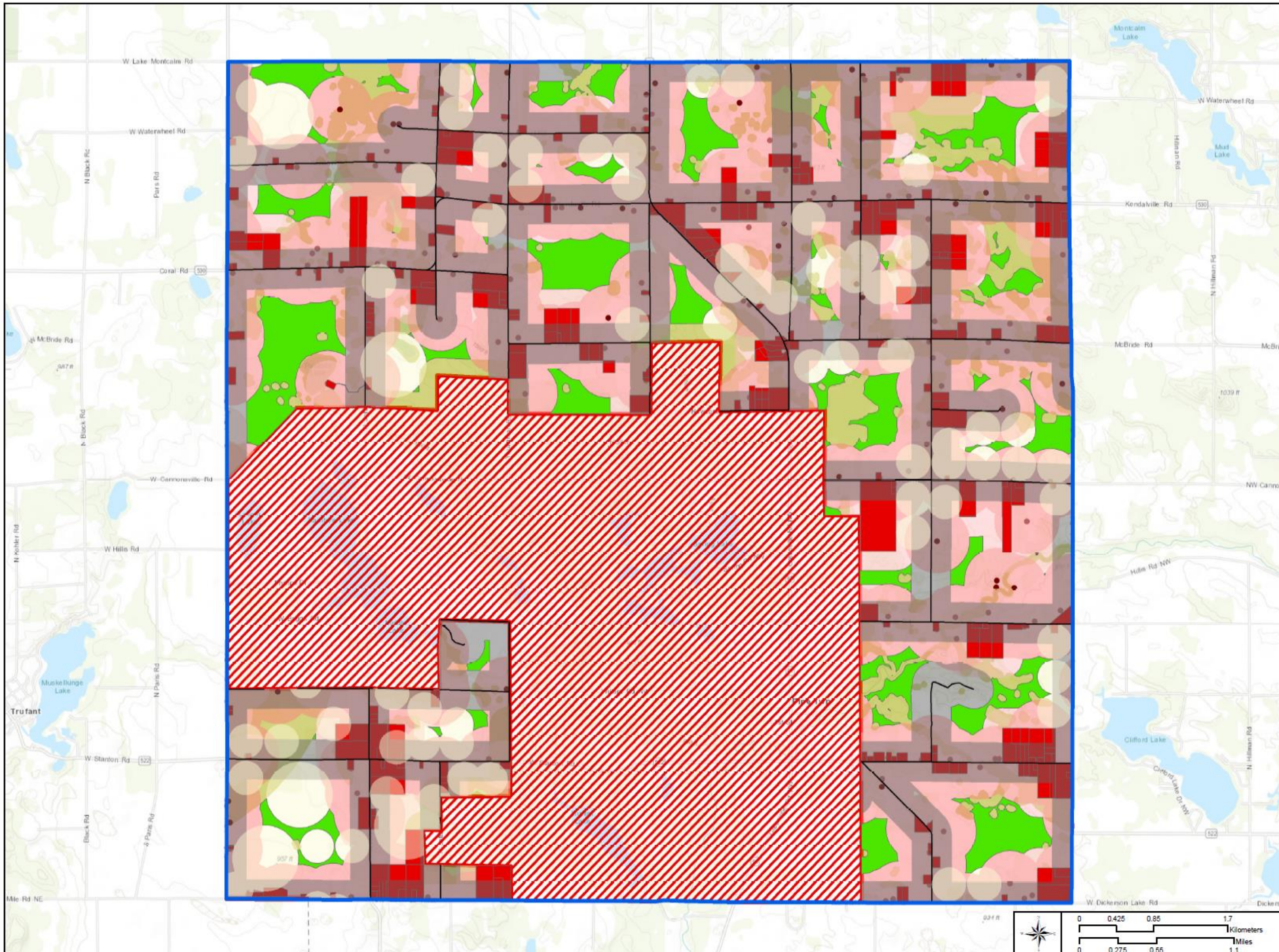
APEX
CLEAN ENERGY

Buildable Area (Green)

Pine Township

assuming >20 Acres Participate

- Pine Township
- Buildable Area
- Pivots Setback
- Roads
- Roads Setback
- Non-Participating Parcel
- Non-Participating Parcel Setback
- Houses
- House Setback
- Environmental Setbacks
- Outside Project Boundary



Date: 5/21/2021 CONFIDENTIAL

Coordinate System: NAD 1983 StatePlane Michigan South FIPS 2113 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US

APEX CLEAN ENERGY

APEX CLEAN ENERGY

Additional Types of Setbacks

- ✓ FAA/Airspace
- ✓ Railroads/Rail Trail
- ✓ Transmission Lines
- ✓ Oil & Gas Infrastructure
- ✓ Lakes, Rivers, streams, ditches, and wetlands
- ✓ Communications Beam Paths (TV, Radio, Cellular)
- ✓ Other occupied buildings
- ✓ Cultural or historic resources
- ✓ Environmental setbacks and avoidance (State lands, sensitive habitat, eagle nests, etc.)

Why Have Setbacks?

- Setbacks help minimize impact to sensitive areas and express community preferences.
- Setting appropriate setbacks is a balancing act - creating space between turbines and on-site features without restricting project feasibility.
- Setbacks are often *misused* by project opponents as a means to exclude wind energy or make a project infeasible.

So how do we strike this balance?

APEX CLEAN ENERGY

Setback References

Industry Standards:

- 1.1x tip height from residences, occupied buildings, public roads, railroads, transmission lines, oil and gas infrastructure. *("Setback Considerations for Wind Turbine Siting" Technical Documentation Wind Turbine Generator Systems, GE Renewable Energy)*
- 1.5 x (hub height + rotor diameter) in cold climates where icing may occur. (*Wind Energy Production in Cold Climate)*

Typical Zoning Standards in Michigan

- In Michigan, wind development has generally occurred in areas with around 2 to 2.5 times height or 1,000 to 1,250 foot setbacks to a dwelling or property line. *("Sample Zoning for Wind Energy Systems" Michigan State University Extension. 2020.)*
- A larger setback may have the effect of severely limiting or even unlawfully excluding wind energy from a jurisdiction.

Setback Fact Check

Do wind turbine manufacturers have a recommended Evacuation/Hazard Zone setback?

- **No.** For several years, opponents of wind energy have taken standard emergency response perimeter distances out of context from outdated Vestas and Nordex work instructions and argued that those clearance areas should be used as setback distances. Both manufacturers have repeatedly made it clear that the protocols referenced were never intended to be used to define turbine setback distances.

NORDEX

We have become aware that Nordex work instructions regarding emergency operating conditions are being cited by opponents of wind energy projects in Ohio as they advocate for additional setback regulations. Nordex's safety manuals should not be misinterpreted as guidance for setback distances for wind turbines from homes, roads, and property lines or otherwise. The manual referenced does not specify any emergency clearance area for siting distance for wind turbines.
- September 1, 2020 Letter to Ohio Power Siting Board

Vestas

"As information provided by Vestas regarding the establishment of siting distances has commonly been taken out of context and misquoted, we no longer publish guidance on the topic."
- February 13, 2019

Vestas' Site Emergency Response Plans (ERP) should not be misinterpreted as guidance for setback distances for wind turbines from homes, roads, property lines or otherwise.
- April 19, 201

APEX CLEAN ENERGY

Striking the Right Balance

<u>Mapping it out can help *(Below from MSU Wind Energy Zoning Guide)*:</u>

- In Michigan and nearby Midwestern states where a system of roads bordering one-mile sections are common…GIS can be helpful in Michigan to illustrate local opportunities or constraints.

- Isabella County used a Geographic Information System (GIS) to determine how different setbacks would change the potential number of turbines that could be built within a square mile section (if any at all).

- Planners applied different setback distances using GIS datasets for roads, wetlands, water bodies, parcel lines, and primary dwellings.

- This mapping exercise illustrated how setbacks, between 1,000 feet and 2,000 feet, would substantially change the number and placement of utility-scale wind towers within a study area. **A larger setback may have the effect of severely limiting or even excluding wind energy.**

- Planners used a set of assumptions including each parcel under 10 acres being considered non-participating (did not sign a lease) and about 80% of parcels over 40 acres considered participating (did sign a lease).

APEX CLEAN ENERGY

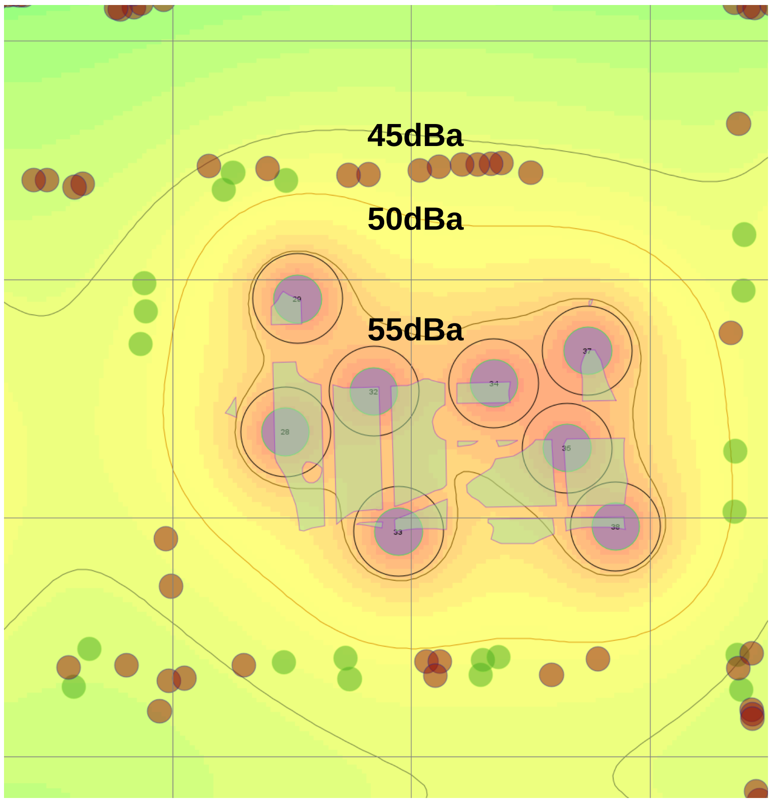
Striking the Right Balance

"The turbine setback must have a rational basis and purpose, that protects health, safety, and welfare."

("Sample Zoning for Wind Energy Systems" Michigan State University Extension, 2020.)

Layout Design: Sound

Layout Design - Sound



Noise Level Chart

A noise level chart showing examples of sounds with dB levels ranging from 0 to 180 decibels.

dBA	Example	Home & Yard Appliances	Workshop & Construction
0	healthy hearing threshold		
10	a pin dropping		
20	rustling leaves		
30	whisper		
40	babbling brook	computer	
50	light traffic	refrigerator	
60	conversational speech	air conditioner	
70	shower	dishwasher	
75	toilet flushing	vacuum cleaner	
80	alarm clock	garbage disposal	
85	passing diesel truck	snow blower	
90	squeeze toy	lawn mower	arc welder
95	inside subway car	food processor	belt sander
100	motorcycle (riding)		handheld drill
105	sporting event		table saw
110	rock band		jackhammer
115	emergency vehicle siren		riveter
120	thunderclap		oxygen torch
125	balloon popping		
130	peak stadium crowd noise		
135	air raid siren		
140	jet engine at takeoff		
145	firecracker		
150	fighter jet launch		
155	cap gun		
160	shotgun		
165	.357 magnum revolver		
170	safety airbag		
175	howitzer cannon		
180	rocket launch		
...			
194	sound waves become shock waves		

*https://www.noisehelp.com/noise-level-chart.html

APEX CLEAN ENERGY

Layout Design - Sound

The L_{eq} is the best metric for use in wind turbine noise regulation:

- The IEC 61400-11 and -14 standards for specifying wind turbine sound output are Leq-based.
- The ISO 9613-2 standard for outdoor sound propagation predictions is Leq-based.
- Studies on the long-term impacts of sound are Leq-based.
- The Leq weights periods with higher sound levels.
- The turbine-only Leq can be calculated by subtracting out background sound mathematically.
- Instantaneous maxima (like Lmax) cannot be reliably predicted, have high variation between measurements, and are unrelated to impact.

*Information provided by RSG - Acousticians

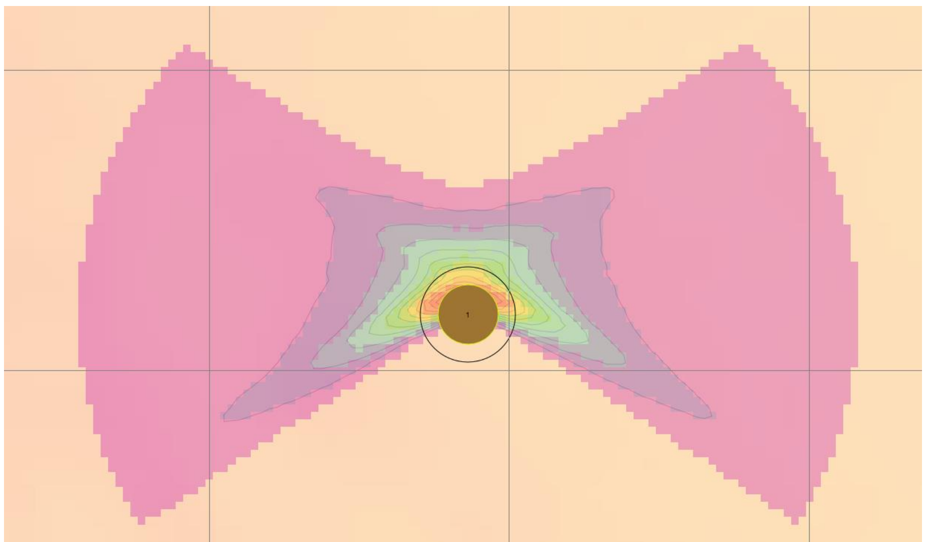
APEX CLEAN ENERGY

Layout Design: Shadow

Layout Design - Shadow

Shadow Flicker is caused by sunlight passing through the rotor sweep area of the wind turbine

- The amount of shadow flicker diminishes rapidly with distance from the turbine



Minutes of Shadow Flicker

>	12000	
10800.1	12000	
9600.2	10800.1	
8400.3	9600.2	
7200.4	8400.3	
6000.5	7200.4	
4800.6	6000.5	
3600.7	4800.6	
2400.8	3600.7	
1200.9	2400.8	
1	1200.9	

* https://www.michiganseagrant.org/wp-content/uploads/2018/08/10-733-Wind-Brief2-Flicker-Noise-Air-Quality2.pdf

The Science of Shadow

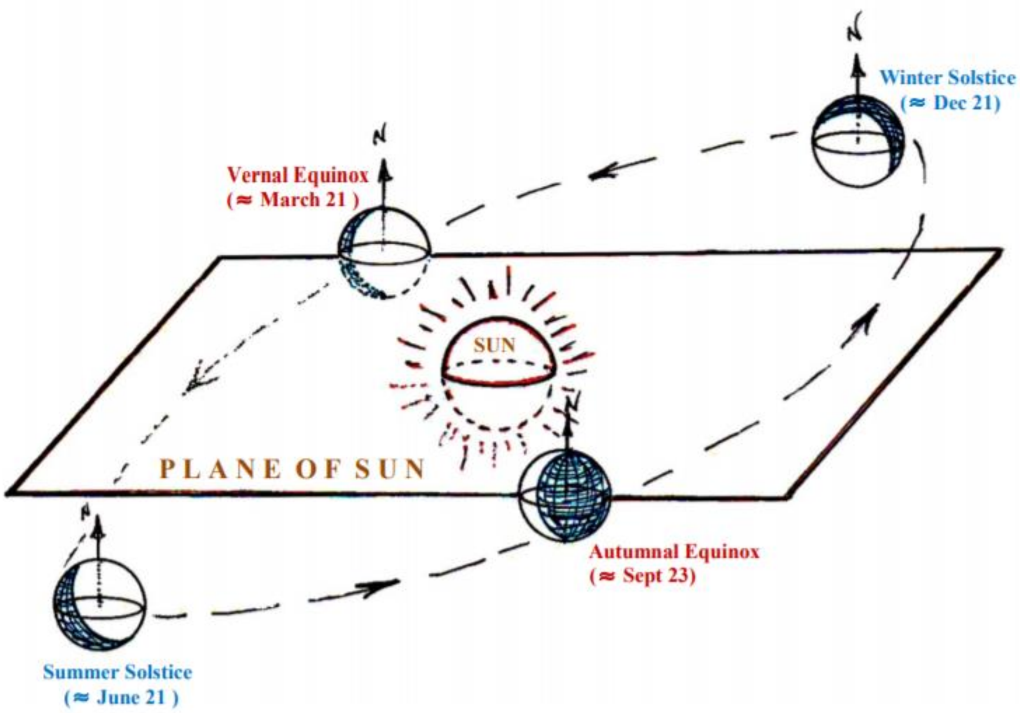
Shadow depends upon the angle between the Earth and Sun

$$L = H/\tan(\alpha)$$

$$\sin(\alpha) = \cos(\delta)\cos(\phi)\cos(\omega) + \sin(\delta)\sin(\phi)$$

Where,

α is the sun elevation angle
δ is the declination of the earth axis
φ is the latitude
ω is the sun hour



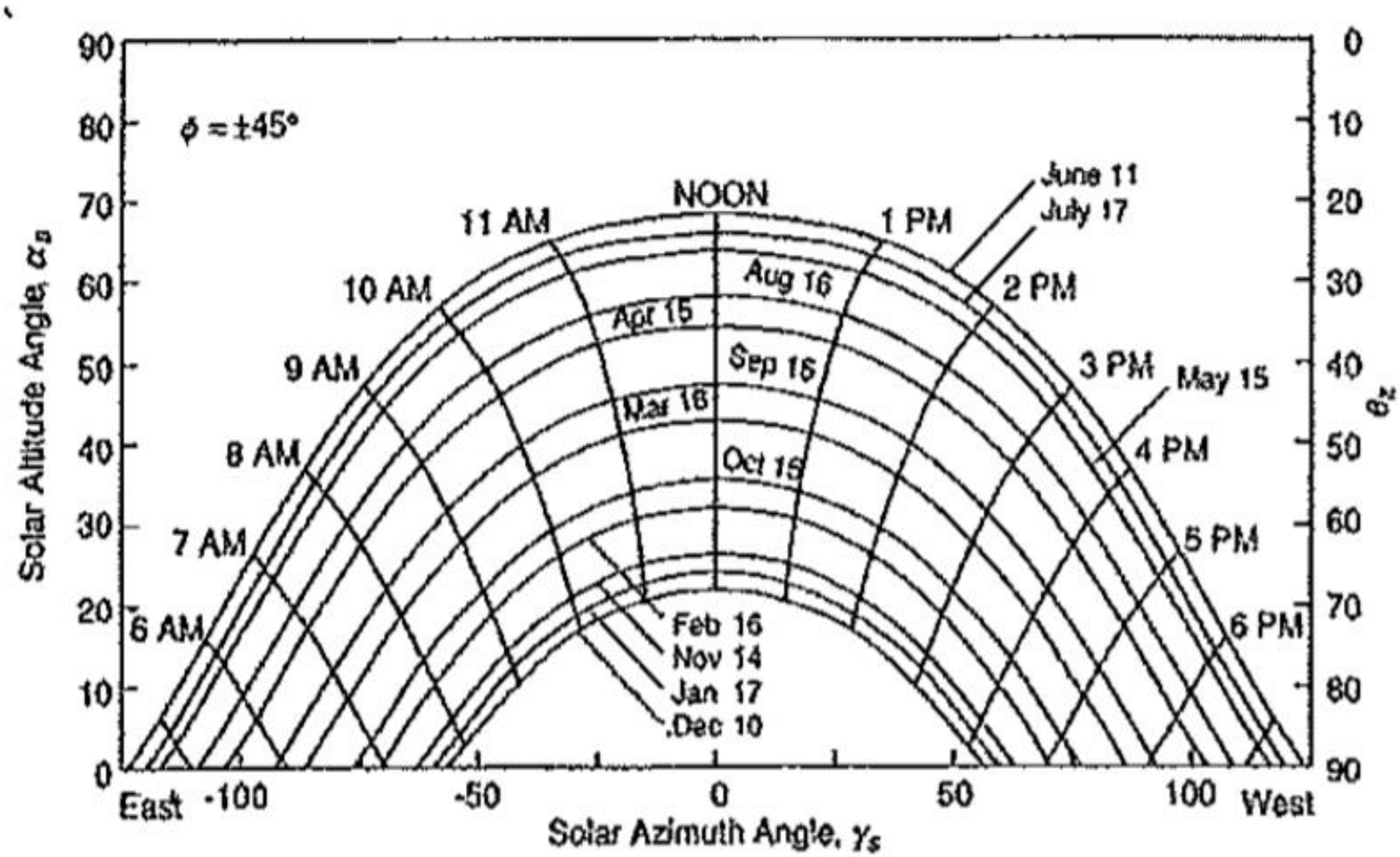
$$\delta = 23.45 \sin\left(360\frac{284+n}{365}\right)$$

n is the day of the year

Image Source: Illinois Institute of Technology, D. Maslanka

APEX CLEAN ENERGY

The Science of Shadow - Sun Path Diagram



The Science of Shadow – By the Numbers

Climate data for Grand Rapids, Michigan (Gerald Ford Int'l), 1991–2020 normals, extremes 1892–present[a] [hide]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	68 (20)	69 (21)	87 (31)	90 (32)	95 (35)	102 (39)	108 (42)	102 (39)	98 (37)	89 (32)	81 (27)	69 (21)	108 (42)
Mean maximum °F (°C)	51 (11)	52 (11)	68 (20)	79 (26)	86 (30)	92 (33)	92 (33)	91 (33)	88 (31)	79 (26)	65 (18)	54 (12)	94 (34)
Average high °F (°C)	31.0 (−0.6)	33.7 (0.9)	44.5 (6.9)	57.8 (14.3)	69.8 (21.0)	79.4 (26.3)	83.1 (28.4)	80.9 (27.2)	73.9 (23.3)	60.7 (15.9)	47.2 (8.4)	36.1 (2.3)	58.2 (14.6)
Daily mean °F (°C)	24.8 (−4.0)	26.6 (−3.0)	35.7 (2.1)	47.6 (8.7)	59.2 (15.1)	68.9 (20.5)	72.8 (22.7)	71.1 (21.7)	63.5 (17.5)	51.5 (10.8)	40.0 (4.4)	30.4 (−0.9)	49.3 (9.6)
Average low °F (°C)	18.6 (−7.4)	19.5 (−6.9)	26.9 (−2.8)	37.3 (2.9)	48.6 (9.2)	58.3 (14.6)	62.5 (16.9)	61.2 (16.2)	53.1 (11.7)	42.2 (5.7)	32.8 (0.4)	24.7 (−4.1)	40.5 (4.7)
Mean minimum °F (°C)	−3 (−19)	0 (−18)	8 (−13)	23 (−5)	33 (1)	44 (7)	51 (11)	49 (9)	39 (4)	29 (−2)	16 (−9)	6 (−14)	−6 (−21)
Record low °F (°C)	−22 (−30)	−24 (−31)	−13 (−25)	3 (−16)	21 (−6)	32 (0)	41 (5)	39 (4)	27 (−3)	18 (−8)	−10 (−23)	−18 (−28)	−24 (−31)
Average precipitation inches (mm)	2.52 (64)	2.12 (54)	2.39 (61)	3.99 (101)	4.00 (102)	3.94 (100)	3.86 (98)	3.55 (90)	3.43 (87)	4.02 (102)	3.10 (79)	2.48 (63)	39.40 (1,001)
Average snowfall inches (cm)	22.6 (57)	17.2 (44)	7.6 (19)	2.0 (5.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.3 (0.76)	7.1 (18)	20.8 (53)	77.6 (197)
Average precipitation days (≥ 0.01 in)	16.8	13.1	11.8	12.8	12.5	10.7	10.0	9.9	10.2	12.5	12.9	15.5	148.7
Average snowy days (≥ 0.1 in)	14.9	11.2	5.9	2.1	0.0	0.0	0.0	0.0	0.0	0.4	4.5	11.9	50.9
Average relative humidity (%)	77.2	74.2	71.1	66.8	65.4	68.1	69.6	73.3	76.1	74.6	76.9	79.5	72.7
Mean monthly sunshine hours	65.0	93.0	181.4	207.9	256.6	292.6	327.4	270.8	226.5	147.3	85.0	53.9	2,207.4
Percent possible sunshine	22.3	31.2	48.9	51.6	56.3	63.6	70.4	63.0	60.6	43.2	29.2	19.3	46.6

Source: NOAA (relative humidity)[39][40][41]

Total sunshine hours for the year = 2,207.4

Industry standard – 30 hours per year shadow flicker limit

2,207.4 / 30 = 1.4% average maximum potential time when sun is shining to experience shadow flicker

APEX CLEAN ENERGY

Shadow Flicker Limit – 30 Hours

While Shadow Flicker is rare, we want to minimize Shadow Flicker to the greatest extent possible. Industry bets practice is to limit to no more than 30 hours per year. **Why 30 hours?**

A national survey conducted by **Lawrence Berkeley National Laboratory**[1] on impacts of operating wind farms in host communities showed the industry standard practice of 30 hours per year leads to negligible levels of annoyance.

Most Michigan communities and Midwestern states have adopted a standard of 30 hours per year of actual shadow flicker on a non-participating dwelling.

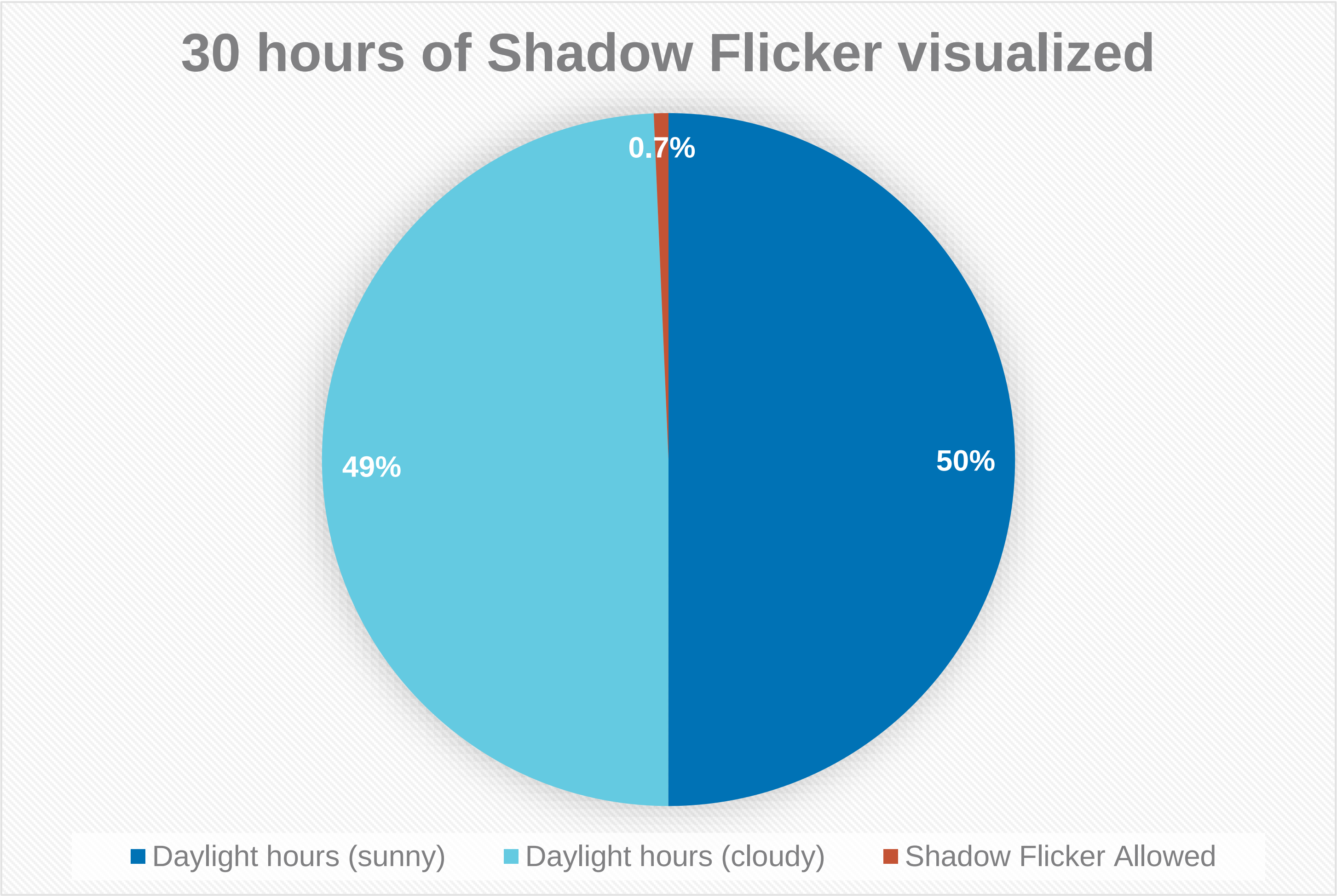
There is no scientific evidence to suggest that shadow flicker negatively effects health.[2]

1. Ben Hoen et al., "National Survey of Attitudes of Wind Power Project Neighbors" Ernest Orlando Lawrence Berkeley National Lab, 2018.

2. Wind Turbine Health Impact Study: Report of Independent Expert Panel. Prepared for: Massachusetts Department of Environmental Protection Massachusetts, Department of Public Health, January 2012.

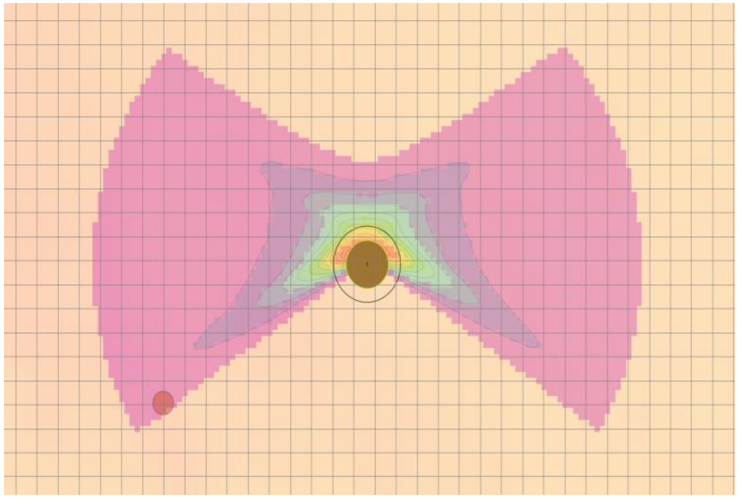
APEX CLEAN ENERGY

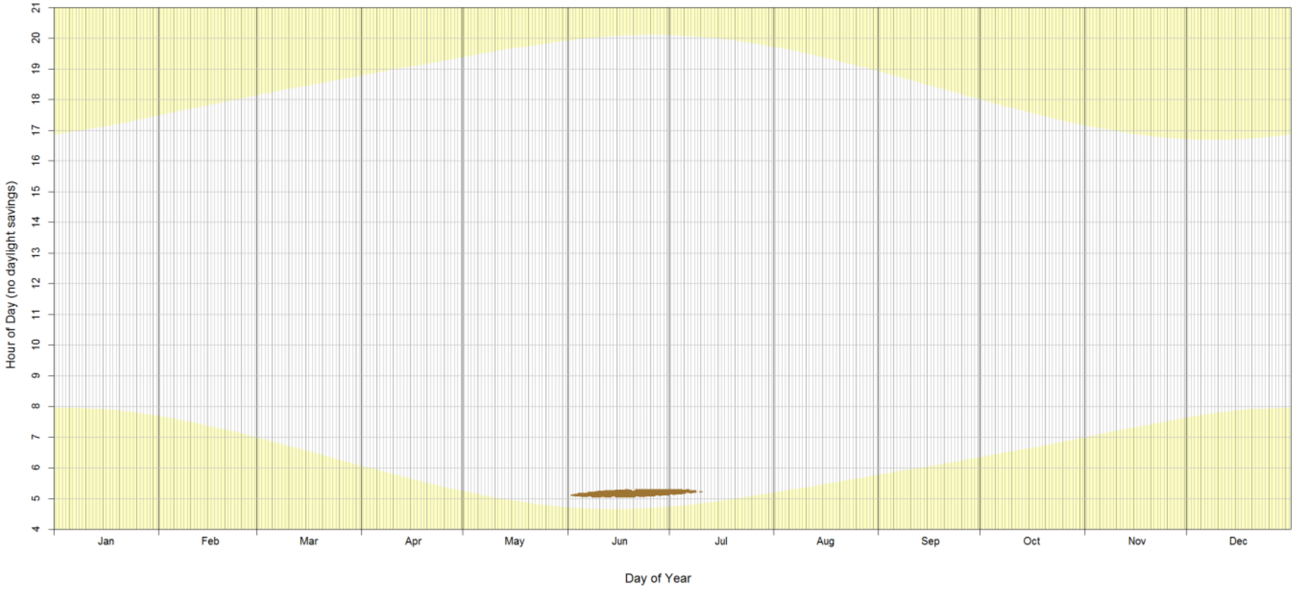
Shadow Flicker – 30 Hours in Context



Based on Grand Rapids region Average Annual Daylight (4383 hours) and Sunshine (2,207 hours)

Shadow Flicker - Example





MONTCALM WIND

Designing for Montcalm

Designing for Montcalm

- **Montcalm Wind is being custom-designed for Montcalm County.**
  - ✓ **Avoid disruption of pivot systems**
  - ✓ **Aerial application**
  - ✓ **Landowner site plan consultation**
  - ✓ **Aircraft Detection Lighting System (ADLS)**
  - ✓ **Setbacks from lake residential and environmentally sensitive areas.**

APEX CLEAN ENERGY

Montcalm Wind Design Goals

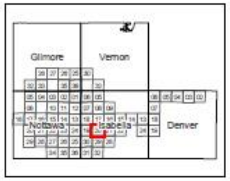
Feature	Standard
Sound (participating)	No more than 50 dba (loudest hour) at a residence
Sound (non-participating)	No more than 45 dba (loudest hour) at a residence
Shadow Flicker	No more than 30 hours per year at a nonparticipating residence

Feature	Setback Distance
Homes	2x Turbine Tip Height or 1,250 feet (whichever is greater)
Non-participating Property Lines	1.5 x Turbine Tip Height or 1,000ft (whichever is greater)
Roads	1.1 x Turbine Tip Height
Telecommunication Towers	1.1 x Turbine Tip Height
Communications Beam Paths	Rotor Radius + 2m
Wetlands and Forested areas	Avoid

Design Goals in Action – Site Plan Review Example

Isabella Wind

Isabella Township
Section 20



Existing:

- County Drain
- Habitable Structure
- Building
- Overhead Power Line
- 2 FT. Elevation Contours
- 10 FT. Elevation Contours
- Treeline
- Wetland Area (ECT)
- Wetland Area (NWI)
- 100-Year Floodplain
- Road Centerline
- Township Line
- Section Line
- Town of Rosebush
- Crossing - Wetlands (ECT)
- Crossing - Stream (ECT)
- Crossing - Floodplain

Proposed:

- Project Boundary
- Proposed Turbine - 114m HH
- Proposed Underground Collection
- Proposed Access Road
- Proposed Substation Parcel
- Proposed Overhead Transmission Line
- Proposed Laydown Yard
- 50 dBA Sound Contour with NRO (Epsilon)
- Tip Height x 1.0 Buffer
- Tip Height x 1.5 Buffer
- Tip Height x 2.0 Buffer
- Surveyed Parcel Boundary
- Nonparticipating Parcel

WTG Setbacks: Isabella County

Setback Type:	Distance: GE 127 at 89mHH	Distance: GE 127 at 114mHH
Hub Height	291.17ft | 88.75m	373.20ft | 113.75m
Tip Height	498.92ft | 152.07m	582.33ft | 177.49m
Ground Clearance	83.42ft | 25.43m	164.07ft | 50.01m
NonPart Property Setback (Tip Height x 1.0)	498.92ft | 152.07m	582.33ft | 177.49m
Public Rd ROW: The Greater Of (Tip Height x 1.5) or (400 ft)	748.39ft | 228.11m	873.50ft | 266.24m
RR ROW: The Greater Of (Tip Height x 1.5) or (400 ft)	748.39ft | 228.11m	873.50ft | 266.24m
Occupied Bldg: The Greater Of (Tip Height x 2.0) or (1000 ft)	997.85ft | 304.14m	1164.66ft | 354.98m

500 Feet

Date: 10/24/2019
Author: OB

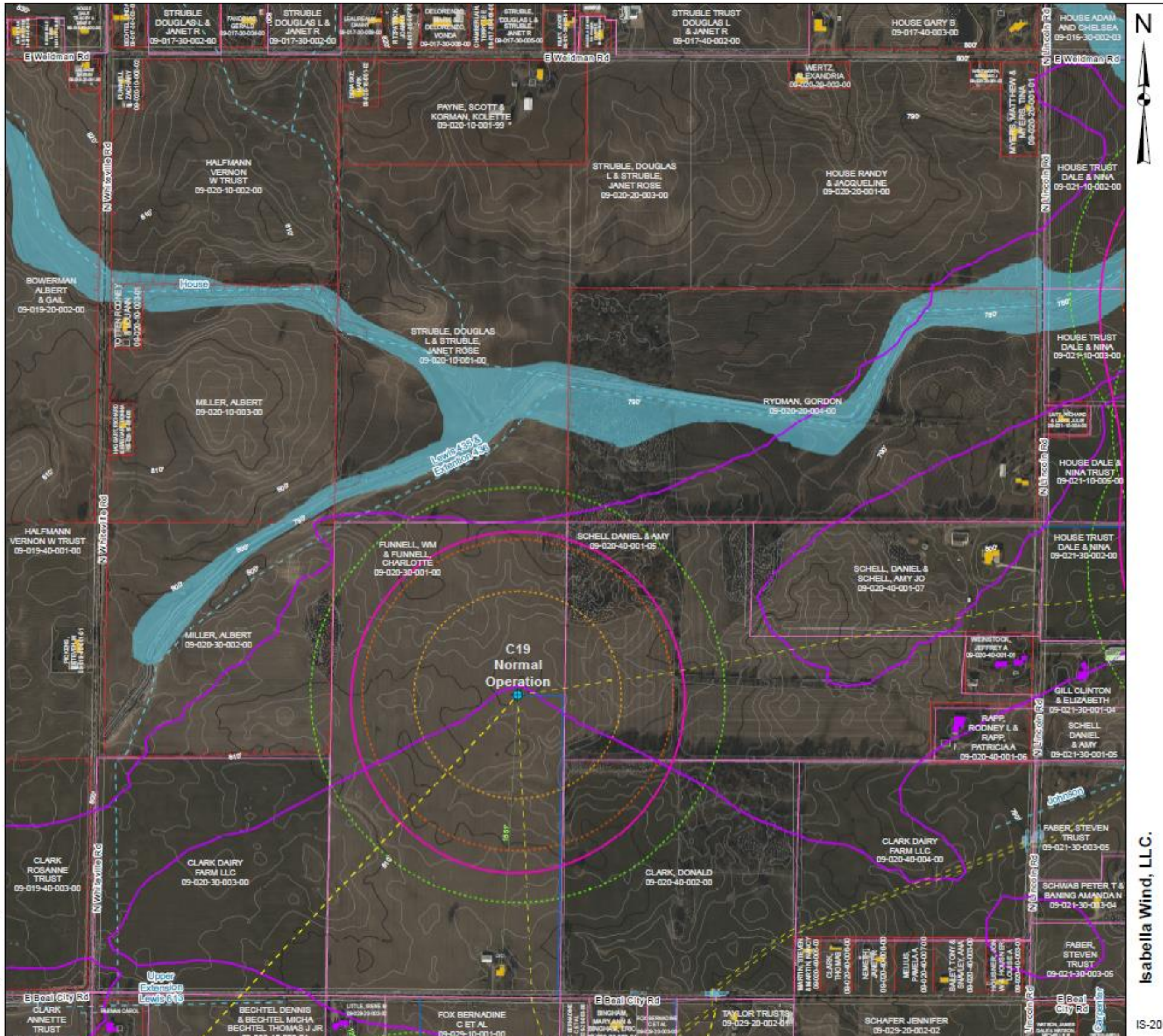
IS-20

Isabella Wind will continue to work with an INCE (Institude of Noise Control Engineering) certified acoustician to ensure the operational arrangement of turbines will be in compliance with a statistically modeled 50 dBA at non-participating property lines.

The locations of existing underground utilities are shown in an approximate way only and have not been independently verified. The contractor shall determine the exact location of all existing utilities before commencing work.

APEX CLEAN ENERGY

Isabella Wind, LLC.



Coming Soon – In-Person Open Houses & Listening Sessions

Township	Date	Location
Maple Valley/Pierson	Early June	TBD
Cato/Pine	Mid June	TBD
Winfield	Late June	TBD
Douglass/Belvidere	Early July	TBD
Montcalm/Sidney	Mid July	TBD

Stay Informed – www.MontcalmWind.com

- Sign-up for e-mail updates or watch the Events page on the Montcalm Wind website for more details once available.

Questions?

MONTCALM WIND

Question Process:

- Zoom Attendees – Open the Q&A window to type in your question for the panelists
- Phone Attendees – Text your question to 989-787-3029