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The Minnesota Model Wind Energy Conversion Systems Ordinance and companion document committee included Mark Lindquist, the Minnesota Project; John Biren, Lyon County Zoning Administrator; Kyle Krier, Pipestone County Zoning Administrator; Mandy Landkamer, Nicollet County Environmental Services Deputy Zoning Administrator, and Annette Bair, Southwest Regional Development Commission. Special Thanks to Janie Hanson, an intern on loan from the Three Rivers Resource Conservation and Development District that assisted in the development of this project.

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The authors and committee have worked to present information and analysis carefully and accurately. However, these issues can be complex and the industry is dynamic and constantly evolving. Local units of government are responsible for evaluating the appropriateness and applicability of ordinance language prior to adoption of the ordinance.

Authored by: Mark Lindquist, The Minnesota Project, December 2005

The Minnesota Project is a nonprofit organization that connects people with policy to nurture collaborations that build strong local economies, vibrant communities, and a healthy environment.

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Wind Energy Development

Background and Support for a Model Ordinance

This project evolved out of two specific needs. First, zoning officials in southwestern Minnesota were beginning to see a need to revise and update ordinances that were developed in the mid to late 1990s to address the new wind energy industry in Minnesota. Second, citizen members of various Clean Energy Resource Teams were interested in learning more about wind zoning to ensure that reasonable standards were adopted that would not place an undue burden on small and community based wind development projects. The Minnesota Project was in a place to bridge these groups and move forward the long process of developing an ordinance based on real experience and real industry needs. The process was focused on county government institutions and organizations. The Minnesota Association of County Planning and Zoning Officials took lead in sponsoring the effort. In addition, the ordinance was provided to various Association of Minnesota Counties committees for review and input. The Model Ordinance and companion document have been reviewed and approved of by the Minnesota Association of County Planning and Zoning Officials at their 2005 annual meeting.

NON-COMMERCIAL WIND DEVELOPMENT:

A revival of the farm-scale wind energy industry occurred in the 1970s. This was promoted through net metering laws which allow an electric utility customer to install a renewable energy system and essentially sell any excess energy back to the utility at retail prices. In Minnesota net-metering applies to generators of less than 40 kw.

Net metering has generated a persistent, though small, market for wind turbines of less than 40 kw. Approximately 100-150 such machines are located within the state. Landowners often install these turbines based on personal values. Though higher energy prices combined with the use of federal tax credits, incentives in the Conservation Security Program and grants available from the US Department of Agriculture are making these projects much more attractive. The long term potential remains for hundreds or even a few thousand of this type of machine to be installed statewide.

These turbines are referred to in this document as non-commercial. This is because these installation are designed to first supply on-site energy needs. Additional sales to the grid are secondary. Commercial wind projects are usually those that are designed to primarily sell bulk electricity as a whole sale commodity.

The authors hope that this document and the accompanying Model Wind Ordinance will provide a basis for good ordinances that enable the wind industry to develop, while also ensuring that the public health safety and welfare is properly protected.

Wind Energy Development in Minnesota

The wind energy industry is growing in Minnesota and the Midwest. Increased demands for electricity as well as concerns for environmental performance are leading to a strong policy climate promoting wind energy. The policy climate combined with rising fossil fuel costs and declining wind energy costs are driving substantial investment in wind energy. In the past decade, investment in Minnesota and Iowa wind projects exceeded one billion dollars with the industry poised for even more rapid expansion. The Minnesota Department of Commerce estimates installed wind capacity in Minnesota will expand from less than 600 megawatts (MW) to nearly 3,000 MW over the next decade.

Wind energy development is proceeding in two distinct patterns: large centralized projects and smaller-distributed projects. The bulk of development is occurring in large blocks, with projects of at least 50 MW and often 100 or more MW. Yet, significant investment in distributed and community-based wind energy projects is also taking place. These projects may include one turbine or a small cluster of perhaps six to ten turbines.

Wind energy project finances, as discussed below, are highly sensitive to the quality of the wind resource. For this reason, wind development has been concentrated in southwest Minnesota where the prominent glacial moraines have been documented as the best wind resource in the state. Wind development, however, is spreading well beyond the "Buffalo Ridge". Developers have been aggressively prospecting other locations in Minnesota, finding better than expected resources in numerous locations around the state. Transmission capacity constraints limit the amount of power able to be exported from southwest Minnesota, which further encourages projects to develop in other locations. Finally, wind turbine manufacturers are adopting designs (taller towers and larger rotor diameters relative to generator capacity) more suited for lower quality wind resource areas.

Transfer of Power Plant Siting Authority to the Public Utilities Commission:

Effective July 1, 2005, Article 3 of the 2005 Omnibus Energy Bill modifies Minn. Stat. §§ 116C.691-.697 by transferring energy facility siting and permitting authority from the Minnesota Environmental Quality Board (EQB) to the Minnesota Public Utilities Commission (PUC). The same law provides for the technical energy facility permitting staff to be moved to the Minnesota Department of Commerce. The Department of Commerce will manage the process and make permitting recommendations to the PUC. The purpose of the move was to integrate economic and environmental regulation of transmission lines and power plants.

Regulation of Wind Energy

State or local land use authorities regulate the siting of wind energy projects. The State regulates the siting of major energy facilities under the Minnesota Power Plant Siting Act (MS § 116C.51-.697). For traditional power plants, the state preempts local authority for plants of greater than 50 MW rated capacity. As the wind industry emerged in Minnesota, however, the Power Plant Siting Act was amended to give the State authority to site wind projects of 5 MW or greater.

The first major wind project in the state, NSP Phase I consisted of a 25 MW project in Lincoln County. Unsure of their capacity to provide adequate oversight for significant projects, officials in counties along the Buffalo Ridge supported the statutory changes shifting regulation of wind projects of 5-50 MW to the Minnesota Environmental Quality Board. That authority was in turn transferred to the Minnesota Public Utilities Commission in 2005.

"Aggregated" projects have been a grey area. These projects typically consist of perhaps six to ten individual turbines that are owned by different legal entities, usually a limited liability corporation (LLC). The individual LLCs each own wind turbines with a generating capacity under the 5 MW threshold. So even though the total capacity of these developments has exceeded 5 MW, they were considered separate projects and regulated by the Counties. However, in the winter of 2004, the EQB and the Attorney General's Office determined that regardless of the ownership of the individual turbines, the development would be considered one project for siting purposes if: there is one developer and the overall development uses a single substation. However, this has not been uniformly applied. Some developers continue to submit applications directly to counties which are accepting and processing the applications.

Wind Energy Basics

People have used wind power technologies for millennia, from ancient grain mills, to the pre-

WHAT IS A WATT?

Electricity is measured in two ways: power and energy. Power, an instantaneous measure, is gauged in watts. Energy is gauged in watt-hours, a cumulative measure of output multiplied by time. Because a watt is a small unit - a typical light bulb uses approximately 60-100 watts of power - production or consumption of power is often measure in kilowatts (1,000 watts) or megawatts (1,000,000 watts). Similarly, a kilowatt-hour (kwh) equals 1,000 watt-hours, while a megawatt hour (MWh) equals 1,000,000 watt-hours. A 100 watt light bulb burning for 10 hours consumes 1 kwh of energy.

Wind turbines, like all power plants, have a rated power capacity measured in watts. A small farm-scale machine might have a rated capacity of 20 kw, while a utility-scale machine might have 1.5 MW (1,500 kw).

*Electric energy production is measured in kwh. In good wind resource areas, turbines might produce 35% of their theoretical maximum on an annual basis. For example, a 1.5 MW turbine might produce 4.5 million kwh per year (1,500 kw * 8,760 hours/year * 35%) For comparison, a typical Minnesota household uses about 7,200 kwh per year.*

rural electric water pumps that have come to be an icon of Midwestern and western agriculture. Serious industrial scale electricity development, however, emerged in the late 1970s and early 1980s as a result of the energy shocks associated with Middle Eastern conflicts. Experimentation with the basic design and technologies of wind power generation was common in the early period. Ultimately, the standard configuration that emerged as the dominant design is the three-bladed, horizontal axis up wind turbine. See Figure 1

Wind turbines convert the kinetic energy of the moving air into electrical energy. This is done through the use of airfoils on the turbine's blades. As air passes over the blades, aerodynamic lift is created. The lift then creates the force which turns the rotor blades and drive shaft and ultimately the generator. On commercial wind turbines, the blades turn as low RPMs and a gear box is required to increase the RPMs at the generator. Generally, the larger the wind turbine the lower the rate at which the blades rotate. Home and farm scale machines might rotate at over 100 RPMs where as the 1.5 MW machines turn at less than 20 RPM. Commercial turbines generate electricity at about 600 volts. This voltage must be "stepped up" to interconnect with the power grid. Each turbine will typically be installed with a transformer that raises the voltage to around 20,000 to 35,000 volts-depending upon the voltage of the power line to which it will be connected. If several turbines are being installed at once and being interconnected with a high voltage transmission line, then a substation is required to again step up voltage to be compatible with the transmission line.

Technology Trends

For two decades the primary trend in wind turbine technology has been toward larger turbines. Leading wind turbine manufactures have steadily worked at scaling up technology over the past two decades. The Danish firm Bonus Energy A/S has been one of the major wind turbine manufactures and was recently purchased by the power industry giant Siemens. The Bonus/Siemens trend is typical for the industry, Figure 2. New products of larger capacity are brought on line every two or three years. Installations in Minnesota reflect the changing products available in the market. In 1994, the first major wind project in Minnesota used 340 kw turbines. However, shortly after that point wind projects were using 600 to 750

Figure 1: Three-bladed horizontal axis wind turbines.

kw machines. By 2001, wind developers were installing 1.5 or 1.65 MW turbines. There is debate within the industry regarding what the ultimate size limits for turbines will be. On-going engineering innovations appear to be facilitating the continued evolution towards larger turbines. One turbine manufacture has installed a 5 MW prototype in Germany. Yet, construction and transportation challenges may ultimately pose limits on turbine size. Issues like the cost and availability of ever larger cranes has lead some Minnesota developers to suggest that we may be approaching a practical limit in turbine size. Yet it is clear that the two to three megawatt turbines are likely to be installed in Minnesota in the next few years.

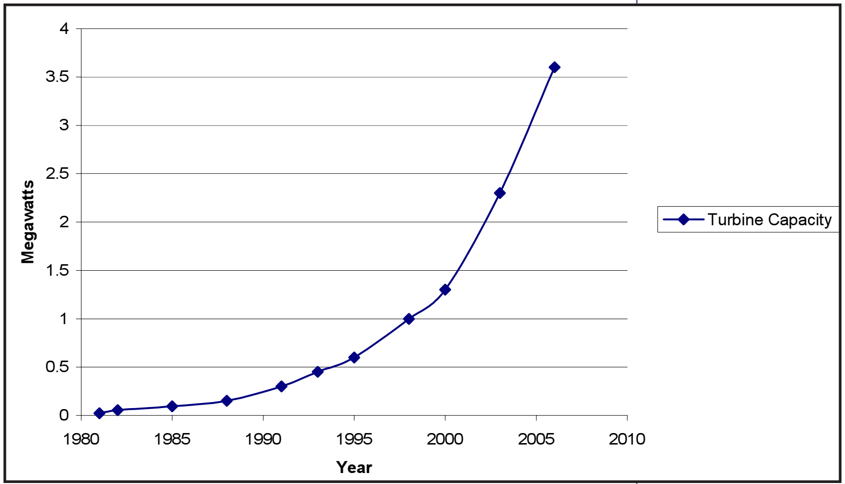


Figure 2. Bonus Energy A/S Product Evolution
Source: Eize de Vries, "Offshore boost for Bonus: Danish Wind Firm Scales Up", Renewable Energy World November-December 2004 Vol.7 No. 8. page 91

Wind Resource

The performance and, ultimately, the economics of a wind project depend enormously on the quality of the wind resource. The speed of the wind determines the power available, which varies with the cube of the wind speed. This means a slight difference in average annual wind speed may result in a significant difference in electricity production. Wind turbines produce at their maximum output when wind speeds reach about 20-25 mph. Therefore, the most desirable areas for wind energy production are those with a relatively reliable range of 15-30 mph winds. Turbines only operate within a specific range of wind speed, roughly 8-50 miles per hour. The cost of building turbines to capturing energy in very low wind speeds or in very high winds is not economically justified.

The "quality" of the wind affects turbine performance as well. Turbulent air does not efficiently create lift when moving across a turbine blade's airfoil, therefore, turbines require clearance from obstructions that will create turbulent airflow, including rough terrain, trees, buildings, and other wind turbines. As elevation above the ground surface increase, the wind resource improves relative to both wind speed and turbulence. Because of this, open farm country, gentle hills, and ridges are preferred locations for wind development. The relationship between elevation and wind resource has also driven the evolution of tall towers for wind turbines. The first major wind development in Minnesota utilized 40-meter (132-foot) towers. Currently, the typical tower height is 70 meters (231 feet), though towers 80 meters and taller are available.

Wind Development Process

Wind project development is complex. It is capital intensive involves long term contracts in a regulated environment. There are a number of steps that need to be worked through; each one requires investments and expenditures.

1) Site prospecting: A project developer selects a target area based on general area wind

resource assessments, proximity to transmission facilities and potential land use constraints. For some local projects, the site prospecting might be limited to the project developer's own land.

2) Securing access to the site -The project developer will acquire legal rights to the site. Usually, this is an option for an easement. The option is exercised when the project has moved through the financing stage.

3) Feasibility Assessment - including

a. Wind resource assessment - detailed on site wind monitoring, 1 year on-site data collection is common.

b. Financial projections based on site wind data and estimated project development costs and assumed price received for energy.

c. More detailed site evaluation for environmental, land use or other regulatory barri ers.

4) Business plan/structure - If the project appears feasible the project developer can structure the deal. This stage requires substantial investment in professional services such as accountants and attorneys.

5) Preliminary project design - The general project size and layout are established and preferred technology is identified.

6) Power Purchase Agreement - The developer seeks to secure a contract to sell electricity to a utility. Detailed negotiation on price and terms of the contract are completed.

7) Regulatory approvals - State or local site permitting, FAA aviation warning applications, and environmental review if required by federal funding sources or local land use authorities.

8) Secure access to transmission -The project developer must secure permission to interconnect with the transmission system from the Midwest Independent System Operator (MISO). The application process is expensive and can be slow as engineering studies are required to investigate the impacts of every proposed generator on the transmission system across several states.

9) Secure financing - once a PPA and transmission rights are in place then the project developer will know what the revenue stream will be, and can seek equity and debt financing for the project.

10) Procure equipment and other vendors - Once the project is a go the project developer can order the turbines and other equipment.

11) Construction and start up - The final stage is to take delivery of the equipment and build the project.

These steps are generalized. In reality the project developer will likely be working on several steps at once, and in an iterative process. The project developer may approach the County for the necessary permits at almost any point in the process. A project developer may wish to secure the permits before spending considerable sums of money on attorneys, accountants and engineers. Alternatively, they may choose to be sure that they have a solid project before taking the time to secure zoning permits.

Ideally, the project developer will be working with county planning and zoning staff during early stages of the project. Early coordination will allow the project developer to make sure that they understand the county's ordinance and concerns prior to project development. However, as every planning official knows, some applicants wait until absolutely necessary to apply for permits.

Wind Energy Issues to Consider in Developing the Ordinance

Public Safety

The first and foremost responsibility of government in regulating land use is the protection of the public's health and safety. Wind energy development maintains an exceedingly good public safety track record. There is only one documented instance of a member of the general public being killed in an accident involving wind turbine. A first-time parachutist flew into a turbine in Germany in 2000.[i] Reasonable safeguards will continue to ensure that the industry's exemplary record continues.

Catastrophic Failure

Catastrophic failures are described as major structural failures. Primary concern generally includes two types of events: the collapse of the tower and the separation of a rotor blade from an operating turbine. These events are rare. The Minnesota Department of Commerce requires wind farm operators permitted by the State to report any such occurrences. The agency staff has received no reports of such failures thus far.[ii]

Complete collapse of wind turbine towers have occurred, but are exceedingly rare. There are a small number of events that are well documented. Wind energy opponents have documented the failure of a tower at Lichtenau, Germany on their web sites. In the siting process for a wind farm in Washington State, officials of Vestas A/S, one of the largest wind manufactures in the world, noted two Vestas turbines had collapsed during his 13 years with the company. This was out of approximately 20,000 turbines installed during that time period.[iii] Globally, the rate of tower failure is exceedingly low. No commercial wind turbine tower has collapsed in Minnesota. Anecdotal stories of non-commercial tower collapse do, however, circulate.

Serious wind turbine failures short of the entire structure collapsing are also a potential concern. The greatest concern being that a blade or portion of the blade will break loose and be hurled some distance from the turbine. A blade throw did occur at the NSP Phase I project near Lake Benton. Other similar instances have occurred elsewhere; one event reported in California cited a blade thrown a distance of over 600 feet.[iv] This type of blade failure was more common a decade ago, but can still happen. The Pipestone County zoning administrator noted that a wind turbine experienced a broken main shaft, which resulted in a blade breaking off after it struck the tower in the recent past. In 2002, there was a well-publicized turbine failure in Norway. In this case the rotors, the entire top assembly including the nacelle box and the rotors came off of the tower.

Lightning strikes have produced blade failures in Minnesota and elsewhere. Blades with inadequate lightning protections "delaminate" when struck, resulting in a blade with an appearance like a "head of broccoli." Pieces can be thrown to the ground. The Lincoln County Zoning Administrator has noted anecdotal instances of pieces being thrown perhaps 600 feet.[v] The wind industry is improving the quality of lightning protection in blades. Many turbines on the Buffalo Ridge have been retrofitted with heavier lightning protection to protect blades.[vi]

Wind turbine manufactures and developers are responsible for sound equipment and design to prevent catastrophic failures. They have been very successful in this. Turbines and supporting towers are designed and built to withstand extreme wind conditions. Turbines, as noted above are designed to cut-out or stop operating as wind speeds hit a maximum level - often around 50 miles per hour. Similarly, turbines are designed with over-speed controls that include both aerodynamic elements and brakes. Many commercial turbines will change the angle of the blades in order to let the wind "spill." Many non-commercial turbines will "furl" that is turn out of the wind either to the side or upward to spill excess wind. The over speed controls ensure that wind turbines do not begin spinning so fast that the machine self-destructs. This is a concern in very high wind speeds or if the turbine looses load - the resistance of the electrical generator.

Small, High RPM Turbines

The smaller non-commercial wind turbines are direct drive. They do not use a gearbox between the blades and the electrical generator. Therefore the blades need to turn at a very high RPM to ensure that the generator turns fast enough to generate electricity. Turbines of 20 kW and smaller capacity often turn at more than 200 RPMs. Some of the smallest machines may spin at nearly 1,000 PRMs. Stories and anecdotes circulate about such machines failing when blades are unbalanced. Though there is little documentation of significant problems.

Electrical / Fire Hazards

In the 1980s, wind turbines were implicated in a number of wild fires in arid California. Power cables transferring electricity from the generator to the transformer on the ground occasionally became excessively twisted. The twisting occurred as the turbine rotated to follow the wind. These cables could then overheat and shower sparks out of the open lattice towers. Some instances were reported where large birds were electrocuted and ignited, starting fires in dry grass environments. Changes in turbine design and improved standards for power line interconnection have dramatically reduced these risks. Minnesota's climate is also more humid than much of California's wind development areas, but periods of high fire hazard exist in Minnesota. Counties on the Buffalo Ridge have reported no known problems with fires initiated by wind turbines.

Ice Throw

The risk of ice build-up on blades during inclement weather, which could be thrown off of the blades during operation, caused an initial concern about wind development in Minnesota. However, experience has shown this to be an issue of limited concern. If a turbine is operational during an icing event, the movement of the blade through the air resists the formation of ice. If icing does occur, it tends to destroy the aerodynamic efficiency of the blade, preventing start up or causing the rotor to stall out if operating. Finally, the vibration sensors mentioned above will shut down the turbine when out of balance. The authors have found no anecdote or other report of serious problems with ice throw in Minnesota. The American Wind Energy Association (AWEA) notes on its web site," One European group that has investigated the ice throw question recommends a setback of 1.5 times the sum of a turbine's hub height and its rotor diameter."[vii]

The largest concern associated with icing on turbines involves ice sloughing directly off the blades. This presents a safety hazard directly under and around the turbine, with the primary risk being to those people that work in the wind farm. The wind industry typically prohibits workers from approaching towers until the turbines are ice-free.

The other concern about ice and wind turbines, is that non-commercial turbines supported by lattice towers need to be designed to accommodate heavy icing. The Universal Building Code does require lattice towers be engineered to support a ½ inch coating of ice.

Attractive Hazard

Periodically, concerned individuals or planning officials raise concerns that turbines will pose an attractive hazard. The structures may be considered fascinating and draw the attention of children or thrill-seekers. Distributed commercial wind facilities are not likely to employ full-time staff on-site to discourage unauthorized access. However, no record of problems with trespass, climbing turbines, or other attractive hazard issues exists in Minnesota. The use of tubular towers for commercial wind turbines largely eliminates the potential for unauthorized tower climbing in commercial turbines; the tower encloses the climbing apparatus with lockable doors to the interior of the tower. Wind towers have been installed on a number of school campuses with no reports of issues associated with "attractive hazard".

Non-commercial turbines are typically installed in or near a farm site or rural home. Wind turbines present no greater risk than the normally accepted range of risks in rural areas. These traditional risks include old silos, old windmill towers, barns, livestock, wells, ponds, and so forth.

Used, Experimental, or Home-Built Turbines

In the oil shock period of residential and home wind turbine installation (mid-1970s to early 1980s), home-built wind generators and 1920s and 30s era wind generators "rescued" from barns and farms were re-installed. These were typically high RPM machines and catastrophic failures did occur as turbine blades became unbalanced or turbines experienced over-speed conditions. Additional attention into the safety of used and reconditioned turbines may be prudent for local governments.

At this time, decommissioning or "re-powering" of older wind farms continues. This creates a supply of used turbines that are reconditioned. In many cases, the turbines are rewound to meet the capacity limits for "net metering," which is 40 kW in Minnesota. These machines should pose no extraordinary safety issues, assuming that qualified technicians properly recondition the machinery. The buyer, however, needs to pay attention to the extent and quality of the reconditioning or remanufacture of such machines.

Air Traffic

Wind development does not pose significant threats to general aviation. Total height of commercial wind turbines is still generally less than 500 feet. The minimum altitude allowed for general aviation is 1,000 feet. Further, all structures greater than 200 feet in height must notify the Federal Aviation Administration. The FAA then determines the appropriate measures needed to warn aircraft and ensure the public safety. The FAA requires aviation warning lights on commercial turbines and other towers in excess of 200 feet at this time. In addition, the FAA must be notified of any proposed towers-regardless of height- within 10,000 feet of an airport. The requirement increases to 20,000 feet if the airport has one or more runway of 3,200 feet in length.[viii] Depending upon the approach slopes for aircraft, the FAA will determine if the turbines present a hazard to aviation.

Ariel sprayers in Faribault County, Minnesota have raised specific concerns with meteorological towers. These towers and their guy wires can be very difficult for the pilots to see. Faribault County has a significant concentration of aerial sprayers, apparently because of the canning vegetables grown in the area. As a result, the county has historically imposed lighting and painting requirements on towers beyond the FAA's requirements. In 2004, Faribault County adopted a tower ordinance that imposed two requirements to ensure visibility. First, the towers need to be painted in an alternating pattern of aviation orange and white. Second, the vegetation in the tower footprint cannot be rowcrops. The intent is to use a differentiating vegetation to identify the points where guy wires are anchored. This appears to be a unique situation in Faribault County, but it may warrant consideration in other agricultural areas.

Snowmobiles and All Terrain Vehicles

In Minnesota there are over 300,000 registered snowmobiles, there are nearly 200,000 registered All Terrain Vehicles (ATVs) as well. Wind development should not generally pose any significant threat to snowmobilers. However, home and farm scale turbines or meteorological towers that use guy wires could pose a hazard to snowmobilers, as much riding occurs after dark and guy wires can be difficult to see. There are anecdotal stories of decapitations when snowmobilers hit guy wires supporting power lines, or communications towers. Observation of power line and communication tower guy lines shows a wide range of approach to this concern. Many guyed power poles along road rights-of-way have only galvanized steel covers-which primarily protect the guy wire. Many other guy wires have a brightly colored plastic sleeve to enhance visibility. In some cases, communications towers can be seen that have fencing around the guy wire anchor points. Guyed towers should not pose undue risk to snowmobilers and ATV riders, assuming that such towers are not located along existing trails.

Impacts on Infrastructure

Roads, Bridges, and Drainage

Road authorities are typically concerned about the impacts that major construction projects can have on roads. The construction of commercial wind turbines requires hauling very heavy components and construction equipment to the site. In addition, many township bridges may have weight and width restrictions. The nacelle for a single commercial wind turbine weighs over 50 tons. The foundations for these turbines require over 200 yards of concrete each. Cranes for construction and turbine repair may weigh a few hundred tons when assembled. Damage can and does occur to road. Impacts might include rutting, damage to road geometry, and crushed culverts.

Culverts under roads and drives are part agricultural the drainage system as well as the road system. Wind turbine construction can impact other drainage infrastructure as well. Cut tile lines a potential impact resulting from excavation of foundations and trenching buried cable. The location of public tiles line should be well documented and the project developer should be able to avoid unanticipated impacts. However, much of the private tile in rural Minnesota is not well documented.

Telecommunications

TV interference has long been a concern of wind project neighbors. Wind development can have significant impacts on a variety of electronic communication technologies.

Television

Commercial turbines can impact television reception on neighboring properties. The impact on television reception is most pronounced where signals are weak. This impact is often a shadow or flicker on the television set. There are several measures that can mitigate the impacts. The simplest is a signal booster that can be purchased at a local TV or electronics shop and plugged into the affected home's TV or antenna. If the problem is severe, it might be appropriate to provide the impacted home a satellite receiver and or service. Non-commercial turbines generally do not create television interference problems.

AM Radio Stations

Wind turbines can create problems for AM radio broadcasters. The Pipestone-Jasper School, at the edge of the City of Pipestone, installed a commercial wind turbine. The campus is adjacent to an AM radio station and broadcast antenna. AM radio is subject to interference when solid obstructions are placed in the path of the broadcast. The Pipestone radio station owner noted that other tall obstructions-such as water towers or grain elevators-create interference problems. These are usually resolved by installing electronic equipment that masks the obstruction from the signal. However, wind turbines create a more complicated obstruction, because of the rotating blades.

The AM radio station raised particular concerns. AM broadcasts carry hundreds of miles in the right weather conditions. As a result, the Federal Communications Commission requires AM broadcasters to maintain their broadcast within a very tight frequency range. Failure to do so creates interference problems with distant radio stations, and can violate FCC permits. The broadcast frequency is monitored at several points within approximately five miles of the broadcast antenna. It appears that the Pipestone situation was worst case. The radio station is a high power broadcast, but not a "clear channel" station and the wind turbines was located within a few hundred yards of the broadcast facilities. While the school worked hard with the radio station to resolve the issues, it did point out the sensitivity of AM broadcasts to interference by wind turbines.

Microwave Transmission

Wind turbines can interfere with microwave communication equipment. Microwaves are essentially a line of sight transmission, and not a broadcast. Physical obstructions within that line of sight will disrupt the transmission. Wind turbines on the Buffalo Ridge disrupted a Minnesota Department of Transportation (MnDOT) microwave communication link. As a result of the wind project, MnDOT was forced to relocate some of its transmission facilities to re-establish its communication network.

MnDOT has developed an extensive state-wide communications systems that relies upon microwave transmission and receiving stations. This network provides communications services to MnDOT and other state agencies, including agencies with emergency response functions. A map of the existing state microwave network is included in the document as Appendix A.

MnDOT is just one of many entities that rely on this type of communication signal. Most counties have established a microwave communications network as the backbone for their emergency response systems. A telecommunications consultant that specializes in working with County governments began distributing a white paper in late 2004 addressing the potential impacts of wind development on these systems. The same consultant noted that many other entities rely on microwave communications systems including railroads and pipelines. Subsequent conversations with consultant and other microwave industry members have indicated that no FCC regulation protects microwave transmissions from interference. The owner of the microwave communication system is entirely at risk of interference from construction of obstructions such as wind turbines, grain elevators, office building, and other similar structures. That said, counties have the ability to consider the impacts of project siting decisions on public infrastructure.

Copper Telephone Lines

One unexpected problem that was created by wind development was interruption of a local telephone exchange on the Minnesota South Dakota Boarder. The34.5 KV feeder lines connecting individual wind projects with the substation were run beside an existing telephone line. This telephone line was copper wire. The magnetic fields induced by the current in the power line were sufficiently strong to interfere with the older copper telephone lines. The problems were ultimately corrected by upgrading the phone line to fiber optic.

Impacts on Neighboring Properties

Visual Impacts

Perhaps the most significant concern or issue associated with wind development is the most subjective issue - visual impacts. The structures are large and located on high ground in open landscapes. Commercial turbines can be seen for miles. Whether people find them objectionable varies dramatically from person to person, place to place and project to project. Some people find a change in the view shed unacceptable and offensive. Others find wind turbines to be interesting and appealing. Others might find wind development acceptable in one place but not another.

Development in special scenic areas will likely generate more concern and opposition than in other places. For example, bluffs overlooking a river valley may be viewed as relatively unspoiled in an area dominated by intensive agriculture. Also development may be accepted generally in a landscape but not in close proximity to natural or recreational areas such as State Parks or historic sites. Also, acceptance may vary with intensity of development. One turbine or clusters of turbines here and there will be received differently than concentrations of development covering many contiguous miles of land.

Acceptance of wind development will also vary with perception of economic need and benefit. The Buffalo Ridge is one of the most rural parts of Minnesota. Communities have been seeking ways to expand and diversify the local economy for many years. Wind development has been broadly and deeply welcomed. The acceptance appears to be even higher if local individuals or institutions are involved in developing the projects.

Each community is ultimately going to wrestle with concerns and acceptance of wind development in its own local context. However, some thoughtful observers have identified a number of factors that impact the general perception of wind development

· Acceptance of non-operational wind turbines is much lower than for operational turbines.
· Visual consistency between turbines and if possible projects.
· On-site "house keeping" such as the prevention of oil leaks and streaks on towers, removal of solid waste and used parts.
· Extent of ancillary facilities such as overhead power lines or substations.
· Scale and density of development (Small clusters of turbines versus several contiguous miles of turbine development.)
· Perception of the benefit of development to the local community.

Noise

Noise is unwanted sound. After visual impacts, noise is the next greatest area of local concern raised about wind development. These machines operate 24 hours per day, and neighbors are often be concerned about how loud the machines are and what they will sound like. There are two basic types of noise emissions from a wind turbine. There is the aerodynamic noise of the blades moving through the air-a whooshing sound-and the mechanical noises of the gearbox and generator- a humming sound. The aerodynamic sound is largely determined by how fast the rotor blade tips are moving. Because larger turbines have a slower rotation, the speed of the blade tips is relatively constant across most turbines. Also as the industry has matured, a side benefit to improving blade efficiency has been reduced noise. The manufactures have increasingly used sound isolating and insulating materials in the nacelle of the turbine to reduce gearbox noise.

Wind turbines are not silent, the volume is generally much less than feared. The American Wind Energy Association compares the sound intensity from a wind farm at 750 to 1,000 feet to a refrigerator. Based on the authors' experience this is a reasonable comparison. The sound of a commercial turbine is typically about 45 decibels at 825 feet according to AWEA. Similar claims and data are noted on the web sites of The Danish Wind Industry Association and the British Wind Energy Association. The noise standard established in Minnesota rules for a residence is 50 decibels at night.

Noise levels can be impacted by a number of factors. Including whether one is up wind or down wind of the turbine, the number of turbines in the areas, and the extent to which a person is sheltered from ambient noise (like the wind in your ears). A recent study indicates that night-time noise levels may vary relative to day time noise levels based on different atmospheric conditions and background noise.[ix]

Commercial turbine design evolution has greatly benefited noise concerns over the years. However, there are still potential issues for non-commercial machines. Less noise level testing has been completed on these machines. Many of the smaller turbines use designs that turn the rotor out of the wind (furl) as wind speeds reach high levels. While this is a fairly simple and direct mechanism to protect these machines from overspeed conditions, it can create significantly more noise than normal operation.

Impacts on Wind Resources

Wind turbines experience a phenomenon known as wake loss. As wind passed through one wind turbine, it slows as it transfers energy to the wind turbine. Eventually the moving air is restored to its previous speed as it blends into the surrounding atmosphere. Similarly, the air become more turbulent as it passes over the rotor blades. Thus, a wind turbine down wind from another wind turbine will have reduced output resulting from both the reduced wind speed and the increased turbulence. This phenomenon is measurable for a distance equal to about ten times the diameter of the rotor.

Siting a turbine on one property can have negative impacts on the production of turbine on the adjacent property. As noted, this impact is noticeable for up to 10 rotor diameters, or approximately ½ mile for a typical turbine with an 80 meter rotor diameter. To manage the amount of wake loss within a wind project, developers usually space turbines in a patter of 3 rotor diameters by 10 rotor diameters. However, major wind farms in Minnesota have been developed with spacing as tight as 3 X 6 rotor diameters. This spacing allows developers to minimize other development costs, such as land leases and wire. The optimized spacing does not achieve zero wake interference. There are several computer programs that can calculate the projected wake losses for specific site layouts.

As discussed earlier, turbines have been steadily increasing in size for two decades. This means that the area impacted by a single turbine has grown as well. To achieve zero wake loss with 1.5 MW turbines, one would need to limit there installation to 1 turbine per 160 acre quarter section. Many parcels owned and farmed in rural Minnesota are 160 acres or less. This means that a farm operator may no longer be able to site a turbine on his or her own property with out impacting the wind resource on adjacent land.

The wind resource does steadily recover to the full level as one moves away from a turbine- which is why developers can and do space wind turbines at less than 10 rotor diameters. Also the most important directions to access wind for energy production are north, north-west, southwest and south. If the properties lie east and west of each other, the impacts will be minimized as due west and due east wind exposure is not as critical for overall energy production. The potential impacts of wake interference are real, but manageable on a site by sit basis.

The State of Minnesota does typically require that turbines are setback 5 rotor diameters from the project boundary. This is based on the assumption that projects should by-in-large not impact each other. If each project has a five rotor diameter setback, then inter project turbine spacing of 10 rotor diameters will be achieved. The State Department of Commerce is also seeking to develop a database of all commercial wind turbines in the state. This database will ensure that projects sited by the State will not conflict with projects sited locally, Appendix B.

Impacts on Natural Resources

Wind development is one of the cleanest and most benign technologies for producing electricity. There is no fuel combustion, and no air emissions. Wind turbines also do not consume the vast amount of water that thermal power plants require for steam and cooling. That said no technology is without impacts.

Wind Turbines individually require little land, perhaps an acre or two for a turbine tower and the access road. However, wind turbines do require a relatively large area to accommodate the necessary spacing. A square mile can support approximately 10 to 20 megawatts of development. Projections are that Minnesota will develop at least 2,500 MW of additional wind capacity in the next decade. This translates to about 250 square miles.

Agricultural Resources

Overall the impacts of wind development on agricultural resources are very minor. As noted above, each wind turbines do take a small amount of space. This is typically converted from agricultural uses such as croplands or pasture. During early phases of development there was concern about the layout of turbine strings and service roads. Wind developers prefer to follow the topography to maximize production. Where possible farmers prefer to have projects laid out so that roads and turbines minimize interference with farming practices. These issues are, however, largely worked out in the negotiations over lease agreements.

Soil compaction has been another issue of concern. Because the construction equipment needs room to maneuver and the turbine components need to be staged prior to installation, compaction may occur on several acres beyond the final turbine footprint. Again, these concerns have largely been addressed through negotiations between land owners and project developers. Crops in the immediate vicinity of existing wind turbines do not appear adversely impacted.

Native Plants and Wildlife

Opponents of wind development usually raise concerns about birds and now bats being killed by wind turbines. Wind turbines can and do kill birds and bats. Fortunately in Minnesota the direct avian and bat mortality is fairly limited. In fact, house cats are a much greater threat to birds that wind turbines. The Altamont Pass, one of the early areas of wind development in California, is home to a significant population of eagles and other birds of prey. There have been problems with these birds using wind turbines as perches and then being struck and killed by the rotor blades. It appears that the larger turbines with slower turning rotors and tubular towers have substantially reduced the risk of wind turbines to birds. Avian monitoring on the Buffalo Ridge has actually found that bat mortality is a greater concern than bird mortality. At this point, the data does not indicate that the level of mortality is great enough to pose a threat to overall populations of specific bat species. The industry and conservation interests continue to monitor and assess the impacts of wind on both birds and bats.

Habitat fragmentation and degradation is a bigger concern to wildlife biologists in Minnesota. Nationally, and in the state, there is a correlation between prairie landscapes and wind resources. Nearly all of Minnesota's native grasslands and associated wetlands have been lost or degraded. Not surprisingly the wildlife species dependent upon grassland habitats have been negatively impacted. In fact, grassland birds as a group are declining more rapidly than any other group of birds in the state or nation.

Construction of wind turbines in or near grassland habitats has two types of habitat impacts. First, if the projects are being located in grassland areas, such as native prairies or even "tame" pastures there is a direct loss of habitat. Because the turbines are located in the interior of a parcel the habitat loss is compounded by "fragmentation." The turbine site and access road break a larger block of habitat in to two or more smaller blocks. As the size of the continuous patch of habitat declines, the number and range of species that it supports declines as well.

Of greatest concern to wildlife biologists in Minnesota has been the impact of tall structures in grassland ecosystems. Many grassland birds appear to have evolved to avoid using habitats near trees and other things that can serve perches for raptors. Minnesota DNR Biologists report that studies show that many grassland birds will avoid nesting, and in some cases other habitat uses such as feeding, within 180 meters (about 600 feet) of wind turbines. Each wind turbine located in grassland habitats, such as native prairies, can potentially degrade 25 acres of habitat for these bird species.

Impacts of wind developments on migrating birds is also typically raised in as part of the review of these projects. An exhaustive review of the literature conducted by the Canadian Wildlife Service pointed out that while migrating birds do occasionally collide with turbines, the number of bird fatalities is low.[x] The greatest concern regarding birds and wind energy is habitat impacts as discussed above.

Wind Energy Ordinance Tools and Standards

Permitting and Land Use Compatibility

The most basic tool for protecting the public interest in regulating wind projects is determining where turbines are and are not compatible with existing and future land uses. There are two approaches to this. First, the county can review its zoning districts and make a determination district by district regarding general compatibility of commercial and non-commercial wind turbines. Most counties with zoning ordinances have approach wind in this manner. The model ordinance has also taken this approach.

The other approach is to create an overlay district where wind is compatible. For some counties s developing an overlay district may be more appropriate. The overlay district could then take into account, land use patterns, sensitive natural and scenic resources and infrastructure such as telecommunications facilities.

Permitted or Conditionally Permitted Use

Minnesota Counties have a range of philosophies and approaches to permitting. The model ordinance is based on a reasonable balance between giving the county sufficient latitude to address particular conditions and issues associated with individual projects and having clear and consistent standards that can be applied uniformly. The model ordinance establishes commercial wind turbines as a conditional use, which will allow a public hearing and the weighing of the specific facts of each project. Non-commercial turbines are either a permitted use or a conditional use depending upon the zoning district. In agricultural areas the non-commercial turbines are identified as a permitted use. However, in more sensitive land use districts where there are other resource concerns or higher population densities these machines become conditional uses.

Application Materials

The Model Ordinance does specify a variety of materials for both commercial and non-commercial wind energy conversion system applications. This information will enable the local planning commission to evaluate the specific facts and situations of the case. These items would include near by scenic resources, communications facilities, wildlife habitats, as well as the impact on adjacent wind resources for existing or future development. The State Department of Commerce has asked for cooperation by Coutnites with the completion of its wind turbine data base survey, Appendix B. This survey could readily be included in the application materials to be completed and forward to the state by the project developer.

Setbacks

Setbacks are the single most important tool for protecting the health, safety and general welfare of the public in regards to sitting wind turbines. Setbacks are used to protect the safety of people and property, as well as to reduce the potential nuisance associated with a wind project. The model ordinance establishes property line setbacks that are sufficient to ensure that in the very unlikely event of tower collapse, the failed equipment will be contained upon the project site. Property line setbacks will also ensure a reasonable probability that debris from a blade failure will be retained within the project site.

Setbacks from dwellings also ensure that there is adequate protection of safety. The model ordinance utilizes the 750 foot setback predominately used in existing Minnesota County wind development ordinances. The 750 foot distance ensures a significant margin of safety for people and residences. The 750 foot dwelling setback is was originally recommended based upon the Minnesota Environmental Quality Board's 500 foot standard for dwelling setbacks, plus an additional margin of safety. Research on these issues in the mid 1990s found that there was one documented instance of a blade being thrown 600 feet in the early 1990s in California. The additional 250 feet of setback was deemed prudent to ensure public safety. To date this setback has been acceptable to the industry as well as project neighbors.

Setback for wind turbines, as with other land uses, is also important tools to minimize other negative impacts on adjacent properties. Visual impact and noise are two of the greatest nuisance issue concerns raised in zoning procedures pertaining to wind projects. Noise impacts are mitigated with distance. Examination of several Environmental Quality Board wind energy conversion system site permit dockets shows that a 750 foot setback from residents is generally adequate to address noise issues, based on compliance with Minnesota Pollution Control Agency noise standards outlined in Minnesota Rules 7030. The Trimont Wind LLC docket notes in the findings of fact that turbines will not be located within 670 feet of residences to address the cumulative noise impacts of multiple turbines. Other dockets note slightly different noise impacts. The G. McNeilus Wind, LLC application and findings of fact note that the calculated point where a Micon 1.65 MW turbine would exceed the 50 dBA level is 738 feet.[xi]

The model ordinance also establishes a conservative property line setback for the purpose of protecting the public safety. The ordinance establishes a fall zone setback from property lines.

If in the very unlikely occurrence a tower collapses, it will collapse entirely on the project developers land. Tubular towers that collapse do tend to fold at a point and drop straight down. A setback of the total structure height (tower height + ½ the rotor diameter) plus a 10% or 25% additional margin, will assure that the probability of the general public being harmed is near zero.

In the early discussions of wind zoning in Southwest Minnesota there was a significant dialogue about "orderly development" of the wind resource. One concern raised at that time, was that a wind turbine on one property might unduly impact the viability of a wind project on the adjacent property. As discussed earlier in this document, wake interference between turbines drops to near zero at 10 rotor diameters. Thus a 5 rotor diameter setback will ensure that projects do not interfere with the neighbors wind resources. However, as turbine size has grown over the past decade, this setback has become onerous for a great number of projects. An 80-meter rotor typical of turbines being installed today would require a minimum parcel size of 160 acres. Even a cursory review of plat maps shows that many land holdings are in parcels that are less than 160 acres. It does not make sense to prevent a project on a 120 acre parcel, because the wind resource on an adjacent 40 acre parcel would be impacted-especially if the topography on the adjacent parcel was not suitable for a wind turbine. Neither parcel would be developable without one landowner securing a wind easement from the other. The safety-based setback or 1.1 or 1.25 times the total structure height still provides for nearly a 3 rotor diameter separation of turbines on adjacent properties. Many wind farm developers will space turbines as close as 3 rotor diameters on an east to west axis.

The County can, through the conditional use process, consider concerns about wind resource impacts due to turbine placement on a case-by-case basis. Much of the mitigation is site specific. An overly broad and protective standard will not serve to encourage orderly development of the wind resource, but would rather hinder overall development of the resource.

Finally setbacks are included in the ordinance to address impacts on natural resources. A setback of 600 feet from the boundary of public conservation lands is included. According to DNR biologists, impacts on habitat use by sensitive species have been documented up to 180 meters or approximately 600 feet. This standard was established in consultation with the Minnesota Department of Natural Resources' Southern Region Environmental Review Team.[xii]   A similar standard was included to address prairie pothole wetlands. The Wetland setback was limited to Type III, IV and V wetlands to ensure that the setback did not apply to farmed wetlands, or other highly degraded and ephemeral wetlands. This standard does not eliminate all habitat impacts associated with wind energy development, but it will protect significant resources that have been developed or maintained at public expense.

The impact on scenic resources is a difficult issue to address for wind turbines. They are by their nature large and visible. There is much debate about the actual aesthetic value of turbines as well. Some people find them visually appealing, while others do not. The initial concept in the model ordinance was to prevent intensive wind energy development along key scenic corridors such as the rivers included in the state or federal wild and scenic river program. It was reported that Wabasha County has a ¼ mile bluff setback for towers, including wind turbines. This seems reasonable given the prominence of the Mississippi River corridor through Southeast Minnesota. However, one wind advocate pointed out that the setback applies to not only the bluffs facing the Mississippi, but also the bluffs of tributaries flowing into the Mississippi. Because of the great number of tributaries and the ravines that they have carved out, this setback becomes very problematic for potential wind development. A review of USGS topographic maps show that enormous amounts of land will be off limits for wind projects under that kind of standard. In other parts of the state, like the Minnesota River Valley a simple bluff top setback is workable. In areas where there is much more complex topography, it might be appropriate for the county to define areas that are acceptable to wind development through an overlay district. It has also not necessarily been the intent that all wind development is invisible along scenic valleys. Bluff top setbacks should be used to prevent the creation of a visual wall of turbines looming over valleys.

Certifications

While setbacks remain the primary mechanism for ensuring public safety in the zoning ordinance, proper design and construction of wind turbines will also substantially reduce the risk of catastrophic failure of turbines and injury to the public. The wind industry has been working on developing a variety of standards including design and safety standards over the past few decades. These standards are codified in the International Electrotechnical Commission (IEC) 61400 Series. In the United States Underwriters Laboratory (UL) has recently begun certifying wind turbine compliance with these standards. Third party certification organizations have been operating in Europe for many years. These include organizations such as Germany's Germanischer Lloyd, Norway's DNV and Denmark's RISO.

To date, UL has primarily certified a handful of turbine models, which are primarily non-commercial scale wind turbines. If the turbine manufacture has not secured third party certification of standards compliance, they should provide a declaration of compliance by the manufacture.

Further, there should be evidence in a permit application that the foundation supporting the tower and turbine is adequate to support the weight and wind loading on the tower. For non-commercial turbines, the applicant should have designs and specifications from the turbine and or tower manufacturer or an other competent professional. For commercial wind projects, the foundation should be matched to local soil types. In Minnesota, these have primarily consisted of a deep pier formed by concrete rings and filled with compacted soil. It would be desirable and appropriate to see documentation that the project developer has completed the necessary geotechnical analysis and engineering to assure that the tower foundation is adequate to support the loads that will be placed upon it. Construction plans signed off by a Professional Engineer, would be clear evidence that the foundation is adequately designed. However, to date the experience that some counties have had is that there is a standard foundation design that is being used from project to project. Some project developers have noted that the number of Professional Engineers registered in Minnesota with proper expertise is limited. They warn that requiring a Professional Engineer to sign off on foundation designs will drive up costs unnecessarily. However, there should be evidence that the foundation was designed by a competent individual and is appropriate to the chosen wind turbine and site conditions.

In counties that enforce the Uniform Building Code, code inspectors will require that the project developer has a design that is signed off on by a registered Professional Engineer.

Discussions with the State of Minnesota Department of Labor and Industry Building Codes and Standards Division staff have noted that the building code for commercial wind turbines is pretty vague. The key item that code inspectors will look for is a design by Professional Engineer.[xiii]

Standards

The model ordinance also employs several additional standards that address a variety of potential impacts, particularly aesthetic concerns. A height limit of less than 200 feet is imposed on non-Commercial wind turbines. It is not likely that any non-commercial turbine will exceed this. However, this standard ensures that smaller turbines do not reach a height where aviation warning lights are required.

Met towers CUP exemption - Most county zoning ordinances require a CUP for structures of greater than 100 feet. Historically this has been to control the construction of large structures and facilities, such as silos, grain storage, and radio towers. The model ordinance presents an option for a lesser standard for meteorological towers as they are not as obtrusive as other tall structures. They are also usually a more temporary land use. If after a few years, the wind project is not moving forward, then the tower will come down. If the wind project does move forward, then the County will be able to review the meteorological tower as part of the overall wind energy conversion system application. However, many counties still seem to prefer to maintain the conditional use for meteorological towers of 100 feet or greater.

Monopole Towers - The ordinance specifies that all commercial WECS shall use tubular monopole type towers to support the wind turbines. For the newer machines this is the general industry practice, particularly in colder climates. However, this was not necessarily the case until the most recent generation of wind turbines. 500 kw turbines have been installed on lattice type towers in Iowa. In addition, if smaller commercial turbines are decommissioned in other locations and moved into Minnesota, it is entirely possible that they will be sold with lattice type towers.

Tubular towers provide several benefits:

· Many people find them aesthetically more acceptable,

· Tubular towers are the industry standard for commercial WECS, and required by the Minnesota EQB. By requiring that all new commercial WECS are installed on tubular towers, the county can ensure visual uniformity of wind turbines. Visual uniformity of turbines generally reduces negative aesthetic impact as the machines tend to blend together visually.

· Tubular towers enhance the ability to safely access and maintain equipment in cold weather.

· Tubular towers reduce the ability of birds to perch, and thereby reduces overall bird mortality.

· Tubular towers enclose electrical equipment and cabling, reducing the potential for igniting wildfires.

Standards addressing color and finish, lighting, signage and burying of feeder lines are all intended to reduce the overall visual impact of WECS. The first three should not generate any significant concerns from wind developers. These approaches are industry standards.

The one area where developers are going to raise concerns is the requirement to burry feeder lines between the wind turbines and substations. Buried power lines are much more expensive to construct. Yet, industry commentators have noted that the wind projects receive more complaints when there is visual clutter beyond the turbines themselves. The feeder lines that connect the wind project and the transmission lines are often a significant part of that visual clutter. This has been noted to the authors in regards to the large Buffalo Ridge wind farms that have a significant number of feeder lines running for many miles to connect to substations.

Feeder lines tend to be more of an issue for larger wind projects, and the clarification by the Department of Commerce staff that the State will exert its authority over "aggregated" developments of 5 MW and greater will reduce the likelihood that the county will be responsible for permitting long feeder lines. Counties with an interest in these issues should seek to coordinate with the Department of Commerce and Public Utilities Commission on projects that are subject to state control to ensure that county concerns are addressed, and that feeder lines are subject to proper oversight.

Discontinuation and Decommissioning: Counties do need to address what happens to the installations at the end of their useful life. California wind resource areas have struggled with the impact of derelict wind turbines that were installed in the early period of wind development. The public has a much more negative impression of wind turbines, if they are not doing something useful- namely producing clean energy. Wind development in Southwest Minnesota has exceeded the capacity of the transmission system to take all the energy produced. So during periods of low local electrical demand and high wind, many wind turbines are shut down. Travelers and residents of the area notice this and comment up on it regularly. In addition, if a turbine is no longer operational it is not likely that the owner is going to expend significant resources on maintaining the equipment. This increases the probability of a catastrophic failure.

For reasons of aesthetic impact and public safety, wind turbines should be removed if they are no longer serviceable. The model ordinance includes a decommissioning requirement, and provides that the project developer provide a decommissioning plan that spells out the costs and financial resources available to remove the structure. However, the model ordinance does not require that specific financial resources be set aside for decommissioning. Some people working on the issue have suggested that Counties require escrow funds be established or bonds purchased to pay for decommissioning costs. In both cases, these requirements add financial burdens to projects at their start or during their early operational years. Small wind projects already have significant challenges in ensuring an adequate cash flow to make debt service and pay out to equity financiers. This type of instrument is not recommended here.

Industry insiders generally assert that the standing tower has enough residual value to ensure that towers can be removed. Either a crane can be hired to dismantle the tower and salvage the equipment for resale, or explosives can be used to topple the tower so that it can be cut up for scrap metal. The decommissioning plan should spell out estimates of costs and the resources available for removal. If the County does not feel that these plans are realistic or adequate they have the option of adding additional conditions. Some counties have included escrow requirements for decommissioning wind projects; however, this kind of requirement can potentially add problematic stresses on cash flow during the critical early years of the project.

The model ordinance also leaves to the counties discretions the extent to which the site is restored after decommissioning. Removal of the tower to ground level will address the principal aesthetic and public safety issues. Removal of the foundation and access roads to three to four feet below the land surface will facilitate return of the land to agricultural use, but increase the cost of the decommissioning. Counties may be interested in protecting the agricultural resource by more strict decommissioning standards, or they may determine that decommissioning beyond tower removal is part of the market transaction between the landowner and the project developer.

Other Applicable Standards: It is also important to note that there are other standards and controls that apply to wind projects beyond the local land use regulations. The model ordinance includes by reference MPCA Noise rule, the National Electrical Code, and FAA lighting and airport distance regulations. Wind energy conversion systems would be subject to these standards regardless of the County including them in the ordinance. But inclusion in the ordinance allows a county additional capacity to ensure public wellbeing. This is particularly true of noise issues. While 750 foot residential setback should minimize noise concerns, it will not eliminate them altogether. This puts the onus on the developer to ensure that they are paying attention to minimum noise standards. The MPCA rules governing noise effectively require that noise from a wind turbine not exceed 50 dBA at neighboring residents. If the developer is cavalier about noise, they can face enforcement by both the MPCA and the County if problems surface after construction.

Interference With Electronic Communication: The Model ordinance does not intend to resolve all potential issues. However, it does intend to provide the county with the basis to ensure that wind projects do not cause undue impacts on public infrastructure or neighbors. Impacts on various broadcasters varies by communication technology, with AM radio and microwave beams the most susceptible. Noticing communication tower owner within 2 to five miles of the project will allow them the opportunity to determine if the WECS will cause a problem for their facility. The ordinance language also specifies that the WECS shall not impact County or State microwave transmission system. These transmission paths are known or readily attainable from the County's own administrative services of from the Minnesota Department of Transportation, see Appendix A. Locating wind turbines outside of these corridors will protect the public infrastructure.

However, there are many non-public microwave transmitters. These private transmitters are not as carefully protected by this ordinance. Industry representatives have noted that the microwave transmitter has no legal recourse if their signal is blocked, as can happen when a grain elevator, water tower or tall office building is constructed. The cost of a "Microwave beam search" is approximately $2,500 for a small project. Further, this will only capture "licensed" microwave transmitters. Many such transmitters are not "licensed", that is registered with the Federal Communication Commission.

AM Radio stations, are most susceptible to problems within a few miles of their broadcast tower. Noticing tower owner within 2 or 5 miles will generally allow problems related to local AM radio broadcasts to be raised and addressed in the permitting process, rather than after the fact. Many rural communities do include AM broadcasters, but the number should be few enough that the burden of identifying and contacting them should be minimal.

Application Fees

Planning and zoning fees for wind projects has been raised as an issue in this process. One developer of small projects has expressed frustration to a number of people regarding the varying fees for wind projects from county to county. Some counties have very low fees, while others have more substantial fees. In most cases this results from the different philosophies and approaches counties take toward planning and zoning fees. Some counties have low flat fees, some counties charge higher fees that escalate with the size of the project. A survey by the Pipestone County Zoning Administrator in Fall 2005 found that permitting fees ranged from under $300 to almost $9,000 for a hypothetical wind turbine.[xiv]

Pipestone County charges $500 for a CUP and $50 for a land use permit. While in neighboring Murray County the CUP fee is $500 and the land use permit is $100, plus $1 per $1,000 of value over $100,000. A $1.7 million wind project would pay about $2,200 in Murray County and $550 in Pipestone County. The same differential would apply to houses, hog barns and any other use. The counties with the highest fees are those enforcing the Uniform Building Code, in that case there is an inspection fee of up to 0.5% of the project cost - resulting in permitting fees of nearly $9,000 per tower.

Some counties collect specialized fees for wind projects. Rock County charges $750 per megawatt of installed capacity for the land use permit and $500 for the CUP. This was adopted at the recommendation of wind developer Dan Juhl. Neighboring Nobles County charges $10 per linear foot of tower height, resulting in a land use permit fee of $2,300 in addition to the $375 for the same tower.

Wind developers certainly prefer lower and standardized fees. They point out that the wind projects are capital intensive with nearly all costs coming upfront. Fees must be paid before the project is complete, and drains the resources available for upfront project development.

The issue of fees was most significant to a number of aggregated projects. Essentially each turbine was charged the same fees, as they were considered separate projects. Counties with higher fees could result in upfront costs for aggregated wind projects running well over $10,000. The issue of aggregated project fees is likely to be diminished by two factors: increasing turbine size and clarification by the State that an aggregated project of 5 MW and over, that involved the same developer and are co-located will be subject to State regulation. As 2 MW turbines increasingly dominate the market for wind turbines, local zoning will increasingly be limited to projects 1-2 turbine projects.

Counties should be aware that the State wind siting process can charge substantial fees. In addition, the site permit application is typically a more detailed and lengthy process that could be very expensive to complete. So in some cases, the aggregated projects that sought relief from county planning and zoning fees, may have already enjoyed relief from the cost of State permitting procedures.

End Notes

[i] Paul Gipe, " Wind Energy - The Breath of Life or the Kiss of Death: Contemporary Wind Mortality Rates" http://www.wind-works.org/articles/BreathLife.html March 29, 2005.

[ii] Larry Hartman, Environmental Quality Board (now Department of Commerce) Personal Communication, November 2004. Mr. Hartman did also acknowledge that the reporting process is dependent upon cooperation of the wind farm operators.

[iii] Henrik Kanstrup Jorgensen, Pre-filed Testimony, Before The State Of Washington Energy Facility Site Evaluation Council In The Matter Of Application No. 2004-01:Wind Ridge Power Partners, Llc; Wild Horse Wind Power Project Exhibit 36 (Hkj-T). http://www.efsec.wa.gov/wildhorse/adj/applprefiled/36-hkj-t.pdf

[iv] Chris Copeland, as citied in Wind Power Development in Southwest Minnesota.

[v] Robert Olson, Lincoln County Minnesota Zoning Administrator. Personal Communication, June 2004.

[vi] Dan Juhl, Personal Communication, October 2004.

[vii] American Wind Energy Association, "Wind Web Tutorial: Wind Energy and the Environment." http://www.awea.org/faq/tutorial/wwt_environment.html

[viii] American Wind Energy Association, Small Wind Systems and Public Safety 2003. http://www.awea.org/smallwind/toolbox/TOOLS/fs_safety.asp

[ix] Eja Pedersen, Högskolan I Halmstad Noise Annoyance From Wind Turbines A Review. Naturvårdsverket (Swedish Environmental Protection Agency) 2003 Http://Www.Naturvardsverket.Se/Bokhandeln/Pdf/620-5308-6.Pdf

[x] Wind Turbines and Birds A Guidance Document for Environmental Assessment Canadian Wildlife Service Environment Canada http://www.canwea.ca/downloads/en/PDFS/BirdStudiesDraft_May_04.pdf

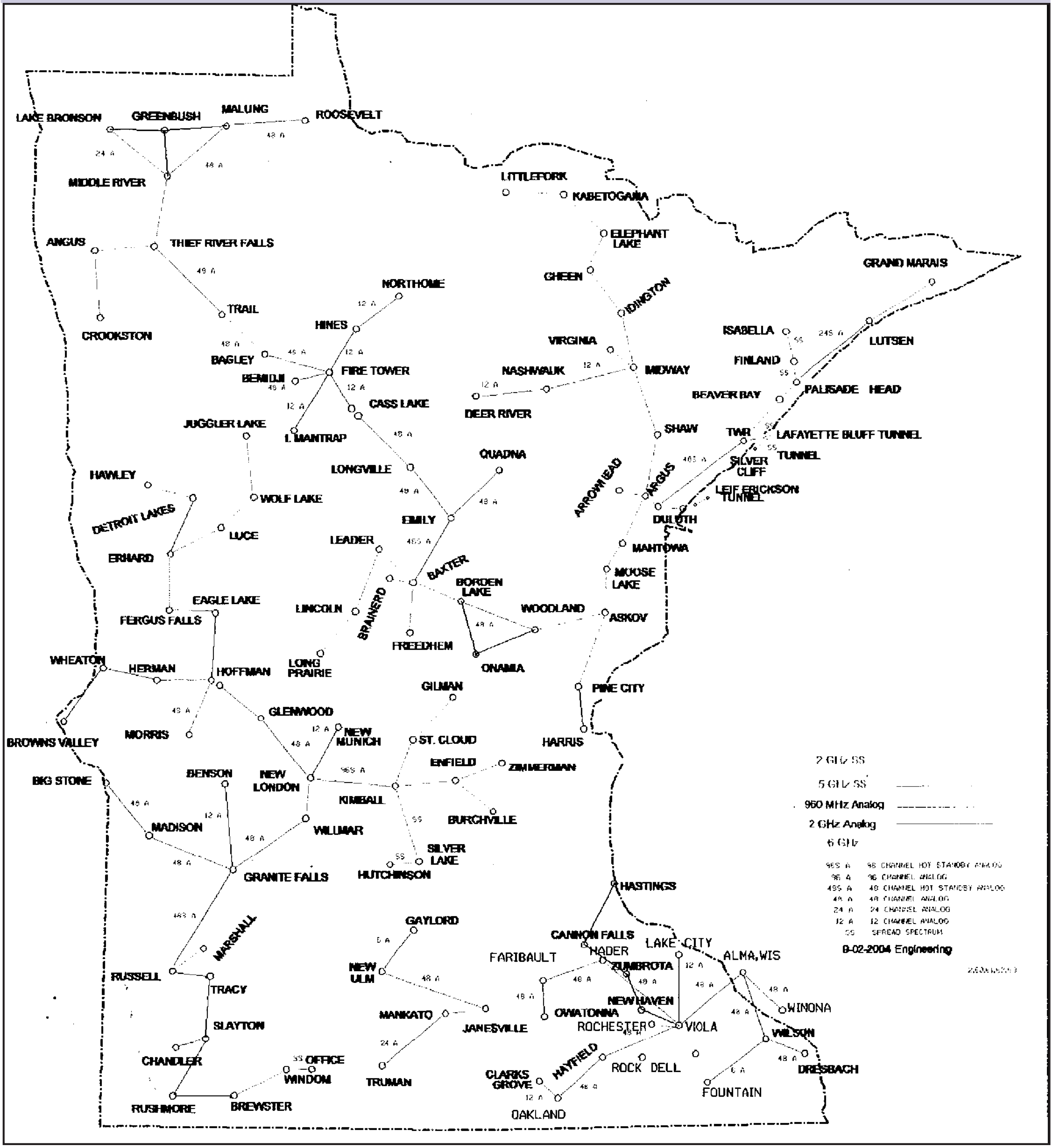
[xi] Environmental Quality Board Project Docket http://www.eqb.state.mn.us/Docket.html?DocketSubject=Wind+power&Status=All&B1=Submit

[xii] Personal Communication in meeting with the MN DNR's Southern Region Environmental Review Team December 2004.

[xiii] Greive, Barry. Building Code Representative, Minnesota Department of Labor and Industry. Personal Communication. June 6, 2005

[xiv] Kyle Krier, "Windtower Fee Survey" unpublished Nov. 11, 2004.

Appendix A: Minnesota State Government Microwave Transmission System Map



Source: Robert Prudhomme, Statewide Maintenance and Operations Supervisor, Minnesota Department of Transportation, 2005.

Appendix B: Minnesota Department of Commerce Wind Turbine Database Survey

Appendix B contains the cover letter by Larry Hartman, Minnesota Department of Commerce (formerly of the Minnesota Environmetal Quality Board) as well as the survey itself. The Minnesota Legislature reorganized the agency structure for energy facility siting in 2005. Current contact information for Larry Hartman is:

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651-296-5089
larry.Hartman@state.mn.us

December 16, 2004
RE: Minnesota's Wind Turbine Inventory Project

Dear Wind Turbine Owner:

Introduction

The Minnesota Environmental Quality Board (EQB) has begun building an inventory of all existing and future commercial wind turbines located in Minnesota. The purpose of the Wind Turbine Inventory is to consolidate and maintain public domain information about wind turbine projects and make that information available via the Web to interested persons. The EQB is the primary state agency responsible for the permitting of large wind energy conversion systems (LWECS) - those greater than five megawatts. Local units of government are responsible for the permitting of small wind energy conversions systems (SWECS) - those less than five megawatts.

Why is this inventory necessary? It is needed because there is a large number of wind turbines currently located in the state, nearly 700. With many more anticipated being built in the future, a comprehensive inventory of wind turbine facilities will serve as a very useful tool for public officials, governmental agencies, researchers, developers and other interested persons. It will allow them to monitor development of wind energy in Minnesota and help them establish public policies that support its continued development. Inventory data could potentially be viewed as reports or even as a series of maps with turbine locations displayed in relation to land use and environmental features. To view examples of existing wind turbine inventory information, see:

www.eqb.state.mn.us/WindInventory/Maps

As we move forward, we expect other applications for the wind turbine inventory information to emerge.

Minnesota Wind Turbine Inventory Survey Form

Although inventory data for a large number of the turbines permitted by the EQB and local units of government are already in a database, the information is incomplete and needs verification. To meet the goals of this project, additional data such as ownership information and turbine characteristics are required. We are requesting that you complete the Minnesota Wind Turbine Inventory form for your wind project so that the data entered in the database is complete and accurate. Please note that the information you are being asked to provide is considered public information, not proprietary.

We are requesting that you provide information for three distinct topic areas: Part A of the inventory asks you to provide project name, owner, contact and developer information; Part B asks you for turbine characteristics and project information; and Part C asks for wind turbine and permanent meteorological tower (MET tower) location information.

The Minnesota Wind Turbine Inventory form can be completed using (1) the enclosed form, instructions and a self-addressed stamped envelope or (2) by filling out an on-line form found at: http://www.eqb.state.mn.us/WindInventory

Please note that the enclosed instructions and survey form are also available at the web address above in the form of PDF documents, which can be downloaded and printed locally. However, we encourage you to complete the Minnesota Wind Turbine Inventory on-line!

If you elect to mail your completed inventory, please make yourself a copy of the completed form before sending it to the EQB. If you submit the form and later realize that there may be an error, or if your information needs to be updated for other reasons, please submit any corrections.

Our goal is 100 percent participation! If we do not hear back from you by January 14, 2005, we will be contacting you again.

The EQB appreciates your assistance and cooperation in this Minnesota Wind Turbine Inventory project. If you have any questions or suggestions, please do not hesitate to contact me. Thank you and may your winds be good.

Sincerely,

Larry B. Hartman, EQB Staff
Telephone: 651-296-5089
Fax: 651-296-3698
E-mail: larry.hartman@state.mn.us

Appendix C: On-Line Wind Energy Information Resources

American Wind Energy Association - www.awea.org

Clean Energy Resource Teams - www.cleanenergyresourceteams.org

Environmental Quality Board -
http://www.eqb.state.mn.us/Docket.html?DocketSubject=Wind+power&Status=All&B1=Submit
The EQB web site archives a rich record of site permits and supporting documents. However, since the transfer of the energy facilities siting staff to the Department of Commerce the documents are difficult to find from the home page.

Department of Commerce - www.commerce.state.mn.us
Click on the Energy Info Center button in the upper left corner to access information on wind and related subjects.

Public Utilities Commission - http://energyfacilities.puc.state.mn.us

National Renewable Energy Laboratory - www.nrel.gov/

USDOE Windpowering America - www.eere.energy.gov/windandhydro/windpoweringamerica/

National Wind Coordinating Committee - www.nationalwind.org/
Click on Workgroups and then Siting

Windustry - www.windustry.org

Appendix D: Glossary

Co-op: Commonly used term to describe rural electric cooperatives. These utilities are member owned and trace their heritage to New Deal policies to bring electric power to un-served rural areas.

DG (Distributed Generation): Small electrical generators that are dispersed across the grid for the purpose of meeting local loads, often in lieu of upgrading local distribution or transmission facilities.

IOU (investor owned utility): A utility company that is a private sector corporation.

IPP (independent power producer): A private entity that operate a power plant and sells electricity to electric utilities for resale to retail customers.

ISO (Independent system operators): A neutral and independent organization with no financial interest in power plants that administers the operation of the transmission system. ISO's have final authority over the dispatch of generation to preserve reliability, facilitate efficiency, and ensure non-discriminatory access to the grid.

KW (Kilowatt): = 1,000 watts. An instantaneous measure of power or demand for power.

KWh (kilowatt hour) = 1,000 watt hours. This is a measure of energy produced or consumed. It equals the rate of power use (kW) times the duration of the use (hours).

MISO (Midwest Independent System Operator): The ISO overseeing the Grid in Minnesota.

MAPP (Mid-Continent Area Power Pool): The Mid-Continent Area Power Pool (MAPP) is an association of electric utilities and other electric industry participants. MAPP was organized in 1972 for the purpose of pooling generation and transmission.

MW (megawatt): 1 million watts = 1,000 kilowatts.

MWh (Megawatt hour): 1 million watt-hours = 1,000 kilowatt hours.

Munis (Municipal Utilities): Municipal Utilities are utilities that are owned and operated by a city, and subject to local regulation.

Net Metering: A pricing system that allows small renewable energy generators (less than 40 kw in MN) to receive retail prices for electricity sold back to the utility in excess of that used by the customer.

PUC (Public Utilities Commission): The state agency with regulatory jurisdiction over certain Minnesota Utilities.

PURPA (Public Utility Regulatory Policy Act of 1978): Federal legislation, which requires utilities to purchase power from private "qualifying facilities" at an avoided cost.

RD (Rotor Diameter): The diameter of the circle formed by the tips of the rotor blades.

WECS (Wind Energy Conversion System) Wind turbines and the ancillary facilities that are required to generate electricity and deliver that electricity to the grid.

Wind Turbine: The electrical generator, rotor blades, and supporting tower that produces electricity.

APPENDIX E: Minnesota Counties Insurance Trust Legal Review

The Minnesota Model Wind Energy Conversion System Ordinance was reviewed by MCIT attorneys. Their comments are included for reference.

or land use rules, regulations, or ordinances adopted by regional, county, local, and special purpose governments. Given the above, I think it would be reasonable to provide a provision in the model ordinance that states that the ordinance does not set forth any requirements for site approval for large wind energy conversion systems as defined as Minn. Stat. § 116C.691. In the section entitled aggregated projects-procedures, I would pull the brackets away.

That's all I have on the ordinance itself. I would suggest that you submit the local ordinance to the EQB for review. Minn. Stat. § 116C.696 states "the Board may assist local governmental units in adopting ordinances and other requirements to regulate the siting, construction, and operation of SWECS, including the development of a model ordinance." It would be worthwhile to get the EQB comments on this ordinance.

Thank you for sending this matter to my attention for review. If you have any further questions or concerns please feel free to contact me.

Very truly yours,

Scott T. A

Scott T. Anderson

STA/jbc
RRM: #80740

Mr. Mark Erickson
August 11, 2005
Page 2

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