Environmental Impacts of Power Plants

This Public Service Commission (PSC) brochure explores the environmental impacts and issues related to the construction and operation of electric generation facilities, or power plants. Included in this publication are some techniques used to avoid, reduce, or mitigate impacts.

The PSC's Role in Power Plant Siting and Environmental Protection

In general, the PSC's objective is to ensure a safe and reliable electricity supply for the public at a reasonable cost with limited adverse environmental and social impact for Wisconsin residents and businesses.

The PSC is the state agency that regulates electric utilities and the construction of power plants. For any new power plant with a capacity of 100 MW or more, the developer must apply for a Certificate of Public Convenience and Necessity (CPCN) from the PSC. If the developer is a Wisconsin utility, it must submit a CPCN application with details on the engineering, economic, and environmental aspects of the proposal, including analyses of alternative energy sources, technologies, or locations.

If the power plant developer is not a Wisconsin utility, the PSC may not consider alternative sources of electricity supply, engineering, or economic factors, or whether the project would reasonably meet the public's need for electric energy in making its decisions.

In most cases, the applicant must provide at least two alternative sites. The PSC reviews the environmental and socioeconomic impacts of the proposed plant sites. The PSC also examines the potential routes for new power lines, natural gas pipelines, or steam/water lines that the plant would require for each site.

The Department of Natural Resources (DNR) assists the PSC in its review of a proposed power plant if the plant requires DNR permits for air emissions, water supply or discharge, or solid waste management and landfills (http://dnr.wi.gov/topic/Sectors/PowerPlants.html). The PSC and DNR obligations are described in Chapter 196 of the Wisconsin Statutes. For reviews of power plant applications, the PSC and DNR jointly prepare an Environmental Impact Statement (EIS) or an Environmental Assessment (EA), and the PSC usually holds a public hearing in the project area. The EIS or EA is submitted as evidence at the hearing. After the hearing and at the end of its review, the Commission issues an "order" that approves, rejects, or modifies the proposed power plant. If the power plant project is approved, the Commission selects the site where it will be built and may also impose a variety of environmental mitigation measures. The DNR approves and issues its permits separately.

Depending on the project cost, public utilities must apply to the PSC for a Certificate of Authority (CA) for a new power plant with a capacity of less than 100 MW. A hearing is not automatically required for a CA, but could be held if appropriate or required under Wisconsin Administrative Code, Chapter PSC 4, the state rule governing the PSC's responsibilities under the Wisconsin Environmental Policy Act (WEPA). An EIS or EA is also jointly prepared with the DNR if one is required. The PSC reviews the application and considers the project's potential financial, electrical, and environmental impacts before issuing a final decision. DNR permits might also be required for air pollutant emissions, water intake and discharge, wetlands impacts, and solid waste disposal.

In every power plant case, the local public receives one or more mailings from the PSC to (1) notify people that the project has been proposed and is being reviewed and (2) obtain information and concerns from the local individuals.

How a Power Plant Might Cause Impacts

A power plant can affect the environment by its construction and by its operation. These effects, or impacts, can be either temporary or permanent. A power plant and its auxiliary components (e.g. natural gas pipelines, water intakes and discharge, coal delivery and storage systems, new transmission lines and waste disposal sites) take up space on the ground and in the air, use water resources, and, in many cases, emit pollutants into the air. The plant's footprint on the ground eliminates opportunities for others to purchase or use the land. It can also affect the existing or future uses of adjoining and nearby land parcels. A coal-fired plant includes some relatively tall buildings and high exhaust stacks. The plant's height may result in safety concerns for aircraft or visual impacts for local landowners. If the land to be used for the power plant is a "greenfield", an undeveloped parcel with mostly vegetation (crops, pasture, or old-field vegetation), there would be impacts on land use, soils, and wildlife present on the site.

Fossil fuel-fired and biomass-fired plants burn fuels to make either hot air or steam needed to spin power turbines generating electricity. Nuclear power plants use the nuclear fission reaction to create steam to do the same. The burning of fuel creates exhaust gases and other by-products, including air pollutants. The use of water to make steam requires large quantities of water from nearby rivers or lakes, or from local underground water aquifers, and it must be purified. In some cases, water must be discharged from the plant after it has been used. The amount of used water discharged, the discharge water's temperature, and the concentration of pollutants in the water are all factors to be considered.

A variety of solid wastes can be produced, and these must be handled. The combustion of coal creates ash as a solid waste. Nuclear power plants create spent nuclear fuel rods and low-level radioactive wastes. Power plants that use water to create steam or for cooling must often filter and purify the water before discharging to surface waters. The filtered solids are a by-product that must be disposed appropriately.

The water used for cooling is often run through cooling towers to reduce the heat. The air that's warmed by the water in the cooling tower goes into the atmosphere carrying great quantities of water as vapor, in some cases millions of gallons per day. That lost water vapor, obtained locally, represents significant water consumption by the power plant.

Some aspects of the construction and operation of a power plant can have unsettling effects on the community in which the power plant is built. Construction of the power plant, while very organized, can be viewed by surrounding landowners and other citizens as ugly and chaotic and might have an effect on community aesthetics or business. Costs for community services such as police, fire protection, emergency medical service, and traffic control can increase. Additional requirements might be placed on the municipal water supply or wastewater treatment capacity, or on solid-waste management systems. Coal-fired power plants require an efficient, reliable and long-term means of coal delivery, usually by rail or barge. Nearby road or rail traffic might be complicated or burdened by construction traffic and the delivery of materials, particularly large items. Noise levels in neighborhoods might increase during construction, and power plant operation also creates noise and vibration. The cooling towers of an operating power plant can also create fog and rime ice. Air space issues and compatibility with local land use must be considered in light of the space the power plant occupies and the way it operates.

There also can be positive effects on the community such as jobs for local residents and purchases of locally-produced goods and services creating additional income streams for the area. Local tax revenue or state shared revenue for the local municipalities would increase. And, of course, the

electricity produced by the plant could replace out-of-state power purchases whose prices might be more volatile and unreliable. The operation of the plant also could help stabilize the local electric transmission grid so that power is more efficiently and reliably moved from one place to another.

There could also be impacts from the construction of auxiliary or ancillary facilities such as power plant support systems and infrastructures, rail lines, roads, natural gas lines, water or steam lines, and electric transmission lines. Water, steam, and natural gas are transported by pipelines. Pipelines often require the digging of trenches that may impact residential yards, roads, farm fields, woodlands, or wetlands. Natural gas and electric transmission line impacts are discussed in other PSC brochures.

Public Information and Input in Power Plant Development

The general public should have access to information about the siting of a power plant and the potential impacts that could occur before construction is authorized by the PSC. People in the area often have information that could affect the power plant developer's siting efforts, the design of the proposed plant, and the ultimate decisions made by the Commission.

A developer might obtain public input by:

- Soliciting input through a periodic newsletter.
- Soliciting responses in personal letters sent to local governments, regional planners, and landowners.
- Holding information meetings to respond to questions, solicit comments, or hand out questionnaires.

With access to the developer's power plant siting criteria, members of the public can think more seriously and meaningfully about the plant. They can:

- Compare sites.
- Understand why particular sites are being examined for a proposal.
- Discuss which environmental factors appear to be of importance in the project.
- Potentially influence the company's siting decisions before it submits a construction application to the PSC.

The public can also provide input during the PSC review of the power plant proposal. There is often discussion about "mitigation." Mitigation involves methods to reduce impacts or to compensate for the impacts in some way so that the adverse effect is lessened. Development of mitigation measures might affect the project review's outcome. Methods for impact mitigation should be considered throughout the regulatory review process.

Natural Resources Impacts

Air

Operating power plants that burn coal, oil, or natural gas emit air pollutants into the atmosphere requiring the plant be fitted with pollution control equipment to reduce emissions. Many of these power plant air pollutants have been identified and are regulated by federal and state environmental regulatory agencies.

Public exposure to air emissions (air pollution) from a power plant is regulated by the U.S. Environmental Protection Agency (EPA) primarily through two sets of standards:

- The National Ambient Air Quality Standards (NAAQS) for major, "criteria," air pollutants including sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ozone (O_3), particulate matter ($PM_{2.5}$ or PM_{10}), and lead (Pb).
- The National Emissions Standards for Hazardous Air Pollutants (NESHAP) for hazardous elements like mercury (Hg) or cadmium (Cd) and compounds like acetaldehyde (CH_3CHO) or hydrochloric acid (H_2SO_4), all often mentioned simply as HAPs.

The Wisconsin DNR is charged with enforcing the NAAQS for criteria pollutants and NESHAP for HAPs. The Wisconsin DNR air pollution control permit program has permits for two kinds of scenarios: new and existing facilities. For a proposed new power plant, the objective is to ensure through a "construction permit" and "air dispersion modeling" that the plant can meet air pollution standards before it is built and operating. Existing plants receive operation permits that set emission limits and establish monitoring and reporting requirements.

SO_2 has been a cause of acid precipitation, commonly known as "acid rain," which can damage vegetation and acidify lakes. Species vulnerable to acidic conditions have trouble reproducing and, in some cases, die. NO_X and volatile organic compounds (VOCs) are components of ozone formation. Ozone is a principal component of smog and can result in respiratory health and other environmental effects. Particulate matter (PM) includes dust and smaller particles with a maximum particle diameter of 10 microns (PM_{10}). It takes 1,000 microns to equal 1 millimeter. In addition to PM_{10} emission standards, there are federal standards for $PM_{2.5}$, extremely small particles with a diameter between 2.5 and 10 microns. Small particulates have been shown to cause respiratory problems because they can penetrate deeper into the lungs than the larger particulates. The DNR has been monitoring $PM_{2.5}$ statewide since 1999. Only a relatively small amount of fine particulates are directly emitted from combustion sources. A more significant concern is the NO_X and SO_2 emissions from power plants that burn coal or natural gas. These compounds are part of a complex chemical reaction in the atmosphere that creates nitrate- and sulfate-based fine particulates. Most of the DNR's efforts to reduce fine particulate pollution are based on year-round control of NO_X and SO_2 contaminants.

Mercury (Hg) is naturally present in small quantities in the environment. Human activities have greatly increased the concentration of this pollutant in the air and water. Coal-fired power plants are the biggest category of mercury emitters. Mercury is very volatile and can travel around the world in the atmosphere, repeatedly being deposited and re-emitted into the atmosphere. Mercury is deposited in lakes and rivers by rain, snow and surface runoff. While mercury is a pollutant with global consequences, the local impacts of mercury emissions from power plants also remain a serious concern. Once deposited in waterways, bacteria can convert mercury into methyl mercury that can be easily absorbed by fish and other organisms. Eating contaminated fish is the primary

pathway for human exposure to mercury. Ingested mercury can damage the nervous system, especially in children and fetuses. Currently, most Wisconsin lakes and streams have DNR fish consumption "safe-eating" guidelines for mercury (http://dnr.wi.gov/topic/fishing/consumption). Some Wisconsin lakes and streams or stream segments have fish consumption "special advice" because of higher levels of mercury in certain sport fish which can be found on the DNR website. Both the fish consumption guidelines and the special advice contain recommendations regarding avoiding or limiting consumption of certain sport fish, especially women of child bearing years, nursing mothers and children under the age of 15.

Mercury emission control from fossil fuel-burning power plants is improving. It may be possible to reach a 70 to 90-plus percent reduction in mercury emissions using certain combinations of control technologies. While the toxic risk of direct inhalation of mercury from power plant emissions is low, both the DNR[1] and EPA[2] are regulating mercury emissions from coal-fired power plants to reduce the build up (bioaccumulation) of mercury in the environment.

It is also important to know about the presence of sensitive environmental resources in the area that would be affected by the power plant's emissions. For example, the plant should be located far from any designated wilderness such as national forests whose ecology, public use and enjoyment could be adversely affected by air pollution.

Federal emissions standards are based on health effects research. In an effort to minimize pollutants released to the air, best-achieving emission control technologies are often made a requirement for plant operation. Even though a power plant's emissions are required to meet air emission standards, more sensitive individuals might not be adequately protected. When air pollution levels increase in an area, more vulnerable individuals like the elderly, the sick, and the very young might experience health problems.

Global Climate

The planet's ability to retain solar heat is dependent on concentrations of "greenhouse gases" (GHGs) that are in the atmosphere. GHGs are gases in the atmosphere that trap heat, like greenhouse glass, and help keep the planet warm enough for life to survive. The three main human-influenced GHGs are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Power plants fueled by fossil fuels like coal or natural gas produce large amounts of CO_2. Since the beginning of the industrial revolution when large-scale consumption of fossil fuels began, atmospheric concentrations of CO_2 have increased over 30 percent. About half of that increase has occurred since 1970, and the rate of increase has grown since 2000. Scientists believe that increases in GHG concentrations have contributed to additional warming of the planet, and continued increases in concentrations are expected to cause further warming and a variety of global climate changes in the near future.

Increasing amounts of CO_2 and other greenhouse gases in the atmosphere appear to be having substantial impacts on the environment and human health in a variety of places on the planet already. These impacts could include rising sea levels, melting of glaciers and polar ice caps, altered ocean currents, climate alteration and wider ranges for insect-borne diseases of humans and crops. In Wisconsin, some impacts include, or could include, warmer and drier summer weather, increased frequencies of severe storms, lower water levels in the Great Lakes and inland lakes and streams, increased average water temperatures, changes in local ecosystems and species populations, changes

[1] Wis. Admin. Code ch. NR 446, "Control of Mercury Emissions"
[2] Federal mercury and air toxics standards (MATS), (http://www.epa.gov/airquality/powerplanttoxics/)

in the farm landscape because of effects on crop productivity, increased forest fires, reduced snow and ice cover in winter, and increased heat stress and mortality among people in summer.

At this time, GHGs have been determined to be air pollutants by the U.S. Supreme Court. As such, they are subject to DNR air permit. The U.S. Environmental Protection Agency (EPA) is currently developing separate sets of rules for regulating greenhouse gases in existing power plants and in future, new power plants.[3]

There has been a growing world-wide consensus agreeing with the Intergovernmental Panel on Climate Change (IPCC) that GHG emissions must be reduced. How to do it is still a matter of debate. One method might involve capturing CO_2 at the exhaust stack and depositing it in underground geologic formations. Current research is investigating where such geologic formations might be and how to offset the high cost of this method. It appears that there are no such formations practicable in Wisconsin. Another method being considered is the planting of forests to take up CO_2 and bind the carbon, offsetting increases in CO_2 emissions. However, it is not likely that enough trees could be planted to significantly reduce GHG levels in the atmosphere, certainly not in time to avoid climate change. A third way to reduce GHG emissions would be to reduce fossil fuel-fired power plant generation with increased industrial, commercial and residential energy efficiency (or conservation) and by generation of electricity using renewable resources such as wind power, solar power, or possibly short-term closed-loop biomass power plant systems. With conservation and renewable resources for energy, methods are also being researched looking for ways to extract CO_2 from the atmosphere. The practicality, feasibility and prudence of all of these methods are being investigated.

Water Quantity

Many power plants use water from lakes, rivers, municipal water utilities, or groundwater aquifers. Surface water is often used for plant cooling, and groundwater is often used for plant processes.

Cooling towers are often utilized to condense the steam produced in power plant operation, moving the heat by contact in the towers with either air or a separate water supply. The large water-cooling towers evaporate large quantities of water into the atmosphere. The evaporated water is lost to local stream flow or the local groundwater aquifer. Decreased stream base flow can adversely affect stream morphology, habitat, aquatic plant and animal communities and species, and promote growth of algae and nuisance or invasive aquatic plants. Lakes can be similarly affected. The DNR is authorized to regulate consumptive water use in power plants.

If the water used to make steam for steam turbines or to cool the steam for reuse in the system, water is often drawn from groundwater aquifers. The pumping of large quantities of groundwater creates a "cone of depression" around the well, lowering water levels in the aquifer for some distance from the well. This could affect the productivity of municipal and other nearby wells, and could affect the viability of groundwater-dependent resources in the area, such as lakes, wetlands, springs, and streams.

Power plants replace water permeable soils and sub-soils with impermeable surfaces such as rooftops, concrete pads, and parking lots. The increased impermeable surface area reduces the area where water can infiltrate into the ground to recharge the aquifers and groundwater supplies. Where it is captured, its energy must be dissipated so that it can soak into the aquifer below. If it is instead rerouted to surface waters, the water lost could also have adverse effects on local aquifers that

[3] EPA, "Clean Air Act Permitting for Greenhouse Gases," (http://www.epa.gov/nsr/ghgpermitting.html)

support wetlands, springs, and stream base-flow, and it could have adverse effects on the power plant's groundwater supply.

The DNR monitors water consumption of large power plants and can put permit conditions on a plant's use of surface water so that the surface water and biological diversity are protected in periods of hot weather and naturally low water levels. It also has a permit process for high-capacity wells, to regulate the withdrawal and consumption of water from the aquifers that supply local municipal wells. Non-municipal well productivity is not protected by this permit process.

Water Quality

Power plants must discharge or dispose of process water someplace. Discharge locations range from streams or lakes to local municipal sewer systems that eventually discharge into streams or lakes. To handle the discharge, surface waters or sewer treatment systems must be able to absorb water that has been altered by the addition of heat, acids, or salts. Larger water bodies or streams might be able to accept more of this altered water because of their size and volume or because they have water containing solutes that can buffer the added chemicals, or they might not. Their ability to do this would have to be modeled and calculated.

Pollution and pollutants discharged to surface water from power plants can result in adverse water quality effects. Some power plants use "once-through cooling." In once-through cooling, cooling water is drawn from the lake or river and used to condense the steam for recycling through the plant. The water used for cooling picks up heat from the steam and is then returned to the lake or river at a warmer temperature. Impacts of this technology could include the warming of the lake or river near the discharge point, potentially affecting temperature-sensitive plants, fish, microbial activities, or chemical and physical reactions in the water. Even with cooling towers instead of once-through cooling, discharged process water that is warmer than ambient water temperatures can alter the local fishery composition, aquatic macroinvertebrate (bugs) communities, and aquatic plant communities. Surface water pollutants can be taken up by aquatic species resulting in diseases and fish contamination.

Power plant discharge water must be cleaned, filtered, and processed before being discharged. It must be relatively neutral and carry as little heat or newly-dissolved materials as possible. Some minute amount of pollutants, such as mercury, may remain in the power plant discharge water even after treatment. The DNR regulates discharges into state waters through Wisconsin Pollution Discharge Elimination System (WPDES) permits. Through these permits, dissolved or suspended materials and heat from power plants are limited and monitored. For a description of the WPDES program, go to the DNR web site: http://dnr.wi.gov/topic/wastewater.

Construction of an electric power plant will expose large areas of bare ground. Left unmanaged, soil and any attached nutrients or pollutants can be washed from construction sites into nearby lakes, streams and wetlands during storm events or spring thaws. Use of erosion control best management practices can limit the amount of sediment and pollutants that would otherwise be washed offsite. A construction site erosion control plan would minimize soil erosion, sedimentation, and transport of pollutants from the construction site during and after storm events.

A power plant site presents challenges from uncontrolled stormwater runoff after it is constructed. Water running off rooftops, parking lots, coal piles and other sources can carry a variety of pollutants to surface water. DNR stormwater requirements include development and implementation of a stormwater management plan whose purpose is to minimize pollutants and excess stormwater from leaving the site. The power plant design must minimize soil erosion, sedimentation, and transport of pollutants during storms. The DNR regulates construction site and

post construction stormwater runoff quantities and quality through its permitting processes (http://dnr.wi.gov/topic/stormwater).

Air pollutants emitted from power plants can also adversely affect surface waters. Air deposition of nitrogen compounds can lead to or accelerate lake eutrophication. This can result in large algae blooms that can deplete oxygen levels in waters killing aquatic organisms. Acid deposition caused power plant emitted airborne pollutants is also a problem in water bodies that are naturally more acidic. Many lakes in northern Wisconsin are in this category. Acid deposition can cause a decline in aquatic plants and microorganisms, affecting fish species populations and diversity. Mercury also can be deposited from the atmosphere. Excess mercury deposited in certain types of lakes has become methyl mercury and led to fish consumption advisories.

Wetlands

Wetlands occur in many different forms and serve vital functions. These functions include storing runoff, regenerating groundwater, filtering sediments and pollutants, serving as spawning areas for some fish species, and providing habitat for wildlife. Power plants with a large construction footprint often require the filling or draining of some wetlands. Even if a wetland is not filled or drained, construction activities near wetlands can damage wetlands in several ways. For example:

- Heavy machinery can crush wetland vegetation, especially that growing on cassocks.
- Wetland soils, especially very peaty soils, can be easily compacted, increasing runoff, and reducing the wetland's water holding capacity.
- The construction of power plant access roads through wetlands can change the quantity or direction of water flow, causing permanent damage to wetland soils and vegetation.

These, and other impacts of power plants, can severely affect wetlands functional values. Some examples of impacts are loss of wetland plant species, decline in species diversity, loss of habitat needed by animal species to survive, a spread of invasive species, and alteration of the wetland hydrologic regime.

Generally, sites with no wetlands or no potential for adverse wetland effects are preferred for power plant construction. Sites with high quality wetlands or large wetlands are less desirable because of the potential adverse impact on a wetland and its functional values.

Potential adverse impacts to wetlands should be avoided. The DNR and the U.S. Army Corps of Engineers both regulate activities affecting wetlands through their permit processes (http://dnr.wi.gov/topic/Waterways/construction/wetlands.html).

Land and Soil

Different power plant types and designs have a wide range of land requirements. Coal-fired power plants need land not only for boilers and turbines but also for rail lines, coal storage piles, and ash landfills. Nuclear power plants may need specific areas for specialized dry cask storage of spent fuel rods. Natural gas-fired plants generally need less space than coal or nuclear plants, but need a large natural gas supply line and sometimes a large tank of oil for backup fuel. If a plant produces steam and the steam is sold to other industries nearby (cogeneration), a large steam line would have to be installed and extended out of the power plant boundary to the steam user. If a proposed power plant is expected to be expanded in the future, the land area must be large enough to accommodate the additional facilities.

Power plants proposed on sites where they are locally perceived to be "out of place" might seek to purchase additional land as a buffer. The surrounding buffer land would prevent new neighbors from locating too near the plant. This buffer could minimize visual and noise effects by increasing distances to nearby homes. Wisconsin's nuclear power plants have large acreages to buffer between the plants and the surrounding communities. Buffer land might also be needed to increase power plant distance from biologically important natural communities. Additional buffer land would increase the land area needed for the power plant project. Since buffer land would be maintained as a "natural" buffer, the impact on that particular acreage of land could be quite positive, as a conserving impact.

If the plant is built on land that is not level, extensive earth-moving and digging activities may be necessary. Soil erosion and sedimentation into nearby waters or wetlands is a risk. Soil would need to be redistributed or transported to another location and properly managed. For commercial facilities, the DNR regulates erosion at construction sites by requiring an approved soil erosion control plan if construction activities will exceed one acre (see the water quality discussion above).

Vegetation

Vegetation impacts can be of two basic kinds:

- Direct impacts of vegetation removal or damage during construction.
- Indirect impacts on vegetation from air pollution or surface water impacts caused by the power plant.

The vegetation communities at any site depend largely on: (1) soil quality and fertility, (2) relative elevations and slopes, (3) moisture availability, (4) solar radiation, and (5) the degree and type of disturbance in the area. A new power plant could affect the vegetation communities by eliminating them or by altering one or more of these five factors, which could weaken the communities (for example, by shading them or by redirecting runoff away so that a vegetative community receives less water.)

Removing or weakening the vegetation on a power plant site could have an effect on the vegetation communities in the surrounding landscape. If the affected vegetation is rare, unique or locally important, the loss of its contribution to the seed or gene pool might have an effect on the surrounding vegetation communities. There could be adverse effects on the insects, wildlife or other organisms that depend on the vegetation as a source of food for insects, wildlife, or other organisms. Non-native plant species introduced or promoted by construction disturbance could spread and encroach into other nearby natural plant communities.

Power plants emit air pollutants and water vapor as fog into the atmosphere that could affect the growth and survival of certain vegetation communities. Some pollutants are toxins or promote diseases that damage or kill plants. Conversely, the pollutants could provide nutrients to the plants, like fertilizer from the air. Fog from cooling towers could change the moisture regime so that some plants have a competitive advantage over others from differences in the ability to utilize the moisture or to resist fungal disease.

Vegetation in surface waters could also be affected, or lost, by construction of water intake or discharge facilities, by the removal of water (intake) for power plant processes, or by the nature of waste water discharged by the power plant into the waterbody.

Wildlife

Impacts to vegetation could create a chain of wildlife impacts. Impacts on local or migrating wildlife could occur when their habitat and source of food is removed or damaged. The food source could be the vegetation itself or bugs, animals, birds, or organisms that rely on the vegetation for food. Nesting and den areas would be destroyed.

Construction of a new power plant could displace certain species of wildlife and attract other species. Loss of habitat for prairie or woodland species could occur, and habitat for "edge species" and "generalists" could be created. Edge species and generalists can thrive or survive on the habitat created by the construction disturbance or the new buildings and landscaping. Species that relied specifically on the original natural habitat might not survive or might need to leave the area. Migratory species that depended on the original local habitat for resting, feeding, or reproduction would have to find new places for these activities. Birds could also be killed outright by striking tall power plant structures or new power lines.

Fish, mussels, and other aquatic life in surface water bodies and streams could also be affected by power plant construction or operation, particularly the construction and operation of water intake or discharge facilities, or the dredging of barge unloading areas. Fish and other aquatic organisms could get drawn into water intake systems. Coal pile and coal dust runoff could cause problems if acids and dissolved toxic metals are deposited in surface water. Loss of feeding, resting, or reproductive habitat could harm a river or lake species' ability to survive.

Protected Species

A number of species of plants, birds, mammals, reptiles, insects, crustaceans, and fish are listed with the U.S. Fish and Wildlife Service or the DNR as "endangered" or "threatened" species. These species have small populations that are particularly vulnerable to habitat disturbance or destruction. Species and natural communities listed as endangered and threatened are actively tracked by the DNR

Wisconsin also lists "special concern" species. These are species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this list is to focus attention on certain species before they become threatened or endangered. Most are actively tracked.

If a local population of a listed species would be reduced or lost, that would constitute a "taking" under the law, and the power plant developer would need to abide by the agency's regulatory requirements to avoid or reduce the adverse effects on that species. The power plant developer must consult with DNR Endangered Resources staff as part of its regulatory application development processes, and it must follow DNR direction to:

- Determine if any protected species or species of special concern are present.
- Protect those species during the construction and operation of the power plant.

Historical and Archaeological Sites

Historic buildings, burial grounds, archeological sites, cultural areas, and Native American sacred areas are all considered "historic properties" by the Wisconsin Historical Society (WHS) and are treated as sensitive and vulnerable resources.

Under the national and state Historic Preservation Acts, the federal and state governments try to protect historic and archeological sites, and also identify cultural areas and Native American sacred

places as protected resources. These resources are important and increasingly rare tools for learning about the past. Some also have religious significance. Power plant construction can damage these resources wherever soils are disturbed or where heavy equipment is used, by:

- Digging them out.
- Breaking or crushing them.
- Mixing them in the sub-soil so that the ability to date them is lost.
- Exposing them to erosion or the elements by uprooting trees and clearing the land.
- Making the sites more accessible to vandals.

The WHS has the primary responsibility in Wisconsin for protecting archeological and historic resources. It manages a database that contains records of known "historic properties" in the state. This inventory must be searched for any historic, archeological, or cultural sites that might be affected by a construction project. If any are found, the PSC must consult with the WHS and follow (or have the developer follow) its recommendations to avoid, reduce, or mitigate impacts. Depending on the situation, surveys by qualified archeologists might be required to clarify the location, geographical spread, and significance of the resources. If there is a federal interest in the project, the appropriate federal agency must consult with WHS under the National Historic Preservation Act. This federal law is more stringent and may require field archeological survey work to determine if there are any yet-unknown resources that could be affected.

Sometimes no historic or archeological resources are discovered in the database but an archeological site is encountered during the actual construction. If this happens, the project developer must stop construction at that site and notify the WHS and PSC. Then, the project must follow the WHS recommendations for managing or minimizing the potential impacts to the archeological site.

Community Resources Impacts

Land Use Compatibility

Active or vacant industrial lands are viewed as being more compatible with power plant projects. Urban or suburban residential lands are often seen as less compatible. Beyond these lands are the rural, more open lands like farmland or old abandoned farm fields, which are generally seen as compatible but with a great deal of local impact potential. Local land use regulations and plans can direct developers to locations where a power plant would be more compatible with current and planned land uses. Depending on the type of power plant being planned, the presence of existing natural gas pipelines, railroad lines, electric transmission lines and sufficient water supply are desirable on or adjacent to a proposed power plant site. Local residents should participate in the company's local site search activities, if possible, and in the PSC's application review process to make sure their concerns are considered.

The location of a power plant will have many local community effects that will be of interest or concern. The power plant developers can gather local concerns about a potential power plant by:

- Noting questions raised by local citizens and officials during private discussions and public meetings.
- Receiving input from the public when comments are solicited.
- Examining organized or advertised public support or opposition to use of a particular site.

Some sites, called "brownfield" sites, may be contaminated from earlier industrial or commercial use. If the power plant developer can clean up a site prior to construction and still cost-effectively build the power plant, the community may view this as a benefit even though the site will be used for an industrial facility.

Agriculture

Farmlands, particularly prime farmlands (areas having more fertile soils), are a valuable resource. Construction of power plant facilities on local farmlands would permanently take those fields out of agricultural production and could affect the economic viability of the farm and, indirectly, the local farm community.

Farm fields outside the proposed power plant property could also be affected, at least temporarily, by construction of ancillary facilities like natural gas or water pipelines or electric transmission lines. The PSC brochure, "*Environmental Impacts of Transmission Lines*" describes ways that a transmission line can affect farm fields and fieldwork.

There are other possible agriculture impacts that could occur. The fog or salts from water vapor from cooling towers and air pollutants from an operating power plant stack could be deposited and affect the yield or quality of nearby crops. It is also possible that noise or light from a power plant could disturb farm families or reduce the productivity of local farm animals.

Recreation

Recreational areas are public or private lands that have public use value. They would include parks, hunting grounds, natural areas with trails, and other designated recreational lands. If the existing land use at a proposed power plant site is recreation, the recreational value of the site would be permanently lost or altered by the new power plant. It could also be damaged by noise, blocked views, or other aesthetic impacts that degrade or ruin recreational experience. However, enhanced land management or habitat restoration to promote recreation can be part of an overall power plant site design and management plan and can succeed if done appropriately.

Property Values

The impact of power plant construction and operation on adjacent or nearby property values has been the subject of discussion for many years. The issues include perceived loss of value, stigma of being located near what is usually considered a local undesirable land use, and possible health effects. Few scientific studies have been conducted regarding the potential impact of power plants on adjacent properties' values. Attitudinal survey data often reveals a high percentage of respondents who, if given a choice, would prefer not to live near power plants. However, actual property value is comprised of an often complex set of desirable and undesirable factors, including proximity and quality of schools, the attractiveness of the house and yard, and access to work and to local amenities. The research has not been conclusive because of the difficulty researchers have of accounting for all of the variables. The few studies done to date have not shown a clear, consistent

correlation between power plant location and reduced property values. More research needs to be done to adequately address this issue.

If property values are damaged or disease is elevated by a power plant's operation, there could also be issues of environmental justice. People with lower incomes could trapped in living situations that are at the mercy of the power plant's local impacts.

Future Development

A new power plant can create opportunities for future development in the community. Steam production might provide opportunities for nearby facilities that can use the steam for process work or heat. The ash production can provide a source of construction materials. The presence of a new power plant could provide an anchor for new industrial and nearby commercial development, both visually and as a local employer.

Alternatively, a new power plant might have the effect of slowing or stopping housing development in its vicinity. It also might have a dampening effect on development plans for retail, entertainment, recreation, and restaurants.

Appropriate local zoning and a good comprehensive land use management plan can help a community in directing a power plant developer to a site having the most benefit to the community while minimizing environmental justice impacts or any adverse impacts on future local development.

Air Space

Tall power plant structures such as transmission towers, exhaust stacks, or wind turbines can be potential hazards to aircraft attempting to land or take off. Whether the airport is a public facility or a private landing strip, the safety of the people in the aircraft must be considered. The level of safety can be maintained by building tall power plant structures in locations clear of runway alignments and aircraft approach paths, where planes reduce altitude and turn to approach the runway at a safe height and speed.

Federal guidelines restrict the height of structures near public airports for safety reasons. In order to comply with the government guidelines, the structures' potential for interference must be evaluated by the Federal Aviation Administration (FAA) and Wisconsin Department of Transportation (WisDOT) Bureau of Aeronautics.

In many cases, local municipalities map areas near public airport approaches with height restriction zoning. There may be restrictions on the siting of power plant-related landfills near airports, as well.

Generally, the best way to avoid or reduce potential safety hazards for aircraft would be to locate the power plant facilities a greater distance from existing public airports or private airstrips or in a location offset from runway approach paths. If structures must be located closer, efforts might be made to reduce structure heights, put transmission lines underground, or place lights or other attention-getting devices at appropriate heights on the structures. The presence of a power plant may put new restrictions on where new runways can be located or how airports can expand.

Fog and Ice

Fossil-fueled power plants that use steam to turn the turbines must condense the steam afterward and re-circulate the water back into the system. In Wisconsin, the cooling is generally done using water taken from a local surface water body or stream. The cooling water then absorbs the heat and is either sent right back to the water body or stream in a process called "once through cooling"

(which adds heat to the lake or stream) or is cooled by exposure to the air or additional cold water in "cooling towers."

Cooling towers send warm moist air into the atmosphere, often at the rate of hundreds of thousands of gallons per hour. If the surrounding air is cooler than the emitted air from the cooling towers, a vapor plume appears. Depending on its height, the plume can affect visibility locally and often can be seen from miles away. Plumes are often considered an aesthetic nuisance if they occur frequently or for extended periods and are observed by a large number of people who do not want to them to interfere with views from their homes, commercial establishments, or workplaces.

Under specific meteorological conditions, a cooling tower plume can extend below the height of the cooling towers or actually touch the ground near the power plant. When this happens, ground fog can occur. In agricultural fields, the fog can alter the growing conditions for the crops by cooling the air down over the cropland or depositing calcium salts. If the temperature is cold enough, the ground fog can produce rime ice on ground surfaces, structures and trees. Ryme ice can be attractive to view, but fog and icing on roads can produce traffic hazards.

Noise

Noise from a power plant is of particular concern to nearby residents, medical facilities, schools, daycares, or users of nearby parks or other recreational places. Noise of different frequencies can have different effects. Lower frequencies are often felt as vibration, or have the effects of vibration on structures. Heavy vibration can be annoying to nearby residents or cause damage to structures.

Major power plant operation noise sources for a coal- or biomass-fired power plant, for instance, could include steam generators, steam turbine generators, fuel handling equipment, air compressors, air separators, cooling towers, and rooftop ventilation fans. Fans in the plant without speed controls can produce "tonal" noise, sounds centered on a narrow frequency band. Tonal noise has been shown to affect people more than other noises, especially at lower overall noise levels, and may require special silencer mechanisms. Delivery trains can be particularly noisy, with cars uncoupling and coupling, unloading fuel, and departing. Trucks hauling fuel in or ash out would add to the overall noise levels. Natural gas-fired combined cycle plants generate noise from the turbines, the air intakes, and the cooling towers. Combustion turbine plants generate noise from turbine operation and air handling facilities. Natural gas-fired plants also use diesel fuel as a backup fuel, and the trucks that deliver it would add to the local noise levels.

To discover the noise impact of a power plant, existing noise levels (ambient sound) are measured in different locations onsite and near the site either before a power plant is built or when it is not operating. This sets benchmarks for impact measurements. Measurements are then taken at the same locations with the power plant operating. The difference in sound levels is attributable to the plant.

During construction of the plant, there would be noise from construction equipment. The levels would range from about 70 decibels (dB) for a paving breaker to about 85 dB from large trucks to about 125 dB for air and steam line blow-offs. The distance from the source to the boundary of the power plant property can dissipate some of this noise. There are a few ways to reduce construction noise. Diesel engine mufflers should be kept in good working order. Heavy construction activities could be limited to five days a week (workdays) between 7:00 a.m. and 5:30 p.m. Night construction work could be limited to relatively quiet activities, such as interior work.

Often, local municipalities have ordinances that regulate loud and objectionable noise. Noises can be blocked or muffled by intervening landscape features like trees. Noise will decrease with distance

from the source. If there are no obstructions, the noise from a source decreases by about 6 dB for every doubling of the distance.

Fugitive Dust

Fugitive dust is dust blowing from an industrial site, construction site, or farm fields. The dust becomes a nuisance in nearby neighborhoods, a face and lung irritant, or a visual obstacle in nearby streets.

During construction of a power plant, fugitive dust comes from blowing exposed soil or other particles. Fugitive dust becomes an issue as the land is cleared and graded, and as delivery trucks and other vehicles and equipment travel on dirt or gravel roadways in the construction area. The dust must be suppressed, and this is usually done by spraying unpaved roads with water and stabilizing exposed soil areas.

Coal-fired plants can create a great deal of fugitive dust. Coal dust can be blown onto nearby properties from coal storage piles, coal handling facilities, or empty coal train cars as they leave the plant. There is also a potential for coal ash to blow from trucks taking the ash off the property. Many people living near power plant sites have been concerned about the potential for dust blowing into their yards and making houses, cars, clothes hung outside, and lawn furniture dirty. Dust wetted by rain can release corrosive acids. Car windshields can require cleaning each day before commuters leave their homes. Breathing fugitive dust is also a health concern.

There are other techniques that can be used to reduce fugitive dust at power plants. Compaction of fuel piles by bulldozers and application of a chemical surfactant are often used to form a hard crust on the surface that is resistant to wind. Coal or biomass fuel could be stored inside a building. The fuel handling system could also be enclosed and could include "baghouse" filters to capture dust. Placement of all of these facilities in locations on the power plant property farther from nearby neighborhoods would increase the distance dust had to travel and decrease the chances of it blowing into those neighborhoods. Ash hauled in trucks would need to be covered or treated to make it more solid and less able to be lifted by the wind as the truck moves. Fly ash, the lighter-weight ash captured on its way to the exhaust stack, could leave the property in tanker trucks.

The DNR regulates fugitive dust under its air permitting rules. The DNR also investigates complaints about fugitive dust and is willing to analyze samples of suspected coal dust damage.

Odors and Light

Odors that come from a power plant can be a concern to nearby residents. There is usually a public interest in understanding the cause and strength of any odors and knowing the distance these odors may travel beyond the plant site boundary.

Stray light at night from power plant building lighting, coal pile lighting, stack aircraft warning lights, and other site lighting is very often a concern, particularly for power plants proposed to be located outside urban areas. A power plant's lighting design can ensure that there will be little or no illumination spilling onto adjacent properties. This can be done through the use of low-emission light fixtures, placement of lights only where needed for safety and security, and shielding the fixtures so that they aim the light only at certain areas.

During construction, lights might be needed for long winter workdays or for second shift work. Light might be needed for equipment laydown areas, parking, construction roadways, and work areas used at night. Floodlights might be used, but they should be shielded and directed at the areas that need light and not allowed to spill off-site or shine into the sky.

Aesthetics

Aesthetic impacts are usually viewed in two basic ways. One way is to analyze the actual impacts of a power plant on the local "viewscape". How will the new plant fit into the local scene? Will it look very different or pretty much the same? How might it block or interfere with views that people value in the area? What visual impacts will it create? These impacts can be a result of the size or height of the facility buildings and stacks or the view of the plume from the exhaust stack or cooling towers, which can also create fog in places.

The other way to look at aesthetics is the perception or impression a power plant creates in the minds of individuals. This impression can be affected by plant appearance, sounds, and smells, as well as by the plant's effect on local traffic patterns and traffic congestion, on the night sky, and on the neighborhood and behavior of the residents. The aesthetics of a power plant can also be affected by what local people feel the power plant represents: an important and needed supply of electrical power, a source of hazardous air pollution emissions, a dangerous place of rail cars and other heavy equipment, a sound business that pays its share of state and federal taxes and contributes to the local community, a symbol of runaway rampant corporate control, or a symbol of reliable and effective state regulation.

Construction, while a more temporary aesthetic impact, might hardly be noticed by some people but might appear chaotic to others. There is heavy equipment, noise, engine sound, and unfamiliar lighting patterns. The chaotic appearance is reduced as the plant is being finished and the site cleaned up before plant operation begins.

Local Economic Impacts

A new power plant can provide new jobs and business in the area and bring economic benefit to the community, particularly during construction. The increase in temporary and permanent jobs would result in more money spent locally. The power plant developer may make numerous purchases in the area for materials or services. New homes for permanent power plant workers may be built. The new income to local businesses would lead to more money circulating in the community.

The selling of power plant by-products could provide additional economic benefit. Coal combustion by-products such as ash and sulfur compounds, if properly captured, could be standardized and sold to provide local paving materials, wallboard ingredients, or fertilizer. A "cogeneration" power plant can utilize the steam it produces not only to turn the turbines but also to sell to a nearby business that would use the steam for heating or industrial processes like paper making or vegetable packing. If a new power plant can serve as a new or improved steam supply for a local industry, it could allow that industry to become more energy efficient and reduce its air pollutant emissions. If that industry becomes more profitable as a result, some indirect financial benefits to the local community could occur.

Community Services

Local communities might need to provide services to a proposed power plant, and this could increase local government costs. Community services might include water supplies, water treatment, fire protection, security and policing, emergency medical response, or snow plowing. Indirect costs to a community might include costs for road upgrades or new roads, new sewer or water extensions, increased refuse collection, more school-age children to serve, or more use of local libraries or other services.

Revenue Sharing

Municipalities and counties with power plants receive payments under a shared revenue system. Newly affected cities, villages, towns and counties receive an annual payment based on the plant's power production capacity. These annual payments begin the year after the plant becomes operational and are meant to offset potential additional costs to the municipality or county for hosting a power plant.

Solid Waste Management

The amount and type of wastes from a power plant depend on the type of power plant and the fuel used. Wastes from power plants include sludge, ash and office wastes.

Office wastes would come from any kind of plant. They can often be recycled locally.

Wastes from other industrial processes, like water purification, are often trucked off the property as sludge by contractors. Water purification and other water treatments would be necessary for any plant that produces steam to turn turbines.

There might be certain, site-specific opportunities for the power plant developer to reduce the volume and concentration of liquid or solid wastes produced, or to recycle or reuse those wastes. Potential users of the wastes could include local industries or industries that are willing to locate nearby because of the profitability of the volume of raw materials that the power plant would create. An example might be a wallboard manufacturer that would use gypsum, a by-product of sulfur emissions control at coal-fired power plants.

A coal-fired plant needs a landfill site to meet the ash disposal requirements of the DNR. Some plants may have landfills on-site while others would need an off-site landfill. There could be additional impacts related to siting the landfill including land use restrictions and impacts, stormwater discharges, leachate control, protection of groundwater and surface water. If the landfill is proposed to be located on the power plant property, additional stormwater controls would be necessary to avoid contaminating ground or surface water bodies. If the landfill site is proposed to be located far from the plant, trucking routes and dust control methods might need to be adapted to avoid impacts during hauling. Traffic safety impacts are also discussed below.

Traffic Safety

Construction of a power plant can increase the amount of truck deliveries and workers commuting in the area. The increase in traffic could result in increased congestion and number of traffic accidents.

Sometimes, the deliveries of very large, heavy components on special, multi-axle semi-trailer trucks require special temporary traffic controls or road modifications. Such rigs are needed for large wind turbines and blades as well as for larger components of coal-, biomass-, or natural gas-fired plants. Some components might be delivered by rail. Automobile traffic near affected rail crossings can also experience some delays or routing concerns.

After the plant is constructed and operating, traffic burdens would likely be lessened. There could still be issues related to regular and frequent fuel and supply deliveries by train or trucks, or from trucks hauling ash and other wastes off-site. When coal is delivered by train, it is unloaded car by car, and coal cars might have to be disengaged and then reassembled. If this activity cannot all take place on the power plant site, there could be effects on local traffic due to rail crossing blockages during coal delivery.

As discussed above in the section on fog and icing, a water tower plume that touches ground in cooler weather could create fog and visibility hazards for drivers. If that plume freezes on the road upon contact, traffic hazards would result from slippery conditions.

Electric Transmission or Distribution Changes

Changes in the local electric distribution system might be necessary, leading to additional inconveniences or costs to local distribution utilities. Usually, the distribution utility and the transmission utility, if they are not the same company, work out an equitable cost-sharing arrangement for distribution changes.

Landscape-scale power plants such as wind farms are constructed of very large components using very large cranes. There may be temporary local electric distribution outages or rerouting of local power while distribution lines are taken down to allow a large crane move among turbine sites. There might also be situations where local distribution lines have to be taken down to allow deliveries of large components to a fossil fuel power plant site.

Utility Ratepayer Impacts

Electric Supply Reliability

A new power plant will also require modifications to existing transmission facilities or new transmission line or substation construction to connect the plant to the existing electrical transmission system. These may lead to new land-use restrictions on some properties and rights-of-way. Other transmission upgrades on different lines or substations may be necessary to balance the new power source with the rest of the transmission system. Potential environmental and social concerns about electric transmission construction are discussed in the PSC brochure, **"***Environmental Impacts of Transmission Lines***."**

Rate Impacts

If a public utility builds a power plant, the cost of siting and constructing it would likely be included in the electric rates charged to customers. The estimated cost of the plant is evaluated to determine both the immediate and the long-term effects on customer rates and on the plant's ability to be cost-competitive in the industry. Generally, power plant sites that cost less to build or provide a lower delivered cost of electrical power are more desirable.

If a non-utility company proposes to build a power plant, the Commission may not consider alternative sources of supply or engineering or economic factors related to the company. Such plants are called "merchant" plants. In those cases, the prices charged in power purchase agreements can reflect the investment the company made to build the plant. The charges paid by the receiving distribution utility as part of its power purchase agreement would likely be passed on to its customers.

The Public Service Commission of Wisconsin is an independent state agency that oversees more than 1,100 Wisconsin public utilities that provide natural gas, electricity, heat, steam, water and telecommunication services.

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