ENVIRONMENTAL IMPACT STATEMENT

XCEL ENERGY PRAIRIE ISLAND NUCLEAR GENERATING PLANT

EXTENDED POWER UPRATE PROJECT
PUC DOCKET NO. E002/CN-08-509
PUC DOCKET NO. E002/GS-08-690

REQUEST FOR ADDITIONAL DRY CASK STORAGE
PUC DOCKET NO. E002/CN-08-510

RED WING, MINNESOTA

office of energy security

Prepared by:
STATE OF MINNESOTA
Minnesota Department of Commerce

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March 17, 2009

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ABSTRACT

The Public Utilities Commission (Commission) is considering two projects proposed by Xcel Energy for the Prairie Island Nuclear Generating Plant (PINGP).

The first project is a proposed extended power uprate (EPU) of 164 Mega-Watts (MW); the 164 MW total capacity uprate at the PINGP would be achieved by increasing the heat produced in the reactor and the steam produced in the steam generators.

The second project is a request for additional dry cask storage at the PINGP's independent spent fuel storage installation (ISFSI). The PINGP currently has state authorization for enough dry casks (e.g., 29) to store the spent fuel generated until the end of the current operating licenses in 2013 and 2014; there are currently 24 dry casks at the PINGP ISFSI. In order for the reactors to continue operation through a license renewal period to 2033 and 2034, up to an additional 35 dry casks would need to be added to the existing ISFSI.

This Environmental Impact Statement (EIS) was produced to satisfy the Commission's environmental review requirements for both projects.

Additional Information on this project is available in the project applications listed in the References section of this EIS. Much of the route application material is also available online at http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602.

DRAFT EIS COMMENTS DUE BY MAY 8, 2009

Formal comments on the accuracy and completeness of the Draft EIS will be accepted until May 8, 2009. Written comments should be mailed to Bill Storm (bill.storm@state.mn.us), Minnesota Department of Commerce, 85 7th Place, Suite 500, St. Paul, Minnesota 55101-2198.

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SUMMARY

There are three dockets before the Commission relative to Prairie Island Nuclear Generating Plant (PINGP); each docket requires an environmental review document.

Item	Docket No.	Review Document
CON for the EPU	E002/CN-08-509	Environmental Report
LEPGP Site Permit for the EPU	E002/GS-08-690	Environmental Impact Statement
CON for Additional Dry Casks	E002/CN-08-510	Environmental Impact Statement

CON = Certificate of Need, EPU = Extended Power Uprate, LEPGP = Large Electric Power Generating Plant

The environmental report (ER) requirement of the extended power uprate (EPU) certificate of need (CON) process and the environmental impact statement (EIS) requirement of the site permit process have been combined into a single environmental review document pursuant to Minn. Rule 7849.7100.

In addition, the Office of Energy Security (OES) within the Department of Commerce (Department) in consultation with Commission staff has determined that further process efficiencies can be achieved by incorporating the EIS requirements for the additional dry cask storage CON process with the environmental review requirements for the EPU CON and Site Permit.

Thus, the Office of Energy Security (OES) has prepared one document to fulfill:

- The Uprate CON and site permit environmental review requirements of Minnesota Rule 7849.7030 and 7849.5300, respectively, combined pursuant to 7849.7100.
- The Independent Spent Fuel Storage Installation EIS required pursuant to Minnesota Statute 116C.83, developed in accordance with MS 116D and MR Chapter 4410.

The EIS Scoping Decision, covering the three dockets, was signed by the Director of the OES on November 14, 2009. The following issues were excluded from the Environmental Impact Statement scoping decision:

> **Prairie Island Plant Radiation and Safety.** The EIS will summarize the environmental impacts of continued operation of the PINGP, but will not include a detailed study of these issues because the U. S. Nuclear Regulatory Commission (NRC) will complete a detailed evaluation of environmental impacts, and mitigation options, of continued plant operations during its license renewal review. Likewise, the EIS will summarize but not evaluate potential mitigation methods regarding radiation and safety issues of continued operation of the plant because the NRC has sole regulatory jurisdiction over those issues.

Storage Technology, Accidents, Terrorism. The EIS will summarize but not evaluate options for dry cask storage because the NRC has sole jurisdiction over whether and how spent fuel is stored on site at nuclear power plants, including ISFSI design and safety from threats such as accident and terrorism. Likewise, the EIS will not evaluate life-cycle safety of the Independent Spent Fuel Storage Installation (ISFSI), ISFSI management, or the adequacy of security at the generating plant or the proposed ISFSI.

Nuclear Fuel Cycle. The EIS will not address in detail, the impacts of the nuclear fuel cycle because that issue will be addressed in the federal generic and supplemental EIS to be completed during the federal re-licensing review.

Off-Site Alternatives. The EIS will not evaluate ISFSI sites outside the PINGP boundaries because the NRC has jurisdiction over whether such a site can be considered. Additionally, the Commission's authority is "limited to the storage of spent nuclear fuel generated by a Minnesota nuclear generation facility and stored on the site of that facility" (MS 116C.83, subdivision 4, item b).

Economic Feasibility of Alternatives. The analysis of the economic feasibility will cover the same alternatives for which environmental impacts are evaluated, but will incorporate by reference the analysis of the Department of Commerce in the CON proceeding.

Transportation of Spent Fuel from PINGP. While certain matters regarding Yucca Mountain will be described in the EIS, the EIS will not include a detailed discussion of issues related to the transportation of spent nuclear fuel from Minnesota to Yucca Mountain.

Nuclear Regulatory Commission Standards. While the EIS will reference certain standards and rules promulgated by the NRC, the EIS will not address the adequacy of any federal standards that are applicable to the ISFSI or the generating plant. Nor will the EIS evaluate potential mitigation measures to reduce radiation exposure, accident risks or security requirements.

This single EIS contains two separate chapters; Chapter 1, covers the extended power uprate CON and Site Permit information; Chapter 2 covers the requirements of the CON for the request for Additional Dry Cask Storage. Each chapter will be evaluated for adequacy by its respective reviewing body (Chapter 1 containing the MR 7849 EIS by the Commission, while Chapter 2 containing the MR 4410 EIS by the OES).

Summary Chapter 1 - Extended Power Uprate

The 164 MW total capacity uprate at the PINGP would be achieved by (1) increasing the heat produced in the reactor and steam produced in the steam generators and (2) improving the balance-of-plant equipment that converts the steam into electricity.

Higher steam flow from the reactors is obtained by operating the reactors at a higher thermal power level. Increasing the thermal output of the reactors requires more uranium in the reactor core to maintain the same fuel cycle length (e.g. 18 - 20 months). This would be accomplished by using a fuel assembly that has slightly larger diameter fuel pellets. These larger fuel rods would also have more surface area for heat transfer offsetting some of the higher operating temperatures.

The EPU will require approval from both the state (Certificate of Need and Site Permit) and federal (NRC approval to increase PINGP's maximum power level and NRC approval to increase the diameter of the fuel rods) authorities.

Section 3 contains an analysis of the feasibility of alternatives to the EPU; options covered include (1) the no build alternative, (2) demand side management, (3) purchase power, (4) alternative fuels (fossil fuel technologies, renewable resources, and developing technologies), (5) up-grading existing facilities, (6) new transmission, (7) distributed generation, and (8) wind/gas combination.

Alternatives were evaluated based on Xcel Energy's stated need for 164 MW of baseload power with an availability date of 2010; the reliability, applicability, cost and environmental impacts of selected alternatives were compared. The proposed PINGP EPU project was found to be the most cost effective and was shown to have the least environmental impacts of those alternatives that could meet the stated need criteria.

Section 4 focuses on the additional impacts to human health and environmental welfare that would result if the 164 MW uprate were to be implemented. The proposed power uprate project will have minimal environmental impacts. Environmental impacts of the power uprate will include (1) an increase in water use by up to 10 percent, remaining within the bounds of current appropriation permit levels, (2) an increase in circulating water outfall temperature of a maximum 3^{o} F, remaining within the limits of current National Pollution Discharge Elimination System (NPDES) discharge permit, and (3) an increase in gaseous radionuclide emissions of not more than 10 percent, remaining well below current limits.

Summary Chapter 2 Additional Dry Cask Storage.

Xcel Energy proposes to extend the concrete storage pad within the existing Prairie Island ISFSI to accommodate an additional 35 dry storage casks of spent nuclear fuel. The ISFSI currently has state authorization for 29 casks. The ISFSI expansion will allow the PINGP to operate through 2034. Xcel Energy proposes using an enhanced version of the current Transnuclear Inc. dry storage casks used at the PINGP for the expansion, the TN-40HT cask. The ISFSI is designed to accommodate, with expansion of the storage pad, the storage casks necessary for operation of the PINGP though 2034 and decommissioning of the Prairie Island plant. Section 3 of this chapter provides further information on the proposed project.

The request for Additional Dry Cask Storage will require approval from both the State (Certificate of Need) and federal (NRC) governments. The NRC regulates nuclear generating plants and spent fuel storage facilities (ISFSIs) to ensure that they are safely operated. Federal regulation preempts state regulation with respect to radiological, engineering, health, and safety standards. The State of Minnesota, however, decides as an economic and policy matter whether it is in the public interest to allow additional storage of spent nuclear fuel at the Prairie Island ISFSI in order to allow the PINGP to continue operating until 2034. Section 2 of this chapter outlines the regulatory framework governing the Prairie Island ISFSI.

Section 4 discusses the non-radiological impacts that expansion of the Prairie Island ISFSI could have on humans and the environment; since this project takes place within the existing footprint of the secured ISFSI no permanent non-radiological impacts are anticipated. There will be minor impacts, such as increased noise and traffic, associated with the construction phase of the project.

Section 5 discusses the radiological impacts that expansion of the ISFSI could have on humans and the environment. Radiation doses to the general public from ISFSI operations result from skyshine radiation. Shielding on the storage casks themselves reduces radiation doses, as does the earthen berm surrounding the ISFSI. The casks and berm greatly minimize direct radiation to the public, leaving skyshine radiation as the primary means of exposure.

Estimated annual dose to the nearest residence with 64 casks on the ISFSI pad was calculated; the estimated dose is within NRC regulatory limits for radiation exposure to the general public from ISFSI operations. This section also includes a discussion on impacts from potential incidents at the ISFSI.

Section 6 discusses alternatives for storing spent nuclear fuel generated by the PINGP through 2034; these include Off-site Storage (reprocessing, private facilities, and the Federal Geologic Repository), On-site Storage (consolidation, re-racking of the pool storage and construction of new pool storage), Alternative Storage Systems (non-canister, horizontal canister, vertical canister, and modular vault dry storage), and the No ISFSI Expansion Alternative.

None of the off-site storage options offers a feasible alternative to expansion of the Prairie Island ISFSI. None of the on-site options appear to be a more reasonable alternative than the proposed ISFSI expansion. The potential human and environmental impacts of ceasing PINGP operations in 2014 and decommissioning the plant are discussed in Section 6 of this chapter.

Section 7 of this chapter discusses alternative methods of generating the 1,100 MW currently produced by the PINGP and the human and environmental impacts of these alternatives. Alternatives were evaluated based on replacing 1,100 MW of baseload power with an availability date of 2014; the reliability, applicability, cost and environmental impacts of selected alternatives were compared.

Six alternative scenarios to continued operation of the PINGP were evaluated: (1) Purchased power, (2) Pulverized coal power plant, (3) Pulverized coal power plant with partial carbon sequestration, (4) Natural gas combined cycle plant, (5) Large wind energy conversion system and natural gas plant combination, and (6) Renewable resource technologies.

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CHAPTER 1

ENVIRONMENTAL IMPACT STATEMENT

Xcel Energy Prairie Island Nuclear Generating Plant
Extended Power Uprate Project

PUC Docket No. E002/CN-08-509
PUC Docket No. E002/GS-08-690

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1.0 INTRODUCTION

Xcel Energy filed two applications with the Public Utilities Commission (Commission) relative to the proposed extended power uprate (EPU) for the Prairie Island Nuclear Generating Plant (PINGP).

The Certificate of Need (CON) application was filed on February 14, 2008, in accordance with Minnesota Rules Chapter 7829 and 7849. On April 10, 2008, the Commission accepted the application as complete (April 18, 2008 order). The docket number for the EPU certificate of need is E002/CN-08-509.

On August 1, 2008, Xcel Energy submitted a large electric power generating plant (LEPGP) Site Permit application to the Commission for the proposed EPU project. On August 14, 2008, the Commission accepted the application as complete (August 18, 2008 Order). The docket number for the LEPGP Site Permit is E002/CN-08-690.

Chapter 1, Section 1 provides specific information about the proposed extended power uprate. Section 2 provides information on the regulatory process for both the Certificate of Need and the Site Permit processes. Section 3 describes and analyzes the alternatives to the proposed EPU project that attempt to reduce, mitigate or eliminate the need for the project. Section 4 addresses the human and environmental impacts and mitigative measures that can be implemented; this section also describes the environmental setting of the PINGP. Section 5 summarizes the unavoidable impacts that would result from the development of the proposed project.

1.1 PROJECT DESCRIPTION

The PINGP utilizes a pressurized-water reactor (PWR). The PINGP consists of two 575 MWe gross (550 MWe net), two-loop, pressurized-water nuclear reactors. The reactors are referred to as Unit 1 and Unit 2. The 560-acre plant site and the associated transmission and other facilities are in Red Wing, Minnesota, on the western bank of the Mississippi River in Goodhue County. The site is approximately 30 miles southeast of St. Paul.

Unit 1 began commercial operation in December 1973, and Unit 2 began operations in December 1974. The initial NRC license for each unit was for a period of 40 years. The initial license will expire in 2013 and 2014 for Unit 1 and Unit 2, respectively. Xcel Energy submitted an application to the NRC for an additional 20-year license extension for both units on April 15, 2008.

Over the past five years (2003 through 2007), Prairie Island has maintained an average capacity factor of 90.2 percent. In 2007, Prairie Island generated a record almost 9 million megawatt-hours of electricity, eclipsing its prior record set in 2003. For 2007, the capacity factor for the entire year was 93.85 percent.

The proposed EPU of 164 MWe consists of an 82 MWe net capacity uprate at Unit 1 and an 82 MWe net uprate at Unit 2. Xcel Energy proposes to complete the uprate on Unit 1 during the 2012 refueling outage and on Unit 2 during the 2015 refueling outage.

Power uprates in a pressurized water reactor (PWR) do not require significant modifications to the reactor, nuclear steam supply system, or emergency core cooling systems. The 164 MWe total capacity uprate at the PINGP would be achieved by:

1. Increasing the heat produced in the reactor and steam produced in the steam generators and;
2. Improving the balance-of-plant equipment that converts the steam into electricity.

Higher steam flow from the reactors is obtained by operating the reactors at a higher thermal power level. Increasing the thermal output of the reactors would require more uranium in the reactor core to maintain the same fuel cycle length (e.g. 18 to 20 months). This would be accomplished by using a fuel assembly that has slightly larger diameter fuel pellets. These larger fuel rods would also have more surface area for heat transfer offsetting some of the higher operating temperatures. To transfer the additional heat energy out of the fuel, the fuel assemblies themselves would operate at slightly higher temperatures. The NRC must approve the new fuel design prior to its use in the PINGP.

In addition to the increased heat output, the EPU would require steam turbine replacements and a variety of other balance-of-plant improvements to take advantage of the increased steam production.
The major modifications that would be completed during the two outages are:

- Upgrade high-pressure turbines;
- Replace or rewind main generators;
- Replace generator step-up transformers;
- Replace moisture separator reheaters; and
- Upgrade isophase bus duct cooling.

Although few modifications are required for the reactor and its support systems, the reactor and support systems have been reanalyzed by Xcel Energy to demonstrate that their functions are unaffected by operation at power uprate conditions, with adequate margin remaining.

The PINGP is located within the city limits of Red Wingo, Minnesota, in Goodhue County, on the western bank of the Mississippi River, in Section 4 and 5, T–113N, R–15W, at 44° 37.3’ N latitude and 92° 37.9’ W longitude, approximately 30 miles southeast of Minneapolis/St. Paul (**Figure 1-1**).

The plant site consists of approximately 560 acres of land owned by Xcel Energy. A perimeter fence and other barriers restrict access to the PINGP. **Figure 1-2** shows the plant site boundaries.

1.1.1 DESCRIPTION of POWER GENERATING EQUIPMENT and PROCESSES

In a pressurized-water reactor (PWR), a nuclear reaction in the reactor core generates heat, which heats water in the primary loop. This heat is transferred to the secondary loop in the steam generators, and the steam produced inside the steam generators is directed to turbine generators to produce electrical power (**Figure 1-3**). The exhaust steam is cooled by a tertiary loop in a condenser and returned to the steam generators to be boiled again. The water in all three loops is force-circulated by electrically powered pumps. Emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators.

The nuclear fuel used at the PINGP has, to date, been fabricated by the Westinghouse and Exxon companies. The new fuel is transported to Prairie Island by truck. Westinghouse was the original plant designer and has supplied the PINGP with most of its fuel and is anticipated to be the future fuel supplier.

The reactor core of each unit is comprised of 121 fuel assemblies. A fuel assembly consists of 179 fuel rods spaced in a 14x14 square array secured by means of stainless steel upper and lower tie plates. Control rod guide tubes occupy sixteen locations of the array and an instrument tube occupies one location. Each fuel assembly is 7.76 by 7.76 inches wide and 161.3 inches long. **Figure 1-4** shows a representation of a typical fuel assembly used at the PINGP.

Each fuel rod within the assembly consists of high-density ceramic uranium dioxide fuel pellets, each about the size of a thimble, stacked in a tube made of a special alloy of steel called Zircaloy. The air in the filled tube is evacuated, helium (an inert gas) is backfilled, and welding Zircaloy plugs in each end seals the fuel rod.

Approximately every 18 to 20 months, a unit is shut down to refuel the reactor. Between refueling outages the unit typically operates at full output around the clock. During each refueling operation under current power levels, a little more than a third of the fuel assemblies (typically 48), in the reactor are replaced with new ones. Thus, a typical nuclear fuel assembly provides heat constantly over about a five-year period before its output declines to the point it is no longer useful. These spent nuclear fuel assemblies are then removed from the reactor and stored in the spent fuel pool.

The spent fuel pool provides storage for spent fuel assemblies. The pool is located within the fuel pool enclosure in the auxiliary building. It is filled with storage racks that hold the spent fuel assemblies and other irradiated reactor components. The spent fuel pool and spent fuel inventory are discussed in Chapter 1, Section 3.3.

1.1.2 DESCRIPTION of PROPOSED POWER UPRATE and PLANT MODIFICATIONS

The EPU at the PINGP will be achieved by increasing the amount of heat produced in the reactor, which will result in more steam being produced by the steam generators. The increased power levels are achieved by loading more uranium into the reactor at the beginning of each fuel cycle. In order to transfer the additional heat energy out of the fuel, the fuel assemblies themselves will operate at slightly higher temperatures.

The increased reactor coolant temperature results in the need to perform several analyses to demonstrate continued compliance with the design criteria for safe operation. The analyses must demonstrate that adequate margin to regulatory limits are maintained at the increased power level. These analyses will be reviewed and approved by the NRC as part of the operating license amendment process.

A PWR consists of two separate loops of water to produce steam; the primary loop, also known as the Reactor Coolant System (RCS), carries high-pressure water, moved by two large reactor coolant pumps, from the reactor to the steam generators where the heat generated by fission in the nuclear fuel is transferred to a second loop of water. The high pressure in the RCS ensures that boiling does not occur in the primary system. The steam generators, which are essentially heat exchangers, transfer the heat through the walls of a series of tubes to heat the water in the secondary system, which operates at a lower pressure. The heat transferred to the secondary loop causes boiling to occur in the secondary side of the steam generators, and the steam produced is sent to the steam turbine, which converts the energy into electricity in the turbine generator. The main steam pressure in the secondary loop will be increased resulting in a corresponding increase in steam temperature.

The balance-of-plant systems that convert the steam produced in the steam generators to electricity will need significant modifications. These modifications are anticipated to be completed on Unit 1 during the 2012 refueling outage and on Unit 2 during the 2015 refueling outage.

The current average annual heat rates for the PINGP units are 10.46 mbtu/MWh on Unit 1 and 10.476 mbtu/MWh on Unit 2. The anticipated average annual heat rate for both units following completion of power uprate is 9.936 mbtu/MWh (after steam generator replacement and power uprate).

Increasing the thermal output of the reactors will require more uranium in the reactor core to maintain the same fuel cycle length (eighteen to twenty months). This will be accomplished by using a fuel assembly that has slightly larger diameter fuel pellets. These larger fuel rods will also have more surface area for heat transfer offsetting some of the higher operating temperatures. Approval for the new fuel design will be sought from the NRC prior to use in the PINGP reactors.

Very few modifications are required to the reactor and its support systems that produce steam. However, significant changes will be required to the systems that convert the steam produced in the steam generators to electricity. The modifications would be installed primarily during refueling outages. The major modifications are described below. Additional smaller scope modifications will be identified during the detailed engineering phase of the project.

In the secondary loop and electrical generation systems, several major equipment changes will be required, both to accommodate the additional steam and feedwater flows, and to handle the extra megawatt output. In making the required changes, features have been incorporated to optimize thermal cycle efficiency under the new steam conditions and therefore maximize gross megawatt output.

High Pressure Turbines. The high-pressure turbine for each unit will require to be upgraded. The existing high-pressure turbines are double-flow, partial arc admission, reaction bladed design, that have been in service since plant commissioning. One design under consideration is a full arc admission, single-flow, impulse bladed, balancing gland design. A single-flow turbine has 2 exhausts versus 4 in the existing turbine, so a portion of the exhaust piping below the turbine would be replaced to work with the new configuration. The turbine governor valves would be redesigned and the flow area through the valve throats increased to minimize the pressure drop imposed on the steam

Main Generator Rewinds. Currently, Xcel Energy is evaluating both generator rewinds and retrofits. A retrofit could include replacement of all of the stator conductors with water-cooled windings.

Generator Step-up Transformers. The generator step-up transformers are reaching the end of their useful lives, and are underrated for the EPU conditions. When they are replaced, Xcel Energy will add the necessary capacity if the EPU is approved.

Moisture Separator Reheaters. The moisture separator reheaters ("MSRs") at PINGP function to improve the steam quality of the high pressure turbine exhaust and superheat the steam before it enters the low-pressure turbines. Replacing the MSRs with larger units with more flow area and heat transfer surface could reduce the pressure drop by 1/2. This would result in higher pressures to the inlet of the low pressure turbines, and a corresponding increase in electrical generation.

Upgrade Isophase Bus Duct Cooling. The isophase bus conducts the electrical output of the main generator to the main transformer. Heat loads in the isophase bus duct will increase with the higher power levels that result from the EPU, resulting in a need to increase the cooling capability of the isophase bus ducts.

1.1.3 SPENT FUEL PRODUCTION

Yucca Mountain Repository

The Yucca Mountain Repository is the proposed United States Department of Energy deep geological repository storage facility for spent nuclear reactor fuel and other radioactive waste.

Yucca Mountain is located in a remote desert on federally protected land within the secure boundaries of the Nevada Test Site in Nye County, Nevada. It is approximately 90 miles northwest of Las Vegas, Nevada.

The NRC is the licensing and regulatory agency that will make the final decision on whether the DOE is allowed to proceed with construction and subsequent licensing to operate the repository.[1]

See Chapter 2, Section 6.1 for more discussion on Yucca Mountain.

National Transportation Plan

In January, 2009, the Department of Energy (DOE), Office of Civilian Radioactive Waste Management (OCRWM) released the National Transportation Plan.[2] The plan outlines the DOE's current strategy and planning for developing and implementing the transportation system required to transport spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from where the material is generated or stored to the proposed repository at Yucca Mountain, Nevada.

The plan describes how DOE's OCRWM intends to develop and implement a safe, secure and efficient transportation system and how stakeholder collaboration will contribute to the development of that transportation system.

1.1.4 FUEL SUPPLY

Availability of uranium to support the continued operation of the PINGP with power uprate is not an issue. The Organization for Economic Cooperation and Development (OECD) and the International Atomic Energy Agency (IAEA) in 2005 jointly produced a report on uranium resources.[3] The report states that uranium resources are adequate to meet the needs of both existing as well as new reactors anticipated in the next decade. The agencies base their conclusion on official projections from 43 uranium-producing countries, as well as independent studies by the agencies.

There are a series of steps involved in supplying fuel for nuclear power reactors. This "nuclear chain" typically includes the following stages:[4]

Uranium recovery. Recovery of the uranium includes the extraction (mining) of the uranium ore and the concentrating (milling) of the ore to produce "yellow cake." Yellowcake is the product of the uranium extraction (milling) process; early production methods resulted in a bright yellow compound, hence the name yellowcake.

[1] http://www.ocrwm.doe.gov/ym_repository/index.shtml
[2] National Transportation Plan, DOE/RW-0603. Office of Civilian Radioactive Waste Management. January 2009.
[3] http://www.nea.fr/html/general/press/2006/2006-02.html
[4] http://www.nrc.gov/materials.html

Conversion. After the yellowcake is produced at the mill, the next step is conversion into pure uranium hexafluoride (UF6) gas suitable for use in enrichment operations. During this conversion, impurities are removed and the uranium is combined with fluorine to create the UF6 gas. The UF6 is then pressurized and cooled to a liquid. In its liquid state it is drained into 14-ton cylinders where it solidifies after cooling for approximately five days. The UF6 cylinder, in the solid form, is then shipped to an enrichment plant. UF6 is the only uranium compound that exists as a gas at a suitable temperature.

One conversion plant is operating in the United States: Honeywell International Inc. (NRC Docket No. 40-3392) in Metropolis, Illinois. Canada, France, United Kingdom, China, and Russia also have conversion plants.

As with mining and milling, the primary risks associated with conversion are chemical and radiological. Strong acids and alkalis are used in the conversion process, which involves converting the yellowcake (uranium oxide) powder to very soluble forms, leading to possible inhalation of uranium. In addition, conversion produces extremely corrosive chemicals that could cause fire and explosion hazards.

Enrichment. Enriching uranium increases the amount of "middle-weight" and “light-weight” uranium atoms. Not all uranium atoms are the same. When uranium is mined, it consists of heavy-weight atoms (about 99.3% of the mass), middle-weight atoms (0.7%), and light-weight atoms (< 0.01%). These are the different isotopes of uranium, which means that while they all contain 92 protons in the atom’s center (which is what makes it uranium). The heavy-weight atoms contain 146 neutrons, the middle-weight contains 143 neutrons, and the light-weight has just 142 neutrons. To refer to these isotopes, scientists add the number of protons and neutrons and put the total after the name: uranium-234 or U-234, uranium-235 or U-235, and uranium-238 or U-238.

The fuel for nuclear reactors has to have a higher concentration of U-235 than exists in natural uranium ore. This is because U-235 is the key ingredient that starts a nuclear reaction and keeps it going. Normally, the amount of the U-235 isotope is enriched from 0.7% of the uranium mass to about 5%. Gaseous diffusion is the only process being used in the United States to commercially enrich uranium. Gas centrifuges can also be used to enrich uranium.

The primary hazards in gaseous diffusion plants include the chemical and radiological hazard of a UF6 release and the potential for mishandling the enriched uranium, which could create a criticality accident (inadvertent nuclear chain reaction).

The only gaseous diffusion plant in operation in the United States is in Paducah, Kentucky. A similar plant is near in Piketon, Ohio, but it was shut down in March 2001. Both plants are leased by the United States Enrichment Corporation (USEC) from the Department of Energy and have been regulated by the NRC since March 4, 1997.

Fuel Fabrication. Fuel fabrication facilities convert enriched UF6 into fuel for nuclear reactors. Fabrication also can involve mixed oxide (MOX) fuel, which is a combination of uranium and plutonium components. NRC regulates several different types of nuclear fuel fabrication operations.

Fuel fabrication for light (regular) water power reactors (LWR) typically begins with receipt of low-enriched uranium (LEU) hexafluoride (UF6) from an enrichment plant. The UF6, in solid form in containers, is heated to gaseous form, and the UF6 gas is chemically processed to form LEU uranium dioxide (UO_2) powder. This powder is then pressed into pellets, sintered into ceramic form, loaded into Zircaloy tubes, and constructed into fuel assemblies. Depending on the type of light water reactor, a fuel assembly may contain up to 264 fuel rods and have dimensions of 5 to 9 inches square by about 12 feet long.

Chemical, radiological, and criticality hazards at fuel fabrication facilities are similar to hazards at enrichment plants. Most at risk from these hazards are the plant workers.

Spent Fuel. There are two acceptable storage methods for spent fuel after it is removed from the reactor core:

> Spent Fuel Pools - Currently, most spent nuclear fuel is stored in specially designed pools at individual reactor sites around the country. The water-pool option involves storing spent fuel rods under at least 20 feet of water, which provides adequate shielding from the radiation for anyone near the pool. The rods are moved into the water pools from the reactor along the bottom of water canals, so that the spent fuel is always shielded to protect workers.
>
> About one-fourth to one-third of the total fuel load from the pools is spent and removed from the reactor every 12 to 18 months and replaced with fresh fuel.
>
> Current regulations permit re-racking of the spent fuel pool grid and fuel rod consolidation, subject to NRC review and approval, to increase the amount of spent fuel that can be stored in the pool. Both of these methods are constrained by the size of the pool.
>
> Dry Cask Storage - If pool capacity is reached, licensees may move toward use of above-ground dry storage casks. In the late 1970s and early 1980s, the need for alternative storage began to grow when pools at many nuclear reactors began to fill up with stored spent fuel. Utilities began looking at options such as dry cask storage for increasing spent fuel storage capacity.
>
> Dry cask storage allows spent fuel that has already been cooled in the spent fuel pool for at least one year to be surrounded by inert gas inside a container called a cask. The casks are typically steel cylinders that are either welded or bolted closed. The steel cylinder

provides a leak-tight containment of the spent fuel. Each cylinder is surrounded by additional steel, concrete, or other material to provide radiation shielding to workers and members of the public. Some of the cask designs can be used for both storage and transportation.

There are various dry storage cask system designs. With some designs, the steel cylinders containing the fuel are placed vertically in a concrete vault; other designs orient the cylinders horizontally. The concrete vaults provide the radiation shielding. Other cask designs orient the steel cylinder vertically on a concrete pad at a dry cask storage site and use both metal and concrete outer cylinders for radiation shielding.

The first dry storage installation was licensed by the NRC in 1986 at the Surry Nuclear Power Plant in Virginia. Spent fuel is currently stored in dry cask systems at a growing number of power plant sites, and at an interim facility located at the Idaho National Environmental and Engineering Laboratory near Idaho Falls, Idaho.

Neither a reprocessing facility nor a Federal waste repository is currently approved (licensed) in the United States, and spent fuel is in interim storage.

1.1.5 WATER USE

Groundwater use is governed by water appropriation limits of the Minnesota Department of Natural Resources (MDNR). The PINGP uses ground water for potable and industrial use from six wells installed within the alluvial aquifer located on the plant property. Five of these wells are permitted by the MDNR. The sixth well does not require a water appropriation permit because it is below the minimum flow requirements of 10,000 gallons per day or 1,000,000 gallons per year set by MDNR.

Although the maximum combined pumping rate equals approximately 850 gallons per minute (gpm), ground water appropriation permit numbers 69-171-G, 78-5153, 86-5114, and 96402, limit the usage to a total of 354.7 million gallons per year for the five wells. Over a recent period of five years (2003 through 2007), the maximum usage was 61.6 million gallons in 2005 (**Table 1-1**)

Surface water use at the PINGP is in accordance with the water appropriation limits of the MDNR. Under surface water appropriation permit number 69-0172, amended in June 1995, PINGP draws water from the Mississippi River for plant condenser cooling and auxiliary water systems, such as service water cooling, intake screen wash, and fire protection. The PINGP may withdraw up to 235,000 million gallons of water per year from the Mississippi River. Over a period of five recent years (2001 through 2005), a maximum of 207,650 million gallons of water was withdrawn, occurring during the year 2005.

The plant's cooling system was heavily modified in the early 1980s to reduce impacts of plant operation on aquatic communities. A new intake screen-house with improved traveling screens was constructed across the mouth of intake canal. A fish return line was installed to convey organisms washed from the traveling screens back to the Mississippi River. A new, half-mile-long discharge canal with a north-south orientation was created by building a 2,350-foot-long dike that paralleled the river shoreline. A new discharge structure was built at the southern terminus of the canal, and connected to the river's edge by four underground discharge pipes. The new submerged jet discharge was intended to promote rapid mixing of the heated effluent, keep fish out of the discharge canal, and prevent recycling of warm discharge water. The intake and discharge modifications were completed in 1983.

The circulating water system removes heat for the generating plant. Excess heat from the steam leaving the turbine is transferred to circulating water flowing through the condenser tubes. Based on seasonal limitations heat is transferred to the environment either by the use of the cooling towers, discharge to the river or a combination of cooling towers and river discharge. Operating restrictions are governed by the National Pollutant Discharge Elimination System (NPDES).

A detailed description of the circulating water system and various modes of operation are contained in Sections 8.2.4.3 and 8.2.4.4, of the Xcel Energy Certificate of Need Application, dated May 16, 2008.

The average annual river water withdrawal for years 2000-2005 was 849 cfs (614,880 acre-ft/yr). The estimated average annual water loss due to evaporation and drift is approximately 39 cfs (28,245 acre-ft/yr) with 810 cfs being returned to the river.

1.1.6 WASTEWATER

Wastewater discharges are regulated by the State of Minnesota through the NPDES permit. The NPDES permit is periodically reviewed and re-issued by the Minnesota Pollution Control Agency (MPCA). The NPDES permit for the PINGP (MN0004006) was issued on June 30, 2006 and expires on August 31, 2010. The NPDES permit authorizes discharges and intakes and imposes limits and/or monitoring/reporting requirements for the discharges listed in **Tables 1-2 and 1-3**.

Thermal limits in the current permit (issued on June 30, 2006) are keyed to temperatures in the Mississippi River up-and downstream of the plant, which are referred to in the permit as spring and fall "trigger points." From April 1 through the fall "trigger point" (when daily average upstream river temperature falls below 43° F for five consecutive days) the PINGP is required to operate cooling towers in such a way that the discharge temperature requirements are such that the river downstream of the plant shall not exceed a daily average of 86° F.

Additionally, the water temperature below Lock and Dam 3 (Outfall SD 001) shall not be raised by more than 5 degrees above ambient (upstream) temperature.

Also, if ambient (upstream) temperature reaches or exceed 78° F for two days, the PINGP is required to operate the cooling towers "to the maximum extent practicable" (NPDES Permit No. MN0004006), meaning two cooling tower per operating unit.

In addition, PINGP operating procedure has administrative targets for canal discharge temperature of 95° F in summer and 85° F in winter.

1.1.7 SOLID AND HAZARDOUS WASTE GENERATION

Construction activities associated with the EPU will generate non-radioactive solid wastes. The volume will be comparable to the waste generated during a typical refueling/maintenance outage. No ongoing solid waste generation will be generated due to the EPU after construction activities have been completed.

A Hazardous Waste Generator License Application is one of many reporting tools used by the Minnesota Pollution Control Agency (MPCA) to evaluate hazardous waste compliance. Hazardous Waste generators must submit an annual license application itemizing the hazardous waste generated the previous year. The PINGP does hold a hazardous waste generator's license from the MPCA; the generator ID number is MND049537780. The electronic database displays data submitted to the MPCA by individual generators.[5]

No changes to the MPCA hazardous waste generators license are required due to the EPU.

Radioactive Solid Wastes
See Section 4.13 for a discussion on radioactive solid waste generation, handling and disposal.

Radioactive Liquid Wastes
See Section 4.13 for a discussion on radioactive liquid waste generation, handling and disposal.

1.1.8 ELECTRICAL INTERCONNECTION

The Midwest Independent System Operator (MISO) has not yet definitively determined whether the transmission system will need to be upgraded to support the EPU. However, preliminary studies have indicated that the steady state power flow is supported satisfactorily by the existing system, even taking into account additional generation in the MISO queue. Dynamic stability studies have not been completed to date.

1.1.9 OPERATION AND MAINTENANCE

The operation of the PINGP will not change due to the power uprate. However, one of the changes will be an increase in the cooling needs of the circulating water system. This may result in more frequent operation of the cooling towers to supplement the Mississippi River cooling

[5] http://www.pca.state.mn.us/waste/hazardousReport.cfm

capacity over the course of a year. If extreme conditions warrant, the facility will reduce power to remain within the constraints of existing permits.
During each refueling outage under current power levels, a little more than a third of the 121 total fuel assemblies (typically 48), in a reactor are replaced with new ones. As a result of utilizing the larger diameter fuel rods, the number of fuel assemblies replaced each refueling outage is not expected to change under power uprate conditions.

The service life of the extra capacity will be until 2033 for Unit 1 and 2034 for Unit 2, assuming the necessary federal and state regulatory approvals are granted.

This capacity should be available 24 hours a day 7 days a week other than during refueling outages, which nominally will occur every 18 to 20 months for duration of approximately 1 month. Assuming a 3 percent forced outage rate annually this translates into availability factor of 92.4 percent for this capacity (**Table 1-4**).

1.2 PURPOSE AND NEED

The stated purpose of the EPU at the PINGP is to meet the growing energy demands of Xcel Energy and its customers. In Xcel Energy's 2004 Resource Plan, the Commission approved its request to pursue a package of uprates – including the PINGP EPU project – as part of an effort to meet the identified base load need (energy and capacity).

Following the passage of major energy initiatives in the 2007 legislative session, the Commission granted Xcel Energy's request to defer implementation of the PINGP EPU project pending a reevaluation of future needs.

In Xcel Energy's Resource Plan filed December 14, 2007, which included compliance with the aggressive new Renewable Energy Standard and DSM initiatives, Xcel Energy's system demand and energy requirements continued to grow at approximately one percent per year, or 133 MW and 556 GWH. By 2012, Xcel Energy puts the deficit at 126 MW, and by 2022, the deficit is expected to grow to over 2,800 MW.

1.3 SOURCES OF INFORMATION

Much of the information contained within this document was provided by the applicant or the applicant's representatives in the form of: (1) the Application for Certificate of Need for the PINGP Uprate Project; (2) the Application for a Site Permit, PINGP Uprate Project; (3) the Application for Certificate of Need for the PINGP Additional Dry Cask Storage; and (4) Correspondence with Xcel Energy. Additional information was obtained through governmental agencies and published data.

Additional sources of information are listed below:

- Minnesota Pollution Control Agency (http://www.pca.state.mn.us/)
- Minnesota Department of Natural Resources (http://www.dnr.state.mn.us/index.html)
- Minnesota Department of Health (http://www.health.state.mn.us/)
- U. S. Environmental Protection Agency (http://www.epa.gov/)
- Electric Power Research Institute (http://www.epri.com/default.asp)
- Nuclear Energy Institute (http://www.nei.org/resourcesandstats/nuclear_statistics/usnuclearpowerplants/)
- United States Nuclear Regulatory Commission, Power Uprates (http://www.nrc.gov/reactors/operating/licensing/power-uprates.html)
- Minnesota Geological Survey (http://www.geo.umn.edu/mgs/)
- Federal Emergency Management Agency (http://www.fema.gov/)
- U. S. Department of Energy, Energy Information Administration (http://eia.doe.gov/)
- Xcel Energy CON Application for the Blue Lake Generating Plant Expansion Project, January 16, 2004.
- Xcel Energy 2007 Minnesota Resource Plan, December 14, 2007 (http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_41994_43524-2835-0_0_0-0,00.html).
- Northern States Power Company, Application for Certificate of Need for Prairie Island Spent Fuel Storage, Docket E-002/CN-91-19. April, 1991.
- Minnesota Department of Commerce, Final Environmental Impact Statement to Establish an Independent Spent Fuel Storage Installation at the Monticello Generating Plant, Docket E-002/CN-05-123. March 20, 2005.
- Applicant's Environmental Report – Operating License Renewal Stage Prairie Island Nuclear Generating Plant Nuclear Management Company, LLC. April 2008. Units 1 and 2 Docket Nos. 50-282 and 50-306 License Nos. DPR-42 and DPR-60
- Cultural Resources Assessment for the Prairie Island Nuclear Generating Plant in Goodhue County, Minnesota. The 106 Group Project No. 07-32. January 2008.

Copies of Xcel Energy's CON and LEPGP Site Permit applications can be viewed and copied at the EFP web site at:

http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602

1.4 HISTORY OF UPRATES

As of January 2008, the NRC has approved 118 uprates, resulting in a gain of approximately 15,600 MWt (megawatts thermal) or 5,263 MWe (megawatts electric) at existing plants. Collectively, these uprates have added generating capacity at existing plants that is equivalent to more than five new reactors.[6]

[6] http://www.nrc.gov/reactors/operating/licensing/power-uprates.html

The design of every U.S. commercial reactor has excess capacity needed to potentially allow for an uprate, which can fall into one of three categories:

- **Measurement uncertainty recapture power uprates** are power increases less than 2 percent of the licensed power level, and are achieved by implementing enhanced techniques for calculating reactor power. This involves the use of state-of-the-art devices to more precisely measure feedwater flow which is used to calculate reactor power. More precise measurements reduce the degree of uncertainty in the power level which is used by analysts to predict the ability of the reactor to be safely shut down under possible accident conditions.
- **Stretch power uprates** are typically between 2 percent and 7 percent, with the actual increase in power depending on a plant design's specific operating margin. Stretch power uprates usually involve changes to instrumentation settings but do not involve major plant modifications.
- **Extended power uprates** are greater than stretch power uprates and have been approved for increases as high as 20 percent. Extended power uprates usually require significant modifications to major pieces of non-nuclear equipment such as high-pressure turbines, condensate pumps and motors, main generators, and/or transformers.

The Xcel Energy's proposed power uprate to the PINGP is an extended power uprate; Xcel Energy intends on filing an amendment to Prairie Island's operating licenses to allow for an increase in the licensed core thermal power level to 1805 MWt with the NRC in 2010.

2.0 REGULATORY FRAMEWORK

In order to increase the generating capacity of the PINGP, Xcel Energy must comply with three principal sets of requirements:

1. A Certificate of Need authorizing the EPU must be obtained from the Commission (Minn. Stat. § 216B.243, Minn. R. Part 7849);
2. A Site Permit authorizing the EPU must be obtained from the Commission (Minn. Stat. § 216E.03); and
3. An operating license amendment from the NRC must be obtained authorizing Prairie Island to operate at the increased thermal power level and generating capacity (10 CFR 50).

2.1 CERTIFCATE OF NEED

Minn. Stat. § 216B.243 requires a Certificate of Need (CON) be obtained before increasing the generating capacity of a plant by 50 MW or more.

Xcel Energy filed an application for a Certificate of Need (CON) with the Commission for the project on May 16, 2008, in accordance with Minnesota Rules Chapters 7829 and 7849. On July 15, 2008, the Commission accepted the application as complete (July 22, 2008 order).

The docket number for the certificate of need is E002/CN-08-509.

Environmental Review
The Department of Commerce Office of Energy Security (OES) prepares an Environmental Report (ER) on proposed large electric power generating plants that come before the Commission for a determination of need (Minn. Rules 7849.7030). The ER must contain information on the human and environmental impacts of the proposed project associated with the size, type, and timing of the project, system configurations, and voltage. The environmental report must also contain information on alternatives to the proposed project and address mitigating measures for anticipated adverse impacts.

Minnesota Rule 7849.7100, Subpart 2, provides that in the event an applicant for a certificate of need for a LEPGP or a HVTL applies to the Commission for a site permit or route permit prior to the time the OES completes the environmental report, the OES may elect to prepare an environmental impact statement (EIS) in lieu of the required environmental report. If combining the processes would delay completion of the environmental review, the applicant and the Commission must agree to the combination.

If the documents are combined, OES includes in the EIS the analysis of alternatives required by part 7849.7060, but is not required to prepare an environmental report under part 7849.7030.

Hearing Process
Minnesota Statutes § 216B.243, Subd. 4 require a public hearing be held for the CON to obtain public comments on the necessity of the project. This subdivision provides that unless the commission determines that a joint hearing on siting and need under this subdivision and section 216E.03, subdivision 6, is not feasible or more efficient, or otherwise not in the public interest, a joint hearing under those subdivisions shall be held.

Final Decision
Once the record is complete, the docket will come before the Commission for the determination of a final decision on the need. If the Commission determines that there is a need for the requested additional power and that increasing the power capacity of an existing nuclear facility is in the best interest of the ratepayers to meet this need, it will issue a certificate of need for that particular size and type of project.

2.2 SITE PERMIT

The proposed EPU of the electrical generating capacity of the PINGP by 164 MW electric falls within the definition of a Large Electric Power Generating Plant (LEPGP) in the Power Plant Siting Act and, thus, requires a Site Permit from the Commission prior to construction (Minnesota Statutes § 216E.03, Subd.1). The Chapter 7849 rules provide for three different procedures for obtaining a site permit: full review, alternative review, and local review.

The proposed PINGP EPU does not qualify for the alternative environmental review process (Minn. Rule 7849.5500); the application is being reviewed under the procedures of the full review process.

LEPGP Site Permit Applications under the full review process must provide specific information about the proposed project, applicant, an alternative site, environmental impacts, and mitigation measures (Minnesota Rule 7849.5220). The Commission may accept an application as complete, reject an application and require additional information to be submitted, or accept an application as complete upon filing of supplemental information (Minnesota Rule 7849.5230).

It should be noted that Minn. Stat. 216B.243, Subdivision 3b, prohibits the issuing of a CON for the construction of a new nuclear-powered electric generating plant, thus the Site Permit application requirement of an alternative site for the proposed project could not be meet. However, alternatives to the proposed project (i.e., the extended power uprate) were evaluated as required by the CON process (Minn. Rule 7849.7060, subpart 1).

The review process begins with the determination by the Commission that the application is complete. The Commission has one year to reach a decision from the time the application is accepted.

On August 14, 2008, the Commission considered the completeness of the Site Permit Application at its regularly scheduled meeting. The Commission Order, dated August 15, 2008, adopted the recommendations of the Office of Energy Security (OES), Energy Facility Permitting (EFP), except as modified regarding the advisory task force. In regards to the advisory task force, the Commission decided to take no action at that time.

The docket number for the certificate of need is E002/CN-08-690.

Advisory Task Force

The Commission may appoint an advisory task force (Minnesota Statute 216E.08). An advisory task force must, at a minimum, include representatives of local governmental units in the affected area. A task force can be charged with identifying additional sites or specific impacts to be evaluated in the EIS and terminates when the Department of Commerce (Department) Commissioner issues an EIS scoping decision. The Commission is not required to assign an advisory task force for every project.

If the Commission does not name a task force, the rules allow a citizen to request appointment of a task force (Minnesota Rule 7849.5580). The Commission would then need to determine at its next meeting if a task force should be appointed or not.

The statutes and rules pertaining to environmental review for Xcel Energy's Application for Certificate of Need (Docket E002/CN-08-509) do not contain provisions for the establishment of an advisory task force. However, in the event that the DOC Commissioner combines the environmental review procedures for a certificate of need (i.e., environmental report requirements) with those for the Site Permit (i.e., environmental impact statement requirements), the procedures of Minn. Rule 7849.5010 to 7849.6500 must be followed (Minn. Rule 7849.7100, subpart 3).

On September 11, 2008, the Commission received two requests from the public for the establishment of an Advisory Task Force. On September 25, 2008, the Commission met to consider the petition for the formation of an ATF. After hearing the interested parties and deliberating, the Commission voted to authorize the OES EFP staff to establish an advisory task force; the Commission also accepted the suggested structure and charge presented by OES staff.

The Advisory Task Force (ATF) met formally three times in October 2008, the 8^{th}, 15^{th} and 22nd. The meetings were open to the public, and frequently additional people attended to listen to the discussion. The ATF, through a facilitated process, reviewed the Xcel Energy proposals, discussed relevant issues, and suggested items for the scope of the EIS. The OES EFP staff released the ATF Summary of Work on November 3, 2008.

Environmental Review

The commissioner of the Department of Commerce (DOC) must prepare a document called an Environmental Impact Statement (EIS). An EIS is a written document that describes the human and environmental impacts of a proposed large electric power generating plant (and selected alternative sites) and methods to mitigate such impacts. The public has the opportunity to comment on the scope of the EIS and the draft EIS through public comment periods and at OES sponsored information meetings.

The first step in the development of the EIS is the "scoping process", intended to reduce the scope and bulk of the EIS and to identify only those potentially significant issues relevant to the proposed project. The scoping process involves a public information meeting and comment period, input from advisory task force (if applicable), participation of other regulatory agencies and culminates in the release of a Scoping Decision by the DOC commissioner. The Scoping Decision describes the major issues to be studied in the EIS, alternatives to the proposed project and the schedule for completion of the document.

The OES EFP staff held a Public Information and Environmental Review Scoping Meeting on September 10, 2008. The purpose of the meeting was to inform the public of the projects (the EPU and the request for additional dry cask storage), the regulatory process, and to solicit input from the public as to the scope of the environmental review document. The comment period for the scoping process closed on October 7, 2008.

Thirty-eight persons signed the attendance sheet at the public meeting, with 10 of those persons pre-registering to speak; another five or so persons raised their hands to speak after the pre-registered speakers had their turn. The major area of concern voiced was the health and safety of the people living in close proximity to the PINGP and the associated ISFSI. Other issues included the environmental impacts from appropriating additional water from the Mississippi River, increased temperatures of the discharge water to the river and potential security of the ISFSI.

After consideration of the public comments, the Commissioner of the Department issued a Scoping Order on November 14, 2008 (**Appendix A**).

Hearing Process

Upon completion of the draft EIS, a public hearing must be held pursuant to Minnesota Statute 216E.03, subd.6 and Minnesota Rule 7849.5330. All hearings held for designating a site or route shall be conducted by an administrative law judge from the Office of Administrative Hearings pursuant to the contested case procedures of chapter 14. Members of the public will have an opportunity to speak at the hearings, present evidence, ask questions, and submit comments.

Final Decision

Once the record is complete, the docket will come before the Commission for the determination on the adequacy of the EIS and of a final decision on the Site Permit; in this case the Commission must determine whether the proposed PINGP site is an appropriate location for this type of project.

The Commission may include conditions in any Site Permit it issues for the PINGP EPU project, if certain conditions are deemed necessary and appropriate. Additionally, any other permits or modifications to existing permits, that Xcel is required to obtain (e.g., water discharge, water appropriations, air emissions discharge, etc.) will include pertinent conditions designed to minimize the environmental impacts of the facility.

An example of a large electric power generating plant site permit is shown in **Appendix B**.

2.3 NUCLEAR REGULATORY COMMISSION

When the Nuclear Regulatory Commission (NRC) issues a license for a commercial nuclear power plant, the agency sets limits on the maximum heat output, or power level, for the reactor core. This power level plays an important role in many of the analyses that demonstrate plant safety, so NRC approval is required before a plant can change its maximum power level. A "power uprate" only occurs after the NRC approves a commercial nuclear power plant's request to increase its power. The process for requesting and approving a change to a plant's power level is governed by 10 CFR 50.90-92.

The operating license amendment for the EPU is anticipated to be filed with the NRC in 2010.

Additionally, the change to the larger diameter fuel rods will require NRC approval. The switch to the new fuel is anticipated to take place over time prior to the implementation of the EPU. Xcel Energy will file for NRC approval of the new fuel in mid 2008 and anticipate a decision by mid 2009. This will allow Xcel Energy to start utilizing the new fuel in the reactors starting with the 2009 fall outage, so that the PINGP will have a full core of the new fuel by the 2012 outage.

2.4 OTHER PERMITS

In addition to the State and NRC permits mentioned above, the EPU project will require interconnection approval and an updated transmission service agreement with the Midwest Independent System Operator (MISO). At this time Xcel Energy has not filed the generator interconnection request or the request for transmission service. Xcel Energy is working with MISO on the review process and will file the appropriate requests prior to the projects implementation.

If a Site Permit is issued for the EPU, no other zoning, building or land use rules by a regional, county or local government apply (Minn. Stat. § 216E.10).

The PINGP possesses a number of the necessary operating permits: Air Quality, Water Appropriations, and Wastewater Discharge Permits; it is not anticipated that any of these will require amendments.

Air Quality

Non-radiological air emissions are not expected to increase or decrease as a result of the EPU. Diesel engines, a boiler, and other sources currently associated with the PINGP site emit various nonradioactive air pollutants to the atmosphere, such as NOx, $S0_2$ and CO. Air emissions from these sources are subject to the terms and conditions of a Title V air pollution control operation permit issued by the Minnesota Pollution Control Agency (MPCA); the Air Emission Permit number is 04900030-004. A copy can be viewed at the MPCA's website.[7] Emission units consist of thirteen (13) diesel-fired engines that are used for emergency purposes, and one (1) distillate-oil fired boiler used for plant steam. There are fuel-use and emissions limits for all of the emission units.

No changes to the MPCA air permit are required due to the EPU.

Water Appropriation

The PINGP uses ground water for potable and industrial use from six wells installed within the alluvial aquifer located on the plant property. Five of these wells are permitted by the Department of Natural Resources (DNR), appropriation permit numbers 69-171-G, 78-5153, 86-5114, and 96402. The sixth well does not require a water appropriation permit because it is below the minimum flow requirements of 10,000 gallons per day or 1,000,000 gallons per year set by DNR. Although the maximum combined pumping rate of the five wells equals approximately 850 gpm, ground water limits the usage to a total of 354.7 million gallons per year.

The PINGP uses surface water from the Mississippi River to cool and condense the steam leaving the turbine. Surface water use at Prairie Island is limited by the DNR water appropriation limits (69-0172 amended in June 1995). Under the DNR surface water appropriation permit the facility may withdraw up to 215,000 Million Gallons of water per year from the Mississippi river.

Wastewater Discharge Permit

The PINGP operations require a number of wastewater discharges, which are regulated by the state of Minnesota through the facility's Nation Pollution Discharge Elimination System (NPDES) permit. The present NPDES permit for the plant, permit number MN0004006, was issued June 30, 2006, and expires August 31, 2010 (MPCA 2006b). This permit authorizes intakes and discharges and imposes limits and/or monitoring/reporting requirements for the discharges.

THE MISSISSIPPI RIVER and COORDINATION BETWEEN AGENCIES

Riparian water rights in Minnesota arise from owning shoreline. Water can be used for multiple purposes (swimming, fishing, taking water for drinking or irrigation) but cannot unreasonably interfere with the riparian rights of others.

[7] http://www.pca.state.mn.us/air/permits/issued/04900030-004-aqpermit.pdf

Minnesota "waters of the state" are any surface or underground waters that are confined. This includes all lakes, ponds, marshes, rivers, streams, ditches, springs, and underground aquifers.

Water planning has been mandated in Minnesota since the mid-1930s. Minnesota recognizes that water resources are best managed through many public bodies and levels of government with different levels of expertise. State agencies that have a role in water regulation and management are the Bureau of Water and Soil Resources (BWSR), DNR, Environmental Quality Board (EQB), Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH), and MPCA.

The Minnesota Pollution Control Agency (MPCA) helps protect the State's water by monitoring its quality, setting standards and controlling discharges. The MPCA is the largest single regulator of water in Minnesota. It enforces federal and state law including the administration of the federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES). The MPCA also issues water quality certifications under §401 of the Clean Water Act.

The water appropriation program, established in 1937 and administered by the DNR, provide a water policy for the state that balances the development and protection of the State's water resources. Minnesota Statutes, section 103G.285, subdivision 2 directs the DNR to limit consumptive appropriations of surface water under certain low flow conditions. The purpose of the limit is to safeguard water availability for in-stream uses and for downstream higher priority users located reasonably near the site of appropriation. In-stream uses include fish and wildlife habitat, navigation, water-based recreation, and aesthetics.

Minnesota law (MS 103G.261) sets the priorities for water use in circumstances when there is a water shortage. State Rules (Minn. Rules 6115.0600 – 6115.0810) were promulgated pursuant to this statute. From highest to lowest priority these uses are:

1. Domestic water supplies and power production with contingency water use plans

2. Uses of water consuming less than 10,000 gallons/day

3. Agricultural irrigation and processing of agricultural products

4. Power production without contingency water use plans

5. Nonessential uses of water

A water use permit from DNR Waters Program is required for all users withdrawing more than 10,000 gallons of water per day or 1 million gallons per year. All permitted water users are required to submit annual reports of water use. Information on permitted water users and reported water use can be used to evaluate impacts from pumping on surface and ground water resources. Water use data are also used for water supply planning and resolving water use conflicts.

The DNR Waters Program provides state leadership for the cooperative management of the commercially navigable Mississippi River, which extends from Minneapolis to the mouth of the Ohio River near Cairo, Illinois, and also includes the St. Croix River from Stillwater to the confluence with the Mississippi and the Minnesota River from Shakopee to the confluence with the Mississippi River. This involvement includes DNR representatives from Ecological Resources, Forestry, Fisheries, Wildlife, Trails and Waterways, and Waters, who work together to develop state positions on issues related to the Upper Mississippi River System (UMRS), as well as technical analysis required for specific issues dealing with the river ecosystem.

The DNR Waters staff also represents the State in the Upper Mississippi River Basin Association (UMRBA), which coordinates policy development and federal lobbying activity for the five UMR states. The DNR Water staff participates in the Environmental Management Program Coordinating Committee (EMPCC) that provides policy advice to the U.S. Army Corps of Engineers in administration of the federal Environmental Management Program (EMP) on the UMRS.

The Mississippi River Resources Forum (MRRF) establishes policy on field-level management of the UMRS within the Army Corps of Engineers' St. Paul District (north of Guttenberg, Iowa), including such matters as fish and wildlife refuge management, recreation management, recreation beach maintenance, dredged material disposal and navigation system improvements. DNR Waters represents the State on the MRRF and several of its subcommittees, coordinating positions both within the DNR and among other state agencies.

3.0 PROJECT ALTERNATIVES

Under Minn. Rules part 7849.7060, subpart 1, the Environmental Report must include certain items with regards to the alternatives that are considered. These items include a general description of the alternatives considered, an analysis of the potential human and environmental impacts of these alternatives and possible mitigative measures, and an analysis of the feasibility and availability of each alternative. In this case the scoping order identifies the following alternatives that will be analyzed in this document: the no build alternative, demand side management, purchase power, alternative fuels (fossil fuel technologies and renewable resource technologies), up-grading existing facilities, and new transmission. Each of these alternatives is addressed in turn below.

In its CON application, Xcel Energy identified two alternatives via its qualitative screening process for further consideration. The screening process selected a 164 MW biomass plant and a 164 MW long-term coal Power Purchase Agreement (PPA); a third alternative was added after the qualitative screening was expanded to the "unconstrained" mode. This added a 164 MW natural gas combustion turbine plant to the list of alternatives evaluated by Xcel Energy.

3.1 NO-BUILD ALTERNATIVE

The no-build alternative means that the PINGP EPU project is not undertaken. Electric power will continue to be supplied in the manner and with the facilities that are presently in existence.

Impacts. Often, in conducting environmental review, the analysis of the no-build alternative involves a discussion of the environmental impacts of continuing the status quo. For example, with a proposed highway project, the no-build alternative would take into account the impacts associated with continuing to have traffic increase along existing roads and highways and for development to occur along these existing arteries.

When a certificate of need is required for a proposed project, however, the no-build alternative takes on a different aspect. If the Commission determines that the need for additional power has not been established, no certificate of need will be issued and nothing new will be constructed. Whatever impacts would result from the expansion of the PINGP will not occur.

If Xcel Energy establishes that there is a need for additional power, but no new facility is authorized, the potential impacts are twofold. One, there could be a shortage of electricity, with all the ramifications that result from a shortage of electricity on hot days in the summer. Two, the electricity will come from someplace else, with the impacts that result from the generation and transmission of electricity from these other sources. These impacts are explored below with the various alternatives.

One impact of not building the proposed facility is that anticipated wages and tax revenues to the local economy would be lost. It is anticipated that the PINGP power uprate project will provide tax benefits, including local, state and federal. Xcel Energy estimated that the local property tax benefits due to the project will results in an additional $3.5 million annually; the total estimated increase in property taxes paid due to the EPU is $79 million between 2010 and 2035.

Xcel Energy also estimated that implementation of the EPU will result in the payment of approximately an additional $80 million in federal income taxes and $14.5 million in state income taxes between 2010 and 2035. The estimated property, state and federal income taxes due to the EPU are in addition to the estimated $42 million in state income taxes, $231 million in federal income taxes, and $122 million in state property taxes the company will pay between 2010 and 2035 for Prairie Island.

PINGP does not emit significant levels of any of the criteria pollutants or green house gases that are emitted from coal or other fossil fuel burning plants. The PINGP EPU project will result in over 16.1 million less tons of carbon being emitted to the atmosphere as compare to the next "best" alternative - a natural gas combustion turbine (CT).

Feasibility and Availability. The no-build alternative is not one that requires any analysis regarding its feasibility or availability. If the EPU project were not to be undertaken, Xcel Energy has stated that it would experience a deficit starting in 2010 that would grow to almost 2,900 MW by 2022. Xcel Energy believes that if the PINGP project or an alternative is not undertaken, that this would place Xcel Energy in opposition to their requirement to provide safe, adequate and reasonable electric service pursuant to Minn. Stat. § 216B.04.

3.2 DEMAND SIDE MANAGEMENT

Demand side management (DSM) is the practice of reducing customers' demand for energy through programs such as energy conservation and load management so that the need for additional generation capacity is eliminated or reduced. More detail on Xcel Energy's conservation and load management programs is available in Appendix C of Xcel Energy's Certificate of Need Application, dated May 16, 2008.

The Next Generation Energy Act of 2007 approximately doubled the DSM goals approved in Xcel Energy's 2004 Resource Plan. The Act sets a mandatory minimum savings goal from Conservation Improvement Programs, or "CIP", programs at 1.0 percent and an overall conservation goal of 1.5 percent.

Xcel Energy has stated that it is committed to achieving a 1.1 percent energy reduction as its CIP/DSM goal. Meeting this goal will be very challenging. Xcel Energy will likely launch new conservation programs as well as expand existing programs to meet the 1.1 percent target. Such aggressive expansion of DSM programs pushes the limits of achievable potential in the Xcel Energy service territory and creates significant uncertainty regarding the size and timing of actual savings. Until Xcel Energy implements their plan to meet the 1.1 percent target and gains some experience operating a significantly larger DSM portfolio, it may be unreasonably risky to rely on increased DSM in order to replace the energy and capacity from the PINGP EPU project. If the DSM alternative was selected and the company failed to achieve the necessary savings, Xcel Energy would be forced to buy replacement capacity and energy from the market.

Impacts. Demand side management can minimize environmental effects by avoiding the construction and operation of new generating facilities. Those impacts that would result from the construction of the proposed facility, or from the supply of the additional power through other means, would be avoided if DSM were sufficient to reduce the need for additional power.

Feasibility and Availability. A determination of whether demand side management can reduce the anticipated need for additional power is what the Public Utilities Commission will determine in the certificate of need proceeding. A conclusion that DSM will eliminate the need for additional power is essentially a decision to deny the requested certificate of need.

The only information reviewed for this document regarding the feasibility of DSM is that information provided by Xcel Energy in its Certificate of Need Application, dated May 16, 2008. Xcel Energy concludes in its application that DSM is not a feasible alternative to the proposed project.

According to Xcel, the demand for electrical power will continue to grow at an average rate of 2.6 percent per year or an average of an additional 240 MW for the Xcel Energy service area each year. The methodology used to develop the forecast demand and other forecast details required by Minnesota Rules part 7849.0270 were described in Appendix B of the CON application.

Xcel Energy’s current DSM program has achieved 50 to 100 MW of demand reduction per year. Xcel has in place over 800 megawatts of load management opportunities. Xcel Energy is in compliance with the demand side management (DSM) goals as ordered by the Commission in the 2000 Resource Planning process.

Xcel also notes that it has been experiencing some difficulty in maintaining its customer base for its load management programs. New customers are being signed up for these programs, but Xcel Energy has seen an increase in the dropout rate of current customers.

Additionally, the project proposed here is intended to address the peak demands for power in the hot summer months. DSM is designed to reduce the demand for power over long terms. Also, Xcel maintains that the additional power will be required in the summer of 2005. It is not practical to expect that the results of the program can be doubled or tripled in less than a year, the time remaining after the result of the Commission’s Need decision

3.3 PURCHASE POWER

Purchased power is exactly what it says – the purchase of electricity from another entity. Utilities like Xcel Energy enter into power purchase agreements (PPA) with other generators of electricity. A power purchase agreement is a contract between a wholesale supplier of electricity and an entity that sells the energy to retail consumers. Xcel Energy has a form power purchase agreement at the following webpage:

http://www.xcelenergy.com/docs/corpcomm/RDFpowerPurchAgrmt.pdf

In addition to generating electricity at its 22 major generating plants in Minnesota, Wisconsin, and South Dakota, Xcel Energy relies on both short-term and long-term power purchase agreements to satisfy the demand for electricity in its Minnesota service area and to meet the Mid-Continent Area Power Pool (MAPP) capacity reserve requirements. (MAPP requires power suppliers to have sufficient accredited generation capacity to provide 15% reserves above the actual summer peak demand.) Short term power purchase agreements are normally for a two or three month period, often the summer peaking time. Long term agreements usually provide for the purchase of power over a ten or even twenty year period.

Xcel has traditionally made long-term purchases and generation capacity additions to meet a median (50^{th} percentile) demand forecast and then has augmented those resources with short term seasonal purchases to cover to the 80^{th} to 90^{th} percentile forecast.

Impacts. The environmental impacts associated with the purchase of electricity depend for the most part on how the electricity that is purchased was generated. Presently, Xcel purchases significant amounts of electricity in the summertime. This electricity comes from various sources, including some from coal-fired power plants and some from hydro facilities. It is difficult to discuss with any specificity what the comparable impacts are at this juncture.

Feasibility and Availability. The feasibility and availability of short term and long power purchase agreements are discussed separately below. The information is taken from Xcel Energy's certificate and Xcel Energy's 2007 Resource Plan.[8]

Short Term Power Purchase Agreements. At this time Xcel Energy believes it cannot rely on short-term seasonal power purchases from distant utilities to meet its reliability obligations. The main reason for this is the significant uncertainty about regional transmission capacity now and into the future. Historically, Xcel Energy has depended on short-term power purchases to cover about the last 5 to 10 percent of their projected capacity and energy needs. Notwithstanding the uncertainty of regional transmission concerns, Xcel Energy believes that this level of short-term power purchases can be achieved for the near future. The 2007 Resource Plan incorporated 750 MW of short-term purchases.

[8] http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_41994_43524-2835-0_0_0-0,00.html

Long Term Power Purchase Agreements. Xcel Energy believes that it does not appear that the long-term market can meet the project's primary objectives because of transmission constraints and lack of unconstrained generation capacity available in the near-term.

Xcel Energy did model an estimate of a long term PPA from a coal-based resource to include as a possible alternative. The hypothetical coal PPA price was modeled to have the same cost, performance, and emission characteristics of a new conventional coal plant. The PPA may have similar capacity and energy characteristics to the EPU and therefore was selected for inclusion in Xcel Energy's quantitative evaluation.

The cost and availability of a 164 MW long term coal-based PPA are highly speculative. This scenario assumed a capacity charge equivalent to the levelized revenue requirements of a new plant and energy charges equivalent to the cost of fuel at a 10 mmBtu/MWh heat rate plus small variable O&M costs. The contract was assumed to deliver 164 MW continuously for a 20-year period. It is expected that a coal-based contract would be structured such that responsibility for the associated emissions would be assigned to the buyer. The emission rates for the hypothetical coal PPA are based on typical emission rates for Xcel Energy's existing coal units.

Table 3-1 presents a cost comparison of the 164 MW coal PPA and the proposed PINGP EPU project. Xcel Energy's estimates put the present value of revenue requirements for a coal PPA at approximately 619 million dollars above that of the PINGP EPU. **Table 3-2** presents a comparison of the total system emissions for the 164 MW coal PPA and the proposed PINGP EPU project. Xcel Energy's estimates the additional tons air emissions from a coal PPA over the proposed EPU at 24,110 of NO_X, 3,158 of PM_{10}, 32,290,370 of CO_2, 39,616 of SO_2, 578 of VOCs and 4,767 of CO.

3.4 ALTERNATIVE FUELS

One of the issues to be examined in the Environmental Report (Minn. Rules part 7849.7060, subpart 1) is the possibility of using a different energy source than the one proposed by the project proposer. In this case Xcel Energy has proposed to increase the capacity at an existing nuclear generating facility.

In Appendix D of its Certificate of Need Application, Xcel Energy addressed to some extent a number of other possible types of facilities including Fossil-Fuel technologies, Renewable Resource Technologies, Composite Resource Technologies and Developing Resource Technologies. Although no specific project is reviewed in this screening analysis, the various technologies are evaluated on their applicability, reliability, economics, and environmental performance.

3.4.1 FOSSIL-FUEL TECHNOLOGIES

Fossil fuel technologies considered in Xcel Energy's screening included: integrated gasification combined cycle (IGCC); coal-fired boiler, and natural gas-fired advanced combined cycle. These units have similar operating characteristics to the PINGP project and are potentially viable alternatives.

Supercritical Pulverized Coal-Fired boiler. A supercritical pulverized coal-fired steam power plant consists of a steam boiler, a steam turbine and an electric generator side. In the simplest terms, steam is generated when water is heated by the thermal energy released when pulverized coal is burned in the boiler. The steam from the boiler is piped to, and drives, a steam turbine, which in turn drives an electric generator. The term "supercritical" refers to a particular range of thermodynamic conditions (pressure and temperature) under which such a plant is designed to operate. Supercritical boilers are typically several percentage points more efficient than boilers not designed to operate under supercritical conditions.

Integrated Gasification Combined Cycle (Coal). An integrated gasification combined cycle (IGCC) power plant consists of a coal gasifier, a combustion turbine, a heat recovery steam generator and a steam turbine. In the gasifier, coal is heated to produce a "syngas" that is burned in a combustion turbine that turns a generator to produce electricity. Waste heat in the exhaust gases from the combustion turbine are used to produce steam in a heat recovery steam generator. Steam from the heat recovery steam generator is piped to, and drives, a steam turbine, which in turn drives an electric generator.

Natural Gas Combined Cycle. A gas-fired combined cycle power plant is a combination of combustion turbine technology, heat recovery and electric generation. In the combustion turbine, incoming air is compressed and mixed with the natural gas fuel. Igniting this mixture results in an expansion of gases (the combustion products and excess air) through a power turbine that in turn drives an electric generator. Hot exhaust gases exiting the combustion turbine pass through a heat recovery steam.

Natural Gas Simple Cycle. A simple cycle power plant uses natural gas as its primary fuel and may use fuel oil as a backup fuel during times of gas supply interruption. A simple cycle combustion turbine is less expensive per kW of capacity and also significantly less efficient than a combined cycle facility because the heat from the combustion turbine exhaust gases is not recovered for secondary electric generation from a steam turbine.

Impacts. Environmental impacts refer to the effects the alternative is expected to have on the environment. Potential environmental impacts associated with fossil-fuel generation technologies include air emissions, effects on land, water consumption, wastewater generation, noise, aesthetics, and traffic.

Pulverized coal-fired plants typically operate in a range of 32 to 35 percent efficiency. When designed for supercritical operating conditions, a pulverized coal-fired plant can be up to 37 percent efficient. The direct environmental impacts of coal burning include air emissions, solid waste (ash) generation, waste-heat discharge to air and water, and rail or barge traffic. Typical carbon dioxide emission rates for new supercritical pulverized coal units are in the range of 200 lb CO_2 per million btu heat input.

IGCC plants are predicted to typically operate in the range of 35 percent to 40 percent efficiency. The direct environmental impacts of coal gasification include air emissions, solid waste (ash) generation, waste-heat discharge to air and water, and rail traffic. Without CO_2 sequestration, an IGCC plant is projected to have similar CO_2 emissions to a supercritical pulverized coal generating plant (in the range of 200 lb CO_2 per million btu fuel consumed).

Environmental impacts show distinct advantages for a natural gas combined-cycle project vs. a coal-fired plant. The energy efficiency for a combined cycle plant can be expected to be in the range of 45 to 50 percent with the efficiency of an advanced combined cycle plant exceeding 50 percent. The direct environmental impacts of operating a natural gas combined-cycle plant include air emissions, wastewater discharge, waste heat discharge to air and water and the potential for on-site ammonia storage if post-combustion NOx control is required. Air emissions from an advanced gas-fired combined cycle plant are lower than that of a coal-fired plant, especially in terms of SO_2 and CO_2 (150 lbs per mmbtu of fuel input). A gas-fired combined cycle plant does not produce any ash.

Environmental impacts would not show a distinct advantage for a natural gas simple cycle turbine-driven project vs. a natural gas combined-cycle plant. The energy efficiency for simple cycle combustion turbine generator can be expected to be in the range of 25 to 30 percent. The direct environmental impacts of operating a simple cycle plant burning natural gas include air emissions, waste heat discharge via the stack and the potential for on-site ammonia storage if post-combustion NO_x control is required.

Feasibility and Applicability. Applicability of the technology refers to the technology's appropriateness for the Applicant's stated purpose and need, including timing and operational mode. One of the objectives of the PINGP project is to provide energy and capacity for base load service (i.e., operational mode). Base load resources normally operate in the range of 50 percent to 100 percent annual capacity factor, with typical capacity factors of newer base load resources being in the range of 80 percent to 90 percent. Base load resources generally have few starts per year (<10) and may be operated at reduced output levels to follow system load during off-peak periods.

An important factor relating to the feasibility of an alternative is its implementation time.

The primary activities that affect implementation time are obtaining necessary regulatory approvals, acquiring necessary transmission services, negotiating financing agreements, selecting and acquiring a site, design and engineering, procuring, construction, and testing facility equipment.

Although the fossil fueled alternatives have similar operating characteristics, the IGCC, coal, and natural gas combined cycle units cannot be built to the appropriate 164 MW scale and none could be constructed in time to meet the 2011 capacity need. Additionally, the advanced combined cycle is currently not a commercially viable technology.
Natural gas simple cycle plants are typically employed for peaking duty and are not well suited to economically meet intermediate and base load needs. Simple cycle combustion turbine generators exceeding 20 percent capacity factor would likely defer to intermediate load facilities or be considered for conversion to a combined cycle unit. Advantages of simple cycle turbine generators include flexibility in siting, relatively low capital cost and, a relatively short construction period.

At the expense of dispatch economics, a simple cycle plant can generally demonstrate high reliability (both the adequacy and security aspects). A simple cycle combustion turbine facility may utilize fuel oil as a backup to address the potential interruption of natural gas supply. However, environmental permitting may be substantially complicated if fuel oil is utilized as a back-up fuel due to the potential for higher air emissions related to there being more sulfur in fuel oil than in natural gas. This consideration limits siting flexibility for additional units at existing peaking plant sites and/or near areas that have little available room to permit any additional air emissions.

The total capital requirement for a simple-cycle gas-fired combustion turbine power plant installation is much lower than for other fossil-fuel technologies. However, the typical energy cost for a simple-cycle gas-fired combustion turbine power plant is estimated to be much higher than for other fossil fuel units, making it a better option for meeting low capacity factor needs.

Building a simple cycle power plant is a major construction project with about a 12-18 month time frame for permitting and 12 months for construction. The time required to implement transmission upgrades necessary to accommodate the output of such a facility is highly variable, depending on the particular site chosen.

The “unconstrained alternative” alternative Xcel Energy selected through its screening process was not a specific resource. In this scenario, the model is allowed to select the most cost-effective combination of resources from the available generic resources including coal, natural gas combined cycle, and natural gas simple cycle resources. In this case, the capacity need was filled by the addition of a natural gas CT. New and existing resources filled the energy needs.

Table 3-1 presents a cost comparison of the natural gas CT and the proposed PINGP EPU project. Xcel Energy’s estimates put the present value of revenue requirements for a coal PPA at approximately 519 million dollars above that of the PINGP EPU. **Table 3-2** presents a comparison of the total system emissions for the natural gas CT and the proposed PINGP EPU project. Xcel Energy’s estimates the additional tons air emissions from a natural gas CT over the proposed EPU at 7,580 of NO_X, 1,370 of PM_{10}, 16,059,200 of CO_2, 9,526 of SO_2, 283 of VOCs and 2,235 of CO.

3.4.2 RENEWABLE RESOURCE TECHNOLOGIES

Renewable resource technologies considered as potential alternatives include wind, solar, biomass, hydropower, and landfill gas.

Wind. Wind energy conversion technology consists of a set of wind-driven turbine blades that turn a mechanical shaft coupled to a generator, which in turn produces electricity. The major components of the wind turbine include: Rotor blades, Gear box, Generator, Nacelle (gearbox/generator housing), Tower, and Collection system of electrical lines connecting a number of wind turbines to a substation (applicable only to multiple wind turbine projects).

Solar. Solar energy to electricity conversion technologies includes thermal conversion (typically using sunlight to generate steam to turn a turbine) and photovoltaic (direct conversion of sunlight to direct current power). Thermal, or concentrating solar power technology (parabolic troughs, power towers, and dish/engine systems), converts sunlight into electricity efficiently with minimal effects on the environment. The heat generated is transferred via a heat exchanger to produce steam. The electricity is produced in conventional steam turbine generators.

The "photovoltaic effect" is the basic physical process through which a photovoltaic (PV) cell converts sunlight into electricity. Solar energy (composed of photons) is transferred to the electrons of atoms making up the PV cell. Higher energy electrons begin to flow and become electric current. By grouping single PV cells into arrays, and then placing many arrays together, power plants of up to 6.5 megawatts have been built.

Biomass (Direct-Fired). The process of direct-firing biomass fuels is very similar to the firing of other solid fuels. Fuel handling and storage, fuel firing, ash handling and disposal, air emissions, water consumption, and wastewater management will have many similarities to coal-fired systems. The primary activity steps for a biomass plant include: Biomass fuel receiving; On-site processing (size reduction, drying, screening); Fuel storage/conveying; Boiler (usually a stoker design); Ash and flue gas handling; Air emission controls (baghouse/ESP for particulate; ammonia for NO_x control); Steam turbine; and Cooling tower.

Biomass fuels can be harvested from the forest, collected as waste materials from processing plants or agriculture, or grown in biomass plantations. Fuel may be shipped to the power plant by truck, rail or barge depending on the plant location and type. Fuel will generally be stockpiled as insurance against interruptions in supply. Depending on fuel characteristics, drying and size reduction may be necessary prior to firing. Drying is sometimes accomplished by utilizing the heat from stack gases. Prepared fuel is fed to the furnace and the resulting heat is used to generate steam. The steam from the boiler is piped to, and drives, a steam turbine, which in turn drives an electric generator to produce saleable electrical power.

Hydropower. Hydroelectric power plants convert the potential energy of water, pooled at a higher elevation, into electricity by passing the water through a turbine and discharging it at a lower elevation. The water turns the turbine connected to an electric generator, thus producing electrical energy. The turbines and generators are installed in, or adjacent to, dams, or use pipelines (called penstocks) to carry the pressurized water below the dam or diversion structure to the powerhouse. Hydropower projects are generally operated in a run-of-river, peaking, or storage mode.
Run-of-river projects use the natural flow of the river and produce relatively little change in the stream channel and stream flow. A peaking project impounds and releases water when the energy is needed. A storage project extensively impounds and stores water during high-flow periods to augment the water available during low-flow periods, allowing the flow releases and power production to be more constant.

The capacity of a hydropower plant is primarily a function of two variables: (1) flow rate expressed in cubic feet per second (cfs); and (2) hydraulic head which is the elevation difference the water falls in passing from the reservoir through the turbine. Depending on the particular waterway being considered, project design may concentrate on either of these variables (high head/low flow or low head/high flow).

Hydrokinetic power refers to the generation of electricity from moving water without impoundments or diversionary structures that are typically used at conventional hydropower facilities, basically placing a turbine within the current.[9]

Landfill Gas. The most common use of landfill gas (LFG) is for on-site electricity generation by firing stationary engine generator sets. Some LFG is used to fire boilers or turbines and LFG, sufficiently processed, could be an energy source for fuel cell operation. Electric generating plants using LFG and those using natural gas or distillate oil are nearly identical; however, firing LFG does require gas processing and careful monitoring of equipment because LFG tends to be more corrosive. Significant quantities of LFG are emitted from municipal solid waste where it has been deposited in landfills; however, LFG typically has a medium Btu content and is not typically a source of energy on a scale larger than a few MW.

LFG recovery for energy is practiced in the United States, Europe and other countries around the world. A typical system consists of the following components:

- The gas collection system, typically a series of wells strategically placed throughout the landfill, which gathers the gas being produced within the landfill;

[9] http://www.marketwatch.com/news/story/First-Commercial-Hydrokinetic-Power-Project/story.aspx?guid=%7B0107E465-4D2F-485A-B507-44D37FC4F7C3%7D

- The gas processing system and engine/generator set, which cleans the gas and converts it into electricity; and
- The interconnection equipment, which delivers the electricity from the project to the final use.

Impacts. Environmental impacts refer to the effects the alternative is expected to have on the environment. The potential environmental impacts associated with renewable resource technologies can be highly variable depending on the technology and may include air emissions, effects on land, water consumption, wastewater generation, noise, aesthetics, and traffic.

Wind turbine generation has many environmental advantages over fossil fuels because there are no air emissions nor solids or water discharges associated with operating the turbines. Turbines may encounter some siting opposition with regard to noise and aesthetics. In many cases, the original use of the land (i.e., agriculture) can continue in the presence of the turbine installation with less than 5 percent of the original land area taken out of production.

Solar power generation has many environmental advantages over fossil fuels because there is no air emissions or solids discharges associated with operating the systems. Trough/gas hybrid systems do utilize a steam loop, which requires process and cooling water, some water treatment and some wastewater discharge (blowdown).

Waste streams from a Biomass fueled furnace include stack gases, bottom ash, and boiler water blowdown. Bottom ash produced in many biomass combustion plants is often of a quality that can be sold, or used as a soil conditioner/fertilizer due to the lack of many trace metals, which often contaminate coal ash. Boiler blowdown, along with other process wastewater streams, will typically be treated to remove solids, oils, and grease prior to discharge. Cooling water used to condense the steam exhausted from the turbine would most likely be cooled using a direct-contact cooling tower. The use of a cooling tower represents a significant consumption of water.

The stack gases will contain particulate matter as well as gaseous pollutants – depending upon the fuel source used. If a thermal drier with auxiliary firing is used, the drying step will increase energy use and environmental emissions. Typically, stack gases will pass through an air pollution control device where particulate matter is removed. A large new boiler will likely be required to also address the control of NOx and CO emissions.

Biomass-fired plants typically operate in a range of 20 – 30 percent efficiency. Biomass power production is affected by a greater variability in biomass fuel quality than is coal-fired power production. Variability in moisture and ash content are characteristic of a diverse fuel source and leads to variability in heat value on a mass basis. The direct environmental impacts of biomass burning are similar to those for coal combustion and include air emissions, solid waste (ash) generation, waste heat discharge to air and water, and truck and/or rail traffic.

A biomass plant utilizing a closed-loop biomass fuel, such as switchgrass or hybrid poplar trees, would have less environmental impact per unit of energy produced with regard to CO_2 emissions because the uptake of CO_2 during the growth of fuel feedstocks would offset CO_2 emissions from the plant when the fuel was burned.

Hydropower projects are not typically associated with air emissions, water discharges or the solid waste disposal issues associated with solid fuel-fired power production; however, hydropower may involve other significant environmental impacts such as altered river basin hydrology, fish mortality, fish migration interference, decrease in water quality, and flooding of land.

Landfill gas projects are expected to be a net benefit to the environment by reducing the amount of LFG emissions to the atmosphere; however, some of the landfill emission reductions are offset by the combustion emissions such as NOx and CO from the combustion equipment. LFG collection systems (i.e., the well networks) are not totally efficient, and combined with the inherent inefficiencies of combustion equipment, the overall energy efficiency of an LFG system generally less than 30 percent.

Feasibility and Applicability. Applicability of a technology refers to the technology's appropriateness for the Applicant's stated purpose and need, including operational mode. One of the objectives of the PINGP project is to provide energy and capacity for base load service (i.e., operational mode). Base load resources normally operate in the range of 50 percent to 100 percent annual capacity factor, with typical capacity factors of newer base load resources being in the range of 80 percent to 90 percent. Base load resources generally have few starts per year (<10) and may be operated at reduced output levels to follow system load during off-peak periods.

Wind turbines can help meet overall system energy needs, but offer inadequate dispatch flexibility to support intermediate or peaking load needs. Wind generation can help meet base load energy needs, but cannot meet the capacity component of base load needs on its own; it must be coupled with other technologies or resources.

Utilization of taller wind turbine towers and the ever-greater geographic diversity of wind resources in the region can reduce the intermittency of wind generation on a system-wide basis and, thus, offer a correspondingly greater capacity contribution to base load capacity needs. However, there are limitations to the benefits these techniques can provide.

Wind turbines are generally expected to have a high availability, but actual availability is dependent on the quality of wind resources of the geographic location in which the resource is located. Even when wind energy is present, wind turbines can only generate power within an optimum range of wind speeds.

A wind turbine installation cannot have an objective of providing a guaranteed performance from the perspective of the utility customer. At best, wind-generated power can replace a percentage of base load generation during periods of low to moderately high wind conditions and subsequently conserve fossil fuels.

The total costs associated with wind vary according to market conditions. Two important factors are the availability of the production tax credit and supply conditions for wind turbines. Permitting and construction for large wind turbine installations can be completed in as little as 12 to 24 months. However, transmission upgrades necessary to accommodate energy production from wind turbines may take as long to implement as transmission upgrades for other base load options, particularly in areas where significant wind generation development has already occurred (i.e., Buffalo Ridge) or where little or no transmission infrastructure currently exists.

The applicability for solar generation to meet capacity needs is defined primarily by problems with reliability. Solar power systems generally represent less capacity than a wind turbine installation and, combined with a dependence on quality insolation rates, cannot meet intermediate load and peaking service needs. Siting of a large solar power plant is also predicated on locating candidate areas that have the solar energy data that would support the project economics.

Solar generating facilities are generally expected to have a high availability, but actual availability is dependent on the quality of solar resources of the geographic location in which the resource is located. A solar power installation cannot meet an objective of providing a guaranteed performance to the end user of generated power. The hybrid design of some solar plants, utilizing natural gas during periods of poor solar intensity, may enable the facility to maintain a capacity rating.

The total capital requirement for either a photovoltaic power plant or a trough/gas hybrid plant continues to be significantly higher than for other resources, making it cost prohibitive for large-scale applications.

A biomass facility may serve as an intermediate load unit; however, biomass-fired power boilers are best suited for base load (steady, high-capacity) duty. Boiler-based biomass-fueled plants are not well suited to operate as peaking plants because of the long lead time (a day or more) necessary to bring a solid fuel-fired plant on-line at full capacity. The forest products and agriculture industries in Minnesota and the Midwest offer a wide and expanding variety of biomass fuels.

The net availability of biomass-fired units is expected to be reasonably high, potentially 85 percent. A biomass-fired plant can generally demonstrate high reliability (both the adequacy and security aspects) for base load and intermediate load service if an adequate supply of fuel is available. Overcoming the logistical and economic challenges of collecting enough fuel to support the operation of a biomass-fueled power plant at a nominal 85 percent capacity factor is a substantial undertaking. Competition for economic fuel feedstocks can be fierce, depending on the feedstock(s) in question and the location of the biomass-fueled plant. This has been especially true of forest product waste fuels and urban wood waste fuel feedstocks.

The total capital requirement for a biomass power plant is highly variable and size dependent. Higher capacity plants will generally be less expensive. Due to the variability, it is important to analyze specific proposals before making cost estimates.

Building a biomass-fired power plant is a major construction project with 12 to 24 months required for permitting and 24 to 36 months for construction. Transmission upgrades necessary to support such a project could take as long to implement as the transmission upgrades for other types of base load options. The relatively small size of biomass power plants (under 100 MW) could minimize the transmission upgrades implementation timeframe.

A 164 MW base load type biomass plant was determined to be a reasonable alternative to the Prairie Island power uprate project. Such a plant will have roughly the same capacity and energy characteristics, but lower expectations for reliability and availability due to technology and fuel supply considerations. The capital costs for a new biomass plant are expected to be similar to other base load type steam plants. This analysis assumed that a plant commissioned in 2013 would cost $3,182 per kW or $522 million. The fuel costs and operating characteristics were based on our existing plants and fuel forecasts.

Table 3-1 presents a cost comparison of the 164 MW biomass plant and the proposed PINGP EPU project. Xcel Energy's estimates put the present value of revenue requirements for a coal PPA at approximately 1,179 million dollars above that of the PINGP EPU. **Table 3-2** presents a comparison of the total system emissions for the 164 MW biomass plant and the proposed PINGP EPU project. Xcel Energy's estimates the additional tons air emissions from a biomas plant over the proposed EPU at 103,722 of NO_X, 4,701 of PM_{10}, 65,357,790 of CO_2, 21,551 of SO_2, 837 of VOCs and 18,498 of CO.

Hydroelectric plants are operated in several modes; plants with large water storage capability lend themselves well to peaking power production and hydroelectric plants are able to come on line much quicker than steam generating systems. Run-of-river plants are more likely to produce a more constant power output though that output is dependent on water levels and, in cold climates, ice conditions.

The U.S. Department of Energy's (DOE) Hydropower Program has estimated that there is additional hydropower in this region. While it is possible that some of the identified potential hydropower could be developed, decisions to do so would need to also consider that transmission systems may not exist in remote areas containing hydropower potential. Development of hydropower, and associated transmission systems, faces the scrutiny of a general environmental trend toward releasing water reservoirs where possible. Developing capacity of a hundred MW or more would require development of multiple existing and/or potential hydropower sites. Such an effort would take several years of environmental study and negotiation to acquire water use and land rights, and permits and licensing for dams and/or transmission lines. During periods of normal precipitation and ice-free conditions, the availability of established hydropower generation is typically very high.

The hydropower sector of power generation is well established with proven technologies installed as standard design. In mechanical terms, hydroelectric plants are highly reliable. Because hydropower depends on water flow, hydroelectric plants are susceptible to fluctuations in output as a function of weather patterns. Reliability can suffer during periods of drought or during periods of freezing conditions in northern climates. Weather-induced fluctuation in power output may be less pronounced than it is for wind or solar power; however, for long-term planning to meet projected demand, hydropower may be better suited to reliably provide peak load capacity.

The total capital requirement for a hypothetical hydropower power plant can be very high, although the all-in energy requirements are reasonable as compared to other alternatives. Most of the potential sites within the region have capability of less than 10 MW and economies of scale would not be realized. Annual operating expenses would likely be less than for a fuel-fired power plant because the hydropower energy source (pooled water) is not typically a purchased input. Building a hydroelectric power plant is a major construction project with a several-year time frame.

The nation's first ever, commercially-operational hydrokinetic power station is scheduled to come on-line in 2009 (City of Hastings, Minnesota). The City of Hastings is installing the project at its 4.4-megawatt hydropower plant on the Army Corps of Engineers' Lock & Dam No. 2. The power generated by the two hydrokinetic units, which each hold a nameplate capacity of 100 kilowatts (0.1 MW), will be placed on the electric power grid through Hastings' existing electrical infrastructure. Once the project is operational, extensive water quality, fish survival and avian studies will be performed.[10]

Landfill gas power generation projects are generally sited on large landfills and produce power in the range of kilowatts to a few megawatts. The driver for LFG power generation is the utilization of a fuel source that would otherwise be flared to avoid an explosion hazard and to avoid an emission source by producing saleable energy. A LFG plant could reasonably be viewed as an emission control technology. LFG does not exist at the levels needed to support large energy needs.

The availability of a LFG-fired generation system is expected to be high, similar to systems firing natural. However, the corrosive nature of landfill gas does introduce more potential for equipment problems. Because of the small-scale nature of most LFG plants, a LFG power installation project typically does not have an objective of providing a guaranteed performance from the perspective of the utility customer. Power output for LFG plants depends upon the LFG production rate that does not adjust to power demand. LFG-generated power can replace a percentage of base load generation and subsequently conserve fossil fuels.

[10] http://www.theengineer.co.uk/Articles/309142/Hydrokinetic+power.htm

The total capital requirement for developing a hypothetical LFG power plant is not very high and all-in costs are also quite competitive. However, the LFG volumes do not exist within one site necessary to fuel a plant with a hundred MW or higher capacity. Most landfill sites will not support more than 10 MW of generation. Annual operating expenses may be less than for a typical fuel-fired power plant because the LFG is not typically a purchased input. However, some municipalities associated with landfills may require a royalty to be paid from energy sales.

3.4.3 DEVELOPING TECHNOLOGIES

Concerns about the adequacy of future generation, air quality and longer-term impacts of global warming have caused many industry participants, policy makers and the public to focus more on renewable and emerging technologies. As with wind power, the higher energy prices during the past few years have improved the commercial viability, stimulated R&D, and encouraged the rapid development of emerging technologies.

Fuel Cell. A fuel cell converts energy directly, without combustion, by combining hydrogen and oxygen electrochemically to produce water, electricity, and heat. Fueled with pure hydrogen, they produce no pollutant emissions. Even if fueled with natural gas as a source of hydrogen, emissions are orders of magnitude below those for conventional combustion generating equipment. The principle of operation of a typical fuel cell consists of the following processes:

- When hydrogen is fed into a fuel cell a catalyst on the anode converts hydrogen gas into negatively charged electrons (e^-) and positively charged ions (H^+).
- The electrons (e^-) flow through an external load to the cathode.
- The hydrogen ions (H^+) migrate through the electrolyte to the cathode where they combine with oxygen and the electrons (e^-) to produce water.

There are a variety of fuel cell designs (referring mainly to the electrolyte style) including solid oxide, alkaline, phosphoric acid, molten carbonate, and proton exchange membrane. The main components of a fuel cell system include:

- A porous anode (example materials are graphite, and nickel, chromium and zirconium alloys);
- An electrolyte (example phosphoric acid);
- A porous cathode (same materials as anode);
- Precious metal catalyst;
- Fuel reformer (to generate hydrogen from fossil fuel); and
- Power conditioner (to convert from DC to AC and to regulate power production in accordance with load).

Mircoturbines. Microturbines are a type of combustion turbine that is used for stationary energy generation applications. They are usually small units (common refrigerator size) with outputs that are very small, usually in the kilowatt range. Microturbines operate similar to a combustion turbine except on a much smaller scale. Generally, microturbines contain the following design features:

- Radial flow compressors;
- Low pressure ratios (single or possibly two stage compression);
- Minimal use of van or rotor cooling;
- Recuperation of exhaust heat for air preheating;
- Use of materials that are amenable to low cost production; and
- Very high rotational speeds on the primary output shaft (25,000 rpm or more).

Microturbines are capable of using many alternative/optional fuels including natural gas, diesel, ethanol, landfill gas, and other biomass-derived liquids and gases.

Energy Storage. The application of energy storage technologies is best suited to peaking power needs since it presumes that there is excess or underutilized generating capacity at some point during which energy can be stored and released at a later point in time. Energy storage technologies have long been considered as a means of leveling the load on existing generating plants, thus allowing them to operate closer to their peak efficiencies. Energy storage is not well suited for meeting base load energy needs and must be combined with other energy resources to address reliability issues. Types of energy storage systems include:

- battery energy storage systems (BESS);
- compressed air energy storage (CAES);
- pumped storage hydroelectric; and
- flywheel energy storage.

Impacts. Environmental impacts refer to the effects the alternative is expected to have on the environment.

Fuel cells can boast great potential for improving energy efficiency. Fuel cells generate significant quantities of waste heat that can be recovered in a cogeneration configuration. The proximity of fuel cells to the end user of generated power greatly reduces transmission losses. Fuel cell environmental impacts directly related to operating the cell are minimal. By eliminating the combustion step of fossil fuel utilization, air emissions are virtually eliminated relative to conventional fuel-fired power generation. Indirect impacts may arise if a preliminary fuel processing step (e.g., coal gasification) is utilized to provide fuel for a fuel cell.

Environmental impacts associated with mircoturbines in terms of energy efficiency show a distinct disadvantage versus natural gas combined-cycle and coal-fired plants. Direct environmental impacts of operating a natural gas combustion microturbine include air emissions and waste heat discharge. Microturbines have manufacturer listed NOx levels from 9 to 50 ppm (typical generator natural gas combustion sources range from 45-200 ppm NOx).

Values for efficiency of each storage system have not been identified here. A feature of all storage systems is that less energy will be extracted than was originally stored. The process of storage requires an energy expenditure that cannot be recovered. None of the four systems will directly release air pollutant emissions in significant amounts, nor will they directly discharge significant quantities of wastewater or noise; these impacts will depend on the sources of energy that is being stored Pumped storage hydro development will have impacts similar to any hydroelectric project development. Substantial areas of land and habitat may be lost due to hydro development.

Feasibility and Applicability. The feasibility and applicability of a technology refers to the technology's appropriateness for the Applicant's stated purpose and need, considering both economics and operational mode.

Fuel cell installations are viewed as an extended generation strategy and thus are typically sited adjoining the end user. Currently, fuel cell installations remain small, just a few megawatts. The fuels potentially used by fuel cell installations are widely available.

Power industry estimates for significant fuel cell technology implementation range from 5 to 10 years. As design improves with experience, fuel cells will provide high availability. Fuel cells have demonstrated high reliability in pilot installation settings. Current manufacturing capacity of fuel cells is not yet established to the point where fuel cell installations are expected to address significant demand.

The total capital requirement for developing a hypothetical fuel cell power plant is estimated to be prohibitively high. The size of fuel cell installations would require hundreds of fuel cell sites to provide capabilities in the range of a hundred MW or more.

Microturbines are well suited to meet intermediate, base load, peaking, or co-generation load needs. High kW output needs may not be feasible because existing power conditioning equipment does not allow easy interconnection between microturbine systems.

Microturbines have relatively few moving parts and can operate continuously with little maintenance. Existing microturbine based power generation systems have demonstrated extremely high availability. Microturbine systems can generally demonstrate high reliability (both the adequacy and security aspects). Natural gas-fired systems typically do no have alternative fuel options for backup. A reliable natural gas or other primary fuel source is required to have a reliable system.

The total capital requirement for a microturbine power plant varies significantly, making it important to evaluate specific proposals before making economic conclusions. However, at this time large-scale implementation of this resource does not appear to be feasible.

Energy storage projects require an energy producer with excess or underutilized generating capacity to charge the storage system. Where this excess capacity exists, energy storage technologies are a means of leveling the load on existing generating plants thus allowing them to operate closer to their peak efficiencies. However, energy storage technologies do not meet intermediate or base load energy needs well.

By their nature, energy storage systems have high availability so that power may be readily extracted and used. These systems would typically back up less reliable parts of the overall electric supply system and are best suited for peaking power needs. Implementation times for the energy storage technologies would be variable due to the differences in issues between them. Small, disperse battery and flywheel systems could likely be installed within months, whereas CAES and pumped storage hydro facilities may require years of development effort likely involving contentious approval processes.

The capital costs for constructing an energy storage facility are variable and dependent on the technology selection. However, as noted previously, energy storage projects require an energy producer to charge the storage system. The costs for energy storage typically assume that underutilized energy production facilities exist. Operating costs are primarily dependent upon the operating costs associated with the original energy source.

None of the developing technologies pass the initial screening as being viable for current implementation to meet the purpose and need as stated for the PINGP project.

3.5 UP-GRADING EXISTING GENERATING FACILITIES

This alternative is a consideration of whether Xcel Energy could upgrade one of its existing generating facilities to provide the additional electricity requested in the CON for the PINGP project. Indeed, Xcel Energy's proposal is essentially one to upgrade an existing facility – the Prairie Island Nuclear Generating Plant.

Combined Heat and Power at PINGP

The waste heat that is generated from the PINGP comes in the form of circulating water that has been warmed by 27 degrees Fahrenheit (when the plant is operating at 100% power) over the temperature of the water within the plant's intake cooling canal as it enters the plant. Prior to condensing the plant's steam back to water, as much of the energy as practical has already been extracted from the steam to either produce electricity or preheat water before it goes back into the reactor or steam generators. At that point minimal heat value remains.

The factors to be considered in utilizing the waste heat contained in the plant's circulating water include finding a use for water that has been heated by 27 degrees, transporting the warmed water for its intended use without losing heat content in transport, and the energy consumed in moving the water to where its remaining heat can be used. To minimize heat loss during transport, Combined Heat and Power plants (CHP) are typically located in close proximity to the structures they will be heating. Close proximity also minimizes the amount of energy needed to move water. To maximize efficient use of waste heat, this effort is typically done as part of the initial design of both the power plant and facility to be heated. It is more difficult and usually less cost-effective to construct as an add-on.

By their nature, nuclear power plants have relatively large buffer areas around the plant's immediate perimeter for security purposes. The large required buffer area would not allow an industrial facility, which might utilize the waste heat, to be placed on the plant site. As a result in order to utilize the heat content of PINGP's circulating water, the water would need to be moved and returned via a relatively long distance as compared to other CHP facilities. This would require long runs of insulated pipe to transport circulated water without losing heat along the way. In addition because of the long distances, pumps would be sized larger and use more energy than other CHP facilities.

Use of waste heat from a nuclear facility would pose additional regulatory, security; monitoring and other issues even if the limited heat value and proximity issues and costs were overcome.

Black Dog

Xcel Energy is evaluating the repowering options of the Black Dog facility. The Preferred Plan in Xcel Energy's 2007 Resource Plan assumed an additional 300 MW at Black Dog. This has since been updated to 750 MW (but also eliminated a 600 MW natural gas combined cycle unit). Xcel Energy's analyses show a need for both additional megawatts from Black Dog (and/or other natural gas facilities) and the proposed EPU at the PINGP. The EPU is lower cost and reduces emissions compared to any of the generic natural gas fired alternatives or Black Dog options being considered.

The reference case used to evaluate the EPU at PINGP did not include any specific potential changes at Black Dog. The analysis was performed with generic alternatives that were available to be selected instead of the EPU. These generics cost more than the EPU and had higher emission levels. The most cost-effective generic alternative was a new natural gas combustion turbine combined with the additional use of existing resources. The EPU also cost less than either the 300 MW or 750 MW Black Dog configurations.

Impacts. It is difficult to determine the impacts of upgrading another facility without knowing what the facility is. The actual physical construction of an expansion to an existing facility could result in environmental effects. The potential environmental impacts of operating an expanded facility have been discussed to some extent in Xcel Energy's Certificate of Need Application through the discussion of the various alternatives that Xcel Energy considered.

Feasibility and Availability. Xcel Energy has identified and is also pursuing uprate/upgrade projects for its existing Monticello Nuclear Generating and Sherco generation plants and has incorporated estimates of these projects in their recently filed resource plan. Xcel Energy's next three largest plants King, Riverside, and High Bridge are all part of the Metro Emission Reduction Program (MERP) and are undergoing significant modifications to reduce their emissions and increase their electrical output. This leaves few opportunities for additional efficiency projects.

3.6 NEW TRANSMISSION

This alternative considers constructing new transmission facilities rather than new generation.

Impacts. The impacts associated with a transmission line depend to a large degree on the location of the line. Landowners whose property will be crossed by a new transmission line are often opposed to the project, particularly if the landowner perceives no personal benefit from the line.

Feasibility and Availability. Additions to or improvements in the electric transmission system are not viable alternatives to the Monticello power uprate proposal. The underlying assumption with this alternative is that additional transmission infrastructure would provide access to additional capacity resources. However, since the capacity construction boom of the late 90's there had been relatively little capacity built in the region. The result has been very tight capacity markets with little or no excess capacity available. Thus, no opportunities exist for new transmission to bring in additional capacity. Timing is also an issue for transmission as an alternative. The planning, permitting, and construction of transmission facilities is a multi-year process. It is unlikely that additional transmission could be planned, permitted and built to import additional energy by the 2011 in-service date.

3.7 DISTRIBUTED GENERATION

Distributed generation is usually considered to be small, modular, decentralized, grid-connected or off-grid energy systems located in or near the electric loads they serve. The term generally is used to refer to power plants that are small enough to be connected to distribution instead of transmission. Depending on the size of nearby loads and the capacity of the distribution line to which it is connected, the maximum size of distributed generation can vary from a few hundred kW to 5 MW.

The smallest DG units commercially available today can produce 30 kW.

Impacts. DG technologies range from emissions-free photovoltaic modules to combustion technologies that can emit much more smog-forming pollutants than the most efficient natural gas power plant technologies.[11] A substantial use of DG equipment in

[11] Bluestein, J. Environmental Benefits of Distributed Generation. Energy and Environmental Analysis, Inc. December 18, 2000

Minnesota could yield important benefits in overall electricity reliability, cost, and power quality. However, the air quality effects from a more widespread use of DG equipment are unknown.

At present, most Minnesotans receive electricity from large central-station power plants that generate tens or hundreds of megawatts and distribute it through the supply grid. Recent advances in the development of DG equipment, however, have made it technologically feasible for businesses and individuals to generate their own electricity onsite. Moving from central generation units to local facilities would result in significantly different emissions profiles, with increased and widely dispersed emissions closer to the general population.

Currently, most combustion DG equipment is fueled by diesel, gasoline, or natural gas which emits varying degrees of pollutants such as nitrogen oxide (NO_X) and particulate matter (PM).

Nitrogen oxide emissions would certainly increase from a greater use of diesel generating units, triggering increases in secondary PM formation that could threaten compliance with the federal $PM_{2.5}$ standard or increase violations of the state PM_{10} standard. Widespread combustion DG implementation could also increase direct PM emissions. Increased NO_X emissions could also increase ambient ozone (smog). It is unknown whether a greater use of combustion DG would result in increased ambient ozone levels that would violate the federal 1-hour ambient air quality standard or the proposed 8-hour ozone standard.

Feasibility and Availability. Compared to large utility base load generating technologies, distributed generation technologies have higher capital costs, higher operating costs, or both. Thus there are relatively few applications or markets today in which DG is economically competitive on a pure base load energy basis. Instead, DG applications tend to fill some special requirement that justifies the additional cost. Most DG applications fall into either emergency generation or peaking/load shaving categories.

3.8 COMBINING WIND and NATURAL GAS TECHNOLOGIES

The Action Plan from Xcel Energy's 2007 Resource Plan, Docket Number E002/RP-07-1572, and subsequently updated via Reply Comments filed September 2008, includes a diverse mix of resources. A diverse resource allows Xcel Energy to reliably meet its customers' energy needs and the RES requirements, while also significantly reducing carbon emissions.

Xcel Energy's Action Plan already includes 2,600 MW of new wind generation, approximately 1,800 MW of new natural gas generation, and 1,880 MW of DSM savings (a 15 percent peak load reduction in 2022 and an energy reduction of 5,740 GWh).

Between 2010 and 2023, the bulk of new energy coming onto the Xcel Energy system is wind, followed by natural gas. The PINGP is base load and also helps to maintain system diversity. Replacing any of the energy that is provided by the EPU at PINGP with natural gas will lead to increased carbon emissions – impacting Xcel Energy's ability to meet the legislated carbon initiative. Additionally, the same individual challenges regarding cost and availability discussed previously would exist for a combined alternative.

4.0 HUMAN AND ENVIRONMENTAL IMPACTS

Under Minn. Rules part 7849.5300, subpart 6, the Environmental Impact Statement must include an analysis of the human and environmental impacts of the proposed project, and mitigative measures that could reasonably be implemented to eliminate or minimize these impacts.

This section contains site specific information on the human and environmental impacts of the proposed PINGP EPU project and mitigative measures taken to minimize these impacts. The impacts evaluated include those resulting from construction and implementation of the proposed project and include potential impacts of the proposed project on water resources, air quality, noise, vegetation, fish, wildlife, traffic, land use, socioeconomic factors, and cultural resources.

The Final Environmental Statement related to the Prairie Island Nuclear Generating Plant, dated May 1973 (United States Atomic Energy Commission) and the Prairie Island Nuclear Generating Plant License Renewal Application Units 1 and 2, Appendix E - Environmental Report dated April 2008, provide additional descriptions of the environmental setting in which the PINGP was built and is situated.

4.1 AIR QUALITY

The region surrounding Redwing is an "attainment area" that currently meets all federally allowed air concentration limits for criteria air pollutants. The EPU project will not affect air quality in the area. Non-radiological air emissions are not expected to increase or decrease as a result of the EPU. No changes to the MPCA air permit are required due to the EPU.

Gaseous radioactive wastes are discussed in Section 4.13.

4.2 BIOLOGICAL RESOURCES

Biological resources include the identification and assessment of the vegetation, wildlife and wetland resources in the project area and the impact of the project on those resources.

Aquatic Communities

The Upper Mississippi River near the PINGP site supports a variety of plant and animal species that are typical of free-flowing rivers in the upper Midwest. The major primary producers, or plant groups, present are periphyton (attached algae), phytoplankton (floating algae), and macrophytes, which are larger flowering plants, either rooted or floating. Near the site, periphytons are the most important primary producer. Their ability to attach to underwater substrates allows these organisms to function in the higher velocity waters near Redwing.

Although big river ecosystems show a high degree of natural variability and aquatic populations in these rivers can experience dramatic changes between years, fish populations in the area of

Prairie Island show a high degree of stability. Fish populations in the vicinity of Prairie Island today look remarkably like fish populations in the 1970s.

A relatively small number of native species (carp, planted in the Mississippi River in the 19th century, are the exception) has dominated collections for 35 years. All indications are that these populations are healthy, composed of fish in good condition, and are reproducing successfully year after year.

Mississippi River aquatic communities upstream of Lock and Dam No. 3 have been monitored since 1970 to determine if the operation of the PINGP was having an effect on distribution, abundance, and overall health of aquatic biota. Since the mid-1970s, fish have been the focus of biological monitoring and study.

The Minnesota Pollution Control Agency has listed the portion of the Mississippi River between the St. Croix and the Chippewa Rivers in Wisconsin as impaired waters for 2006 for aquatic consumption, due to the presence of mercury and polynuclear chlorinated biphenyls (PCBs), and for aquatic life due to turbidity.

Various agencies (DNR, MPCA and the Wisconsin DNR) have been directly involved with negotiations and consultations for the licensing, permitting, and general operation of the PINGP. A wealth of biological, physical, and water chemistry data has been gathered and reviewed by these agencies over the operating life of the PINGP. The required monitoring of the fish populations, upstream and downstream of the plant discharge, has been conducted to provide assurance that any impairment to aquatic biota of the river is avoided or reduced to the lowest practical level. The monitoring has demonstrated that the discharge resulting from past operation of the PINGP has not caused appreciable harm to aquatic organisms, and that the protection and propagation of a balanced, indigenous biota has been maintained.[12]

Impingement and Entrainment

Fish and other aquatic organisms can be killed or harmed when they are pulled into power plant cooling water intake systems. Section 316(b) of the Clean Water Act (CWA) requires the location, design, construction, and capacity of cooling water intake structures to reflect the best technology available for minimizing adverse environmental impacts.

The current PINGP NPDES permit already reflects major modifications in design and operation of the Cooling Water Intake Structure (CWIS) made in the early 1980s to minimize entrainment and impingement mortality and constitutes the current CWA Section 316(b) determination for the PINGP. In addition to the hardware changes to the CWIS structure, the NPDES permit also imposes limits on plant withdrawal of cooling water over the April 15 to June 30 period:

April 15 – 30 97 mgd when river flow < 15,000 cfs

[12] Minnesota Department of Natural Resources Comment Letter on the PINGP Scope. October 7, 2008.

April 15 – 30 194 mgd when river flow > 15,000 cfs

May 01 – 31 194 mgd

June 01 – 15 259 mgd

June 16 – 30 517.5 mgd

The design changes and flow/withdrawal restrictions in spring and early summer are intended to reduce both impingement and entrainment mortality. NPDES permit No. MN 0004006, Chapter 6, Section 4.1, contains specific requirements related to intake screen operation. The PINGP is allowed to operate with a 3/8-inch mesh screen from September 1 – March 31, but must employ fine mesh (0.5 mm) screens over the April 1 – August 31, period to minimize the mortality of fish and other organisms.

The EPU will not affect impingement and entrainment significantly. There is not expected to be any significant increases in the mortality of fish or other aquatic organisms above present levels due to the EPU. The EPU does not introduce any significant changes to the screen wash, service water, or circulating water flow requirements and does not involve any changes to the water appropriation requirements of the NPDES permit.

Themophilic Organisms and Pathhogens

The thermal plume is normally formed by the cooling tower discharge during spring, summer, and fall. During the winter, helper-cycle operation is typically used, subject to permit limitations on downstream river temperature and the need to deice intake screens and other associated equipment. Thus, the size and characteristics of the thermal plume vary over the course of the year, depending on the mode of operation of the circulating water system. The current NPDES permit limits act to minimize the size of the plume and resultant stress to aquatic biota when the ambient river temperatures are high.

Thermophilic bacteria generally occur at temperatures from 77°F to 176°F, with maximum growth at 122°F to 140°F. While water at the PINGP discharge temperatures could, in theory, allow limited survival of thermophilic microorganisms, these temperatures are well below the optimal for growth and reproduction of thermophilic microorganisms. The probability of the presence of thermophilic microorganisms due to plant operations is low.

During the early 1980s, PINGP identified the presence of the parasitic amoeba *Naegleria* at high population densities within the plant's circulating water system. In cooperation with the Minnesota Pollution Control Agency and Minnesota Department of Natural Resources, Prairie Island conducted chlorination and subsequent dechlorination of the circulating water system in August 1980, September 1981, and August 1983. The chlorination processes were successful in controlling and reducing the populations of the organisms; however, the dechlorination process does impact the fish populations in the Mississippi River. Although the Minnesota Department of Health did not consider the presence of the organism to be a public health threat, it was recognized as an occupational health hazard and plant personnel were instructed to wear protective equipment when in contact with the circulating water system components. The PINGP continues to periodically chlorinate the circulating water system to control microbiological organisms and zebra mussels in accordance with the NPDES permit requirements.

Given the thermal characteristics at the PINGP discharge and the fact that Xcel Energy periodically chlorinates the circulating water system, it is not expected that a less than 3° F inlet temperature increase to result in any significant increase in harmful thermophylic organisms in the discharge canal. Under certain circumstances, these organisms might be present in limited numbers in the station's discharge, but would not be expected in concentrations high enough to pose a threat to recreational users of the Mississippi River.

Cold Shock

Cold shock is caused by an unplanned shutdown. The probability of an unplanned shutdown is independent of the EPU. The projected increase in discharge-canal-inlet temperature of less than 3°F does not result in a significant increase in the overall discharge canal temperature; thus, the magnitude of the temperature decrease in a cold shock situation is not significantly changed. The cold shock concerns of river fish species have been reduced at the PINGP by the construction of a discharge structure at the end of the discharge canal and by the construction and operation of the intake screenhouse. The discharge structure and intake screens limit the number of fish in the discharge canal and reduce the impact of cold shock on aquatic species of the river.

Terrestrial Communities

Approximately 240 acres of the Prairie Island site were disturbed and modified by plant construction activities in the early 1970s. Approximately 60 acres of the 240 disturbed acres support the generating facility and associated buildings, maintenance facilities, parking lots, and roads. After plant construction was completed, the remaining 180 acres of disturbed land were landscaped and today most of this is mowed grass or unmowed prairie-like grassland. The remainder of the site (approximately 338 acres) consists primarily of scattered wooded areas.

Wildlife species in the forested and the open grassy portions of the Prairie Island site are those typically found in similar habitats of southeastern Minnesota. Upland areas tend to be dominated by burr oak (Quercus macrocarpa), red oak (Q. rubra), bitternut hickory (Carya cordiformis), and Eastern red cedar (Juniperus virginiana). Common trees in lower areas along the Mississippi River, Sturgeon Lake, the Vermillion River, and river sloughs include silver maple (Acer saccharinum), cottonwood, green ash (Fraxinus pennsylvanica), American elm (Ulmus americana), box elder (Acer negundo), river birch (Betula nigra), and willows (Salix spp.) The topography of the site is level to slightly rolling, and elevations range from about 690 to 700 feet above mean sea level (msl).

Rare and Unique Natural Resources

The proposed EPU will be limited to the existing plant footprint. Therefore, no incremental impacts to native plant communities or terrestrial organisms, including birds, are anticipated. The only impact to natural resources will be the off-site impact of the slight increase in the temperature of the cooling water discharged to the Mississippi River (up to 3° F) primarily during the fall and winter, when "once through" cooling is used.

Minnesota DNR was contacted, by the applicant, to obtain records from the Natural Heritage Information System ("NHIS") database of known locations of sensitive species. The NHIS database includes known locations of endangered, threatened and special concern species, as well as occurrences of unique or uncommon plant communities and habitat types (**Appendix C**).

The species indicated in the October 2007 DNR response include birds, fish, mollusks, plants, and amphibians. All six species that are state-listed as endangered are mollusks; each of these species has been observed in the Mississippi River within one mile downstream of the plant. The Higgins' eye pearly-mussel (*Lampsilis higginsii*) is also listed as endangered at the federal level and the sheepnose (*Plethobasus cyphyus*) is a federal candidate species. The Higgins' eye pearly-mussel has been observed both upstream (~0.3 miles) and downstream of the PINGP plant (just under one mile).

The sheepnose has been documented approximately one mile downstream of the plant. Of the remaining species, there are three state-threatened species – the paddlefish (*Polyodon spathula*), Blanding's turtle (*Emydoidea blandingii*) and the peregrine falcon (*Falco peregrinus*). The remaining species on the NHIS records for the area are special concern species.

Impacts to mollusks and other aquatic organisms would be related to changes in water quality, such as increases in thermal discharge from the plant into the Mississippi River. Water temperature can influence the timing of certain aspects of the mollusk life cycle, including the timing and length of release of the immature form of mollusks to attach to host fish species.
The slight increase in the temperature of cooling water discharge due to the EPU should not affect mollusk species or other aquatic organisms.

Prairie Island is located in the Mississippi flyway, a major route for migratory bird species. A variety of birds follow this route when migrating to and from their breeding or wintering grounds. State-threatened peregrine falcons (*Falco peregrinus*) have been observed nesting within the site since 1997. A nesting box was mounted to a ledge on the containment dome of the power plant in 2006. Bald eagles *(Haliaeetus leucocephalus)*, a state-listed species of special concern and previously listed as threatened at the federal level, have been observed in the vicinity of the Prairie Island plant. In addition, the original Prairie Island FES (AEC 1973) stated that trumpeter swans (*Cygnus buccinator*), which are state-listed as threatened, might migrate through the plant area. The MN DNR database shows this species in Dakota County and records maintained by the Minnesota Ornithologists' Union indicate that trumpeter swans are occasionally observed in Goodhue County (MOU 2006). The slight increase in discharge temperature to the Mississippi River in the area will not affect these bird species.

Higgins Eye pearly-mussel

Mussel surveys conducted by the Corps of Engineers in 1986, 1999, 2000, and 2003 did not reveal any Higgins' eye pearly-mussels in the area around Lock and Dam 3 (USACE 2006). However, this species has been cultured (reared in cages) and recently re-introduced into lower Pool 4 and both upper and lower Pool 3 (Sturgeon Lake) of the Mississippi River. The Sturgeon Lake relocation site, where 195 sub-adult *Lampsilis higginsii* were placed in 2003 and 1,400 more sub-adults were placed in 2005 (Mussel Coordination Team 2005), is approximately 0.5 mile up-river of the PINGP Intake Screenhouse.

The life cycle of *L. higginsii* is complicated, with sessile adults releasing planktonic larvae (known as glochidia) that are parasitic, attaching to the gills of fish. Glochidia develop on the gills of host fish for several weeks and drop off as juveniles, ultimately settling on suitable substrate and (if successful) growing into adults. In the genus *Lampsilis*, the mantle of the female grows into a ribbon-like appendage that resembles a minnow and is believed to have evolved to attract fish hosts. Females are known to expel glochidia in the presence of these fish, increasing the likelihood that they will attach to fish gills and survive. Sauger, walleye, yellow perch, largemouth bass, smallmouth bass, and freshwater drum all serve as hosts for Higgins eye glochidia. When glochidia are released into the water column in the absence of fish, survival is greatly reduced.

State (MN DNR) and federal (FWS and USACE) agency partners determined that the area 0.5 mile north of the PINGP intake was suitable area for the relocation of *L. higginsii*, notwithstanding the fact that it was a short distance upstream of the plant's intake. Sub-adult *higginsii* planted upstream of the PINGP intake screenhouse in 2003 reached adulthood (sexual maturity) in 2005 and are assumed to be releasing glochidia into Sturgeon Lake. It is conceivable that some larval *higginsii* will be carried downstream into the power plant's intake screenhouse. It should be noted, however, that mortality rate of early life stages of mussels is very high under the best of circumstances, and glochidia that do not attach to fish hosts soon after being released have a very low probability of survival.

The Mississippi Flyway

The Mississippi Flyway is a bird migration route that generally follows the Mississippi River in the United States and the Mackenzie River in Canada. The main endpoints of the flyway include central Canada and the region surrounding the Gulf of Mexico. Some birds even use this flyway to migrate from the Arctic Ocean to Patagonia.

Birds use this route along the Mississippi River typically because no mountains or ridges of hills block this path over its entire extent. Good sources of water, food, and cover exist over its entire length. About 40% of all North American migrating waterfowl and shorebirds use this route as well as many birds of prey. The longest migration route of any in the Western Hemisphere lies in this flyway. Its northern terminus is on the Arctic coast of Alaska and its southern end in Patagonia. During the spring migration some shorebirds travel the full length of the flyway and several species that breed north in Yukon and Alaska cover the larger part of it twice each year. This route is used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warblers, thrushes, hawks, owls, and eagles.

4.3 CULTURE, ARCHEOLOGICAL and HISTORIC RESOURCES

In September and October of 2007, The 106 Group Ltd. (106 Group) conducted a cultural resources assessment of the PINGP.[13] The assessment was conducted under contract with the Nuclear Management Company (NRC), which was preparing an application to renew PINGP's federal nuclear power plant operating license.

The methodology utilized by the 106 Group for the Archaeology Study included an extensive review of the collected site files, reports, and other literature to aid in determining the areas of previous disturbance within the study area and assess archaeological sites potential. Additional documentary sources were consulted, including aerial photographs, historical plat maps, General Land Office survey maps, and USGS topographic maps. The original 1853 land survey map was also reviewed.

In addition to the resources above, the architectural history investigation included background research at the SHPO to identify recorded architectural history properties or surveys within the study area.

No site visits were undertaken.

The study area for the Cultural Resources Assessment included the entire area within the boundaries of the PINGP plant and grounds. A railroad line running diagonally from northwest to southeast through the study area is not part of the PINGP property and, thus, splits the study area into two sections (**Figure 4-1**).

The PINGP is located on Prairie Island, near the city of Red Wing, a region that is extremely rich in pre-contact Mississippian Period archaeological resources. Eight pre-contact villages and hundreds of mounds have been recorded at the confluence of the Cannon and Mississippi Rivers. Other sites date to the Woodland Period, earlier than the Mississippian tradition. Prairie Island was also the site of at least one French fur trading post during the contact period. Historically, Prairie Island has been the reservation home for the Mdewakanton Dakota since 1889. In the late 1960s, Northern States Power (NSP) purchased a portion of the island to construct their nuclear energy facility.

[13] Cultural Resources Assessment for the Prairie Island Nuclear Generating Plant in Goodhue County, Minnesota. The 106 Group Project No. 07-32. January 2008.

Information gathered from the cultural resources assessment is shown on **Table 4-1 and Figure 4-2**.

There are six National Register historic sites located within five miles of the PINGP: five of the historical sites are in Goodhue County, Minnesota and one is in Pierce County, Wisconsin (**Table 4-2 and Figure 4-3**).

The proposed EPU will be limited to the footprint of the existing buildings, thus no impacts to archaeological artifacts are anticipated as a result of the EPU project. Xcel Energy will follow standard procedures during implementation of the EPU to avoid potential impacts to artifacts that may have not yet been discovered on the site. To avoid impacts to potential archaeological artifacts during any construction projects on the site, Xcel Energy has developed a corporate procedure ("Excavation and Trenching Controls," number FP-IH-EXC-01) that protects cultural resources at all its plant sites.

The procedure requires a review of any planned excavation (greater than 6 inches deep) to ensure the protection of archaeological and historical resources.

The Site Environmental Coordinator is responsible for determining if proposed land-disturbing activity will occur in the vicinity of a culturally significant site, and if so, consulting with the SHPO to mitigate potential impacts. The Site Environmental Coordinator is also responsible for evaluating any cultural artifacts inadvertently discovered during construction to determine if the material discovered has potential archaeological or historic significance and thus should be reported to the SHPO.

In accordance with the procedures, the discovery of cultural artifacts requires employees to stop work until the Site Environmental Coordinator has evaluated the situation. Work can resume only after the situation had been addressed, disposition of any material or artifacts has been documented, and the Site Environmental Coordinator agrees that culturally significant material is not at risk.

4.4 GEOLOGY and SOILS

The PINGP site occupies an outwash terrace formed on the Minnesota side of the Mississippi River. The site is located at an elevation of about 690 feet above mean sea level (msl), about 15 feet above the normal pool elevation of the river. The general area is nearly level, with a local relief ranging from about 675 feet above msl (along the river frontage) to about 700 feet above msl. There are a few scarps along the Mississippi River shoreline that have resulted from river scouring.

The type of bedrock beneath the area is predominantly composed of sedimentary rock of the St. Lawrence and Franconia Formations, both within the Upper Cambrian System.

The St. Lawrence Formation is comprised of tan to gray, well-cemented, thin- to medium-bedded silty dolostone and siltstone. There are also thin shale beds. The dolostone in this formation contains variable amounts of clay, silt, sand and glauconite. Thin to medium beds of very fine grained sandstone are common, particularly in the upper 20 feet of the formation. This formation is typically about 40 to 50 feet in thickness.

The Franconia Formation is mostly comprised of glauconitic, feldspathic, very fine to fine-grained sandstone. There is also green and gray shale, and pink or tan, sandy, glauconitic dolostone. Intraclasts and burrow mottling are common in this formation. The Franconia Formation is generally coarser grained and more poorly cemented than the St. Lawrence Formation. This formation is typically about 165 to 175 feet in thickness. Three members of the Franconia Formation are recognized; these are the Reno Member, the Tomah member and the Birkmose member.

The Reno Member comprises the upper 90 to 100 feet of the Franconia Formation. It consists of very fine grained to fine-grained glauconitic sandstone interbedded with siltstone and shale.

The Tomah Member comprises the medial 40 feet of the Franconia Formation. It consists of interbedded, very fine-grained sandstone, siltstone and shale, with minor amounts of the mineral glauconite. This member is finer grained and has more shale than adjacent members.

The Birkmose Member comprises the basal 30 feet of the Franconia Formation. It consists of very fine grained to fine-grained sandstone, with abundant glauconite. Dolomite cement and sandy dolostone beds are common.

The depth to bedrock beneath the PINGP site is approximately 100 feet. Overlying the bedrock is sand and gravel of the Holocene and Pleistocene age Grey Cloud terrace. The Grey Cloud terrace is comprised of coarse, clean sand and gravel derived from the Mississippi valley train and reworked by the swift water of the River Warren, an ancient river formed by the meltwater of the combined ice lobes of the Minnesota and western Wisconsin glaciers.

The prevalent soil types at the PINGP are the Plainfield loamy sand and the Sparta loamy sand. The Plainfield loamy (PaB) sand is a nearly level to steep, excessively drained soil on benches and escarpments along major streams. This soil formed in sandy outwash. Permeability is rapid and water capacity is low in this soil, and the hazard of drought is severe with respect to crops. The hazard of erosion or soil blowing is moderate in areas without vegetative cover. This is the dominant soil mapped in the area, comprising the entire northern and central portions of the essentially inverted triangle-shaped PINGP site.

The Sparta loamy sand (SpA) is a nearly level, excessively drained soil on benches of major streams. This soil formed in sandy outwash. Slopes are smooth and decline in the direction of the escarpments adjacent to the flood plain. Permeability is very rapid and water capacity is low in this soil, and the hazard of drought is severe with respect to crops. The hazard of erosion or soil blowing is also severe in areas without vegetative cover. Some deep gullies occur along escarpments where surface runoff spills over. This soil is mapped in the southern part of the PINGP site.

The EPU will not impact the geologic or soil resources on the site.

4.5 HEALTH and SAFETY

This section identifies the potential impacts on public health and safety that could result from implementation of the proposed EPU. Public health and safety are not necessarily environmental factors, but it is important for public decision makers to consider how features of the proposed EPU may affect health and safety issues.

The EPU does not create any new or different sources of offsite radiological doses from PINGP operation, and it does not involve significant increases in present radiation levels. Therefore, it is reasonable to conclude that the offsite dose will remain well within regulatory criteria with no significant environmental impact; for further analysis on radiological impacts see Section 4.13 of this chapter and Chapter 2, Section 5.0.

Health Studies
See Section 4.13 for a discussion on health studies.

Emergency Planning
See Section 4.13 for a discussion on emergency planning.

Electric and Magnetic Fields (EMF)
Voltage on any wire (conductor) produces an electric field in the area surrounding the wire. The electric field associated with high voltage transmission lines (HVTLs) extends from the energized conductors to other nearby objects, such as the ground, towers, vegetation, buildings, and vehicles. The electric field from a transmission line gets weaker with increasing distance from the transmission line. Nearby trees and building material also greatly reduce the strength of transmission line electric fields.

The intensity of electric fields is related to the voltage of the transmission line.

Current passing through any conductor, including a wire, produces a magnetic field in the area around the wire. The magnetic field associated with HVTLs surrounds the conductor and decreases rapidly with increasing distance from the conductor.

The question of whether exposure to power frequency [60 Hertz (Hz)] magnetic fields can cause biological responses, or even health effects, has been the subject of considerable research for the past three decades. The most recent and exhaustive reviews of the health effects from power frequency fields conclude that the evidence of health risk is weak. The National Institute of Environmental Health Sciences (NIEHS) issued its final report, *NIEHS Report on Health Effects* *from Exposure to Power-Line Frequency Electric and Magnetic Fields,* on June 15, 1999, following 6 years of intensive research. NIEHS concluded that there is little scientific evidence correlating extra low frequency electromagnetic field (EMF) exposures with health risk.

The Prairie Island Nuclear Plant currently has four existing 345kV electric power transmission lines. No additional lines are necessary to support the extended power uprate.

The average magnetic field strength from each of these lines, measured in milliGauss or mG, is 107 mG directly under the power line (based on 2008 peak flow). This number reduces to 7 mG at 100 feet from the line, 2-3 mG at 200 feet and 1 mG at 300 feet. The average electric field strength from each of these lines, measured in kilovolts per meter or kV/m, is 5.8 kV/m directly under the power line. This number reduces to 0.16 kV/m at 100 feet from the line, 0.05 kV/m at 200 feet and 0.03 kV/m at 300 feet.

The earth contains natural electric and magnetic fields. Some levels of these fields are always present. Customers located 300 feet or more from the transmission lines only receive EMF levels consistent with naturally occurring levels of EMF.

The amount of electricity flowing in the transmission lines may increase following the EPU if and when there is an increase in demand for electrical power. If this does occur, there will be no change to the electric field strength (kV/m) but, the magnetic field strength (mG) will increase slightly. Based on an analysis of 2008 peak power flows, assuming the 164 MW increase from the EPU is spread evenly across the four 345 kV transmission lines, the average magnetic field strength directly under the lines would increase by approximately 15%.

Consumption of Local Plants and Animals

The MDH Radioactive Materials Unit, Indoor Environments and Radiation Section conduct annual environmental radioactivity monitoring in Minnesota.[14] Media sampled include milk, air, river water, groundwater, food crops and sediments. Monitoring allows the MDH to develop a database on radioactivity within the state.

The environmental monitoring program consists of:

- sample collection around the two nuclear power generating plants;
- measurement of gamma radiation near the nuclear power generating plants;
- surveying of spent fuel storage casks;
- radiochemical analysis of the samples by the MDH Public Health Laboratory and interpretation of the data; and
- estimation of doses from the nuclear power plants.

In 2006, no federal or state standards or guidelines were exceeded anywhere in the state, including near the nuclear power generating plants.

[14] 2006 Environmental Radiation Data Report. Minnesota Department of Health, Radiation Control Unit.

Monitoring data can be accessed through the Minnesota Department of Health and Wisconsin Department of Health Services' web sites.[15,16]

See Section 4.13 for additional information.

Psychological Impacts Associated with Living Near a Nuclear Generating Plant

OES staff conducted a literary search in an effort to obtain information on the potential psychological impacts associated with living near a nuclear generator power plant.

The vast majority of articles dealt with post incident (i.e., Chernobyl, Three Mile Island, Diablo Canyon) surveys or studies. Other studies dealt with public opinions of the nuclear industry generically. Neither of these categories seemed appropriate to the proposed EPU.

Research which has focused on communities living in very close proximity to nuclear facilities, has found that proximity is associated with somewhat higher levels of support for nuclear power. A commonly voiced explanation is that acceptance of, or refusal to overtly criticize, nuclear power by those living close to an existing nuclear facility, stems from the perceived economic benefits it brings to a host community, in particular where a community is otherwise economically marginalized. However, even where support and acceptance is expressed, this can be highly qualified with a degree of underlying unease. For the reader interested in this topic, staff recommends a British study that looked at three communities (South Gloucestershire, Essex and Bridgwater) with nuclear power stations.[17]

Additionally, considering the comments received during the site permitting process for the Monticello Nuclear Generating Plant uprate (PUC Docket Number E002/GS-07-1567) versus the public comments expressed during these proceedings, it would appear that assessing the potential psychological impacts of a given facility on its host community would be very specific to each community. To adequately assess this impact would require a level of detail (i.e., basic research) that is outside the scope of this environmental review.

4.6 LAND USE

The PINGP is on an approximately 560-acres site in Goodhue County, on the west bank of the Mississippi River, within the city limits of Red Wing, Minnesota. The city of Hastings is approximately 13 miles northwest (upstream) of the plant. Minneapolis is approximately 39 miles northwest and St. Paul is approximately 32 miles northwest of the plant.

The PINGP is located adjacent to the Prairie Island Indian Community Reservation. In 1936, the federal government officially recognized Prairie Island Indian Community (PIIC) as a

[15] http://www.health.state.mn.us/divs/eh/radiation/monitor/pi/index.html
[16] http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/EnvironmentalMonitoringNuclear.htm
[17] Pidgeon, N.F., Henwood, K.L., Parkhill, K.A., Venables, D. and Simmons, P. (2008) *Living with Nuclear Power in Britain: A Mixed Methods Study*. School of Psychology, Cardiff University.

reservation for the Mdewakanton, awarding them 534 acres. The Prairie Island Indian Community is a Federally Recognized Indian Tribe organized under the Indian Reorganization Act (25 USC 476). Currently, the reservation population is approximately 160, while the total enrollment of the tribal community is 486. The Tribal government employs about 100 members on a variety of service projects. The PIIC owns and operates Treasure Island Resort and Casino, employing about 1500 people.

The Treasure Island Resort and Casino includes a 250-room hotel and convention center that is currently being expanded to include an additional 230 rooms (Treasure Island Resort and Casino undated). The expansion includes a 24-lane bowling center and a multi-use event center with a maximum seating capacity of 2,800. Treasure Island Resort and Casino offers gaming, dining, live entertainment, a 95- space RV park, a 137-slip marina to accommodate visitors arriving by the Mississippi River, and sightseeing and dinner cruises on their river boat.

Goodhue County and the adjacent counties of Dakota and Pierce (in Wisconsin) remain predominantly rural but are rapidly developing. Principal crops include soybeans, corn, oats, hay, and some cannery crops.

Zoning/land Use

The Goodhue County covers approximately 499,369 acres of land. Existing land use in the County is as follows: agricultural land - 64 percent, deciduous forests - 20 percent, grassland - 10 percent, farmsteads and other rural developments - 2 percent, areas that are urbanized or industrialized -1 percent, wetlands - 1 percent, and other – 2 percent.

Goodhue County uses a comprehensive land use plan, and zoning and subdivision ordinances to guide development.[18] The ordinances promote the public health, safety, and general welfare of residents; protect agricultural land from urban sprawl; and provide a basis for orderly development. The ordinances require building permits, conditional use permits, plat development, zoning district controls, and variance requests. The County, however, has no formal growth control measures

Dakota County is located west of the PINGP site and covers approximately 371,200 acres. A very small portion of this County falls within five miles of the site. This area is classified as Vacant/Agricultural on the Dakota County Land Use and Cover map, State of Minnesota 1990.[19] This classification comprises 74% of Dakota County. This information was compiled by the Land Management Information Center and is the most recent Land Use data available for this county.

Pierce County covers approximately 378,240 acres, and is currently in the first phase (data collection) of developing a countywide comprehensive plan. Pierce County GIS contains a rudimentary land cover classification of field and non-field. Additional land use mapping is not

[18] http://www.co.goodhue.mn.us/misc/files/CompPlan_2004.pdf
[19] http://www.lmic.state.mn.us/chouse/land_use_recent.html

planned at this time because of the nonexistent relationship between township zoning classifications and land use. Predominant land use within five miles of the PINGP are Agricultural, and water (Mississippi River). Until a comprehensive land use plan is complete, the County's municipalities through the use of local zoning and subdivision regulations guide land development activities.
None of the EPU-related activities represent any changes in land use or displace other land uses because the site is already developed for power generation.

Demographics
Population information was obtained from Census Bureau Topologically Integrated Geographic Encoding and Referencing system (TIGER) /Line File, Version 2000.[20] The 2000 TIGER/Line file uses town and city boundaries as of January 1, 2000. **Figure 4-4** presents this data for the permanent population within 50 miles of the PINGP by minor civil divisions. Each civil division is color coded by range of population. Based upon this information, the total permanent population within 50 miles of the PINGP is calculated to be 2,949,234. This estimate is slightly conservative since, where the 50-mile radius bisects a civil division; the entire population of the civil division has been included.

Red Wing (approximately 3 miles southeast) is the nearest population center, with a 2000 population of 16,116.[21] Minneapolis (approximately 39 miles northwest), St. Paul (approximately 32 miles northwest), and Rochester (approximately 50 miles southeast) are the largest population centers within the 50-mile radius, with 2000 populations of 382,618, 287,151, and 85,806, respectively (USCB 2000).

From 1990 to 2000, the population of the Red Wing increased from 40,690 to 44,127, an increase of 8.4 percent. The population of the Minneapolis-St. Paul-St. Cloud, MN-WI CSA increased from 2,809,713 to 3,271,888, an increase of 16.4 percent.[22]

Because approximately 83 percent of employees at the PINGP reside in Goodhue and Dakota Counties, MN and Pierce County, WI, they are the counties with the greatest potential to be economically affected by the EPU.

Over the last couple of decades, all three counties and both states have experienced positive growth rates and are projected to continue to grow. By far, Dakota County experienced the greatest growth from 1980 to 2000. While Dakota County's growth rates are somewhat larger than those of the other counties and states, Minnesota demographers project that growth to slow as 2030 approaches.

[20] http://www.census.gov/geo/www/tiger/
[21] http://www.lmic.state.mn.us/datanetweb/php/census2000/2000Glance.php
[22] Ibid

The License Renewal Application Environmental Report prepared by Nuclear Management Company, LLC (NMC) provides detailed information on demographic characteristics within 50 miles of the site.

The footprint of the PINGP will not change and the EPU will not affect nearby infrastructure; there will be no displacement of nearby residents or business.

Recreational

There are no National Parks, Monuments, Landmarks, Wilderness Areas, Forests, Trails or Water Fowl Production Areas within five miles of the site. There are no Minnesota State Parks, Wayside Parks, Recreational Areas, State Trails, Zoos, or trout lakes or streams located within five miles of the PINGP. The portion of the Mississippi that passes by the Prairie Island Generating Station is not federally designated as wild and scenic.

There are no State Critical Areas within five miles of the PINGP. The Mississippi River Critical Area Corridor extends southward to the border of Dakota and Goodhue Counties, but is approximately 5.5 miles from the PINGP at its closest point. The Mississippi National River and Recreation Area (MNRRA), a unit of the National Park Service, has been designated as a State Critical Area. The boundaries of the Mississippi River Critical Area Corridor and that of MNRRA are the same.

There are no Wisconsin State Parks, Wayside Parks, Recreational Areas, State Trails, Zoos, or trout lakes or streams located within five miles of the PINGP.

There are federally-owned recreational areas, wildlife refuges, State Wild and Scenic Rivers, State Forest, State Scientific and Natural Areas, State Wildlife Management Areas, and County/local Parks within 6 miles (**Figure 4-5 and Figure 4-6**) of the PINGP.

The Cannon River from Faribault, Rice County to its confluence with the Mississippi River just north of Red Wing, was added to Minnesota's Wild and Scenic Rivers Program in 1980. The mouth of the Cannon River at the Mississippi River, the nearest the Cannon River is to the PINGP, is located in a large wetland complex known as the Rice Lake Bottoms, approximately 2.7 miles south of the site. The purpose of the State Wild and Scenic Rivers Act (Minn. Stat. § 103F.301 et seq.) is to preserve and protect the outstanding Minnesota rivers and their adjacent lands. The Act's intent is not to restore pre-settlement conditions, but rather to prevent intensive development and recreational overuse from damaging these rivers. The legal extent of lands covered by the program is a maximum of 320 acres per each river mile on both sides of the river. All state, local, and special governmental units (councils, commissions, boards, districts, agencies, etc.), and all other authorities must exercise their powers to further the purpose of the act and adopted management plans. Since the Cannon River does not pass directly by the site, management plans associated with this river do not affect the PINGP.

The Cannon River has been designated as a Minnesota Wild and Scenic River because of its outstanding scenic and recreational value. The portion of the river within five miles of the site is considered to be "scenic." The scenic designation is attributed to those rivers that exist in a free-flowing state and where adjacent land is largely undeveloped. Regulations, which are generally more restrictive than shore-land rules, have been established to protect the river in its present condition. In addition, the Cannon Valley offers a diversity of recreational opportunities to area residents. Biking, camping, hunting, and fishing attract thousands of people each year. As described in the Red Wing Comprehensive Plan, the city recognizes the importance of maintaining the Cannon Bottoms in its natural state.

The Richard J Dorer Memorial Hardwood State Forest surrounds the PINGP. According to the DNR, state forest campgrounds have evolved from traditional camping areas within working forests.[23] They provide access to many self-directed activities in forested areas. Unlike state parks, forest campgrounds do not have resident managers, organized nature programs, or modern facilities such as showers and flush toilets. They are semi-modern areas, designed to furnish the basic needs and provide opportunities for recreationists to pursue a variety of unstructured outdoor activities. Campgrounds are patrolled regularly to provide security and service to visitors. While camping is allowed throughout state forests, there are no designated state forest campgrounds near the Prairie Island site. All designated campgrounds in the forest are south and southeast of the PINGP site.

Only 45,000 acres of the nearly 2 million acres of this state forest are owned by the state of Minnesota. The use of mountain bikes, horses, OTVs and ATVs is restricted to designated trails only.

The DNR oversees the Scientific and Natural Areas (SNA) program which serves to preserve natural features and rare resources of exceptional scientific and educational value. SNAs are open to the public for nature observation and education, but are not meant for nor do they support intensive recreational activities. The DNR has identified three types of SNAs in the state of Minnesota: Prairie grasslands, deciduous woods, and coniferous forest. Within five miles of the PINGP, there are two SNAs that are designated as the deciduous woods type. These are described below:

- Cannon River Turtle Preserve – The Cannon River Turtle Preserve, created in 1985, is located along a significant reach of the lower Cannon River. The closest the Cannon River Turtle Preserve is to the Plant is its eastern limit in Harliss, Goodhue County, about 3.2 miles south of the Plant. This 909-acre area contains floodplain forest dominated by silver maple and cottonwood. The site supports habitat for the state-listed threatened wood turtle, which nests on the river's sand bars. This area is accessed by the Cannon Valley Bike trail.

[23] http://www.dnr.state.mn.us/state_forests/sft00033/index.html

- Spring Creek Prairie – The Spring Creek Prairie SNA is located approximately five miles south-southeast of the Plant. This 145-acre site consists of sandstone and limestone outcrops overlooking open, sandy draws where streams once cut their way down to the Mississippi. At the south edge of the SNA, a small maple-basswood community thrives with maiden-hair fern, hepatica, trillium, blood root, and other woodland species. The southwest-facing bluff gives rise to a bedrock bluff prairie as it climbs to a narrow ridge top. The silvery bladderpod, a state-endangered species, grows in one of its largest known populations.

Wildlife Management Areas (WMAs) are part of Minnesota's outdoor recreation system and are established to protect and enhance land and water bodies that have a high potential for wildlife production, public hunting, trapping, fishing, and other compatible recreational uses. Much of the wildlife managers' work is directed toward protecting and enhancing wildlife habitat on WMA lands. For instance, prairie and grasslands are planted to provide prime nesting cover critical to waterfowl and pheasant production. Wetlands are restored and enhanced to benefit waterfowl and other wetland wildlife species. Within five miles of the PINGP, there are two WMAs; they are described below:

- Gore's Pool #3 – Gore's Pool #3 is located three miles north of the PINGP. This 6,449-acre site consists of flood plain marshes, forest and backwater marshes associated with the Mississippi and Vermillion Rivers. The purpose of this WMA is to preserve this natural resource and provide recreational opportunities (fishing and boating) in this unique environment, as well as provide habitat for waterfowl and furbearers. There are three boat launches located within the area and its vicinity. There is a designated Migratory Waterfowl refuge at the southern end of the property, which is off limits to all recreational activities.

- Espen Island – Espen Island is located about 4.9 miles south of the PINGP. This 13-acre site is comprised of bottomland hardwood forest. The purpose of the area is primarily for forest wildlife species and riparian/riverine wildlife species. Wildlife viewing and hunting for small game and waterfowl are allowed in this area.

The state of Minnesota administers several canoe and boating rivers. Two of these are within five miles of the PINGP site and are described below

- **Cannon River -** The Cannon River has few rapids and several dams. Downed trees and logjams are hazards in high water. The river varies in width from 50 to 200 feet. Stream flow usually peaks in early April. Very heavy rains can cause the river to flood. From Faribault to its mouth, the Cannon falls 280 feet, an average of 4.8 feet per mile.

  Bounded by rolling hills, bluffs, farmland and woods in its upper reaches, the Cannon River enters a broad gorge below Cannon Falls, where it is flanked by bluffs up to 300 feet high.

- **Mississippi River (Hastings to the Iowa border) -** From Hastings, Minnesota to the Iowa border the river requires some paddling skills in order to avoid snags and downed trees, especially in the backwaters. Motorboats and barges often throw large waves that can "swamp" canoes. Because the river is so wide, the current can be deceptively swift.

  Spring runoff normally brings the river to its highest flow of the year. Though some stretches are fast and can be dangerous, others are restrained by dams and have little current. The water level in this stretch is always sufficient for canoeing, though winds can be strong.

  This segment of the river is towered on the right and left by spectacular bluffs. The main river channel will be along the east bank at times and along the west bank at other times. Extensive backwaters often extend to the bluffs on the side opposite the main channel.

The SNA Program is administered by the Wisconsin Department of Natural Resources' Bureau of Endangered Resources and advised by the Natural Areas Preservation Council. The purpose of SNAs is to protect outstanding examples of native natural communities, significant geological formations, and archaeological sites. They harbor natural features essentially unaltered by human-caused disturbances or that have substantially recovered from disturbance over time. SNAs also provide the refuges for rare plants and animals. More than 90% of the plants and 75% of the animals on Wisconsin's list of endangered and threatened species are protected on SNAs.

Public use of SNAs is two-fold: scientific research and compatible recreation. These areas are not appropriate for intensive recreation such as camping or mountain biking, but they can accommodate low-impact activities such as hiking, bird watching, and nature study. As such, many SNAs contain few or no amenities such as parking areas, restrooms, or maintained trails.

- Trenton Bluff Prairie (Area #136) – Trenton Bluff Prairie State Natural Area is located in Wisconsin just north of Hager City and roughly four miles from PINGP. This site is owned by the Wisconsin DNR and was established as a State Natural area in 1977. Trenton Bluff Prairie is comprised of two separate dry prairies situated on steep Mississippi River sandstone bluffs, which are capped by massive limestone cliffs and are some of the best examples of prairie remaining in the region.

  The western unit has two prairie openings separated by a wooded draw, while the steeper eastern portion contains open cliff which transitions to shrubby oak woods. The bluff summit rises some 300 feet above the flat, sandy river terrace below with vertical cliffs. Dominant grasses include Indian grass, little blue-stem, big blue-stem, side-oats grama, and needle grass. Near the far western edge of the area, several Great Plains species can be found: foothill bladder-pod prairie sage-wort, ground plum, plains muhly, and prairie larkspur. The state-threatened prairie thistle is also found here.

> The upper cliff area has numerous outcrop crevices that harbor several fern species including slender lip fern and smooth cliff brake. Animal species of concern that inhabit this area include the state-listed endangered peregrine falcon, bullsnake, hognose snake and two butterfly species – olive hairstreak and Reakert's blue.

There is one county designated park and recreational area within five miles of the PINGP. The A.P. Anderson County Park is located approximately 4.5 miles south of PINGP. There are no other known county operated resource areas located within five miles of the site. Goodhue and Pierce Counties maintain numerous boat launches and hiking, biking and snowmobiling trails within 5 miles of the PINGP. There are no county forests located within 5 miles of the PINGP.

The Red Wing Wildlife League manages and operates 2,800 acres of bottomland and floodplain just south of PINGP along the Mississippi River. As the largest landowner in Goodhue County, the League funds restoration and maintenance of its land through membership dues, charitable gambling, donations and usage fees. On its property the League supports hunting, fishing and an environmental learning center.

Red Wing has numerous community parks and playgrounds located within the city limits and along the river, however these are all located greater than five miles from PINGP. A portion of the Cannon Valley Trail is located within five miles of PINGP. This trail, which follows the Cannon River offers biking, hiking, in-line skating, skateboarding and cross-country skiing opportunities. As discussed previously, the Prairie Island Indian Reservation supports several recreational resources including a marina and camp ground.

The City of Red Wing, as part of its Comprehensive Plan published in 2006 has developed policies for the continued development and enhancement of parks, trails, open space and public art. These policies are focused on conserving and establishing a network of "Green Infrastructure" in order to improve quality of life for its citizens and provide wildlife habitat.

Except for transportation of equipment and routine disposal of waste, the EPU construction, operation and maintenance activities will be confined to the inner-plant security fenced area. The EPU project will not affect the storage requirements for above- or below-ground tanks. Other lands located outside the inner security fence will not be modified or changed to support EPU activities.

4.7 NOISE

A sound level survey was conducted on November 15-16, 2006, to document the existing ambient sound levels at the closest residents to the plant. This data was used to assess the noise impact of the construction and operation of the spent fuel storage facility. The plant was operating during the ambient survey, but the cooling towers were not. The wind was mostly calm to 3.5 mph from the north, the temperature around 39^{o} F, with overcast skies and a 46 percent relative humdity.

The State of Minnesota has noise standards found in Minnesota Rule 7030.0040, Subp. 2. These rules limit the daytime L50 sound level to 60 dBA1. The L50 is the sound level exceeded 50 percent of the time.

Six noise measurement locations were used and are shown in **Figure 4-7**. The measured ambient sound level data are summarized in **Table 4-3**. As indicated in the table the daytime sound levels are mostly controlled by local traffic and trains. The highest sound levels were at Location #3 near the casino, which was in the 43-46 dBA range because of casino related traffic. The quietest levels were generally the more distant locations, such as #1 and #6, which were mostly in the 32-36 dBA range or about 10 dBA quieter than the levels near the casino. Locations #2 and #4 were in between, in the range of 40 dBA.

The power plant was only audible at Location #1, with what sounded like ventilation fan noise.

The power uprate will not result in any significant changes to the character, sources, or energy of noise generated at the PINGP. The majority of new equipment necessary to implement the EPU will be installed within existing plant buildings – the new transformers being the exception. All equipment will be installed within the existing plant footprint. No new significant noise-generating equipment is planned as part of the EPU project. No significant increases in ambient noise levels are expected within the plant.

4.8 SOCIOECONOMICS

On a local economic level, the construction activities for the power uprate project are expected to occur primarily during refueling outages in 2012 for Unit-1 outage and 2015 for Unit 2 outage.

The size of the workforce during the two refueling outages when power uprate is implemented is not expected to change significantly from the size of the workforce during a normal refueling outage. In addition, the size of the PINGP's workforce during periods of normal operation will be the same before and after the power uprate.

Resources such as groundwater or surface water will be utilized within established appropriation limits. There are no anticipated changes to the distribution or demand for these resources that could affect other economic activities. Tourism, forestry, and mining activities are not dependent on the site or its immediate environs and therefore are unlikely to be increased or decreased as a result of the power uprate.

There is minimal to no impact from the EPU on the size of PINGP or the city of Red Wing's workforce during periods of normal operation. Because no changes to existing workforce are anticipated, no workers will be displaced by the EPU.

No impacts to public activities including recreation are anticipated because the EPU activities will be confined to within the plant boundaries and primarily the existing plant buildings.

Although minor changes in thermal discharge are anticipated, these changes are unlikely to have any noticeable effect on recreation (e.g. sport fishing).

No additional demands will be placed on public services because significant changes to the site, workforce, and infrastructure are not anticipated as part of the project. The EPU is not anticipated to result in additional traffic generated beyond normal levels currently experienced at PINGP during periods of power generation and refueling outages. Modifications to accomplish the EPU will be completed primarily during refueling outages and equipment deliveries for EPU will not involve deliveries that are materially different from those required during past refueling outages. Post EPU traffic patterns will not differ from levels currently experienced during normal operations.

Since the footprint of PINGP will not change and the EPU will not affect nearby infrastructure, there will be no displacement of nearby residents or business

4.9 TRANSPORTATION

The PINGP is served by a transportation system that includes US Highways, Minnesota State highways, county roads and local access roads. U.S Highway 61 is a two and four lane roadway which runs north/south from the Minneapolis/St. Paul Metropolitan area to the junction of Minnesota State Routes 50 and 20 where it turns east to Red Wing and the Mississippi River. From US 61, County Road 19 and 18 provide direct access to the PINGP just north of Red Wing.

Route 61 continues south from Red Wing along the Mississippi to La Crosse, Wisconsin. US Highway 63 crosses the Mississippi River at Red Wing north to Hager City, Wisconsin. Route 63 continues north to Ellsworth and ends just south of Lake Superior. Wisconsin State Highway 35 follows the Mississippi River in the vicinity of the plant. Numerous county and local roads feed the major roadway system in both Minnesota and Wisconsin.

The Red Wing Municipal Airport is located approximately seven miles southeast of the PINGP. The Red Wing Regional Airport is located in Wisconsin, five miles East of Red Wing. The airport is currently completing a major expansion. The airport has a runway 5,010 feet long by 100 feet wide, with full night landing facilities. The airport is now an all-weather operation with state of the art Instrument Landing Systems. Minneapolis-St Paul International/World-Chamberlain Airport (MSP) is the closest international airport to PINGP and is approximately 50 miles northwest of the site.

The Federal Aviation Administration high and low altitude enroute charts were reviewed to determine if there are air traffic corridors within five miles of the site. The site is located approximately 3 miles southwest from low altitude VFR airway V2-97 and high altitude airway J36, both which run on a similar path. V2-97 is used for primarily private airplane flights between Minneapolis/St. Paul, MN and Red Wing, MN, Winona, MN, or La Crosse, WI. J36 is primarily used for commercial jet traffic between Minneapolis/St. Paul, MN and Chicago, IL.

Construction will be completed during planned refueling outages in 2012 and 2015 for Unit 1 and Unit 2 respectively. It is not expected that the number of workers at the PINGP will be significantly higher during the refueling outages when EPU is implemented than during non-power uprate refueling outages. There are approximately 500 additional workers on-site during a typical refueling outage. It is estimated the EPU construction will increase that by a few dozen more. Since the EPU project will only minimally increase the number of workers at the PINGP during the outages, the additional traffic generated is negligible. Power uprate equipment deliveries will involve similar types of equipment deliveries as have been made for past refueling outages. After the project has been implemented, the on-going operation of the plant will not require additional employees and traffic will not differ from current levels.

Traffic safety will not be degraded, because the EPU will not result in a long-term change to the routes, number of trips, types of vehicles, speed compared to current conditions. Any changes affecting traffic will be temporary in nature to accommodate delivery of equipment for the project.

4.10 VISUAL IMPACTS and AESTHETICS

The EPU project will not change the visual appearance of plant features from outside the facility boundaries; therefore, there is no anticipated impact to aesthetics. Cooling tower operation involves the discharge of water vapor that is potentially visible from outside the plant boundaries. Although the number of days that the cooling towers are used may increase by about 20 days per year, resulting in a visible plume, the appearance of cooling tower in operation will not change as a result of the EPU.

4.11 WATER RESOURCES

This section identifies the potential impacts on water resources, including surface waters, groundwater, wetlands, and ice cover) that could result from implementation of the proposed EPU.

SURFACE WATER

The PINGP uses surface water taken from the Mississippi River, under authorization granted through a DNR water appropriation permit, to cool and condense the steam leaving the turbine. The heat from the steam is transferred to circulating water flowing through the condenser tubes. Based on seasonal limitations, this heat is transferred to the environment either by the use of the cooling towers, discharged to the river, or a combination of both. These wastewater discharges are regulated by the MPCA through the NPDES permit (MPCA NPDES Permit Number MN0004006).

Figure 4-8 shows the location of the surface water intake and discharge structures.

Water Appropriation

Flow in the reach of the Mississippi adjacent to PINGP is controlled in part by the Army Corps of Engineers Lock and Dam 3, which creates a pool that, extends upstream to Lock and Dam 2, and also influences stream levels in the St. Croix River. The lock and dam was created by the Army Corps of Engineers as part of a flood control and navigation project. During the initial rise in pool level, Sturgeon Lake was created by the flooding of low lying areas in the floodplain adjacent to the Mississippi River.

At PINGP, the surface water withdrawal from the Mississippi River (Sturgeon Lake) occurred at an average rate of approximately 381,031 gallons per minute (gpm) (849 cfs) for the period from 2000 through 2005. PINGP's water withdrawal from the Mississippi River represents approximately 4.6 percent of the average river flow (18,380 cfs) and 11 percent of the lowest annual mean (7,656 cfs in 1977) at Prescott since completion of Lock and Dam 3. The rate of consumptive use at PINGP is 39 cfs. This value is the difference between PINGP's surface water withdrawal and the average annual blowdown rate discharged under the site's NPDES permit back to the river or the amount of water consumed by PINGP.[24]

The 39 cfs represents approximately 5 percent of PINGP's average river withdrawal during the 2000 to 2005 period. This rate of consumptive use represents approximately 0.2 percent of the Mississippi River's annual average flow and approximately 0.5 percent of the lowest annual mean at Prescott. The storage capacity curve for this section of the river shows that the consumption of 39 cfs , (849 cfs – 810 cfs = 39 cfs) translates into a maximum local water elevation decrease of approximately 0.1 inch. Under normal circumstances, consumptive use of water at PINGP (evaporative losses from cooling towers) represent a small reduction in Mississippi River flow and an imperceptible (0.1 inch) reduction in stream level. A reduction in flow (or stream level) of this magnitude would have only small impacts on instream and riparian ecological communities.[25]

Based on a range of assumptions, the EPU will increase surface water appropriations by approximately 1300 acre ft/year or 10 percent. This increase is within the limits of the current surface water appropriation permit (DNR Water Appropriation Permit Number 690172).

Assuming that evaporative rate is proportional to the proposed power increase of about 10 percent, the EPU could potentially cause an increase in evaporation rate to about 43 cfs. The water loss of 43 cfs by evaporation is about 0.23 percent of the 18,380 cfs average Mississippi River flow and is approximately 1 percent of the lowest annual mean of 4,367 cfs. Based on this comparison, impacts caused by higher evaporative losses of 43 cfs from the Mississippi river are very small and will likely have insignificant impact on the Mississippi River flow.

[24] Applicant's Environmental Report – Operating License Renewal Stage Prairie Island Nuclear Generating Plant Nuclear Management Company, LLC. April 2008. Units 1 and 2 Docket Nos. 50-282 and 50-306 License Nos. DPR-42 and DPR-60

[25] Applicant's Environmental Report – Operating License Renewal Stage Prairie Island Nuclear Generating Plant Nuclear Management Company, LLC. April 2008. Units 1 and 2 Docket Nos. 50-282 and 50-306 License Nos. DPR-42 and DPR-60

Water Discharge: Temperature

The EPU project will slightly increase the temperature of the circulating water discharged to the Mississippi River (3°F maximum). Discharge temperatures will be maintained within current NPDES permit (MPCA NPDES Permit Number MN0004006) limits by increasing the use of cooling towers, which can operate in various modes or, if necessary, by derating the plant to meet permit requirements for water appropriations and thermal discharge. No physical modifications or operational changes are required for these systems to implement the EPU.

The PINGP can be operated in any one of three modes: open cycle (once-through flow, with no cooling towers in operation), helper cycle (once-through flow with cooling towers in operation), and closed cycle (recirculation of up to 95 percent of the cooling water flow). Operation of PINGP's circulating water system is governed by spring and fall "trigger points." The spring trigger point is the point in time that the daily average ambient river temperature increases to 43° Fahrenheit (F) or above for five consecutive days, or April 1, whichever occurs first. The fall trigger point is the point at which the daily average upstream ambient river temperature falls below 43° F for five consecutive days.

In addition, from the spring trigger point to the fall trigger point, PINGP is required to operate the cooling towers as necessary to meet the following requirements:

1. The temperature of the receiving water immediately below Lock and Dam No. 3 cannot be raised by more than 5° F above ambient;
2. the cooling-water discharge can not exceed a daily average temperature of 86° F; and,
3. if the daily average ambient river temperature reaches 78° F for two consecutive days all cooling towers must be operated to the maximum extent practicable (NPDES Permit No. MN0004006).

From the fall trigger point through March 31, the temperature of the receiving water immediately below Lock and Dam No. 3 cannot be raised above 43° F for an extended period of time. If the receiving water temperature exceeds this limit for two consecutive days, Xcel Energy must notify the MPCA Commissioner and the MN DNR. The Commissioner may require us to operate the cooling towers or take alternative action to meet the 43° F criterion (NPDES Permit No. MN0004006).

The potential maximum 3°F increase in surface-water-discharge temperature due to the EPU would occur when the circulating cooling-water system is operated in open-cycle mode. Open-cycle mode is used primarily in the winter when cooling tower operation is not required to meet NPDES permit temperature requirements. In contrast, during closed-cycle and modified helper-cycle operation, the temperature of water entering the discharge canal is expected to increase by less than 0.5°F, due to increased heat removal in the cooling towers. Therefore, the temperature increase is lowest in summer and during periods of low river flow, when NPDES permit limits require cooling tower use.

The resultant increase in downstream river temperature in the modified helper-cycle mode is expected to be less than approximately 0.2° F, even under low river flow conditions.
These increases will not result in any significant impacts to the environment.

Water Discharge: Sedimentation
The water discharge volume at PINGP will not increase due to the EPU. Thus, the impact on sediment distribution will not increase from current operations.

There are no anticipated changes to the river intake flow limits for operation after the EPU is implemented. However, assuming the evaporative rate is proportional to the power increase, there will be an increase in the percentage of that intake flow that is diverted during cooling processes. This increase in use is primarily due to water lost to the atmosphere through evaporation of circulating water as the cooling towers cool it. The increased water use does not represent an increase in the amount of water discharged into the river.

Water Discharge: Water Quality
In addition to the limitations imposed on temperature discharges, the PINGP NPDES permit imposes water quality standards and monitoring/reporting requirements for each discharge.

Table 4-4 lists the surface water discharge streams.

Specific limits for each discharge are detailed in the NPDES permit; none of these limits will require modification to implement the EPU. The EPU will not introduce any new contaminants or pollutants to the existing surface water discharges.

Lake Pepin Ice Cover
The impact of the PINGP's operation on Lake Pepin's ice thickness is an issue that has been discussed for a number of years. DNR resource professionals at Lake City who are familiar with the Lake Pepin area have reported observing uncharacteristic periods of open water areas at the upstream end of Lake Pepin.[26]

Xcel Energy had taken ice thickness measurements on Lake Pepin for a number of years in accordance with Special Provision number 12 of the PINGP discharge permit (#80-5081).

The Special Provision number 12 data under-went an independent review by Dr. H. G. Stefan of the St. Anthony Falls Hydraulic Laboratory.[27] The study and report by H. G. Stefan analyzed the heat input from the plant and attempted to identify any correlation between plant operations and ice thickness at Lake Pepin. The report did not identify any correlation and formed the basis for the Department of Natural Resources decision to allow Northern States Power Company (i.e.,

[26] DNR letter to OES, dated February 20, 2009.
[27] Stefan, HG. Residual Heat Input from the Mississippi River to Lake Pepin During the Winters of 1981/82 to 1985/86. St. Anthony Falls Hydraulic Laboratory. Septmeber 1987.

Xcel Energy) to end measurements of ice thickness at Lake Pepin.[28] While concluding that the ice thickness on Lake Pepin did not appear to response to large variations in residual heat input, Dr. Stefan did recommend further analysis to confirm that the warmer river inflow (heat input) formed an interflow passing through the lake at an intermediate depth, well below the ice cover.

In 1999 the Army Corp of Engineers resumed measuring ice thickness at Lake Pepin for the purpose of predicting when ice out in Lake Pepin would occur such that barge traffic on the river might resume.[29]

Table 4-5 shows the average river flow rate at Lock and Dam No. 3 for the three month period from January through March; the thickness of ice at Lake Pepin (mile marker 770) when the thickest ice measurement was taken; and when plant outages occurred (reducing heat input from plant operations to the river). There does not appear to be any correlation between ice thickness, river flow and plant operations.

There are four years shown on the table (2000, 2004, 2005 and 2006) when there was no winter refueling outages at the PINGP. No refueling outages would result in the most heat being inputted into the river for an extended period. If there were a direct correlation between plant operation and ice thickness, one would expect that should result in the thinnest ice occurring during years when there were no refueling outages. In two of the years (2000 and 2006) ice thickness was below average and in two years (2004 and 2005) ice thickness was above average.

The ice thickness in 2005 was the second thickest (25 inches) during the 10 year period. The ice was also 25 inches thick in 2003, a year in which there was a refueling outage on Unit 1 from mid-November to mid-December, 2002. The ice was 26 inches thick in 2008, a year in which there was a refueling outage on Unit 1 from mid-February to mid-March. These results (from 1999 to 2008) tend to support the earlier study (1981 to 1986) that ice thickness at Lake Pepin does not have any direct correlation to the PINGP operations and that ice thickness at Lake Pepin is a complex phenomenon impacted by meteorological conditions and river flow conditions below the ice.

Flooding

According to the U.S. Army Corps of Engineers (COE), the 1965 flood was the highest on record and has a reoccurrence interval of 150 years. The peak stage at Lock and Dam Number 3 during this flood was 687.7 feet.

A study to determine the magnitude of the probable maximum flood was conducted for this area of the Mississippi River by Harza Engineering Company.[30] The probable maximum discharge was determined to be 910.300 cfs and to have a corresponding peak stage of 703.6 feet. The flood would result from meteorological conditions which could occur in the spring and could

[28] Letter from MN DNR to NSP dated November 23, 1987
[29] http://www.mvp.usace.army.mil/navigation/default.asp?pageid=188
[30] Harza Engineering Company

reach maximum river level in approximately 12 days. It was estimated that the flood stage would remain above 695 feet for 13 days. Wind generated waves would be of maximum height when the wind is from the east to west in the direction of the circulating water intake canal. With persistent wind speed of 45 mph there could be significant waves up to 1.8 feet; maximum highest wave is estimated up to 3.10 feet. Given these assumptions, the maximum water level could be as high as 706.7 feet.

The PINGP is designed such that all areas critical to nuclear safety are protected against the effects of the probable maximum flood and associated wave run-up; the main powerhouse, structure consisting of the reactor buildings, the auxiliary and fuel handling building, the turbine building, D5/D6 diesel generator building, and the pump section of the screen house structure are protected against the flood level of 704.1 feet. The base slabs of these structures have been designed to resist the full hydrostatic head of the probable maximum flood. The top of the substructure and/or superstructure flood walls are at 705.0 feet, and are designed to resist probable maximum flood. These structures are capable of withstanding the hydrostatic forces associated with the probable maximum flood and associated maximum wave run-up of 706.7 feet.[31]

The EPU will not change the elevation of any of these structures.

Wetlands

The National Wetland Inventory (NWI) maps of the following USGS quadrangles indicate numerous wetland systems within five miles of the PINGP site:

- Diamond Bluff East, WI-MN;
- Red Wing, MN-WI;
- Welch, MN; and
- Diamond Bluff West, WI-MN

The PINGP site is located on the Welch, MN quadrangle. There are no wetlands on the Prairie Island site that are designated as protected under Minnesota Statute 103G.005, subd. 15. Although wetland resources are located on the plant property. Essentially, wetlands within five miles of the PINGP are established within the floodplains of the major river systems: the Mississippi, the Cannon and the Vermillion Rivers all have well-established and often extensive wetlands associated within their respective corridors.

The EPU will not affect the hydrology or populations in these wetland habitats.

GROUNDWATER

PINGP is located on Prairie Island, an island terrace associated with the Mississippi River flood plain. The Mississippi River flood plain in this area is confined within a valley approximately three miles wide. Rocky bluffs and heavily forested slopes rise abruptly from both sides of the valley some 300 feet. The bluffs are deeply trenched by numerous streams emptying into the

[31] Prairie Island Updated Safety Analysis Report, Revision 29, Section2.4.3.5.

Mississippi River. The site is located on the western limb of the Red Wing anticline. The aquifers in the vicinity of the PINGP include the alluvial aquifer (water table) and the underlying bedrock (confined) aquifers. Generally, wells in the alluvial material in the vicinity of the site are less than 100 feet in depth.[32]

The Prairie Island alluvial aquifer receives recharge from and discharges to surface waters. The aquifer is also recharged through direct precipitation, flood waters, snowmelt, and from underlying aquifers. A USGS study performed in 1997 stated that the amount of water discharged to wells in the Prairie Island study area from the alluvial aquifer was less than one-third of the water that was discharged from the alluvial aquifer to surface waters or to the atmosphere.[33]

As discussed in Section 1.1.5, groundwater use at the PINGP is governed by a water appropriation permit issued by the DNR. Assuming a 10 percent increase in groundwater use applied to the maximum annual usage over the past five years of 61.6 million gallons in 2005, the projected maximum use would be approximately 68 million gallons or 129.4 gpm. The maximum 68 million gallons is still significantly less than the 355 million gallons per year permit limit. Thus, the EPU project will not affect compliance with the permit limits.

The Prairie Island Indian Community draws its groundwater for domestic uses through wells completed in the Mt. Simon-Hinckley aquifer, a confined sedimentary bedrock aquifer.

Impacts from Surface Water Use

The rate of surface consumptive use of water at PINGP is small compared to average monthly discharges at Lock and Dam 3, which ranged from 10,425 (January) to 39,562 cfs (May) in the 1995 to 2006 period. A consumptive loss of 39 cfs represents to 0.1 percent and 0.4 percent of the highest monthly and lowest monthly average flow at Lock and Dam 3. The average consumptive use relates to a decrease in pool level at Pool 3 of 0.1 inch. The loss of cooling water through evaporation has no significant effect on Mississippi River flows, pool level, or on the adjacent alluvial aquifer. In addition, most groundwater in the vicinity of PINGP is withdrawn from the deeper confined aquifer, not from the alluvium along the Mississippi River.

The impacts of withdrawing additional water from the Mississippi river due to the EPU on the alluvial aquifer would be small and mitigation measures would not be warranted.

Impacts on Nearby Groundwater Users

PINGP used an annual average of approximately 92 gpm of groundwater from 2000 through 2005. However, during 2005, PINGP pumped 118 gpm of groundwater.

In order to determine potential offsite impacts to wells, the 118 gpm well yield from 2005 was used to calculate drawdown as though it had been pumped from a single onsite well. Well

[32] Nuclear Management Company, LLC., Prairie Island Nuclear Generating Plant License Renewal Application, Appendix E - Environmental Report. April 2008.
[33] Ibid

number 256121 was used, due to its close proximity to the PINGP property boundary (approximately 1,800 feet) and its proximity to the closest off-site residence (approximately 2,100 feet). The well is also one of the site's primary production wells.[34]

Based on the conservative results of the modeling, pumping at a rate of 118 gpm in Well number 256121 would create a stabilized drawdown of 0.4 foot at a distance of 2,100 feet from the pumping well during the first 10 years of pumping. Based on the modeling performed, there would be no additional drawdown that would occur over the period of the current operating license (40 year period) or during the license renewal period (additional 20 years).

Based on the predicted conservative drawdown (0.4 foot) that would occur during the life of the current operating permit and the fact that no additional drawdown would occur during the license renewal period, the impacts to the aquifer system over the license renewal period would be small, not requiring mitigative measures, such as drilling wells deeper.

Degradation of Groundwater Quality
Xcel Energy monitors groundwater as part of a Radiological Environmental Monitoring Program.

See Section 4.13 for a detailed discussion on radiological monitoring and data.

4.12 WASTE MANAGEMENT and DISPOSAL

Non-Radioactive Solid Waste
Construction activities associated with the EPU generate non-radioactive solid wastes. The volume will be comparable to the waste generated during a typical refueling/maintenance outage. No ongoing non-radioactive solid wastes will be generated due to EPU.

Radioactive Waste
See Section 4.13 for a discussion on radioactive waste.

4.13 RADIOLOGICAL

Radiation is a public health concern associated with nuclear plant operations and spent fuel storage. It is subject to extensive monitoring, regulation, and incident management planning. This section discusses the radiation monitoring programs at the Prairie Island plant, including monitoring performed by Xcel Energy, the Minnesota Department of Health, and the Wisconsin Department of Health Services. Additionally it discusses emergency response plans. Potential radiological impacts from PINGP operations and the proposed power uprate are discussed in this section. Potential radiological impacts from ISFSI operations are discussed in Chapter 2, Section 5.

[34] Nuclear Management Company, LLC., Prairie Island Nuclear Generating Plant License Renewal Application, Appendix E - Environmental Report. April 2008.

Background Radiation[35]

All life forms are exposed to radiation from natural and man-made sources. Natural sources of radiation include cosmic radiation and radiation from radionuclides in the Earth's crust. Cosmic radiation originates from the high energy particles of the sun or other stars interacting with the earth's upper atmosphere. As these high energy particles are absorbed through the earth's atmosphere, they become lower energy particles. Because of this shielding effect of the atmosphere, exposure to cosmic radiation is greater at higher elevations than it is at sea level. For instance, the exposure from cosmic radiation in Denver is typically twice as high as exposure at sea level.

Radionuclides in the Earth's crust have been present since the formation of the planet over four billion years ago. Radioactive decay of the shorter-lived isotopes left behind those radionuclides with very long half-lives of a hundred million years or more. These naturally-occurring isotopes include uranium and thorium along with their decay products such as radon. These elements produce internal exposure from radon gas and external gamma radiation exposure.

Natural sources of radiation account for approximately 82 percent of the radiation to which the public is exposed every year. Man-made sources account for about 18 percent. The most common man-made source of background radiation is medical procedures. Diagnostic x-rays and nuclear medicine procedures are used in more than half of all medical diagnoses.
The average American receives approximately 360 millirem (mrem) of radiation each year. Approximately 300 mrem come from natural sources: the sun's rays, rocks, soil, building materials, and other sources. The other 60 mrem come from human activities and consumer products such as medical/dental X-rays, television sets, and tobacco. Sources of background radiation exposure are summarized in **Table 4.6**.

Man-made sources of radiation are regulated and monitored by federal and state agencies to minimize immediate and long-term public health effects.

Radiological Health Effects[36]

Radiological health effects result from the deposition of radiation energy with the human body. This energy causes cellular damage, which may or may not be able to be repaired by normal cellular repair mechanisms. Health effects can be roughly divided into two types: (1) deterministic, high-dose effects, and (2) stochastic, low-dose effects. High doses of radiation delivered in a short time period can kill cells or damage them such that they cannot repair themselves. Low doses of radiation affect cells, but may or may not damage them. That is the rate of cell repair may or may not be greater than the rate of damage caused by energy deposition. If cell damage does occur, health effects may also occur. The primary low-dose health effect of concern is cancer.

[35] Adapted from the Prairie Island Nuclear Generating Plant, Certificates of Need Application, May 2008, Appendix E, Radiation Primer.
[36] Adapted from the Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix E, Radiation Primer.

Data demonstrating the relationship between high levels of radiation and deterministic health effects is substantial. Many atomic bomb survivors and Chernobyl emergency responders demonstrated deterministic effects shortly after their exposures. From this data, biological responses can be estimated based on doses received. However, this is not the case for stochastic effects from low doses (≤ 10 rem). Health effects due to low doses of radiation must be extrapolated from studies of exposure to high doses (or determined through epidemiological studies, discussed below). This extrapolation introduces uncertainty. For this reason, the study of long-term health effects is a stochastic (probabilistic) science. The risk of a health effect from a specific low-level dose is expressed as a probability. This probability reflects the uncertainty in the relationship between health risks and low doses of radiation.

The current best estimate of this relationship is that the relationship between dose and risk is linear, even at very low doses.[37,38] This is known as the linear non-threshold (LNT) model. This means holds there is no *de minimis* dose for which risks need not be considered; all doses present some level of risk. As the dose increases, the risk increases in a linear manner. For purposes of this document, a linear relationship between dose and risk (LNT model) is assumed and guides the discussion of potential radiological health effects.

The primary health risk for low level radiation doses is cancer. In this document, estimates of additional cancer diagnoses due to long-term, low-level radiation doses are calculated using a risk coefficient of 1 E-06 (i.e., 1 in a million) incident cancers per mrem received, the coefficient suggested by the National Academy of Sciences' BEIR VII report.[39] Estimates of additional cancer fatalities due to long-term low-level radiation doses are calculated using a risk coefficient of 5 E-07 fatal cancers per mrem received, the coefficient suggested by the National Council on Radiation Protection and Measurements.[40] For purposes of discussion and comparison, estimated cancer incidence and fatality effects are compared to national cancer incidence and fatality data for lifetime cancer risk from all causes.[41]

Minnesota state policy regarding risks due to licensed activities utilizing radioactive materials is not provided as numeric guidance.[42] Rather, licensees must achieve doses to workers and the general public that are as low as reasonably achievable (ALARA).[43] However, Minnesota

[37] United Nations Scientific Committee on the Effects of Atomic Radiation. *Sources and Effects of Ionizing Radiation*. Volume II: Effects. UNSCEAR 2000 Report to the General Assembly, with Scientific Annexes. New York: United Nations; 2000.
[38] BEIR VII Phase 2: Health Risks from Exposure to Low Levels of Ionizing Radiation, http://www.nap.edu/openbook.php?record_id=11340&page=R1
[39] Id.
[40] National Council on Radiation Protection and Measurements (NCRP, 1993), Report No. 115. http://www.ncrponline.org/Publications/115press.html
[41] SEER Stat Fact Sheet, http://seer.cancer.gov/statfacts/html/all.html; SEER Cancer Statistics Review, 1975-2005, http://seer.cancer.gov/csr/1975_2005/results_merged/topic_lifetime_risk.pdf. The average lifetime risk for American citizens of being diagnosed with cancer is 40.35%. The average lifetime risk of dying from cancer is 21.21%.
[42] Minn. Stat. § 4731.2010, Subp. 2.
[43] Id.

statutes do provide numeric guidance for other forms of carcinogenic risk, (e.g., chemicals in groundwater or air) to which Minnesota are involuntarily exposed.[44] The acceptable level for additional lifetime carcinogenic risk from contaminants in these mediums is 1 in 100,000 (1 E-05).[45] Though ALARA is the controlling state policy, for comparison purposes, estimated risks of cancer incidence will be expressed in this format (i.e., X in 100,000).

Monitoring Programs

Radiological monitoring programs are required for the PINGP to ensure that controlled radioactive releases are within applicable standards and to provide emergency response information on uncontrolled releases should an incident occur at the plant. Monitoring programs for the PINGP are required at the federal level and at the state level. Xcel Energy is required under its NRC operating license and special nuclear materials license to monitor and ensure that plant operations meet applicable federal regulations. Public health agencies in the states of Minnesota and Wisconsin are required to monitor the Prairie Island plant to ensure compliance with applicable state standards, which typically coincide with federal standards.

Xcel Energy. The radiological monitoring program implemented by Xcel Energy has been developed in accordance with and is required by NRC regulations. The principal regulatory basis for requiring effluent and environmental monitoring at nuclear power plants is contained in 10 CFR 50, Appendix A. Appendix A requires that a licensee control, monitor, evaluate, document, and report all radiological effluents discharged into the environment. Power reactor licensees are required to keep the public dose from radioactive effluents as low as is reasonably achievable (10 CFR 50, Appendix I). Licensees must also conduct operations such that the total effective dose equivalent to individual members of the public from licensed operations does not exceed 100 mrem/yr (10 CFR 20).

To ensure compliance with NRC regulations, Xcel Energy is required to implement a radiological environmental monitoring program (REMP). The REMP provides for radioactive effluent controls and monitoring of the potential impact of radioactive effluents on the environment. The REMP requires sampling of various environmental exposure pathways which are then analyzed for the presence of specified radiological constituents. Several strategies are used to interpret monitoring results and distinguish potential radioactive impacts associated with the PINGP from background radiation levels. These strategies include an indicator – control program design, analysis for radionuclide proportions characteristic of fission products, and trend analysis. For example, most types of samples are collected both at indicator locations (nearby, downwind, or downstream) and at control locations (distant, upwind, or upstream). A plant effect would be indicated if the radiation level at an indicator location was significantly greater than that at the control location. The difference would have to be greater than that which could be accounted for by typical fluctuations in background radiation levels.

[44] Minn. Stat. § 4747.7100, Minn. Stat. § 4717.8000.
[45] Minn. Stat. § 4717.8000.

Sampling for the Prairie Island radiological environmental monitoring program is extensive with over 80 sampling locations near and around the Prairie Island plant.[46] To monitor the air environment, airborne particulates are collected on membrane filters by continuous pumping at five locations. Airborne iodine is collected by continuous pumping through charcoal filters at these same locations. Filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity and charcoal filters for iodine-131. Quarterly composites of particulate filters from each location are determined by gamma spectroscopy.

Offsite ambient gamma radiation is monitored at 34 locations, using thermoluminescent dosimeters (TLDs): 10 in an inner ring in the general area of the site boundary, 15 in the outer ring within a 4-5 mile radius, eight at special interest locations, and one control location, 11.1 miles distant from the plant. They are replaced and measured quarterly. Ambient gamma radiation is monitored at the Prairie Island ISFSI with 20 TLDs. Twelve dosimeters are located inside the earthen berm in direct line of sight from the storage casks and eight dosimeters are located outside of the earthen berm. They are also replaced and measured quarterly.

Ingestion pathways are monitored through targeted food supply sampling. Milk samples are collected monthly from six local farms (five indicator and one control) and analyzed for iodine-131 and gamma-emitting isotopes. The milk is collected biweekly during the growing season (May – October) when animals are likely to be grazing on pasture. Green leafy vegetables (cabbage) are collected annually from an indicator and a control location and analyzed for gamma-emitting isotopes, including iodine-131. Corn is collected annually only if fields are irrigated with river water and is analyzed for gamma-emitting isotopes.

Water resources and the riparian environment are monitored by multiple sampling strategies. Well water and ground water are collected quarterly from four locations near the plant and analyzed for tritium and gamma emitting isotopes. River water is collected weekly at two locations, one upstream of the plant and one downstream. Monthly composites are analyzed for gamma-emitting isotopes. Quarterly composites are analyzed for tritium. Drinking water is collected weekly from the city of Red Wing well. Monthly composites are analyzed for beta, iodine-131, and gamma-emitting isotopes. Quarterly composites are analyzed for tritium. The aquatic environment is also monitored by semi-annual upstream and downstream collections of fish, invertebrates, and bottom sediments. Shoreline sediment is collected semi-annually from one location. All samples are analyzed for gamma-emitting isotopes.

Minnesota Department of Health. The Minnesota Department of Health (MDH) is charged with protecting, maintaining, and improving the health of Minnesotans (Minn. Stat. § 144.05). To this end, the Environmental Health Division, Radioactive Materials Unit conducts an environmental monitoring program focused on the State's two nuclear generating power plants (Monticello, Prairie Island). The program is designed to assess the nuclear generating plants'

[46] 2007 Annual Radiological Environmental Monitoring (REMP) Report, Prairie Island Nuclear Generating Plants Units 1 and 2, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html

impact to the environment and the public over time. Data collected is used to determine compliance with appropriate NRC and EPA standards and to establish long-term trends. Trend analysis allows MDH to identify potential problems and, if necessary, initiate corrective actions. Annual environmental monitoring reports are generated and made available for public review.

Monitoring for radioactivity began in Minnesota in 1953 as a response to nuclear weapons testing. Monitoring was designed to determine the level of above ground nuclear testing fall-out within Minnesota. The monitoring program adapted to the construction of nuclear power plants in Minnesota with additional monitoring locations and sampling protocols. Over time, some collection points and types of samples have been discontinued (e.g., sampling shoreline sediment), while others have been added (e.g., pressurized ionization chambers to measure radiation levels at the Prairie Island ISFSI).

The primary components of the present MDH environmental monitoring program are sample collection, data analysis, and interpretation. Sample types and locations are selected based on potential exposure pathways and the likelihood of public health impacts. Potential exposure pathways for radioactivity include: inhalation, ingestion, uptake by deposition on crops or other foods, uptake by fish, and external exposure. Samples types are selected to represent the various potential exposure pathways. Samples that are currently collected around the PINGP include: air, surface water, well water, and milk. Ambient gamma radiation dose levels are monitored through the use of thermoluminescent dosimeters (TLDs).

In addition to these samples, since 1995, MDH has monitored the Prairie Island ISFSI with two pressurized ion chambers (PICs). The PICs constantly measure and report the levels of ambient gamma radiation around the ISFSI. They are designed to alert MDH immediately if radiation levels are exceeded. MDH staff receives reports twice daily indicating current radiation levels at the ISFSI. The monitoring system conveys alarm messages to MDH staff if the radiation levels are significantly high or if electronic reporting from the PICs is disrupted.

Sampling locations for MDH monitoring are shown in **Figures 4-9a and 4-9b**. MDH uses continuous air monitoring from an air sampler located near Lock & Dam #3 to determine the level of airborne radioactivity that could impact the public through inhalation. The location at Lock & Dam #3 was selected based on the predominant wind direction around the plant as the area most likely to receive the largest particulate count. Particulate filters and cartridges are collected every other week and analyzed for radioactive material in the air.

In the event of a radioactive release to the air or water, particulates would most likely enter the Mississippi River and could possibly impact public health since surface water is the drinking water source for many cities in the state. MDH samples Mississippi River water downstream from the PINGP. Quarterly samples are taken at Lock & Dam #3 and analyzed. The results are compared to federal drinking water standards and measured against historical data for changes that may have occurred due to releases from the plant. Because radioactive releases from the plant could move through the soil profile and enter the water table, well water is periodically sampled and analyzed. These samples are collected quarterly and compared to drinking water standards and historical data. Collections are made from a private well on a farm located near the PINGP.

Radioactive releases that could enter the food supply are monitored through milk sampling. In a radioactive release to the environment it is likely that particles would settle on nearby pastures and be consumed by cows. This radioactivity is concentrated and transferred to the milk produced, and thus could enter the public food supply. MDH samples and monitors milk produced on a farm near the PINGP. Since there are no applicable health standards for milk related to radioactivity, except for emergency situations, sample analysis is compared to drinking water standards.

Ambient gamma radiation levels are measured around the PINGP by thermoluminescent dosimeters (TLDs). Currently, seven TLDs are located beyond the plant's boundaries to estimate the dose received by a member of the public if they were to be at that location continuously throughout the monitoring period. TLDs are changed quarterly, analyzed, and dose levels are compared to control readings and historical data.

Wisconsin Department of Health Services. The Wisconsin Department of Health Services (WDHS) is charged with environmental radiation monitoring of nuclear power facilities that impact Wisconsin (Wis. Public Health Stat. § 254.41). The PINGP and Prairie Island ISFSI, being located across the Mississippi River from Wisconsin, have the potential to impact Wisconsin citizens. Accordingly, the WDHS conducts environmental monitoring for the PINGP and publishes monitoring reports on an annual basis.

The WDHS monitoring program is focused on air, water, and terrestrial exposure pathways. Monitoring includes air sampling, water sampling (surface water, well water, and precipitation), soil sampling, milk sampling, sampling of fauna (fish), and sampling of vegetation.[47] Additionally, thermoluminescent dosimeters (TLDs) are used to measure background and direct radiation. Monitoring and sampling is conducted at approximately 23 sites nearby and generally eastward of the PINGP. The WDHS does not anticipate changes to its current monitoring program for the PINGP should the proposed power uprate and ISFSI expansion occur.

Radiation Pathways and Potential Impacts

The PINGP releases small amounts of radionuclides during normal operations in the form of gaseous and liquid effluents. Release pathways for gaseous and liquid effluents are controlled and monitored to ensure that unintentional radionuclide releases are minimized, and to provide a basis for estimating the radiological dose and potential impacts to humans and the environment. Xcel Energy is charged with keeping radiological doses below applicable federal regulations (e.g., 10 CFR 20, 10 CFR 50).

[47] State of Wisconsin 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf

Current radionuclide releases from the PINGP result in radiological doses well within federal regulations and indistinguishable from background radiation. If the activity associated with radionuclide releases increases proportionately with the power uprate, i.e., the activity of releases increases by approximately 10 percent, radiological doses will remain within federal regulations and indistinguishable from background radiation. Impacts to humans and the environment from near-background level radiation are not anticipated to be significant. Studies on potential impacts from low-level, long-term radiation exposure to citizens near nuclear power plants are discussed separately in this section.

Gaseous Effluents. Gaseous radioactive wastes principally include activation gases and fission product radioactive noble gases resulting from process operations, gases used for tank cover gases, gases collected during venting, and gases generated in the radiochemistry laboratory. During normal power operations at the PINGP, the gaseous effluent treatment systems process and control the release of gaseous effluents to the environment, and there are almost no releases of radioactive gaseous effluents. However, during refueling and maintenance operations, when the primary reactor system is open to the building atmosphere, small quantities of noble gases, halogens, tritium, and particulates are removed by the ventilation systems.

The gaseous-waste management systems include the off-gas system and various building ventilation systems. This air is monitored for radioactivity before undergoing controlled release. Whenever radioactivity is present, the ventilation air is passed through filters to remove particulate material. Releases are controlled and inadvertent releases prevented by valve systems which require multiple, manual operations to effect a release (e.g., unlocking a valve). Xcel Energy projects that the concentration of radionuclides in the gaseous radioactive effluents streams would, at most, increase linearly with power as a result of the proposed uprate, i.e., by approximately 10 percent.

The activity of gaseous effluents from the PINGP and estimated doses to the public is shown in **Table 4-7**. Estimated exposure and dose levels for the general public are indistinguishable from background radiation. Monitoring data from Xcel Energy, MDH, and WDHS support this conclusion.[48] Estimated doses after the power uprate are less than 0.01 mrem/yr. These are below the NRC regulatory level of 30 mrem/yr (10 CFR 50).

Health risks to the general public due to long-term exposure to radioactive gaseous effluents from the PINGP are not expected to be significant. The primary health concern is cancer. If we assume, conservatively, that local residents receive a whole body dose of 0.01 mrem/yr due to gaseous effluents and that they receive this dose continuously for 70 years, it is estimated that an additional 1 person in 1,430,000 (0.07 in 100,000) would be diagnosed with cancer and an additional 1 person in 2,850,000 would die from cancer.

[48] 2007 Annual Radiological Environmental Monitoring (REMP) Report, Prairie Island Nuclear Generating Plants Units 1 and 2, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html; Minnesota Department of Health, 2006 Environmental Radiation Data Report, http://www.health.state.mn.us/divs/eh/radiation/monitor/annual2006.pdf; State of Wisconsin 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf

With approximately 450 residents within the immediate vicinity of the Prairie Island plant (2 mile radius), these risks translate into a hypothetical 0.0003 additional cancer diagnoses and 0.00015 additional cancer deaths among these residents during a 70-yr. time period. Approximately 40 percent of these residents (180 persons) would be diagnosed with cancer and 20 percent of these residents (90 persons) would be expected to die from cancer from all cancer causes during this same period.

Liquid Effluents. The liquid radioactive waste management system at the PINGP is designed to: (1) process wastes through filtration and ion exchange, (2) measure and evaluate all radionuclide concentrations and, based on results, (3) reprocess them through the radioactive-waste system for further purification or discharge them to the environment. Liquid wastes are generated during normal plant operations from a variety a sources, e.g., component drains, chemical laboratory drains, sampling systems, steam generator blowdown. Processed liquid wastes are discharged via a monitored double-walled piping system to the Prairie Island discharge canal and from there diffused to the Mississippi River. All releases are monitored and the activity of effluents recorded. As with gaseous effluents, releases are controlled and inadvertent releases prevented by valve systems which require multiple, manual operations to effect a release.

The power uprate will not significantly increase the inventory of liquid normally processed by the liquid waste management system. System functions are not changing and volume inputs will remain nearly the same. However, Xcel Energy anticipates that the discharge liquid effluent radioactivity level would increase linearly with the power uprate, i.e., by approximately 10 percent.

The activity of liquid effluents from the PINGP and estimated doses to the public are shown in **Table 4-8**. Estimated exposure and dose levels are indistinguishable from background radiation. Monitoring data from Xcel Energy, MDH, and WDHS support this conclusion.[49] Estimated doses after the power uprate are less than 0.01 mrem/yr. These are below the NRC regulatory levels of 6 mrem/yr (whole body) and 20 mrem/yr (organ) (10 CFR 50).

Health risks to the general public due to long-term exposure to radioactive liquid effluents from the PINGP are not expected to be significant. Again, the primary health concern is cancer. The estimated dose to local residents is similar to that due to gaseous effluents (< 0.01 mrem/yr). Thus, the above analysis of potential cancer impacts for gaseous effluents is bounding.

Liquid Effluents – Drinking Water Standards. The EPA promulgates standards related to the presence of radionuclides in drinking water supplies.[50] These standards are set to limit the

[49] 2007 Annual Radiological Environmental Monitoring (REMP) Report, Prairie Island Nuclear Generating Plants Units 1 and 2, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html; Minnesota Department of Health, 2006 Environmental Radiation Data Report, http://www.health.state.mn.us/divs/eh/radiation/monitor/annual2006.pdf; State of Wisconsin 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf
[50] Radionuclides in Drinking Water, http://www.epa.gov/safewater/radionuclides/index.html

annual whole body dose from the radionuclide tritium (H-3) to 4 mrem/yr. For a person who regularly consumes water from a primary water source (e.g., public water supply, private well), the concentration of tritium corresponding to this dose level is 20,000 picocuries/liter (pCi/L). Thus, EPA rules limit tritium concentrations in drinking water to less than 20,000 pCi/L.

As noted in Table 4-8, the primary radioactive liquid effluent from the PINGP is tritium. Because the Prairie Island plant is located in close proximity to three river systems (Mississippi, Vermillion, Cannon), the potential movement of tritium releases through groundwater or surface waters systems is closely monitored. Movement of tritium to groundwater that could be consumed by local residents, as opposed to released to the Mississippi River, could result in relatively high levels of tritium and adverse health impacts.

In 1989, based on elevated tritium levels in well water at a residence south of the PINGP, the Xcel Energy initiated a special water sampling program.[51] In 1991 and 1992, upgrades to the liquid effluent discharge pipe were made to minimize the ability of radioactive effluents to enter groundwater. Monitoring by the special water program indicates that tritium levels in groundwater and well water are near background levels (5 – 150 pCi/L). In 2007, all offsite wells sampled contained very low levels of tritium (< 65 pCi/L).[52] On-site sampling of wells exhibited similar concentrations, with the exception of three locations, which ranged from several hundred up to 2,258 pCi/L. These locations are clustered on-site, just south and east of the PINGP. Xcel Energy believes these relatively higher levels may be due to prior leakage of the discharge pipe or inadvertent discharge of turbine building sump water into the area. In sum, Xcel's monitoring shows on-site groundwater tritium concentrations to be less than 10 percent (2,000 pCi/L) of the EPA standard (20,000 pCi/L) and off-site groundwater concentrations to be less than 1 percent (200 pCi/L) of the EPA standard.

Monitoring by MDH and WDHS supports Xcel Energy's monitoring results. Excepting one year (2002), MDH monitoring indicates tritium concentrations of less than 200 pCi/L in nearby residential well water.[53] WDHS monitoring indicates tritium concentrations below the lower limit of detection used by the WDHS program.[54]

The results of monitoring by Xcel Energy, MDH, and WDHS indicate that tritium concentrations in groundwater and well water near the PINGP are within EPA standards and average less than 1 percent (200 pCi/L) of the standard. It appears that there may be spikes in tritium concentrations

[51] 2007 Annual Radiological Environmental Monitoring (REMP) Report, Prairie Island Nuclear Generating Plants Units 1 and 2, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html
[52] Id.
[53] Minnesota Department of Health, 2006 Environmental Radiation Data Report, http://www.health.state.mn.us/divs/eh/radiation/monitor/annual2006.pdf. The year 2002 was the only exception to this trend. In 2002, median tritium concentrations were near 5,000 pCi/L.
[54] State of Wisconsin 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf. The lower limit of detection from tritium (H-3) used in the WDHS program is 300 pCi/L.

in certain areas (Xcel's on-site monitoring wells) and at certain times (Xcel's monitoring prior to upgrading its discharge pipe; MDH's 2002 well water monitoring data). These spikes are most likely related to plant operations. However, these spikes are well within EPA standards and short-lived. As before, the primary health risk due to long-term exposure to low levels of radiation is cancer. Assuming that the dose received is proportional to tritium concentrations, a concentration of 200 pCi/L would result in an annual whole body dose of approximately 0.04 mrem/yr. Health risks from this dose are not anticipated to be significant. If we assume that local residents receive a whole body dose of 0.04 mrem/yr due to tritium exposure and that they receive this dose continuously for 70 years, it is estimated that an additional 1 person in 357,000 (0.28 in 100,000) would be diagnosed with cancer and an additional 1 person in 714, 000 would die from cancer during this time period.

Solid Wastes. The solid radioactive waste management system at the PINGP collects, processes, packages, and temporarily stores radioactive dry and wet solid wastes before they are shipped off-site for permanent disposal.[55] The Prairie Island plant produces dry active waste (paper, plastic, wood, rubber, glass, floor sweepings, cloth, and metal), sludge, oily waste, bead resin and filters. Any increase in the volume of solid waste due to the proposed power uprate would likely be insignificant because the uprate would neither alter installed equipment performance nor require changes in system operation or maintenance.

With the power uprate, any increase in volume of solid waste would be expected to be due to increases in disposal of bead resins and filters. This volume increase would not be significant; however, the radioactivity of the waste is expected to increase proportionally with the power uprate, i.e., approximately 10 percent.

The volume and activity of radioactive solid wastes from the PINGP is shown in **Table 4-9**.

In recent years (2004 and 2005), the solid waste volume generated at the Prairie Island plant has been above the quantity anticipated in the NRC's Final Environmental Statement for the plant (14, 925 ft^3/yr). This increase in solid waste volume was temporary. It was a direct result of the disposal of equipment associated with the Unit 1 steam generator replacement and the Unit 1 and 2 reactor vessel head replacement projects.

As radioactive solid wastes are shipped off-site for proper disposal, health risks due to these wastes will not be significant.

Impacts of Long Term Radiation Exposure – Health Studies

Despite extensive monitoring and regulation of nuclear power facilities, there remains a public concern about possible health effects due to living next to a nuclear facility. As noted above in the discussion of radioactive effluents from the Prairie Island plant, monitoring, sampling, and

[55] For example, radioactive resins and contaminated trash from the PINGP are sent to a federally licensed low level waste disposal facility in Clive, Utah owned by Energy Solutions; http://www.nrc.gov/waste/llw-disposal/locations.html.

exposure calculations indicate that possible health effects (primarily, cancer) due to low-level, long-term radiation exposure are not significant. Nonetheless, there are differences of opinion on the subject.

Because estimated dose levels and cancer rates near nuclear power plants are very low, they are difficult to detect in public health studies. A number of studies have been conducted worldwide over the past two decades to examine this issue.[56] Childhood cancer is used in nearly all of these studies to evaluate health risks, as children are more susceptible than adults to radiation exposure. However, the studies differ in their methods – e.g., some studies examine cancer mortality rather than cancer incidence; some studies use local control groups and others do not.

The majority of studies that indicate an elevated risk of childhood cancer near a nuclear facility have been conducted outside of the United States.[57] Only one study of cancer rates near nuclear power plants in the United States has reported an elevated risk of childhood cancer.[58] Several studies indicate that there is no increased risk of cancer attributable to living near a nuclear facility in the United States. A National Cancer Institute survey found no increased risk of death from cancer for persons living in 107 counties near nuclear facilities in the United States.[59] An Illinois Department of Health study found that cancer incidence and mortality rates for children living near nuclear power plants in Illinois were not significantly different from rates for children living elsewhere in Illinois.[60] There has been substantial study of cancer rates near the Prairie Island plant by the Minnesota Department of Health. These studies are discussed here.

Minnesota Department of Health Studies of Cancer Rates. Since 1995, the Minnesota Department of Health (MDH) has undertaken two analyses and two updates of cancer rates and trends in counties near Minnesota's nuclear power plant facilities. These analyses were undertaken due to either specific allegations of increased cancer rates near the Prairie Island and the Monticello generating facilities or to general public concerns and perceptions about cancer rates and risks near nuclear power plants. Each of these analyses is summarized here.

Breast Cancer Rates and Trends Around Nuclear Power Plants in Minnesota.[61]
An analysis was conducted of long-term trends in breast cancer mortality rates in counties surrounding Minnesota's two nuclear power plants. This analysis was undertaken following

[56] Pediatric Cancer Incidence and Mortality in the Vicinity of Nuclear Power Plants in Illinois, Illinois Department of Public Health, January 2006,
http://www.idph.state.il.us/cancer/pdf/nuclear%20study%20final%20report%20ERS06_1.pdf
[57] Elevated Childhood Cancer Incidence Proximate to U.S. Nuclear Power Plants, Archives of Environmental Health, February 2003.
[58] Id.
[59] No Excess Mortality Risk Found in Counties with Nuclear Facilities, National Cancer Institute Fact Sheet,
http://www.cancer.gov/cancertopics/factsheet/Risk/nuclear-facilities
[60] Pediatric Cancer Incidence and Mortality in the Vicinity of Nuclear Power Plants in Illinois, Illinois Department of Public Health, January 2006,
http://www.idph.state.il.us/cancer/pdf/nuclear%20study%20final%20report%20ERS06_1.pdf
[61] Breast Cancer Rates and Trends Around Nuclear Power Plants in Minnesota. In: The Occurrence of Cancer in Minnesota 1988 - 1992: Incidence, Morality, Trends. Minnesota Department of Health, March 1995.

suggestions by individuals and environmental groups in 1994 that significant increases in breast cancer mortality rates had occurred in counties (ten counties in Minnesota and four in Wisconsin) close to the Prairie Island and Monticello nuclear power plants.[62] The differences in cancer mortality rates in these counties and other "nuclear counties" in Minnesota and throughout the U.S. were, according to the suggested analyses, attributable to the operation of nuclear power plants. The Minnesota Department of Health (MDH) attempted to replicate and expand these analyses using complete cancer mortality data for the period 1950 through 1992. No significant differences in trends in breast cancer mortality rates were detected for the ten Minnesota counties surrounding the Monticello and Prairie Island plants compared to the overall Minnesota average.

This analysis also examined rates of newly-diagnosed breast cancer (incidence rates) using data from the Minnesota Cancer Surveillance System (MCSS) – the statewide cancer registry which began operation in 1988 at the Minnesota Department of Health. No significant differences were found for the rates of newly-diagnosed breast cancers for the years 1988-1992. A total of 2,208 new breast cancers were diagnosed over that five year period. Based on the population of these counties and the statewide rate, 2,278 new cancers would have been expected. In other words, the breast cancer incidence rate in these counties is virtually identical to the statewide average over this time period. This is consistent with the findings from the mortality data.

Finally, this study also examined cancer incidence and mortality rates for three additional cancers: leukemias, bone cancer, and thyroid cancer. No differences were found in mortality or incidence rates for these cancers in the 10-county region compared to all of Minnesota.

Update 1. In a subsequent biennial report of the Minnesota Cancer Surveillance System,[63] an additional two years of cancer data were available and were re-analyzed for the 10-county region alleged to have had higher breast cancer mortality rates. Rates were examined for the seven-year period 1988-94. The average annual rate of new diagnoses of breast cancer in the ten Minnesota counties was 105.3 cases per 100,000. During that same time period the rate throughout all Minnesota was 109.5 per 100,000. Put in a different perspective, a total of 3,147 new breast cancers were diagnosed among women in these ten counties over that seven year period. That number was 4 percent below the number of expected cases (3,271) based on the population of the counties and the statewide rate, a marginally significant deficit. The incidence of breast cancer in these ten counties was lower than the state average for every year between 1988 and 1994. Breast cancer mortality for that same time period (1988-94) showed a similar pattern. The average annual rate of breast cancer deaths per 100,000 women in the ten counties was 26.1 compared to the statewide average of 26.2 during that same period.

[62] The ten Minnesota counties included in the analysis by Sternglass and by MDH: Anoka, Benton, Dakota, Goodhue, McLeod, Meeker, Sherburne, Stearns, Wabasha, Wright.
[63] The Occurrence of Breast Cancer in Minnesota. In: The Occurrence of Cancer in Minnesota 1988 – 1994: Incidence, Mortality, Trends. Minnesota Department of Health, May 1997.

Update 2. A second update[64] was published in 2000 as part of another Minnesota Cancer Surveillance System (MCSS) report on cancer in Goodhue County (see discussion below). This update included cancer data through 1996. For the nine-year period 1988-1996, no excesses were found for newly-diagnosed cancers of the breast and thyroid or for leukemias in the 10-county region. Breast cancer incidence was significantly below the statewide average (4,247 cases observed, 4,426 cases expected). Over the same time period, there was also no excess of breast cancer deaths (1,056 cases observed, 1,044 expected).

Cancer Occurrence in Goodhue County[65]

The primary purpose of this analysis and report was to address ongoing public concerns about cancer rates in Goodhue County, particularly in relation to the Prairie Island Nuclear Generating Plant near Red Wing. This report was not able to address cancer rates in the Prairie Island Indian Community members who reside near the plant. The study examined cancer incidence and cancer mortality rates for Goodhue County for the nine-year period 1988-1996.

This analysis found that a total of 1,828 new cancers were diagnosed among Goodhue County residents during the period 1988-1996. The overall cancer incidence rate for females was the same as the statewide average and the overall rate for males was significantly below average. Childhood cancer rates were the same as the state average for males and significantly below average for females.

For specific types of cancer, there were no rates among females that were significantly higher or lower than the statewide average. Among males, two types of cancer occurred less frequently than expected (colon cancer, non-Hodgkin's Lymphoma) and two occurred more frequently than expected (melanoma, Hodgkin's disease).

Overall cancer death rates for the same time period (1988-1996) were the same as or less than the state average for both adults and children. For specific types of cancer, there were fewer than expected deaths for cancer of the esophagus among males and fewer than expected lung cancers among females. For females, there was a greater than expected number of deaths from breast cancer (for 1988-1997). Further analyses using limited data indicated that a significantly higher percentage of breast cancers in Goodhue County were diagnosed at the most advanced stage compared to the state overall.

Analyses of cancer incidence within the county (urban vs. rural) showed a general pattern of somewhat lower rates in rural areas compared to the urban areas. This difference was greatest for females over 65 years of age. An analysis of breast cancer incidence in 20 other comparable Minnesota counties found a similar urban-rural difference.

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[64] Appendix A. Cancer Occurrence in 10 Counties Near Nuclear Power Plants: 1988-1996. In: Cancer Occurrence in Goodhue County: MCSS Epidemiology Report 2000:2. Minnesota Department of Health, December 2000. http://www.health.state.mn.us/divs/hpcd/cdee/mcss/documents/goodhue.pdf

[65] Cancer Occurrence in Goodhue County: MCSS Epidemiology Report 2000:2. Minnesota Department of Health, December 2000, http://www.health.state.mn.us/divs/hpcd/cdee/mcss/documents/goodhue.pdf

Taken as a whole, the analyses of the MDH support the conclusion that there is no significant additional cancer risk associated with living near the Prairie Island plant. The analyses are consistent with monitoring data and dose rates reported by MDH, WDHS, and Xcel Energy.

Emergency Response Plans

The State of Minnesota has developed an emergency response plan for potential incidents and uncontrolled releases of radioactive materials at the Prairie Island plant. This plan involves state agencies and response systems as well as coordination with counties, federal agencies (NRC, DOE) and Xcel Energy. In the event of a radiological or security incident at the plant, each of these agencies/entities would perform emergency response functions. The emergency response for a security incident, as opposed to a radiological incident, would have unique characteristics depending on the nature of the incursion. Due to concern about facility security, details of security response plans are not available to the public, but only to those with a demonstrated need to know.

The lead federal agency for most radiological incidents at nuclear generating stations is the Nuclear Regulatory Commission (NRC). The NRC reports to the President of the United States and Congress in emergency situations. The NRC coordinates any federal assets that the NRC or states request. A federal agency that will also likely provide assistance is the Department of Energy (DOE). The DOE may provide resources in the form of the Federal Radiological Monitoring and Assessment Center (FRMAC). FRMAC provides technical assistance such as field sampling, sample analysis, and plotting of radiological data to assist county, state, and federal agencies in decision-making.

The State of Minnesota provides direction, coordination, and control in accordance with the Minnesota Emergency Operations Plan. The State Emergency Operations Center (SEOC) is structured on the Minnesota Incident Management System with facilities for planning, operations, finance, logistics, and public information. The governor or governor's delegate participates in the SEOC in the command function.

For actual or projected severe core damage or loss of control of the Prairie Island plant, the plan recommends evacuation for a 2-mile radius around the station and 5 miles downwind, depending on local conditions. Data from the plant and from field teams is continually assessed to determine the need to extend distances or add other areas. People in the plume emergency zone are advised to go indoors and listen to the Emergency Alert System messages. General status is maintained until close out or reduction of the level of the emergency.

If a radiological incident were to occur, the counties surrounding the Prairie Island plant would also respond with their emergency operations plans. Their focus is to maximize the protection of lives and property, ensure that government can survive and continue to provide essential services, and support local units of government. By activating their Emergency Operations Centers they will assure that this is accomplished by exchange of information between county departments and where appropriate, to coordinate operations with other counties, state and federal agencies, as well as Native American communities. All county Emergency Operations Centers will be in direct contact with the state center and participate in the decision process for all protective actions.

Xcel Energy maintains an emergency operations plan that is used if a radiological incident at a plant would occur. The plant's main responsibility is to find the cause of the radioactive release and stop it as soon as possible while keeping the plant safe from further damage. The utility monitors conditions at the plant and determines Emergency Classification Levels (ECL) that are then communicated to the state and counties based on those conditions. The utility makes projections of radiation dose to the public based on plant conditions and makes protective action recommendations. The radiation dose projections and protective action recommendations are sent to the state and counties for review and implementation. The plant dispatches monitoring teams to verify the amount of radioactivity that has been released. As the NRC is the lead federal agency, the utility stays in close communication with this agency.

Emergency drills and exercises are conducted regularly by state and federal agencies to ensure that emergency response plans are effective. Exercises are conducted biennially and evaluated at the state and federal level. The most recent emergency exercise at the PINGP was July 2008. The next exercise is schedule for August 2010.

5.0 UNAVOIDABLE IMPACTS AND MITIGATION

The primary impact of the proposed 164 MW EPU is an increase in the temperature of the circulating water (3 F^o maximum) leaving the main condenser, due to the increase in thermal power output. Cooling-water-discharge temperature will be maintained through increased use of the cooling towers or other methods. The thermal discharge will remain within the limits of the current NPDES permit.

No changes are planned for the PINGP intake system or intake-flow velocity; therefore, no change in permitted water appropriation is needed. Increased use of the evaporative cooling towers will slightly increase the amount of water used at the plant, but water consumption will remain approximately 1 percent of the lowest annual mean Mississippi River flow.

The proposed EPU will also increase gaseous radionuclide emissions, but will not measurably change the maximum projected annual off-site radiation dose or on-site cumulative radiation dose. On-site and off-site radiological doses will remain well below federal regulatory limits.

TABLES

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FIGURES

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APPENDIX A

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APPENDIX C

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CHAPTER 2

ENVIRONMENTAL IMPACT STATEMENT

Xcel Energy Prairie Island Nuclear Generating Plant
Additional Dry Cask Storage

PUC Docket No. E002/CN-08-510

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FIGURES

1.0 INTRODUCTION

On April 15, 2008, Xcel Energy applied to the United States Nuclear Regulatory Commission (NRC) for a license renewal for the Prairie Island Nuclear Generating Plant (PINGP). The renewal would allow the PINGP to operate through 2034. Operation through 2034 would require additional storage of spent nuclear fuel within the existing Prairie Island Independent Spent Fuel Storage Installation (ISFSI). Expansion of the ISFSI to accommodate additional spent fuel requires approval from the NRC and the Minnesota Public Utilities Commission (Commission).

On May 16, 2008, Xcel Energy applied to the Commission for a Certificate of Need (CON) to expand the existing Prairie Island ISFSI to accommodate an additional 35 casks of spent nuclear fuel. The docket number for the additional dry cask storage certificate of need is E002/CN-08-510. This chapter (Chapter 2) of this environmental impact statement (EIS) is required as part of the Commission CON process (Minn. Stat. § 116C.83, Subd 6).

The specific topics and extent of discussion in this chapter were outlined in the Prairie Island EIS Scoping Decision, approved by the Office of Energy Security (OES) director on November 14, 2008 (**Chapter 1, Appendix A**).

Section 2 of this chapter outlines the regulatory framework governing the Prairie Island ISFSI. Section 3 provides information on the proposed project. Section 4 discusses the non-radiological impacts that expansion of the Prairie Island ISFSI could have on humans and the environment. Section 5 discusses the radiological impacts that expansion of the ISFSI could have on humans and the environment. Section 6 discusses alternatives for storing spent nuclear fuel generated by the PINGP by operations through 2034. Section 7 discusses alternative methods of generating the electrical power currently produced by the PINGP and the human and environmental impacts of these alternatives.

1.1 SOURCES OF INFORMATION

Information in this chapter is drawn from multiple sources, which are footnoted throughout. Primary sources include Xcel Energy's Application for a Certificate of Need for additional dry cask storage, Xcel Energy's license amendment request to the Nuclear Regulatory Commission and associated safety analysis report (SAR), and correspondence with Xcel Energy. Select sources are noted here:

- Application to the Minnesota Public Utilities Commission for Certificates of Need for the Prairie Island Nuclear Generating Plant for Additional Dry Cask Storage and Extended Power Uprate, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602
- License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) and enclosures, http://www.nrc.gov/reading-rm/adams/web-based.html >> "Begin Adams Search" >> http://adamswebsearch.nrc.gov/scripts/securelogin.pl >> Search on the following accession numbers:

  - 081290197, Prairie Island ISFSI, LAR
  - 081290198, Enclosure 3
  - 081290199, Enclosure 5, Safety Analysis Report Addendum A
  - 081370151, Enclosure 5, Safety Analysis Report Addendum A
- Prairie Island Nuclear Generating Plant, Environmental Report for License Renewal Application, is Appendix J of the Xcel Energy's Application for Certificates of Need, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602
- Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Update Qualifications and Analysis Report, EPRI, 2004, www.epri.com

2.0 REGULATORY FRAMEWORK

The U.S. Nuclear Regulatory Commission (NRC) regulates nuclear generating plants and spent fuel storage facilities to ensure that they are safely operated. The State of Minnesota decides as an economic and policy matter whether it is in the public interest to allow additional storage of spent nuclear fuel at the Prairie Island ISFSI such that the PINGP can continue operations until 2034.

In 2003, the Minnesota Legislature made the Public Utilities Commission (Commission) responsible for deciding whether to issue a certificate of need (CON) for spent nuclear fuel storage facilities, including expansion of such facilities (Minn. Stat. § 116C.83, Subd. 2). The legislature retained the option of reviewing Commission decisions regarding independent spent fuel storage installations (ISFSIs). In addition, the legislature required an environmental impact statement (EIS) be prepared prior to any Commission ISFSI decision (Minn. Stat. § 116C.83, Subd 6).

2.1 FEDERAL REGULATION

The U.S. Nuclear Regulatory Commission (NRC) has responsibility for regulating the nuclear fuel cycle and the use of radioactive materials, including source material (uranium and thorium), special nuclear material (enriched uranium and plutonium), and byproduct material (material made radioactive in a reactor and residues from the milling of uranium and thorium). Nuclear generating plants like the PINGP are considered part of the nuclear fuel cycle.

The NRC regulates PINGP and Prairie Island ISFSI operations through an overlapping series of federal regulations (**Table 2.1**). Section 10 of the Code of Federal Regulations (CFR) Part 20 provides "Standards for Protection Against Radiation." Part 20 includes requirements for dose limits for radiation workers and members of the public, monitoring and labeling radioactive materials, posting radiation areas, and reporting the theft or loss of radioactive material. It also includes penalties for not complying with NRC regulations.

Radiation dose limits are imposed in 10 CFR 20, 50, and 72. The NRC also enforces U.S. Environmental Protection Agency (EPA) rules on nuclear power operations (40 CFR 190 and 191) through a Memorandum of Understanding. The Minnesota Department of Health has identical requirements to the NRC for radioactive materials use (Minn. Rules Chapter 4731) and very similar requirements for x-ray machine use (Minn. Rules Chapter 4730).

Nuclear Generating Plant License Renewal
The NRC licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations, including 10 CFR 51 and 10 CFR 54 (Requirements for Renewal of Operating Licenses for Nuclear Power Plants). NRC regulations provide for an operating license renewal period for up to 20 years beyond the initial 40-year license term.

The NRC license renewal process focuses on technical and engineering aspects of plant operations but also includes a federal environmental review component (both a generic EIS and a facility-specific supplemental EIS or ER). This federal process and these documents will cover, among other issues, the expected radiation safety and health impacts of continued operation of the plant and ISFSI, as well as a separate analysis of the impacts of generation alternatives to the continued operation of the Prairie Island plant itself. The NRC environmental review process includes a scoping process, public meetings, and opportunity for public comment.

Generic Environmental Impact Statement (GEIS) and Supplemental Environmental Impact Statement (SEIS). The NRC prepares a Generic Environmental Impact Statement (GEIS) to examine the possible environmental impacts of renewing any commercial nuclear power plant license, and, to the extent possible, establishes the significance of these potential impacts. For each type of environmental impact, the GEIS attempts to establish generic findings covering as many plants as possible.

While plant and site-specific information is used in developing generic findings, the NRC does not intend for the GEIS to be a compilation of individual plant environmental impact statements. Instead, this report may be incorporated by reference by an applicant into a license renewal application. The GEIS makes maximum use of environmental and safety documentation from original licensing proceedings and information available from state and federal regulatory agencies, the nuclear utility industry, scientific literature and plant operating experience. It allows the applicant to concentrate on those impacts that must be evaluated on a plant-specific basis. The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, is available on the NRC website:

http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/

The NRC prepares a Supplement Environmental Impact Statement (SEIS) to look potential environmental impacts that must be evaluated on a plant-specific basis. The NRC initiated development of an SEIS for the PINGP with the submission of Xcel Energy's application for a license renewal. The draft SEIS for the PINGP is scheduled to be issued in March 2009. The SEIS preparation process and PINGP license renewal process is viewable on the NRC website:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/prairie-island.html#public

Environmental Report. Every facility applying to the NRC for license renewal is required to complete a plant and site-specific supplemental environmental report to deal with unique facility and location issues. NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document entitled, *Applicant's Environmental Report - Operating License Renewal Stage*. The report is to include an assessment of the environmental consequences and potential associated mitigating actions and is to supplement the

GEIS. Appendix E to the Prairie Island license renewal application contains the environmental report for the PINGP operating license renewal.[66]

Independent Spent Fuel Storage Installation (ISFSI) License Renewals and AmendmentsThe NRC licenses the storage of spent nuclear fuel separately and independently of the licensing of nuclear generating plants under 10 CFR 72 (Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor Related Greater than Class C Waste). The license for spent fuel storage is a Special Nuclear Materials (SNM) license. License renewals must include technical specifications than ensure safety through design, monitoring, and administrative controls. The NRC reviews spent fuel storage systems by evaluating each design for resistance to accident conditions, e.g., earthquakes, tornadoes, and temperature extremes.

License renewals require a site-specific environmental report, similar to that for a generating plant license renewal. All spent nuclear fuel storage facilities must use storage casks that have been approved by the NRC. A list of NRC-approved spent fuel storage casks is available on the NRC website:

http://www.nrc.gov/waste/spent-fuel-storage/designs.html

Information on the NRC's licensing of spent fuel storage is also available on the NRC website:

http://www.nrc.gov/waste/spent-fuel-storage/licensing.html#public.

Prairie Island ISFSI Expansion. Three NRC licenses or license amendments will be required for the expansion of spent fuel storage at the Prairie Island ISFSI: (1) approval of the enhanced Transnuclear spent fuel storage cask (TN-40HT cask), (2) renewal of the current ISFSI license that is set to expire in 2013, and (3) an amendment to the current ISFSI license to increase the number of casks beyond the 48 currently authorized by the NRC.

The Prairie Island ISFSI is currently licensed to store spent fuel in up to 48 TN-40 vertical metal casks (24 on each of the two storage pads) under the existing site-specific license issued in October 1993 (License No. SNM-2506). The NRC license amendments to expand spent fuel storage at the ISFSI are further detailed here:

1) **Approval of the TN-40HT Cask.** The first license amendment requirement is certification that an enhanced version of the TN-40 cask, referred to as the TN-40HT cask, complies with the requirements of 10 CFR 72. The TN-40HT is very similar to the TN-40 cask in dimensions, storage capacity, and operation. It is designed to use the same handling, transfer and operating equipment as used for the TN-40 casks. The enhancements involve features that improve heat transfer and neutron absorption. These

[66] Applicant's Environmental Report – Operating License Renewal Stage, Prairie Island Nuclear Generating Plant, Nuclear Management Company, LLC, Docket Nos. 50-282 and 50-306, License Nos. DPR-42 and DPR-60, April 2008.

features will enable the TN-40HT casks to store fuel assemblies that have a higher uranium-235 enrichment and higher burn-up, i.e., energy per fuel assembly. The license amendment request was submitted March 28, 2008. The expected NRC approval date is approximately March 2009.

2) **Renewal of ISFSI License**. The second license amendment requirement is renewal of the Prairie Island ISFSI license (No. SNM-2506). The license was issued in October 1993 with a 20-year term. Therefore, to continue operation beyond October 2013, the license must be renewed. Per 10 CFR 72.42, the application for renewal of a license must be filed at least two years prior to the expiration of the existing license. Thus, a submittal will be made prior to October 2011 and it is anticipated that the NRC will renew the license prior to October 2013.

3) **Increase Cask Authorization.** The third license amendment requirement is to increase the allowed number of storage casks at the ISFSI beyond the current NRC approved 48-cask limit. To house up to 35 additional casks, two new concrete storage pads would be constructed adjacent to the existing pads. Since the cask loading plans do not call for the utilization of these new storage pads until 2022, it is projected that the installation of the pads would not occur until 2020**.** To support this timeline, it is projected that the license amendment request would be submitted to the NRC sometime in 2018 with an anticipated NRC approval in 2019.

In anticipation of transporting the spent nuclear fuel stored at the ISFSI to a federal repository, Transnuclear, the designer of the TN-40 and TN-40HT casks, is requesting transportation licenses from the NRC for these casks (10 CFR 71). Transnuclear has submitted a request for the TN-40 cask. After the NRC has approved the TN-40 casks for transportation, Transnuclear plans to submit a license amendment request to license the TN-40HT cask design for transportation. It is anticipated that the NRC would approve that amendment some time in 2009.

2.2 STATE REGULATION

In addition to federal requirements, nuclear power generating plants and independent spent fuel storage installations (ISFSIs) in Minnesota are governed by state statutes, rules, and regulatory processes.

Certificate of Need (CON) Application

The storage of spent nuclear fuel storage in Minnesota, including the expansion of an existing ISFSI, requires a certificate of need from the Minnesota Public Utilities Commission (Minn. Stat. § 116C.83, Subd. 2). The Commission determines the need for the expanded storage pursuant to Minn. Stat. § 216B.243 and rules adopted under this statute. The Commission "may make a decision that could result in a shutdown of a nuclear generating facility" (Minn. Stat. § 116C.83, Subd. 2). Prior to the granting of a certificate of need by the Commission, an environmental impact statement (EIS) must be developed for the proposed storage expansion (Minn. Stat. § 116C.83, Subd. 6).

Xcel Energy applied for a certificate of need (CON) for expansion of the Prairie Island ISFSI on May 16, 2008.[67] The application provides information on the economics and potential impacts of expanding the current ISFSI – thus allowing the PINGP to remain operating – as compared to the economics and environmental impacts of alternative storage options and energy sources. The application discusses potential human and environmental impacts from the proposed ISFSI expansion, including estimated radiation exposures and doses.

Environmental Impact Statement

An environmental impact statement (EIS) must be prepared prior to the Commission decision on a certificate of need for expanded dry cask storage (Minn. Stat. § 116C.83, Subd. 6). The EIS must discuss the potential human and environmental impacts of the proposed project and compare the impacts of the proposed project with reasonable alternatives to the project (Minn. Rules Chapter 4410.2300). Its purpose is to inform the Commission of potential human and environmental impacts, and possible mitigative measures, as it considers the CON determination.

The Minnesota Department of Commerce is the responsible governmental unit for preparation of the EIS. The Commissioner of the Department of Commerce must determine the adequacy of the final EIS (Minn. Stat. § 116C.83, Subd. 6). With respect to this document, the Commissioner must find Chapter 2 adequate in addressing those issues and potential impacts described in the scoping decision for the EIS.

Environmental Review Process

As discussed in Chapter 1, Sections 1 and 2, the EIS for the proposed Prairie Island ISFSI expansion and the EIS development process (e.g., public meeting, scoping, comment period) have been consolidated with the EIS requirements for the proposed PINGP power uprate. Chapter 1 of this document covers the proposed power uprate; Chapter 2 covers the proposed expansion of dry cask storage at the ISFSI.

When the draft EIS (DEIS) is completed, it will be issued for public review and comment, including a public meeting. Timely, substantive comments on the DEIS will be responded to and included in a final EIS (FEIS) (Minn. Rules 4410.2700). The Commissioner of the Department of Commerce must determine the adequacy of Chapter 2 of the FEIS. Concurrent with development of the FEIS, the DEIS will be entered in the record of the contested case hearing for the ISFSI expansion CON. The Commission has consolidated the hearing for the ISFSI expansion with that of the proposed PINGP power uprate.[68] Upon issuance of the report of the Administrative Law Judge from the contested case, the docket will come before the Commission for a decision on the issuance of a CON for the proposed ISFSI expansion.

[67] Certificates of Need Application, Prairie Island Nuclear Generating Plant, May 16, 2008, http://energyfacilities.puc.state.mn.us/Docket.html?Id=19602
[68] Minnesota Public Utilities Commission, Notice and Order for Hearing, https://www.edockets.state.mn.us/EFiling/ShowFile.do?DocNumber=5373456

3.0 PROJECT DESCRIPTION

Xcel Energy is proposing to extend the concrete storage pads within the current Prairie Island ISFSI to accommodate additional dry storage casks of spent nuclear fuel. The ISFSI currently has state authorization for 29 casks. In order to operate the Prairie Island nuclear generating plant (PINGP) an additional 20 years, Xcel Energy is seeking state authorization for storage of an additional 35 casks. Thus, the total number of casks required for operations through 2034 would be 64.

The current ISFSI is constructed with concrete storage pads sufficient to place 48 casks. To place 64 casks, the concrete storage pads need to be expanded to accommodate 16 additional casks. This expansion would allow the PINGP to operate through 2034. The ISFSI is designed to accommodate storage casks necessary for decommissioning the Prairie Island plant. Additional concrete storage pads would be needed to place these casks in the ISFSI at decommissioning.

In addition, Xcel Energy is proposing to use an enhanced version (TN-40HT) of the current Transnuclear dry storage cask used at the PINGP for the expansion. The proposed project can be summarized as: (1) extending the concrete storage pads within the current ISFSI, (2) placing spent nuclear fuel from PINGP operations into the TN-40HT casks, (3) transporting and placing the casks on the storage pads within the ISFSI, and (4) monitoring the casks until removed to a federal repository.

3.1 PROJECT SETTING

The Prairie Island Nuclear Generating Plant (PINGP), including its associated Independent Spent Fuel Storage Installation (ISFSI), is located on the west bank of the Mississippi River in Goodhue County within the city limits of Red Wing, MN. The PINGP is situated on the southeastern portion of Prairie Island, an outwash terrace above the Mississippi River. The plant site is located at an elevation of 690 feet above mean sea level (MSL), about 15 feet above the normal pool elevation of the river. The general area is nearly level, with a local relief ranging from about 675 feet above MSL (along the river frontage) to about 700 feet above MSL.

At the plant location, the Mississippi River serves as the state boundary between Minnesota and Wisconsin. The Mississippi River at this location is known as Sturgeon Lake, a backwater area located approximately one mile upstream from the U.S. Army Corps of Engineers (USACE) Lock and Dam 3. The Vermillion River lies just west of the PINGP and flows into the Mississippi River approximately two miles downstream of Lock and Dam 3.

The PINGP site comprises approximately 578 acres of land, owned in fee by Northern States Power, a subsidiary of Xcel Energy. Access to the site is controlled and there is an enforced exclusion zone. On Prairie Island, access to the exclusion zone is restricted by a perimeter fence with “No Trespassing” signs. East of the plant the exclusion zone boundary extends to the main channel of the Mississippi River. Islands within this boundary as well as a small strip of land northeast of the plant are owned by USACE. An agreement exists with USACE such that no residences will be built on that strip of land or islands within the exclusion zone for the life of the plant.

The Prairie Island Indian Reservation is located directly north of the Prairie Island site. The Prairie Island Indian Community (PIIC) is a Federally Recognized Indian Tribe organized under the Indian Reorganization Act (25 USC 476). The reservation population is approximately 250 persons; the total enrollment of the tribal community is approximately 760 persons. The Prairie Island Indian Community owns and operates the Treasure Island Resort and Casino, which includes a hotel and convention center.

ISFSI Setting

The Prairie Island ISFSI is located approximately 300 yards west of the main generating plant at an elevation of 694 feet above MSL (**Figure 3.1**).

The ISFSI consists of a lighted area, approximately 720 feet long and 340 feet wide, roughly 5.5 acres in size. The tallest structures are the light poles that are approximately 40 feet tall. Two fences surround the facility with a monitored, clear zone between the two fences. Within the storage area, the casks are currently stored on two reinforced concrete pads, 36 ft. x 216 ft. x 3 ft. The additional casks necessary to support PINGP operations through 2034 would reside on new 18 ft. concrete pads to be located immediately south of each of the existing concrete pads (**Figure 3.2**, proposed new concrete pads shaded).

The approach to the pads consists of 14 inches of compacted Class 5 aggregate with a 2% slope. A 30 ft. x 50 ft. steel frame equipment storage building approximately 30 feet high is located on the ISFSI site. The primary purpose of this building is to store the cask transport vehicle. A smaller block building within the ISFSI houses the security equipment while one outside the ISFSI houses the pressure monitoring equipment. A 17 ft high earthen berm surrounds the ISFSI. The site is monitored with cameras and other security devices. An access road connects the ISFSI to the rest of Prairie Island.

The current NRC licensed capacity of the ISFSI is 48 TN-40 storage casks. The proposed extension of the storage pads will be sufficient to accommodate an additional 16 casks. The storage facility is laid out so that the storage pads could be extended to the north and south to accommodate a total of 100 casks without having to change the security perimeter. The extra space could be used for casks to decommission the Prairie Island plant.

3.2 INDEPENDENT SPENT FUEL STORAGE INSTALLATION EXPANSION

The proposed Prairie Island ISFSI expansion project consists of: (1) extending the concrete storage pads within the current ISFSI, (2) placing spent nuclear fuel from PINGP operations into Transnuclear TN-40HT casks, (3) transporting and placing the casks on the storage pads within the ISFSI, and (4) monitoring the casks until removed to a federal repository.

Extending the Concrete Storage Pads within the ISFSI

The Prairie Island ISFSI was granted a federal operating license in October 1993. In 1994, the Minnesota Legislature granted Xcel Energy permission to store a limited amount of spent nuclear fuel in dry storage casks at an on-site ISFSI. ISFSI construction was completed in 1995; the first cask was loaded and placed on the ISFSI pad in May 1995. There are currently (2008) 24 casks on the ISFSI pad.

In order to store an additional 16 casks, two new pads will need to be constructed. Construction of each new pad will consist of pouring an 18 ft. wide x 216 ft. long x 3 ft. thick slab. In addition, underground concrete duct banks and associated electrical conduit will need to be installed from the cask monitoring building to the new pads. The work will include excavation of the pad area, trenching of the duct bank path, pouring the concrete pad and duct bank, and replacing the structural fill. Site preparation will involve using earth moving equipment such as bull dozers, scrapers, backhoes, and graders to excavate and level the pad and duct bank areas. Following the leveling of the area, reinforced steel, conduit, and forms will be put in place and concrete will be poured forming the storage pads and duct banks. Concrete trucks will deliver concrete to the site and pumping trucks will place it. The area around the pad and trench over the duct bank will be back-filled and returned to the 2% grade when complete.

During construction it is anticipated that storm water will drain into the existing structural fill within the ISFSI and into drainage ditches. Construction measures will be taken to ensure that there are no point discharges from the site into flow routes that discharge into the Mississippi River. Sediment controls such as geo-textiles will be used to minimize soil sediment runoff into drainage ditches.

Prior to any construction activities, a radiation survey of the work area near the existing dry storage casks will be performed. A plan to limit radiological doses to construction workers will be developed based dose rates in these areas. The plan will utilize standard radiation practices, e.g., time, distance and shielding. It is not anticipated that excavated fill (aggregate) will become activated or contaminated by radioactive materials. If monitoring of the ISFSI reveals ground water or soil contamination at the site, the fill would be tested prior to its removal from the site and disposed of properly.

The primary function of the concrete storage pads is to provide a uniform level surface for storing the casks. The pads are designed to prevent unacceptable levels of cracking or settlement under normal and off-normal loads. Since the cask loading plans do not call for the utilization of these new storage pads until 2022, it is projected that the installation of the pads would not occur until 2020.

Loading and Transporting Dry Storage Casks to the ISFSI

The loading of spent nuclear fuel into dry storage casks and the transportation of these casks to the ISFSI will utilize processes and safeguards very similar, if not identical, to those currently used at the PINGP. The process will use the same fuel source (the spent nuclear fuel pool at the PINGP), the same lifting and handling devices, the same transport vehicle, and the same ancillary equipment. The primary difference will be the use of the enhanced Transnuclear cask (TN-40HT) and the loading of spent fuel with a higher fuel loading and burnup.

Operations. When it is time to load spent fuel assemblies, a TN-40HT cask is placed in the PINGP auxiliary building and lowered into the spent fuel pool. Fuel assemblies (40 assemblies per cask) are loaded into the cask and the lid for the cask is installed underwater. The cask is lifted from the pool, drained, and moved to a cask decontamination area. In the decontamination area, the outer surface of the cask is decontaminated. The cask is vacuum dried, backfilled with helium, and a helium leak test of the cask seals is performed.

The decontaminated cask is placed into a specialized cask transport vehicle (CTV). A neutron shield is placed on the cask top. The cask's overpressure system is pressurized and tested. A final protective weather cover is attached, and the cask is moved via the CTV to the ISFSI and placed on the pad.

Dry Storage Cask, TN-40HT. All spent nuclear fuel storage casks must be licensed by the NRC and meet design criteria established by 10 CFR 72. Storage casks are designed to ensure that: (1) fuel critically is prevented, (2) cask integrity is maintained, and (3) fuel is not damaged so as to preclude its removal from the cask. These design criteria must be met for normal operations and for off-normal events including natural phenomena (e.g., tornadoes, floods) and man-made accidents (e.g., missiles).[69]

The Prairie Island ISFSI currently uses the Transnuclear TN-40 cask. Xcel Energy proposes using this cask for storage of spent fuel in casks number 1 through 29 at the ISFSI. Starting with cask number 30, Xcel Energy proposes using an enhanced version of the Transnuclear cask, the TN-40HT. Use of the TN-40HT cask is dependent upon approval by the NRC of the cask for use at the Prairie Island ISFSI. A license amendment application was submitted to the NRC on March 28, 2008, requesting that the enhancements to the TN-40HT cask be found to comply with the requirements of 10 CFR 72. It is anticipated the NRC will issue the amendment to the license in 2009.

The TN-40HT cask is an enhanced version of the TN-40 dry fuel storage cask (**Figure 3.3**). The TN-40HT cask is designed to hold 40 fuel assemblies and will allow for storage of relatively more highly enriched fuel and greater burnups. A cask consists of an internal basket, containment vessel, lid, outer shell, neutron radiation shields, and a weather cover.

The cask is designed to be an independent, passive storage system which does not rely on other systems or components for operation. Individual casks are approximately 8 ft. in diameter, 16 ft. tall, and weigh approximately 240,000 lbs. when loaded.

[69] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 3.2

The TN-40HT cask consists of two concentric shells. The containment vessel is the inner most cask shell and is a 1.5-inch thick carbon steel cylinder with a welded carbon steel plate at the bottom. The vessel includes stainless steel boxes (fuel basket) separated by heat conduction and neutron absorption plates. The stainless steel box geometry provides structural rigidity to support the fuel assemblies. At the top of the containment vessel is a flange, which provides the positioning and sealing surface for the bolted carbon steel lid. The lid is 10 inches thick and is attached to the upper vessel flange by 48 bolts. Two metallic O-rings are installed on the lid to provide a redundant seal, capable of being monitored, between the flange and the lid.

The outer cask shell is a 7.25-inch thick steel cylinder. It is welded to a 7.25-inch bottom shield plate and to the containment vessel closure flange, thereby enclosing the containment vessel inner shell and bottom plate. Attached to the shell are resin filled containers arrayed vertically and surrounding the shell. The resin contains neutron-absorbing material to reduce neutron radiation levels. A circular neutron shield disk provides neutron shielding on the lid during storage. In order to keep the cask lid clean and to avoid the accumulation of water in recesses of the cask lid, a weather cover is provided above the cask lid. The resultant overall dimensions of a cask are an outer diameter of 101 inches and a height of approximately 200 inches.

The TN-40 cask is currently licensed to store spent fuel assemblies with a maximum burnup of 45 giga-watt days/metric ton of uranium (GWD/MTU), maximum enrichment of 3.85 wt. % U235, and a minimum cooling time of 10 years after reactor discharge. The TN-40HT cask is expected to be licensed to accommodate a maximum burnup of 60 GWD/MTU, maximum enrichment of 5.0 wt. % U235, a minimum cooling time of 12 years after reactor discharge, and a thermal capacity of 32 kW (0.8 kW per fuel assembly).

Though the TN-40HT cask is nearly identical to the TN-40 cask, the TN-40HT cask includes enhancements to safely accommodate higher enrichment and burnup fuel. These enhancements include: (1) making the fuel basket structurally stronger by increasing the thickness of fuel cell compartment walls, (2) improving heat transfer capability by utilizing aluminum plates between fuel compartments that improve heat conduction from the center of the cask to the cask body, and (3) increasing the concentration of neutron absorbing material in the fuel basket itself.

Monitoring, Inspection, and Maintenance

The Prairie Island ISFSI is designed to be a passive storage system. However, there is monitoring and maintenance that is required to ensure the casks are operating properly and that they can maintain proper functioning throughout the life of the ISFSI.

The double seal (O-ring) system on the TN-40HT cask is pressurized with helium to approximately 5.5 atmospheres (80 pounds per square inch, psi). This pressure is monitored by a transducer which, via a pressure transmitter mounted on the side of cask, sends an electronic signal to the ISFSI monitoring system. The monitoring system is checked daily. Should the pressure in the seal drop, it would indicate that either: (1) the inner seal may have failed and helium is leaking into the cask, or (2) the outer seal may have failed and helium is leaking into the space between the lid and protective cover. Additionally, it could be that there is a malfunction in the monitoring system. PINGP personnel would immediately investigate the cask and indicated pressure drop. If necessary, the cask would be returned to the auxiliary building and the cask seals repaired or replaced.

The first dry storage cask was placed in the Prairie Island ISFSI in 1995. Since that time, there have been eight low-pressure alarms at the ISFSI. All eight alarms were due to a leak in the monitoring system tubing or pressure transmitter. None of the alarms were caused by a cask seal leak. Accordingly, no casks, to date, have been removed to the auxiliary for cask seal repair. Casks are visually inspected periodically for signs of weathering. The casks are painted with a corrosion-inhibiting coating. This coating is inspected and touched up as necessary.

The minimum design life for the TN-40 series of Transnuclear casks is 25 years.[70] However, due to the passive nature of the dry storage casks and the robustness of their components, it is anticipated that the ISFSI could physically be operated for several hundred years. The extent and possible impacts of temporary, long-term storage of spent nuclear fuel at the Prairie Island ISFSI are discussed further in Sections 4 and 5 of this chapter.

Security for the Prairie Island ISFSI is provided by the PINGP security force. Access to the ISFSI is controlled. The ISFSI is surrounded by two security fences with an intrusion detection system and a monitored clear zone. The intrusion detection system would alert the PINGP security force in the event of an unauthorized attempt to enter the ISFSI. Lighting and video cameras will provide video monitoring to assist the security force. The ISFSI perimeter is patrolled by plant personnel at least once per shift. The ISFSI (including casks and berm) are inspected quarterly to ensure proper functioning of the ISFSI. Any maintenance indicated by these inspections is then performed.

Project Costs

The estimated installed cost of the ISFSI in 2008 dollars is $155.7 million. The estimate includes the following component costs:

Component	**Cost (millions)**
State Regulatory Processes	$2.0
Cask Licensing	$4.6
ISFSI Construction	$3.0
ISFSI Re-licensing	$2.8
35 TN-40HT casks	$143.3
TOTAL	**$155.7**

[70] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Table 3.4-1, Design Criteria for the TN-40 Casks.

3.3 SPENT FUEL INVENTORY

Spent nuclear fuel from PINGP operation is temporarily stored in the spent nuclear fuel pool in the PINGP auxiliary building. The pool provides the means to safely handle and manage the spent fuel assemblies. Additionally, storage in the pool allows the fuel assemblies to cool with respect to thermal and radioactive emissions so that they can be safely stored in dry casks.

The spent nuclear fuel pool is filled with storage racks that hold the spent fuel assemblies and other irradiated reactor components. The depth of water in the pool is approximately 37 feet The spent fuel pool is equipped with redundant cooling systems to remove heat that continues to be generated by the assemblies. The filtering portion of the system maintains pool water chemistry and removes suspended particles. The water above the spent fuel also provides radiation shielding. The spent fuel pool also provides an area for cask loading operations (**Figure 3.4**). Space is set aside so that a cask may be lowered into the pool and assemblies transferred to it for dry storage or transport ("cask lay down area"). Spent fuel assemblies are placed in the pool for between 10 and 12 years to cool before they can be placed in dry casks for storage.

Xcel Energy's NRC operating licenses allow for long-term storage of up to 1,386 spent fuel assemblies in the spent fuel pool. As of April 2008, there were 1,149 spent fuel assemblies in the spent fuel pool. Four storage racks, with a combined capacity of 196 assemblies, may be installed in the cask lay down area to provide additional temporary storage. The PINGP maintains the ability to temporarily remove all of the fuel from both reactors (referred to as full core offload capability) with the use of these temporary storage racks.

Refueling of the PINGP reactor cores takes place every 18 to 20 months. Approximately one third of the fuel assemblies in the core are replaced with new assemblies at each refueling. As of April 2008, 2,109 spent fuel assemblies had been discharged from the PINGP, of which 1,149 reside in the spent fuel pool and 960 in 24 dry casks. Xcel Energy estimates that 1,786 spent fuel assemblies will be discharged from Prairie Island's reactors during operation between April 15, 2008 and 2034 (**Table 3.1**).

3.4 PLANT CLOSURE and DECOMMISSIONING

When the operating license for the PINGP expires, the plant will be removed from service, decontaminated, and dismantled. Non-radioactive deconstruction would be handled in a conventional fashion, with extra precautions for workers handling low-level radioactive waste and contaminated debris. Spent nuclear fuel will be managed and stored based on storage alternatives available at the time the plant is removed from service.[71] It is anticipated and most likely that spent fuel would be stored in the spent nuclear fuel pool until such time as it could be transferred to dry casks and transported to the Prairie Island ISFSI.

[71] See Section 6.0 for a discussion of spent fuel storage alternatives.

The Prairie Island ISFSI will be decommissioned once all spent fuel stored in dry casks has been transported to an off-site facility. It is anticipated that the TN-40 and TN-40HT casks will be licensed for transportation by the NRC[72]. The federal government will take title to the casks when they are transported to a federal repository. This leaves only the concrete storage pads and supporting infrastructure to be disposed of by Xcel Energy. Since the casks are sealed, no radioactive materials will be present once the casks and spent fuel have been shipped. No activation of the concrete in the storage pads is expected. A survey will be conducted to ensure that no activation has occurred. Once it is confirmed that no activation has occurred, the concrete storage pads and infrastructure will be dismantled, and the site will be returned to a green field state. If limited activation has occurred, deconstruction of the storage site would be handled appropriately, with precautions and mitigation measures for dealing with any low-level radioactive components (e.g., reinforcing steel).

Funding for Decommissioning

A nuclear decommissioning trust fund (NDT) has been established per NRC regulations to cover the costs of decommissioning the PINGP and Prairie Island ISFSI. The NDT for Prairie Island includes funds for radiological removal of the plant, site restoration, and ISFSI operations. ISFSI operations included in the fund are for operating the ISFSI after plant shutdown until all fuel is removed from the site and then the removal of the ISFSI structures.

The monies placed in the NDT are recovered through rates from Xcel Energy customers. The Minnesota Public Utility Commission reviews the funds collected from ratepayers and placed into the NDT triennially. A triennial review is currently underway for 2009 accruals (Commission docket number: E002/M-08-1201).

In 2008 dollars, the current cost estimates for decommissioning are: $1.026 billion for radiological removal, $83.7 million for site restoration, and $404 million for ISFSI operations. Recognition of these ISFSI operating costs in the NDT is not intended to acknowledge that these costs will ultimately be borne by Xcel Energy or its ratepayers, as some costs (or all) are expected to be the responsibility of the U.S. Department of Energy as a result of the breach to the Standard Contract of Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste.[73] The NRC reviews the level of funding every 2 years and by the Minnesota Public Utility Commission every 3 years to ensure that the NDT has sufficient funds.

[72] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 2.5.1.2. On August 7, 2006, Transnuclear Inc. requested from the NRC a transportation license for the TN-40 casks pursuant to 10 CFR 71.

[73] Under federal court decisions, the U.S. Department of Energy (DOE) has been found liable for damages attributable to delays in accepting spent nuclear fuel for placement in a federal repository; *Maine Yankee Atomic Power Company v. United States*, 225 F.3d 1336 (Fed. Cir. 2000), *Northern States Power Company v. United States*, 224 F.3d 1361 (Fed. Cir. 2000).

4.0 HUMAN AND ENVIRONMENTAL IMPACTS (NON-RADIOLOGICAL)

This section addresses the non-radiological impacts on human economies and the environment resulting from the proposed 35-cask expansion of the Prairie Island ISFSI. In addition, it discusses non-radiological impacts from two related actions – the continuing operation of the Prairie Island Nuclear Generating Plant (PINGP), and the continuing operation of the ISFSI. Radiological impacts are discussed in Section 5 of this chapter.

4.1 GEOLOGY and SOILS

The expansion of the ISFSI will not have a significant impact on the geology or soils of the area. The ISFSI expansion will occur entirely within the confines of the existing ISFSI. No geologic or soil resources within the PINGP site are anticipated to be disturbed.

The Prairie Island ISFSI is constructed on alluvial soils (loamy sands) which are supported by sedimentary rock of the St. Lawrence and Franconian formations. The existing concrete storage pads within the ISFSI are three feet thick. The area within the ISFSI that is not currently used for storage pads is covered with compacted aggregate. Thus, within the ISFSI there are no undisturbed soils which could be impacted by the expansion of the concrete storage pads. Movement of equipment used for construction of the new concrete pads within the ISFSI may cause some erosion to unpaved roads within and near the PINGP site. This erosion is anticipated to be minimal.

4.2 BIOLOGICAL and ECOLOGICALLY SENSITIVE RESOURCES

Expansion of the Prairie Island ISFSI will not have a significant impact on biological and ecologically sensitive resources. The ISFSI expansion will occur entirely within the confines of the existing ISFSI. Neither the construction of the new concrete storage pads, nor the pads and dry storage casks themselves will impact high quality habitat for flora or fauna.

Fauna

The PINGP and Prairie Island ISFSI are located near the Mississippi River and its associated riparian and wetland habitats. There are numerous wetlands within five miles of the Prairie Island ISFSI, all associated with the floodplains of the Mississippi, Cannon, and Vermillion rivers. These wetland habitats and nearby upland habitats support a diversity of fauna, including fish, mollusks, turtles, frogs, birds, waterfowl, muskrats, and raccoons.[74] The habitats are also part of the larger Mississippi River flyway ecosystem that supports migration of birds and waterfowl between the Americas. The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact these habitats. Construction will occur within the current ISFSI, which provides little or no habitat for fauna.

[74] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.3 Biological Resources.

The new concrete pads will add approximately one acre of impervious surface to the ISFSI. This surface will not impact the quality of water runoff from the ISFSI, but will slightly increase the quantity of runoff from the ISFSI. This additional runoff is anticipated to be minor such that it will not impact habitat for regional or migratory fauna. The energy in the additional runoff water will be mitigated by physical barriers that are part of the existing ISFSI, e.g. berm, rip-rap.

Noise due to construction activities at the ISFSI may be intrusive to some fauna. However, noise levels during construction will be only slightly higher than ambient levels (local traffic, trains) and will remain below the Minnesota daytime code limit of 60 dBA.[75] Noise impacts are discussed further in section 4.6.

Flora

Of the 578 acres that comprise the PINGP site, approximately 338 acres have been undisturbed by the construction of the PINGP and Prairie Island ISFSI. This acreage is covered with non-native herbaceous species (e.g. brome grass), shrubs, and trees. Common trees include elms, cottonwoods, ashes, box elders, and burr oaks. The PINGP site itself is surrounded by the Richard J. Dorer Memorial Hardwood State Forest. Wetland plant communities are found around, adjacent to, and, in some places, within the PINGP site. For example, the area roughly between the ISFSI and PINGP cooling towers includes portions of floodplain forest.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact the region's flora. Construction will occur within the current ISFSI, with little or no disturbance of acreage within the PINGP site.

Threatened and Endangered Species

Within counties near the PINGP site there are approximately 60 animal species and 30 plant species that are of special concern. These are species that are federally-listed or state-listed as threatened or endangered, species proposed for federal listing, candidates for federal listing, and species state-listed as species of special concern.[76] Of these, seven species are found within one mile of the PINGP site: Higgins Eye pearlymussel, peregrine falcon, Blanding's turtle, paddlefish, and mucket, washboard, and butterfly mussels. The Higgins Eye pearlymussel is federally listed; the other six species are state-listed.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not significantly impact these species. Construction and operation of the expanded ISFSI will not significantly impact water and wetland habitats upon which most of these species rely. Peregrine falcons have nested in a nest box on the PINGP Unit 1 containment dome since 1997. They are apparently habituated to activities at the PINGP and will likely not be impacted by construction or operations at the Prairie Island ISFSI.

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[75] Minn. Rules 7030.0040. The daytime limit is expressed as an L_{50} level of 60 dBA. L_{50} means the sound level is exceeded 50 percent of the time.
[76] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.3.3 Threatened or Endangered Species, Table 2.3-1.

4.3 WATER RESOURCES

Expansion of the Prairie Island ISFSI is not expected to have a significant impact on water resources. The expansion will not impact nearby riverine or wetland resources. It will withdraw a small amount of water from the Mississippi River for construction purposes. It will not impact groundwater resources.

Water Resources

There are bountiful water resources within five miles of the PINGP site, including the Mississippi River, local tributaries (Cannon, Vermillion, Trimbelle rivers), and associated wetlands. The PINGP site is located on Sturgeon Lake, a backwater area of the Mississippi River created by Lock and Dam Number 3. The Cannon, Vermillion, and Trimbelle rivers enter the Mississippi River near and just south of this dam.

The Mississippi National River and Recreation Area extends from north of Minneapolis, MN to just south of Hastings, MN. This recreation area is approximately 6 miles north of the PINGP site. The Cannon River is a designated State Wild and Scenic River. A large wetland complex, the Rice Lake Bottoms, is located at the confluence of the Cannon and Mississippi rivers, approximately 3 miles south of the PINGP site. There are numerous wetlands associated with Sturgeon Lake and Pool Number 3, the Mississippi River pool created by Lock and Dam Number 3.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not significantly impact these water resources. Construction will occur within the current ISFSI, with little or no disturbance of acreage within the PINGP site. Construction of the new storage pads will require the excavation of approximately 864 cubic yards (CY) of existing aggregate and subsoil within the ISFSI. Movement of these materials will occur within a facility with existing runoff controls, thus the possibility of impacting water resources is minimal. Nonetheless, practices to minimize run-off and erosion will be employed during construction – e.g., strategic placement of hay bales, silt fencing, geo-textiles, and in-situ vegetation. Xcel Energy will consult with the Minnesota Pollution Control Agency as to the permits required, if any, for expansion of the ISFSI.

The new concrete pads will add approximately one acre of impervious surface to the ISFSI. This surface will not impact the quality of water runoff from the ISFSI, but will slightly increase the quantity of runoff from the ISFSI. The energy in the additional runoff water will be mitigated by physical barriers that are part of the existing ISFSI, e.g. berm, rip-rap.

Water Use

Water use due to the construction of new concrete storage pads and the operation of the casks and ISFSI will be minimal. Xcel Energy proposes drawing water from the Mississippi River for dust control purposes. This amount is estimated at approximately 53,000 gallons total over the course of construction. The ISFSI itself uses no water for operations. Expansion of the ISFSI will not change water use at the PINGP.

Groundwater Quality
Groundwater at the PINGP site moves generally toward the Mississippi River and its tributaries. On outwash terraces such as the one upon which the PINGP and Prairie Island ISFSI are situated, groundwater levels coincide closely with river elevation. Additionally, because the terraces are formed from permeable alluvial soils, the groundwater table responds quickly to changes in river elevation.

The approximate river elevation at the PINGP site is 675 ft. above mean sea level (MSL). The ISFSI is constructed at an elevation of 694 ft. MSL, with the top of the storage pad at 697 ft. MSL. Thus, it is approximately 22 feet to groundwater from the ISFSI surface; however, this distance varies readily with river elevation.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact groundwater resources. There are no effluents from the ISFSI. There are no borings, holes, or other channels within the ISFSI that could reach groundwater and commute surface pollutants. The requirements of Minn. Stat. § 116C.83, Subd. 6(b) regarding radiological groundwater standards are discussed in Section 5.

4.4 CULTURAL and HISTORICAL RESOURCES

Expansion of the Prairie Island ISFSI will not have a significant impact on cultural and historical resources. There are 60 properties on the National Register of Historic Places in Goodhue County. There are seven properties listed in Pierce County, WI, across the Mississippi River from the PINGP site. The Final Environmental Statement (FES, 1973) for the PINGP identified three sites with historical significance within six miles of the Prairie Island plant.[77] One of these, the Barton Site, was added to the National Register of Historic Places in 1970. The site appears to have been inhabited by people of the Oneota culture sometime between 1050 and 1300 A.D.

The Prairie Island Indian Community (PIIC) is located directly north of the PINGP site. The PIIC is home to the Mdewankanton Band of Eastern Dakota. The lands and waters of the PIIC are a cultural and historic resource. These lands and waters encompass over 3000 acres.

The Mississippi River and its associated parks, trails, and roads are cultural resources for the area. The Mississippi National River and Recreation Area is located upriver from the PINGP site. The Mississippi River corridor in the region is a scenic byway designated as the “Great River Road.” The Road is comprised of U.S. Highway 61 in Minnesota and Wisconsin Route 35 in Wisconsin. Additional cultural resources include state wildlife management areas, state forest areas, and boating areas. The A. P. Anderson County Park is approximately 5 miles south of the PINGP. The Cannon Valley Trail, which follows the Cannon River, offers biking, hiking, skating, and skiing opportunities.

[77] Prairie Island Nuclear Generating Plant, License Renewal Application, Appendix E – Environmental Report, Section 2.10 Historic and Archaeological Resources.

The construction of new concrete storage pads and the operation of the casks and ISFSI will not impact these cultural and historical resources. Construction will occur within the current ISFSI and will utilize existing facilities on the PINGP site (e.g., roads). No historic or cultural resources will be disturbed by the expansion of the ISFSI or ongoing ISFSI operations. Noise due to construction activities at the ISFSI may temporarily impinge on the enjoyment of some cultural resources. However, noise levels during construction will be only slightly higher than ambient levels (local traffic, trains).

4.5 TRAFFIC

Expansion of the Prairie Island ISFSI will not have a significant impact on local transportation resources and no traffic mitigation measures are warranted for construction of the project. No additional staff persons are required for operation of the expanded ISFSI. Operation of the ISFSI creates no new traffic impacts.

Construction of the new concrete storage pads within the ISFSI will create traffic impacts. These impacts are anticipated to be minimal. Construction of the new pads is expected to be completed in a 4 week period. Xcel Energy projects that during this time period 6 additional construction labor workers will be commuting to the ISFSI work site. Trucks will be used to deliver construction supplies to the work site, including structural fill, rebar, and concrete. During the weeks when supplies are delivered, Xcel Energy projects approximately 24 additional truck trips per day on roads leading to the ISFSI work site. These roads include U.S. Highway 61, Prairie Island Blvd., and Sturgeon Lake Rd. These are major roads in good condition such that they can easily handle the additional construction traffic or minor roads with very limited use such that they can accommodate a temporary increase in traffic.

4.6 NOISE

Expansion of the Prairie Island ISFSI will not create significant noise impacts. Impacts from operations of the ISFSI are minimal and primarily reflect ambient noise levels from operations at the PINGP. There will be additional noise impacts related to construction of the concrete storage pads within the ISFSI. These impacts are expected to be minimal.

Construction at the ISFSI site will generate noise. Noise will be generated primarily by the operation of heavy equipment, e.g., bulldozers, dump truck, backhoes, and concrete trucks. Xcel Energy has compared projected construction noises with ambient noise levels at six locations around the PINGP site.[78] Ambient noise levels are highly dependent on location. For example, daytime ambient noise levels at the Prairie Island Casino are in the range of 45 dBA, due primarily to casino related traffic. Daytime ambient noise levels at rural residences are in the range of 35 dBA.

[78] Prairie Island Nuclear Generating Plant, Certificates of Need Application, May 16, 2008. Section 7.3.9, Table 7-8.

Xcel Energy projects construction noises in the range of 40-55 dBA. Thus, some citizens will experience noise impacts of 10-20 additional dBA; other citizens will experience no increase in noise. For those citizens who are impacted, the additional noise impact is limited in extent and duration. The impact will be below the Minnesota daytime code limit (60 dBA). It will occur only during daytime hours, and only during the 4-6 weeks of construction.

The noise impacts from operation of the Prairie Island ISFSI will be the occasional placement of spent fuel casks on the ISFSI pad. Noise levels related to the transport of a cask are approximately equal to that of construction (use of heavy machinery) but of less duration (one or two days per year).

4.7 SOCIOECONOMICS

Expansion of the Prairie Island ISFSI will not have a significant impact on the socioeconomics of the region. The expanded ISFSI will require no additional workers for operations. There will be a small positive impact due to the need for laborers during construction of the concrete pads within the ISFSI. Xcel Energy projects employing 13 additional workers at the ISFSI site over the one-month construction period. Additionally, local companies that supply and transport materials for the construction project will experience a small positive economic impact. Construction of the ISFSI expansion is schedule for 2020. Thus, economic impacts related to construction activities will not occur until that year.

4.8 VISUAL IMPACTS and AESTHETICS

Expansion of the Prairie Island ISFSI will not create significant visual or aesthetic impacts. The ISFSI is situated within a wooded area on the PINGP site and surrounded by a 17 foot high earthen berm. It is not visible from the Mississippi River or adjacent properties. The ISFSI is illuminated for security purposes. However, the light fixtures are approximately 40 ft. high, which is lower than many of the trees surrounding the site.

The illumination of the ISFSI and that of the Prairie Island plant create a small visual impact for persons attempting to enjoy a dark night sky in the area (e.g., stargazing). It is difficult to mitigate this impact. However, this is an existing impact and independent of the ISFSI expansion. The expansion of the ISFSI will not create new or additional visual impacts.

4.9 HEALTH and SAFETY

The health of citizens is dependent upon the health of the ecosystems in which they live and work. The discussions in this section related to ecosystem health, e.g., biological resources and water resources, indicate that the expansion of the Prairie Island ISFSI will not have a significant non-radiological health impact on citizens.

There are very few aspects of health that can be extracted and considered outside of the natural environment. Two health concerns related to the built environment are considered here: (1) the possible impacts to the psychological health of citizens, and (2) the possible radiological health impacts to citizens. Psychological health impacts are discussed in Chapter 1, Section 4.5 of this EIS. Possible radiological impacts are discussed are discussed in Chapter 2, Section 5 of this EIS.

Expansion of the Prairie Island ISFSI will not pose significant non-radiological safety risks and all related possible impacts to citizens (e.g., fall, burn) are minimal. Pursuant to NRC regulations, Xcel Energy maintains an emergency plan for all activities at the PINGP site. As access to the PINGP site is controlled, non-radiological safety incidents involving the general populace are extremely rare. The far greater exposure to safety incidents is to plant personnel. The Prairie Island ISFSI is part of a large industrial facility. As such, there are risks to plant personnel typical of an industrial facility. Xcel Energy implements safety programs to reduce the impact of such risks, e.g., spill prevention plan. It is not anticipated that expansion of the Prairie Island ISFSI will increase risks or introduce new risks to plant personnel that are not well managed by these safety programs. The PINGP had no lost workdays to worker injuries in 2007 or 2008. In 2008, it received a Governor's Safety Award for its safety performance record.

4.10 CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result from the incremental effects of a project in addition to past, present, and reasonably foreseeable future projects regardless of who undertakes these projects.[79] Two reasonably foreseeable future projects are considered here: (1) continued operation of the PINGP until 2034, and (2) use of the ISFSI to facilitate decommissioning of the PINGP after cessation of operations.

Operation of the PINGP Through 2034

If Xcel Energy is granted a certificate of need to expand the storage capacity of the Prairie Island ISFSI by 35 dry storage casks, it is foreseeable that the PINGP will continue operating an additional 20 years past its original license term. Xcel Energy has submitted an operating license renewal application to the NRC to allow continued operation of Prairie Island Units 1 and 2 until 2033 and 2034 respectively.

The potential impacts of the continued operation of the PINGP are discussed in Chapter 1 of this EIS. It's anticipated that no new or additional impacts, beyond those discussed in Chapter 1, would occur if the PINGP continued operations through 2034.

Use of the ISFSI to Facilitate Decommissioning

If the PINGP operates through 2034, it is foreseeable that the plant would cease operations at that time and undergo decommissioning. In the decommissioning process, spent nuclear fuel would need to be temporarily stored (e.g., in the spent nuclear fuel pool) until it could be placed in temporary, long-term storage (Prairie Island ISFSI) or in a federal geologic repository. Although there is uncertainty as to the storage alternatives that will be available in 2034, a likely

[79] Minn. Rules 4410.0200, Subp. 11.

scenario is temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI until the dry storage casks can be transported to a federal repository. In this scenario, approximately 34 additional casks would be needed for decommissioning, creating a total of 98 casks on the ISFSI pad upon removal of all spent nuclear fuel from the plant.

Given the uncertainty as to when a federal repository will be available to accept casks from the Prairie Island ISFSI, this document assumes, for analysis purposes only, that the casks (a total of 98) will be at the ISFSI for up to 200 years. Potential radiological impacts from the long-term storage of the casks are discussed in Chapter 2, Section 5. Potential non-radiological impacts are discussed here.

As discussed in this section, the non-radiological impacts related to the expansion of the Prairie Island IFSI are not significant. Additionally, operation of the ISFSI, an essentially passive, monitored structure, poses no significant non-radiological impacts. If an additional 34 casks will be need for decommissioning, an expansion of the pad at the Prairie Island ISFSI very similar to the currently proposed expansion (35 casks) would be required. The ISFSI site is designed such that it can be expanded to accommodate 98 casks. Thus, sometime around 2030, a second expansion of the concrete pads within the ISFSI would be likely. Once this expansion is constructed, the ISFSI would require no further structural changes to store 98 casks.

Construction of new storage pads and operation of the ISFSI most likely presents no significant non-radiological impacts for storage of 98 dry storage casks for up to 200 years. Man-made and natural phenomena could occur during this 200-year period that would introduce substantial non-radiological impacts to the region, e.g., flood, earthquake. However, the marginal impact due to the continued operation of the ISFSI within such phenomena would be insignificant.

5.0 RADIOLOGICAL IMPACTS

This section discusses the radiological impacts expected due to normal operations and to incidents and off-normal operations at the Prairie Island ISFSI. Additionally, it assesses potential radiological impacts from two related actions – the continued operation of the Prairie Island Nuclear Generating Plant (PINGP) through 2034 and the operation of the ISFSI through decommissioning.

5.1 RADIATION MONITORING – ISFSI

Radiation monitoring at the Prairie Island plant, including the ISFSI, is discussed in Chapter 1, Section 4.13.

5.2 RADIOLOGICAL IMPACTS – NORMAL ISFSI OPERATIONS

Radiological impacts from expansion of the Prairie Island ISFSI are anticipated to be within NRC regulatory limits and will not be significant during normal operations. The dry storage casks are passive systems that emit no radioactive effluents. There are no projected impacts or discharges to groundwater from ISFSI operations. Accordingly, there is a "reasonable expectation that the operation of the facility will not result in groundwater contamination."[80] Any radioactive wastes generated during loading of the storage casks in the Auxiliary Building will be treated and handled using existing waste control systems at the PINGP.

Sources of Information

Information and analysis in this section related to operation of the Prairie Island ISFSI is drawn from the Safety Analysis Report (SAR) for the ISFSI and Xcel Energy's Certificate of Need application for additional dry cask storage. The SAR is required by the NRC in order for Xcel Energy to obtain a Special Nuclear Materials (SNM) license to operate the ISFSI (SNM-2506). The Prairie Island ISFSI SAR contains essentially two analyses: (1) an initial safety analysis reflecting the placement of 48 TN-40 casks on the ISFSI pad, and (2) a subsequent safety analysis reflecting the placement of 48 TN-40HT casks on the ISFSI pad. This subsequent analysis is included as Addendum A to the SAR and reflects Xcel Energy's intent to use the TN-40HT casks at the Prairie Island ISFSI. Analysis for the TN-40HT casks was submitted as a license amendment request to the NRC on March 28, 2008.

The Prairie Island ISFSI is licensed federally for storage of up to 48 casks. The ISFSI currently has approval from the State of Minnesota for storage of up to 29 casks. Discussion and analysis in this section is focused on state benchmarks: (1) the pending request for an additional 35 casks (for a total of 64), and (2) the possible placement of a total of 98 casks on the ISFSI pad prior to transport to a federal repository.

[80] Minn. Stat. § 116C.83, Subd. 6.

The safety analysis for a Prairie Island ISFSI composed of TN-40 casks is very similar to an analysis for an ISFSI composed of TN-40HT casks or a mix of TN-40 and TN-40HT casks. However, where there is a significant difference in the characteristics of the casks or in the analyses reported in the SAR regarding the operation of the casks, it is noted and discussed.

Estimation of Doses. The dose estimates in the Prairie Island ISFSI SAR and in Xcel Energy's Certificate of Need application are obtained by computer simulation of neutron and gamma radiation transport in a three dimensional model. This modeling is computing power intensive, requiring CPU days of computation for each simulation. However, this modeling is the only way to obtain meaningful dose estimates. In the discussion that follows there are instances where dose estimates for a specific scenario are not available. These are noted and estimates or projections based on the best available data are made.

Impacts to the General Public

Radiation doses to the general public from ISFSI operations result from skyshine radiation. Skyshine radiation is gamma and neutron radiation that travels upward from the storage casks and is reflected off the atmosphere back to the ground. Shielding on the storage casks themselves reduces radiation doses, as does the earthen berm surrounding the ISFSI. The casks and berm greatly minimize direct radiation to the public, leaving skyshine radiation as the primary means of exposure.

The estimated annual dose to the nearest permanent residence (0.45 miles; 724 meters NW of the ISFSI) with 64 casks on the ISFSI pad is 0.4 mrem/yr.[81] This dose is within NRC regulatory limits for radiation exposure to the general public – 100 mrem/yr from all man-made sources (10 CFR 20) and 25 mrem/yr from ISFSI operations (10 CFR 72). The dose from skyshine radiation decreases with distance from the ISFSI. Members of the public at a distance greater than 0.45 miles would receive less than 0.4 mrem/yr. For example, the estimated annual dose at the Prairie Island Community Center and Treasure Island Casino (0.8 miles; 1285 meters NW of the ISFSI) is approximately one-tenth of the estimated dose to the nearest residence (0.04 mrem/yr).[82]

The radiation exposure contribution from ISFSI operations to a member of the general public (≤ 0.4 mrem/yr.) is indistinguishable from background radiation. Monitoring programs corroborate ISFSI exposure and dose estimates and their near-background levels. Data from themoluminescent dosimeters (TLDs) monitored by the Minnesota Department of Health (MDH) indicates exposure rates near the Prairie Island plant are at background radiation levels.[83] Monitoring by the Wisconsin Department of Health Services (WDHS) shows radiation exposure rates within background levels and comparable to other areas within Wisconsin.[84] Monitoring

[81] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 7.2.3. This estimate assumes the placement of 64 TN-40HT casks loaded with spent fuel at anticipated PINGP fuel enrichments and burnups.
[82] The change in estimated dose with distance from the ISFSI is illustrated by dose rate tables in the SAR, Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.5.
[83] 2006 Environmental Radiation Data Report, Minnesota Department of Health, http://www.health.state.mn.us/divs/eh/radiation/monitor/envriondatareport.html
[84] State of Wisconsin, 2007 Prairie Island Environmental Radioactivity Survey, http://dhs.wisconsin.gov/dph_beh/EnvMonitoring/PrairieIsland/piwww07.pdf

by Xcel Energy at thirty-four locations near the PINGP indicates exposure rates at background levels.[85]

Health risks to the general public result from potential long-term exposure to low-level skyshine radiation from the Prairie Island ISFSI. These risks are not anticipated to be significant. The primary health concern is cancer. If we assume that members of the local public live at the nearest residence and that they are at home, outdoors, continuously for 70 years, it is estimated that an additional 1 person in 35,700 (2.8 in 100,000) would be diagnosed with cancer and an additional 1 person in 71,000 would die from cancer.

As there are approximately 450 full-time residents within the immediate vicinity of the Prairie Island plant (2 mile radius), this translates into a hypothetical 0.013 additional cancer diagnoses and 0.006 additional cancer deaths among these residents during a 70-yr. time period. Approximately 40 percent of these residents (180 persons) would be diagnosed with cancer and 20 percent of these residents (90 persons) would be expected to die from cancer from all cancer causes during this same period.

Impacts to Plant Personnel

Radiological exposures and doses to personnel at the PINGP and Prairie Island ISFSI are monitored and controlled according to the Prairie Island radiation protection program. Per NRC regulations (10 CFR 72), exposures are kept as low as reasonably achievable (ALARA) through design and operational procedures. Radiation exposures to plant personnel from all operations at Prairie Island have decreased over time and now average approximately 110 person-rem annually.[86]

Radiation exposures to plant personnel due to operation of the Prairie Island ISFSI can be divided into three categories: (1) exposure due to handling and placing casks, (2) exposure due to surveillance and maintenance activities, and (3) exposure due to skyshine radiation. Exposures for all three categories will increase with the use of the TN-40HT casks due to higher fuel loadings and burnups. Because cask handling and maintenance are specialized, high exposure rate tasks, it is difficult to estimate individual dose rates and impacts. The SAR estimates these doses as collective doses, i.e., in person-rem (**Table 5-1**).

The SAR dose estimates are based on NRC-required assumptions and are conservative.[87] Personnel involved in these tasks will have their doses managed by the Prairie Island radiation protection program to keep them below NRC regulatory limit of 5,000 mrem/yr. for occupational exposure (10 CFR 20). Plant personnel doses are individually monitored and tracked to ensure compliance with NRC regulations. Health risks to "cask personnel" will be higher than those to the general public. If we assume that cask surveillance staff performs the same job for 70 years,

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[85] 2007 Annual Radiological Environmental Monitoring Program (REMP) Report, Xcel Energy, Prairie Island Nuclear Generating Plant, May 2008, http://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-specific-reports/prai1-2.html
[86] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 8.2.5.2.
[87] For example, the NRC requires the assumptions that all TN-40HT casks are loaded with spent fuel at maximum fuel loading (410 kg U per fuel assembly) and burnup (60,000 MWD/MTU). PINGP fuel has a lower fuel loading (360-400 kg U per fuel assembly) and burnup (53,000 MWD/MTU).

it is estimated that there would be 0.32 additional cancer diagnoses and 0.16 additional cancer deaths among the staff during this time period.

In contrast to direct radiation received from cask operations, skyshine radiation from the ISFSI impacts all plant personnel regardless of their duties. There is not a direct estimate (an estimate based on 64 casks on the ISFSI pad) for skyshine radiation dose to plant personnel in the SAR or in Xcel Energy's Certificate of Need application.[88] The best estimate, based on available data, for the annual average dose to plant personnel from skyshine radiation is 14 mrem/yr.[89] Individual employees will receive more or less than this average depending on their employment status and their work location. This dose is within the NRC regulatory limit of 5,000 mrem/yr. for occupational exposure (10 CFR 20).

Health risks to plant personnel result from potential long-term exposure to low-level doses from ISFSI operations. As before, the primary health concern is cancer. Assuming that all workers receive a dose of 14 mrem/yr and that they are full-time employees for 70 years, it is estimated that an additional 1 person in 1020 (98 in 100,000) would be diagnosed with cancer and an additional 1 person in 2040 would die from cancer. As there are 923 employees at the Prairie Island plant, this translates into a hypothetical 0.9 additional cancer diagnoses and 0.45 additional cancer deaths among plant personnel during a 70-yr. time period. Approximately 40 percent of plant personnel (369) would be diagnosed with cancer and 20 percent of plant personnel (185 persons) would be expected to die from cancer from all cancer causes during this same period.

Impacts to Flora and Fauna

Direct radiation doses to flora and fauna from normal ISFSI operations are typically not estimated or monitored. It is assumed that the exposure to flora and fauna is similar to that of the general public, i.e., indistinguishable from background radiation, and thus there is no significant radiological impact. However, this assumption would not hold for two cases: (1) flora that is very near the ISFSI, and (2) fauna that lives in, moves through, or otherwise utilizes the ISFSI site or nearby habitat.

The earthen berm that surrounds the ISFSI greatly minimizes radiation exposure in these cases; however, it cannot eliminate skyshine radiation, nor radiation within the ISFSI. Radiation impacts to tall nearby flora, e.g., trees, are anticipated to be minimal but unavoidable (or likely not to be mitigated as trees around the ISFSI, though receiving radiation exposure, are healthy and provide desirable ecosystem services). Radiation impacts to nearby fauna are mitigated by the fact that there is no potential habitat for fauna within the ISFSI. Birds, for example, may light on top of the earthen berm, but likely would not make a nest on the concrete pads. ISFSI

[88] SAR dose estimates are based on 48 casks (TN-40 or TN-40HT) placed on the ISFSI pad.
[89] This is the estimated dose for 48 TN-40HT casks. Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A7.4 (12.9 person-rem / 923 persons = 14 mrem). The dose estimate is conservative in that it is based on maximum fuel loading, fuel burnups, and cask loading rates. Additionally, it assumes that plant personnel are outdoors, unprotected by buildings from skyshine radiation. The estimate is not conservative in that it is based on 48 casks on the ISFSI pad.

operating procedures preclude use of the ISFSI site by nesting animals. Accordingly, radiation impacts to fauna are anticipated to be minimal.

5.3 RADIOLOGICAL IMPACTS – POTENTIAL INCIDENTS and OFF-NORMAL ISFSI OPERATIONS

Radiological impacts from potential incidents and off-normal operations at an expanded Prairie Island ISFSI are not anticipated to be significant. The potential impacts from natural and man-made phenomena have been analyzed in the Safety Analysis Report for the ISFSI. In these scenarios, the probability of damaging the dry storage casks such that they release radioactive materials is very low. Additionally, assuming such damage might occur, the estimated radiological doses are within NRC regulatory limits (10 CFR 72).

Natural Phenomena
Incident and off-normal operation scenarios caused by natural phenomena discussed in this section include earthquakes, tornadoes, and floods. These phenomena are considered design basis accidents and are covered by cask design requirements in 10 CFR 72. All casks licensed for use by the NRC must meet these design requirements.

Earthquakes. The design basis earthquake for the Prairie Island ISFSI is the equivalent of the safe shutdown earthquake (SSE) for the PINGP. The SSE is projected to cause accelerations of 12 percent of gravity (g) horizontally and 8 percent g horizontally. This is roughly equivalent to an intensity of VI on the Mercalli scale and a magnitude of 5.4 on the Richter scale. Such an earthquake is slightly larger than the largest recorded earthquake in Minnesota.[90] Analysis of the storage casks in a safe shutdown earthquake predicts that the casks will not tip or slide. Accordingly, there is no anticipated radiological impact.

Tornadoes. The design basis tornado is a tornado with winds of 360 miles per hour (mph). Analysis of the storage casks in such a tornado predicts that the casks will not tip or slide. An additional hazard considered in this scenario is the impacting of the casks by an object which is picked up in the tornado. Such an object, impelled by the wind, would act as a missile against the casks. Analysis of two potential missiles (an automobile, a plank of wood) predicts that the missiles will not tip the casks. A cask is predicted to slide about 1 inch when hit by an automobile in a tornado. Neither missile would penetrate a cask. Thus, there is no anticipated radiological impact.

Floods. The design basis flood is the probable maximum flood that could occur at Prairie Island. This flood is a hypothetical flood that would result if all of the factors that contribute to the flood (e.g., rainfall, timing, runoff) were to reach their most critical values concurrently. The probable maximum flood at Prairie Island is calculated to be 706.7 ft. above mean sea level (MSL), with a water velocity of 6.2 ft/sec. The surface of the ISFSI concrete pads is 697 ft. above MSL. Waters from a probable maximum flood would cover the ISFSI pad and extend approximately 10

[90] Minnesota Earthquake Information, http://earthquake.usgs.gov/regional/states/?region=Minnesota

ft. up the sides of the casks. The casks are approximately 16 ft. tall and flood waters would remain below cask seals. The velocity of the water in a probable maximum flood would not cause the casks to tip or slide. Accordingly, there is no anticipated radiological impact.

Burial. Thermal analysis of the dry storage casks in the Safety Analysis Report includes a scenario in which the casks cannot dissipate heat to the environment and are effectively insulated. Such a scenario might occur if the casks were buried in dry soil. Analysis of this scenario predicts that cask temperatures would reach 570º F approximately 60 hours after burial. This temperature would likely cause cask seal failure (radiological impacts from failure of a cask seal are discussed in this section). It's unclear what natural or man-made phenomena might lead to complete burial of a cask. Accordingly, there are substantial uncertainties in estimating the risk of burial and possible radiological impacts. The Prairie Island emergency response plan provides for accident conditions that could impact cask confinement. Cask burial is included as a possible accident condition and there is a plant abnormal operations procedure in the event a cask becomes buried.

Other Phenomena. Other natural phenomena, e.g., lightning, snow loading, have been modeled in the ISFSI Safety Analysis Report and are predicted to have no impact on the dry storage casks.

Man-made Phenomena

Incident and off-normal operation scenarios caused by man-made phenomena discussed in this section include fire, explosion, mishandling of the casks, terrorism, and impact by airplane.

Fire. The only source of fuel which could cause a fire at or near a cask is the fuel for the cask transporter. Analysis of this fuel combusting and engulfing a cask indicates that the cask would maintain its integrity. The cask's neutron shield would suffer damage in the fire and could lose effectiveness. Thus, the radiological impact would be limited to an increase in neutron radiation near the cask, until such time as the cask / shield could be repaired.

Accident analysis in the SAR for the TN-40HT cask assumes that all neutron shielding is lost due to the fire and that a hypothetical person remains at the site boundary 24 hours a day for 30 days. The dose to this hypothetical person is estimated to be 322 mrem, which is within NRC regulatory limits (10 CFR 72). As a fire at the ISFSI which damaged a cask would trigger emergency response measures that would preclude a local resident standing at the site boundary for 30 days, this dose estimate is very conservative. It better reflects dose levels that would be considered by plant and emergency response personnel.

Explosion. A cargo explosion on a barge in the Mississippi River would create a pressure wave that might damage the PINGP and ISFSI. Analysis of a hypothetical cargo explosion indicates that the resulting pressure wave would not damage ISFSI casks. No radiological impacts would occur.

Mishandling of Casks. The handling of dry storage casks is discussed in Chapter 2, Section 3. The primary steps include loading spent fuel assemblies into casks, preparing the casks for storage, and transporting casks to the ISFSI. Each of these steps contains sub-steps which, if performed incorrectly, could create a potential radiological impact. Consequently, there are substantial control and design measures in place at the Prairie Island plant to ensure proper cask handling.

The ISFSI Safety Analysis Report (SAR) examines possible mishandling scenarios. The casks at the PINGP are lifted in the Prairie Island Auxiliary Building by a single failure proof crane. Single failure proof means that the failure of any single component will not result in a load being dropped. The trunnions by which the casks are lifted are designed to ANSI standards for critical loads. All cask lifts are performed in accordance with the PINGP heavy load program, which requires operator and riggers that have specific training and qualifications. The casks are transported by the specialized cask transport vehicle (CTV), and are never lifted higher than 18 inches during transport.

For purposes of the SAR, these design and handling standards preclude several possible mishandling scenarios, e.g., dropping a cask in the Auxiliary Building. However, even if a cask can be handled securely in the Auxiliary Building, it is still possible that: (1) the cask was loaded with an incorrect fuel assembly, or (2) that the cask is dropped by the CTV. The SAR analysis of the administrative and record controls required by the NRC license for the ISFSI indicates that an erroneously loaded fuel assembly would be detected prior to sealing the cask. Thus, the storage casks would perform as designed and there would be no radiological impact. Analysis of an 18 inch drop of a cask onto a concrete surface (ISFSI pad, Auxiliary Building floor) indicates that the cask and its contents would remain intact. Cask confinement would not be breached; no radiological impacts would occur.

The Electric Power Research Institute (EPRI) has conducted a risk assessment of the use of the Transnuclear TN series casks at a generic nuclear generating plant.[91] The assessment evaluates possible incident-initiating events and follows these events to estimate the radiological risk to a person at the plant site boundary. The risk assessment indicates a low level of radiological risk, with no early fatality risk to the general public. The risks are expressed in latent cancer deaths per cask per year (**Table 5-2**).

The EPRI risk assessment results include the possibilities of incorrect fuel assembly loading and of crane failure (dropping a cask in the Auxiliary Building). The cask loading phase contains the least risk of the three cask handling phases, followed by cask storage and cask transportation. The relatively higher cask transportation risk is due to the possibility of a generic transporter fire which is of sufficient duration to cause cask seal failure.

Considering the SAR and EPRI risk assessments together, the SAR indicates that specific cask storage risks (e.g., flood, tornado) and specific cask transportation risks (fire) present little or no radiological risk. Specific cask loading risks (incorrect fuel loading, crane failure) are not considered credible. The EPRI risk assessment supports the SAR in concluding that loading

[91] Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Updated Qualification and Analysis Report, EPRI, Palo Alto, CA; 2004, www.epri.com.

risks represent the smallest share of cask handling risks. The EPRI risk assessment highlights that a transporter fire represents a relatively higher radiological risk, one that should be evaluated for a specific site-transporter-cask combination. The SAR performs this evaluation (discussed above). Thus, the SAR and EPRI risk assessments suggest that radiological impacts due to mishandling of casks are not likely.

Terrorism. The radiological risks resulting from a terrorist attack on the Prairie Island ISFSI are covered to a great degree by the risk analyses for natural and man-made phenomena referenced in this section. That is, there are few forces that could be brought to bear on the storage casks by terrorists greater than those already examined, e.g., tornado, flood, fire, explosion. It is possible that armaments could be used to attack the casks, creating damage or a fire that causes a cask seal failure. An airplane could be commandeered to attack the casks (discussed below). These risks are difficult to assess and include substantial uncertainties. However, the risks and potential radiological impacts are likely no greater than risks from natural and man-made phenomena discussed in this section.

Following the events of September 11, 2001, the NRC developed and required security enhancements for all spent fuel storage installations. The NRC also initiated a classified review of the capability of nuclear facilities to survive a terrorist attack, including commercial aircraft attacks, vehicle bomb assaults, and ground assaults. This review indicated that the likelihood of a radioactive release with significant radiological impacts was very low. Nonetheless, the NRC is providing revised guidance to all licensees regarding security requirements against terrorism.[92] Xcel Energy has implemented security enhancements at the Prairie Island in accordance with NRC guidance and regulations.

Impact by Airplane. The radiological risks associated with the impact of an airplane on a dry storage cask were discussed in the 1991 final environmental impact statement (FEIS) for the Prairie Island ISFSI and are discussed in the 2004 EPRI risk assessment. The FEIS notes that an airplane crash is an unlikely event, and is not analyzed in the ISFSI SAR.[93] The impact of a small propeller aircraft or jet would be similar to a tornado impelled missile, and would likely not create a radiological risk. Impact from a commercial airplane would likely cause a cask to tip over but would not breach the cask confinement. The FEIS suggests that the worst case scenario for a commercial airplane would be the direct impact of jet turbine rotor with a cask, which would damage the outer shell and shielding, but likely leave the cask confinement intact.

The EPRI risk assessment analyzes the impact of an airplane as a "loss of integrity due to high temperature and heavy missiles."[94] The EPRI risk assessment indicates that impact from a small airplane could cause a fire, but would not tip a cask or penetrate the cask. Depending on the fire characteristics, cask shielding would be damaged and cask confinement may or may not be maintained. The assessment indicates that impact from a commercial airliner could cause a cask

[92] Backgrounder – Nuclear Security, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/security-enhancements.html
[93] Final Environmental Impact Statement, Prairie Island Independent Spent Fuel Storage Installation, Minnesota Environmental Quality Board, 1991.
[94] Probabilistic Risk Assessment (PRA) of Bolted Storage Casks: Updated Qualification and Analysis Report, Section B.4.3.7, EPRI, Palo Alto, CA; 2004, www.epri.com.

to tip, depending on which part of the airplane hits the cask. The impact would likely cause a fire which would damage cask shielding and could compromise cask confinement.

Taken together, the FEIS and EPRI risk assessment indicate that radiological risks due to airplane impact are low, but that there are substantial uncertainties, particularly concerning impact by a commercial airliner, in estimating the risks. Significant radiological impacts to the general public are not anticipated.

Hypothetical Cask Confinement Failure

The scenarios and analyses discussed in this section indicate that loss of cask confinement is a very low risk event. None of the specific risks evaluated in the SAR compromise cask confinement. Nonetheless, recognizing the fallibility of all human endeavors, the SAR evaluates the possibility of breach of the cask seal by some hypothetical unspecified means and the resulting radiological impacts. The confinement failure analyses in the SAR for the TN-40 and TN-40HT casks are slightly different and are discussed separately here.

In the confinement failure analysis for the TN-40 cask, it is assumed that the cask seal is breached and that the fuel pellets and cladding for all fuel assemblies in the cask fail.[95] This failure releases radioactive Krypton gas (Kr-85), the only nuclide in the fuel assemblies in a gaseous state. It is assumed that all of the Kr-85 gas is release instantaneously, is not mitigated in any way, and exposes a person at the Prairie Island site boundary to a dose of radiation. The distance from the ISFSI to the nearest site boundary is approximately 0.07 miles (110 meters). The estimated dose to this person is 338 mrem. This dose is within the NRC limit of 5 rem (5,000 mrem) for a design basis accident at an ISFSI (10 CFR 72). The estimated dose to the nearest permanent residence (0.45 miles away; 720 meters) is approximately 12 mrem. If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.005 additional cancer diagnoses and 0.003 additional cancer deaths among these residents during their lifetimes.

In the confinement failure analysis for the TN-40HT cask, it is assumed that all fuel rods fail and fire conditions exist.[96] However, unlike the TN-40 analysis, the release rate of radionuclides is limited to the seal leak rate (1 E-05 cm^3/sec) and occurs over a 30 day period. As before, Krypton gas is projected to provide the greatest amount of activity and exposure. The estimated dose to a person at the nearest site boundary (110 meters) is 24 mrem. This dose is within the NRC regulatory limits for a design basis accident at an ISFSI (10 CFR 72). The estimated dose to the nearest permanent residence (0.45 miles away; 720 meters) is approximately 1 mrem. If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.0005 additional cancer diagnoses and 0.0002 additional cancer deaths among these residents during their lifetimes.

The SAR analyses indicate that doses to local residents under cask confinement failure conditions will be limited and will not cause significant impacts. Persons at the plant, either

[95] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section 8.2.9.
[96] Prairie Island Independent Spent Fuel Storage Installation, Safety Analysis Report, Section A8.2.9.

working at the plant or for some reason within the plant boundary, would likely receive higher doses and would experience relatively greater health impacts. These persons would receive approximately one year's worth of background radiation in one accident event. Emergency responders could receive even higher doses.

It is conceivable that an incident at the ISFSI (e.g., impact by commercial airliner) could cause more than one cask to suffer a confinement failure. If in constructing a worst-case scenario we assume: (1) the ISFSI pad is loaded with 98 casks (the projected decommissioning total), half of which experience confinement failure due to airliner impact, (2) the failure is one of immediate release (such as the TN-40 cask analysis), and (3) the estimated dose per cask to local residents is that of the TN-40 analysis (12 mrem), then the estimated dose to residents is approximately 588 mrem/person (49 x 12 mrem). If we assume all local residents (450 persons) receive this dose, this translates into a hypothetical 0.26 additional cancer diagnoses and 0.13 additional cancer deaths among these residents during their lifetimes. There are substantial uncertainties in estimating such a worst-case dose, e.g., damage to casks, release conditions, release rates. There are also uncertainties related to the risk of such a dose, e.g., probability of airliner impact causing 49 casks to fail, release conditions caused by such an impact, and the effectiveness of emergency response measures. Nonetheless, projecting from confinement failure analyses in the SAR, it appears that multiple cask confinement failures would not cause a significant human health impact to local residents. Plant personnel and emergency responders would experience relatively greater health impacts. Because of the substantial uncertainties involved in making a worst-case scenario projection there are likely differences of opinion regarding potential health impacts.

5.4 CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result from the incremental effects of a project in addition to past, present, and reasonably foreseeable future projects regardless of who undertakes these projects.[97] Two reasonably foreseeable future projects are considered here: (1) continued operation of the PINGP until 2034, and (2) use of the ISFSI to facilitate decommissioning of the PINGP after cessation of operations.

Operation of the PINGP Through 2034

If Xcel Energy is granted a certificate of need to expand the storage capacity of the Prairie Island ISFSI by 35 dry storage casks, it is foreseeable that the PINGP will continue operating an additional 20 years past its original license term. Xcel Energy has submitted an operating license renewal application to the NRC to allow continued operation of Prairie Island Units 1 and 2 until 2033 and 2034 respectively.

The potential radiological impacts of the continued operation of the PINGP are discussed in Chapter 1 of this EIS. It's anticipated that no new or additional impacts, beyond those discussed in Chapter 1, would occur if the PINGP continued operations through 2034.

[97] Minn. Rules 4410.0200, Subp. 11.

Use of the ISFSI to Facilitate Decommissioning

If the PINGP operates through 2034, it is foreseeable that the plant would cease operations at that time and undergo decommissioning. In the decommissioning process, spent nuclear fuel would need to be temporarily stored (e.g., in the spent nuclear fuel pool) until it could be placed in temporary, long-term storage (Prairie Island ISFSI) or in a federal geologic repository. Although there is uncertainty as to the storage alternatives that will be available in 2034, a likely scenario is temporary long-term storage of spent nuclear fuel at the Prairie Island ISFSI until the dry storage casks can be transported to a federal repository. In this scenario, approximately 34 additional casks would be needed for decommissioning, creating a total of 98 casks on the ISFSI pad upon removal of all spent nuclear fuel from the plant.

Given the uncertainty as to when a federal repository will be available to accept casks from the Prairie Island ISFSI, this document assumes, for analysis purposes only, that the casks (a total of 98) will be at the ISFSI for up to 200 years. Potential non-radiological impacts from the long-term storage of the casks are discussed in Chapter 2, Section 4. Potential radiological impacts are discussed here.

Normal Operations. Assuming that regular monitoring and maintenance continue as currently performed at the ISFSI, radiological impacts from continued operation of the Prairie Island ISFSI for up to 200 years would be within NRC regulatory limits and would not be significant during normal operations. The dry storage casks are passive systems that emit no radioactive effluents. Radiation exposure would occur solely through cask monitoring and skyshine radiation (discussed above, Section 5.2).

It is assumed that the 34 additional casks needed for decommissioning would be TN-40HT casks. Thus, the composition of casks on the ISFSI pad at decommissioning would be: 29 TN-40 casks and 69 TN-40HT casks, for a total of 98 casks. The additional 34 casks would increase radiation exposure to the general public by increasing skyshine radiation. The maximum exposure and dose rate would occur when the 98th cask is placed on the pad. Once it is placed, exposure rates would decrease due to radioactive decay of the contents of the casks.

There is not a direct estimate (an estimate based on 98 casks on the ISFSI pad) for skyshine radiation dose to the general public in the SAR or in Xcel Energy's Certificate of Need (CON) application (**Table 5-3**).

However, dose estimates in the SAR and the CON application can be used to project, with some confidence, a bounding dose rate for the general public. The annual dose to the nearest residence (0.45 miles; 724 meters NW of the ISFSI) with 98 casks on the ISFSI pad is projected to be no greater that 5 mrem/yr.[98] This dose would be within NRC regulatory limits for radiation exposure to the general public (25 mrem/yr., 10 CFR 72). Members of the public at a distance greater than 0.45 miles would receive less than 5 mrem/yr.

[98] Doubling the estimated dose in SAR Addendum A (2.2 x 2 =4.4 mrem/yr.) would be a conservative estimate of 96 casks on the ISFSI pad.

Health risks from this exposure and dose are not expected to be significant. The primary health concern is cancer. If we assume that members of the local public live at the nearest residence and that they are at home, outdoors, continuously for 70 years, it is estimated that an additional 1 person in 2,850 (35 in 100,000) would be diagnosed with cancer and an additional 1 person in 5,700 would die from cancer. As there are approximately 450 full-time residents within the immediate vicinity of the Prairie Island plant (2 mile radius), this translates into a hypothetical 0.16 additional cancer diagnoses and 0.08 additional cancer deaths among these residents during a 70-yr. time period.

Radiological impacts to plant personnel during decommissioning are expected to be minimal. Casks would no longer need to be loaded and placed on the ISFSI pad. Thus, this component of plant personnel exposure would be eliminated. Casks would still need to be monitored and maintained until moved to a federal repository, thus this exposure component would remain.

It is assumed that plant staffing levels would drop with decommissioning. Thus, impacts due to skyshine radiation would be greatly reduced. There would still be radiation due to the storage casks, but few persons to receive the exposure.

Incidents and Off-normal Operations. Assuming that regular monitoring and maintenance continue as currently performed at the ISFSI, radiological impacts from incidents and off-normal operations at the Prairie Island ISFSI which might occur within 200 years, would be within NRC regulatory limits and would likely not be significant. The addition of 34 casks for decommissioning and the storage of the casks for up to 200 years do not introduce any new phenomena, natural or man-made, that could compromise cask confinement.

The risk that is introduced by storing the casks for 200 years is time itself. For many of the risks discussed in this section, the passage of time does not increase the probability that a radiological impact will occur. The casks are designed to withstand design basis accidents that are essentially independent of a 200 year timeframe, e.g., earthquake, maximum probable flood, tornado. For example, if the casks can withstand a tornado in 2010, they can withstand a tornado in 2040. There may be many tornadoes over time, but the passage of time does not change the risk of a radiological impact.

Time is a consideration for risks related to the mishandling of casks. The more times you operate a particular mechanical system, the more opportunities there are for the system to fail in some regard. For the Prairie Island ISFSI, once the casks are loaded, transported, and placed on the ISFSI pad, they are no longer handled. Barring the need to repair a cask seal or other possible damage, the casks are not handled or transported within the PINGP site. Thus, handling of the casks effectively ends within the first 50 years of the 200 year time frame. The 2004 EPRI risk assessment estimates the risks associated with loading and transporting casks is on the order of 3 E-13 latent cancer deaths per cask per year. Multiplying this risk by an additional 34 casks and 50 years does not make this risk significant.

The only additional handling that would occur is the loading of the casks for transport to a federal geologic repository. The federal Department of Transportation (DOT) and NRC share responsibility for establishing standards for the safe transport of the casks. Casks must be licensed for transport by the NRC (10 CFR 71). It is anticipated that the risks associated with cask handling for removal to a geologic repository, under DOT and NRC regulation, are of a similar magnitude as the risks associated with cask handling operations at the ISFSI. As discussed above, these risks are not expected to be significant.

Time is also a consideration for risks posed by man-made phenomena that, unlike cask handling, will exist for the full 200 years and may change over time, e.g., risk of explosion, terrorism, airplane impact. Current analyses indicate that the risk of radiological impacts from these events is small. If emergency planning measures remain effective into the future and if we assume that these man-made risks remain relatively constant over time, then multiplying these risks over an additional 200 years will likely not make them significant. Compared with natural phenomena and well-regulated cask handling systems, risks posed by these man-made phenomena are likely the more uncertain.

NRC Waste Confidence Rule. The Nuclear Regulatory Commission (NRC) has expressed confidence that radioactive wastes produced by nuclear power plants can be safely stored at ISFSIs until such time as a federal geologic repository is available. The NRC initially expressed this opinion in a rulemaking known as the Waste Confidence proceeding.[99] The findings from the proceeding were codified in federal regulations (10 CFR 51.23) and are known as the Waste Confidence Rule. The NRC reviewed and confirmed this rule in 1990 and again in 1999. On October 9, 2008, the NRC opened this rule for comment and revision.[100]

The NRC is proposing to revise the Waste Confidence Rule to lengthen the time period for which there is reasonable assurance that spent nuclear fuel can be safely stored. The NRC is proposing the following language:

> The Commission finds reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely without significant environmental impacts for at least 60 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor in a combination of storage in its spent fuel storage basin and either onsite or offsite independent spent fuel storage installations.[101]

Accordingly, the NRC, based on its analysis of the risks and potential impacts of natural and man-made phenomena, is proposing that the dry casks at the Prairie Island ISFSI can be safely stored until at least 2094. Additionally, the NRC notes that the words "at least" used in it proposed revision, do not represent any technical limitations on the safe storage of spent fuel in ISFSIs.

[99] 44 FR 1372, October 25, 1979.
[100] 73 FR 197, October 9, 2008.
[101] 73 FR 197, October 9, 2008.

Confidence at the NRC that temporary, long-term storage of dry casks at ISFSIs nationwide can be effected safely does not provide or supplant an independent decision by the State of Minnesota regarding the risks of long-term storage of dry casks at the Prairie Island ISFSI. However, discussion in this section, based on analysis required by the NRC (Safety Analysis Report) and independent analysis (EPRI risk assessment), is congruent with the NRC's Waste Confidence Rule.

6.0 SPENT FUEL STORAGE ALTERNATIVES

This section analyzes the feasibility of alternatives for storing the spent nuclear fuel generated by PINGP operations for the term of its proposed license renewal (2014 – 2034). The alternatives to storing spent fuel at the Prairie Island ISFSI discussed in this section include: (1) Storing the spent fuel off site, (2) Storing the spent fuel on site, but not in the ISFSI, (3) Storing the fuel at the ISFSI but with different cask technology, and (4) Reducing the need for spent fuel storage by ceasing PINGP operations in 2014.

None of the off-site storage options offers a feasible alternative to expansion of the Prairie Island ISFSI. None of the on-site options appear to be a more reasonable alternative than the proposed ISFSI expansion. The potential human and environmental impacts of ceasing PINGP operations in 2014 and decommissioning the plant are discussed in Section 7 of this chapter.

6.1 OFF-SITE STORAGE ALTERNATIVES

Minnesota law requires that spent nuclear fuel stored in Minnesota be stored on the site at which the fuel is used.[102] Thus, off-site storage of spent nuclear from the Prairie Island plant must also be out-of-state. The four alternatives discussed here are all out-of-state.

Reprocessing

Reprocessing is a method of recovering unused uranium and plutonium from used nuclear fuel and recycling it for use in new reactor fuel. Reprocessing does not result in elimination of all nuclear wastes and radioactivity. However, the volume of high-level waste to be stored is reduced. When electric power companies first considered using nuclear energy to generate electricity, it was assumed that when the nuclear fuel was used up or "spent," it would be recycled so that useful fuel could be extracted and used again. Approximately 96 percent of the spent fuel is uranium that could be reprocessed into usable fuel to generate electricity. It is this assumption that led to sizing spent fuel pools to provide the limited space necessary to cool spent fuel for a few years before transporting for reprocessing.

In 1977, President Carter, concerned about the possibility of nuclear proliferation, banned commercial reprocessing for private companies. As a result, the two private reprocessing facilities, then under construction, were never made operational. In 1981, President Reagan lifted the ban, but because of the economics of reprocessing compared to fabrication of new fuel and the political uncertainty surrounding reprocessing, no private companies invested in the construction or operation of reprocessing facilities in United States. In 1993, the Clinton administration reinstated policy opposing reprocessing in the United States.

In 2006, as part of President Bush's Advanced Energy Initiative, the Department of Energy (DOE) launched a new initiative, the Global Nuclear Energy Partnership (GNEP).[103] One of the goals of this partnership is to "recycle nuclear fuel using new proliferation-resistant technologies

[102] Minn. Stat. § 116C.83, Subd. 4b.
[103] 71 FR 55, March 22, 2006.

to recover more energy and reduce the volume of waste."[104] In October, 2008, the GNEP released a draft programmatic environmental impact statement for its proposed programs.[105] The DOE states that it "envisions changing the U.S. nuclear energy fuel cycle from an open (or once through) fuel cycle …to a closed fuel cycle in which SFN [spent nuclear fuel] would be recycled to recover energy-bearing components for use in new nuclear fuel." Given the political and institutional history of reprocessing in the U.S., there are substantial uncertainties that preclude reprocessing as a feasible off-site storage alternative.

Existing Off-Site Storage Facilities

The only facility currently storing spent fuel on a contract basis from commercial nuclear power reactors is the General Electric Morris facility in Morris, Illinois. However, it is no longer accepting spent fuel from commercial nuclear power plants. Thus, this facility is not a feasible off-site storage alternative.

Private Fuel Storage Initiative

Xcel Energy is pursuing temporary, off-site storage of spent nuclear fuel in Utah as a member of Private Fuel Storage, LLC ("PFS").[106] PFS is a consortium of eight utilities, including Xcel Energy, which is working to build a spent fuel storage facility on the west central Utah reservation of the Skull Valley Band of Goshute Indians. PFS and the Skull Valley Band of Goshute Indians entered into an agreement in December 1996 that allows for temporary storage of spent fuel from commercial nuclear power plants.

The license application for PFS was submitted to the NRC in June 1997. The NRC staff issued their final Safety Evaluation Report in December 2001. The NRC issued their Final Environmental Impact Statement in January 2002. Both reports declared that the project design and supporting analyses met the federal regulatory requirements for Independent Spent Fuel Storage Installations. The Nuclear Regulatory Commission approved the license for PFS on September 9, 2005.

In September 2006 the U.S. Department of the Interior ("DOI") disapproved the PFS-Goshute lease and the use of public lands for an Intermodal Transfer Facility, which was to be used for a rail spur from the mainline to the storage facility. On July 17, 2007, PFS and the Skull Valley Band of Goshute Indians filed a complaint in U.S. District Court challenging the September 2006 decision.

Even if PFS and the Skull Valley Band are successful in their judicial challenge to reverse the DOI decision, the project faces further obstacles. The State of Utah remains opposed to the project. Ultimately the feasibility of PFS will depend not only on the outcome of the licensing process, legislative activity, and litigation, but also on the interest and commitment to use the facility by utilities with spent fuel. Due to the considerable uncertainty surrounding the project, PFS is not a feasible alternative to additional spent fuel storage at Prairie Island.

[104] 71 FR 55, March 22, 2006.
[105] GNEP, Programmatic Environmental Impact Statement, http://www.gnep.energy.gov/peis.html
[106] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.2.3, May 16, 2008.

If PFS were to become available, it may represent an opportunity to reduce the overall number of storage casks used to keep Prairie Island operating beyond 2014 or the length of time that a dry cask storage facility will be needed on-site.

Federal Geologic Repository

In 1982, Congress, through the Nuclear Waste Policy Act (NWPA), directed the Department of Energy (DOE) to characterize and recommend two geologic repository sites for the disposal of the nation's spent nuclear fuel (SNF) and high-level radioactive waste. In 1987, Congress amended the NWPA to: (1) select Yucca Mountain in Nye County, Nevada as the only site for further study, and (2) terminate the program for a second repository. In 2002, after numerous technical studies, legal challenges, and an environmental impact statement, the U.S. Senate passed and the president signed into law legislation designating Yucca Mountain as the site for the nation's first repository.[107]

Responsibility for operations at Yucca Mountain is divided among three federal agencies. The DOE is responsible for design, construction, and operation of the repository. The DOE must obtain a license for the repository from the NRC. The NRC is responsible for reviewing the license application and ensuring compliance with safety and radiological standards. The Environmental Protection Agency (EPA) is charged with setting radiological standards that will protect public health and the environment from the risks of radioactive material in the repository for up to 1 million years after the facility closes.

The DOE submitted a license application to construct the Yucca Mountain repository in June 2008. The EPA promulgated amended standards for the protection of public health and the environment in September 2008. If, after review, the NRC approves the license application, the DOE will construct the repository, and the DOE will then apply to the NRC for a license to receive SNF and HLW. The DOE's best-achievable repository schedule projects that receipt of SNF will being in March 2017.[108]

There are several significant uncertainties with respect to the ability of Yucca Mountain to serve as an off-site storage alterative for SNF from the Prairie Island plant. These uncertainties preclude Yucca Mountain as a feasible off-site storage alternative.

Timing. The PINGP currently has authorization from the State of Minnesota for enough dry casks (29) to store spent fuel generated until the end of the plant's current NRC license in 2013 and 2014. The DOE's best-achievable availability for storage at Yucca Mountain is 2017. Thus, storage at Yucca Mountain will be available at least three years too late. Given the history of the Yucca Mountain repository, it is uncertain that the repository will open in 2017. In 1984, DOE anticipated that the first repository would begin operation in 1998 and the second in 2004. Xcel Energy estimates that the Yucca Mountain repository will not begin receiving SNF until 2020.[109]

[107] Yucca Mountain Repository: History of the Nuclear Waste Program, http://www.ocrwm.doe.gov/ym_repository/about_project/history.shtml
[108] Yucca Mountain Repository: About the Project, http://www.ocrwm.doe.gov/ym_repository/about_project/index.shtml
[109] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 3A.1, May 16, 2008.

In 2008, the U.S. House Appropriations Committee requested DOE to plan for taking custody of SNF stored at decommissioned reactor sites and placing it an interim storage facility to demonstrate that "DOE can move forward in the near-term with at least some element of nuclear waste policy."[110] In response, DOE noted that it does not have authority under the NWPA to construct or operate an interim storage facility prior to the opening of the Yucca Mountain repository. Thus, there is no possibility, absent new federal legislation, of interim storage for SNF prior to final disposal at Yucca Mountain.

Capacity. The SNF storage capacity of Yucca Mountain is a statutory limit.[111] The limit, set by the NWPA, is 70,000 metric tons heavy metal (MTHM). Under NWPA this limit will remain in place until a second repository is in operation. Of the 70,000 MTHM limit, 63,000 MTHM is reserved for SNF from commercial reactors. The current inventory of commercial SNF in the U.S. is approximately 58,000 MHTM and is increasing by about 2,000 MTHM annually. At this rate, that portion of Yucca Mountain capacity reserved for commercial SNF will be exceeded by 2010.

The queue for accepting SNF at Yucca Mountain is managed according to the principle of "old fuel first" (OFF). The oldest SNF, as measure by date of discharge from the reactor, is given the highest priority in the acceptance queue. The additional SNF generated by continued operation of the PINGP for an additional 20-yr. license term (2014-2034) would not enter the Yucca Mountain queue until several years after 2014. Thus, there is currently no room at Yucca Mountain for the SNF proposed to be generated by the PINGP during its license renewal term. To place the additional Prairie Island SNF in a federal geologic repository will require raising the statutory limit on Yucca Mountain's capacity or developing a second geologic repository.

In December 2008, U.S. Secretary of Energy, Samuel Bodman, recommended to the President and Congress that the statutory limit of 70,000 MTHM for Yucca Mountain be removed.[112] DOE studies indicate that the Yucca Mountain repository could be expanded to safely hold at least three times its current statutory limit. DOE suggests that lifting the statutory limit on Yucca Mountain is preferable to the alternative of beginning work on a second repository given the uncertainty about the future growth of nuclear power and the possibility of fuel reprocessing. If the Yucca Mountain limit is removed, then Yucca Mountain could have capacity for additional SNF from the PINGP. It's uncertain when the additional capacity at Yucca Mountain would be available.

Funding. The development of Yucca Mountain is paid for by customers of utilities who own and generate electricity from nuclear power plants. A fee of 1 mil (0.1 cents) for each kilowatt-hour generated by a nuclear power plant is collected and paid to the federal government. These fees are placed into the federal government's general fund and Congress must act each year to appropriate the collected funds to the Yucca Mountain project. Through December 2006, Xcel

[110] Report to Congress on the Demonstration of the Interim Storage of Spent Nuclear Fuel from Decommissioned Nuclear Power Reactor Sites, December 2008, DOE/RW-0596.
[111] The Report to the President and Congress by the Secretary of Energy on the Need for a Second Repository, December 2008, DOE/RW-0595.
[112] *Id.*

Energy's customers have paid approximately $620 million into the federal Nuclear Waste Fund to finance nuclear waste management. Nationally, customers have contributed $25.9 billion into the federal Nuclear Waste Fund. Through December 2006, the DOE has received $6.1 billion in disbursements from the Nuclear Waste Fund. For fiscal year 2008, the DOE requested $495 million and was appropriated $387 million.[113] Under-funding of the Yucca Mountain repository adds uncertainty to the timeline for completion of the repository and the possibility of expanding its capacity.

6.2 ON-SITE STORAGE ALTERNATIVES

There are three on-site alternatives to increase the present capacity at the PINGP to store spent fuel assemblies without expanding the Prairie Island ISFSI: consolidation, re-racking, and a new spent fuel storage pool.[114] Two of the three are not feasible alternatives to expansion of the ISFSI. The third alternative, a new spent fuel storage pool, is feasible, but not a more reasonable alternative than expansion of the ISFSI.

Consolidation

Fuel rod consolidation is a process that reduces the volume of spent fuel assemblies by disassembling and repackaging the fuel rods and assembly hardware. Fuel rod consolidation and hardware processing can be performed in the existing spent fuel pool. During this process, fuel rods are removed from the fuel assembly. The rods are then grouped in a closer-packed array and placed in a container with similar dimensions as a fuel assembly. The assembly hardware is compacted and then packed into separate containers in the pool or in a dry storage configuration.

Fuel rod consolidation has not been widely used and U.S. nuclear industry experience with consolidation is not extensive beyond demonstration projects. Consequently, the technology is not optimized or as commercially mature as other alternatives. Rod consolidation would require a complex and site-specific solution, if implemented.

Northern States Power (NSP, Xcel Energy) conducted a fuel rod consolidation demonstration project at the PINGP in 1986. Although some volume reductions for spent fuel were realized, the predicted compaction ratios for assembly hardware were not achievable. Additionally, the occupational dose was significantly higher than predicted because workers were subject to increased exposure from the time consuming and labor intensive fuel-handling activities.

Since 1986, there have been no industry initiatives or design advances that would render rod consolidation to be a more feasible alternative. No U.S. nuclear plant owner that is considering rod consolidation as a long-term solution to spent fuel storage. Therefore, consolidation is not a feasible alternative to expanded storage at the Prairie Island ISFSI.

Re-Racking to Increase Pool Storage

[113] Civilian Radioactive Waste Management, Budget and Funding, http://www.ocrwm.doe.gov/about/budget/index.shtml
[114] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.3, May 16, 2008.

Re-racking is a process by which current storage racks are replaced with storage racks designed to provide a more compact array for storing the spent fuel assemblies. Re-racking has already been performed twice at Prairie Island, once in 1977 and again in 1981. The current licensed storage capacity of the spent fuel pool is 1,386 fuel assemblies. In 1995, a feasibility study was performed to assess the potential increase in wet storage capacity via the use of state-of-the-art storage racks. The study concluded that it might be possible to gain up to 790 storage cells within Prairie Island's spent fuel storage pools. An increase in wet storage of 790 spent fuel assemblies is not sufficient additional storage to support 20 additional years of PINGP operations. Thus, re-racking to increase pool storage is not a feasible alternative to expanded storage at the Prairie Island ISFSI.

Constructing a New Spent Fuel Storage Pool

Storage of additional spent nuclear fuel in a new storage pool would require constructing a new building on the PINGP site containing a new spent fuel storage pool and associated components. The new building and pool structure would be designed and constructed to the same or higher standards as the existing spent fuel storage pool and would be licensed and regulated by the NRC. A transfer cask would be required to transfer spent fuel assemblies from the existing pool to the new pool. Under this alternative, the number of times the spent fuel assemblies are handled would most likely increase. This handling would in turn increase radiation doses received by plant personnel.

A new storage pool would require the same components as the existing pool and would rely on active cooling rather than passive cooling systems. These components would include storage racks, pool cooling and filtration systems, pool bridge crane and fuel assembly handling tools, building ventilation systems, radiation monitoring equipment, and a cask decontamination area. It would take approximately three years to design a new pool building and to complete state and federal reviews and approvals. Construction would last approximately two years; the total design and construction period would be approximately five years. The new storage pool would likely be located at close as possible to the existing spent fuel storage area.

This alternative was evaluated in the 1991 Prairie Island Certificate of Need Application. The estimates of the project costs in 1991 were on the order of $31 million to build, $0.5 million per year to operate, and $50 million to decommission the pool. This estimate did not include costs associated with purchasing hardware or plant personnel to load and transport the spent fuel to Yucca Mountain when it becomes available. In 2008 dollars, costs for a new spent fuel storage pool would be approximately $140 million. This cost, coupled with an increase in radiation exposure to plant personnel due to extra handling of fuel assemblies, makes this alternative less attractive than expansion of the ISFSI. The financial risk and safety risks associated with a new spent fuel storage pool make the ISFSI expansion a more reasonable approach.

6.3 ALTERNATIVE STORAGE SYSTEMS

The NRC approves spent fuel dry storage systems by evaluating each design for resistance to accident conditions such as floods, earthquakes, tornado missiles, and temperature extremes, and authorizes a nuclear power plant licensee to store spent fuel in NRC-approved systems at a site that is licensed to operate a power reactor. All spent fuel storage systems must meet NRC licensing requirements established in 10 CFR 72. As a result, all alternative storage technologies provide the same level of safety and resistance to accident conditions.

Currently there are four types of NRC-approved storage systems available for dry storage of spent nuclear fuel. Xcel Energy evaluated and compared these technologies before deciding on the Transnuclear TN-40HT casks.[115] All four systems rely on passive cooling to remove decay heat from the spent fuel. They vary in the manner in which they store the spent fuel, how they accommodate the transfer of spent fuel from the power plant, and how they are transported. All of the alternative storage systems are feasible alternatives. Based on costs, projected radiological doses to personnel, ease of use, and past experience, none of the alternative storage systems appears more reasonable than the TN-40HT casks.

Non-Canister Storage Systems
The non-canister storage system is the proposed system for the Prairie Island ISFSI expansion. It is the system currently used at the Prairie Island ISFSI (see Project Description, Chapter 2, Section 3). The storage system is a metal cask with a bolted lid, O-rings, and a pressure monitoring system. The casks are designed to store up to 40 spent fuel assemblies in an internal basket or in storage cells dispersed throughout the cask. The Transnuclear TN-40 cask currently in use at Prairie Island is licensed for storage under 10 CFR 72. The Transnuclear TN-40HT cask will be licensed prior to use in the Prairie Island ISFSI.

The proposed Transnuclear non-canister system is the system that has been used at the Prairie Island ISFSI for the past 10 years. Thus, the PINGP has in place the equipment, procedures, and infrastructure needed to load and transport a cask to the ISFSI. The system is simpler than most of the alternatives, e.g., no welding or transfer of a loaded canister from a transfer cask to a storage vault. The relatively higher number of fuel assemblies that may be stored within a cask, i.e., 40 vs. 24, reduces the number of casks/containers that must be loaded, transferred, and stored in the ISFSI. This reduced handling results in reduced radiological doses to plant personnel.

Horizontal Canister Systems
The horizontal canister storage system consists of: (1) a welded sealed metal canister to contain spent fuel assemblies and provide the primary confinement boundary, (2) concrete storage modules that house the canisters, (3) a transfer cask to handle the canisters, (4) and a transportation cask to ship the canisters offsite. The storage module, transfer cask and

[115] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 5.4, May 16, 2008.

transportation cask provide radiation shielding and physical protection during canister transportation, transfer, or storage. A typical canister will hold 24 or 32 spent fuel assemblies. Currently, the only horizontal system available is the TN NUHOMS (Nuclear Horizontal Modular System), which is designed, licensed and manufactured by Transnuclear, Inc. The system is used at several nuclear power plants throughout the United States including Xcel Energy's Monticello nuclear generating plant.

Transitioning from the current non-canister system to a canister system would require construction at the ISFSI site to occur approximately 10 years earlier. It would also require the purchase of new major equipment (e.g., a transfer cask, trailer, automatic welding machines, and a building to store new equipment). The loading process is more complicated for the canister storage system, e.g., welding and transfer of a canister, which would require new and specialized training for personnel. Currently, NRC licensed horizontal canister systems can store 24 fuel assemblies of the high burnup fuel utilized at Prairie Island. Thus, this system would require 66 percent more canisters be purchased, loaded, transferred, and stored than casks in the proposed system. Handling more canisters would increase the radiological dose received by plant personnel and would increase the cost per fuel assembly stored.

Vertical Canister Systems

Vertical canister storage systems are similar to horizontal systems except that the canisters and concrete modules are stored vertically on a pad as opposed to horizontally. For the reasons discussed above, these systems are not preferable to the proposed Transnuclear non-canister system.

Modular Vault Dry Storage Systems

The modular vault dry storage (MVDS) system is a large concrete storage vault designed to store multiple storage containers of spent nuclear fuel. MVDS differs from other systems in that, rather than storing individual casks on a concrete storage pad outdoors, the spent fuel is stored in tube like containers within an indoor concrete vault. One fuel assembly is loaded into each container. The MVDS system consists of: (1) the storage vault, (2) fuel storage containers to hold the spent fuel assemblies, (3) a container handling machine to transfer the containers, (4) a structure that supports the fuel containers, and (5) an overhead crane to lift the container handling machine. Several vaults can be constructed end-to-end to provide a larger vault. Each vault is designed to hold up to 83 fuel assemblies, each within its own storage container.

The MVDS System is expected to have relatively greater upfront costs for design, licensing, and installation compared to the proposed non-canister system. The vault system is used by one utility and its primary purpose was to support decommissioning of the Fort St. Vrain plant in Colorado. Transferring fuel to the MVDS system would be relatively more time consuming and complicated since only a single fuel assembly is placed in each storage container and transfer of the container involves additional handling compared to the proposed system.

6.4 ALTERNATIVE ISFSI SIZE – NO ISFSI EXPANSION, CEASING PINGP OPERATIONS in 2014

Xcel Energy's proposed 35-cask expansion of the Prairie Island ISFSI is intended to support storage of spent nuclear fuel for the 20 year term of its proposed license renewal (2014 – 2034). The availability of off-site storage alternatives is uncertain. Accordingly, to ensure that the Prairie Island plant is reliably available and to facilitate long-term planning, it is reasonable to consider the proposed Prairie Island ISFSI expansion appropriately sized. No larger or smaller expansion is proposed by Xcel Energy. No other expansion size is considered in this document, except consideration of a no expansion alternative, which is discussed here.

If a Certificate of Need is not granted by the Minnesota Public Utilities Commission for the proposed ISFSI expansion, the PINGP could not operate beyond 2014 and would be forced to shut down. The PINGP would be decommissioned. To complete the decommissioning process, spent fuel assemblies would be removed from the reactor and pool, and eventually stored at the Prairie Island ISFSI. Thus, denial of a Certificate of Need does not eliminate the need for additional ISFSI storage, but rather changes the purpose of dry cask storage expansion from support for continued operations to support for decommissioning. Xcel Energy would be required to apply to the Commission for an ISFSI expansion to accommodate decommissioning.

It's anticipated that 39 additional dry storage casks will be required to decommission the PINGP. Thus the potential human and environmental impacts of a decommissioning expansion would be very similar to the continuing operation impacts discussed in this chapter (35 casks).[116]

There would be some additional impacts due to decommissioning. Decommissioning activities must be completed within 60 years after operations cease and are subject to environmental review under the National Environmental Policy Act. The NRC Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586) provides a summary of decommissioning activities, generic environmental impacts of the decommissioning process, and an evaluation of potential changes in impact that could result from deferring decommissioning.[117] Decommissioning of the Prairie Island plant is more specifically discussed in Appendix J of Xcel Energy's Certificates of Need Application.[118]

Finally, there would be additional human and environmental impacts from activities undertaken to replace the electrical power currently produced by the PINGP. These potential impacts are discussed in Section 7 of this chapter.

[116] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4.6.3, May 16, 2008.
[117] NRC (U.S. Nuclear Regulatory Commission). 1988. *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*. NUREG-0586. Office of Nuclear Regulatory Research. Washington, D.C.
[118] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7.1, May 16, 2008.

7.0 PRAIRIE ISLAND PLANT ALTERNATIVES

The "No ISFSI Expansion" alternative, described in Section 6.4 of this chapter, would lead to the shutdown and decommissioning of the PINGP and subsequent loss of 1,100 megawatts (MW) of generating capacity. This section discusses alternatives for replacing this electrical power and examines the potential human and environmental impacts of these alternatives.

7.1 ELECTRICAL ENERGY SOURCES

In 2005, Minnesota's electrical generators had a total generating capacity of 12,105 megawatts electrical (MWe).[119] This capacity is primarily coal (45%), natural gas (26%), and nuclear (13%), with smaller contributions from renewables (8%), petroleum (6%), and others sources.

The PINGP currently has a net generating capacity of 1,100 megawatts electrical (MWe). The plant provides approximately 10 percent of the electricity used by Xcel Energy customers. In 2007, the plant generated approximately 8,913,000 megawatt-hours (MWh) of electricity.[120] The plant is a reliable energy producer with an average capacity factor over the past five years of 90.2 percent.

7.2 ALTERNATIVES to CONTINUED OPERATION of the PINGP

This section discusses the potential human and environmental impacts of reasonable alternatives for replacing the electrical power currently generated by the PINGP.[121] The PINGP is highly reliable plant that produces a substantial portion of Xcel Energy's generation portfolio. Reasonable alternatives would be energy sources, or combinations of sources, that could effectively replace the electrical generating characteristics of the PINGP.

Xcel Energy's Environmental Report for its operating license renewal considered three reasonable alternatives to the PINGP: (1) purchased power, (2) gas-fired generation, and (3) coal-fired generation.[122] Xcel Energy's Certificates of Need application considered two feasible alternatives to the PINGP: (1) coal-fired generation with carbon sequestration and (2) gas-fired generation.[123] Other possible energy sources (e.g., wind, DSM) were not considered reasonable alternatives to the PINGP. Factors that made these options unreasonable included reliability, economics, and difficulty in implementation.[124]

Considerations of reliability, economics (in particular, valuing externalities), and difficulty of implementation are, for the greater part, beyond the scope of this document. These factors will be discussed by parties to the Certificates of Need proceedings, including by the Office of

[119] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[120] Energy Information Administration (EIA), http://www.eia.doe.gov/cneaf/nuclear/page/nuc_generation/usreact07.xls
[121] Minn. Rules 4410.2300, Part G.
[122] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[123] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4, May 16, 2008.
[124] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7.2.3, Environmental Report, May 16, 2008

Energy Security, Energy Regulation and Planning unit. General economic impacts of PINGP alternatives are discussed in Section 7.3 of this chapter. For purposes of analysis here, reasonable alternatives include energy sources which by themselves, or in combination with other resources, could effectively replace the electrical generating characteristics of the PINGP.

Six reasonable alternative scenarios to continued operation of the PINGP are discussed in this section:

1) Purchased power
2) Pulverized coal power plant
3) Pulverized coal power plant with partial carbon sequestration
4) Natural gas combined cycle plant
5) Large wind energy conversion system (LWECS) and natural gas plant combination
6) Renewable resource technologies

Potential human and environmental impacts of each of these scenarios could be reduced through demand side management (DSM). Thus, the impacts discussed for each of the scenarios are bounding, i.e., they are worst-case impacts which could be mitigated by DSM. For example, if DSM could reduce the need for generating capacity by 10 percent, then environmental impacts would be reduced by 10 percent.

Human and environmental impacts of the alternative scenarios, because they are hypothetical scenarios, are of a generic nature. General characteristics of the energy sources in these scenarios are discussed in Chapter 1, Section 3. Land use, fuel consumption, emissions, and other environmental characteristics are estimated for each scenario. Additional facilities such as new natural gas supply pipelines, new rail for delivery of coal, and new transmission lines to connect to the grid would be required for some scenarios.

Purchased Power

A purchased power scenario would include a long-term power purchase agreement between Xcel Energy and a power provider (e.g., utility, group of utilities, merchant plant). Impacts from purchased power are difficult to estimate due to two uncertainties: (1) uncertainty as to the how the purchased power will be generated and (2) uncertainty related to transmission of the power itself.

If there is not sufficient power in Mid-Continent Area Power Pool (MAPP) for purchase, then a power purchase scenario would likely require construction of an energy source somewhere in the region. The need to construct a replacement energy source as well as many of the potential impacts from the source would be shifted to this region. Technologies that would be used to generate the purchased power are a matter of conjecture; however, based on Minnesota capacity and utilization data and national and regional projections, Xcel Energy believes that the most likely candidates would be coal-fired and nuclear sources during off-peak periods and gas-fired sources during on-peak periods, probably supplemented by power from renewable sources, particularly wind turbines.[125]

In view of constraints in the existing transmission infrastructure, Xcel Energy projects that substantial additions to either the 500 kV or 345 kV transmission systems in the Upper Midwest would be required to import power into Minnesota in amounts that would replace generation from the PINGP.[126] The construction and operation of new transmission lines would impact land uses, ecosystems, and aesthetics. Assuming for purposes of analysis that 100 miles of new 345-kV transmission line with a 150-foot wide right-of-way is required, approximately 1,800 acres would be affected.

Pulverized Coal Power Plant

A pulverized coal power plant scenario would replace the PINGP with a supercritical, pulverized coal-fired steam plant with advanced, clean-coal technology and air emission controls. Such technology is commercially available in large-capacity unit sizes that could effectively replace the generating capacity of the PINGP.

The plant would consist of two 550 MWe units (for a total of 1,100 MWe). Projected operating and environmental characteristics of the plant are shown in **Table 7.1**.

The plant would be designed to meet applicable Minnesota Pollution Control Agency (MPCA) emissions standards and Minnesota Department of Natural Resources (DNR) water appropriation permit standards. As noted in Chapter 1, Section 3, the primary environmental impacts of a pulverized coal power plant include air emissions, solid waste (ash), discharge of waste heat to the environment, land use, and rail or barge traffic.

Pulverized Coal Power Plant with Partial Carbon Sequestration

A pulverized coal power plant with partial carbon sequestration scenario would replace the PINGP with a supercritical, pulverized coal power plant with some type of carbon sequestration technology. Carbon sequestration technology is not currently commercially available; it is confined to demonstration projects. U.S. Department of Energy analysis identifies the price of the technology as a limiting factor in its deployment:

> Existing [carbon] capture technologies…are not cost-effective when considered in the context of sequestering CO_2 from power plants. Most power plants and other large point sources use air-fired combustors, a process that exhausts CO_2 diluted with nitrogen. Flue gas from coal-fired power plants contains 10-12 percent CO_2 by volume, while flue gas from natural gas combined cycle plants contains only 3-6 percent CO_2. For effective carbon sequestration, the CO_2 in these exhaust gases must be separated and concentrated.

[125] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Section 7, Environmental Report, May 16, 2008
[126] *Id.*

> CO_2 is currently recovered from combustion exhaust by using amine absorbers and cryogenic coolers. The cost of CO_2 capture using current technology, however, is on the order of $150 per ton of carbon - much too high for carbon emissions reduction applications. Analysis performed by SFA Pacific, Inc., indicates that adding existing technologies for CO_2 capture to an electricity generation process could increase the cost of electricity by 2.5 cents to 4 cents/kWh depending on the type of process. Furthermore, carbon dioxide capture is generally estimated to represent three-fourths of the total cost of a carbon capture, storage, transport, and sequestration system.[127]

Operating and environmental characteristics of this plant would be similar to the pulverized coal power plant, with an anticipated 50 percent reduction in CO_2 emissions. There would likely be a greater land requirement for this plant in order to place carbon sequestration facilities.

Natural Gas Combined Cycle Plant

A natural gas combined cycle plant scenario would replace the PINGP with a combined cycle natural gas plant. For purposes of analysis, the plant would consist of two 520 MWe units (for a total of 1040 MWe). Though this generating capacity is slightly less than that of the PINGP, it facilitates comparisons with recently constructed plants and is reasonably comparable. Each unit is assumed to consist of two steam combustion turbines (CTs), each with an associated heat recovery steam generator (HRSG) that together supply steam to a single steam turbine generator.

Projected operating and environmental characteristics of the plant are shown in **Table 7.2**.

The gas plant would be designed to meet applicable MPCA emissions standards. Offsite infrastructure needed for this scenario could reasonably include a natural gas supply pipeline and new transmission facilities to connect the plant to the grid.

LWECS and Natural Gas Plant

In the LWECS and natural gas plant scenario, the PINGP is replaced by 990 MW of natural gas generation and 440 MW of wind power generation. The relative generation contributions of each power source are based on the LWECS and gas plant scenario proposed in the Monticello Nuclear Generating Plant ISFSI EIS.[128] Wind power is an intermittent source of electric generation; power output varies depending on the speed of the wind and ability of the transmission system to carry the power when it is generated. Wind power's discontinuous availability means it is not, by itself, well suited to replace the generating characteristics of the PINGP. In order to provide an equivalent reliability and generating capacity, wind power must be combined with some other energy source or storage capability.[129] In this scenario, wind power is paired with natural gas power generation.

[127] Carbon Capture Research, http://fossil.energy.gov/sequestration/capture/index.html
[128] Monticello Spent Fuel Storage Installation Final Environmental Impact Statement, March 2006, http://energyfacilities.puc.state.mn.us/documents/9901/Final-EIS-CN-05-123.pdf
[129] As noted in Chapter 1, Section 3, the growth of interconnected and geographically dispersed wind power generation in the Upper Midwest has increased the system-wide capacity and reliability of this generation alternative.

The operating and environmental characteristics of a combined cycle natural gas plant are shown in Table 7.2. This scenario assumes the same operating characteristics, but with impacts modified to reflect the addition of wind power generation. The operating and environmental characteristics of a typical LWECS (wind farm) are shown in **Table 7.3**.

Projected environmental impacts of an LWECS and natural gas plant scenario are shown in **Table 7.4**.

The environmental impacts an LWECS – natural gas plant scenario are dependent on a number of site-specific factors such as the availability of a large gas pipeline, adequate wind resources, sufficient transmission capacity, and proximity to power demand. Thus, there are uncertainties in estimating these impacts.

Renewable Resources Technologies

In the renewable resources technologies scenario, the PINGP is replaced by a combination of renewable resource technologies – wind, biomass, anaerobic digestion, and solar. Renewable energy sources have the potential to be sustainable energy sources with relatively fewer environmental impacts. Renewable energy sources are typically diffuse and geographically dispersed. These characteristics have potential benefits and drawbacks. Benefits include fewer environmental impacts (though impacts vary with the technology) and the potential to integrate energy sources more directly into communities which they might serve. Drawbacks include the need to connect dispersed energy sources to the electrical grid. These connections may require the construction of additional transmission lines. Because they rely on relatively diffuse energy sources, renewables also have relatively lower capacity factors, i.e., their power generation tracks the sporadic nature of their energy source (e.g., wind, sunlight).

The scenario discussed here is adapted from the distributed generation scenario proposed in the Monticello Nuclear Generating Plant ISFSI EIS.[130] This is one scenario of many possible renewable technology scenarios; nonetheless, it is representative and provides a reasonable basis for comparing potential impacts.

The operating and environmental characteristics of an LWECS are shown in Table 7.3. This scenario assumes the same operating characteristics, but with impacts modified to reflect the addition of other energy sources. The operating and environmental characteristics of typical biomass power generation, anaerobic digestion, and solar (photovoltaic) power generation are shown in **Table 7.5**.

For purposes of analysis, this scenario assumes that each renewable resource technology provides a percentage of the total replacement generating capacity for the PINGP. In this scenario the PINGP is replaced by 1600 MW of wind generation, 700 MW of biomass generation, 50 MW of anaerobic digestion generation, and 200 MW of solar generation. This combination provides an approximate accredited generation capacity of 976 MW.

[130] Monticello Spent Fuel Storage Installation Final Environmental Impact Statement, March 2006, http://energyfacilities.puc.state.mn.us/documents/9901/Final-EIS-CN-05-123.pdf

Wind power. This scenario relies heavily on generation by large energy wind conversion systems (LWECS). As noted above, this technology has a relatively lower capacity factor and performs best when combined with another energy source.

Biomass. This scenario also relies heavily on generation powered by biomass – including woody biomass, crop residues, and biodiesel. Biomass technologies are commercially available and there is strong state and federal support for their development. As an example, in September, 2008, Xcel Energy announced its intention to convert a coal-fired unit at its Bay Front Power Plant in Ashland, WI, to biomass gasification technology.[131] Challenges to implementing biomass technology include long-term biomass availability, transportation, and competition for biomass with other uses, e.g., food, fiber.

Biodiesel is included in this scenario as a biomass generation source. Biodiesel can be used in commercially available diesel fueled turbines and associated generators. Biodiesel is readily available in Minnesota; the state has capacity to produce approximately 63 million gallons of biodiesel per year.[132] Ethanol is not included in this scenario as a biomass generation source. Reasons for not including ethanol include: (1) a lack of suitable ethanol fueled generating equipment, (2) the quantity of ethanol that would be required, and (3) the lack of mature markets for ethanol as an electrical generation resource.

Anaerobic Digestion. Anaerobic digesters of animal manure, food processing waste, and municipal waste water solids provide a limited amount of power generation in this scenario. The capacity factor for anaerobic digesters is based on experience in Minnesota with anaerobic digestion of dairy cow manure.[133]

Solar. Solar power (photovoltaic) provides a limited amount of power generation in this scenario. Solar power is a renewable resource with few operational environmental impacts. Photovoltaic technology is just beginning to reach commercial viability and utility scale application.[134] Due to it reliance on direct sunlight, it has a very limited capacity factor.
The potential environmental impacts of a renewable resources technologies scenario are shown in **Table 7.6**. These impacts are highly dependent on the relative proportion of each technology in the scenario.

7.3 COMPARISON of IMPACTS of the ALTERNATIVES

This section compares the potential human and environmental impacts associated with continued operation of the PINGP with those of the six alternatives scenarios. Human impacts include

[131] Xcel Energy Announces Largest Biomass Plant in Midwest, September 30, 2008, http://www.xcelenergy.com/Company/Newsroom/Pages/XcelEnergyAnnouncesLargestBiomassPlantintheMidwest.aspx
[132] Prospects for Expansion of the Soy-Based Biodiesel Industry in Minnesota, November 2006, http://www.auri.org/research/diesel/pdfs/Executive%20Summary%20Bio-Diesel%20Study%20December%2006.pdf
[133] Final Report: Haubenschild Farms Anaerobic Digester, August 2002, http://www.mnproject.org/pdf/Haubyrptupdated.pdf
[134] PG&E Signs Historic 800 Mw Photovoltaic Solar Power Agreements With Optisolar and Sunpower, http://www.pge.com/about/news/mediarelations/newsreleases/q3_2008/080814.shtml

economic, employment, and sociological impacts.[135] More detailed economic analysis will be provided, as appropriate, by the Office of Energy Security, Energy Regulation and Planning unit in the Certificates of Need proceedings for this project.

Environmental Impacts

The potential environmental impacts associated with alternatives to the PINGP are summarized in **Table 7.7**. Potential impacts from operation of the PINGP and Prairie Island ISFSI are discussed in this document. As appropriate, these impacts have been included in Table 7.7 for comparison purposes.

PINGP and Prairie Island ISFSI. The relative environmental advantages of continued operation of the PINGP include no new land use, no CO_2, SO_x, or NO_x emissions, and a compact fuel cycle with relatively small fuel throughput and solid waste generation. Additionally, continued operation of the PINGP requires no new transmission line construction. The environmental impacts include water consumption, discharge of heat to the environment, and controlled emissions of radioactivity (see Chapter 1, Section 4 and Chapter 2, Sections 4 and 5).

Fossil Fuel Technologies. The relative environmental advantages of fossil fuel technologies are limited. Fossil fuel technologies require high fuel throughput which creates substantial CO_2, SO_x, and NO_x emissions as well as solid wastes (ash). If operated without evaporative cooling towers, these technologies can consume relatively less water than the PINGP. Carbon dioxide (CO_2) is now understood to be the most important greenhouse gas (GHG) – responsible for global warming and associated environmental impacts including significant changes to world weather systems and ecosystems.[136] Sulfur oxides (SO_x) can cause acid rain and human respiratory illness.[137] Nitrous oxides (NO_x) are greenhouse gases that also cause ozone and related respiratory illnesses.[138] As an example of the debilitating effect of nitrous oxides, a recent EPA rulemaking to strengthen NO_x standards projected that the rulemaking change would avoid 200 – 2000 premature deaths annually by 2020.[139] Potential local impacts from SO_x and NO_x emissions can be mitigated by dispersion of these emissions by prevailing winds to other regions of the country. Dispersion is not a mitigating strategy for CO_2 emissions.

Impacts related to fossil fuel technologies can be mitigated by sequestering carbon before it can become a greenhouse gas (scenario #3), or by using natural gas, which has a relatively lower potential for CO_2 generation (scenario #4). A natural gas plant, compared to other fossil fuel technologies, has relatively lower SO_x and NO_x emissions, consumes less water for operations, and generates no solid wastes. Of the fossil fuel technologies, a natural gas plant has the fewest potential environmental impacts. All of the fossil fuel technologies, if sited other than at the current Prairie Island plant, would likely require the development of new transmission lines.

[135] Minn. Rules 4410.2300, Subd. H.
[136] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/
[137] Health and Environmental Impacts of SO_2, http://www.epa.gov/oar/urbanair/so2/hlth1.html
[138] Health and Environmental Impacts of NO_x, http://www.epa.gov/air/urbanair/nox/hlth.html
[139] Strengthened National Standards for Ground Level Ozone, http://www.epa.gov/air/ozonepollution/actions.html#mar07s

Renewable Resource Technologies. The relative environmental advantages of renewable resource technologies vary with the technology. In general these technologies use or capture a more diffuse energy resource. Thus, they typically have a relatively greater land use impact and lower waste impacts. Of the renewable resource technologies that are commercially available, wind power has the fewest potential environmental impacts. Wind turbines do not consume fuel or water, or create emissions or wastes. They do have a relatively higher land use impact. However, these impacts are limited because wind turbine operations allow for concurrent land uses, e.g., agriculture. Direct land use impacts – impacts associated with the physical footprint of the wind turbine – are minor. Of the technologies considered in this section, including the PINGP, wind power has the fewest potential environmental impacts.

Renewable resource technologies that utilize carbon energy sources have drawbacks associated with fossil fuel technologies, e.g., emissions, solid wastes. However, these technologies (biomass, biodiesel, anaerobic digestion) have a greater potential to operate as carbon neutral technologies. Because they depend on current, annually renewable carbon stocks (plants, trees, manures), they cannot as easily draw down their fuel stocks. Or, rather, the effect of doing so is more readily apparent as compared to fossil fuel technologies.

All of the renewable resource technologies would likely require the development of new transmission lines to distribute their power generation. These lines would have negative environmental impacts associated with them.

Risks and Uncertainties. The alternative scenarios to the PINGP all involve impacts, risks, and uncertainties. In the near term, renewable resource technologies will likely need to be supplemented by fossil fuel technologies in order to replace the generating characteristics of the PINGP. Fossil fuel technologies create significant risks and uncertainties related to global warming. Though research has illuminated the linkages between human activities, greenhouse gas (GHG) emissions, and global warming, there is uncertainty as to the projected effects of these linkages, how to mitigate them, and how to value them in public decision-making processes.[140,141]

The PINGP and Prairie Island ISFSI avoid the uncertainties of GHG emissions, but do so by trading them for uncertainties related to the safe handling, storage, and eventual placement in a federal repository of spent nuclear fuel (SNF) generated at the PINGP. The potential human and environmental impacts of handling and storing SNF have been discussed in this document in the context of the Prairie Island ISFSI. They are not anticipated to be significant. Nonetheless, uncertainties remain, e.g., the uncertainty of a terrorist attack on the ISFSI, the uncertainties related to the availability of a federal repository.

All this is to say that potential human and environmental impacts associated with the PINGP and alternatives to the PINGP – in particular, those related to safe handling of SNF and to GHG

[140] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 11.4, May 16, 2008
[141] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/

emissions – are subject to social-political-institutional forces and value judgments. Accordingly, there may be differences of opinion as to potential risks and impacts.

Economic and Employment Impacts

Xcel Energy analyzed the economics of alternatives to the PINGP in its Certificates of Need application.[142] Its analysis indicated that continued operation of the PINGP was more cost effective than coal-fired or gas-fired generation. In addition, sensitivity analysis indicated that the cost effectiveness of the PINGP was relatively robust, i.e., not sensitive to changes in assumptions about costs and externalities. Though Xcel Energy did not examine all of the possible scenarios presented in this section (e.g., gas-fired plant plus wind power), it appears that continued operation of the PINGP would reduce economic impacts to ratepayers. Economic modeling and analysis of the PINGP and of appropriate alternative scenarios will be provided by the Office of Energy Security, Energy and Regulatory Planning unit in the Certificates of Need proceeding for this project.

Economic impacts to Minnesota communities and citizens were analyzed in Xcel Energy's Environmental Report accompanying its NRC license renewal application.[143] This analysis projects socioeconomic impacts of PINGP alternatives to be "moderate" to "large," based on loss of tax revenue for the City of Red Wing. This impact is more properly framed as economic impact to citizens of Red Wing, not citizens of Minnesota. Alternatives to the PINGP, located in other cities within Minnesota, would generate similar tax revenues for these cities. Thus, the economic impact within Minnesota would be minimal. Loss of the PINGP would disrupt tax revenues and negatively impact citizens of Red Wing; however, these revenues would likely be generated elsewhere in the state by a PINPG alternative and positively impact citizens in these regions.

The Environmental Report estimates that economic impacts due to changes in employment would be small. However, the report does project changes in long-term employment under alternative scenarios to the PINGP. The report estimates that it takes approximately 520 permanent employees to operate the PINGP; whereas, it would take only 120 employees to operate a coal plant, and 35 employees to operate a gas plant.[144] Thus, alternatives to the PINGP could have an adverse economic impact related to long-term employment. As the Environmental Report did not analyze potential employment impacts related to wind power generation or other renewable resource technologies, it's uncertain how these alternatives would impact employment. Because these technologies harness relatively more diffuse energy sources, it's likely that they would employ more persons than a coal or gas plant.[145] Thus, renewable resource technologies could have a neutral or positive long-term employment impact compared to continued operation of the PINGP.

[142] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Section 4, May 16, 2008
[143] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, May 16, 2008.
[144] Prairie Island Nuclear Generating Plant, Certificates of Need Application, Appendix J, Environmental Report, Table 8-2, May 16, 2008.
[145] Putting Renewables to Work: How Many Jobs can the Clean Energy Industry Generate?, RAEL Report, University of California, Berkeley, 2006, http://rael.berkeley.edu/old-site/renewables.jobs.2006.pdf

All alternatives to the PINGP would likely have a positive economic impact on short-term construction employment.

Sociological Impacts

Potential sociological impacts related to the PINGP and PINGP alternatives are difficult to assess. Sociological impacts include but are not equivalent to socioeconomic impacts. The relative economic impacts of the PINGP alternative scenarios are discussed in this section. The economic dislocation that would occur to citizens of Red Wing should the PINGP be shut down and an alternative constructed, is likely better described as a sociological impact than an economic impact to the State of Minnesota. All of the alternative scenarios would disrupt the Red Wing community. They would also likely foster growth in other Minnesota communities.

Aesthetics is likely a factor in assessing sociological impacts. How citizens feel about their community depends to some degree on the perceived beauty that they interact with on a daily basis. Thus, generally, alternatives that require new land use (e.g., new power plant, new transmission lines, new pipeline) would likely have a negative aesthetic and sociological impact. Continuing operation of the PINGP (no new land use) would likely have a neutral aesthetic and sociological impact. There will be differences of opinion as to the extent of new land use impacts. For example, some persons find wind turbines graceful and peaceful; others find them to be an eyesore on the landscape.

Additionally, new land use could interfere with cultural and social activities, e.g., hunting, gathering, recreation, worship. When such activities are associated with a particular geography, impacts to this geography create negative sociological impacts.

Finally, psychology likely plays a factor in sociological impacts. The psyche of a community could be influenced independent of aesthetics. For example, a person might be positively impacted by the thought of using renewable resource technologies, yet not like the sight of wind turbines out their back window. The potential psychological impacts of the PINGP are discussed in Chapter 1, Section 4.5. Whether the psychological impacts of PINGP alternatives would be relatively less or more than continued operation of the PINGP is uncertain. A negative psychological impact could occur due to fear or distrust of a PINGP alternative that is located close to a citizen's home. For example, research on the effect of transmission lines on property values indicates that part of the potential negative impact on property values is due to safety concerns of homeowners.[146] Research also indicates that the passage of time can ameliorate psychological impacts, i.e., known risks that have been lived with are less likely to have a negative psychological impact than the introduction of new risks.

[146] Power Lines and Property Values Revisited, Appraisal Journal, Fall 2007, http://www.entrepreneur.com/tradejournals/article/171851335.html

TABLES

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FIGURES

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