Appendix A

Summary of Scoping Comments

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APPENDIX A
SUMMARY OF SCOPING COMMENTS

Comment	EIS Chapter Where Comment Will Be Addressed
Air Quality	
An Air Emission Risk Analysis should be conducted as part of the EIS analysis.	Chapter 3
Thoroughly examine the impacts of all criteria pollutants with emphasis on sulfur dioxide (SO_2) and nitrous oxides (NO_x) since these pollutants travel widely.	Chapter 4
Modeling results should be included in the EIS on impacts of mercury emission on local deposition and accumulation in regional water bodies.	Chapter 3, Chapter 4
Document the variance in greenhouse gas emission on the proposed project and on all the alternatives.	Chapter 2, Chapter 4
Include an analysis of adverse impacts from increased road and rail traffic and the resulting increased emissions.	Chapter 4
Examine the effectiveness of brominated carbon injection technology for mercury removal from coal-fired plants.	Chapter 2
Examine whether the proposed pollution control is most effective for mercury removal.	Chapter 1, Chapter 4
Examine the impacts to air quality from acid rain and mercury deposition to areas down wind of the proposed power plant.	Chapter 4
Fully assess increased carbon dioxide (CO_2) emissions as well as capture and sequestration of CO_2.	Chapter 4
Analysis of CO_2 emissions should be consistent with the President's stated mission to reduce greenhouse gas emissions and the 8th Circuit Court of Appeals case ("Mid States Coalition for Progress v. Surface Transportation Board").	Chapter 4
Identify the point of maximum concentration of direct and indirect $PM_{2.5}$.	Chapter 4
Address impacts to ambient air quality for the seven-county Twin Cities areas, as well as Rochester and Duluth.	Chapter 4
Include a description of existing controls and emissions at the existing plant and an analysis for reducing emissions to offset the increased emission from Big Stone II.	Chapter 1, Chapter 4
Modeling protocol should be developed and shared with affected state agencies along with the U.S. Environmental Protection Agency (USEPA).	Chapter 3
Air quality analysis should include a wind rose representing conditions in Grant County, South Dakota, to inform local residents of downwind directions from the proposed plant.	Chapter 3
Air quality analysis should discuss the area's attainment status with both state and federal air quality standards as well as identify any PSD Class I areas.	Chapter 3
Air dispersion modeling should show compliance with the National Ambient Air Quality Standards (NAAQS) for CO, NO_x, SO_2 and particulate matter for both the existing facility and the proposed facility.	Chapter 3
Long-range air quality impacts resulting from coal combustion such as acid rain, mercury deposition, greenhouse gas and air toxics emissions should be discussed including downwind impacts on ozone levels in the Minneapolis-St. Paul area.	Chapter 4
The following additional concerns were expressed: • The power plant's contributions and impacts to global warming • Radioactive emission from burning coal, which could contain trace amounts of radionuclides • Impacts to the environment and fish due to acid rain and mercury contamination • Visibility impacts to Minnesota's Class I areas • NO_x emissions in Minnesota since South Dakota is not part of the Clean Air Interstate Rule and therefore not subject to a nationwide emissions cap	Chapter 4 Chapter 4 Chapter 4 Chapter 3, Chapter 4 Chapter 3, chapter 4

Comment	EIS Chapter Where Comment Will Be Addressed
Realty/Land Use	
Several questions regarding easement acquisition process, payment and compensation, and when landowners would be contacted.	Chapter 4
Impacts to the Big Stone National Wildlife Refuge (NWR) is a concern.	Chapter 4
Why can't the transmission lines be located on government/Department of Natural Resources/wildlife refuge land?	Chapter 4
The following concerns were expressed regarding project impacts to: • The old dump ground in southern Granite Falls • Personal property located near Long Lake and Ringo Lake • Proposed new sewage plant in Willmar • Newly annexed area southeast of Willmar that is zoned for a new business park and commercial property • DeGraff cemetery, Oak Park Church cemetery in Fahlun Township, and cemetery located on the southwest corner of Hazel Run • State and national parks and natural and cultural resource areas • Land use in Dovre Township identified in the Dovre Township's Comprehensive Land Use Plan as suitable for agriculture • Property values along County Road 27, Long Lake and areas to the north and Highway 12 • Conservation Reserve Program lands • NWR or Wetland Management District properties • Wildlife management areas (WMAs) including the Brouillet WMA, Omro WMA and the Lanners WMA located within proposed corridors Additional concerns expressed include: • Interference with the new airport in Willmar, future air strip being constructed in Hazel Run Township and expansion of airport in Minnesota Falls Township • Construction impacts of the transmission lines to Scientific and Natural Areas (SNA), specifically to the Mound Spring SNA located within the proposed transmission line corridor	Chapter 4
Agriculture	
Land use in Dovre Township west of County Road 5 has been identified in the Comprehensive Land Use Plan as suitable for agriculture.	Chapter 3
Single-pole structures are preferred in agricultural fields.	Chapter 2
Address impacts to plant-related ozone formation from plant emissions on crops.	Chapter 4
Additional concerns expressed include: • Impacts to center pivot irrigation and farming activities, particularly along Highway 12 • Electrical effects of the transmission lines on Global Positioning System units used for guiding farm machinery and interference with UH7 two-way radio • Transmission line structures interfering with aerial sprayers and ground spraying equipment • Potential for damage to farm machinery striking power line poles	Chapter 4
Solid Waste/Hazardous Materials	
Thoroughly address the adequacy of the existing on-site waste/ash management site.	Chapter 2
Discuss the chemical characteristics of fly and bottom ash and proposed methods for disposal.	Chapter 4

Comment	EIS Chapter Where Comment Will Be Addressed
General Alternatives	
Provide in comparative form impacts associated with each reasonable alternative.	Chapter 2
Rigorously explore and objectively evaluate all reasonable alternatives and discuss reasons why any alternatives were eliminated from further study.	Chapter 2
Supports project alternatives and design analyses that would avoid adverse impacts to USFWS Trust lands and resources.	Chapter 2, Chapter 4
Alternative Technologies	
Analyze an alternative which addresses energy efficiency and demand side management.	Chapter 2
Analyze the use of wind power with ancillary utility services as an alternative.	Chapter 2
Consider the use of wind power in combination with hydroelectric generation.	Chapter 2
Evaluate the use of wind power plus the use of new thermal generation sources as an alternative.	Chapter 2
Consider community-based energy projects using local fuels (agricultural waste, forestry wood waste, municipal waste, etc.) as an alternative.	Chapter 2
Consider industrial co-generation as source such as ethanol plants as an alternative to coal-fired generated energy.	Chapter 2
Evaluate the alternative of coal gasification with carbon capture and storage.	Chapter 2
Wind power combined with a smaller coal-fired power plant should be considered as an alternative.	Chapter 2
Supports wind energy on ridges near Spicer instead of coal-fired power plant.	Chapter 2
Nuclear power plants should be considered as an alternative to coal-fired power plants.	Chapter 2
Consider photovoltaic sources as an alternative to coal-fired generated energy.	Chapter 2
Disclose a range of power generating technologies alternatives and feasibility for the Big Stone II plant.	Chapter 2
Thoroughly analyze alternatives to the Big Stone II plant, particularly wind-generated power and biomass.	Chapter 2
Provide additional information on the economies of scale for connecting into the transmission system.	
Analyze an alternative that incorporates the maximum wind energy potential with an Integrated (coal) Gasification Combined Cycle plant that utilizes carbon capture technology.	Chapter 2
Consider an alternative that incorporates the majority of baseload generation from wind and backup with natural gas or biomass instead of coal-fired generated energy.	Chapter 2
Analyze an alternative that incorporates the Oxyfuel process and state-of-the-art pollution controls.	Chapter 2
Advanced combined cycle gas facility should be considered an alternative.	Chapter 2
Evaluate as an alternative state-of-the-art emission control technologies.	Chapter 2
Address alternative coal technologies using various combinations of state-of-the-art emission control technologies for mercury recovery and SO_2 and NO_x emission reductions that would result in overall emissions reduction for the combined Big Stone facility.	Chapter 2
Power Plant Siting Alternative	
Suggests building the plant at the existing NSP plant in Granite Falls.	Chapter 2
Cumulative Impacts	
Address other sources affecting the climate when evaluating cumulative impacts of the project.	Chapter 4
The cumulative analysis should include the existing plant and the new plant, as well as other pollution sources.	Chapter 4
Air dispersion modeling should show compliance with NAAQS standards for CO, NO_x, SO_2 and particulate matter for both the existing facility and the proposed facility and results included in the cumulative impacts.	Chapter 4

Comment	EIS Chapter Where Comment Will Be Addressed
Transmission Line Corridor/Routing Alternatives	
The transmission line corridor alternative south of Willmar is preferred.	Chapter 2
The Big Stone to Willmar transmission line corridor is preferred as an alternative.	Chapter 2
Consider an alternative transmission line corridor that avoids Highway 12 and follows the Big Stone line along the Lac qui Parle refuge from Ortonville to Appleton, then south to the south side of Willmar.	Chapter 2
An alternative transmission line corridor alignment should be sited south of Willmar.	Chapter 2
Transmission line corridor Alternative 2B south of Willmar is preferred and avoids wetland areas.	Chapter 2
The transmission line corridor Alternative 1 north to Morris is preferred.	Chapter 2
Use an alternative transmission line corridor along the Minnesota River or Highway 7 south to Granite Falls.	Chapter 2
Rebuilding transmission lines should be considered an alternative over a new transmission line.	Chapter 2
Consider an alternative that would avoid routing of transmission lines through "Sites of Biodiversity Significance."	Chapter 2
Adjust the transmission line route from Ortonville to Morris to run north along Highway 75 from Ortonville to County Road 10, then east on County Road 10 to County Road 21, before following the existing line north and east to Morris.	Chapter 2
An east-west corridor in the Dawson or Madison area is recommended rather than the Canby area to avoid sensitive natural resource areas.	Chapter 2
Preference to single-pole structures.	Chapter 2
Dovre Township has voted against construction of power lines through the area.	Chapter 2
Opposes transmission line routing near Ringo Lake.	Chapter 2
Supports additional transmission lines be sited within existing corridors.	Chapter 2
A 4-lane road to avoid a large agricultural system and future prime building area was suggested due to concern regarding the proposed transmission line being sited passed the junction of Highway 12 and County Road 9 east of Willmar.	Chapter 2
Route the transmission line along County Road 56 between Ortonville and Benson.	Chapter 2
Transmission lines should be sited along existing transmission and transportation corridors.	Chapter 2
Transmission line alignments should be located underground.	Chapter 2
Transmission lines should be located along county road rights-of-way.	Chapter 2
Site transmission lines along roads and not cross-country.	Chapter 2
Locate transmission lines south of Danvers.	Chapter 2
No preference to H-frame or single pole structures.	Chapter 2
Route transmission line corridors along county roads to avoid sensitive wildlife areas such as Lanners Lake.	Chapter 2
Include a complete evaluation of impacts associated with the new substation in Spicer, Minnesota.	Chapter 2
South Dakota and Minnesota regulatory agencies, tribes (including the Upper Sioux and Sisseton Wahpeton), and towns should be included as contacts for this project.	Chapter 1
Additional concerns expressed include: • Transmission line routing near the Dominick's Pit • Negative impacts of transmission line siting to the lakes and watersheds within the Dovre Township • What is the reason for siting the transmission line 1 mile from existing lines? • Can existing lines be relocated?	Chapter 2

Comment	EIS Chapter Where Comment Will Be Addressed
Purpose and Need	
Review the utilities' demand forecast to determine if additional energy is needed.	Chapter 1
Concern regarding the need for additional power and transmission in the Willmar area.	Chapter 1
Supports the purpose and need and that the additional generation is needed for future capacity.	Chapter 1
Project Description	
Project description needs to clarify where the transmission lines would be located within the corridor in order to effectively comment.	Chapter 2
The project should include retrofitting Big Stone I with state-of-the-art emission control technologies to reduce overall emission reduction for the combined plant facility.	Chapter 2
Federal NEPA Process	
Address the large-scale, long-term environmental impact of coal-fired power plants; the net benefits should be broken down into each individual unit.	Chapter 4
The federal EIS should be conducted before the state agency permitting processes reach their respective public comment stages so the public is informed of the impacts that will be at issue in the South Dakota and Minnesota regulatory proceedings.	Chapter 1
Questions regarding how the public can be involved and whether there would be additional public meetings.	Chapter 1, Chapter 6
Include a complete evaluation of impacts associated with the new substation in Spicer, Minnesota.	Chapter 2
Recommend that the South Dakota and Minnesota regulatory agencies, tribes (including the Upper Sioux and Sisseton Wahpeton), as well as towns be included as contacts for this project.	Chapter 1
Other Federal Permitting	
The proposed project involves navigable waters of the United States (U.S.), such as the Minnesota River, and therefore may be subject to the USACE' jurisdiction under Section 10 of the Rivers and Harbors Act of 1899.	Chapter 1
The proposed project may be subject to Section 404 of the Clean Water Act if project activities include deposition of dredged or fill material into waters of the U.S.	Chapter 1
Placement of aerial lines that cross navigable waters of the U.S. requires authorization under Section 10 of the Rivers and Harbors Act.	Chapter 1
Underground utility lines through waters of the U.S., including wetlands, are regulated under Section 404 of the Clean Water Act.	Chapter 1
Connecting points for installation of underground lines installed by vibratory plow and directional bore method, that requires excavation and backfill in waters of the U.S., including wetlands, would require a permit.	Chapter 1
Temporary placement of fill material into any water body or wetland for purposes of access roads, temporary stream crossings, etc. may require a permit.	Chapter 1
The proposed project will require Section 7 consultation with USFWS under the Endangered Species Act (ESA) of 1973 since two federally listed and candidate species (bald eagle and Dakota skipper) may be present in four counties affected by the project.	Chapter 1
Include a discussion that informs the public of the potential requirement of a Section 404 permit.	Chapter 2
The 404 permit process should be conducted concurrently with the NEPA process and a draft 404(b)(1) analysis should be prepared for the preferred alternative and appended to the NEPA document.	Chapter 1
State Permitting Process	
Some landowners in South Dakota have not been notified, particularly the Nassau area in Vernon Township.	Chapter 1
There is some confusion regarding where the transmission lines would be sited since landowners within and outside of the proposed corridor were notified.	Chapter 1

Comment	EIS Chapter Where Comment Will Be Addressed
Water Resources/Quality	
Modeling and the results on local mercury deposition and accumulation in regional water bodies should be included in the EIS. (Also refer to comments under air quality, public health, wildlife.)	Chapter 3, Chapter 4
Evaluate the plant's impacts on the water quality of Big Stone Lake and the Minnesota River.	Chapter 4
Describe current groundwater and surface water conditions at the plant facility and the potential for impacts.	Chapter 4
The water quality analysis in the EIS should describe coal pile runoff and potential impacts.	Chapter 4
The water quality analysis should include information regarding boiler blowdown capture and treatment, whether the current blowdown pond is sufficient for both plants.	Chapter 2, Chapter 4
Identify all stream crossing for each transmission line corridor alternative and whether streams would be impacted by impaired waters.	Chapter 3, Chapter 4
404 Permit process – see comments under Other Federal Permitting.	Chapter 1
Additional concerns expressed include: • Impacts to groundwater supplies resulting from waste disposal and pollutants such as sulfate, chloride and boron from coal-fired power plants • Water quality issues associated with the loss of isolated wetlands	Chapter 4
Wetlands/Riparian	
Concerns expressed include: • Impacts to the Minnesota River and riparian habitat • Impacts to USFWS wetlands easements located in the Big Stone II to Gary, South Dakota, corridor	Chapter 4
Address isolated wetland destruction and present potential alternatives to that destruction.	Chapter 4
Thoroughly describe where and to what extent mercury emissions will affect wetlands.	Chapter 4
Describe existing wetlands, including acreage, type and ecological role as well as how the acreage and function will be protected in accordance with Executive Order 11990.	Chapter 3
Consultation on wetlands permitting should be conducted with USEPA, the USACE and USFWS.	Chapter 1
Additional concerns expressed include: • Impacts of CO_2 emissions on wetlands of the Prairie Pothole Region • Water quality issues associated with the destruction of wetlands • Impacts to wetlands located within the Alternative Transmission Line Corridor 2	Chapter 4
Special Status Species	
Include and consider the 35 special status state species for South Dakota.	Chapter 3
Address the ESA by including a biological assessment and associated USFWS Biological Opinion or other formal consultation.	Chapter 3
Known locations of threatened and endangered species must be avoided by the proposed project.	Chapter 4
Additional concerns expressed include: • Project's impacts to the bald eagle, Topeka shiner and the Western prairie-fringed orchid • Adequate protection of the bald eagle nest located near the plant site and identified in the siting permit • Impacts on state and federal endangered and threatened species due to the deposition of coal plant emissions • Impacts to rare, threatened and endangered, and special concern mussel species resulting from project construction over streams and rivers including the Lac qui Parle River	Chapter 4

Comment	EIS Chapter Where Comment Will Be Addressed
Wildlife	
Concerns expressed include: • Impacts of mercury pollution to the bald eagle, loons and otters (Also refer to comments under air quality, public health, water resources.) • Long-term impacts to species and game and nongame wildlife habitat associated with the loss of isolated wetlands • Impacts to bird species and migratory birds resulting from the continued loss of wetlands • Impacts to bald eagle nests on Long Lake • Impacts to habitat resulting from transmission line construction • Impacts to the DNR-protected island known as Long Lake Herondry where known migratory birds, bald eagle, Franklin's gull and American white pelican nests are located • Interference with high voltage power lines with migratory bird species • Address impacts on existing wildlife corridors, habitat fragmentation and migratory birds • Impacts to pheasant habitat • Impacts to migratory birds using the Minnesota River corridor caused by the proposed transmission lines • Impacts to Waterfowl Production Areas and Wildlife Management areas primarily in the northern corridor alternatives • Impacts to the migratory bird area near the Salt Lake on the South Dakota/Minnesota border	Chapter 4
Aquatic/Fisheries	
Concerns expressed include: • Impacts from the power plant on fish and aquatic ecosystems of the Big Stone Lake and the Minnesota River • Impacts to fisheries due to acid rain and mercury contamination	Chapter 4
Vegetation	
Concerns expressed include • Endangered plants, such as the ball cactus and fame flower located on the granite outcrops within the Big Stone NWR • Impacts to USFWS grassland easements located in the Big Stone II to Gary, South Dakota corridor • Impacts to the Northern Tallgrass Prairie NWR USFWS easements near the Canby area • Impacts to prairie lands south of Granite Falls • Project impacts to a 4-square-acre tree claim in Six Mile Grove Township. • Vulnerability to invasive species associated with construction (Refer to comments in construction impacts.) • Transmission line pole sites as a weed source and infecting nearby areas • Impacts to "Railroad Rights-of-way Prairie" areas located within the proposed alternative transmission line corridors • Impacts to rock outcrop areas where habitat for several rare plant species are located within proposed corridors • Impacts to mesic prairie native plant communities, Prairie Mimosa, special concern plants and threatened and special concern butterfly species known to occur within the proposed alternative transmission line corridors • Impacts to dry prairie native plant communities located within proposed alternative transmission line corridors	Chapter 4
Noise	
Concern was expressed about noise impacts from high-voltage transmission lines and applicability under the Noise Control Act and Quiet Communities Act.	Chapter 4

Comment	EIS Chapter Where Comment Will Be Addressed
Recreation	
The private hunting area (near airport) on the Big Stone to Morris transmission line corridor alternative should be avoided.	Chapter 4
Additional concerns expressed include: • Impacts to the Environmental Learning Center and recreational clay shooting south of the Dovre Township • Impacts to fishing, hunting, birding and outdoor enthusiasts near the Big Stone Lake and the Whetstone River • The loss of wildlife and recreational hunting as a result of wetlands loss • Impacts of mercury emissions on recreational and subsistence fishing • Impacts from the transmission line to tourism at the Glacial Ridge Trail	Chapter 4
Cultural/Historical	
The following concerns were expressed: • Effects of the transmission lines on historical buildings • Impacts to the Glacial Ridge Trail, which is of historical significance to the Dovre Township • Impacts to tee pee ring south of Highway 75 at curve in the road • Impacts to the old railway trestle near the City of Canby currently being considered historical • Impacts to a railroad stone arch bridge trestle, possibly eligible for listing, located on the proposed transmission line corridor between Big Stone and Granite Falls	Chapter 4
Public Safety	
Concerns expressed include: • Electromagnetic field and stray voltage associated with transmission lines to human safety and questions regarding the safe distance for homes • Potential for electrocution when it is misting outside • Transmission lines would act as a lightning rod • Impacts from air pollution (including contribution of NO_x to ozone formation and mercury emissions) on the health of communities in the vicinity of the plant site • Fish and game consumption resulting from mercury deposition in area lakes • Impacts associated with the disposal of coal ash on human health • Health impacts from coal dust and the increased coal handling operations at the plant site • Risk for increased accidents associated with transmission line structures	Chapter 4
Visual	
Quantify the extent that pollutants from the plant would limit visibility in the region.	Chapter 3
A visual impacts analysis should be conducted for the project, particularly where new transmission lines would be constructed.	Chapter 4
Additional concerns expressed include: • Visual impacts associated with construction of transmission lines near Long Lake • Visual impacts to hobby farms along Transmission Line Corridor Alternative 2 • Visual impacts associated with the power plant stack • Visual impacts associated with the transmission lines from the bluffs in Granite Falls • Would there be a difference in the visual impacts from a 345-kV transmission line and a 230-kV transmission line?	Chapter 4

Comment	EIS Chapter Where Comment Addressed
Socioeconomics	
Examine the economic impacts (e.g., healthcare costs and lost productivity) associated with mercury pollution as well as other air pollutants such as lead, arsenic, beryllium, nickel and cadmium.	Chapter 4
Address the economic impacts on pollution control, water quality and flood control due to the loss of wetlands.	Chapter 4
Address the costs associated with reducing CO_2 emissions, including the costs of retrofitting both plants and capture and sequestration.	Chapter 4
Address environmental justice and comply with the "EPA Guidance for Consideration of Environmental Justice in Clean Air Act Section 309 Reviews (July 1999)."	Chapter 3, Chapter 4
Additional concerns expressed include: • Construction of transmission lines reducing property values • The loss of economic opportunities in terms of jobs, taxes and local income, including South Dakota, as a result of the proposed project • Costs to ratepayers and residents in all states affected by the proposed project • Economic impacts (e.g., healthcare costs) associated with the disposal of coal ash disposal and air emissions • Additional costs to ratepayers associated with compliance of future carbon regulations to reduce global warming	Chapter 4
Construction Impacts	
Question regarding the differences in transmission line construction and pipeline construction. [Note: The proposed project does not include pipeline construction.]	Chapter 4 (transmission line construction)
Address impacts to wetlands and riparian areas during construction.	Chapter 4
Additional concerns expressed include: • Control of noxious and invasive weeds during construction • Impacts to soils, vegetation and wildlife during transmission line construction	Chapter 4
Mitigation	
Provide detailed mitigation plans to minimize impacts to isolated wetlands.	Chapter 4
Include an analysis of a detailed solid waste/ash management plan for coal handling from construction through operation of the plant.	Chapter 4
Provide mitigation measures to reduce the project's mercury emissions to the maximum achievable control levels.	Chapter 2, Chapter 4
The opportunity to avoid wetlands should be considered prior to mitigation.	Chapter 4
Spring Creek (spring-fed) should be monitored.	Chapter 4
Include storm water runoff monitoring and/or collection and treatment.	Chapter 4
Include methods to mitigate offsite impacts associated with coal pile runoff.	Chapter 4
Include mitigation measures to prevent potential impact to groundwater contamination associated with boiler blowdown.	Chapter 4
Include measures to avoid stream crossings for routing transmission lines and mitigation for streams not avoidable.	Chapter 4
Visual impacts resulting from the project should be mitigated, particularly where new transmission lines are proposed to be constructed.	Chapter 4
Use of native plant species in disturbed areas by the project are recommended as well as integrated pest management.	Chapter 4
Sound erosion and sediment control practices should be implemented during project construction to avoid impacts to sensitive species mussels.	Chapter 4

Appendix B

B1: Plant Site and Transmission Corridor Alternatives Considered but Eliminated

B2: Cooling System Alternatives Screening Process and Results

Appendix B1

Plant Site and Transmission Corridor Alternatives Considered but Eliminated

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LIST OF FIGURES

APPENDIX B1
PLANT SITE AND TRANSMISSION CORRIDOR ALTERNATIVES CONSIDERED BUT ELIMINATED

1.0 Introduction

To comply with Section 1502.14 of the National Environmental Policy Act (NEPA) (40 CFR 1502.14), reasonable project alternatives were considered and evaluated for the proposed Project. Specifically, the environmental impact statement is required to "Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Section 1502.14 also states that "…each alternative (must be) considered in detail including the Proposed Action so that reviewers may evaluate their comparative merits."

This appendix provides a description of the process and analyses for the alternative plant site evaluations and the alternative transmission corridor evaluations.

2.0 Alternative Site for the Big Stone II Plant

Resource planning studies completed by the Co-owners indicate that each utility will need additional baseload generating resources in the near future. Due to the economies of scale, the Co-owners identified the development of a large, jointly-owned generating facility as being more cost effective than constructing several smaller units individually. Once the Co-owners identified their baseload power needs, they conducted an extensive analysis of alternative technologies and potential alternative sites that would meet their objectives and needs, as described in Section 2.3 of the Final EIS.

2.1 Applicant's Screening Process

The Co-owners conducted an extensive analysis of alternative power plant sites. A broad range of alternatives were first developed based on input from the Co-owners, the public, participating agencies and special interest groups. During the initial screening process, alternatives were compared using criteria considered important in meeting the objectives of the proposed Project. Evaluation criteria included consideration of environmental, technical, social, and cost factors. Alternatives that failed to meet the Co-owners' objectives and those that were considered infeasible were eliminated from further evaluation.

The Co-owners' objectives used in conducting a qualitative assessment of the available alternative technologies included:

- Ability to reliably meet customer baseload energy and demand requirements.
- Commercially proven technology at the several hundred megawatt scale.

- Minimize environmental and community impacts by leveraging existing generation site and transmission infrastructure.
- Enhance customer value and reduce customer risk by implementing a proven, efficient technology.

The alternative plant site evaluations for the proposed power plant site included:

- Identifying a study area (South Dakota, North Dakota and Minnesota).
- Identifying preliminary site areas by identifying siting constraints and siting opportunities within the study area.
- Screening the preliminary siting areas using topographic mapping and aerial photography to identify a smaller number of candidate site areas.
- Screening the candidate site areas using evaluation criteria and field reconnaissance.
- Identifying a preferred site that meets the Co-owners’ objectives for the proposed Project.

The alternate transmission interconnection evaluations included the following steps:

- Identification of multiple transmission interconnection points within the regional transmission system considering both 230-kilovolt (kV) and 345-kV.
- Evaluation and screening of identified interconnection alternatives using transmission loss, system transfer limit capability and economic criteria.
- Elimination of less desirable interconnection alternatives considering the loss, transfer limit and economic criteria.
- Further evaluation of remaining interconnection alternatives in an interconnection study prepared by Midwest Independent System Operator (MISO).
- Identification of two interconnection alternatives, including multiple interconnection points (substations), for interconnecting and integrating the proposed Big Stone II Project into the transmission grid.
- Use of two interconnection alternatives as the basis (i.e. end points which are existing substations) to identify alternative transmission line corridors between the Big Stone site and the end points.
- Identification of multiple alternative corridors using corridor opportunity criteria (i.e. existing transmission lines or similar linear facilities).
- Evaluation of alternative corridors using environmental constraint criteria allowing elimination of less desirable alternatives and selection of preferred alternative corridors for detailed evaluation in this Environmental Impact Statement (EIS).

2.1.1 Power Plant Site Location Alternatives Analysis

From previous analyses conducted by Otter Tail Power Company (OTP), the existing Big Stone plant site was initially identified as a preferred site for the proposed Project. To further enhance and more thoroughly analyze other alternatives considered in the siting analyses performed by OTP, the Co-owners conducted a detailed power plant siting study in early 2005 to identify and comparatively evaluate alternative sites within the study area. The entire states of Minnesota, North Dakota and South Dakota were identified as the study area (Figure 1). This three-state area includes the service territories of the majority of the Co-owners.

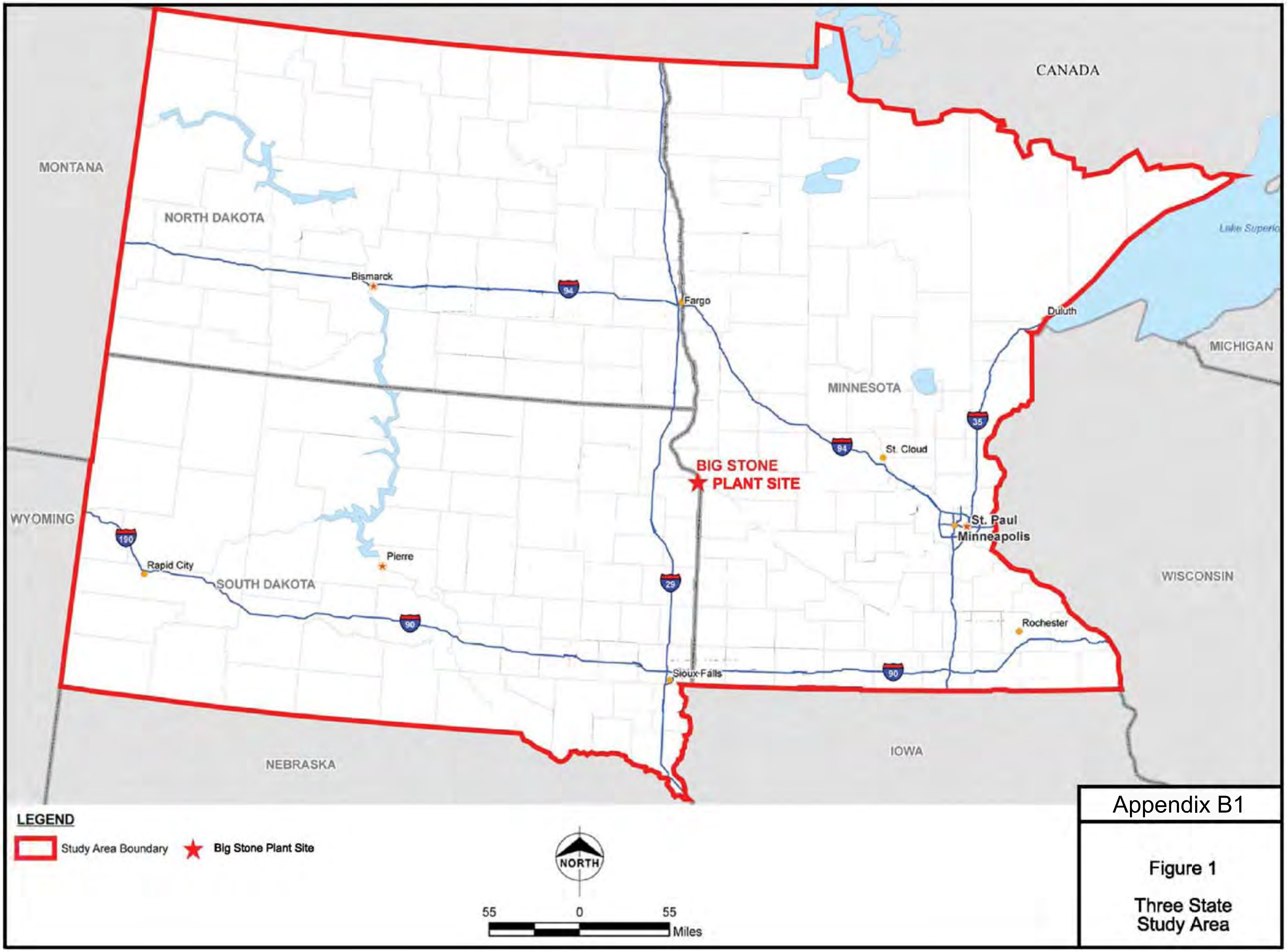
The Co-owners' siting study included the completion of the following tasks:

- Identify general areas within the study area that may be less attractive for power plant siting due to environmental reasons.
- Map locations within the study area of the necessary electrical transmission infrastructure, fuel delivery infrastructure and potential water supplies.
- Identify preliminary site areas from review of environmental constraint and infrastructure maps.
- Screen preliminary site areas using readily available topographic mapping and aerial photography and designate remainder candidate site areas.
- Perform a field reconnaissance of the candidate site areas.
- Collect relevant information on the candidate site areas to prepare a narrative description of each one.
- Develop evaluation criteria for the candidate site areas.
- Evaluate and rank the candidate site areas to identify the preferred locations for the proposed Project.
- Formulate conclusions reached during the study.

The first step in the site selection process was to identify candidate site areas. Candidate site areas are general locations that possess the necessary infrastructure and other characteristics that allow the siting of a power plant. The candidate site areas also must be of sufficient size to accommodate plant development and allow sufficient buffer area to mitigate impacts on surrounding areas.

As part of this first step, undesirable locations were mapped within the proposed Project study area where power plant siting may be impractical or difficult for institutional or social reasons, and where the required infrastructure was unavailable. This included Class I areas and designated use areas. Class I areas are defined under the Clean Air Act and includes national parks greater than 6,000 acres in size, national wilderness areas and national memorial parks greater than 5,000 acres in size and international parks. Similarly, desirable locations within the study area were mapped where infrastructure critical to economical power plant development exists, such as electric transmission lines with voltage of 230-kV or higher, rail lines and major rivers and lakes.

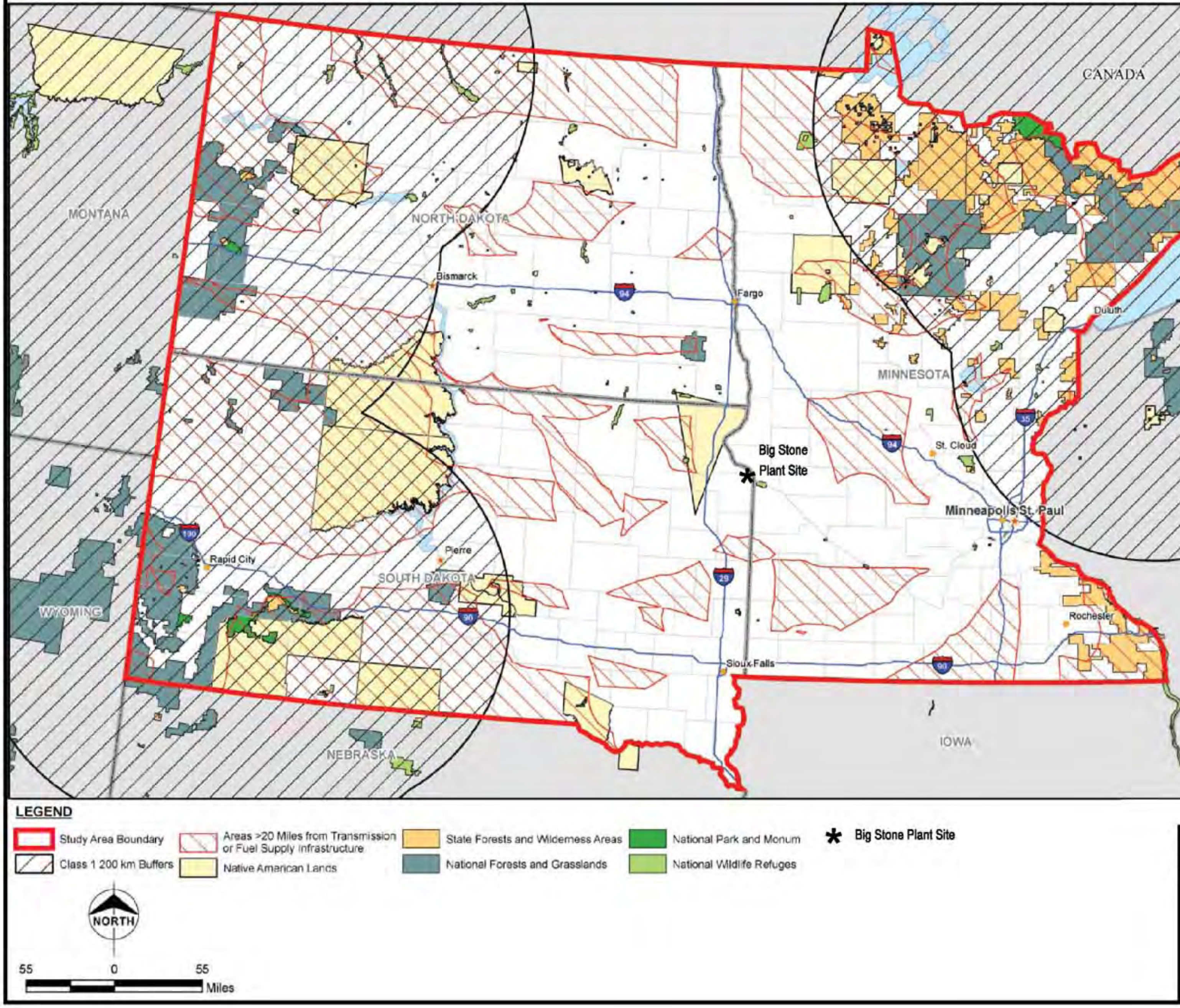
The Class I and designated use areas and infrastructure locations were overlaid to help identify specific areas with better potential for development as power plant sites. Figure 2 shows the results of the constrained mapping for the study area. From this composite map and available topographic maps and aerial photographs, 38 specific site areas were identified as preliminary site areas. Figure 3 shows the 38 preliminary site areas identified.



Appendix B1

Figure 1

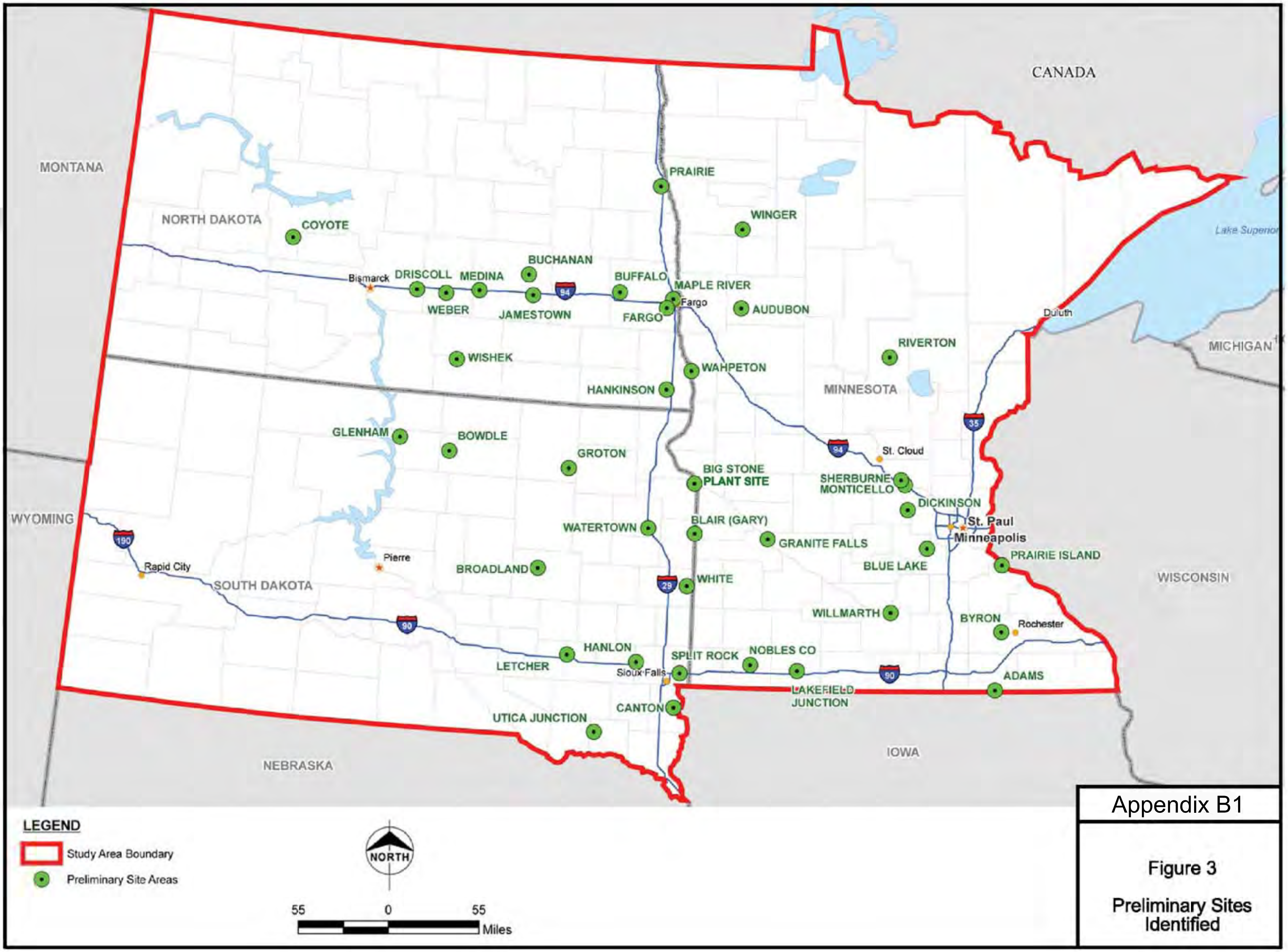
Three State Study Area



Appendix B1

Figure 2

Area Constraints



Appendix B1

Figure 3

Preliminary Sites Identified

The 38 preliminary site areas were then subjected to desktop screening to eliminate those sites with more obvious development constraints. Through this process, 30 of the 38 preliminary site areas were eliminated for two primary reasons: limited water supply potential or nearby residential development. The remaining eight site areas are listed below:

- Big Stone – Grant County, South Dakota
- Coyote – Mercer County, North Dakota
- Dickinson – Wright County, Minnesota
- Fargo – Cass County, North Dakota
- Glenham – Walworth County, South Dakota
- Maple River – Cass County, North Dakota
- Split Rock – Minnehaha County, South Dakota
- Utica Junction – Yankton County, South Dakota

A field reconnaissance of the remaining eight sites was conducted in early March 2005. The reconnaissance consisted of an automobile survey along public roads in the vicinity of each site area. Information was collected on land availability, local land use, number of nearby residences and other structures, suitability of terrain and the condition of local transportation systems.

Following completion of the reconnaissance, the Maple River and Split Rock sites were eliminated from further review. Maple River was eliminated because it had relatively more nearby residences and other development than the nearby Fargo site. The Split Rock site was eliminated because it lacks sufficient developable land area and because of encroaching residential development. The remaining six site areas (candidate site areas) were retained for further evaluation. All remaining six sites met the Co-owners' objectives, purpose and need.

2.1.2 Statistical Evaluation

The six remaining site areas were evaluated using a numerical decision analysis. First, site criteria were identified. These criteria vary in their importance to the decision-making process, so each criterion also was assigned a weight. Criteria with the highest weights are considered to be the most important. These weights were assigned by first organizing the evaluation criteria into major categories. Within each major category, the individual evaluation criteria were assigned subweights to define their relative importance within that category. The major category weights and subweights were combined to yield a composite weight for each criterion as presented in Table 1.

Each of the six candidate site areas was assigned a relative score between one and five for each of the 17 evaluation criteria. These scores were combined with the composite weights listed in Table 1 to yield a weighted composite score for each candidate site area. Table 2 shows the relative scores assigned to each candidate site area based on the technical analyses along with the criteria weights developed in Table 1. While different professionals can assign the site scores in different ways based on their judgment of a specific criterion, the important part of the scores is not the absolute score but rather the relative score among the candidate sites. Also, the composite scores should not be used as an absolute measure of each candidate site area's suitability, but as a tool for screening and ranking.

Table 1. Candidate Site Evaluation Criteria

Major Category	Category Weight in Percent	Criterion	Subweight	Composite Weight in Percent
Air Impacts	15	Class I Areas	10	10.71
		Airspace Restrictions	4	4.29
		Category Totals:	14	15.00
Water Supply	20	Surface Water Proximity	5	6.67
		Water Supply Potential	10	13.33
		Category Totals:	15	20.00
Environmental	15	Socioeconomics	5	2.68
		Land Use Compatibility	4	2.14
		Protected Species Impacts	2	1.07
		Noise Impacts	10	5.36
		Wetlands	7	3.75
		Category Totals:	28	15.00
Fuel Supply	20	Rail Line/Mine Proximity	10	11.11
		Fuel Delivery Competition	6	6.67
		Reagent Delivery	2	2.22
		Category Totals:	18	20.00
Transmission	20	Proximity to Interconnection Point	2	2.67
		Expected System Impacts	13	17.33
		Category Totals:	15	20.00
Other	10	Highway Access	2	1.05
		Land Availability	10	5.26
		Common Facilities/Staff	7	3.68
		Category Totals:	19	10.00

Source: Burns & McDonnell 2005(c)

The highest ranked site in this evaluation was Big Stone with a composite score of 401 and the lowest ranked site was Fargo with a composite score of 303.

A number of sensitivity analyses were performed to test the sensitivity of the composite evaluation scores to changes to the weighting value assigned to individual criteria. The weights assigned to the six major evaluation categories were adjusted for this testing. The subweights for the criteria within the respective categories and the individual scores assigned to the sites for each criterion were not changed. While there are many sensitivity cases that could have been performed, six different sensitivity cases were evaluated by the Co-owners, one for each of the major evaluation categories. Within each of the sensitivity cases, the base case category weight for the category was doubled while the weights for each of the remaining five categories were lowered so the sum of all categories totaled 100 percent. The composite weights for each category and weighted composite scores for each site were then recalculated. The resulting site rankings generally showed that a site's rank was not sensitive to the assigned category weights. The Big Stone site area maintained its top ranking for most of the cases in the sensitivity analysis.

Table 2. Candidate Site Composite Scores

Major Category/Criterion	Weight[a]	Big Stone	Coyote	Dickinson	Fargo	Glenham	Utica Junction
Air							
Class I Areas	10.71	5	2	4	5	3	5
Airspace Restrictions	4.29	3	1	2	1	5	5
Category Totals	15.00						
Water							
Surface Water Proximity	6.67	5	1	3	3	5	5
Water Supply Potential	13.33	3	5	3	1	5	5
Category Totals	20.00						
Environmental							
Socioeconomics	2.68	1	3	5	5	2	2
Land Use Compatibility	2.14	5	5	1	3	3	3
Protected Species Impacts	1.07	5	5	3	4	3	3
Noise Impacts	5.36	5	5	1	4	5	3
Wetlands	3.75	3	4	1	5	4	2
Category Totals	15.00						
Fuel Supply							
Rail Line/Mine Proximity	11.11	5	5	4	2	1	3
Fuel Delivery Competition	6.67	1	5	3	1	1	1
Reagent Delivery	2.22	2	2	4	3	3	1
Category Totals	20.00						
Transmission							
Proximity to Interconnection Pt	2.67	5	5	5	2	4	5
Expected System Impacts	17.33	4	1	3	4	2	5
Category Totals	20.00						
Other							
Highway Access	1.05	5	1	4	3	4	3
Land Availability	5.26	5	5	3	5	5	5
Common Facilities/Staff	3.68	5	5	1	1	1	1
Category Totals	10.00						
Weighted total Score		401	340	305	303	318	379

[a] Weighted composite scores are the sum of the weights multiplied by the site score for each criterion.

Source: Burns & McDonnell 2005(c).

2.1.3 Summary of Preferred and Alternate Site Areas

The relative strengths and weaknesses of each candidate site area are summarized below. Overall, when considering the siting analysis and the objectives of the Co-owners, the Big Stone site is the preferred site for the proposed Project by the Co-owners.

Big Stone Site

The Big Stone site is the preferred site for the proposed Project by the Co-owners. The Big Stone site is located at an existing power plant site in Grant County, South Dakota. The existing Big Stone plant was originally configured to accommodate a second generating unit. Some of the existing facilities, such as coal handling, rail spur, cooling water supply system, access road and solid waste disposal facility, are already sized for an additional unit, which would minimize construction costs. The Big Stone site is centrally located within the geographic service territory of the Co-owners thus allowing an opportunity to minimize transmission line losses.

The Big Stone site also meets the Co-owners' specific project goals by providing an opportunity to minimize operating costs by sharing the supervisory, operation and maintenance workforce between the existing Big Stone plant and the proposed Big Stone II plant.

The Big Stone site offers the opportunity to reduce sulfur dioxide emissions from the existing plant by installing one wet scrubber that will be shared by both the existing plant and the proposed Big Stone II plant.

Coyote Site

Similar to the Big Stone site, the Coyote site area is located at an existing power plant that was initially designed to accommodate a second generating unit. However, this site has certain distinct disadvantages not present at the Big Stone site. These disadvantages relate to air quality and transmission.

The Coyote Plant is located about 73 miles from Theodore Roosevelt National Park and 94 miles from Lostwood National Wildlife Refuge, which are both Class I areas. There are also six other lignite-fired power plants in the vicinity of the Coyote Plant. The proximity of these existing emissions sources and Class I areas may make permitting a new generating unit at the Coyote site more difficult than at the Big Stone site.

The existing transmission system at the Coyote site does not have capacity to accommodate additional power exports out of the North Dakota lignite mining area. Upgrading this system to allow location of another 600 megawatts (MW) of generation in this same area would be more costly than at the Big Stone site.

Although the site rankings place the Coyote site near the middle of the six candidate sites, air quality and transmission issues discussed above are distinct disadvantages associated with its development.

Dickinson Site

The Dickinson site area was the fifth-ranked site under the base case. Although the site is located at a major substation and close to load centers in eastern Minnesota, the transmission system that serves the substation is currently operating near full capacity. Therefore, substantial new transmission investments would still be required to develop the proposed generating unit at the site. Because this site is located less than 25 miles outside of the Twin Cities metropolitan area and surrounded by rural residential development, the population densities near the site are the highest of any of the six candidate sites.

Fargo Site

The Fargo site area is located in a rural agricultural area outside of Fargo, North Dakota. The evaluation scores for the site area are consistently among the lowest of all the six candidate sites for the base case. The major disadvantage of the site is its lack of water supply potential.

Glenham Site

The Glenham site area is located in north-central South Dakota, near the Missouri River, and has an abundant water supply potential. The sparse population of the area also reduces the potential for impacts to neighbors at the site. The chief concern at the site is transmission capacity because this site is relatively close to the lignite fields of North Dakota and the existing transmission within the region is constrained. Construction of the plant at this site would require extensive transmission costs. The Glenham site area was ranked fourth for the base case.

Since the Glenham site is located on a greenfield site, there would be no opportunity for labor sharing, and there would be additional operating costs over locating the plant at the Big Stone site. Additionally, the site is also closer to Class I areas, which would make permitting at this site more difficult.

Utica Junction Site

The Utica Junction site area is located near the Missouri River and has an abundant water supply potential. The Utica Junction and the Glenham sites share many similarities. Transmission capacity also is a potential concern at this site; however, it is farther from the congested area in North Dakota than the Glenham site, and other planned transmission additions in Nebraska and Iowa would help alleviate transmission constraints to the south. The Utica Junction site is located on a greenfield site, which would require development and construction of all supporting infrastructure (ie. water supply, rail interconnection, road access, waste disposal) as compared to sharing of existing facilities at an existing site. Additionally, the site is located on the southernmost portion of the Co-owners’ service areas, and some of the Co-owners would incur additional costs for distributing power to their customers. The Utica Junction site area was ranked second under the base case.

2.1.3.1 Co-owners Site Selection Determination

Based on the evaluations summarized above, and considering the development costs for constructing a new large base load generating facility, the Co-owners selected Big Stone site as their preferred alternative and concluded that none of the other alternatives offered environmental or economic benefits that warranted more detailed investigation. This decision was heavily based on the fact that the construction of a new unit at the Big Stone site would use the following existing plant features:

- Cooling water intake structure and supply line.
- Plant access roads and site roads.
- Rail spur.
- Coal unloading facilities.
- Solid waste disposal facility.
- Operational staff, control and communications.

In addition, the Co-owners proposed to install a single large wet flue gas desulfurization (WFGD) system to control emissions (sulfur dioxide and mercury) from the existing Big Stone plant and the proposed Big Stone II plant. One WFGD system controlling emissions from both units is less costly to construct, operate and maintain than two individual systems. Consequently, it is less costly to reduce sulfur dioxide and mercury emissions from the existing plant if the proposed Big Stone II is located on the same site rather than add new air control technologies to the existing plant.

The ability to use the existing Big Stone plant facilities along with installing a single WFGD system offers significant cost savings and environmental benefits to the Co-owners as compared to development at a new greenfield site such as Utica.

The Big Stone site is located at an existing power plant that was originally configured to accommodate a second generating unit. Use of existing infrastructure would be cost effective. Operational costs would be reduced due to shared resources. Additionally, the Big Stone site provides an opportunity to reduce air emissions from an older existing plant. Retrofitting the existing plant would be very costly if done independently. Furthermore, it would not be required, as it is currently operating under an approved air permit.

The Big Stone site is centrally located within the geographic service territory of the Big Stone II Co-owners thus allowing an opportunity to minimize transmission line losses and reduce costs for delivery for some of the smaller Co-owners.

While the Utica Junction site meets some of the Co-owners stated objectives, it fails to leverage the use of existing facilities which pose significant economic disadvantages as compared to the Big Stone site. Transmission constraints are also a major factor. Transmission constraints that currently exist in delivering power from the lignite fields of North Dakota to the study area coupled with the need to integrate a new generating facility at the Utica site would likely require considerably more investment in transmission system improvements to effectively transfer power to the Co-owner's services areas, as compared to the Big Stone site. Other transmission additions in Nebraska and Iowa would be required to alleviate transmission constraints to the south of this area to make the Utica Junction site an economically viable alternative. These other projects have not been fully planned or funded.

3.0 Transmission Alternatives Analysis

3.1 Applicant's Screening Process

To support the proposed Big Stone II Project, a transmission system study was conducted during late-2003 through early-2004 by OTP Delivery Planning. This study identified 11 potential transmission interconnection locations. These locations were studied at 230- and 345-kV levels of service. A series of analyses were performed through a screening study that identified the constraints on the transmission system within the Mid-continent Area Power Pool (MAPP) region due to the injection of an additional 300 MW and 600 MW of power from the proposed Big Stone II plant. The studies were carried out using a projected 2009 timeframe for Summer Peak conditions. The 11 potential transmission line and interconnection alternatives that were evaluated are summarized in Table 3.

Table 3. Transmission Alternatives Developed for Big Stone II Screening Study

Alternative Number	Description	Mileage
1	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate	90
2	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – Willmar – Blue Lake 345-kV Line	175
3	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – Willmar – West Waconia 345-kV Line with	158
	Dickenson – West Waconia 345-kV Line	44
3a	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – Willmar – West Waconia 345-kV Line with	158
	Dickenson – West Waconia – Blue Lake 345-kV Line	64
4	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – Blair – White 345-kV Line with	69
	Ivanhoe – Lyon County 115-kV Line	35
5	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with	47
	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Blair – Lyon County 230-kV Line with	63
	Lyon County - Franklin 115-kV Line	40
6	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – 6 Mile Grove 230-kV Line with	46
	Morris – 6 Mile Grove – Granite Falls 230-kV Line with	60
	Benson- 6 Mile Grove – Kerkhoven 115-kV line	32
7	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – 6 Mile Grove - Willmar 230-kV Line with	102
	Morris – 6 Mile Grove 230-kV Line with	60
	Benson- 6 Mile Grove – Kerkhoven 115-kV line	32
8	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – 6 Mile Grove – Willmar - McLeod 230-kV Line with	156
	Morris – 6 Mile Grove 230-kV Line with	60
	Benson- 6 Mile Grove – Kerkhoven 115-kV line	32
9	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – 6 Mile Grove – Willmar - McLeod 230-kV Line with	156
	Morris – 6 Mile Grove 230-kV Line with	60
	Benson- 6 Mile Grove – Kerkhoven 115-kV line with	32
	Dickenson – West Waconia – Willmarth 345-kV Line	44
10	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with	90
	Big Stone – 6 Mile Grove – Willmar - McLeod 230-kV Line with	156
	Morris – 6 Mile Grove 230-kV Line with	60
	Benson- 6 Mile Grove – Kerkhoven 115-kV line with	32
	Dickenson – West Waconia – Blue Lake 345-kV Line	64

Source: Otter Tail

The preliminary transmission screening study of the 11 alternatives included the following types of analyses:

1. Economic Analysis.
2. Transfer Limit Table Generating (TLTG) Analysis.
3. Loss Analysis.

Economic analysis was completed to calculate capital costs for each alternative. The computer simulation software tool used by OTP Delivery Planning to perform the preliminary transmission screening study is called Power System Simulator for Engineering (PSS/E). Within PSS/E there is a software activity called TLTG, which was used in the preliminary transmission screening study to identify potential loading violations on the transmission system while contingencies were simulated at the same time that the output of the proposed Big Stone II was increased. This analysis allowed for the identification of overloads on the existing transmission system for different output levels of the proposed Big Stone II Project. Loss analysis was also included in the preliminary transmission screening study, which compared system losses for each of the different transmission alternatives for three different output levels of the proposed Big Stone II Project.

Upon completing the preliminary transmission screening analysis results were reviewed and further evaluations were conducted, including:

- More detailed loss analyses.
- Evaluating and testing of various interconnection options among the alternatives.
- Evaluation of minimum transmission interconnections necessary for various size new units for the proposed Big Stone II Project.
- Contingency analyses of system component overloads for the various alternatives along with potential other new generation in the region.

Upon completing these evaluations and analyses the preliminary transmission screening study was published in mid-May 2004 that outlined the results of the study (*Preliminary Transmission Screening Study for Big Stone II Feasibility Study, Otter Tail Power Company Delivery Planning Department, November 2004*). The transmission screening study did not provide recommendations as to which transmission alternative performed the best with the proposed Big Stone II Project, but provided the following summary points.

1. Economic analysis determined that the 11 different transmission alternatives varied in cost from as low as $53 million for alternatives 1 and 6 to as high as $168 million for alternatives 2, 3, and 3b.
2. TLTG analysis indicated that the upgrade costs necessary to mitigate overloads on the existing transmission system were higher for the lower capital cost alternatives (230-kV alternatives 1 and 6) than those of the higher capital cost alternatives (345-kV alternatives 3 and 3b); however, the total cumulative upgrade costs associated with the lower capital cost alternatives does not exceed the investment needed for the higher capital cost alternatives.
3. Loss analysis indicated that those transmission alternatives that had the highest capital costs result in the most effective reduction in system losses while those transmission alternatives that

had the lowest capital costs result in the largest incremental system losses as the size of the proposed Big Stone II Project increases.

After reviewing the preliminary transmission screening study, the Co-owners decided to proceed with the lowest capital cost transmission alternatives. This was due to the uncertainty in cost recovery methods and the uncertainty of the new MISO market and the treatment of losses. The transmission alternatives brought forward to MISO for further analysis during the interconnection study are shown in Table 4.

Table 4. Big Stone II Transmission Alternatives for Further Consideration

Alternative Number	Description
1	Big Stone – Ortonville – Johnson Junction – Morris 115-kV to 230-kV Uprate with Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate
2	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with Big Stone – 6 Mile Grove 230-kV Line with Morris – Six Mile Grove – Granite Falls 230-kV Line with Benson – 6 Mile Grove – Kerkoven 115-kV Line
3	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with Big Stone – Willmar 230-kV Line
4	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with Big Stone – Willmar – McLeod 230-kV Line
5	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with Big Stone – Willmar 230-kV Line with Paynesville – West St. Cloud 230-kV Line
6	Big Stone – Canby – Granite Falls 115-kV to 230-kV Uprate with Big Stone – 6 Mile Grove 230-kV Line with Morris – 6 Mile Grove 230-kV Line with Benson- 6 Mile Grove – Kerkhoven 115-kV line

Source: OTP, 2005

Alternatives 1 and 2 were identical to two of the original 11 alternatives (Alternative 1 and Alternative 6, respectively). Alternative 5 was a new alternative formulated through other regional transmission plans. Alternatives 3 and 4 included modifications to the original 11 alternatives as follows:

- Alternative 3 (similar to Alternative 7 from the original 11 transmission alternatives, but without Morris-to-6 Mile Grove and Benson-to-6 Mile Grove-to-Kerkhoven).
- Alternative 4 (similar to Alternative 8 from the original 11 transmission alternatives, but without Morris-to-6 Mile Grove and Benson-to-6 Mile Grove-to-Kerkhoven).

These five alternatives were reviewed by the Co-owners and a decision was made to use computer models to simulate 2007 summer peak conditions and 2007 summer off-peak conditions. Two of the five alternatives (Alternatives 1 and 3) were considered to be somewhat representative of all five alternatives and were selected for detailed evaluation. The remaining three alternatives (Alternatives 2, 4 and 5) were retained for further analysis, pending modeling results of Alternatives 1 and 3.

Alternatives 1 and 3 (referred to in this EIS as Alternatives A and B) were then carried forward for the more detailed study work required as part of the MISO interconnection process. After a lengthy steady state analysis review, a draft report documenting the study results was published in November 2004 (*Draft Big Stone II Generator Interconnection Study, Otter Tail Power Company Delivery Planning Department, November 2004*), which concluded that either of the two transmission alternatives result in acceptable system performance from an interconnection standpoint given that constraints on the existing transmission system are mitigated through system upgrades. With these study results and the known interconnection locations, corridor development and identification was initiated.

3.2 Co-Owners Initial Corridor Development

The Co-Owners undertook an initial corridor development analysis for the proposed Project prior to applying for interconnection with Western's transmission system. This analysis identified corridors for each segment of the two alternatives: Big Stone to Morris, Big Stone to Willmar and Big Stone to Granite Falls. These corridors are identified as Corridors A, B and C on Figure 4. These corridors and other alternative corridors were initially identified to take advantage of existing transmission line corridors. Selected corridors averaged three miles wide, with some corridor area widths varying from two to four miles.

3.3 Alternative Corridor Development Subsequent to Scoping

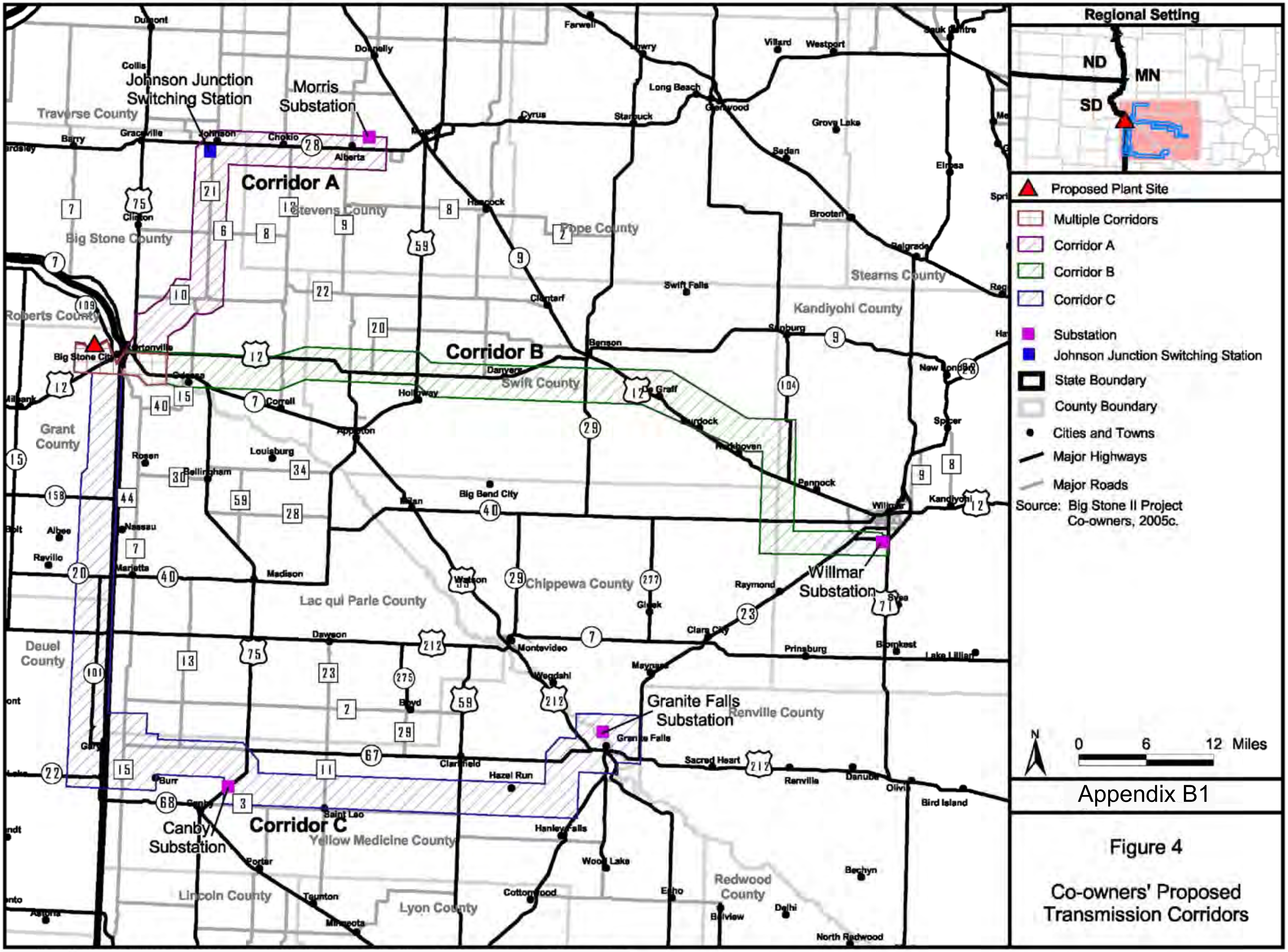
The range of comments received during scoping resulted in further analyses to identify additional areas that should be avoided and areas that may be suitable for transmission line routing. Scoping comments expressed concern regarding environmentally sensitive resources in the Ortonville area where the Co-owners have proposed rebuilding the existing Big Stone – Morris Substation 115-kV Transmission Line to 230-kV service. Scoping comments also expressed concern about routing transmission lines along U.S. Highway 12, in the vicinity of Danvers, through Dovre Township (north of Willmar), and within the Willmar area.

3.3.1 Corridor Routing Opportunities

Further corridor development and evaluation was carried out as a result of project scoping, field analyses and review of area maps which were used to identify opportunities. Corridor opportunities typically include paralleling linear features such as roads, highways, section lines, mid-section lines, transmission lines, railroads and pipelines. The objective of defining wide transmission line corridors included identifying those that would maximize the range of opportunities that would be available for routing one or more specific transmission routes within each corridor. Each of the linear features identified as corridor opportunities are described in the following paragraphs.

County Roads and Highways

The proposed Project area is largely comprised of a network of highways and rural roads laid-out in a one-mile grid pattern that provides numerous opportunities to route transmission lines from Big Stone to the three interconnection points. The use of roads and highways within a given three-mile-wide east-west or north-south corridor provides a minimum of four linear opportunities along section lines and rural roads.



Source: Big Stone II Project Co-owners, 2005c.

Appendix B1

Figure 4

Co-owners' Proposed Transmission Corridors

Section and Mid-section Lines

Although public comments appear to favor placing transmission lines along county roads, many lines are present along mid-section lines and approximately 0.5 mile from the nearest parallel road. Routing of transmission lines along mid-section lines is likely to have originated from a period when farmsteads and related agricultural practices were oriented to 160-acre (quarter section) parcels divided along mid-section lines. Placing transmission lines along mid-section lines largely avoided routing lines in front of farmsteads that were typically located along county roads. Modern-day agricultural practices have evolved to a point where traditional 160-acre farmsteads are no longer in widespread practice. In many cases, two or more farmsteads have been consolidated into single-ownership, resulting in single croplands that extend throughout a square mile. Routing transmission lines along county roads reduces potential impacts to agricultural activities, improves access to structure locations, and (to some extent) reduces loss of cropland. Conversely, routing along county roads frequently results in placing transmission lines in front of farmsteads and results in adverse visual impacts. Actual routing of transmission lines within designated corridors is largely at the discretion of the utility company in cooperation with landowners and the state permitting process. The use of mid-section lines within such a corridor provides an additional three opportunities. The number of opportunities within a corridor that does not extend north-south or east-west within the area greatly decreases the range of opportunities available for transmission line routing.

Existing Transmission Lines

Several comments were received during scoping that indicated a preference for using existing transmission lines through double-circuiting because it would reduce the need for additional transmission line right-of-ways (ROWs) and reduce the proliferation of transmission lines throughout the area. The availability of such transmission lines provides the utility company the opportunity of paralleling, uprating or double-circuiting such lines.

Although paralleling, uprating or double-circuiting of lines has merit from an environmental prospective, the practice of locating transmission lines close together or double-circuiting can have far reaching reliability and safety implications. The applicability of placing two circuits from Big Stone on a single structure or placing single-circuit lines from the facility in close proximity can jeopardize facility operations, should both circuits become disabled. Furthermore, maintenance of double-circuit lines is more difficult and inherently more dangerous than that of single-circuit lines. Therefore, separation of circuits serves to enhance overall system reliability and reduces potential maintenance problems.

Reliability issues also are addressed as part of the existing North American Electric Reliability Council (NERC) standards, which define minimum system performance requirements following different categories of transmission system contingencies. A contingency that would eliminate two circuits from the Big Stone facility (such as the loss of a double-circuit structure, carrying two circuits from the facility) would result in severely reduced generation capabilities from the plant. Therefore, prudent measures dictate that lines from the facility be constructed on single-circuit structures and that the structures of parallel lines be separated adequately to reduce the potential that a single event could affect both circuits.

Railroads and Pipeline Corridors

Railroads and highways provide corridor routing opportunities that often include relatively direct routes between two points. Although such features are typically included in transmission line routing, they have limited applicability in the Project area because they tend to limit the range of opportunities that would be available within a given corridor. Corridors that would extend diagonally (northwest-southeast or northeast-southwest) exclude the use of county roads along section lines and use of mid-sections. Additional complications frequently arise with routing transmission lines parallel to existing railroads due to distance constraints imposed by the railroad.

Figure 5 identifies corridor routing opportunities available within the proposed Project area. As noted on the figure, much of the area is comprised of a uniform grid of county roads, highways and transmission lines that are oriented along section lines in a north-south/east-west configuration. Linear features that are not laid out in a grid configuration include U.S. Highway 12, State Route 75, portions of a transmission line from Morris Substation to Granite Falls Substation, State Route 7 from Ortonville to Granite Falls. Pipeline corridors were not identified in the Project area.

3.3.2 Corridor Routing Constraints

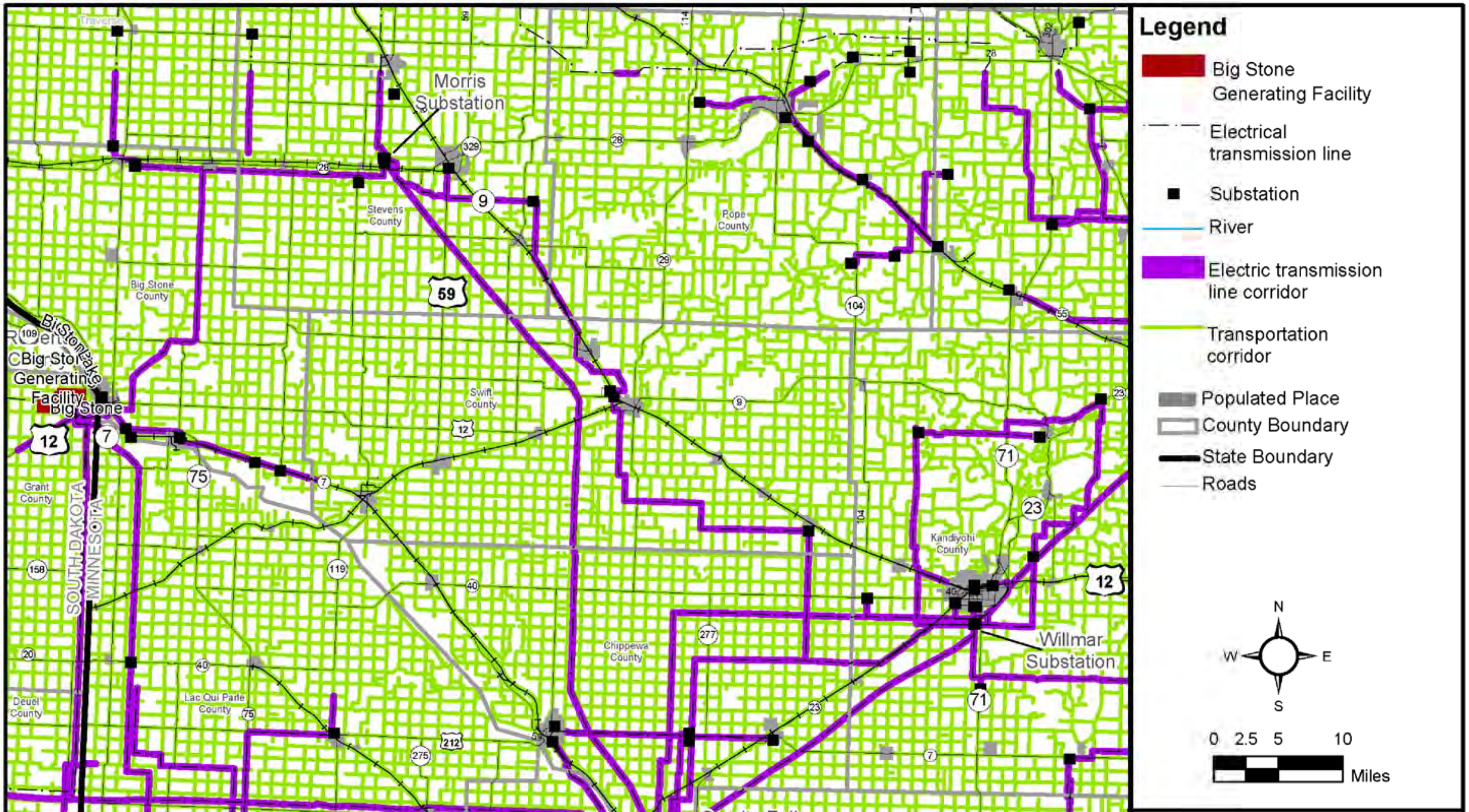
Comments received during scoping also were used to identify potential corridor routes and to eliminate routes that would be largely unacceptable due to environmental reasons. Environmental constraints were mapped to identify areas that should be avoided and are described in the following paragraphs.

Population Centers and Incompatible Land Uses

Population centers and features that would be considered to be incompatible with transmission line routing were derived from the Minnesota Department of Transportation and the Minnesota Department of Natural Resources and overlain on an area map using Geographic Information System. Population centers in the area are relatively scattered throughout the area with concentrations along U.S. Highway 75 and a parallel railroad alignment, along the Minnesota River and in the vicinity of Willmar and Granite Falls. Inclusion of population centers as a constraint is in response to comments received from the public indicating that transmission line routing should avoid Danvers and Dovre Township. Figure 6 identifies the locations of populated places and incompatible land uses in the region of the proposed Project.

An airport north of Appleton was considered to be an incompatible land use due to potential structure and conductor encroachments to surrounding air space. Similar constraints were identified along a proposed transmission line northwest of Ortonville. Airspace constraints typically include height restrictions that are most extensive at the ends of runways and less restrictive parallel to the runways. Other incompatible land uses included wildlife management areas and refuges.

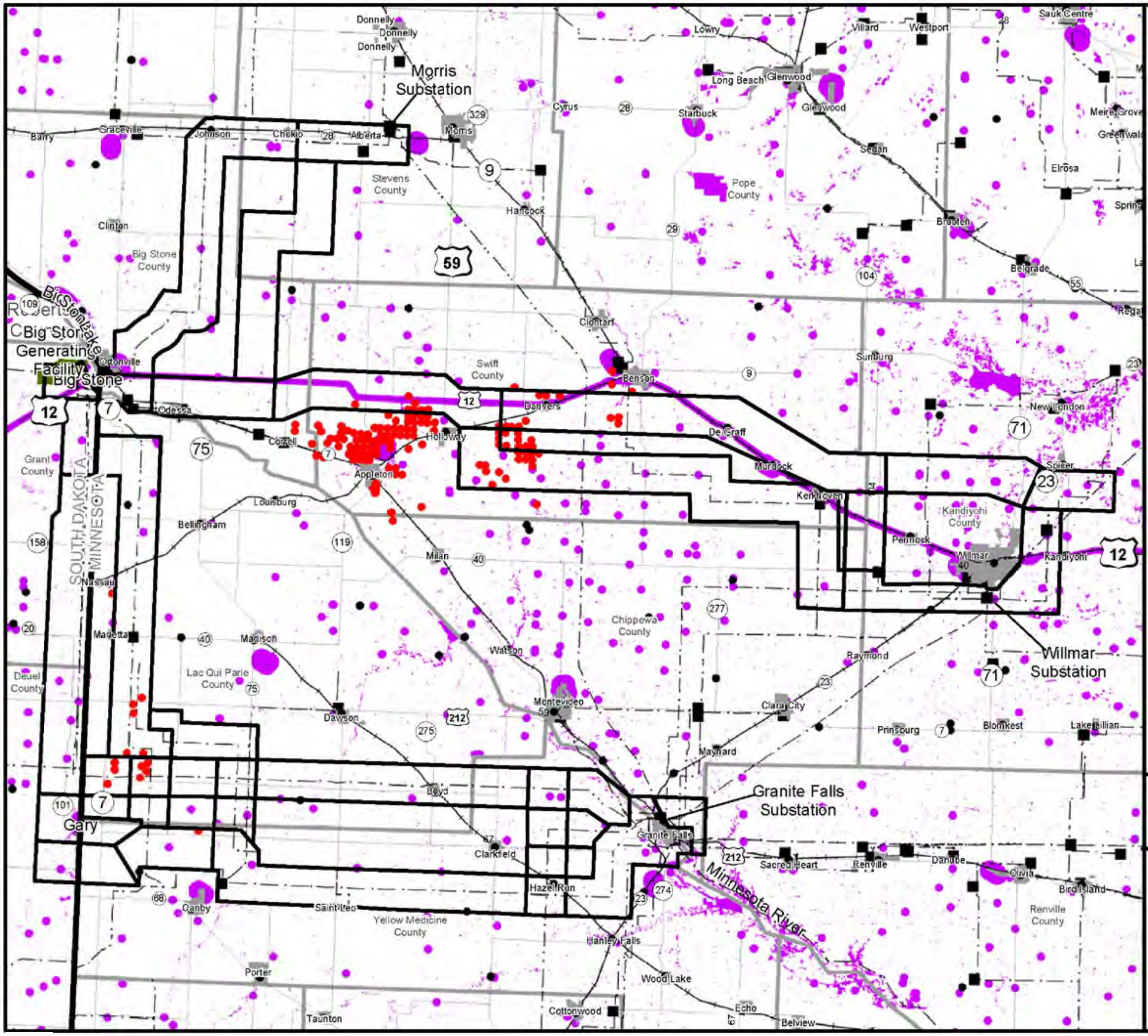
Areas of concentrated irrigation were considered to be incompatible with the installation and operation of transmission lines. The presence of such features was derived from aerial photo interpretation in which pivot irrigation can be readily identified (Figure 6). It was assumed that such areas also contain roller type irrigation, which could not be readily identified from available data. The presence of pivot or roller irrigation systems could impair routing of transmission lines through an area and/or impact agricultural activities. Linear irrigation systems also should be avoided to reduce the potential for induced current from transmission lines to the equipment.



Appendix B1

Figure 5

Corridor Routing Opportunities



Appendix B1

Figure 6

Corridor Constraints - Populated Places or Incompatible Land Use

Wetlands and Waterbodies

Wetlands and waterbodies data were derived from the Minnesota Department of Natural Resources and were found to be most concentrated along the Minnesota River, the area north of Willmar, and the area north of Ortonville. Avoidance of wetlands and waterbodies was considered important to reduce potential impacts to such resources as well as wildlife using the resources. Figure 7 illustrates the locations of wetland and water bodies in the region of the proposed Project.

Environmentally Sensitive Areas

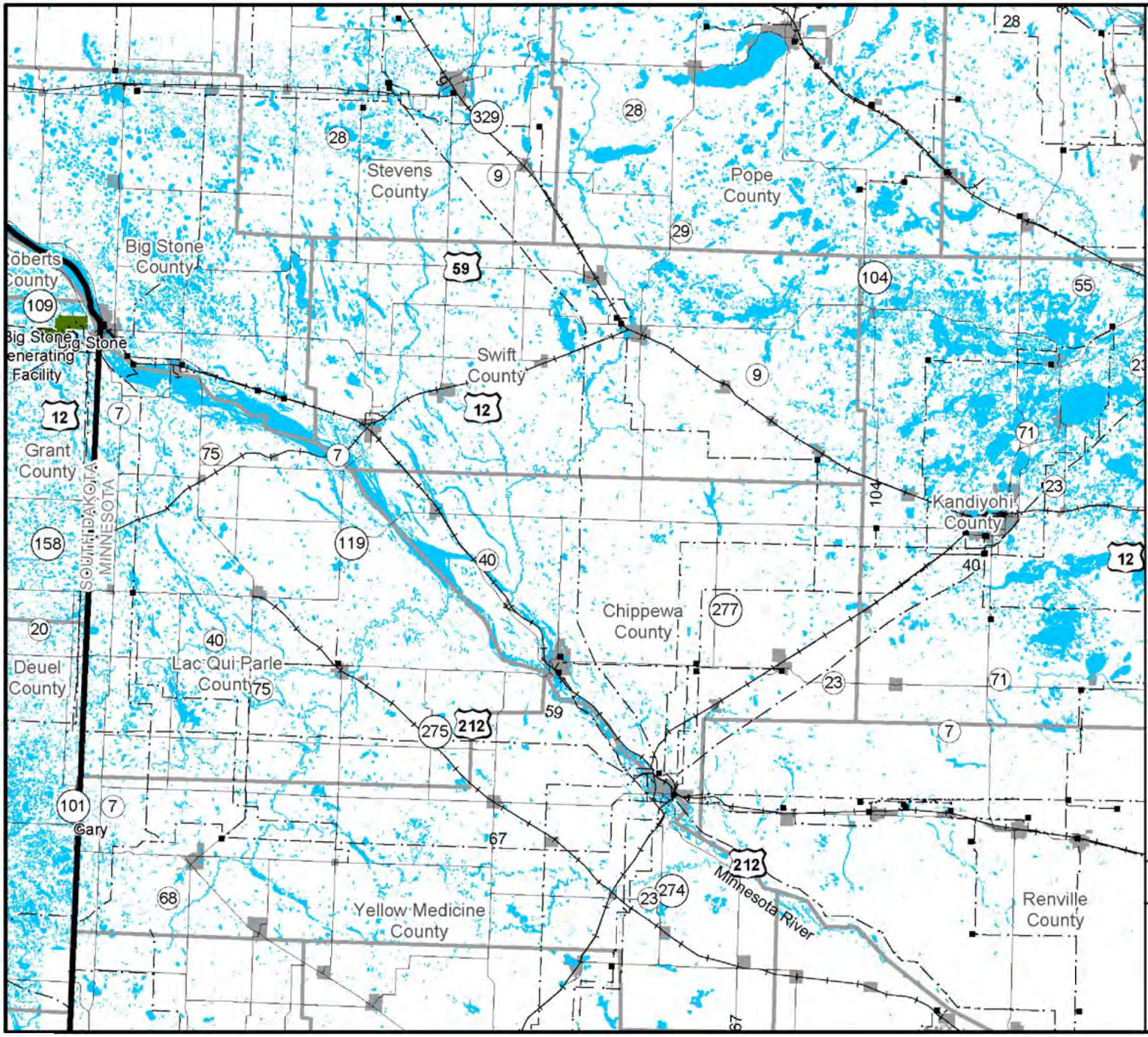
Areas that were considered to be environmentally sensitive were identified and included on a geographical information system. Those areas included known concentrations of federally listed threatened and endangered species, areas of historical importance and visually sensitive areas (i.e., scenic byways). Environmentally sensitive areas were found to be largely limited to an area north of Ortonville, the southwestern portion of the Project area (near Gary, South Dakota), and U.S. Highway 12 (a highway of historic importance).

Routing constraints were compiled to produce a composite map of locations to be avoided. This composite map was then overlain with the routing alternatives identified in the routing opportunities analysis to define locations that would be best suited for corridor development and those areas that should be avoided. Figure 8 illustrates the composite map of routing constraints along with the overlain route alternatives identified by the route opportunity analysis. Based on the corridor opportunities between the Big Stone site and the interconnection points identified in the MISO interconnection studies and the initial routing constraint analysis, alternative corridors were identified as illustrated in Figure 9. Final criteria used in the analysis were:

- Avoidance of areas of environmental sensitivity;
- Avoidance of population centers;
- Compliance with regional transmission planning objectives;
- Maximizing the availability of linear features;
- Maximizing opportunities to upgrade existing transmission lines; and
- Ensure reliability by providing adequate corridor width and opportunity for line separation.

Avoidance of Areas of Environmental Sensitivity

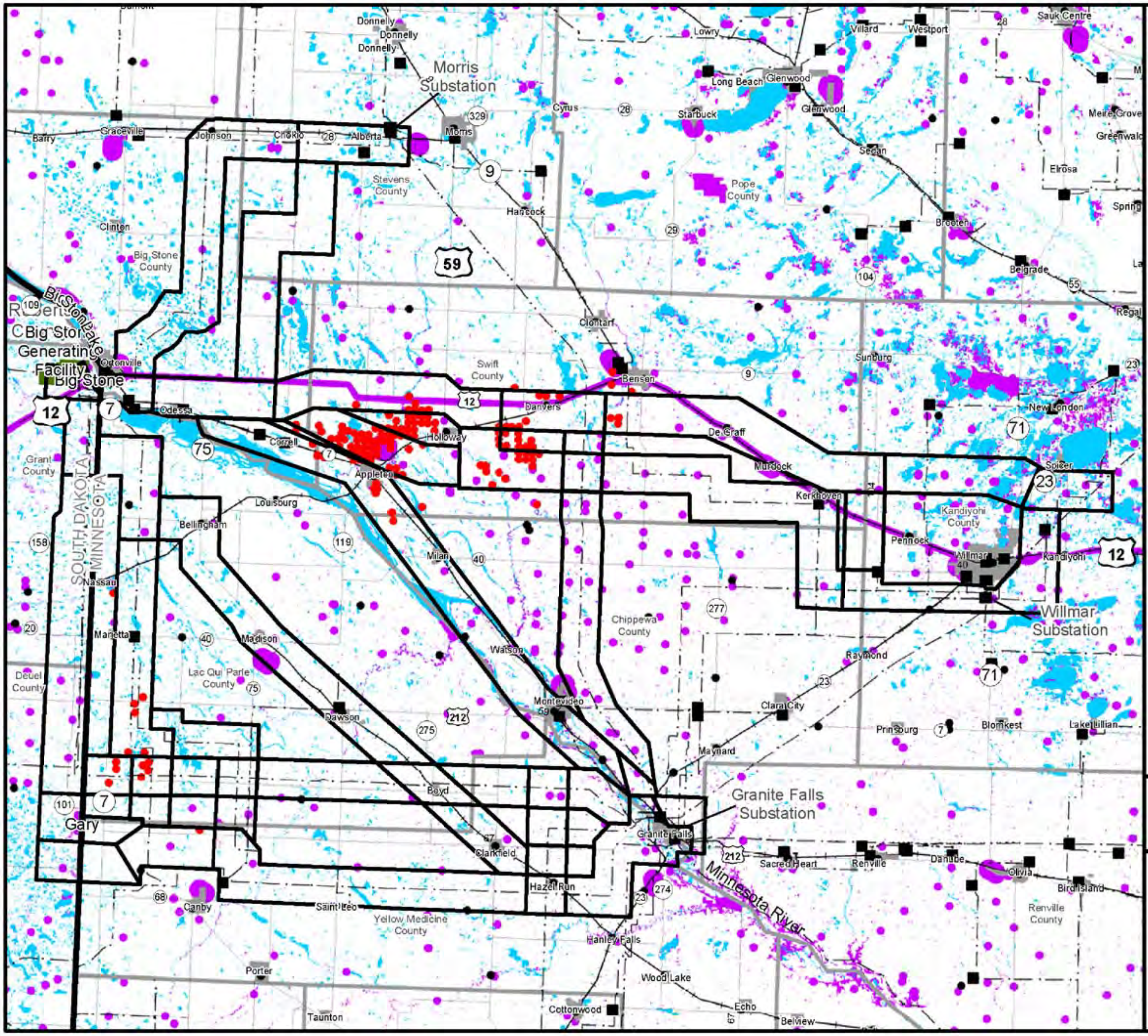
Areas of environmental sensitivity include known locations of Federally-listed and other sensitive species, areas of scenic and/or historic importance, relatively high concentrations of Wildlife Management Areas, Game Production Areas, Waterfowl Production Areas and relatively high concentrations of lakes and wetlands. Available data were compiled to graphically show areas of environmental sensitivity (constraints) within the overall Project area. As shown on Figure 8, areas of environmental sensitivity include those along the proposed transmission line corridor northeast of Ortonville, north of Willmar to Spicer, and those near Gary, South Dakota.



Appendix B1

Figure 7

Corridor Constraints - Wetlands and Water Bodies



Legend

- Big Stone Generating Facility
- Corridors
- Electrical transmission line
- ■ Substation
- River
- Wetland or Water Body
- ● Pivot Irrigation
- Incompatible Land Use
- Populated Place
- County Boundary
- State Boundary
- Roads

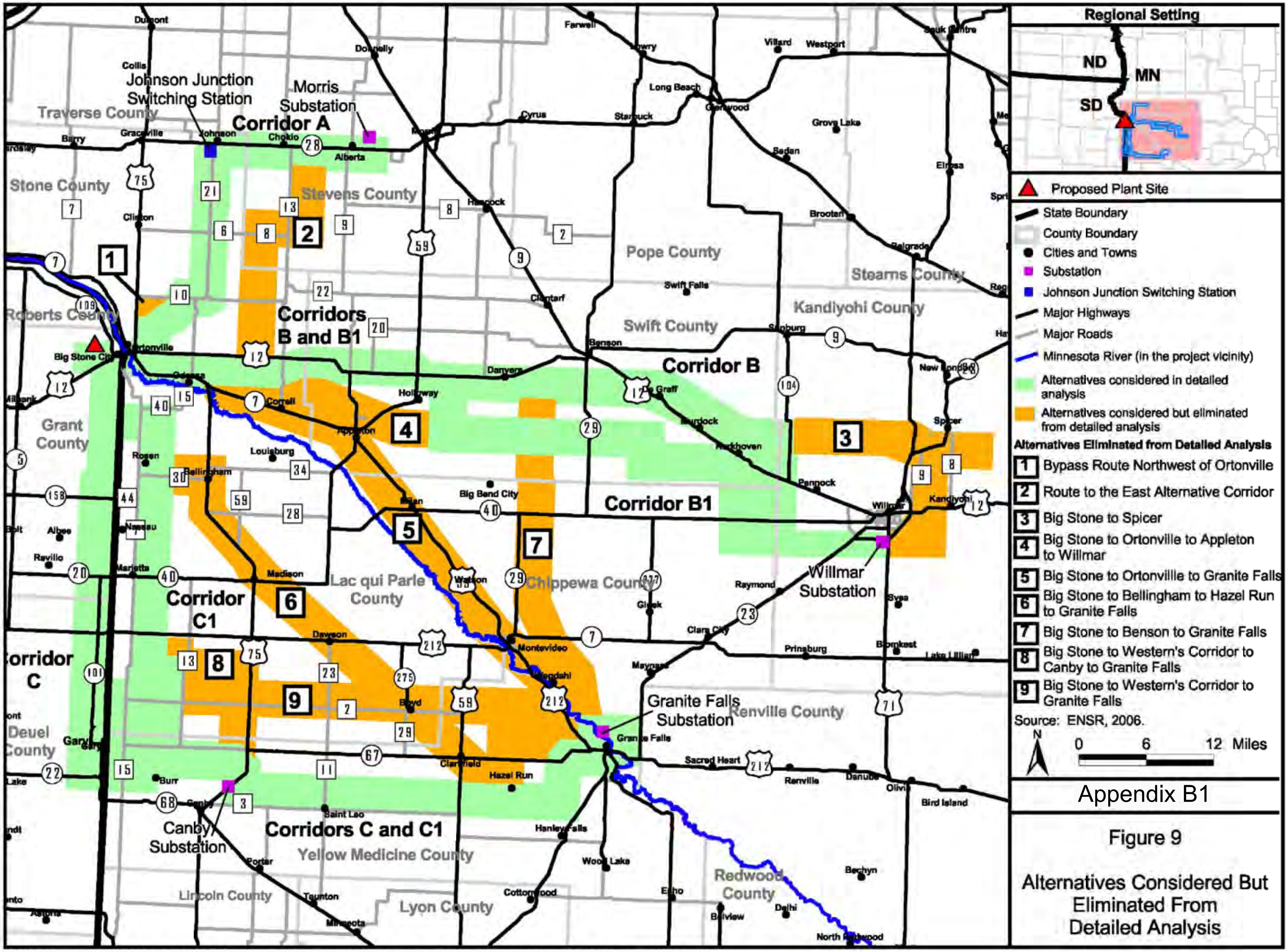
N
W E
S

0 2.5 5 10 Miles

Appendix B1

Figure 8

Corridor Constraints - Composite of Populated Places, Incompatible Land Use, Wetlands, and Water Bodies



Appendix B1

Figure 9

Alternatives Considered But Eliminated From Detailed Analysis

Avoidance of Population Centers

Public comment expressed a desire to avoid populated areas such as Danvers and those in proximity to Willmar, including Dovre Township. Although actual transmission line routing can generally avoid such areas, the presence of population centers limits the number of routing options and routing flexibility. Therefore, avoidance of such areas was included as a screening criterion.

Compliance with Regional Transmission Planning Objectives

The State of Minnesota has instituted long-range studies to strengthen transmission capabilities from states to the west and to ensure that adequate capacity is available to support renewable energy projects in the region. At the present time, emphasis is placed on the availability of 345-kV and higher voltage lines that will support continued load growth that is primarily in the St. Paul/Minneapolis area (CapX 2020). In accordance with the concept of providing transmission capacity from the west to the east and in support of potential wind generation projects, such as those proposed in the Buffalo Ridge area of South Dakota and southwestern Minnesota, transmission lines from Canby to Granite Falls should be planned for 345-kV capability, but could be initially operated at 230-kV service. Also, consideration for a future new 345-kV substation south of the existing Big Stone Plant would best support the regional transmission planning objectives.

Maximizing Availability of Linear Features

Comments received from the public indicate a preference for locating transmission lines adjacent to existing roads, highways and transmission lines. Consequently, the majority of alternative corridors are oriented in a north-south and east-west direction, which is consistent with rural roads in the proposed Project area.

Maximizing Opportunities to Upgrade Existing Transmission Lines

Several comments were received during scoping that indicated a preference for using existing transmission lines through double-circuiting because it would reduce the need for additional transmission line ROW and reduce the proliferation of transmission lines throughout the area. However, the practice of locating transmission lines close together or double-circuiting of existing transmission lines can have far reaching reliability and safety implications.

Reliability

The applicability of placing two circuits from Big Stone on a single structure or placing single-circuit lines from the facility in close proximity can jeopardize facility operations, should both circuits become disabled. Furthermore, maintenance of double-circuit lines is more difficult and inherently more dangerous than that of single-circuit lines. Therefore, separation of circuits serves to enhance overall system reliability and reduces potential maintenance problems.

Reliability issues also are addressed as part of the NERC standards to define minimum system performance requirements for each of several contingencies. A contingency that would eliminate two circuits from the Big Stone facility (such as the loss of a double-circuit structure, carrying two circuits from the facility) would result in severely reduced generation capabilities. Therefore, prudent measures dictate that lines from the facility be constructed on single-circuit structures and that the structures of parallel lines be separated adequately to reduce the potential that a single event could affect both circuits.

Alternative Corridors Considered but Eliminated from Detailed Analysis

Using the above final screening criteria the various corridors identified in Figure 9 were evaluated and certain alternative corridors were eliminated. A summary of the considerations for elimination of various corridors is included in Tables 5 and 6.

3.3.3 Alternative Corridors Selected for Environmental Impact Statement Analysis

Based on this evaluation and the elimination of certain corridors, two additional corridors were carried forward for detailed analysis in the EIS: Corridor B1 and C1**.** Combinations of corridors comprise the two alternatives selected for detailed analysis in the EIS. Alternative A and Alternative B are illustrated in Figures 2.3-2 and 2.3-3, respectively.

Alternative A

- A new Big Stone – Ortonville 230-kV line with the upgrade of the existing Ortonville – Johnson Junction – Morris 115-kV line to 230-kV (Corridor A)
- A new Big Stone – Canby 230-kV line with the upgrade of the existing Canby – Granite Falls 115-kV line to 230-kV (Corridor C or Corridor C1)

Alternative B

- A new Big Stone – Willmar 230-kV line (Corridor B or Corridor B1)
- A new Big Stone – Canby 230-kV line with the upgrade of the existing Canby – Granite Falls 115-kV line to 230-kV (Corridor C or Corridor C1)

Table 5. Screening Criteria Evaluation of Corridors Eliminated from Further Consideration Alternatives to Corridor A and Corridor B

	Alternatives to Corridor A		Alternatives to Corridor B	
Criteria	**Bypass Route Northwest of Ortonville**	**Route to the East Alternative Corridor**	**Big Stone to Spicer**	**Big Stone to Ortonville to Appleton to Willmar**
Avoidance of Areas of Environmental Sensitivity	Both alternatives would bypass environmentally sensitive resources along the southern portion of the Co-owners proposed corridor. Upgrading the existing line would minimize impacts to sensitive areas.		The corridor crossed numerous lakes and wetlands around the Spicer area and through Dovre Township, north of Willmar.	This corridor would avoid environmentally sensitive areas around Danvers.
Avoidance of Population Centers	Commercial land uses and Ortonville Airport may be impacted.	The alternative avoids Johnson and Chokio but not Alberta.	The corridor would include population centers of Danvers, DeGraff, Murdock, and the Spicer area.	Population centers would include Ortonville, Appleton and Holloway. Conflict with pivot irrigation in the Appleton-Holloway area.
Compliance with Regional Transmission Planning Objectives	Both alternatives support regional transmission planning objectives by alleviating a previously identified 115-kV line overload between Ortonville and Johnson Junction, which would have needed increased capacity in the near future due to previously studied generation projects outside of Big Stone II. It also has the potential to increase the ability of interconnecting new generation sources to a high-capacity transmission line along the corridors.		The corridor is oriented east – west and would provide an opportunity to support regional transmission planning objectives by increasing the reliability of the transmission system around the large load center of Willmar. It also has the potential to increase the ability of interconnecting new generation sources to a high-capacity transmission line along the corridor.	The corridor is oriented east – west and would provide an opportunity to support regional transmission planning objectives.
Maximizing the Availability of Linear Features	County roads could be paralleled in southern portion. State highways and county roads could be paralleled in northern portion.	The corridor would include county roads and highways that could be paralleled.	The corridor would provide opportunities to parallel linear features such as county roads and highways.	Existing county roads and highways, section lines and mid-section lines would maximize routing opportunities with the corridor.
Maximizing Opportunities to Upgrade Existing Transmission Lines	Opportunities would be limited to the northern portion of the corridor.	No known transmission lines are present within the corridor; no opportunities to upgrade existing transmission lines.	Existing transmission lines are not present within the corridor.	Existing transmission lines are not present within the corridor.
Reliability	Both alternatives offer opportunities to construct new lines separate from existing transmission lines.		Both alternatives offer opportunities to construct new lines separate from existing transmission lines.	

Table 6. Screening Criteria Evaluation of Corridors Eliminated from Further Consideration Alternatives to Corridor C

Criteria	Big Stone to Ortonville to Granite Falls	Big Stone to Bellingham to Hazel Run to Granite Falls	Big Stone to Benson to Granite Falls	Big Stone to Western's Corridor to Canby to Granite Falls	Big Stone to Western's Corridor to Granite Falls
Avoidance of Areas of Environmental Sensitivity	Environmental constraints occur along the Minnesota River.	Environmentally-sensitive areas are largely absent within the corridor.	Environmentally-sensitive areas are largely absent from the Benson/Danvers area to Granite Falls.	This corridor would avoid environmentally sensitive areas in the southwestern portion of the corridor.	Environmentally sensitive areas are likely to be minimal.
Avoidance of Population Centers	Population centers include Odessa, Correll, Appleton, Milan, Watson, Montevideo and Granite Falls.	Population centers include Bellingham, Madison, Dawson, Boyd, Clarkfield, Hazel Run and Granite Falls.	Population centers include the Benson/Danvers area and Granite Falls.	The corridor would largely avoid population centers.	The corridor would largely avoid population centers. Population centers include Boyd and Granite Falls.
Compliance with Regional Transmission Planning Objectives	The corridor would extend to the southeast and would not provide an opportunity to support regional transmission planning objectives.	The corridor would extend to the southeast and would not provide an opportunity to support regional transmission planning objectives.	The corridor would extend to the south and would not provide an opportunity to support regional transmission planning objectives.	The corridor would extend east-west and would provide an opportunity to support regional transmission planning objectives.	The corridor would extend east-west and would provide an opportunity to support regional transmission planning objectives.
Maximizing the Availability of Linear Features	Routing opportunities are limited to the existing Highway 59 and a railroad ROW that extend from the northwest to the southeast.	Routing opportunities are parallel to State Route 75 and an existing railroad ROW in a southeasterly direction.	Reduced potential to parallel rural roads, section lines, and mid-section lines along southern portion of the corridor.	The corridor would provide minimal opportunities to parallel county roads.	The corridor would provide opportunities to parallel linear features such as roads, highways and section lines throughout much of its alignment.
Maximizing Opportunities to Upgrade Existing Transmission Lines	The corridor would not provide opportunities to upgrade existing transmission lines; lines are not present within the majority of the corridor.	The corridor would not provide opportunities to upgrade existing transmission lines; lines are not present within the majority of the corridor.	Although transmission lines are present, reliability concerns prevent opportunities for them to be upgraded.	Existing transmission lines are present; reliability concerns prevent opportunities for them to be upgraded.	Although transmission lines are present, reliability concerns prevent opportunities for them to be upgraded.
Reliability	The corridor offers opportunities to construct new lines separate from existing transmission lines.		Constrained by the presence of existing transmission lines.		

Appendix B2

Cooling System Alternatives Screening Process and Results

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APPENDIX B2

COOLING SYSTEM ALTERNATIVES SCREENING PROCESS AND RESULTS

In evaluating alternatives to support the supply of backup water to the proposed Big Stone II Project, four alternatives were considered, including:

Alternative 1 – Wet Cooling with Surface Water Back-up

Alternative 2 – Wet Cooling with Groundwater Back-up

Alternative 3 – Wet/Dry Cooling with Groundwater Back-up

Alternative 4 – Dry Cooling with Groundwater Back-up

The Co-owners compared the four alternatives using operating, economic, and environmental screening criteria. Comparisons of operating criteria included net power output, heat rates improvement, and auxiliary power uses. Economic criteria included capital costs differences, chemical cost differences, and net present worth. Environmental criteria included comparisons of water consumption, air emissions, land use, and impact to wetlands.

Operational Criteria

Net power output provides a comparison of the maximum net power that could be produced (in megawatts) by the plant under each alternative, as the plant is subjected to average operating climatic conditions. Differences arise due to design requirements, design steam cycle efficiency, and auxiliary power requirements. A higher net power output provides the benefit of more power delivery to the electrical grid under conditions when ambient temperatures are near annual average.

Heat rate measures how efficiently a generator produces electric energy. It is expressed as the number of British thermal units (Btu's) required to produce a kilowatt-hour of electrical energy. A lower heat rate indicates a more efficient generator. Generators that are more efficient cost less to operate and generate less pollution.

Auxiliary power uses, such as those required for fans for dry cooling, water treatment systems, and water pumps, are drains on net power output. Therefore, more auxiliary power reduces the amount of net power delivered to the electric grid.

Economic Criteria

The Co-owners compared differences in capital costs and operations costs required by each of the alternatives. Operational and capital costs are passed on to consumers through higher rates, and higher electricity rates would not be favorable to the consumer. Analysis of the net present worth (reported in 2007 dollars) allowed the Co-owners to compare the alternatives by projecting costs (capital, operating, and fuel costs) over a defined service life for each alternative. In this case, the lowest net present worth would be the most favored alternative.

Environmental Criteria

The following environmental criteria were evaluated for each alternative:

Consumptive water requirements

Air emissions

Acres if land required

Impacts to wetlands

Often times, there is a direct relationship between operational and environmental criteria; for example, where generator efficiency suffers due to higher heat rate, air emissions would increase as well. The type of cooling selected (e.g. wet vs. dry) is the primary factor determining the amount of water consumption and losses due to evaporation. Land use impact and wetlands impacts are also sensitive to the selection of the source for back-up water (i.e., surface water or groundwater).

Screening Results

Screening was completed based on the comparison of the four alternatives for various operational, cost, and environmental impacts outlined in the screening criteria. Table 1 provides the results of the screening analysis.

Table 1 Comparison of Cooling Alternatives and Water Supply Sources

Screening Criteria	Units[a]	Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Wet Cooling with Surface Water Back-up	**Wet Cooling with Groundwater Back-up**	**Wet/Dry Cooling with Groundwater Back-up**	**Dry Cooling with Groundwater Back-up**
Performance					
Net Output @ Average Annual Ambient Condition	MW	651	654	658	660
Differential Heat Rate[b]	Btu/kWh	+ 55	Base[l]	+ 147	+ 111
Differential Capital Cost[c]	$	$84,190,000	Base[l]	$53,520,000	$71,770,000
Differential Chemical Costs	$/yr	$1,131,500	$1,934,500	$82,344	Base
Differential Net Present Worth	$	$82,100,000	Base	$50,400,000	$65,000,000
Annual Average Water Consumption					
Losses due to Evaporation:					
Tower	gpm	3,878	3,878	320	0
Make-up Pond	gpm	500	0	0	0
Make-up Water (Surface and Groundwater)	afy	13,817	13,033	7,291	7,065
Auxiliary Power					
Water Treatment Systems Auxiliary Power[d]	kW	6,300	120	90	70
Heat Rejection Auxiliary Power[e]	kW	7,550	7,550	7,955	10,255
Total BSP II Auxiliary Power [f, g]	kW	54,250	50,270	50,515	53,105
Environmental Impacts					
New Land Use Impact[h]	Acres	532	39	39	39
Wetland Impacts[i]	Acres	65	0	0	0
Air Impacts: Air Emission (SO_2, NO_X, CO, PM, Hg & CO_2)[j, k]	%	0.15%	Base[l]	2.28%	2.18%

[a] Megawatts (MW) equal to 1,000 Kilowatts (kW), kilowatt-hour (kWh), British thermal units/ kilowatt hour (Btu/kWh); acre-feet per year (afy); kilowatt (kW); gallons per minute (gpm); sulfur dioxide (SO_2); nitrogen oxides (NO_X); carbon monoxide (CO); particulate matter (PM); mercury (Hg); carbon dioxide (CO_2).

[b] Net Plant Heat Rate at Boiler maximum continuous rating (MCR) and Average Ambient Conditions, shown as a differential from the "base" case. Alternative 2 is the base case for heat rate. Alternatives 1, 3, and 4 heat rates would be slightly higher, as shown.

[c] The capital costs provided by the assessment do not include installation costs of groundwater wells, costs for construction of the pipeline corridors, and did not include auxiliary power requirements for groundwater pumping systems. These costs were assumed to be relatively similar for Alternatives 2, 3, and 4.

[d] Accounts for both existing plant and proposed Big Stone II auxiliary power consumption.

[e] Proposed Big Stone II auxiliary power only.

[f] Existing Big Stone Plant auxiliary power savings are not factored into proposed Big Stone II heat rate values.

[g] Auxiliary Power at boiler MCR and Average Ambient Conditions.

[h] Alternative 1 includes all long-term acreage impacts due to construction of the proposed power plant and associated facilities, such as the make-up water storage pond and the cooling tower blowdown pond, which are eliminated in Alternatives 2, 3, and 4. Acreage impacts for Alternatives 2, 3, and 4 are all long-term acreage impacts due to installation of the proposed power plant, including new impacts due to groundwater production wells and ancillary facilities (i.e., well pumphouses, and access roads), but do not include temporary impacts due to pipeline construction (about 36.7 acres).

[i] For Alternative 1, impact to wetland/riparian areas due to construction of the new 450-acre make-up water storage pond and the cooling tower would be 65 acres. No wetlands would be impacted due to installation of groundwater wells.

[j] Air emissions, as percent over "base," assume emission control efficiencies remain constant and emission increase is dependant on the heat rate (Btu/kWh).

[k] Increased emission of six pollutants of concern (SO_2, NO_X, CO, PM, Hg & CO_2) are calculated as the ratio of the proposed Big Stone II heat rate, for any alternative, to the lowest heat rate, noted within as the "base" emission rate. The lowest heat rate is achieved in Alternative 2, where wet cooling is used with groundwater as the back-up water supply. Therefore, all increased air emissions are percentages above this "base."

[l] Base is the lowest cost alternative, lowest impact value, or lowest heat rate for the four alternatives. Using the Base Value, the other alternatives are then compared to the Base Value in terms of increased cost, increased impacts, or increased heat rate.

Source: Black & Veatch, 2007

Operational Comparison

There is a differential of nine MW of net output among the four alternatives. With respect to heat rate, the higher heat rates (55 Btus to 147 Btus) are unfavorable when compared to the lowest heat rate for Alternative 2 (wet cooling with groundwater back-up). Auxiliary power is least for the base case and Alternative 1. The dry cooling technology in Alternatives 3 and 4 increases auxiliary power requirements as compared to the base case. Alternative 1 requires significantly higher auxiliary power to support the water treatment systems (i.e. brine concentrator).

Economic Comparison

The alternative with the lowest capital cost is Alternative 2. Capital costs are approximately $53 million to $84 million higher for the other three alternatives. Differences in chemical costs are the lowest for the dry cooling alternative, since no annual expenses are required for water treatment for cooling purposes. However, when capital costs and annual chemical costs are factored into the net present worth analysis, Alternative 2 is significantly lower as compared to the other three alternatives, by approximately $50 million to $82 million.

Environmental Comparison

Air emission impacts were highest for Alternative 3 and 4 due to the higher heat rates (i.e., less efficient) associated with these alternatives. Alternative 2 showed the lowest air emissions impacts. Water consumption was the highest for the two wet cooling alternatives (Alternatives 1 and 2) and lowest where the dry cooling alternatives were utilized (Alternatives 3 and 4). Land use impacts were significantly higher for Alternative 1 due to the construction of the 450-acre make-up water storage pond and the 25-acre cooling tower blowdown pond. Land use impacts of these ponds would not occur for Alternatives 2, 3, and 4. No wetlands would be impacted from construction of the groundwater production wells (Alternatives 2, 3, and 4), assuming placement of wells in agricultural areas. Under Alternative 1, 65 acres of wetlands would be impacted from construction of the 450-acre make-up water storage pond and the former cooling tower location.

Summary

Based on the comparative review of the four alternatives, Alternative 2 offers the least economic costs and the least environmental impacts. Alternatives 4 and 3 require the least water consumption, respectively. However, the costs for the cooling technologies for Alternatives 3 and 4 are significantly higher. Based on the review, Alternatives 1 and 4 were eliminated due to their higher costs and environmental impacts and Alternatives 2 and 3 were carried forward for analysis in the Supplemental Draft EIS.

DOE/EIS-0377

Final Environmental Impact Statement

Volume III - Appendices

June 2009

Big Stone II Power Plant and Transmission Project

Prepared for:

Lead Agency:
Western Area Power Administration

Cooperating Agency:
U.S. Army Corps of Engineers

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Appendix C

Floodplain Considerations

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APPENDIX C
FLOODPLAIN CONSIDERATIONS

Executive Order (EO) 11988, Floodplain Management, states that actions by Federal agencies must avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplain development wherever there is a practicable alternative. Each agency must provide leadership and must take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for 1) acquiring, managing, and disposing of Federal lands and facilities; 2) providing Federally undertaken, financed or assisted construction and improvements; and 3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities.

Each agency has a responsibility to evaluate the potential effects of any actions it may take in a floodplain; to ensure that its planning programs and budget request reflect consideration of flood hazards and floodplain management; and to prescribe procedures to implement the policies and requirements of the EO. If an agency has determined to, or proposes to, conduct, support, or allow an action to be located in a floodplain, the agency must consider alternatives to avoid adverse effects and incompatible development in the floodplains. If the head of the agency finds that the only practical alternative consistent with the law and with the policy set forth in the EO requires sitting in a floodplain, the agency must, prior to taking action, 1) design or modify its action to minimize potential harm to or within the floodplain, consistent with regulations issued in accord with the EO, and 2) prepare and circulate a notice containing an explanation of why the action is proposed to be located in the floodplain.

U.S. Department of Energy (DOE) rules and regulations pertaining to compliance with floodplain and wetland environmental review requirements are described in 10 Code of Federal Regulations (CFR) § 1021 and 1022. In summary, DOE has the responsibility to:

1. Incorporate floodplain management and wetland protection goals into its planning and decision-making processes to the extent practical by:
    - Reducing the risk of flood loss.
    - Minimizing impacts of floods on human safety, health and welfare.
    - Restoring and preserving natural and beneficial values served by floodplains.
    - Requiring construction of structures and facilities to be within Federal Emergency Management Agency (FEMA) flood insurance standards.
    - Minimizing the destruction, loss or degradation of wetlands.
    - Preserving and enhancing the natural and beneficial values of wetlands.
2. Undertake careful evaluation of potential effects of any proposed floodplain or wetland action.
3. Avoid to the extent possible the long- and short-term adverse impacts associated with destroying wetlands, or occupying or modifying floodplains and avoid direct or indirect

support for development or construction in floodplains and wetlands whenever there is a practical alternative.

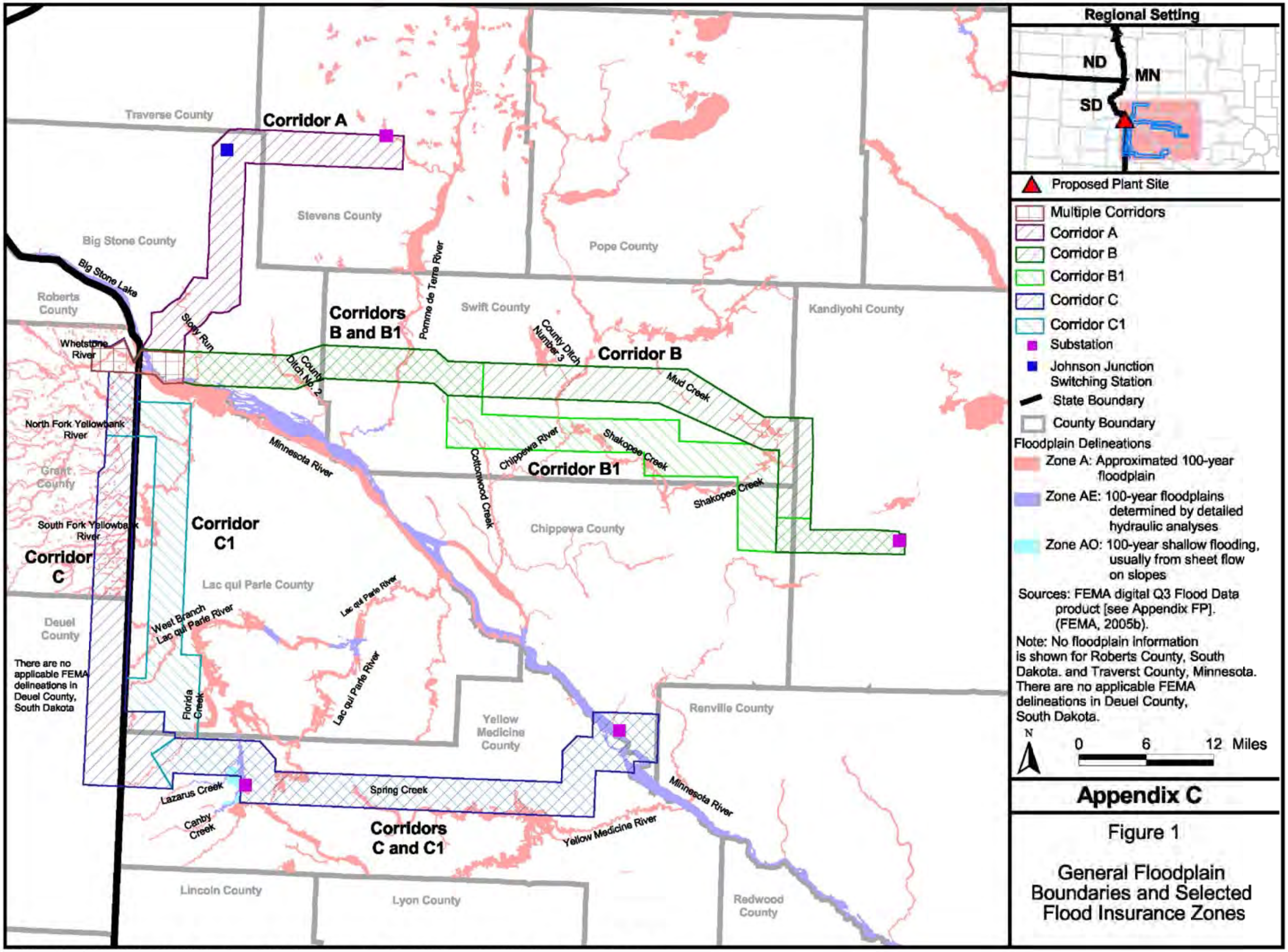
4. Identify, evaluate and as appropriate, implement alternative actions that may avoid or mitigate adverse impacts to floodplains or wetlands.
5. Provide early public review opportunities for any plans or proposals that involve actions in floodplains or wetlands.

Much of the basic inventory, regulation and mitigation effort for floodplains and flood mitigation, including the National Flood Insurance Program (NFIP), has been led by FEMA. FEMA defines a floodplain as being any land area susceptible to inundation by waters from any source (FEMA, 2005a). FEMA defines flooding as:

1. A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area, or of two or more properties (at least one of which is the policyholder's property) from: 1) overflow of inland waters, 2) unusual and rapid accumulation or runoff of surface waters from any source, or 3) mudflows.
2. Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above (FEMA, 2005).

The term “policyholder’s property” as used above refers to coverage under NFIP. As part of this program, FEMA has identified and mapped Special Flood Hazard Areas (SFHAs). FEMA-designated SFHAs within the proposed project area are indicated on Figure 1. SHFA designations within the proposed project area consist of flood zones that start with the letter A. These are lands subject to inundation by a flood that has a one percent chance of being equaled or exceeded in any given year (the “base flood”). The Base Flood Elevation (BFE) is the elevation at which there is a one percent chance of flooding in any given year. For Flood Zone A, BFEs are not provided by FEMA on maps. For Flood Zone AE, BFEs resulting from detailed hydraulic analyses are provided by FEMA on the official hardcopy maps. Flood Zone AO is for areas of shallow water pathways (sheet flows of one to three feet), and depths from hydraulic analyses are provided by FEMA on the official hardcopy maps. Zone AH areas are those where shallow ponding (non-flowing water accumulations one to three feet deep) occurs, and BFEs are provided (FEMA, 2005b). Non-special flood hazard areas (zones B, C, D or X) also occur in the proposed Project area but are not shown. These are lands having moderate or minimal flood hazard (B, C or X) or undetermined flood hazard (D) (FEMA, 2004a).

The information depicted on Figure 1 is derived from the FEMA digital “Q3 Flood Data” product. The data are created by scanning the applicable Flood Insurance Rate Map hardcopy and digitizing selected features. FEMA states that these data are expected to be used for a variety of planning applications, including broad-based review for floodplain management and natural resources/ environmental analyses (FEMA, 2004b). The data are simply designed to provide broad guidance and a general approximation of the location of SFHAs. The digital Q3 Flood Data product is not suitable for engineering applications and cannot be used to determine absolute delineations of floodplain boundaries (FEMA, 2004b). For such applications, it is especially important to refer to the official paper Flood Insurance Rate Map, interact closely with state and local floodplain management officials, and understand the 250-foot buffer beyond the floodplain boundary that FEMA recommends.



Sources: FEMA digital Q3 Flood Data product [see Appendix FP]. (FEMA, 2005b).

Note: No floodplain information is shown for Roberts County, South Dakota. and Traverst County, Minnesota. There are no applicable FEMA delineations in Deuel County, South Dakota.

Appendix C

Figure 1

General Floodplain Boundaries and Selected Flood Insurance Zones

The roles of Federal agencies in floodplain assessments and decision-making have been previously summarized. Major aspects of FEMA's flood hazard mitigation program are administered at the community (state, county and/or local) level. With regard to a water resources environmental impact analysis, major community activities for flood-prone areas or SFHAs under the FEMA program (44 CFR § 60) are to:

1. Review all proposed development to assure that all necessary permits have been received from appropriate agencies, including a Section 404 permit.
2. Notify the State Coordinating Officer and adjacent communities of any alteration or relocations of existing watercourses.
3. Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained.
4. Require that the cumulative effect of the proposed development and all other proposed and existing developments do not increase the base flood water surface elevation more than one foot at any point.
5. Require that adequate drainage paths are provided around structures on slopes in Zones AH and AO (see paragraph above).

Under the FEMA program, similar requirements exist for flood-related erosion-prone areas (FEMA Zone E). Communities (including states) are required to conduct permit reviews to ensure that proposed site alterations and improvements will be reasonably safe from flood-related erosion, and will not cause or aggravate such existing erosion. Improvement re-locations or adequate protective measures can be used to ensure that this objective is met. Setbacks from water bodies are required for Zone E delineations indicated on detailed community maps, and vegetation or contour strips of adequate size are required as buffers to protect the water body (44 CFR § 60). Tables 1, 2 and 3 indicate the major floodplains in the corridors.

Table 1. Major FEMA 100-year Floodplain Segments - Corridor A

State	County	Water Resource	Location
Minnesota	Big Stone	Minnesota River	Odessa Township
		Stony Run	Big Stone Township
	Stevens	Muddy Creek	Darnen

Source: HDR, 2005a.

Table 2. Major FEMA 100-year Floodplain Segments - Corridors B and B1

State	County	Water Resource	Location
Minnesota	Big Stone	Minnesota River	Odessa Township
		Stony Run	Odessa Township
		County Ditch No. 2	Akron Township
	Swift	Pomme de Terre River	Moyer Township
		County Ditch No. 3 (Corridor B only)	Six Mile Grove Township
		Chippewa River	Six Mile Grove Township
		Mud Creek (Corridor B only)	Kildare and Pillsbury Townships
		Shakopee Creek	Pillsbury Township
		Cottonwood Creek (Corridor B1 only)	Kildare and Pillsbury Townships

Source: HDR, 2005a.

Table 3. Major FEMA 100-year Floodplain Segments – Corridors C and C1

State	County	Water Resource	Location
South Dakota	Grant	Whetstone River and Tributaries	Big Stone Township
		North Fork Yellow Bank River and Tributaries	Alban and Vernon Townships
		South Fork Yellow Bank River and Tributaries	Vernon and Adams Townships
		Mud Creek	Adams Township
	Deuel	Tributaries to Lac qui Parle River	Adams Township
Minnesota	Lac qui Parle	West Branch, Lac qui Parle River and tributaries	Mehurin, Manfred Townships
	Yellow Medicine	Florida Creek	Florida Township
		Lac qui Parle River	Oshkosh Township
		Spring Creek	Omro, Tyro, Friendship and Hazel Run Townships
		Canby Creek	Hammer Township
	Chippewa/ Yellow Medicine	Minnesota River	Granite Falls

Source: HDR, 2005a.

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APPENDIX D
WATER QUALITY

In accordance with the U.S. Environmental Protection Agency (USEPA) requirements, both South Dakota and Minnesota have water quality programs in place to protect surface water and groundwater resources. Major aspects of these programs include the establishment of water quality standards and associated monitoring and management. The following discussion and associated tables generally depict water quality standards in the proposed Project area. Additional standards and conditions apply. For more detailed information, see specific state rules, regulations and appropriate agencies.

Standards. Generally, water quality standards are based on several components:

- Beneficial use classifications and corresponding designations of waters.
- Numeric standards for water quality constituents (e.g., mercury, lead, arsenic, nitrate) that maintain and protect the beneficial uses.
- Narrative standards that describe target conditions or limits.
- Non-degradation provisions that are used to further maintain and protect water quality, particularly for high-quality or unique waters.

Beneficial use classifications form a major basis for assigning water quality standards. Standards are assigned to protect the uses designated for a particular water body (e.g., a stream segment or lake); these designations indicate the minimum water quality to be maintained and protected.

Beneficial uses of surface waters in South Dakota are listed by number below. For reference, surface water inventory tables for the proposed corridors also refer to these use classifications by their number. Unless otherwise indicated, the entire course of a named stream is the segment with the designated use. It should be noted that all streams in South Dakota are assigned the beneficial uses of irrigation, fish and wildlife propagation, recreation and stock watering as defaults (SDDENR no date (a)). When assigned, however, other use classifications also apply.

1. Domestic water supply
2. Cold water permanent fish life propagation
3. Cold water marginal fish life propagation
4. Warm water permanent fish life propagation
5. Warm water semi-permanent fish life propagation
6. Warm water marginal fish life propagation
7. Immersion recreation
8. Limited-contact recreation
9. Fish and wildlife propagation, recreation and stock watering
10. Irrigation
11. Commerce and industry

Groundwater resources in South Dakota are classified as drinking water supplies suitable for human consumption wherever they have ambient Total Dissolved Solids concentrations of 10,000 milligrams per liter or less (SDDENR no date (b)). This use designation applies to groundwater resources at the proposed Big Stone II plant site and elsewhere in the proposed Project area within South Dakota.

Beneficial use classifications for Minnesota waters are provided in the following sections. The listed classifications include uses of both surface water and groundwater resources. For reference, surface water inventory tables for the proposed corridors and variations also refer to these use classifications by their number and by any additional subclass indicators. The subclasses include:

1. Domestic consumption
2. Aquatic life and recreation
3. Industrial consumption
4. Agriculture and wildlife
5. Aesthetic enjoyment and navigation
6. Other uses
7. Limited resource value waters

In Minnesota, additional subclasses of Use Classifications 1 through 4 are employed to further designate uses, conditions and protective standards. Domestic consumption classes are primarily based on treatment requirements. Class 1A waters meet both primary and secondary drinking water standards without treatment; these are typically groundwaters with a high degree of natural protection. Class 1D waters meet both primary and secondary drinking water standards after substantial treatment that usually consists of several processes occurring in stages. Classes 1B and 1C require intermediate treatment levels. Class 2A waters permit the propagation and maintenance of cold water sport or commercial fish and associated aquatic life and habitats. They also are suitable for contact recreation (e.g., swimming) and are protected as sources of drinking water. Class 2Bd waters are to be protected similarly, but are for cool or warmwater fish and aquatic habitats. Class 2B waters support cool or warm water fisheries and aquatic habitats, but are not protected as sources of drinking water. Class 2C waters support healthy communities of indigenous fish and associated aquatic habitats and may be suitable for boating or other recreation. Class 2D waters support healthy communities of aquatic and terrestrial species indigenous to wetlands and their habitats (Minnesota Rules Chapter 7050). Classes 2B, 2C and 2D are not protected for drinking water purposes.

Classes 3A through 3C waters and wetlands in Minnesota support different types of industrial consumption, with appropriate levels of chemical treatment required for those applications (which do not include food processing). Classes 4A through 4C waters and wetlands support irrigated croplands (4A), livestock and wildlife (4B), or a combination of these and other uses without adverse effects (Minnesota Rules Chapter 7050). For example, Class 4C waters can be used for low flow augmentation. All surface waters of Minnesota that are not listed for beneficial uses and that are not wetlands are classified as Class 2B, 3B, 4A, 4B, 5 and 6 waters. In Minnesota, Class 7 waters include groundwater used for potable water supply, as well as aesthetic and secondary body contact uses.

Water quality standards of interest for selected beneficial uses in South Dakota are shown in Tables 1 and 2. Comparable standards for Minnesota waters are shown in Tables 3 and 4.

Table 1. Selected South Dakota Numeric Water Quality Standards for Domestic Water Supply (Surface Water) and Groundwaters Qualifying as Drinking Water Supplies[a,b]

Water Quality Constituent	Standard[c] (Maximum Contaminant Level or Allowable Range)	Water Quality Constituent	Standard[c] (Maximum Contaminant Level or Allowable Range)
Aluminum	0.05 to 0.2	Nitrite (as N)	1
Arsenic	0.01	Nitrate + Nitrite (as N)	10
Barium	1 / 2	Selenium	0.05
Cadmium	0.005	Silver	0.1
Chromium	0.1	Radium 226, 228 combined (pCi/l)[d]	5
Copper	1.3 / 1.0	Chloride	250
Fluoride	4	pH (standard units)	6.5 – 9.0
Lead	0.015	Sulfate	250 / 500
Manganese	0.05	Total Dissolved Solids	500 / 1,000
Iron	0.3	Total Coliform (per 100 milliliter (ml))	5,000 / 2.2 (MPN)[e]
Mercury (Total)	0.002	Total Petroleum Hydrocarbons	1
Nitrate (as N)	10	Zinc	5

[a] Units are milligrams per liter (mg/l), dissolved, unless otherwise indicated. Additional calculations, time periods, or narrative standards may apply.

[b] For groundwaters having background concentrations less than 10,000 mg/l of Total Dissolved Solids.

[c] Where differing values are separated by a slash (/), the foregoing values reflect surface water standards and the subsequent values reflect groundwater standards (other provisions in Chapters 74:54:01 or 74:54:02 may apply).

[d] Picocuries per liter

[e] Most probable number

Source: South Dakota Administrative Rules 74:51:01 and 74:54:01; USEPA 2005.

Table 2. Selected South Dakota Numeric Water Quality Standards for Fisheries and Wildlife, Recreation, and Agricultural Uses Common in the Proposed Project Area[a]

Water Quality Constituent	Coldwater Marginal Fish Life Propagation	Warmwater Semi-permanent Fish Life Propagation	Limited Contact Recreation	Irrigation	Fish and Wildlife, Recreation, and Stock Watering
Dissolved Oxygen	≥ 5.0	≥ 5.0	≥ 5.0	-	-
Fecal Coliform (per single 100 ml sample)	-	-	≤ 2,000	-	-
Total Ammonia Nitrogen as N	Temperature and pH -based	Temperature and pH -based	-	-	-
Nitrates as N[b]	-	-	-	-	≤ 50
Total Alkalinity[b] ($CaCO_3$)[c]	-	-	-	-	≤ 750
Total Suspended Solids[b]	≤ 90	≤ 90	-	-	-
pH (standard units)	6.5 – 8.8	6.5 – 9.0	-	-	6.5 – 9.0
Total Dissolved Solids[b]	-	-	-	-	≤ 2,500
Temperature, ºF [d]	≤ 75	≤ 90	-	-	-
Total Petroleum Hydrocarbon	-	-	-	-	≤ 10
Oil & Grease	-	-	-	-	≤ 10
Electrical Conductivity[b] (at 25ºC)[d]	-	-	-	≤ 2,500	≤ 4,000
Sodium Adsorption Ratio	-	-	-	≤ 10	-

[a] Units are milligrams per liter (mg/l), dissolved, unless otherwise indicated. Blanks indicate no specific numeric constituent standard for the use. Additional calculations, time periods, numeric or narrative standards may apply as set forth under South Dakota Administrative Rules 74:51:01.

[b] Thirty-day averages. Daily maximums have larger values.

[c] Measured as Calcium Carbonate

[d] Degrees Farenheit (F) or Celsius (C)

Source: South Dakota Administrative Rules 74:51:01

Table 3. Minnesota Numeric Water Quality Standards for Domestic Consumption (Class 1A)[a]

Water Quality Constituent	Standard (Maximum Contaminant Level or Allowable Range)	Water Quality Constituent	Standard (Maximum Contaminant Level or Allowable Range)
Aluminum	0.05 to 0.2	Nitrite (as N)	1
Arsenic	0.01	Nitrate + Nitrite (as N)	10
Barium	2	Selenium	0.05
Cadmium	0.005	Silver	0.1
Chromium	0.1	Radium 226, 228 combined (pCi/l)	5
Copper	1.0	Chloride	250
Fluoride	4	pH (standard units)	6.5 – 8.5
Lead	0.015	Sulfate	250
Manganese	0.05	Total Dissolved Solids	500
Iron	0.3	Total Coliform	5 percent positive
Mercury (Total)	0.002	Zinc	5
Nitrate (as N)	10	-	-

[a] Units are milligrams per liter (mg/l), dissolved, unless otherwise indicated. Additional calculations, time periods, or narrative standards may apply. Additional Standard: No sewage, industrial waste, or other wastes from point or nonpoint sources, treated or untreated, shall be discharged into or permitted by any person to gain access to any waters of the state classified for domestic consumption so as to cause any material increase in the taste, hardness, temperature, chronic toxicity, corrosiveness, or nutrient content or in any other manner to impair the natural quality or value of the waters for use as a source of drinking water (Minnesota Rules Chapter 7050.0221, Subpart 6).

Source: Minnesota Rules Chapter 7050; EPA 2005.

Table 4. Selected Minnesota Numeric Water Quality Standards for Other Common Beneficial Uses in the Proposed Project Area[a]

Water Quality Constituent	Aquatic Life and Recreation[b] (2A)	Aquatic Life and Recreation (2C)	Industrial Consumption (3B)	Limited Resource Values (7)
Dissolved Oxygen (daily minimums)	7	5	-	Avoid odors or putrid conditions; 1 mg/l if measurable
Temperature °F[c]	No material increase	90, within background limits	-	-
Turbidity (NTU)[d]	10	25	-	-
Chlorides	230	230	100	-
Hardness (Ca + Mg as $CaCO_3$)[e]	-	-	250	-
pH (standard units)	6.5 – 8.5	6.5 – 9.0	6.0 – 9.0	6.0 – 9.0

[a] Units are milligrams per liter (mg/l), dissolved, unless otherwise indicated. Additional calculations, time periods, numeric or narrative standards may apply.

[b] Standards for metals are expressed as total metal but must be converted to dissolved metal standards to determine water quality-based effluent limits. Conversion formulas are provided in Minnesota Rules 7050.0222, Subpart 9. Class 2A waters are also protected as sources of drinking water.

[c] Degrees Farenheit

[d] Nephelometric Turbidity Units

[e] Calcium plus Magnesium measured as Calcium Carbonate

Source: Minnesota Rules Chapter 7050.

Examples of narrative standards include maintaining background pH or temperature within limits, prohibiting discharges of untreated sewage or other waste materials, or prohibiting discharges that create visible oil films and other nuisance conditions. Narrative standards frequently consist of short descriptions that limit or prohibit specified activities or identify target conditions. They are typically set forth in regulatory rules that are applied more broadly than numeric standards, which are oriented to specific water uses.

In combination, numeric and narrative water quality standards have several functions. They are used to:

- Identify levels of pollutants allowed while maintaining beneficial uses.
- Investigate and compare water quality within an area or state.
- Help establish priorities for treatment and cleanup.
- Set effluent limits and treatment requirements for some dischargers under permit programs.
- Help define cleanup goals and assess risks for groundwater contamination sites (MPCA, 2003).

Another element of water quality standards, in addition to beneficial uses and numeric or narrative standards, consists of policy related to anti-degradation (or “nondegradation”). A major feature of USEPA and state anti-degradation programs is that lakes, rivers and streams which have existing water quality better than the applicable standards should be maintained at that higher quality. Such waterbodies are generally not allowed to degrade to the level of otherwise applicable standards (MPCA, 2003). A three-tiered approach, set apart by increasing levels of existing water quality and resource significance, is used as the anti-degradation framework. For example, under Tier I, water quality standards are employed as minimums for comparison to the water body in question. Anti-degradation regulations are used to control allowable discharges into receiving water bodies, and to protect and maintain the quality of water resources with respect to standards and existing conditions.

Monitoring and Management. Rivers, streams, lakes and groundwaters in South Dakota and Minnesota have been assigned designated uses and respective water quality standards as described above. For each water body, the standards define the maximum amounts of specific pollutants that can be present while not adversely affecting a particular designated use. The responsibility for monitoring falls primarily on state-funded programs and point-source permit holders. In addition to regulatory permitting and anti-degradation programs as mentioned above, assessments of water quality conditions and listings of “impaired waters” are required for each state under the Clean Water Act (CWA). Impaired waters are those streams, rivers and lakes that currently do not meet their beneficial use designations and associated water quality standards.

The CWA requires that the states provide water quality assessments for all their waters every two years [section 305(b)] and develop a list of waters that are impaired or threatened [section 303(d)]. Threatened waters currently meet applicable standards, but have trends toward impairment within two years. In addition, a section 314 report should accompany each 305(b) submittal. Section 314 of the CWA requires an assessment of the status and trends of significant publicly-owned lakes, including the extent of point-source and nonpoint-source impacts due to toxics, conventional pollutants and acidification (USEPA, 2005). An example of a point source of pollutants would be a specific pipe or conveyance discharging to a river from a municipal water treatment plant. Examples of nonpoint sources of pollutants include runoff carrying sediment and nutrients from an agricultural watershed, or deposition of mercury from the atmosphere. USEPA encourages states to use an integrated reporting approach as well as integrated monitoring and assessment techniques to fulfill these requirements. Site-specific assessments, probability-based assessments and other predictive tools are recommended investigative procedures.

USEPA, through the CWA, developed the Total Maximum Daily Load (TMDL) program to address impaired waters. South Dakota and Minnesota are mandated to adopt and implement this program. The TMDL process involves four phases: 1) assessment and listing, 2) TMDL study, 3) implementation plan development and implementation and 4) effectiveness monitoring. A TMDL study identifies both point and non-point sources of each pollutant that fails to meet water quality standards. Rivers and streams may have several TMDLs, one for each pollutant. A TMDL establishes the maximum amount of a pollutant that a water body can receive and still meet water quality standards for the designated use (MDA, 2004). Establishing TMDLs for a given waterbody also includes the process of allocating pollutant loadings to streams or lakes among various point and nonpoint sources.

Regulatory permit programs and cooperative stakeholder processes are used to manage pollutant loading allocations. In addition to National Pollutant Discharge Elimination System permit requirements for specific construction and industrial activities (such as the proposed Project), watershed-based pollutant control programs have been developed to address existing issues in several parts of the proposed Project region. Examples of TMDL assessment and implementation projects include the Big Stone Lake Restoration Project; the Fish Lake/Lake Alice and Lake Cochrane/Lake Oliver watershed assessments in Deuel County, South Dakota; the Chippewa River fecal coliform bacteria TMDL Project in Minnesota; and other projects along the Minnesota and Lac qui Parle rivers (SDDENR, 2005; MPCA, 2005a). In addition, Minnesota is preparing a statewide TMDL and reduction plan for mercury (MPCA, 2005b).

In conclusion, water quality regulatory programs in South Dakota and Minnesota are intended to protect the beneficial uses of surface water and groundwater. The discharge permit approval process, along with implemented monitoring programs and management practices, are important features of these regulatory programs.

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APPENDIX E
SURFACE WATER BODIES

Table 1. Minnesota Public Waters - Corridor A

County	Public Water[a]	Beneficial Use[b]	Location of Public Waters		
			Township	Range	Section
Big Stone	Minnesota River	1C, 2Bd, 3B	121	45	16
	Long Tom Lake (29P)	2 -6 or 3-7	121	45	6
	Unnamed (36P)	2 -6 or 3-7	122	45	2, 3
	Unnamed (37P)	2 -6 or 3-7	122	45	3
	Unnamed (38P)	2 -6 or 3-7	122	45	3, 10
	Unnamed (40P)	2 -6 or 3-7	122	45	8
	Unnamed (42P)	2 -6 or 3-7	122	45	17
	Unnamed (46P)	2 -6 or 3-7	122	45	14, 15
	Unnamed (48P)	2 -6 or 3-7	122	45	15 16, 21, 22
	Otrey Lake (50P)	2 -6 or 3-7	122	45	19, 20, 28-30
	Unnamed (52P)	2 -6 or 3-7	122	45	21
	Unnamed (53P)	2 -6 or 3-7	122	45	21, 22, 27
	Unnamed (55P)	2 -6 or 3-7	122	45	22, 23
	Unnamed (59P)	2 -6 or 3-7	122	45	28
	Unnamed (60P)	2 -6 or 3-7	122	45	SW ¼ 31
	Unnamed (61P)	2 -6 or 3-7	122	45	31
	Unnamed (62P)	2 -6 or 3-7	122	45	31
	Unnamed (63P)	2 -6 or 3-7	122	45	SW ¼ 32
	Unnamed (68P)	2 -6 or 3-7	122, 123	45	4, 5, 32, 33
	Olson Lake (69P)	2 -6 or 3-7	122, 123	45	5, 32
	Dismal Swamp (73P)	2 -6 or 3-7	123	45	11, 14
	Unnamed (80P)	2 -6 or 3-7	123	45	27
	Unnamed (81P)	2 -6 or 3-7	123	45	28, 29, 32, 33
	Bentsen Lake (90P)	2 -6 or 3-7	122	45, 46	7, 18, 13
	Walter Lake (92P)	2 -6 or 3-7	121	46	1, 2
	Unnamed (95P)	2 -6 or 3-7	121	46	2, 3, 10, 11
	Lindgren Lake (96P)	2 -6 or 3-7	121	46	11, 12
	Unnamed (98P)	2 -6 or 3-7	121	46	12
	Unnamed (108P)	2 -6 or 3-7	122	46	25, 26
	Twin Lake (109P)	2 -6 or 3-7	122	46	26, 35, 36
	Unnamed (110P)	2 -6 or 3-7	122	46	SW ¼ 26
	Unnamed (201P)	2 -6 or 3-7	122	46	1, 36
	Unnamed (209P)	2 -6 or 3-7	122	46	26
	Unnamed (218P)	2 -6 or 3-7	123	45	2
	Unnamed (219P)	2 -6 or 3-7	123	45	NW ¼ 14
	Unnamed (266P)	2 -6 or 3-7	122	45	3
	Unnamed (268P)	2 -6 or 3-7	122, 123	45	2, 35
	Unnamed (302P)	2 -6 or 3-7	122	45	2
	Unnamed (390P)	2 -6 or 3-7	123	45	14, 23
	Unnamed (416P)	2 -6 or 3-7	122	45	31
	Stony Run	2C	122	46	13, 24, 25, 36
	Unnamed stream	2 -6 or 3-7	123	45	8, 28, 29
	Unnamed stream	2 -6 or 3-7	123	45	3
	Unnamed (41P)	2 -6 or 3-7	122	45	8
	Larson Slough (54P)	2 -6 or 3-7	122	45	21, 27, 28
	Unnamed (86P)	2 -6 or 3-7	124	45	32
	Unnamed (87P)	2 -6 or 3-7	124	45	32, 33
	Unnamed (112P)	2 -6 or 3-7	122	46	26, 27
	Unnamed (114P)	2 -6 or 3-7	122	46	36

Table 1 (continued)

County	Public Water[a]	Beneficial Use[b]	Location of Public Waters		
			Township	Range	Section
Big Stone (continued)	Unnamed (219P)	2 -6 or 3-7	123	45	14
	Unnamed (335P)	2 -6 or 3-7	122	45	21
	Unnamed (380P)	2 -6 or 3-7	124	45	32
	Unnamed (381P)	2 -6 or 3-7	124	45	33
	Unnamed (382P)	2 -6 or 3-7	124	45	35
	Unnamed (389P)	2 -6 or 3-7	123	45	14
Swift	Unnamed (165P)	2 -6 or 3-7	124	42, 43	7, 12
	Clear Lake (192P)	2 -6 or 3-7	124	43	8, 9, 16, 17
	Unnamed (194P)	2 -6 or 3-7	124	43	12
	Unnamed (196P)	2 -6 or 3-7	124	43	15
	Gravel Lake (291P)	2 -6 or 3-7	124	44	7, 8, 17, 18
	Jipson Slough (294P)	2 -6 or 3-7	124	44	SW ¼ 15
	Unnamed stream	2 -6 or 3-7	124	44	7, 18
	County Ditch No. 3	2 -6 or 3-7	124	44	10, 15
	Unnamed stream	2 -6 or 3-7	124	43	1, 12, 13

[a] Public waters basins, watercourses, and ditches = P. Public waters wetlands = W

[b] See Appendix D for beneficial use classifications. Designated Beneficial Uses from Minnesota Rules 7050.0430 and 7050.0470. Additional agency clarifications may be required during any permitting efforts.

Source: HDR, 2005a.

Table 2. Minnesota Public Waters - Corridor B

County	Public Water[a]	Beneficial Use[b]	Location of Public Waters		
			Township	Range	Section
Big Stone	Unnamed (8P)	2-6 or 3-7	121	44	11, 12
	Unnamed (9P)	2-6 or 3-7	121	44	12
	Unnamed (10P)	2-6 or 3-7	121	44	13
	Unnamed (11W)	4	121	44	26, 27
	Unnamed (27P)	2-6 or 3-7	121	45	5, 6
	Unnamed (297W)	4	121	44	16
	Unnamed (296W)	4	121	44	21
	Unnamed (449W)	4	121	44	21
	Unnamed (428W)	4	121	45	23
	Horseshoe Lake (32P)	2-6 or 3-7	121	45	15, 16
	Unnamed (426W)	4	121	45	15
	Unnamed (197P)	2-6 or 3-7	121	45	15
	Unnamed (198W)	4	121	45	22
	Unnamed (294P)	2-6 or 3-7	121	45	6
	Minnesota River (MR)	1C, 2Bd, 3B	121	45	29, 30
	Unnamed to MR	2-6 or 3-7	121	45	16, 17, 20, 28, 29
	Stony Run	2C	121	45	17-19
	Unnamed (427W)	4	121	45	18
	Unnamed (419W)	4	121	45; 46	18; 13
	Unnamed (99W)	4	121	46	14
Chippewa	Shakopee Creek	2C	119	37	2
	Unnamed (92W)	4	119	37	25
Kandiyohi	Shakopee Creek	2C	120	36	19, 30
	Hawk Creek	3-7	119	36	25, 27
	Unnamed (304P)	2-6 or 3-7	120	36	5
	Unnamed (280P)	2-6 or 3-7	119	36	32
Swift	Shakopee Creek	2C	120	37	25, 26
	Mud Creek	2-6 or 3-7	120, 121	37, 38, 39	numerous
	Unnamed (6W)	4	120	37	23,26
	Unnamed (275W)	4	120	37	24
	Unnamed (272W)	4	120	37	2, 11
	Cottonwood Creek	2C	120	37	2, 11
	Unnamed (234W)	4	121	39	24
	Chippewa River	2-6 or 3-7	121	40	13, 14, 23, 24, 27
	Unnamed (203W)	4	121	40	25,26
	Unnamed (105W)	4	121	40	21
	Unnamed (104W)	4	121	40	17
	Unnamed (211W)	4	121	40	17
	Unnamed (114W)	4	121	41; 42	19; 24
	Pomme de Terre River	2-6 or 3-7	121	42	8, 9, 17-19
	Unnamed (120W)	4	121	42	7
	Unnamed (144W)	4	121	43	22
	Hart Lake (140P)	2-6 or 3-7	121	43	20
	Unnamed (139W)	4	121	43	20
	Unnamed (138W)	4	121	43	6, 7

[a] Public waters basins, unnamed watercourses, and ditches = P. Public waters wetlands = W

[b] See Appendix D for beneficial use classifications. Designated Beneficial Uses from Minnesota Rules 7050.0430 and 7050.0470. Additional agency clarifications may be required during any permitting efforts.

Source: HDR, 2005a; MnDNR 2006.

Table 3. Minnesota Public Waters – Corridor B 1

County	Public Water[a]	Location of Public Waters			
		Beneficial Use[b]	Township	Range	Section
Big Stone	Unnamed (8P)	2-6 or 3-7	121	44	11, 12
	Unnamed (9P)	2-6 or 3-7	121	44	12
	Unnamed (10P)	2-6 or 3-7	121	44	13
	Unnamed (11W)	4	121	44	26, 27
	Unnamed (27P)	2-6 or 3-7	121	45	5, 6
	Unnamed (297W)	4	121	44	16
	Unnamed (296W)	4	121	44	21
	Unnamed (449W)	4	121	44	21
	Unnamed (428W)	4	121	45	23
	Horseshoe Lake (32P)	2-6 or 3-7	121	45	15, 16
	Unnamed (426W)	4	121	45	15
	Unnamed (197P)	2-6 or 3-7	121	45	15
	Unnamed (198W)	4	121	45	22
	Unnamed (294P)	2-6 or 3-7	121	45	6
	Minnesota River (MR)	1C, 2Bd, 3B	121	45	29, 30
	Unnamed to MR	2-6 or 3-7	121	45	16, 17, 20, 28, 29
	Stony Run	2C	121	45	17-19
	Unnamed (427W)	4	121	45	18
	Unnamed (419W)	4	121	45; 46	18; 13
	Unnamed (99W)	4	121	46	14
Chippewa	Shakopee Creek	2C	119	37	2, 3, 4
	Unnamed (8W)	4	119	37	10, 11
	Unnamed (80P)	2-6 or 3-7	119	37	26
	Unnamed (81P)	2-6 or 3-7	119	37	23, 26
	Unnamed (93W)	4	119	37	28, 29
Kandiyohi	Shakopee Creek	2C	120	36	19, 30
	Hawk Creek	3-7	119	36	25, 27
	Unnamed (280P)	2-6 or 3-7	119	36	32
Swift	Pomme de Terre River	2-6 or 3-7	121	42	8, 9, 17-19
	Unnamed stream	2-6 or 3-7	119	37	24, 25, 35
	Unnamed stream	1B, 2A, 3B	119	37	2
	Cottonwood Creek	2-6 or 3-7	119	37	3
	Chippewa River	2-6 or 3-7			33, 34
	Unnamed stream	2-6 or 3-7	119	37	23, 24
	Unnamed stream	2-6 or 3-7	120	37	2, 11
	Unnamed stream	2-6 or 3-7	120	37	3
	Hart Lake (140P)	2-6 or 3-7	121	43	20

[a] Public waters basins, watercourses, and ditches = P. Public waters wetlands = W

[b] See Appendix D for beneficial use classifications. Designated Beneficial Uses from Minnesota Rules 7050.0430 and 7050.0470. Additional agency clarifications may be required during any permitting efforts.

Source: HDR, 2005a; MnDNR, 2006.

Table 4. Minnesota Public Waters - Corridors C and C1

County	State Waters	Beneficial Use[a]	Location of Waters		
			Township	Range	Section
Grant (SD)	Whetstone River	5, 8	121	46, 47	20, 18, 13, 23
	Lake Albert	9, 10	121	46, 47	6, 1
	Unnamed stream	9, 10	120	48	13
	North Fork Yellowbank River	4, 8	120	47	16, 17, 19, 20
	Unnamed stream	9, 10	120	47, 48	17, 19, 24
	North Fork Yellowbank River	4, 8	120	47, 48	29, 32, 31, 36
	Unnamed stream	9, 10	119	47, 48	7, 12
	Kaufman Slough	9, 10	119	47, 48	21, 20, 19, 24
	Unnamed stream	9, 10	119	47, 48	28, 29, 32, 31, 36
	Unnamed stream	9, 10	117	47, 48	4, 5, 6, 12
	South Fork Yellowbank River	3, 8	117	47, 48	7, 8, 9, 12
	Mud Creek	9, 10	117	47, 48	16, 17, 18, 13
	Unnamed stream	9, 10	117	47	19, 20, 21
	Unnamed stream	9, 10	117	47, 48	31, 32, 33, 36
Deuel (SD)	Unnamed stream	9, 10	116	47	4, 5, 6
	Unnamed stream	9, 10	116	47, 48	7, 21, 1
	Lost Creek	9, 10	116	47, 48	16, 17, 18, 13
	Crow Timber Creek	9, 10	116	47, 48	19, 20, 24, 25
	Crow Creek	9, 10	114	47	3, 4, 7, 8
	Cow Spring Creek	9, 10	114	48	13
	Unnamed stream	9, 10	114	47	30
	Lake Francis	9, 10	114	48	25, 36
	Monighan Creek	3, 8	114	47, 48	31, 32, 33, 36
	Monigham Creek	9, 10	113	48	1
	West Branch Lac qui Parle River	3, 8	113	47	8, 9, 17, 18
	Briggs Lake	9, 10	113	48	13, 24
	North Branch Cobb Creek	3, 8	113	48	25
	Cobb Creek	3, 8	113	47, 48	19, 20, 28, 29, 30, 25
	Lake Oliver	9, 10	113	47	33
	Lake Cochrane	9, 10	112	47	4
	Culver Lake	9, 10	112	46	6
Yellow Medicine (MN)	Unnamed (38P)	2-6, 3-7	115	39	3, 4
	Unnamed (93P)	2-6, 3-7	115	42	19
	Unnamed (111P)	2-6, 3-7	115	43	20
	Unnamed (112P)	2-6, 3-7	115	43	21, 22
	Lanners Lake (114P)	2-6, 3-7	115	43	23, 26
	Unnamed (131P)	2-6, 3-7	115	39	3
	Unnamed (133P)	2-6, 3-7	115	43	35
	Unnamed (157P)	2-6, 3-7	115	43	26, 35
	Unnamed (159P)	2-6, 3-7	115	44	23
	Unnamed tributary to Florida Creek	2-6, 3-7	115	46	2, 10
	Unnamed tributary to Cobb Creek	2-6, 3-7	115	46	2, 3, 4, and 9
	Unnamed tributary to Cobb Creek	2-6, 3-7	115	46	4, 7, and 8

Table 4 (continued)

County	State Waters	Beneficial Use[a]	Location of Waters		
			Township	Range	Section
Yellow Medicine (MN) (continued)	Florida Creek and tributaries	2C, 3B	115	46	1, 2, 10-18, 21, 22, 28 30
	Lazarus Creek	2C, 3B	115	45	7-10, 15, 16
	Canby Creek and tributaries	2C, 3B	115	45	2, 11, 12, 14, 15, 21, 22
	Lac qui Parle River	2C, 3B	115	44	7, 8, 17, 18, 21-23, 28, 29, 32
	Spring Creek and tributaries	2C	115	43, 44	19-21, 27, 29, 30, 34; 24-28, 34, 35
	Unnamed stream to Minnesota River	2-6 or 3-7	115	39	5, 8, 9
Chippewa (MN)	Minnesota River	1C, 2Bd, 3B	116	39	36
	Palmer Creek	2C	116	39	16
	Unnamed tributary to Minnesota River	2-6 or 3-7	116	39	22, 23, 27, and 34

[a] See Appendix D for beneficial use classifications. Designated Beneficial Uses from South Dakota Administrative Rules 74:51=03:01, 74:54:03:04 and Minnesota Rules 7050:0430, 7050:0470. Additional agency clarifications may be required during any permitting efforts.

Source: HDR, 2005a.

Appendix F

Wildlife, Special Status, Fish, Plant, and Noxious and Invasive Weed Species Lists

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APPENDIX F

Wildlife, Special Status, Fish, Plant, and Noxious and Invasive Weed Species Lists

Table 1. Wildlife Species Identified for the Proposed Project Area

List of Representative Mammal Species in the Proposed Project Area[a]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[b]**
Arctic shrew	*Sorex arcticus*	Moist woods and riparian areas	D, G, K, L, St, Sw
Big brown bat	*Eptesicus fuscus*	Deciduous forests	D, G, K
Deer mouse	*Peromyscus maniculatus*	Grasslands and forests	BS, D, G
Eastern chipmunk	*Tamias striatus*	Deciduous forests, forest edges and scrubland	BS, K
Ermine	*Mustela erminea*	Forests and scrubland, hunt in wet areas	D, G, K, Sw
Hayden's shrew	*Sorex haydeni*	Moist woods and riparian areas	D, G, K, L, St, YM
House mouse	*Mus musculus*	Fields and farmland	K, St
Masked shrew	*Sorex cinereus*	Bottomland and upland forests	BS, D, G, K, L St, Sw, YM
Meadow jumping mouse	*Zapus hudsonius*	Riparian areas	BS, D, G, K, L, St, Sw, YM
Meadow vole	*Microtus pennsylvanicus*	Prairies and wet meadows	BS, D, G, K, St, Sw, YM
Northern grasshopper mouse	*Onychomys leucogaster*	Grasslands	D, G, Sw
Mule deer	*Odocoileus hemionus*	Upland forest	BS, C, D, G, K, L, ST, SW, YM
Short-tailed shrew	*Blarina brevicauda*	Moist woods and riparian areas	D, G, K, St, YM
Plains pocket gopher	*Geomys bursarius*	Prairies and pastures	BS
Prairie deer mouse	*Peromyscus maniculatus bairdii*	Prairies	St, Sw, YM
Southern red-backed vole	*Clethrionomys gapperi*	Mixed forests and marshes	K
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	Grasslands	BS, D, G, K, L, St, Sw, YM
Virginia opossum	*Didelphis virginiana*	Deciduous open woods and farmland	D, G, K
Western harvest mouse	*Reithrodontomys megalotis*	Grasslands	D, G, YM
White-footed mouse	*Peromyscus leucopus*	Upland forests	BS, K, St, Sw, YM
White-tailed deer	*Odocoileus virginianus*	Woodlands	BS, C, D, G, K, L, ST, SW, YM

[a] References include Minnesota Department of Natural Resources, Nongame Birds, Small Mammals, Herptiles, Fishes: Sand Lake National Wildlife Refuge, and South Dakota Species of Greatest Conservation Need List.

[b] BS = Big Stone County, C = Chippewa County, D = Deuel County, G = Grant County, K = Kandiyohi County, L = Lac qui Parle, Sw = Swift County, St = Stevens County, YM = Yellow Medicine County. No data was available for Chippewa County.

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Acadian flycatcher	*Empidonax virescens*	Mature forest	K, Sw
Alder flycatcher	*Empidonax alnorum*	Swamps, streamside and lakeside thickets	BS, C, K, St, Sw, YM
American avocet	*Recurvirostra americana*	Mudflats, saline lakes, in fresh water and saltwater marshes	BS, C, D, G, K, St, Sw, YM
American bittern	*Botaurus lentiginosus*	Marshes, and grassy lakeshores	BS, C, D, G, K, L, St, Sw, YM
American black duck	*Anas rubripes*	Marshes, ponds and lakes	BS, C, D, G, K, L, St, Sw, Y, M
American coot	*Fulica americana*	Marshes, ponds and lakes	BS, C, D, G, K, L, St, Sw, YM
American crow	*Corvus brachyrhynchos*	Forested areas along streams, city streets and parks	BS, C, D, G, K, L, St, Sw, YM
American golden-plover	*Pluvialis dominica*	Lakeshores and prairies	BS, C, D, G, K, L, St, Sw, YM
American goldfinch	*Carduelis tristis*	Weedy fields and flood plains	BS, C, D, G, K, L, St, Sw, YM
American kestrel	*Falco sparverius*	Open fields and forest edges	BS, C, K, L, St, Sw, YM, G, D
American pipit	*Anthus rubescens*	Grasslands and sedge meadows	BS, C, D, G, K, L, St, Sw, YM
American redstart	*Setophaga ruticilla*	Open deciduous or mixed woodlands, forest edges, roadside trees	BS, C, K, St, Sw, YM
American robin	*Turdus migratorius*	Open woodlands, fields, gardens and yards	BS, C, D, G, K, L, St, Sw, YM
American tree sparrow	*Spizella arborea*	Willow and birch thickets, fields, weedy woodland edges	BS, C, D, G, K, St, Sw, YM, G, D
American white pelican	*Pelecanus erythrorhynchos*	Shallow lakes and marshes	BS, C, D, G, K, L, St, Sw, YM
American wigeon	*Anas americana*	Ponds, lakes and marshes	BS, C, G, D, K, L, St, Sw, YM
American woodcock	*Scolopax minor*	Moist, early-successional woodlands near open fields or forest clearings	BS, C, D, G, K, L, St, Sw, YM, G, D
Baird's sandpiper	*Calidris bairdii*	Marshes and wet meadows	BS, C, D, G, K, L, St, Sw, YM
Bald eagle	*Haliaeetus leucocephalus*	Forested areas near lakes and rivers	BS, C, D, G, K, L, St, Sw, YM
Baltimore oriole	*Icterus galbula*	Deciduous woodlands and shade trees	BS, C, D, G, K, L, St, Sw, YM
Band-tailed pigeon	*Columba fasciata*	Coniferous forests	St
Bank swallow	*Riparia riparia*	Found near water, nest in riverbanks	BS, C, D, G, K, L, St, Sw, YM, G, D
Barn swallow	*Hirundo rustica*	Farmsteads and open woods	BS, C, D, G, K, L, St, Sw, YM
Barred owl	*Strix varia*	Forests with some mature trees near open country	BS, K, St, Sw, YM
Barrow's goldeneye	*Bucephala islandica*	Lakes and marshes	BS
Bay-breasted warbler	*Dendroica castanea*	Boreal forests	BS, C, D, G, K, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Bell's vireo	*Vireo bellii*	Upland and lowland carr, riparian areas, brushy fields, and young second-growth forest or woodland	St
Belted kingfisher	*Ceryle alcyon*	Lakes and marshes, nests in river banks	BS, C, D, G, K, L, St, Sw, YM
Black scoter	*Melanitta nigra*	Lakes and boreal forests	BS, C, K
Black tern	*Chlidonias niger*	Marshes and lakes	BS, C, D, G, K, L, St, Sw, YM
Black-and-white warbler	*Mniotilta varia*	Deciduous forests	BS, C, D, G, K, St, Sw, YM
Black-backed woodpecker	*Picoides arcticus*	Mature forest	YM
Black-bellied plover	*Pluvialis squatarola*	Lake shores and mud flats	BS, C, D, G, K, L, St, Sw, YM, G, D
Black-billed cuckoo	*Coccyzus erythropthalmus*	Moist thickets in low overgrown pastures and orchards	BS, C, K, St, Sw, YM
Black-billed magpie	*Pica hudsonia*	Grasslands and savannah	BS, St
Blackburnian warbler	*Dendroica fusca*	Coniferous forests	BS, C, K, St, Sw, YM
Black-capped chickadee	*Poecile atricapillus*	Deciduous and mixed forests and open woodlands	BS, C, D, G, K, St, Sw, YM
Black-crowned night-heron	*Nycticorax nycticorax*	Marshes and lakes	BS, C, D, G, K, St, Sw, YM
Black-necked stilt	*Himantopus mexicanus*	Lakeshores and marshes	K, St
Blackpoll warbler	*Dendroica striata*	Coniferous forests	BS, C, D, G, K, L, St, Sw, YM
Black-throated blue warbler	*Dendroica caerulescens*	Mature forest	BS, C, K, St, YM
Black-throated green warbler	*Dendroica virens*	Coniferous forests	BS, C, D, G, K, L, St, Sw, YM
Blue grosbeak	*Guiraca caerulea*	Brushy areas, open woods, thickets and old fields	YM
Blue jay	*Cyanocitta cristata*	Mixed and deciduous stands and parklands around inhabited areas	BS, C, D, G, K, L, St, Sw, YM
Blue-gray gnatcatcher	*Polioptila caerulea*	Moist deciduous forests	BS, C, D, G, K, L, St, Sw, YM
Blue-headed vireo	*Vireo solitarius*	Mixed coniferous and deciduous forest	BS, C, D, G, K, L, St, Sw, YM
Blue-winged teal	*Anas discors*	Marshes and lakeshores	BS, C, D, G, K, L, St, Sw, YM
Blue-winged warbler	*Vermivora pinus*	Shrubland and old fields	K, YM
Bobolink	*Dolichonyx oryzivorus*	Grassland and prairie	BS, C, D, G, K, L, St, Sw, YM
Bohemian waxwing	*Bombycilla garrulus*	Open coniferous forests	C, K, St, Sw, YM
Bonaparte’s gull	*Larus philadelphia*	Forested lakes and rivers	BS, C, D, G, K, L, St, Sw, YM
Boreal chickadee	*Parus hudsonicus*	Coniferous forests	K, St, Sw, YM
Boreal owl	*Aegolius funereas*	Coniferous forests	K
Brewer’s blackbird	*Euphagus cyanocephalus*	Prairies, fields and farmyards	BS, C, D, G, K, L, St, Sw, YM
Broad-winged hawk	*Buteo platypterus*	Deciduous woodlands	BS, C, D, G, K, L, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Brown creeper	*Certhia americana*	Mixed coniferous forest	BS, C, D, G, K, St, Sw, YM
Brown thrasher	*Toxostoma rufum*	Hedgerows and open forest	BS, C, K, St, Sw, YM
Brown-headed cowbird	*Molothrus ater*	Grasslands and forest edges	BS, C, D, G, K, St, Sw, YM
Buff-breasted sandpiper	*Tryngites subruficollis*	Prairies and grasslands	BS, C, K, St, Sw, YM
Bufflehead	*Bucephala albeola*	Wooded wetlands and ponds	BS, C, K, St, Sw, YM
Burrowing owl	*Speotyto cunicularia*	Grasslands	BS, St, Sw, YM
Cackling goose	*Branta hutchinsii*	Lakes and marshes	C, St
California gull	*Larus californicus*	Lakes	BS
Canada goose	*Branta canadensis*	Lakes and open water wetlands	BS, C, D, G, K, L, St, Sw, YM
Canada warbler	*Wilsonia canadensis*	Moist mature forests	BS, C, D, G, K, L, St, Sw, YM
Canvasback	*Aythya valisineria*	Pot holes, and open marshes	BS, C, D, G, K, L, St, Sw, YM
Cape may warbler	*Dendroica tigrina*	Open coniferous forests	BS, C, D, G, K, L, St, Sw, YM
Carolina wren	*Thryothorus ludovicianus*	Woodland thickets, ravines, and rocky slopes	K
Caspian tern	*Sterne caspienne*	Rivers and streams	BS, C, D, G, K, L, St, Sw, YM
Cattle egret	*Bubulcus ibis*	Ponds and pasturelands	BS, C, D, G, K, L, St, Sw, YM, G, D
Cedar waxwing	*Bombycilla cedrorum*	Open woodlands, fields, gardens and yards	BS, C, D, G, K, St, Sw, YM
Cerulean warbler	*Dendroica cerulea*	Deciduous forests	K
Chesnut-collared longspur	*Calcarius ornatus*	Prairie	BS, C, D, G, K, L, St, Sw, YM
Chestnut-sided warbler	*Dendroica pensylvanica*	Open woodland and scrub	BS, C, D, G, K, L, St, Sw, YM
Chimney swift	*Chaetura pelagica*	Nest in man-made structures	BS, C, K, L, St, Sw, YM
Chipping sparrow	*Spizella passerina*	Open woods and fields	BS, C, K, L, St, Sw, YM
Cinnamon teal	*Anas cyanoptera*	Shallow ponds, marshes, lakes	BS, C, D, G, K, St, Sw, YM
Clark's grebe	*Aechmophorus clarkii*	Sloughs and shallow lakes with emergent vegetation	BS, K, L, St, YM, G, D
Clay-colored sparrow	*Spizella pallida*	Prairies	BS, C, K, L, St, Sw, YM
Cliff swallow	*Petrochelidon pyrrhonata*	Open country near cliffs	BS, C, K, L, St, Sw, YM
Common goldeneye	*Bucephala clangula*	Mature forests near wetlands	BS, C, K, St, Sw, YM
Common grackle	*Quiscalus quiscula*	Open areas with scattered trees	BS, C, D, G, K, L, St, Sw, YM
Common loon	*Gavia immer*	Lakes and open water wetlands	BS, C, K, L, St, Sw, YM, G, D
Common merganser	*Mergus merganse*	Marshes, shallow lakes and ponds	BS, C, K, L, St, Sw, YM
Common moorhen	*Gallinula chloropus*	Near marshes, lakes, and ponds	C, K, St

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Common nighthawk	*Chordeiles minor*	Grasslands and open fields	BS, C, K, L, St, Sw, YM
Common redpoll	*Carduelis flammea*	Open fields, forest edges	BS, C, D, G, K, St, Sw, YM
Common tern	*Sterna hirundo*	Lakeshores	BS, C, D, G, K, L, St, Sw, YM
Common yellowthroat	*Geothlypis trichas*	Marshes and wetlands	BS, C, D, G, K, L, St, Sw, YM, G, D
Connecticut warbler	*Oporornis agilis*	Forested wetlands	BS, C, K, St, YM
Cooper's hawk	*Accipiter cooperii*	Dense deciduous and coniferous forests and riparian areas	BS, C, D, G, K, L, St, Sw, YM, G, D
Curlew sandpiper	*Calidris ferruginea*	Mudflats	BS
Dark-eyed junco	*Junco hyemalis*	Mixed open woods and brush	BS, C, K, L, St, Sw, YM
Dickcissel	*Spiza americana*	Prairies, grasslands, and pastureland	BS, C, K, L, St, Sw, YM
Double-crested cormorant	*Phalacrocorax auritus*	Lakes, rivers, and marshes	BS, C, D, G, K, St, Sw, YM, G, D
Downy woodpecker	*Picoides pubescens*	Mixed woodlands and bottomland forests, forest edges	BS, C, K, L, St, Sw, YM
Dunlin	*Calidris alpina*	Wet meadows and ponds	BS, C, D, G, K, St, Sw, YM
Eared grebe	*Podiceps nigricollis*	Open water with emergent vegetation	BS, C, D, G, K, L, St, Sw, YM
Eastern bluebird	*Sialia sialis*	Grasslands and open woods	BS, C, K, L, St, Sw, YM
Eastern kingbird	*Tyrannus tyrannus*	Open areas and forest edges	BS, C, K, L, St, Sw, YM
Eastern meadowlark	*Sturnella magna*	Grasslands and prairies	C, K, Sw, YM, G, D
Eastern phoebe	*Sayornis phoebe*	Open woodlands near streams	BS, C, D, G, K, L, St, Sw, YM
Eastern screech-owl	*Otus kennicotti*	Open woods and forest edges	BS, C, K, L, St, Sw, YM
Eastern towhee	*Pipilo erythrophthalmus*	Open woods and forest edges	BS, C, K, L, St, Sw, YM
Eastern wood-pewee	*Contopus virens*	Open woods, forest edges	BS, C, D, G, K, St, Sw, YM
Eurasian collared-dove	*Streptopelia decaocto*	Parks, fields, and farmland	BS, C, K, Sw
European starling	*Sturnus vulgaris*	Open fields and farmland	BS, C, D, G, K, L, St, Sw, YM
Evening grosbeak	*Coccothraustes vespertinus*	Coniferous forests	BS, C, K, St, Sw, YM
Ferruginous hawk	*Buteo regalis*	Grassland and farmland	BS, C, D, G, K, St, YM
Field sparrow	*Spizella pusilla*	Pastures and old fields	BS, C, D, G, K, L, St, Sw, YM
Forster's tern	*Sterna forsteri*	Marshes	BS, C, D, G, K, L, St, Sw, YM
Fox sparrow	*Passerella iliaca*	Forest edges and scrub areas	BS, C, D, G, K, St, Sw, YM
Franklin's gull	*Larus pipixcan*	Lakeshores and marshes	BS, C, D, G, K, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Gadwall	*Anas strepera*	Marshes, rivers and ponds	BS, C, K, St, Sw, YM
Glaucous gull	*Larus hyperboreus*	Large lakes	BS, K
Golden eagle	*Aquila chrysaetos*	Open and semi-open areas	BS, C, D, G, K, St, Sw, YM
Golden-crowned kinglet	*Regulus satrapa*	Coniferous forests	BS, C, K, St, Sw, YM
Golden-crowned sparrow	*Zonotrichia atricapilla*	Forest edges and scrub areas	C
Golden-winged warbler	*Vermivora chrysoptera*	Woods and forest edges	K, Sw, YM
Grasshopper sparrow	*Ammodramus savannarum*	Grasslands, farmlands	BS, C, D, G, K, St, Sw, YM
Gray catbird	*Dumetella carolinensis*	Dense shrubby areas near forests and streams	BS, C, D, G, K, St, Sw, YM
Gray jay	*Perisoreus canadensis*	Coniferous forests	Sw
Gray partridge	*Perdix perdix*	Grasslands and farmlands	BS, C, D, G, K, St, Sw, YM
Gray-cheeked thrush	*Catharus minimus*	Coniferous forests	BS, C, K, St, Sw, YM
Great blue heron	*Ardea herodias*	Lakes, rivers and marshes	BS, C, D, G, K, St, Sw, YM
Great crested flycatcher	*Myiarchus crinitus*	Open woods and mixed forest	L
Great egret	*Ardea alba*	Lakes, rivers, and marshes	L
Great gray owl	*Strix nebulosa*	Dense coniferous forests near wetlands	K, St
Great horned owl	*Bubo virginianus*	Woodlands	BS, C, K, St, Sw, YM
Greater prairie chicken	*Tympanuchus cupido*	Mixed prairie	C, D, G, K, St
Greater scaup	*Aythya marila*	Lakes and bogs near forest	BS, C, D, G, K, St, Sw, YM
Greater white-fronted goose	*Anser albifrons*	Pot holes, ponds and grassland	BS, C, K, St, Sw, YM
Greater yellowlegs	*Tringa melanoleuca*	Lakes, ponds and marshes	BS, C, D, G, K, L, St, Sw, YM
Green heron	*Butorides virescens*	Lakes, rivers, and marshes	BS, C, D, G, K, St, Sw, YM,
Green-winged teal	*Anas crecca*	Marshes and ponds	BS, C, D, G, K, L, St, Sw, YM, G, D
Gyrfalcon	*Falco rusticolus*	Open areas near river bluffs	BS, C
Hairy woodpecker	*Picoides villosus*	Deciduous forests	BS, C, K, L, St, Sw, YM
Harlequin duck	*Histrionicus histrionicus*	Wetland and riparian areas	BS, K
Harris's sparrow	*Zonotrichia querula*	Wetlands and scrub areas	BS, C, K, St, Sw, YM
Henslow's sparrow	*Ammodramus henslowii*	Grassland	BS, K, Sw
Hermit thrush	*Catharus tuttatus*	Mixed forest	BS, C, D, G, K, St, Sw, YM
Herring gull	*Larus argentatus*	Lakes and rivers	BS, C, K, St, Sw, YM
Hoary redpoll	*Carduelis hornemanni*	Shrubby open areas	BS, K, St, Sw, YM
Hooded merganser	*Lophodytes cucullatus*	Marshes and lakes	BS, C, K, St, Sw, YM
Horned grebe	*Podiceps auritus*	Lakes and ponds	BS, C, D, G, K, St, Sw, YM
Horned lark	*Eremophila alpestris*	Grassland and farmland	BS, C, D, G, K, L, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
House finch	*Carpodacus mexicanus*	Developed areas, farmland and grassland	BS, C, D, G, K, St, Sw, YM
House sparrow	*Passer domesticus*	Developed areas, farmland and grassland	BS, C, D, G, K, L, St, Sw, YM
House wren	*Troglodytes aedon*	Developed areas, farmland, forest edges	BS, C, D, G, K, L, St, Sw, YM
Hudsonian godwit	*Limosa haemastica*	Mudflats and wetland	BS, C, K, St, Sw, YM
Indigo bunting	*Passerina cyanea*	Farmland and old fields	BS, C, D, G, K, St, Sw, YM
Kentucky warbler	*Oporornis formosus*	Moist deciduous forests	K
Killdeer	*Charadrius vociferus*	Mudflats	BS, C, D, G, K, St, Sw, YM
King eider	*Somateria spectabilis*	Pot holes and marshes	C
King rail	*Rallus elegans*	Marshes and ponds	D, G, K, Sw
Lapland longspur	*Calcarius lapponicus*	Prairies, pastures and wetlands	BS, C, D, G, K, St, Sw, YM
Lark bunting	*Calamospiza melanocorys*	Prairies and grasslands	BS, C, D,G,YM
Lark sparrow	*Chondestes grammacus*	Grasslands and savannah	BS, C, D, G, K, L, YM
Lazuli bunting	*Passerina amoena*	Scrubby fields and riparian areas	K, D, G
Leconte's sparrow	*Ammodramus leconteii*	Grasslands and wet meadows	BS, C, D, G, K, St, Sw, YM
Least bittern	*Ixobrychus exilis*	Marshes	BS, C, K, St, Sw, YM, G, D
Least flycatcher	*Empidonax minimus*	Mixed forests and marsh edges	BS, C, K, L, St, Sw, YM
Least sandpiper	*Calidris minutilla*	Marshes and wet meadows	BS, C, K, St, Sw, YM
Lesser scaup	*Aythya affinis*	Marshes and ponds	BS, C, K, St, Sw, YM
Lesser yellowlegs	*Tringa flavipes*	Open woods	BS, C, D, G, K, St, Sw, YM
Lincoln’s sparrow	*Melospiza lincolnii*	Marshes and wooded wetlands	BS, C, D, G, K, St, Sw, YM
Little blue heron	*Egretta caerulea*	Marshes, lakes and ponds	BS, K, YM, G, D
Little gull	*Larus minutus*	Lakes	BS
Loggerhead shrike	*Lanius ludovicianus excubitorides*	Fields, savannah and open woods	BS, C, D, G, K, St, Sw, YM
Long-billed curlew	*Numenius americanus*	Grasslands and prairies	K, Sw
Long-billed dowitcher	*Limnodromus scolopaceus*	Mudflats and marshes	BS, C, D, G, K, St, Sw, YM
Long-eared owl	*Asio otus*	Open woods and forest edges	BS, C, D, G K, Sw, YM
Long-tailed duck	*Clangula hyemalis*	Marshes and lakes	BS, K, YM
Magnolia warbler	*Dendroica magnolia*	Mixed coniferous woods	BS, C, K, L, St, Sw, YM
Mallard	*Anas platyrhynchos*	Marshes, lakes and ponds	BS, C, K, L, St, Sw, YM
Marbled godwit	*Limosa fedoa*	Prairies	BS, C, K, L, St, Sw, YM
Marsh wren	*Cistothorus palustris*	Marshes	BS, C, K, L, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Merlin	*Falco columbarius*	Prairies and coniferous forests	BS, C, K, St, Sw, YM
Mountain bluebird	*Sialia currucoides*	Forest edges and grasslands	C, K, Sw
Mourning dove	*Zenaida macroura*	Open woodland and grasslands, developed areas	BS, C, D, G, K, St, Sw, YM
Mourning warbler	*Oporornis philadelphia*	Open woodlands and scrubland	BS, C, K, St, Sw, YM
Mute swan	*Cygnus olor*	Lakes and ponds	Sw
Nashville warbler	*Vermivora ruficapilla*	Forest edges	BS, C, D, G, K, L, St, Sw, YM
Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*	Marshes and wet meadows	Sw
Neotropic cormorant	*Phalacrocorax brasilianus*	Marshes	BS
Northern cardinal	*Cardinalis cardinalis*	Forest edges and scrub areas	BS, C, K, St, Sw, YM
Northern flicker	*Colaptes auratus*	Open woods and forest edges	BS, C, K, St, Sw, YM
Northern goshawk	*Accipiter gentilis*	Coniferous forests	BS, K, St, Sw, YM
Northern harrier	*Circus cyaneus*	Open fields, grasslands, wet meadows and marshes	BS, C, D, G, K, St, Sw, YM
Northern hawk owl	*Surnia ulula*	Coniferous forests	K, St
Northern mockingbird	*Mimus polyglottos*	Forest edges and pastureland	BS, K, St, Sw, YM
Northern parula	*Parula americana*	Moist forests	C, K, St, Sw, YM
Northern pintail	*Anas acuta*	Pot holes and marshes	BS, C, K, St, Sw, YM
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Open woods and grasslands	BS, C, D, G, K, St, Sw, YM
Northern saw-whet owl	*Aegolius acadicus*	Mixed forest	BS, C, D, G, K, St, YM
Northern shoveler	*Anas clypeata*	Pot holes and marshes	BS, C, K, St, Sw, YM
Northern shrike	*Lanius excubitor*	Open fields and grasslands	BS, C, K, St, Sw, YM
Northern waterthrush	*Seiurus noveboracensis*	Lakeshores, marshes, and wooded wetlands	BS, C, K, St, Sw, YM
Olive-sided flycatcher	*Contopus cooperi*	Woodlands	BS, C, K, St, Sw, YM
Orange-crowned warbler	*Vermivora celata*	Shrubby mixed woodlands	BS, C, D, G, K, St, Sw, YM
Orchard oriole	*Icterus spurius*	Deciduous riparian forests	BS, C, K, St, Sw, YM
Osprey	*Pandion halieatus*	Lakes and rivers	BS, C, K, St, Sw, YM
Ovenbird	*Seiurus aurocapilla*	Mixed upland forests	BS, C, K, St, Sw, YM
Palm warbler	*Dendroica palmarum*	Open grasslands	BS, C, D, G, K, St, Sw, YM
Pectoral sandpiper	*Calidris melanotos*	Flooded areas, marshes, lakeshores	BS, C, K, St, Sw, YM
Peregrine falcon	*Falco peregrinus*	Open grasslands and wetlands near cliffs	BS, C, D, G, K, St, Sw, YM
Philadelphia vireo	*Vireo gilvus*	Open woodlands and riparian areas	BS, C, K, St, Sw, YM
Pied-billed grebe	*Podilymbus podiceps*	Marshes and ponds	BS, C, K, St, Sw, YM, G, D
Pileated woodpecker	*Dryocopus pileatus*	Mature forests	BS, C, K, St, Sw, YM
Pine grosbeak	*Pinicola enucleator*	Coniferous forests	C, K, St, Sw, YM
Pine siskin	*Carduelis pinus*	Coniferous forests	BS, C, K, St, Sw, YM
Pine warbler	*Dendroica pinus*	Coniferous forests	BS, K, Sw
Piping plover	*Charadrius melodus*	Lakes and ponds	BS, D, G, St, YM
Prairie falcon	*Falco mexicanus*	Grasslands	BS, D, G, Sw, YM
Prothonotary warbler	*Protonotaria citrea*	Bottomland and riparian forests	K, Sw

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution**[2]
Purple finch	*Carpodacus purpureus*	Coniferous forests	BS, C, K, St, Sw, YM
Purple martin	*Progne subis*	Open woods and pastureland	BS, C, K, St, Sw, YM
Red crossbill	*Loxia curvirostra*	Coniferous forests	BS, C, K, St, Sw, YM
Red knot	*Calidris canutus*	Marshes	BS, K, St
Red-bellied woodpecker	*Melanerpes carolinus*	Open and moist woodlands	BS, C, D, G, K, St, Sw, YM
Red-breasted merganser	*Mergus serrator*	Lakes and ponds	BS, C, K, St, Sw, YM
Red-breasted nuthatch	*Sitta canadensis*	Coniferous forests	BS, C, K, St, Sw, YM
Red-eyed vireo	*Vireo olivaceus*	Deciduous forests	BS, C, K, St, Sw, YM
Redhead	*Aythya americana*	Lakes, ponds, and marshes	BS, C, K, St, Sw
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Open woods and forest edges	BS, C, D, G, K, St, Sw, YM
Red-necked grebe	*Podiceps grisegena*	Lakes and ponds	BS, C, K, St, Sw, YM
Red-necked phalarope	*Phalaropus lobatus*	Marshes and ponds	BS, D, G, K, St, Sw, YM
Red-shouldered hawk	*Buteo lineatus*	Mature forests near lakes and streams	BS, C, K, St, Sw, YM
Red-tailed hawk	*Buteo jamaicensis*	Grasslands and deciduous forests	BS, C, D, G, K, St, Sw, YM
Red-winged blackbird	*Agelaius phoeniceus*	Marshes and wet meadows	BS, C, K, St, Sw, YM
Ring-billed gull	*Larus delawarensis*	Lakes and rivers	BS, C, K, L, St, Sw, YM
Ring-necked duck	*Aythya collaris*	Marshes	BS, C, K, St, Sw, YM
Ring-necked pheasant	*Phasianus colchicus*	Farmland and old fields	BS, C, D, G, K, L, St, Sw, YM
Rock pigeon	*Columba livia*	Dry rocky areas and urban zones	BS, C, K, St, Sw, YM
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Open deciduous forests	BS, C, D, G, K, St, Sw, YM
Ross's goose	*Chen rossii*	Marshes and ponds	BS, C, K, St, Sw, YM
Rough-legged hawk	*Buteo lagopus*	Grasslands, farmlands and marshes	BS, C, D, G, K, St, Sw, YM
Ruby-crowned kinglet	*Regulus calendula*	Mixed forests	BS, C, K, St, Sw, YM
Ruby-throated hummingbird	*Archilochus colubris*	Mixed forests and forest edges	BS, C, D, G, K, St, Sw, YM
Ruddy duck	*Oxyura jamaicensis*	Marshes, lakes and pot holes	BS, C, K, St, Sw, YM
Ruddy turnstone	*Arenaria interpres*	Marshes, ponds	BS, C, D, G, K, St, Sw, YM
Ruff	*Philomachus pugnax*	Marshes, ponds and wet meadows	BS, K, St, YM
Ruffed grouse	*Bonasa umbellus*	Open woods and scrub areas	K
Rusty blackbird	*Euphagus carolinus*	Swamps and riparian areas	BS, C, K, St, Sw, YM
Sabine's gull	*Xema sabini*	Lakes and ponds	BS, K
Sage thrasher	*Oreoscoptes montanus*	Brushy, scrub areas	YM
Sanderling	*Calidris alba*	Lakes	BS, C, K, St, Sw, YM
Sandhill crane	*Grus canadensis*	Wetlands mixed with shrubby uplands	BS, C, D, G, K, St, Sw, YM
Savannah sparrow	*Passerculus sandwichensis*	Prairies, meadows and pastures	BS, C, D, G, K, St, Sw, YM
Say's phoebe	*Sayornis saya*	Grasslands and shrubland	BS
Scarlet tanager	*Piranga olivacea*	Woodlands	BS, C, D, G, K, St, Sw, YM
Sedge wren	*Cistothorus platensis*	Marshes and wet meadows	BS, C, D, G, K, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Semipalmated plover	*Charadrius semipalmatus*	Mudflats, lakes and marshes	BS, C, K, St, Sw, YM
Semipalmated sandpiper	*Calidris pusilla*	Lakes and marshes	BS, C, D, G, K, St, Sw, YM
Sharp-shinned hawk	*Accipiter striatus*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Sharp-tailed grouse	*Tympanuchus phasianellus*	Prairie	BS, D, G
Short-billed dowitcher	*Limnodromus griseus*	Wooded wetlands and coniferous bogs	BS, C, D, G, K, St, Sw, YM
Short-eared owl	*Asio flammeus*	Grassland	BS, C, K, St, Sw, YM
Smith's longspur	*Calcarius pictus*	Forest edges and grasslands	BS, St, YM
Snow bunting	*Plectrophenax nivalis*	Grassland and farmland	BS, C, K, St, Sw, YM
Snowy egret	*Egretta thula*	Marshes and ponds	BS, K, St, YM, G, D
Snowy owl	*Nyctea scandiaca*	Open fields and pastures	BS, C, K, St, Sw, YM
Solitary sandpiper	*Tringa solitaria*	Ponds and marshes near coniferous forests	BS, C, D, G, K, St, Sw, YM
Song sparrow	*Melospiza melodia*	Wet meadows, marshes and riparian areas	BS, C, D, G, K, L, St, Sw, YM
Sora	*Porzana carolina*	Marshes	BS, C, D, G, K, St, Sw, YM
Spotted sandpiper	*Actitis macularius*	Marshes, lakes and rivers	BS, C, D, G, K, St, Sw, YM
Spotted towhee	*Pipilo maculatus*	Forest edges and open woodlands	St
Sprague's pipit	*Anthus spragueii*	Prairies	BS, St
Stilt sandpiper	*Calidris himantopus*	Lakes and ponds	BS, C, D, G, K, St, Sw, YM
Summer tanager	*Piranga rubra*	Mixed forests and forest edges	BS, K, St, Sw
Surf scoter	*Melanitta perspicillata*	Ponds and marshes	BS, C
Swainson’s hawk	*Buteo swainsoni*	Grasslands and farmlands	BS, C, D, G ,K, St, Sw, YM
Swainson’s thrush	*Catharus ustulatus*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Swamp sparrow	*Melospiza georgiana*	Marshes and scrub-shrub wetlands	BS, C, D, G, K, St, Sw, YM
Tennessee warbler	*Vermivora peregrina*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Thayer's gull	*Larus thayeri*	Lakes and rivers	BS, K
Townsend's solitaire	*Myadestes townsendi*	Open woodlands	BS, C, K, St, Sw, YM
Tree swallow	*Tachycineta bicolor*	Wooded areas near wetlands	BS, C, K, St, Sw, YM
Trumpeter swan	*Cygnus buccinator*	Lakes, streams and marshes	BS, C, K, Sw
Tufted titmouse	*Baelophos bicolor*	Mixed forests	C, K
Tundra swan	*Cygnus columbianus*	Lakes and ponds	BS, C, K, St, Sw, YM
Turkey vulture	*Cathartes aura*	Grasslands	BS, C, K, St, Sw, YM
Upland sandpiper	*Bartramia longicauda*	Dry prairies	BS, C, D, G, K, St, Sw, YM
Varied thrush	*Ixoreus naevius*	Moist coniferous forests	BS, C, K, St, Sw
Veery	*Catharus fuscescens*	Bottomland and riparian forests	BS, C, D, G, K, St, Sw, YM
Vermilion flycatcher	*Pyrocephalus rubinus*	Riparian forests	K
Vesper sparrow	*Pooecetes gramineus*	Open grasslands and pastures	BS, C, K, St, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Virginia rail	*Rallus limicola*	Marshes and ponds	BS, C, D, G, K, St, Sw, YM
Warbling vireo	*Vireo gilvus*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Western grebe	*Aechmophorus occidentalis*	Lakes and ponds	BS, C, K, St, Sw, YM, G, D
Western kingbird	*Tyrannus verticalis*	Grasslands and pastureland	BS, C, K, St, Sw, YM
Western meadowlark	*Sturnella neglecta*	Grassland	BS, C, D, G, K, St, Sw, YM
Western sandpiper	*Calidris mauri*	Mudflats and marshes	BS, Sw
Western tanager	*Piranga ludoviciana*	Mixed forests	K, St
Whimbrel	*Numenius phaeopus*	Mudflats and marshes	BS, K
Whip-poor-will	*Caprimulgus vociferus*	Upland forests	BS, C, K, Sw, YM
White-breasted Nuthatch	*Sitta carolinensis*	Open woodlands	BS, C, D, G, K, St, Sw, YM
White-crowned Sparrow	*Zonotrichia leucophyrus*	Boreal forests	BS, C, D, G, K, St, Sw, YM
White-eyed vireo	*Vireo olivaceus*	Upland forests	C
White-faced ibis	*Plegadis chihi*	Marshes and flooded fields	BS, C, K, Sw
White-rumped sandpiper	*Calidris fuscicollis*	Mudflats and marshes	BS, C, D, G, K, St, Sw, YM
White-throated sparrow	*Zonotrichia albicollis*	Coniferous forests	BS, C, D, G, K, St, Sw, YM
White-winged crossbill	*Loxia leucoptera*	Coniferous forests	BS, C, K, St, Sw, YM
White-winged scoter	*Melanitta fusca*	Lakes	BS, K, Sw, YM
Wild turkey	*Meleagris gallopavo*	Upland woods and grassland	BS, C, D, G, K, St, Sw, YM
Willet	*Catoptrophorus semipalmatus*	Marshes and grassland	BS, C, D, G, K, St, Sw, YM
Willow flycatcher	*Empidonax traillii*	Riparian forests	BS, C, D, G, K, St, Sw, YM
Wilson’s phalarope	*Phalaropus tricolor*	Marshes, ponds and mudflats	BS, C, D, G, K, St, Sw, YM
Wilson’s warbler	*Wilsonia pusilla*	Moist forests and riparian areas	BS, C, K, St, Sw, YM
Wilson's snipe	*Gallinago delicata*	Marshes, ponds and fresh meadows	BS, C, K, St, Sw, YM
Winter wren	*Troglodytes troglodytes*	Mixed forests	BS, C, K, St, Sw, YM
Wood duck	*Aix sponsa*	Forested wetlands and marshes near woods	BS, C, D, G, K, St, Sw, YM
Wood thrush	*Hylocichla mustelina*	Deciduous forests	BS, C, D, G, K, L, St, Sw, YM
Worm-eating warbler	*Helmintheros vermivorous*	Deciduous forests	K
Yellow rail	*Coturnicops noveboracensis*	Marshes and wet meadows	K, D, G
Yellow warbler	*Dendroica petechia*	Riparian areas	BS, C, K, St, Sw, YM
Yellow-bellied flycatcher	*Sphyrapicus varius*	Mixed forests	BS, C, K, St, Sw, YM
Yellow-bellied sapsucker	*Sphyrapicus varius*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Yellow-billed cuckoo	*Coccyzus americanus*	Open woodlands	BS, C, K, Sw, YM

Table 1 (continued)

List of Representative Bird Species in the Proposed Project Area[1]			
Common Name	**Scientific Name**	**Habitat**	**Distribution[2]**
Yellow-breasted chat	*Icteria virens*	Forest edges and riparian areas	BS, K, YM
Yellow-crowned night-heron	*Nyctanassa violacea*	Forested wetlands	BS, St
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Marshes	BS, C, D, G, K, St, Sw, YM
Yellow-rumped warbler	*Dendroica coronata*	Mixed forests	BS, C, D, G, K, St, Sw, YM
Yellow-throated vireo	*Vireo flavifrons*	Forest edges	BS, C, D, G, K, St, Sw, YM
Yellow-throated warbler	*Dendroica dominica*	Mixed forests	K

[1] References include Minnesota Department of Natural Resources, Minnesota Ornithologists' Union and South Dakota Breed Bird Atlas.

[2] BS = Big Stone County, C= Chippewa County, D = Deuel County, G = Grant County, K = Kandiyohi County, Sw = Swift County, St = Stevens County, YM = Yellow Medicine County. No data was available for Chippewa County.

Table 1 (continued)

List of Representative Reptile and Amphibian Species of the Proposed Project Area[1]

Common Name	Scientific Name	Habitat	Distribution
American toad	*Bufo americanus*	Woodlands, grasslands and developed areas	SWM, SD
Bullsnake	*Pituophis catenifer*	Dry prairies and bluff lands	SWM
Canadian toad	*Bufo hiophrys*	Wetlands, pastureland, forests and grasslands	SWM, SD
Cope's gray treefrog	*Hyla chrysoscelis*	Prairies, grasslands and savannahs	SWM
Eastern garter snake	*Thamnophis sirtalis*	Grasslands and forest edges	SWM, SD
Eastern gray treefrog	*Hyla versicolor*	Forest edges	SWM, SD
False map turtle	*Graptemys pseudogeographica*	Slow flowing areas in large rivers	SWM
Five-lined skink	*Eumeces fasciatus*	Granite outcroppings	SWM
Fox snake	*Elaphe vulpina*	Forest edges, prairies, wet meadows	SWM
Great plains toad	*Bufo cognatus*	Grasslands	SWM, SD
Milk snake	*Lampropeltis triangulum*	Rocky outcrops	SWM
Mudpuppy	*Necturus maculosus*	Medium to large rivers and lakes	SWM, SD
Northern leopard frog	*Rana pipiens*	Wetlands, lakes and streams	SWM, SD
Northern prairie skink	*Eumeces sptentrionalis*	Dry prairies and grasslands	SWM, SD
Plains garter snake	*Thamnophis radix*	Dry plains and grasslands	SWM, SD
Redback salamander	*Plethodon cinereus*	Upland mixed and coniferous forests	SWM
Redbelly snake	*Storeria occipitomaculata*	Woodlands near marshes or lakes	SWM, SD
Smooth softshell turtle	*Apalone muticus muticus*	Rivers and streams with sandy or muddy bottoms	SWM
Snapping turtle	*Chelydra serpentina*	Lakes, rivers, ponds and marshes	SWM, SD
Spiny softshell turtle	*Trionyx spiniferus*	Rivers, streams and large lakes with sandy or muddy bottoms	SWM
Tiger salamander	*Ambystoma tigrinum*	Ponds, small mammal burrows	SD

[1] References: Minnesota Herpetological Society, Nongame Birds, Small Mammals, Herptiles: Fishes: Sand Lake National Wildlife Refuge, 1995-1996, and South Dakota Snakes.

SWM = Southwestern Minnesota, SD = South Dakota.

Table 2. Special Status Species Potentially Occurring Within the Proposed Project Area

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area			Corridor										References
				P[1]		A		B		B1		C		C1		
				H[2]	O[3]	H	O	H	O	H	O	H	O	H	O	
Northern river otter *Lontra canadensis*	SD-T	This species inhabits streams, rivers, lakes and marshes.	This species was located within Corridor C.	Y[4]	0	Y	0	Y	0	Y	0	Y	3	Y	0	MDNR, 2005
Prairie vole *Microtus ochrogaster*	MN-SOC	This species inhabits dry, upland prairie ecosystems, pastures, alfalfa fields, and weedy areas. It feeds on grasses, forbs, seeds, roots and rhizomes.	Low to moderate. This species was located within a mile of Corridor C.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	0	MDNR, 2005; NHIS, 2005a
Birds																
American woodcock *Scolopax minor*	SD-S2	This species inhabits a mix of open fields, wet thickets, moist woods and bushy swamps.	Corridor C and Corridor C1	Y	0	Y	0	Y	0	Y	0	Y	1	Y	1[5]	NHIS, 2005a
Bald eagle *Haliaeetus leucocephalus*	FT; SD-E; MN-SOC	This species typically occurs near large water bodies that support suitable roosting and foraging habitat. Nests are commonly built in deciduous trees or conifers along lakes or other large bodies of water.	High. This species is known to nest and winter within the vicinity of the power plant and within Corridors C and C1.	Y	1	Y	0	Y	0	Y	0	Y	1	Y	1	FWS, 2004; MDNR, 2005; NHIS, 2005a, 2005c
Burrowing owl *Athene cunicularia*	MN-E	This species nests in upland habitats including abandoned burrows of prairie dogs, ground squirrels, foxes, and badgers in grassland, open shrubland, and woodland communities.	Low. This species was located within Corridor C1.	Y	0	Y	1	Y	0	Y	0	Y	0	Y	1	NHIS, 2005a
Loggerhead shrike *Lanius ludovicianus*	MN-T	This species inhabits open country, with thickets of trees, shrubs and shelterbelts adjacent to cropland, native prairie and roads.	Moderate. This species was located within Corridors C1, B, and B1.	Y	0	Y	0	Y	1	Y	1	Y	0	Y	1	MDNR, 2005; NHIS, 2005c
Wilson’s phalarope *Phalaropus tricolor*	MN-T	This species inhabits wetlands and wet meadows.	Low. This species was located within Corridor C1.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	1	MDNR, 2005; NHIS, 2005a
Reptiles																
Five-lined skink *Eumeces fasciatus*	MN-SOC	This species inhabits wooded areas with granite or limestone rock outcrops.	High. This species was located at six locations within Corridors C and C1.	N	0	Y	0	Y	0	Y	0	Y	8	Y	8	LeClere (no date); MDNR, 2005; NHIS, 2005a
Western hognose snake *Heterodon nasicus*	MN-SOC	This species inhabits grassland, prairie, and mixed forest/prairie habitats preferring sandy and gravelly areas.	Low. This species may occur throughout the project area.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	0	MDNR, 2005; NHIS, 2005a

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area	Corridor												References
				P^1		A		B		B1		C		C1		
				H^2	O^3	H	O	H	O	H	O	H	O	H	O	
Spiny softshell *Apalone spinifera*	SD-S2	This species inhabits streams, rivers and lakes with sandy or muddy bottoms.	Low. Known occurrences include the North and South Forks of the Yellow Bank River.	N	0	N	0	N	0	N	0	Y	2	Y	1	NHIS, 2005a Le Clere, 2005
Invertebrates																
Arogos skipper *Atrytone arogos*	MN-SOC	This species occurs in mesic, disturbed tall- to mixed-grass native bluestem and sand prairie ecosystems. Big bluestem is the caterpillar's host plant.	Low to moderate. This species was located within Corridors A and C1.	Y	0	Y	2	Y	0	Y	0	Y	0	Y	1	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c; USGS (no date)
Dakota skipper *Hesperia dacotae*	MN-T; FC	This species occurs in undisturbed tall- to mixed-grass prairie pastures with little bluestem, needle and thread, and purple coneflower.	Low to moderate. This species was located within Corridors A and C1.	Y	0	Y	1	Y	0	Y	0	Y	0	Y	1	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c; USGS (no date)
Pawnee skipper *Hesperia leonardus pawnee*	MN-SOC	This species occurs in undisturbed, often sandy prairies on *Liatris* blooms. The larvae feed on native grasses, especially *Bouteloua, Stipa* and *Poa.*	Low to moderate. This species was located within Corridors C and C1.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	0	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c
Powesheik skipper *Oarisma powesheik*	MN-SOC	This species inhabits wet mesic prairie ecosystems with native grasses and sedges. Its larval plants include prairie dropseed (*Sporobolus heterolepsis*) and little bluestem (*Schizachyrium scoparium*).	High. This species was located within Corridors A, B, B1, and C1.	Y	0	Y	3	Y	2	Y	2	N	0	Y	1	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS 2005c
Regal fritillary *Speyeria idalia*	MN-SOC	This species inhabits large grassland areas with prairie remnants of lightly grazed pasture lands. Its larval plants are violets, primarily prairie violet (*Violoa* pedatifida), birdfood biolte (*V. pedata*) and arrowleaf violet (*V. sagittata*).	High. This species was located within all the proposed corridors.	Y	0	Y	1	Y	3	Y	3	Y	1	Y	1	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c
Red-tailed prairie leafhopper *Aflexia rubranura*	MN-SOC	This species is known to inhabit dry to mesic prairie ecosystems. This species' host plant is prairie dropseed (*Sporobolus heterolepsis*).	Moderate. This species was located within Corridor A.	Y	0	Y	1	Y	0	Y	0	Y	0	Y	0	MDNR 2005; NHIS, 2005b

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area			Corridor										References
				P[1]		A		B		B1		C		C1		
				H[2]	O[3]	H	O	H	O	H	O	H	O	H	O	
Elktoe mussel *Alasmidonta marginata*	MN-T	This species may be found in riffle sections of small to medium-sized streams with gravel or mixed sand/gravel substrates.	Low to moderate. Known occurrences include the Minnesota and Lac qui Parle rivers in Minnesota.	N	0	N	0	N	0	N	0	Y	2	Y	2	MDNR, 2005; NHIS, 2005a
Mucket mussel *ActiNnaias legamentina*	MN-T	This species inhabits medium to large rivers with gravel or mixed sand/gravel substrates.	Low to moderate. Known occurrences include the Chippewa and Lac qui Parle rivers in Minnesota.	N	0	N	2	N	1	N	2	Y	4	Y	4	MDNR, 2005; NHIS, 2005a; NHIS, 2005c
Spike mussel *Ellipio dilatata*	MN-SOC	This species inhabits small to large streams and occasional lakes in mud or gravel substrates.	Low. Known occurrences include the Lac qui Parle River in Minnesota.	N	0	N	0	Y	0	Y	1	Y	3	Y	3	MDNR, 2005; NHIS, 2005a
Yellow sandshell mussel *Lampsilis teres*	MN-E	This species inhabits medium to large rivers with sand or fine gravel substrates.	Low to moderate. Known occurrences include the Chippewa and Lac qui Parle rivers in Minnesota.	N	0	N	0	N	0	N	0	Y	1	Y	1	NHIS, 2005c; Cummings and Mayer, 1995; Bright et al., 1995
Creek heelsplitter mussel *Lasmigona compressa*	MN-SOC; SD-S1	This species inhabits small or medium river with fine gravel or sand substrates at the beginning mark.	Low to moderate. Known occurrences include Lac qui Parle, Pomme de Terre, and Chippewa rivers in Minnesota.	N	0	N	0	Y	1	Y	1	Y	1	Y	1	MDNR, 2005; NHIS, 2005c
Fluted-shell mussel *Lasmigona costata*	MN-SOC	This species inhabits medium to large rivers with fine gravel, sand or mud and with slow to moderate flow.	Low to moderate. Known occurrences include the Minnesota River.	N	0	N	0	N	0	N	0	Y	2	Y	2	MDNR, 2005; NHIS, 2005a
Black sandshell *Ligumia recta*	MN-SOC	This species inhabits medium to large rivers in riffles and raceways in gravel or firm sand in the Minnesota and Chippewa rivers.	Low to moderate. Known occurrences include the Minnesota River.	N	0	N	0	Y	0	Y	1	Y	3	Y	3	MDNR, 2005; NHIS, 2005a; NHIS, 2005c; Bright et al., 1990; 1995
Salamander mussel *Simpsonaias ambigua*	MN-T	This species inhabits rivers on mud or gravel bars and under flat slabs of rock, stones or in ledges of underwater cliff faces.	Low. The only known record of a live specimen in Minnesota was in the St. Croix River. Shells found in the Minnesota River.	N	0	N	0	N	0	N	0	Y	2	Y	2	MDNR, 2005; NHIS, 2005a
Ellipse mussel *Venustaconcha ellipsiformis*	MN-T	This species inhabits small to medium-sized streams with gravel or mixed sand gravel substrates.	Low. Known occurrence in the Minnesota River.	N	0	N	0	N	0	N	0	Y	1	Y	1	NHIS, 2005a; Cummings and Mayer, 1995
Round pigtoe *Pleurobema coccineum*	MN-T	Habitat consists of medium and large rivers in sand, gravel, or mud substrates.	Low. Known occurrences include the Minnesota River.	N	0	N	0	N	0	N	0	Y	2	Y	2	NHIS, 2005a; Illinois Natural History Survey, 1995

Table 2 (continued)

Mammals	**Status**	**Habitat Association**	**Potential for Occurrence Within the Project Area**	**Corridor**												**References**
				P^1		**A**		**B**		**B1**		**C**		**C1**		
				H^2	**O^3**	**H**	**O**	**H**	**O**	**H**	**O**	**H**	**O**	**H**	**O**	
Threeridge mussel *Amblema plicata*	SD-S2	Habitat consists of small to large rivers and impoundments in mud, sand or gravel substrates.	Low. Known occurrences include the Whetstone River.	Y	1	Y	1	Y	1	Y	1	Y	1	Y	1	NHIS, 2005a; Illinois Natural History Survey, 1995
Cylindrical papershell mussel *ANdontoides ferussacianus*	SD-S4	Habitat includes small creeks and headwaters of larger streams in mud and sand substrates.	Low to moderate. Known occurrences include the Minnesota, North Fork Whetstone, and North Fork Yellow Bank rivers.	Y	2	Y	2	Y	2	Y	2	Y	2	Y	2	NHIS, 2005a; Illinois Natural History Survey, 1995
Wabash pigtoe mussel *Fusconaia flava*	SD-S1	Habitat is mud, sand or gravel substrates in creeks and large rivers.	Low. Known occurrences include the Minnesota, North Fork Whetstone, and North Fork Yellow Bank rivers.	Y	1	Y	2	Y	2	Y	2	Y	2	Y	2	NHIS, 2005a; Illinois Natural History Survey, 1995
Plain pocketbook mussel *Lampsilis cardium*	SD-S1	Habitat includes small creeks to large rivers in mud, sand or gravel substrates.	Low. Known occurrences include the Minnesota, North Fork Whetstone, and North Fork Yellow Bank rivers.	Y	1	Y	2	Y	2	Y	2	Y	1	Y	1	NHIS, 2005a; Illinois Natural History Survey, 1995
Fatmucket mussel *Lampsilis siliquoidea*	SD-S4	Species occurs in small to medium-size streams and lakes in mud, sand or gravel substrates.	Low to moderate. Known occurrences include the Minnesota, North Fork Whetstone, and North Fork Yellow Bank rivers.	Y	1	Y	2	Y	2	Y	2	Y	2	Y	2	NHIS, 2005a; Illinois Natural History Survey, 1995
Pink heelsplitter mussel *Potamilus alatus*	SD-S3	Habitat includes medium to large rivers in mud or mixed mud, sand and gravel substrates.	Low to moderate. Known occurrences include the North Fork Yellow Bank River.	N	0	Y	1	Y	1	Y	1	N	0	N	0	NHIS, 2005a; Illinois Natural History Survey, 1995
Fish																
Paddlefish *Polyodon spathula*	MN-T	Habitat includes large rivers and lakes.	Low known occurrence in the Minnesota River.	N	0	Y	0	Y	0	Y	0	Y	1	Y	1	NHIS, 2005a; Hatch and Schmidt, 2004
Lake sturgeon *Acipensor fulvescens*	MN-SOC	Limited numbers occur in the lower Mississippi, St. Croix, Minnesota, Red and Rainy rivers in Minnesota. Habitat consists of deep waters in large rivers.	Low potential in the Minnesota River.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	1	MDNR, 2005; NHIS 2005b, NHISc; Hatch and Schmidt, 2004.
Blue sucker *Cycleptus elongatus*	MN-SOC	Habitat consists of deep rivers with cobble and gravel bottoms.	Low. This species may be found in the lower Minnesota and Lac qui Parle rivers in Minnesota.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	1	NHIS, 2005a; Hatch and Schmidt, 2004

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area	Corridor												References
				P[1]		A		B		B1		C		C1		
				H[2]	O[3]	H	O	H	O	H	O	H	O	H	O	
Black buffalo *Ictiobus niger*	MN-SOC	This species prefers large rivers with strong currents and deep water. It also utilizes sloughs, backwaters, and impoundments.	Low. Known occurrence in the lower Minnesota River.	N	0	Y	0	Y	0	Y	0	Y	1	Y	1	NHIS, 2005a; Wisconsin DNR, 2003
PugNose shiner *Notropis aNgenus*	MN-SOC	This species inhabits vegetated areas of clear glacial lakes and streams.	Low. Known occurrences include tributaries to the Minnesota River.	N	0	Y	0	Y	0	Y	0	N	0	N	0	NHIS, 2005c; Hatch and Schmidt, 2004
Central mudminnow *Umbra limi*	SD-T	This species inhabits vegetated areas of clear glacial lakes and streams.	Low. Known occurrences include tributaries to the Minnesota River.	N	0	N	0	N	0	N	0	Y	1	Y	1	NHIS, 2005a; Eddy and Underhill, 1974
Northern redbelly dace *Percina maculata*	SD-T	Habitat mainly consists of small streams and bogs.	Low to moderate. Known occurrences include Monighan and Cobb creeks and the West Fork of Lac qui Parle River.	N	0	N	0	N	0	N	0	Y	3	Y	0	NHIS, 2005a; Eddy and Underhill, 1974
Blackside darter *Percina maculata*	SD-S2	Preferred habitat includes streams and small rivers.	Low. Known occurrences include the North Fork of the Whetstone River and the Minnesota River.	Y	1	Y	1	Y	1	Y	1	N	0	N	0	NHIS, 2005a; Eddy and Underhill, 1974
Rosyface shiner *Notropis rubellus*	SD-S2	Preferred habitat includes streams and small rivers.	Low. Known occurrences include the Whetstone River.	Y	1	Y	1	Y	1	Y	1	Y	1	Y	1	NHIS, 2005a; Eddy and Underhill, 1974
Hornyhead chub *Ncomis biguttatus*	SD-S3	Habitat mainly includes small and medium-size streams, but also occurs in lakes and large rivers.	Low to moderate. Known occurrences include the Whetstone River, North Fork of the Whetstone River, Monighan Creek, and the Yellow Bank River.	Y	2	Y	4	Y	4	Y	4	Y	2	Y	2	NHIS, 2005a; Eddy and Underhill, 1974
Golden redhorse *Moxostoma erythrurum*	SD-SH	It occurs in streams, rivers and lakes.	Low. Known occurrences include the Whetstone River, North Fork of the Whetstone River and Minnesota River.	Y	0	Y	2	Y	1	Y	2	Y	1	Y	1	NHIS, 2005a; Eddy and Underhill, 1974

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area	Corridor												References
				P[1]		A		B		B1		C		C1		
				H[2]	O[3]	H	O	H	O	H	O	H	O	H	O	
Plant Species																
Eared false foxglove *Agalinis auriculata*	MN-E	This species inhabits mesic and wet prairie habitats preferring calcareous soils at the base of river bluffs or on terraces.	Low. No known occurrences within any corridor; however, potentially suitable habitat is present within the proposed plant site and each proposed corridor.	Y	0	Y	0	Y	1	Y	1	Y	0	Y	0	NHIS, 2005c
Red three-awn *Aristida purpurea var. longiseta*	MN-SOC	This species inhabits dry hills and plains.	Moderate. Known occurrence within Corridor C1.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	1	MDNR, 2005; NHIS, 2005b
Sullivant's milkweed *Asclepias sullivantii*	MN-T	This species inhabits undisturbed mesic, tallgrass prairies and is commonly associated with other rare prairie species such as tuberous Indian-plantain (*Cacalia plantaginea*) and wild quinine (*Parthenium integrifolium*).	Moderate. Known occurrence in Corridors C and C1 in Yellow Medicine County, Minnesota.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	1	MDNR, 2005; NHIS, 2005a
Slender milkvetch *Astragalus flexuosus*	MN-SOC	This species inhabits mesic and dry mesic prairie habitats confined to dry, gravelly or rocky ridges, terraces and kames.	Moderate. Known occurrences in Corridors A, B, and B1 in Big Stone County, Minnesota.	Y	1	Y	3	Y	2	Y	2	Y	0	Y	3	MDNR, 2005; NHIS, 2005a; NHIS, 2005b
Missouri milkvetch *Astragalus missouriensis*	MN-SOC	This species inhabits dry, gravelly prairie slopes preferring open soil between clumps of perennial grasses. Species is frequently associated with other rare, peripheral species such as yellow prairie violet (*Viola nuttallii*) and cutleaf ironplant (*Haplopappus spinulosus*).	Moderate. Known occurrences in Corridors A, C, and C1, in Chippewa and Lac qui Parle counties, Minnesota.	Y	0	Y	1	Y	0	Y	0	Y	6	Y	7	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c`
Prairie moonwart *Botrychium campestre*	MN-SOC	This species inhabits exposed dry prairie or dune habitats, as well as sandy, dry disturbed sites, such as roadsides and old fields.	Moderate. Known occurrence at the proposed plant site in Grant County, South Dakota.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	1	MDNR, 2005; NHIS, 2005b
Black disc lichen *Buellia nigra*	MN-E	This species inhabits exposed granite or chert rocks near hardwood forests.	Moderate. Known occurrences in all proposed corridors in Yellow Medicine, Chippewa, Big Stone, and Lac qui Parle counties, Minnesota.	Y	1	Y	2	Y	2	Y	2	Y	2	Y	1	MDNR, 2005; NHIS, 2005a; NHIS, 2005b; NHIS, 2005c

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area	Corridor												References
				P[1]		A		B		B1		C		C1		
				H[2]	O[3]	H	O	H	O	H	O	H	O	H	O	
Larger water-starwort *Callitriche heterophylla*	MN-SOC	This species inhabits shallow water or mud of springs and stream pools, in open areas.	Moderate. Known occurrences in Corridors A, B, and B1 in Big Stone County, Minnesota.	Y	1	Y	1	Y	1	Y	1	Y	1	Y	1	MDNR, 2005; NHIS, 2005b; NHIS, 2005c
Yellow-fruited sedge *Carex a0ctens*	MN-SOC	This species inhabits wet prairies, pond margins and ditches. Populations have also been found in sparsely vegetated sand dune habitats.	Moderate. Known occurrences in Corridor C in Yellow Medicine County, Minnesota.	Y	0	Y	0	Y	0	Y	0	Y	2	Y	0	MDNR, 2005; NHIS, 2005a
Short-pointed umbrella sedge *Cyperus acuminatus*	MN-T	This species inhabits wetland and riparian areas associated with sparsely vegetated shallow rock pools with a thin layer of organic soil.	Low. No known occurrences within any proposed corridor; however, potentially suitable habitat is present within the proposed plant site and each proposed corridor.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	0	NHIS, 2005c
Small white lady's-slipper *Cypripedium candidum*	MN-SOC	This species inhabits wet to wet-mesic prairies, sedge meadows and calcareous fens. Populations have also been found on dry hill prairies.	Moderate. Known occurrences in Corridors B and B1 in Big Stone, Swift, Chippewa, and Kandiyohi counties, Minnesota.	Y	0	Y	0	Y	5	Y	5	Y	0	Y	0	MDNR, 2005; NHIS, 2005c
White prairie clover *Dalea candida var. oligophylla*	MN-SOC	This species inhabits mesic prairies, although it can also tolerate dry conditions and can be found in savannahs.	Low. No known occurrences within any proposed corridor; however, potentially suitable habitat is present within the proposed plant site and each proposed corridor.	Y	0	Y	0	Y	0	Y	0	Y	5	Y	0	MDNR, 2005; NHIS, 2005a
Prairie mimosa *Desmanthus illiNensis*	MN-SOC	This species inhabits shallow prairie lake margins and stream banks, usually in open areas.	Moderate. Known occurrences within Corridor A in Big Stone County, Minnesota.	Y	0	Y	3	Y	0	Y	0	Y	0	Y	0	MDNR, 2005; NHIS, 2005b; NHIS, 2005c
Few-flowered spike-rush *Eloecharis qinqueflora*	MN-SOC	This species inhabits open areas in calcareous fen, wet prairie, and sedge meadow habitats.	Moderate. Known occurrences within Corridors B and B1 in Big Stone County, Minnesota.	Y	0	Y	0	Y	1	Y	1	Y	0	Y	0	MDNR, 2005; NHIS 2005c
Ball cactus *Escobaria vivipara*	MN-E	This species inhabits rock outcrops preferring sandy or rocky soils in dry areas. Occasionally associated with oak trees.	Moderate. Known occurrences within Corridors A, B, and B1, and the proposed plant site.	Y	10	Y	9	Y	9	Y	9	Y	0	Y	0	MDNR, 2005; NHIS, 2005b; NHIS, 2005c

Table 2 (continued)

Mammals	Status	Habitat Association	Potential for Occurrence Within the Project Area	Corridor												References
				P¹		A		B		B1		C		C1		
				H²	O³	H	O	H	O	H	O	H	O	H	O	
Cutleaf ironplant *Haplopappus spinulosus*	MN-SOC	This species inhabits rock outcrops, on excessively drained hillsides. Often found on river bluffs, kames, eskers or morainic ridges.	Moderate. Known occurrences within Corridor C1 in Big Stone and Swift counties, Minnesota.	Y	0	Y	0	Y	2	Y	2	Y	0	Y	2	NHIS, 2005c
Mudwort *Limosella aquatica*	MN-SOC	This species occurs along stream banks, shallow margins of prairie ponds and rock pools.	Moderate. Known occurrences within Corridors A, B, and B1 in Big Stone County, Minnesota.	Y	0	Y	3	Y	3	Y	3	Y	0	Y	0	MDNR, 2005; NHIS, 2005b; NHIS, 2005c
Sea naiad *Najas marina*	MN-SOC	This species inhabits shallow water of brackish lakes and marshes.	Low. No known occurrences within any proposed corridor; however, suitable habitat is present within each proposed corridor.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	0	MDNR, 2005; NHIS, 2005c
Plains prickly pear *Opuntia macrorhiza*	MN-SOC	This species inhabits rocky and sandy soil in grasslands preferring thin soil over bedrock, and commonly occurs in crevices of exposed bedrock. This species is intolerant of shading and will decline if habitat is overgrown with trees or shrubs.	Moderate. Known occurrences within Corridor C1.	Y	0	Y	0	Y	0	Y	0	Y	3	Y	3	MDNR, 2005; NHIS, 2005a
Clustered broomrape *Orobanche fasciculate*	MN-SOC	This species inhabits granite outcrops, dry gravelly prairies and sand dunes. The species primarily occurs on the roots of wormwood (*Artemisia* spp).	Moderate. Known occurrences within Corridor C1.	Y	0	Y	0	Y	0	Y	0	Y	2	Y	2	MDNR, 2005; NHIS, 2005a
Western prairie fringed orchid *Platanthera praeclara*	FT; MN-E	This species inhabits wet calcareous or subsaline prairie and sedge meadow habitats.	Low. No known occurrences within any corridor; however, suitable habitat is present within the proposed plant site, and each proposed corridor.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	0	FWS, 2004; NHIS, 2005c
Hair-like beak rush *Rhynchospora capillacea*	MN-T	This species inhabits calcareous fens and bogs and the margins of fen pools and marl flats. Less often it is found in spring fens within large peatland complexes in forested areas.	Moderate. Known occurrences in Corridors B and B1 in Kandiyohi and Big Stone counties, Minnesota.	Y	0	Y	0	Y	1	Y	1	Y	0	Y	0	MDNR, 2005; NHIS, 2005c

Table 2 (continued)

Mammals	**Status**	**Habitat Association**	**Potential for Occurrence Within the Project Area**			**Corridor**										**References**
				P[1]		**A**		**B**		**B1**		**C**		**C1**		
				H[2]	**O[3]**	**H**	**O**	**H**	**O**	**H**	**O**	**H**	**O**	**H**	**O**	
Widgeon grass *Ruppia maritime*	MN-SOC	This species inhabits saline areas of marshes and mudflats.	Low. No known occurrences within any corridor; however, suitable habitat is present within the proposed plant site and each proposed corridor.	N	0	Y	0	Y	0	Y	0	Y	0	Y	0	NHIS, 2005c
Tumblegrass *Schedonnardus paniculatus*	MN-SOC	This species inhabits tallgrass prairie habitat, preferring rocky areas. In Minnesota, it is usually found in sparsely vegetated cracks in quartzite outcrops and in thin soil at the base of outcrops.	Moderate. Known occurrences within Corridors A, B, and B1 and in the proposed plant site.	Y	1	Y	1	Y	1	Y	1	Y	0	Y	0	MDNR, 2005; NHIS, 2005b; NHIS, 2005c
Soft goldenrod *Solidago mollis*	MN-SOC	This species inhabits dry shortgrass prairie habitats, sometimes in association with other rare species such as the yellow prairie violet, cutleaf ironplant, and Missouri milkvetch.	Low. No known occurrences within any corridor; however, suitable habitat is present within the proposed plant site and each proposed corridor.	Y	0	Y	0	Y	0	Y	0	Y	0	2	2	NHIS, 2005b
SNw trillium *Trillium nivale*	SD-S2	This species inhabits moist, hardwood forests, preferring bottomlands of large or moderate-sized river valleys, but also occurring on slopes and terraces.	Moderate. Known occurrence within the proposed plant site in Grant County, South Dakota.	Y	0	Y	0	Y	0	Y	0	Y	0	Y	0	MDNR, 2005; NHIS, 2005b
Yellow prairie violet *Viola nuttallii*	MN-T	This species inhabits loose, barren soil on gravelly kame and morainic formations. It usually occurs with other rare peripheral species such as Missouri milkvetch and cutleaf ironplant.	Moderate. Known occurrence in Corridor C.	Y	0	Y	0	Y	0	Y	0	Y	1	Y	0	MDNR, 2005; NHIS, 2005a

FE = Federally listed as endangered.
FT= Federally listed as threatened.
FT w/ CH = Federally listed as threatened with critical habitat.
FC = Federal Candidate.
PE = Proposed to be listed as Federally endangered.
PT = Proposed to be listed as Federally threatened.
SD-E= State listed as endangered in South Dakota.
SD-T= State listed as threatened in South Dakota.
SD-S1=Critically imperiled because of extreme rarity.
SD-S2=Imperiled because of rarity.
SD-S3=Either very rare or local throughout its range or found locally in restricted range.
SD-S4=Apparently secure although it may be quite rare in parts of its range.
SD-SH=Historically known, may be rediscovered.
MN-E= State listed as endangered in Minnesota.
MN-T= State listed as threatened in South Dakota.

Sources: NHIS, 2005a

[1] Proposed power plant.
[2] H= Suitable habitat present.
[3] Number of occurrence records for species within project area.
[4] Y= Yes, N = No.
[5] = Within a mile of the corridor.

Table 3. Common and Scientific Names of Fish Species in the Proposed Project Area

Common Name	Scientific Name
Eels	Family Anguillidae
Trout	Family Salmonidae
Brook trout	*Salvelinus fontinalis*
Gar	Family Lepisosteidae
Gar species	*Lepisosteus* spp.
Bowfin	Family Amiidae
Bowfin	*Amia calva*
Paddlefish	Family Polyodontidae
Paddlefish	*Polyodon spathula*
Mudminnows	Family Umbridae
Central mudminnow	*Umbra limi*
Minnows	Family Cyprinidae
Central stoneroller	*Campostoma anomalum*
Spotfin shiner	*Cyprinella spilopterus*
Common carp	*Cyprinus carpio*
Brassy minnow	*Hybognathus hankinsoni*
Common shiner	*Luxilus cornutus*
Hornyhead chub	*Nocomis biguttatus*
Golden shiner	*Notemigonus cyrsoleucas*
Emerald shiner	*Notropis atherinoides*
Bigmouth shiner	*N. dorsalis*
Spottail shiner	*N. hudsonius*
Rosyface shiner	*N. rubellus*
Sand shiner	*N. stramineus*
Bluntnose shiner	*N. Simus*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*P. promelas*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Suckers	Family Catostomidae
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersoni*
Bigmouth buffalo	*Ictiobus cyprinellus*
Black buffalo	*I. niger*
Silver redhorse	*Moxostoma anisurum*
Golden redhorse	*M. erythrurum*
Shorthead redhorse	*M. macrolepidotum*
Greater redhorse	*M. valenciennesi*
Catfishes	Family Ictaluridae
Black bullhead	*Ameriurus melas*
Yellow bullhead	*A. natalis*
Brown bullhead	*A. nebulosus*
Channel catfish	*Ictalurus punctatus*
Stonecat	*Noturus flavus*
Tadpole madtom	*Noturus gyrinus*
Pike	Family Esocidae
Northern pike	*Esox lucius*
Sunfishes	Family Centrachidae
Rock Bass	*Ambloplites rupestris*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*L. gibbosus*
Orangespotted sunfish	*L. humilis*
Bluegill	*L. macrochirus*

Table 3 (continued)

Common Name	Scientific Name
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*M. salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*P. nigromaculatus*
Temperate Basses	Family Percichthyidae
White bass	*Morone chrysops*
Sticklebacks	Family Gasterosteidae
Brook stickleback	*Culaea inconstans*
Drum	Family Sciaenidae
Freshwater drum	*Aplodinotus grunniens*
Perches	Family Percidae
Iowa darter	*Etheostoma exile*
Johnny darter	*E. nigrum*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Blacknose darter	*P. maculata*
Slenderhead darter	*P. phoxocephala*
Sauger	*Stizostedion canadense*
Walleye	*S. vitreum*
Saugeye	*S. canadense* x *S. vitreum* hybrid

Table 4. Common Plant Species Found Within the Proposed Project Area by Community Type

Common Name	Scientific Name
Agricultural Species	
Soybeans	*Glycine max*
Sorghum	*Sorghum vulgare*
Wheat	*Triticum aesitivum*
Corn	*Zea mays*
Wetland/Riparian Species	
Box elder	*Acer negundo*
Canada bluejoint	*Calamagrostis canadensis*
Hairy-leaved sedge	*Carex atherodes*
Wooly sedge	*Carex pellita*
Red-osier dogwood	*Cornus racemosa*
Barnyard grass	*Echinochloa crusgallii*
Green ash	*Fraxinus pennsylvanica*
Baltic rush	*Juncus balticus*
Duckweed	*Lemna* spp.
Water lily	*Nympaea* spp.
Virginia creeper	*Parthenocissus quinquifolia*
Eastern cottonwood	*Populus deltoides*
Willow	*Salix* spp.
Softstem bulrush	*Schoenoplectus taberneamontanea*
River bulrush	*Scirpus fluviatilis*
Prairie cordgrass	*Spartina pectinata*
Poison ivy	*Toxicodendron rydbergii*
Broad-leaved cattail	*Typha latifolia*
Elm	*Ulmus* spp.
Wild rice	*Zizania aquatica*
Woodland (Forest) and Shrubland Species	
Maple	*Acer* spp.
White birch	*Betula papyrifera*
American hazelnut	*Corylus americana*
Dogwood	*Cornus* spp.
Red pine	*Pinus resinosa*
Aspen	*Populus tremuloides*
Black cherry	*Prunus serotina*
Oak	*Quercus* spp.
European black elderberry	*Sambucus nigra*
American basswood	*Tilia americana*
Dry Hill Prairie Species	
Leadplant	*Amorpha canescens*
Big bluestem	*Andropogon gerardii*
Skyblue aster	*Aster oolentangiensis*
Buffalo bean	*Astragalus crassicarpus*
Side-oats grama	*Bouteloua curtipendula*
Blue grama	*Bouteloua gracilis*
Garden cornflower	*Centaurea cyanus*
Prairie smoke	*Geum triflorum*
Wild licorice	*Glycerrhiza lepidota*
Needle-and-thread grass	*Hesperostipa comata*
Western wheatgrass	*Pascopyrum smithii*

Table 4 (continued)

Purple prairie clover	*Petalostemon purpureum*
Prairie phlox	*Phlox pilosa*
Silverleaf scurfpea	*Psoralea argophylla*
European pasqueflower	*Pulsatilla vulgaris*
Little bluestem	*Schizachyrium scoparium*
Indiangrass	*Sorghastrum nutans*
Prairie dropseed	*Sporobolus heterolepis*
Porcupine grass	*Stipa spartea*
Green needlegrass	*Stipa viridula*
Calcareous Fen Species	
Bog birch	*Betula pumila*
Prairie sedge	*Carex praires*
Sterile sedge	*Carex sterilis*
Tussock sedge	*Carex stricta*
Beaked spike-rush	*Eleocharis rostellata*
Lesser fringed genian	*Genianopsis procera*
Kalm's lobelia	*Lobelia kalmii*
Marsh muhly grass	*Muhlenbergia glomerata*
Grass-of-Parnassus	*Parnassia glauca*
Shrubby cinquefoil	*Potentilla fruticosa*
Sage-leaved willow	*Salix candida*
Hardstem bulrush	*Schoenoplectus acutus*
Whorled rut-rush	*Scleria verticallata*
Riddell's goldenrod	*Solidago riddellii*
Mesic Prairie Species	
Big bluestem	*Andropogon gerardii*
Blazing stars	*Liatris ligulistylis* and *L. aspera*
Leiberg's panic grass	*Panicum leibergii*
Switchgrass	*Panicum virgatum*
Purple prairie clover	*Petalostemon purpureum*
Pinnate prairie coneflower	*Ratibida pinnata*
Little bluestem	*Schizachyrium scoparium*
Indiangrass	*Sorghastrum avenaceum*
Prairie dropseed	*Sporobolus heterolepis*
Ironweed	*Vernonia faciculata*
Heart-leaved alexanders	*Zizia aptera*
Southern Bedrock Outcrop Species	
Aromatic aster	*Aster oblongifolius*
Ball cactus	*Coryphantha vivipara*
Awned cyperus	*Cyperus aristatus*
Golden aster	*Heterotheca villosa*
Slender-leaved bluet	*Houstonia longifolia*
False pennyroyal	*Isanthus brachiatus*
Prickly pear cactus	*Opuntia fragilis*
Rock spike-moss	*Selaginella rupestris*
Sand dropseed	*Sporobolus cryptandrus*
Fameflower	*Talinum parviflorum*
Rusty woodsia	*Woodsia ilvensis*

Table 4 (continued)

Wet Prairie Species	
New England aster	*Aster novac-angliae*
Bluejoint grass	*Calamagrostis canadensis*
Woolly sedge	*Carex lasiocarpa*
Sartwell’s sedge	*Carex sartwellii*
Red-osier dogwood	*Cornus stolonifera*
Sneezeweed	*Helenium autumnale*
Prairie blazingstar	*Liatris pycnostachya*
Great lobelia	*Lobelai siphilitica*
Virginia mountain-mint	*Pycnanthemum virginianum*
Willows	*Salix spp.*
Prairie cordgrass	*Spartina pectinata*
Dry Sand-Gravel Prairie Species	
White sage	*Artemesia ludoviciana*
Bluebell bellflower	*Campanula rotundifolia*
Larkspur	*Delphinium virescens*
Hoary frostweed	*Helianthemum bicknellii*
Longleaf summer bluets	*Houstonia longifolia*
Prairie junegrass	*Koeleria macrantha*
Narrowleaf stoneseed	*Lithospermum incisum*
Plains muhly grass	*Muhlenbergia cuspidate*
Pasqueflower	*Pulsatilla nuttalliana*
Indian grass	*Sorghastrum avenaceum*
Prairie dropseed	*Sporobolus heterolepis*
Prairie bird-foot violet	*Viola pedatifida*

Sources: USEPA, 2003; USGS, 2002; MnDNR, 2002.

Table 5. Noxious and Invasive Weeds for Minnesota and South Dakota

Common Name	Scientific Name	Present Within the Proposed Plant Site
Noxious Weeds – Minnesota and South Dakota		
Velvetleaf[a]	*Abutilon theophrasti*	--
Garlic mustard	*Alliaria petiolata*	X
Absinth wormwood[a]	*Artemisia absinthium*	--
Hemp	*Cannabis sativa*	--
Plumeless thistle	*Carduus acanthoides*	--
Musk thistle	*Carduus nutans*	--
Spotted knapweed[a]	*Centaurea maculosa*	--
Canada thistle	*Cirsium arvensis*	--
Bull thistle	*Cirsium vulgare*	--
Field bindweed	*Convolvulus arvensis*	--
Leafy spurge	*Euphorbia esula*	X
Wild sunflower[a]	*Helianthus annuus*	--
Purple loosestrife	*Lythrum salicaria* or *L. virgatum*	--
Wild proso millet[a]	*Panicum miliaceum*	--
Common buckthorn	*Rhamnus cathartica*	--
Glossy buckthorn	*Rhamnus frangula*	--
Perennial sow thistle	*Sonchus arvensis*	--
Black nightshade[a]	*Solanum nigrum*	--
Poison ivy	*Toxicodendron radicans*	--
Cocklebur[a]	*Xanthium strumarium*	--
Invasive (Non-listed) Weeds – South Dakota		
Box elder	*Acer negundo*	X
Smooth brome	*Bromus inermis*	X
Red cedar	*Juniperus virginiana*	X
Tartarian honeysuckle	*Lonicera tatarica*	X
Kentucky bluegrass	*Poa pratensis*	X
Buckthorn	*Rhamnus cathartica*	X

[a] County prohibited or local listed as noxious weed species.

Table 6. Federally Listed or Candidate Species, by County

County	Species	Rank	Habitat
Richland, ND	Dakota skipper (*Hesperia dacotae*)	C	This species occurs in undisturbed tall- to mixed- grass prairie pastures with little bluestem, needle and thread and purple coneflower
Richland, ND	Gray wolf (*Canis lupus*)	E[a]	This species is wide-ranging; in North Dakota more likely to be found in forested areas and/or areas with low densities of roads and people
Grant, SD	Topeka shiner (*Notropis topeka*)	E	This species inhabits small, clear prairie streams
Richland, ND & Roberts, SD	Western Prairie Fringed Orchid (*Plantanthera praeclara*)	T	This species inhabits wet calcareous or subsaline prairie and sedge meadow habitats
Richland, ND	Whooping Crane (*Grus Americana*)	E	This species inhabits shallow wetlands characterized by cattails, bulrushes and sedges.

[a] Note that this population (that includes the eastern half of North Dakota) has been proposed for delisting

Source: USFWS Mountain Prairie Region County List of Species. http://www.fws.gov/mountain-prairie/endspp/name_county_search.htm

Table 7. Documented Occurrences of State Special Status Species within One Mile of Hankinson Line

State	Species (Common name)	Species (Scientific name)	State Rank	Habitat
Birds				
SD	American Woodcock	*Scolopax minor*	S3	This species inhabits a mix of open fields, wet thickets, moist woods and bushy swamps
SD	Black Tern	*Chlidonias niger*	S3	This species inhabits marshes and lakes
SD	Long-eared Owl	*Asio otus*	S3	This species inhabits open woods and forest edges
ND	Mountain Plover	*Charadrius montanus*	SX	This species inhabits open grasslands
ND	Northern Mockingbird	*Mimus polyglottos*	SU	This species inhabits forest edges and pastureland
SD	Red-necked Grebe	*Podiceps grisegena*	S1	This species inhabits lakes and ponds
SD	Ruby-throated Hummingbird	*Archilochus colubris*	S2	This species inhabits mixed forests and forest edges
SD	Veery	*Catharus fuscescens*	S2	This species inhabits bottomland and riparian forests
SD	Wood Thrush	*Hylocichla mustelina*	S2	This species inhabits deciduous forests
Fish				
SD	Carmine Shiner	*Notropis percobromus*	S2	This species inhabits streams and small rivers
SD	Golden Redhorse	*Moxostoma erythrurum*	SH	This species inhabits streams, rivers and lakes
SD	Hornyhead Chub	*Nocomis biguttatus*	S3	This species inhabits small and medium-sized streams, but also occurs in lakes and large rivers
SD	Slenderhead Darter	*Percina phoxocephala*	SX	This species inhabits streams and rivers

Table 7 (continued)

Invertebrates				
SD	Creek Heelsplitter mussel	*Lasmigona compressa*	S1	This species inhabits small to medium sized streams in sand or gravel substrates
SD	Creeper mussel	*Strophitus undulatus*	S3	This species inhabits shallow water in small, medium or large rivers, in silt, sand, gravel or rocky substrates
SD	Fatmucket mussel	*Lampsilis siliquoidea*	S4	This species inhabits small to medium-sized streams and lakes in mud, sand or gravel substrates
SD	Lilliput mussel	*Toxolasma parvus*	S3	This species inhabits ponds, lakes and streams in mud, sand or gravel substrates
SD	Wabash Pigtoe mussel	*Fusconaia flava*	S1	This species inhabits creeks and large rivers with mud, sand or gravel substrates
Mammals				
SD	Eastern Chipmunk	*Tamias striatus*	S3	This species inhabits deciduous forests, forest edges and scrubland
SD	Northern River Otter	*Lontra canadensis*	S2	This species inhabits streams, rivers, lakes and marshes
ND	Plains Pocket Mouse	*Perognathus flavescens*	SU	This species inhabits open grasslands
SD	Plains Spotted Skunk	*Spilogale putorius interrupta*	S3	This species occurs in a wide range of habitats: forest edges, grasslands, riparian areas
Plants				
SD	American Spikenard	*Aralia racemosa*	S3	This species inhabits woodlands
ND	Cluster Dodder	*Cuscuta glomerata*	SU	This species inhabits prairies and fens
SD	Downy Gentian	*Gentiana puberulenta*	S4	This species inhabits mesic to dry calcareous prairies, sandy ridges and open woods

Table 7 (continued)

SD	Flattop Aster	*Aster pubentior*	S2	This species inhabits moist woods and marshes
SD	Great Plains Ladies' Tresses	*Spiranthes magnicamporum*	SNR	This species inhabits dry calcareous prairies
ND	Purple-leaved Willow herb	*Epilobium coloratum*	SU	This species inhabits wet meadows and seeps
ND	Spiny Naiad	*Najas marina*	S1	This species inhabits shallow water of brackish lakes and marshes
ND	Tall Hairy Groovebur	*Agrimonia gryposepala*	S3	This species inhabits woodlands and thickets
SD	White Rattlesnake Root	*Prenanthes alba*	S2	This species inhabits moist, open woods and thickets
Amphibians and Reptiles				
SD	Northern Redbelly Snake	*Storeria occipitomaculata occipitomaculata*	S3	This species inhabits moist woodlands
SD	Smooth Green Snake	*Liochlorophis vernalis*	S4	This species inhabits grasslands and forest edges
SD	Spiny Softshell Turtle	*Apalone spinifera*	S2	This species inhabits streams, rivers and lakes with sandy or muddy substrates
SD	Wood Frog	*Rana sylvatica*	S1	This species requires semi-permanent or temporary ponds for breeding; other habitat includes marshes, sedge meadows, willow hummocks and moist forests

S1 = Critically imperiled because of extreme rarity in South Dakota
S2 = Imperiled because of rarity in South Dakota
S3 = Either very rare or local throughout its range or found locally in restricted range in South Dakota
S4 = Apparently secure although it may be quite rare in parts of its range in South Dakota
SH = Historically known, may be rediscovered in South Dakota
SNR/SU = Possibly in peril, but status uncertain, more information necessary in South Dakota
SX = Believed extinct, historical records only in South Dakota
Note – none of these species are federally listed.

Source: SD Game Fish Parks Department, Natural Heritage Database.

Appendix G

Cultural Sites

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APPENDIX G
CULTURAL SITES

Table 1: Results of the Class I File Search for Corridor A

Site Number	Site Type	NRHP Eligibility
39GT2007	Chicago, Milwaukee, St. Paul & Pacific Railroad	Eligible
39GT0024	Multi-component artifact scatter	Unknown
39GT0006	Earth lodge village	Unknown
21BS0009	Earthworks	Unknown
21BS0008	Earthworks	Unknown
21BS0021	Rock alignment; Feature	Unknown
BS-ORT-059	Marsh Co. Bridge (built 1920)	Eligible
BS-ORT-070	Paul Bunyon’s Anchor	Unknown
BS-ORT-071	Freightor (built ca. 1910)	Unknown
BS-ORT-103	Bridge 6456 (built 1953)	Unknown
BS-OTN-005	U.S. Hwy. 12 State Line Marker (built 1942)	Eligible
BS-OTN-004	Granite View Farm (house built ca. 1913, barn built ca. 1914)	Unknown
BS-OTN-003	Homan Farmstead (built ca. 1900)	Unknown
BS-ORT-068	Big Stone Canning Company (built ca. 1902)	Unknown
21SE000m	Earthworks	Unknown
21SE0036	Lithic scatter	Unknown
21BS0012	Earthworks	Unknown
21BS0020	Cemetery	Unknown
21BS0040	Artifact scatter	Unknown
BS-MAL-001	Tomschin Farm (built ca. 1898-1905)	Unknown
BS-MAL-003	School (built ca. 1900)	Unknown
BS-MAL-004	German Lutheran Church of Johnson (built ca. 1895)	Unknown
BS-MOO-001	School (built ca. 1905-1910)	Unknown
BS-BIG-004	Geier Farmstead (built 1883)	Unknown
BS-BIG-006	David Zehringer Farm (built ca. 1900)	Unknown
BS-OTN-001	Harold Dimberg Farmstead (built ca. 1895)	Unknown
BS-OTN-002	Nels Lindgren Farm, Gordon Anderson Log Cabin (built 1872/1876)	Unknown
BS-ORT-066	Ortonville Farmers’ Co-op Elevator Company (built ca. 1900)	Unknown
BS-ORT-067	House (built ca. 1895)	Unknown
BS-OTR-001	Otrey Town Hall (built ca. 1900)	Unknown
BS-OTR-002	Eidskog Lutheran Church (built 1917)	Unknown
21SEm	Earthworks	Unknown
21SEf	Single artifact	Unknown
21BSq	Earthwork? Cemetery?	Unknown
21BSt	Artifact scatter?	Unknown
Ortonville, Minnesota (city)		
BS-ORT-001	P.D. Products (built ca. 1905)	Unknown
BS-ORT-002	Ortonville Power and Light Plant (built ca. 1919/1933)	Unknown
BS-ORT-003	House (built ca. 1895-1905)	Unknown
BS-ORT-004	Ortonville Fire Department (built ca. 1935-1945)	Unknown
BS-ORT-005	I.O.O.F. Hall (built ca. 1912)	Unknown
BS-ORT-006	Ortonville State Bank (built ca. 1914) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-007	N. Schoen and Son, Wholesale and Retail Furniture (built 1909) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District

Table 1 (continued)

Site Number	Site Type	NRHP Eligibility
BS-ORT-008	N. Schoen and Son, Wholesale and Retail Furniture (built 1903/1922) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-009	Masonic Building (built 1898) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT 010	Ortonville Mercantile Store (built 1916) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-011	Culver Drug Company (built ca. 1900) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-012	Pioneer Meat Market (built 1893) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-013	Brown's Jewelry Store (built 1907) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-014	Grosenick's Menswear (built 1903) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-015	Schmidt Building (built 1897) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-016	Bernie's Shoes (built 1978) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-017	Citizens National Bank (built 1898) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-018	First National Bank of Ortonville (built 1901) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-019	Clarke Building (built ca. 1910) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-020	Wihlborg Store (built ca. 1905) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-021	Orton Block (built 1879/1907) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-022	C.J. Stark Building (built 1903) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-023	Nielson Drug (built 1901) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-024	Shumaker Building (built 1897/1905) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-025	Brown Building (built 1903) Downtown Ortonville Historic District	Contributing property of NRHP-listed Downtown Ortonville Historic District
BS-ORT-026	Grand Theatre (built 1913)	Unknown
BS-ORT-027	Columbia Hotel (built 1892)	Listed
BS-ORT-028	Metropolitan Theatre (built 1912)	Unknown
BS-ORT-029	Commercial Building (built ca. 1900)	Unknown
BS-ORT-030	Lake House (built 1881)	Unknown
BS-ORT-031	Ortonville Free Library (built ?)	Listed
BS-ORT-032	House (built ca. 1895)	Unknown
BS-ORT-033	House (built ca. 1895-1900)	Unknown
BS-ORT-034	House (built ca. 1905)	Unknown
BS-ORT-035	House (built ca. 1910)	Unknown
BS-ORT-036	House (built ca. 1920s)	Unknown
BS-ORT-037	House (built ca. 1915)	Unknown
BS-ORT-038	A.L. and Katherine Shumaker House (built 1901)	Unknown
BS-ORT-039	House (built 1890s-1900)	Unknown
BS-ORT-040	House (built ca. 1915)	Unknown
BS-ORT-041	Big Stone County Courthouse (built 1902)	Listed

Table 1 (continued)

Site Number	Site Type	NRHP Eligibility
BS-ORT-042	First English Lutheran Church (built 1939)	Unknown
BS-ORT-043	House (built ca. 1885-1895)	Unknown
BS-ORT-044	House (built ca. 1890)	Unknown
BS-ORT-045	Ortonville Police Department (built ca. 1940s)	Unknown
BS-ORT-046	House (built ca. 1890)	Unknown
BS-ORT-047	Congregational United Church of Christ (built ca. 1915)	Unknown
BS-ORT-048	House (built ca. 1890)	Unknown
BS-ORT-049	House (built ca. 1905)	Unknown
BS-ORT-050	House (built ca. 1885)	Unknown
BS-ORT-051	House (built ca. 1885-1895)	Unknown
BS-ORT-052	House (built ca. 1900)	Unknown
BS-ORT-053	House (built ca. 1895)	Unknown
BS-ORT-054	George Mowery House (built 1920)	Unknown
BS-ORT-055	House (built ca. 1890)	Unknown
BS-ORT-056	House (built ca. 1894)	Unknown
BS-ORT-057	Ortonville High School (built 1916)	Unknown
BS-ORT-058	Carl and Josephine Hasslen House (built ca. 1890)	Unknown
BS-ORT-060	Charles E. Chrisman House (built ca. 1905)	Unknown
BS-ORT-061	House (built ca. 1890s-1900)	Unknown
BS-ORT-062	House (built ca. 1900)	Unknown
BS-ORT-063	House (built ca. 1900-1905)	Unknown
BS-ORT-064	House (built ca. 1890)	Unknown
BS-ORT-065	Zion Lutheran Church (built 1963)	Unknown
BS-ORT-068	Big Stone Canning Company (built ca. 1902)	Unknown
BS-ORT-069	Ortonville Grain Company (built ca. 1895/1910)	Unknown
BS-ORT-072	House (built ca. 1915) not in project corridor[a]	Unknown
BS-ORT-073	Sioux Historic Park Pavilion (built ca. 1920) not in project corridor[a]	Unknown
BS-ORT-074	Railroad Building (built ca. 1900)	Unknown
BS-ORT-075	Bagley Elevator (built ca. 1895)	Unknown
BS-ORT-076	Ortonville City Jail (built ca. 1880)	Unknown
BS-ORT-077	MN National Guard Armory/City Hall (built ca. 1924)	Unknown
BS-ORT-078	House (built ca. 1900)	Unknown
BS-ORT-079	Methodist Society of Ortonville; United Methodist Church (built 1885; altered ca. 1915-1925)	Unknown
BS-ORT-080	Judge Emmett House (built 1880?)	Unknown
BS-ORT-081	St. John's Catholic Church (built ca. 1960)	Unknown
BS-ORT-082	Duplex Cabin (built ca. 1910) not in project corridor[a]	Unknown
BS-ORT-083	House (built ca. 1900)	Unknown
BS-ORT-084	House (built ca. 1900)	Unknown
BS-ORT-085	House (built ca. 1915-1920)	Unknown
BS-ORT-086	F.L. and Sara Cliff House (built ca. 1884)	Unknown
BS-ORT-087	House (built ca. 1885)	Unknown
BS-ORT-088	David and Etta Geier House (built ca. 1892)	Unknown
BS-ORT-089	R.H. Chapman House (built ca. 1895)	Unknown
BS-ORT-090	House (built ca. 1890s)	Unknown
BS-ORT-091	House (built ca. 1945)	Unknown
BS-ORT-092	House (built ca. 1900)	Unknown
BS-ORT-093	House (built ca. 1920)	Unknown
BS-ORT-094	House (built ca. 1920)	Unknown
BS-ORT-095	Trinity Lutheran Church (built 1949)	Unknown
BS-ORT-096	Bridge (built ca. 1900-1910) not in project corridor[a]	Unknown

Table 1 (continued)

Site Number	Site Type	NRHP Eligibility
BS-ORT-097	First Methodist Church (built ca. 1950)	Unknown
BS-ORT-098	Resort (built ca. 1910-1940) not in project corridor[a]	Unknown
BS-ORT-099	Grand View Hospital (built ca. 1906)	Unknown
BS-ORT-100	Martin Schoen House (built ca. 1905)	Unknown
BS-ORT-101	Ortonville Commercial Historic District (see BS-ORT-006 – BS-ORT-025)	Listed
BS-ORT-102	Bridge 5411 (built 1941)	Unknown
BS-ORT-104	Bridge L09161 (built 1935) not in project corridor[a]	Unknown
Johnson, Minnesota (city)		
BS-JOH-001	J. Luchsinger Building; currently J&J's Grocery (built 1912)	Unknown
BS-JOH-002	Great Northern Depot (built ca. 1901)	Unknown
BS-JOH-003	Johnson Public School (built ca. 1905)	Unknown
Chokio, Minnesota (city)		
SE-CHC-001	Chokio Hardware Company (not recorded)	Unknown
SE-CHC-002	Service station (not recorded)	Unknown
SE-CHC-003	Chokio Depot (not recorded)	Unknown
SE-CHC-004	Lumber Yard (not recorded)	Unknown
SE-CHC-005	Chokio Elevators (not recorded)	Unknown
SE-CHC-006	Creamery (not recorded)	Unknown
SE-CHC-007	Chokio Public School (not recorded)	Unknown
SE-CHC-008	Chokio Fire Hall (not recorded)	Unknown
SE-CHC-009	Chokio Water Tower (not recorded)	Unknown
SE-CHC-010	Cadwell House (not recorded)	Unknown
SE-CHC-011	Stone house (not recorded)	Unknown
SE-CHC-012	House (not recorded)	Unknown
SE-CHC-013	Methodist Episcopal Church (not recorded)	Unknown
Alberta, Minnesota (city)		
SE-ALC-001	Commercial Building (not recorded)	Unknown
SE-ALC-002	Alberta State Bank (not recorded)	Unknown
SE-ALC-003	Two residences (not recorded)	Unknown
SE-ALC-004	Scott Town Hall (not recorded)	Unknown
SE-ALC-005	Alberta Elevators (not recorded)	Unknown
SE-ALC-006	Alberta Public School (not recorded)	Unknown
SE-ALC-007	Alberta Teachers House (built 1917)	Listed
SE-ALC-008	Trinity Lutheran Church (not recorded)	Unknown
SE-ALC-009	Alberta City Hall (built 1929-1930)	Unknown
SE-ALC-010	Commercial building and residence (not recorded)	Unknown
SE-ALC-011	Farmstead (not recorded)	Unknown
Total 160 **15 sites** **145 structures**		**1 eligible site** **2 eligible structures** **5 listed structures** **20 contributing properties**

[a] The architectural property is located outside of the three-mile-wide file search corridor; however, it is listed in the table because the property is associated with a historic district, site, or feature located within the corridor.

Source: HDR, 2005.

Table 2: Results of the Class I File Search for Corridor B

Site Number	Site Type	NRHP Eligibility
39GT2007	Chicago, Milwaukee, St. Paul & Pacific Railroad	Eligible
39GT0024	Multi-component artifact scatter	Unknown
39GT0006	Earth lodge village	Unknown
21BS0008	Earthworks	Unknown
21BS0009	Earthworks	Unknown
21BS0021	Rock alignment; Feature	Unknown
BS-OTN-003	Homan Farmstead (built ca. 1900)	Unknown
BS-OTN-004	Granite View Farm (house built ca. 1913, barn built ca. 1914)	Unknown
BS-OTN-005	U.S. Hwy. 12 State Line Marker (built 1942)	Eligible
BS-ORT-059	Marsh Co. Bridge (built 1920)	Eligible
BS-ORT-068	Big Stone Canning Company (built ca. 1902)	Unknown
BS-ORT-070	Paul Bunyon's Anchor	Unknown
BS-ORT-071	Freightor (built ca. 1910)	Unknown
BS-ORT-103	Bridge 6456 (built 53)	Unknown
21BS0006	Earthworks	Unknown
21BS0007	Earthworks	Unknown
21BS0027	Lithic scatter	Unknown
21BS0028	Lithic scatter	Unknown
21SW0013	Lithic scatter, cemetery	Unknown
SW-MOY-005	Bridge 3858 (built ca. 1900)	Unknown
SW-MOY-006	Bridge No. 5359 (built ca. 1934)	Unknown
SW-MOY-007	Pomme de Terre Roadside Parking Area (built ca. 1936)	Unknown
SW-MOY-008	Bridge 5359 (built 1934)	Unknown
BS-ODS-003	Russel and Dorienne Huizenga (built 1914)	Unknown
SW-SHI-001	Immanuel Lutheran Church (built ca. 1892)	Unknown
SW-SHI-002	School (built ca. 1900)	Unknown
SW-SHI-003	Town Hall (built ca. 1900)	Unknown
Odessa, Minnesota		
BS-ODE-001	House (built ca. 1945)	Unknown
BS-ODE-002	Richard Menzel Lumberyard (built ca. 1889)	Unknown
BS-ODE-003	Mobil Gas Station (built ca. 1920)	Unknown
BS-ODE-004	Meat Market (built ca. 1927)	Unknown
BS-ODE-005	Commercial Building (built ca. 1900-1910)	Unknown
BS-ODE-006	House (built ca. 1900)	Unknown
BS-ODE-007	Odessa Fire Hall and Village Hall (built ca. 1937)	Unknown
BS-ODE-008	Hope United Methodist Church; currently Baily House (private residence; built 1897)	Unknown
BS-ODE-009	Odessa Farmers' Elevator Company (built ca. 1890)	Unknown
BS-ODE-010	House (built ca. 1895)	Unknown
BS-ODE-011	Trinity Lutheran Church (built ca. 1910/1952)	Unknown
BS-ODE-012	House (built ca. 1900)	Unknown
BS-ODE-013	School (built ca. 1900)	Unknown
BS-ODE-014	House (built ca. 1885)	Unknown
BS-ODE-015	Circle B Grocery (built ca. 1910/1940)	Unknown
BS-ODE-016	Doug's Place (built ca. 1915)	Unknown
BS-ODE-017	Auto Garage (built ca. 1925)	Unknown
BS-ODE-018	Odessa Jail (built 1913)	Listed
BS-ODE-019	Odessa High School (built 1915)	Unknown
BS-ODE-020	House (built ca. 1885-1895)	Unknown
BS-ODE-021	House (built ca. 1885-1895)	Unknown

Table 2 (continued)

Site Number	Site Type	NRHP Eligibility
BS-ODE-022	Odessa Hotel (built ca. 1882)	Unknown
BS-ODE-023	H. Kollitz Building (built ca. 1897)	Unknown
21SW0007	Lithic scatter	Unknown
KH-MMR-003	Mamre Town Hall (built ca. 1895)	Unknown
KH-MMR-004	Salem Covenant Church (built ca. 1968)	Unknown
KH-SJH-002	St. John’s Town Hall (built ca. 1910)	
SW-DUB-001	Farmhouse (built ca. 1875-1885)	Unknown
SW-SIX-002	Six Mile Town Hall (built ca. 1915)	Unknown
SW-TOR-001	School (built ca. 1905)	Unknown
Danvers, Minnesota		
SW-DAN-001	Church of the Visitation (built 1931)	Unknown
SW-DAN-002	Commercial building (built ca. 1900)	Unknown
SW-DAN-003	House (built ca. 1900-1905)	Unknown
DeGraff, Minnesota		
SW-DEG-001	Church of St. Bridget (built 1901)	Listed
SW-DEG-002	House (built ca. 1895)	Unknown
SW-DEG-003	Service station (built ca. 1945)	Unknown
SW-DEG-004	Elevator (built ca. 1900)	Unknown
SW-DEG-005	J.V. Pappenfus Elevator/Farmer’s Exchange (built ca. 1900)	Unknown
SW-DEG-006	House (built ca. 1895)	Unknown
SW-DEG-007	Old Bank Building (built ca. 1910)	Unknown
SW-DEG-008	DeGraff Auditorium (built 1939; demolished 2001)	Unknown
Murdock, Minnesota		
SW-MUR-001	Sabin S. Murdock Home (built 1878)	Listed
SW-MUR-002	Calvary Lutheran Church (built ca. 1915)	Unknown
SW-MUR-003	The Church of Sacred Heart (built 1925)	Unknown
SW-MUR-004	House (built ca. 1890)	Unknown
SW-MUR-005	Hotel, possible railroad hotel (built ca. 1879)	Eligible
Total 73 **12 sites** **61 structures**		**1 eligible site** **3 eligible structures** **3 listed structures**

Source: HDR, 2005.

Table 3: Results of the Class I File Search for Corridor B1

Site Number	Site Type	NRHP Eligibility
39GT2007	Chicago, Milwaukee, St. Paul & Pacific Railroad	Eligible
39GT0024	Multi-component artifact scatter	Unknown
39GT0006	Earth lodge village	Unknown
21BS0008	Earthworks	Unknown
21BS0009	Earthworks	Unknown
21BS0021	Rock alignment; Feature	Unknown
BS-OTN-003	Homan Farmstead (built ca. 1900)	Unknown
BS-OTN-004	Granite View Farm (house built ca. 1913, barn built ca. 1914)	Unknown
BS-OTN-005	U.S. Hwy. 12 State Line Marker (built 1942)	Eligible
BS-ORT-059	Marsh Co. Bridge (built 1920)	Eligible
BS-ORT-068	Big Stone Canning Company (built ca. 1902)	Unknown
BS-ORT-070	Paul Bunyon's Anchor	Unknown
BS-ORT-071	Freightor (built ca. 1910)	Unknown
BS-ORT-103	Bridge 6456 (built 1953)	Unknown
21BS0006	Earthworks	Unknown
21BS0007	Earthworks	Unknown
21BS0027	Lithic scatter	Unknown
21BS0028	Lithic scatter	Unknown
21SW0013	Lithic scatter, cemetery	Unknown
BS-ODS-003	Russel and Dorienne Huizenga Farm (built 1914)	Unknown
SW-SHI-001	Immanuel Lutheran Church (built ca. 1892)	Unknown
SW-SHI-002	School (built ca. 1900)	Unknown
SW-SHI-003	Town hall (built ca. 1900)	Unknown
SW-MOY-005	Bridge 3858 (built ca. 1900)	Unknown
SW-MOY-006	Bridge No. 5359 (built ca. 1934)	Unknown
SW-MOY-007	Pomme de Terre Roadside Parking Area (built ca. 1936)	Unknown
SW-MOY-008	Bridge 5359 (built 1934)	Unknown
Odessa, Minnesota		
BS-ODE-001	House (built ca. 1945)	Unknown
BS-ODE-002	Richard Menzel Lumberyard (built ca. 1889)	Unknown
BS-ODE-003	Mobil Gas Station (built ca. 1920)	Unknown
BS-ODE-004	Meat Market (built ca. 1927)	Unknown
BS-ODE-005	Commercial Building (built ca. 1900-1910)	Unknown
BS-ODE-006	House (built ca. 1900)	Unknown
BS-ODE-007	Odessa Fire Hall and Village Hall (built ca. 1937)	Unknown
BS-ODE-008	Hope United Methodist Church; currently Baily House (private residence; built 1897)	Unknown
BS-ODE-009	Odessa Farmers' Elevator Company (built ca. 1890)	Unknown
BS-ODE-010	House (built ca. 1895)	Unknown
BS-ODE-011	Trinity Lutheran Church (built ca. 1910/1952)	Unknown
BS-ODE-012	House (built ca. 1900)	Unknown
BS-ODE-013	School (built ca. 1900)	Unknown
BS-ODE-014	House (built ca. 1885)	Unknown
BS-ODE-015	Circle B Grocery (built ca. 1910/1940)	Unknown
BS-ODE-016	Doug's Place (built ca. 1915)	Unknown
BS-ODE-017	Auto Garage (built ca. 1925)	Unknown
BS-ODE-018	Odessa Jail (built 1913)	Listed
BS-ODE-019	Odessa High School (built 1915)	Unknown

Table 3 (continued)

Site Number	Site Type	NRHP Eligibility
BS-ODE-020	House (built ca. 1885-1895)	Unknown
BS-ODE-021	House (built ca. 1885-1895)	Unknown
BS-ODE-022	Odessa Hotel (built ca. 1882)	Unknown
BS-ODE-023	H. Kollitz Building (built ca. 1897)	Unknown
21CP0052	Lithic scatter	Unknown
21SW0010	Artifact scatter	Unknown
Kerkhoven, Minnesota (city)		
SW-KER-001	House (built ca. 1905)	Unknown
SW-KER-002	Evangelical Free Church (built ca. 1915)	Unknown
SW-KER-003	Kerkhoven Depot (built ca. 1940)	Unknown
SW-KER-004	House (built ca. 1880-1885)	Unknown
SW-KER-005	McKinley School (built 1904)	Unknown
SW-KER-006	House (built ca. 1900)	Unknown
SW-KER-007	House (built ca. 1880)	Unknown
SW-KER-008	Town Hall (built ca. 1890s-1910)	Unknown
SW-KER-009	Bank (built ca. 1910)	Unknown
SW-KER-010	State Bank of Kerkhoven (built ca. 1915)	Unknown
SW-KER-011	Commercial Building (built ca. 1890s)	Unknown
SW-KER-012	Commercial Building (built 1919)	Unknown
SW-KER-013	House (built ca. 1915-1920)	Unknown
CP-WOO-001	District 85 School	Unknown
SW-CAS-001	School (built ca. 1900)	Unknown
SW-CAS-004	Bridge 6552 (built 1947)	Unknown
SW-SWE-001	Swenoda Town Hall (built ca. 1900)	Unknown
SW-SWE-003	Bridge L7175 (built 1947)	Unknown
SW-SWE-004	Bridge L7189 (built 1940)	Unknown
SW-SWE-005	Bridge L7193 (built 1951)	Unknown
SW-WES-001	West Bank Lutheran Church (built ca. 1905)	Unknown
SW-WES-002	Saterbak Farm (house built ca. 1905, barn built 1910)	Unknown
SW-WES-003	West Bank Township Hall (built ca. 1900)	Unknown
SW-WES-004	District School No. 77 (built ca. 1900)	Unknown
SW-WES-008	Bridge 89460 (built 1920)	Unknown
Total 77 **13 sites** **64 structures**		**1 eligible site** **2 eligible structures** **1 listed structure**

Source: HDR, 2005.

Table 4: Results of the Class I File Search for Corridor C

Site Number	Site Type	NRHP Eligibility
39GT2007	Chicago, Milwaukee, St. Paul & Pacific Railroad	Eligible
39GT0024	Multi-component artifact scatter	Unknown
39GT0006	Earth lodge village	Unknown
30GT0032	Farmstead	Unknown
39DE00000018	Building (unknown building date)	Not eligible
39DE00000019	Zoar Lutheran Church (built 1901)	Not eligible
39DE00000020	Antelope Valley Reformed Church (built 1907)	Not eligible
39DE0021	Stone circle	Unknown
39DE0065	Rock pile, cairn	Unknown
39GT2000	Burlington Northern Railroad	Eligible
39GT2015	Minneapolis & St. Louis Railroad	Eligible
39DE0079	Artifact scatter	Unknown
39DE2003	Chicago Northwestern Railroad	Eligible
21YMae	Minnesota/South Dakota State Line	Unknown
Gary, South Dakota (Herrick)		
DE00000026	Building	Eligible
DE00000036	Building (built 1900)	Not eligible
DE00000038	Building	Not eligible
DE00000041	Structure (built 1906)	Eligible
DE00000081	Building	Eligible
DE00000103	Building (built 1909)	Not eligible
DE00000113	Building (built 1913)	Eligible
DE00000131	First National Bank (built 1917)	Listed
DE00000137	South Dakota School for the Blind Historic District (built 1899)	Listed
DE00000138	Odd Fellows Hall (built 1898)	Listed
YM-FLD-006	Frank E. Millard Farmstead (built early 20th century)	Unknown
39DE0016	Foundation and depression	Unknown
39DE0053	Native American burial	Unknown
39DE0054	Small prehistoric occupation site	Unknown
39DE0055	Depression, artifact scatter	Unknown
39DE0056	Late Archaic occupation site	Unknown
YM-FLD-002	Farmstead (built ca. 1890)	Unknown
YM-FLD-003	Fred Meyen Farm (built ca. 1905)	Unknown
YM-FLD-004	Burr District 95 School (built ca. 1902)	Unknown
YM-HAM-003	District School No. 98 (built 1903)	Unknown
21CPa	Cemetery	Unknown
21CPb	Granite Falls Mill, Henry Hill's Mill	Unknown
21CP000d	Historic settlement of Minnesota Falls	Unknown
21CP0010	Earthworks	Unknown
21CP0011	Earthworks	Unknown
21CP0012	Artifact scatter, earthworks	Unknown
21CP0013	Earthworks	Unknown
21CP0029	Artifact scatter	Eligible
21CP0030	Artifact scatter	Eligible
21CP0042	Lithic scatter	Unknown
21CP0050	Lithic scatter	Unknown
21CP0053	Lithic scatter	Unknown
21CP0054	Single artifact	Unknown
21CP0055	Single artifact	Unknown

Table 4 (continued)

Site Number	Site Type	NRHP Eligibility
21CP0060	Single artifact	Unknown
21CP0061	Single artifact	Unknown
21CP0062	Lithic scatter	Unknown
21YMq	Single artifact	Unknown
21YMw	Single artifact	Unknown
21ym000b	Artifact scatter	Unknown
21YM0004	Artifact scatter	Unknown
21YM0014	Earthworks	Unknown
21YM0018	Earthworks, cemetery, artifact scatter	Unknown
21YM0019/21YM0003	Earthworks, cemetery	Unknown
21YM0031	Artifact scatter	Unknown
21YM0032	Lithic scatter	Unknown
21YM0033	Artifact scatter	Unknown
21YM0034	Lithic scatter	Unknown
21YM0035	Artifact scatter	Unknown
21YM0036	Artifact scatter	Unknown
21YM0039	Lithic scatter	Unknown
21YM0040	Artifact scatter	Unknown
21YM0042	Lithic scatter	Unknown
21YM0044	Lithic scatter	Unknown
21YM0047	Artifact scatter	Unknown
21YM0053	Single artifact	Unknown
21YM0072	Lithic scatter	Unknown
21YM0073	Artifact scatter	Unknown
21YM0075	Single artifact	Unknown
21YM0076	Single artifact	Unknown
21YM0077	Single artifact	Unknown
21YM0078	Lithic scatter	Unknown
21YM0079	Single artifact	Unknown
21YM0080	Lithic scatter	Unknown
21YM0081	Lithic scatter	Unknown
21YM0084	Lithic scatter	Unknown
21YM0085	Lithic scatter	Unknown
21YM0092	Lithic scatter	Unknown
21YM0093	Lithic scatter	Unknown
21YM0094	Lithic scatter	Unknown
21YM0095	Lithic scatter	Unknown
21YM0096	Lithic scatter	Unknown
21YM0098	Cemetery	Unknown
21YM0101	Single artifact	Unknown
CP-GRT-001	Riverside Sanatorium (historic name)/Riverside Apartments/Minnesota Lakeside Center (current name) (built 1916)	Unknown
CP-GRT-007	Bernt Frederickson House (built ca. 1900)	Unknown
YM-OMR-004	Bartel Kokelman Farmstead (built ca. 1900)	Unknown
YM-FRT-002	Bridge 90308 (built 1915)	Unknown
YM-MNF-001	District School No. 6 (built 1905)	Unknown
YM-MNF-002	Assembly of God Church (built ca. 1950)	Unknown
YM-MNF-003	Pajutazee Presbyterian Church (built ca. 1954)	Unknown
YM-MNF-006	Minnesota Falls Plant and Dam (built 1905, razed 1950s)	Unknown
YM-OSK-004	District School No. 39 (built ca. 1881)	Unknown
YM-OSK-005	Bridge 532 (built 1912)	Unknown

Table 4 (continued)

Site Number	Site Type	NRHP Eligibility
YM-HAM-002	District School No. 81 (built ca. 1900)	Unknown
YM-HAM-005	Stage road (1880-1882)	Unknown
St. Leo, Minnesota		
YM-SLC-001	Catholic Church of St. Leo (built 1881/1940)	Unknown
YM-SLC-002	Henry Shanber Hardware (built 1897)	Unknown
YM-SLC-003	First State Bank of St. Leo (built ca. 1924)	Unknown
Hazel Run, Minnesota		
YM-HRC-001	Hazel Run School/District 20 (built 1939)	Unknown
YM-HRC-002	Hazel Run Evangelical Lutheran Church (built 1892-1903)	Unknown
YM-HRC-003	Hazel Run village Hall (built 1901)	Unknown
YM-HRC-004	Hazel Run Produce Company (built 1892-1944)	Unknown
YM-HRC-005	Hazel Run Post Office (built 1910/1931)	Unknown
YM-HRC-006	Hazel Run State Bank (built 1902)	Unknown
YM-HRC-007	Hazel Run Fire Department (built ca. 1960)	Unknown
YM-HRC-008	James H. Jertson House (built ca. 1895)	Unknown
YM-HRC-009	Torger Jenson Farmhouse (built ca. 1892)	Unknown
YM-HRC-010	Bridge 914 (built 1913)	Unknown
Granite Falls, Minnesota		
YM-GRN-001	House (built ca. 1885-1895)	Unknown
YM-GRN-002	House (built ca. 1900)	Unknown
YM-GRN-003	House (built ca. 1895)	Unknown
YM-GRN-004	House (built ca. 1920)	Unknown
YM-GRN-005	House (built ca. 1880)	Unknown
YM-GRN-006	Olaf Lokensgaard House (built ca. 1888)	Unknown
YM-GRN-007	House (built ca. 1885)	Unknown
YM-GRN-008	Creamery; presently an apartment building (built ca. 1920)	Unknown
YM-GRN-009	Franklin J. Cressy House (built ca. 1880)	Unknown
YM-GRN-010	George Morse House (built ca. 1875-1880)	Unknown
YM-GRN-011	Franklin J. Cressy House (built ca. 1875-1880)	Unknown
YM-GRN-012	House (built ca. 1915)	Unknown
YM-GRN-013	Methodist Episcopal Church (built ca. 1881)	Unknown
YM-GRN-014	United Lutheran Church (built ca. 1882)	Unknown
YM-GRN-015	House (built ca. 1910)	Unknown
YM-GRN-016	Andrew J. Volstead House (built 1878)	Eligible
YM-GRN-017	First Congregational Church (built 1899)	Unknown
YM-GRN-018	House (built 1895)	Unknown
YM-GRN-019	House (built ca. 1895)	Unknown
YM-GRN-020	House (built ca. 1890)	Unknown
YM-GRN-021	House (built ca. 1900)	Unknown
YM-GRN-022	House (built ca. 1885)	Unknown
YM-GRN-023	Granite Falls Lutheran Church (built 1950/1951)	Unknown
YM-GRN-024	Yellow Medicine County Jail (built 1893)	Unknown
YM-GRN-025	Yellow Medicine County Courthouse (built 1889)	Unknown
YM-GRN-026	Granite Falls High School (built 1930)	Unknown
YM-GRN-027	William Lee House (built ca. 1915-1920)	Unknown
YM-GRN-028	House (built ca. 1895)	Unknown
YM-GRN-029	House (built ca. 1890)	Unknown
YM-GRN-030	House (built ca. 1890)	Unknown
YM-GRN-031	House (built ca. 1885)	Unknown
YM-GRN-032	House (built ca. 1900)	Unknown
YM-GRN-033	House (built ca. 1900)	Unknown
YM-GRN-034	Yellow Medicine County Courthouse (built 1874)	Unknown

Table 4 (continued)

Site Number	Site Type	NRHP Eligibility
YM-GRN-035	House (built ca. 1890)	Unknown
YM-GRN-036	House (built ca. 1885)	Unknown
YM-GRN-037	House (built ca. 1880)	Unknown
YM-GRN-038	House (built ca. 1880)	Unknown
YM-GRN-039	House (built ca. 1885-1890)	Unknown
YM-GRN-040	Grace Evangelical Free Church (built ca. 1915)	Unknown
YM-GRN-041	House (built ca. 1895)	Unknown
YM-GRN-042	Great Northern Railroad Depot (built 1940)	Unknown
YM-GRN-043	Minnesota Falls Co-op Elevator (built ca. 1940)	Unknown
YM-GRN-044	St. Andrew's Catholic Church (built 1943)	Unknown
YM-GRN-045	Yellow Medicine County Museum (built 1968)	Unknown
YM-GRN-046	World War Memorial Park (Established 1925)	Eligible
YM-GRN-047	Bridge (built ca. 1940)	Unknown
YM-GRN-048	Bridge (built ca. 1970)	Unknown
YM-GRN-049	House (built ca. 1900)	Unknown
YM-GRN-050	House (built ca. 1880)	Unknown
YM-GRN-051	Standard Lumber (built ca. 1900)	Unknown
YM-GRN-052	Commercial Building (built ca. 1895)	Unknown
YM-GRN-053	Commercial Building (built ca. 1900)	Unknown
YM-GRN-054	Granite Falls State Bank (built 1912)	Unknown
YM-GRN-055	Commercial Building (built 1900)	Unknown
YM-GRN-056	Theatre (built ca. 1940)	Unknown
YM-GRN-057	D.N. McLarety Building (built ca. 1900)	Unknown
YM-GRN-058	Commercial Building (built ca. 1900)	Unknown
YM-GRN-059	Commercial Building (built ca. 1900)	Unknown
YM-GRN-060	Footbridge (built ca. 1950-1970)	Unknown
YM-GRN-061	K.K. Berge Store (built 1924)	Unknown
YM-GRN-062	Commercial Building (built ca. 1910-1925)	Unknown
YM-GRN-063	Avalon Theatre (built ca. 1930)	Unknown
YM-GRN-064	Granite Falls Power Plant (built 1892-1940s)	Unknown
YM-GRN-065	Jordon House (built ca. 1940)	Unknown
YM-GRN-066	House (built ca. 1880)	Unknown
YM-GRN-067	Episcopal Church/Trinity Church Society Church (built 1889)	Unknown
YM-GRN-068	Frank Hacking House (built ca. 1898)	Unknown
YM-GRN-069	House (built ca. 1895)	Unknown
YM-GRN-070	Hazelberg House (built 1903)	Unknown
YM-GRN-071	B. E. Nelson House (built 1898)	Unknown
YM-GRN-072	LaMar House (built ca. 1878)	Unknown
YM-GRN-073	House (built ca. 1875)	Unknown
YM-GRN-074	House (built ca. 1885 or ca. 1920)	Unknown
YM-GRN-075	House (built ca. 1885)	Unknown
YM-GRN-076	Henry Hill Grist and Saw Mill (razed) (built 1871/1872)	Unknown
YM-GRN-077	Granite Falls Dam (built 1911)	Unknown
YM-GRN-078	Granite Falls Overlook (built 1937)	Unknown
CP-GRN-001	Elevator (built ca. 1900)	Unknown
CP-GRN-002	Chicago Milwaukee and St. Paul Depot (built ca. 1890-1905)	Unknown
CP-GRN-003	House (built ca. 1880)	Unknown
CP-GRN-004	City Water Tank (built ca. 1930)	Unknown
CP-GRN-005	Pillsbury Benjamin and Susan House (built ca. 1880)	Eligible
CP-GRN-006	Bridge No. 5045 (built 1931)	Unknown

Table 4 (continued)

Site Number	Site Type	NRHP Eligibility
CP-GRN-008	Hydroelectric Plant (built ca. 1915)	Unknown
CP-GRN-009	James O'Conner House (built ca. 1900)	Unknown
CP-GRN-010	House (built ca. 1885)	Unknown
CP-GRN-012	House (built ca. 1880)	Unknown
Total 202 **83 sites** **119 structures**		**10 eligible sites** **3 listed structures** **8 eligible structures**

Source: HDR, 2005.

Table 5: Results of the Class I File Search for Corridor C1

Site Number	Site Type	NRHP Eligibility
39GT2007	Chicago, Milwaukee, St. Paul & Pacific Railroad	Eligible
39GT0024	Multi-component artifact scatter	Unknown
39GT0006	Earth lodge village	Unknown
21LP0009	Earthworks	Unknown
21LP0011	Lithic scatter	Unknown
21LP0025	Cemetery	Unknown
LP-MEH-001	School (built ca. 1910)	Unknown
LP-MEH-002	Mehurin Town Hall (built ca. 1920)	Unknown
LP-MEH-004	Bridge L07845 (built 1909)	Eligible
LP-YEL-001	School (built ca. 1895)	Unknown
LP-YEL-002	Immanuel Lutheran Church (built 1881)	Unknown
LP-YEL-003	Yellow Bank Campground (built ca. 1940)	Unknown
LP-YEL-004	Farmstead (built ca. 1890)	Unknown
LP-YEL-005	School (built ca. 1895)	Unknown
LP-YEL-006	St. Joseph's Catholic Church (built 1907/1947)	Unknown
LP-YEL-007	Rosen Parochial School (built 1927)	Unknown
LP-YEL-008	Commercial Building (built ca. 1900)	Unknown
LP-YEL-009	Commercial Building (built ca. 1900)	Unknown
LP-YEL-010	Yellow Bank Church Campground Bridge (L-7744) (built 1893)	Unknown
YM-FLD-002	Farmstead (built ca. 1890)	Unknown
YM-FLD-003	Fred Meyen Farm (built ca. 1905)	Unknown
YM-FLD-004	Burr District 95 School (built ca. 1902)	Unknown
YM-HAM-003	District School No. 98 (built 1903)	Unknown
21CPa	Cemetery	Unknown
21CPb	Granite Falls Mill, Henry Hill's Mill	Unknown
21CP000d	Historic settlement of Minnesota Falls	Unknown
21CP0010	Earthworks	Unknown
21CP0011	Earthworks	Unknown
21CP0012	Artifact scatter, earthworks	Unknown
21CP0013	Earthworks	Unknown
21CP0029	Artifact scatter	Eligible
21CP0030	Artifact scatter	Eligible
21CP0042	Lithic scatter	Unknown
21CP0050	Lithic scatter	Unknown
21CP0053	Lithic scatter	Unknown
21CP0054	Single artifact	Unknown
21CP0055	Single artifact	Unknown
21CP0060	Single artifact	Unknown
21CP0061	Single artifact	Unknown
21CP0062	Lithic scatter	Unknown
21YMq	Single artifact	Unknown
21YMw	Single artifact	Unknown
21ym000b	Artifact scatter	Unknown
21YM0004	Artifact scatter	Unknown
21YM0014	Earthworks	Unknown
21YM0018	Earthworks, cemetery, artifact scatter	Unknown
21YM0019/21YM0003	Earthworks, cemetery	Unknown
21YM0031	Artifact scatter	Unknown
21YM0032	Lithic scatter	Unknown
21YM0033	Artifact scatter	Unknown

Table 5: Results of the Class I File Search for Corridor C1

Site Number	Site Type	NRHP Eligibility
21YM0034	Lithic scatter	Unknown
21YM0035	Artifact scatter	Unknown
21YM0036	Artifact scatter	Unknown
21YM0039	Lithic scatter	Unknown
21YM0040	Artifact scatter	Unknown
21YM0042	Lithic scatter	Unknown
21YM0044	Lithic scatter	Unknown
21YM0047	Artifact scatter	Unknown
21YM0053	Single artifact	Unknown
21YM0072	Lithic scatter	Unknown
21YM0073	Artifact scatter	Unknown
21YM0075	Single artifact	Unknown
21YM0076	Single artifact	Unknown
21YM0077	Single artifact	Unknown
21YM0078	Lithic scatter	Unknown
21YM0079	Single artifact	Unknown
21YM0080	Lithic scatter	Unknown
21YM0081	Lithic scatter	Unknown
21YM0084	Lithic scatter	Unknown
21YM0085	Lithic scatter	Unknown
21YM0092	Lithic scatter	Unknown
21YM0093	Lithic scatter	Unknown
21YM0094	Lithic scatter	Unknown
21YM0095	Lithic scatter	Unknown
21YM0096	Lithic scatter	Unknown
21YM0098	Cemetery	Unknown
21YM0101	Single artifact	Unknown
CP-GRT-001	Riverside Sanatorium (historic name)/Riverside Apartments/Minnesota Lakeside Center (current name) (built 1916)	Unknown
CP-GRT-007	Bernt Frederickson House (build ca. 1900)	Unknown
YM-OMR-004	Bartel Kokelman Farmstead (built ca. 1900)	Unknown
YM-FRT-002	Bridge 90308 (built 1915)	Unknown
YM-MNF-001	District School No. 6 (built 1905)	Unknown
YM-MNF-002	Assembly of God Church (built ca. 1950)	Unknown
YM-MNF-003	Pajutazee Presbyterian Church (built ca. 1954)	Unknown
YM-MNF-006	Minnesota Falls Plant and Dam (built 1905, razed 1950s)	Unknown
YM-OSK-004	District School No. 39 (built ca. 1881)	Unknown
YM-OSK-005	Bridge 532 (built 1912)	Unknown
YM-HAM-002	District School No. 81 (built ca. 1900)	Unknown
YM-HAM-005	Stage road (1880-1882)	Unknown
St. Leo, Minnesota		
YM-SLC-001	Catholic Church of St. Leo (built 1881/1940)	Unknown
YM-SLC-002	Henry Shanber Hardware (built 1897)	Unknown
YM-SLC-003	First State Bank of St. Leo (built ca. 1924)	Unknown
Hazel Run, Minnesota		
YM-HRC-001	Hazel Run School/District 20 (built 1939)	Unknown
YM-HRC-002	Hazel Run Evangelical Lutheran Church (built 1892-1903)	Unknown
YM-HRC-003	Hazel Run village Hall (built 1901)	Unknown
YM-HRC-004	Hazel Run Produce Company (built 1892-1944)	Unknown
YM-HRC-005	Hazel Run Post Office (built 1910/1931)	Unknown
YM-HRC-006	Hazel Run State Bank (built 1902)	Unknown
YM-HRC-007	Hazel Run Fire Department (built ca. 1960)	Unknown

Table 5: Results of the Class I File Search for Corridor C1

Site Number	Site Type	NRHP Eligibility
YM-HRC-008	James H. Jertson House (built ca. 1895)	Unknown
YM-HRC-009	Torger Jenson Farmhouse (built ca. 1892)	Unknown
YM-HRC-010	Bridge 914 (built 1913)	Unknown
Granite Falls, Minnesota		
YM-GRN-001	House (built ca. 1885-1895)	Unknown
YM-GRN-002	House (built ca. 1900)	Unknown
YM-GRN-003	House (built ca. 1895)	Unknown
YM-GRN-004	House (built ca. 1920)	Unknown
YM-GRN-005	House (built ca. 1880)	Unknown
YM-GRN-006	Olaf Lokensgaard House (built ca. 1888)	Unknown
YM-GRN-007	House (built ca. 1885)	Unknown
YM-GRN-008	Creamery; presently an apartment building (built ca. 1920)	Unknown
YM-GRN-009	Franklin J. Cressy House (built ca. 1880)	Unknown
YM-GRN-010	George Morse House (built ca. 1875-1880)	Unknown
YM-GRN-011	Franklin J. Cressy House (built ca. 1875-1880)	Unknown
YM-GRN-012	House (built ca. 1915)	Unknown
YM-GRN-013	Methodist Episcopal Church (built ca. 1881)	Unknown
YM-GRN-014	United Lutheran Church (built ca. 1882)	Unknown
YM-GRN-015	House (built ca. 1910)	Unknown
YM-GRN-016	Andrew J. Volstead House (built 1878)	Listed
YM-GRN-017	First Congregational Church (built 1899)	Unknown
YM-GRN-018	House (built 1895)	Unknown
YM-GRN-019	House (built ca. 1895)	Unknown
YM-GRN-020	House (built ca. 1890)	Unknown
YM-GRN-021	House (built ca. 1900)	Unknown
YM-GRN-022	House (built ca. 1885)	Unknown
YM-GRN-023	Granite Falls Lutheran Church (built 1950/1951)	Unknown
YM-GRN-024	Yellow Medicine County Jail (built 1893)	Unknown
YM-GRN-025	Yellow Medicine County Courthouse (built 1889)	Unknown
YM-GRN-026	Granite Falls High School (built 1930)	Unknown
YM-GRN-027	William Lee House (built ca. 1915-1920)	Unknown
YM-GRN-028	House (built ca. 1895)	Unknown
YM-GRN-029	House (built ca. 1890)	Unknown
YM-GRN-030	House (built ca. 1890)	Unknown
YM-GRN-031	House (built ca. 1885)	Unknown
YM-GRN-032	House (built ca. 1900)	Unknown
YM-GRN-033	House (built ca. 1900)	Unknown
YM-GRN-034	Yellow Medicine County Courthouse (built 1874)	Unknown
YM-GRN-035	House (built ca. 1890)	Unknown
YM-GRN-036	House (built ca. 1885)	Unknown
YM-GRN-037	House (built ca. 1880)	Unknown
YM-GRN-038	House (built ca. 1880)	Unknown
YM-GRN-039	House (built ca. 1885-1890)	Unknown
YM-GRN-040	Grace Evangelical Free Church (built ca. 1915)	Unknown
YM-GRN-041	House (built ca. 1895)	Unknown
YM-GRN-042	Great Northern Railroad Depot (built 1940)	Unknown
YM-GRN-043	Minnesota Falls Co-op Elevator (built ca. 1940)	Unknown
YM-GRN-044	St. Andrew’s Catholic Church (built 1943)	Unknown
YM-GRN-045	Yellow Medicine County Museum (built 1968)	Unknown
YM-GRN-046	World War Memorial Park (Established 1925)	Eligible
YM-GRN-047	Bridge (built ca. 1940)	Unknown
YM-GRN-048	Bridge (built ca. 1970)	Unknown
YM-GRN-049	House (built ca. 1900)	Unknown

Table 5: Results of the Class I File Search for Corridor C1

Site Number	Site Type	NRHP Eligibility
YM-GRN-050	House (built ca. 1880)	Unknown
YM-GRN-051	Standard Lumber (built ca. 1900)	Unknown
YM-GRN-052	Commercial Building (built ca. 1895)	Unknown
YM-GRN-053	Commercial Building (built ca. 1900)	Unknown
YM-GRN-054	Granite Falls State Bank (built 1912)	Unknown
YM-GRN-055	Commercial Building (built 1900)	Unknown
YM-GRN-056	Theatre (built ca. 1940)	Unknown
YM-GRN-057	D.N. McLarety Building (built ca. 1900)	Unknown
YM-GRN-058	Commercial Building (built ca. 1900)	Unknown
YM-GRN-059	Commercial Building (built ca. 1900)	Unknown
YM-GRN-060	Footbridge (built ca. 1950-1970)	Unknown
YM-GRN-061	K.K. Berge Store (built 1924)	Unknown
YM-GRN-062	Commercial Building (built ca. 1910-1925)	Unknown
YM-GRN-063	Avalon Theatre (built ca. 1930)	Unknown
YM-GRN-064	Granite Falls Power Plant (built 1892-1940s)	Unknown
YM-GRN-065	Jordon House (built ca. 1940)	Unknown
YM-GRN-066	House (built ca. 1880)	Unknown
YM-GRN-067	Episcopal Church/Trinity Church Society Church (built 1889)	Unknown
YM-GRN-068	Frank Hacking House (built ca. 1898)	Unknown
YM-GRN-069	House (built ca. 1895)	Unknown
YM-GRN-070	Hazelberg House (built 1903)	Unknown
YM-GRN-071	B. E. Nelson House (built 1898)	Unknown
YM-GRN-072	LaMar House (built ca. 1878)	Unknown
YM-GRN-073	House (built ca. 1875)	Unknown
YM-GRN-074	House (built ca. 1885 or ca. 1920)	Unknown
YM-GRN-075	House (built ca. 1885)	Unknown
YM-GRN-076	Henry Hill Grist and Saw Mill (razed) (built 1871/1872)	Unknown
YM-GRN-077	Granite Falls Dam (built 1911)	Unknown
YM-GRN-078	Granite Falls Overlook (built 1937)	Unknown
CP-GRN-001	Elevator (built ca. 1900)	Unknown
CP-GRN-002	Chicago Milwaukee and St. Paul Depot (built ca. 1890-1905)	Unknown
CP-GRN-003	House (built ca. 1880)	Unknown
CP-GRN-004	City Water Tank (built ca. 1930)	Unknown
CP-GRN-005	Pillsbury Benjamin and Susan House (built ca. 1880)	Eligible
CP-GRN-006	Bridge No. 5045 (built 1931)	Unknown
CP-GRN-008	Hydroelectric Plant (built ca. 1915)	Unknown
CP-GRN-009	James O'Conner House (built ca. 1900)	Unknown
CP-GRN-010	House (built ca. 1885)	Unknown
CP-GRN-011	Julian A. Weaver House (built ca. 1878)	Listed
CP-GRN-012	House (built ca. 1880)	Unknown
Total 191 **60 sites** **131 structures**		**3 eligible sites** **3 eligible structures** **2 listed structures**

Source: HDR, 2005.

Table 6: Results of the Class I File Search for the Proposed Big Stone II Plant Site and Expanded Groundwater Areas.

Site Number	Site Type	NRHP Eligibility
39GT0002	Precontact artifact scatter	Not evaluated
39GT0020	Precontact artifact scatter	Not evaluated
39GT0006	Earthwork	Not evaluated
39GT0024	Multi-component artifact scatter	Not evaluated
39GT2007	Active railroad line	Eligible
39GT2042	Railroad spur raised bed	Eligible
39GT0030	Edward Folk Barn	Not evaluated
39GT0031	Anthony Folk Barn	Not evaluated
39GT0392	Farm	Not eligible
39GT0394	Bridge	Not eligible
39GT0432	Tony Vanlith Barn	Not evaluated
39GT0434	Wayne Folk	Not evaluated
39GT0500	Matt Fonder Farm	Not eligible
39GT0502	Marianne Lantis House	Not eligible
39GT0504	Concrete Bridge	Not eligible
39GT0506	C. Korstjens Barn	Not eligible
39GT0508	Dale Tuchscherer House	Not eligible
39GT0037	Big Stone City Hall	Listed on NRHP
39GT0006	Milwaukee Road Bridge O-262 ½	Eligible
39GT0010	Big Stone City School	Not eligible

Table 7: Results of the Architectural History Resource Survey for the Proposed Big Stone II Transmission Line, Duel and Grant Counties, South Dakota

Site Number	Site Type	NRHP Eligibility
28853	Farmstead	Not eligible
28856	Farmstead	Not eligible
28857	House	Not eligible
28858	Farm remnant	Not eligible
28859	C.D. Auto Sales	Not eligible
28866	House	Not eligible
28867	Farmstead	Not eligible
28868	Farmstead	Not eligible
28869	Farmstead	Not eligible
28870	House and outbuildings	Not eligible
28871	Farmstead	Not eligible
28872	Farm remnant	Not eligible
28873	Farmstead	Not eligible
28877	Farmstead	Not eligible
28878	Bridge	Not eligible
28879	Farm remnant	Not eligible
28880	Farmstead	Not eligible
28881	Farmstead	Not eligible
28882	Farm remnant	Not eligible
28883	Farmstead	Not eligible
28884	Farmstead	Not eligible
28885	Farm remnant	Not eligible
28886	Bridge	Not eligible
28887	Farm Remnant	Not eligible
28888	Farmstead	Not eligible
28889 (DE-007-0004)	Farmstead	Eligible (barn only)
28890	Abandoned dwelling	Not eligible
28891	Farmstead	Not eligible
28892	Abandoned farmstead	Not eligible
	17 modern properties	Not eligible
	9 power lines and 2 substations	Not eligible
GT-000-00424	Abandoned farm	Not eligible
GT-000-00428	House	Not eligible
GT-000-00266	Vacant house	Eligible

Appendix H

Transmission Safety and Emergency Services in the Proposed Project Area

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Appendix H

Transmission Safety and Emergency Services in the Proposed Project Area

Emergency Services	Proposed Plant Site	Corridor A	Corridor B and Corridor B1	Corridor C and Corridor C1
Hospitals	St. Bernard's Providence Hospital, Milbank, South Dakota Ortonville Municipal Hospital, Ortonville, Minnesota Holy Trinity Hospital, Graceville, Minnesota	Holy Trinity Hospital, Graceville, Minnesota Wheaton Community Hospital, Wheaton, Minnesota Stevens Community Medical Center, Morris, Minnesota Minnewaska District Hospital, Starbuck, Minnesota	Appleton Municipal Hospital, Appleton, Minnesota Madison Hospital, Madison, Minnesota Swift County-Benson Hospital, Benson, Minnesota Stevens Community Medical Center, Morris, Minnesota Minnewaska District Hospital, Starbuck, Minnesota Rice Memorial Hospital, Wilmar, Minnesota Wilmar Regional Treatment Center, Wilmar, Minnesota Paynesville Area Hospital, Paynesville, Minnesota Renville County Hospital, Olivia, Minnesota Meeker County Memorial Hospital, Litchfield, Minnesota	Deuel County Memorial Hospital, Clear Lake, South Dakota Madison Hospital, Madison, Minnesota Appleton Municipal Hospital, Appleton, Minnesota Hospital, Canby, Minnesota Hendricks Hospital, Hendricks, Minnesota Brookings Hospital, Brookings, South Dakota Weiner Memorial Medical Center, Marshall, Minnesota Granite Falls Municipal Hospital, Granite Falls, Minnesota
Burn Centers	McKennon Hospital, Sioux Falls, South Dakota Hennepin County Medical Center Burn Center, Minneapolis, Minnesota Regions Hospital, St. Paul, Minnesota			
Ambulance Services	Ortonville Ambulance Service, Ortonville, Minnesota Grant-Roberts Ambulance Service, Milbank, South Dakota	Ambulance Service of Wheaton, Wheaton, Minnesota City Ambulance, Herman, Minnesota Stevens County Ambulance Service, Morris, Minnesota Morris Ambulance, Morris, Minnesota	Stevens County Ambulance Service, Morris, Minnesota Morris Ambulance, Morris, Minnesota Murdock, Minnesota Kerkhoven, Minnesota Montevideo, Minnesota Sunburg, Minnesota Pennock, Minnesota Spicer, Minnesota Atwater, Minnesota Cosmos, Minnesota Paynesville, Minnesota Gold Cross Ambulance, Litchfield, Minnesota	Gary, South Dakota Brandt, South Dakota Hendricks, Minnesota Astoria, South Dakota Montevideo, Minnesota Granite Falls Municipal Hospital, Granite Falls, Minnesota Ghent, Minnesota North Ambulance, Marshall, Minnesota Danube, Minnesota North Ambulance, Redwood Falls, Minnesota

Emergency Services	Proposed Plant Site	Corridor A	Corridor B and Corridor B1	Corridor C and Corridor C1
Fire Departments	Odessa, Minnesota Milbank, South Dakota Corona, South Dakota	Clinton, Minnesota Graceville, Minnesota Chokio, Minnesota Morris, Minnesota Hancock, Minnesota Cyrus, Minnesota Donnelly, Minnesota	Correll, Minnesota Milan, Minnesota Hancock, Minnesota Danvers, Minnesota Clonarf, Minnesota De Graff, Minnesota Murdock, Minnesota Kerkhoven, Minnesota Morris, Minnesota Cyrus, Minnesota Starbuck, Minnesota Terrace Fire Department, Sedan, Minnesota Sunburg, Minnesota Willmar, Minnesota Kandiyohi, Minnesota Pennock, Minnesota Spicer, Minnesota Raymond, Minnesota Blomkest, Minnesota Atwater, Minnesota New London, Minnesota Lake Lillian, Minnesota Prinsburg, Minnesota	Nassau, Minnesota Marietta, Minnesota Gary, South Dakota Brandt, South Dakota Canby, Minnesota Madison, Minnesota Dawson, Minnesota Hendricks, Minnesota Astoria, South Dakota Porter, Minnesota Taunton, Minnesota Minneota, Minnesota Boyd, Minnesota Clarkfield, Minnesota Hazel Run, Minnesota Montevideo, Minnesota Granite Falls, Minnesota Maynard, Minnesota Hanley Falls, Minnesota Sacred Heart, Minnesota
Sheriff	Big Stone County, Big Stone, Minnesota Grant County, Milbank, South Dakota	Big Stone County, Big Stone, Minnesota Stevens County, Morris, Minnesota Traverse County, Wheaton, Minnesota	Big Stone County, Big Stone, Minnesota Lac Qui Parle Sheriff, Madison, Minnesota Swift County Sheriff, Benson, Minnesota Swift County Sheriff, Benson, Minnesota Chippewa County Sheriff, Montevideo, Minnesota Kandiyohi County Sheriff, Willmar, Minnesota Kandiyohi County Sheriff, Willmar, Minnesota	Grant County, Milbank, South Dakota Deuel County Sheriff, Clear Lake, South Dakota Lac Qui Parle Sheriff, Madison, Minnesota Yellow Medicine County Sheriff, Granite Falls, Minnesota Lac Qui Parle Sheriff, Madison, Minnesota Yellow Medicine County Sheriff, Granite Falls, Minnesota Chippewa County Sheriff, Montevideo, Minnesota

Emergency Services	Proposed Plant Site	Corridor A	Corridor B and Corridor B1	Corridor C and Corridor C1
Police Departments	Big Stone City, South Dakota Milbank, South Dakota	Beardsley, Minnesota Browns Valley, Minnesota Herman, Minnesota Morris, Minnesota Hancock, Minnesota	Appleton, Minnesota Milan, Minnesota Clontarf, Minnesota Benson, Minnesota De Graff, Minnesota Murdock, Minnesota Kerkhoven, Minnesota Sunburg, Minnesota Pennock, Minnesota Willmar, Minnesota Spicer, Minnesota Atwater, Minnesota	Madison, Minnesota Canby, Minnesota Hendricks, Minnesota Ivanhoe, Minnesota Minneota, Minnesota Ghent, Minnesota Boyd, Minnesota Clarkfield, Minnesota Hazel Run, Minnesota Granite Falls, Minnesota Montevideo, Minnesota

Appendix I

Visual Resources Inventory Methods

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APPENDIX I
VISUAL RESOURCES INVENTORY METHODS

There are no formal guidelines for documenting and analyzing impacts to visual resources on private, state or county-owned lands found within the proposed Project area. Therefore, the visual inventory was conducted using principles derived from the Bureau of Land Management Visual Resource Management 8400 System manuals and modified to accommodate the analysis of the proposed Big Stone II plant and transmission corridors in the proposed Project area's diverse landscapes (BLM, 1984). This method provides a consistent inventory process across the proposed Project area for both public and private lands.

A series of two- to four-mile-wide study corridors were inventoried to document existing visual resources. The study process included Geographic Information System (GIS) analyses of Gap Analysis Program land cover patterns, digital elevation models, topographic maps, satellite images, field reconnaissance surveys and review of existing literature sources. The result is a consistently inventoried database used to assess visual impacts for the proposed corridors as described in Section 4.9. The inventory consists of the following five components:

- Regional setting/landscape character
- Scenery quality ratings
- Viewer sensitivity
- Distance zones
- Visual management classifications

The following subsections define visual resource terminology and describe the specific methods used for conducting the visual resource inventory.

Regional Setting/Landscape Character

Analysis of the scenic values of the landscape began with an examination of the region's physiography described by Fenneman's Physiography of the Eastern United States (Fenneman, 1938). Related literature, field investigations, and interpretation of GIS data were used to determine the landscape character classifications and scenic quality ratings for areas crossed by the proposed corridors. Landscape character types are landscape units refined from the regional physiographic province and section classifications. These classifications describe the visual character of the landscape at a regional scale. Observed and noted during field visits to the proposed Project area were dominant landform and land cover features (e.g., ridges, hills, plains, lakes, wetlands, tree groves, homesteads and communities) that define landscape character types in this region.

Scenic Quality Ratings

The scenery quality rating analysis ranks project areas and elements based upon their relative visual and aesthetic appeal. In the visual resource inventory process, landscapes are rated based on the apparent scenic quality inherent in seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity and cultural modifications. During the rating process, each of these factors is ranked on a comparative basis with similar features within the physiographic province. Three levels of scenery quality are documented in the proposed Project area including Class A scenery, where visual quality is at a high level; Class B scenery, where visual quality is at a moderate level; and Class C scenery, where visual quality is at a low level.

Viewer Sensitivity

The viewer sensitivity inventory documents those areas where viewers could be concerned about changes to the landscape. Three components make up the viewer sensitivity inventory, as follows: viewpoints and areas, visual sensitivity and seen areas/visibility thresholds.

Views from Sensitive Viewpoints

Potentially sensitive viewpoints near the vicinity of the plant site and within the proposed corridors were identified and inventoried through analysis of map data and field reconnaissance. The inventory includes the following types of viewpoints and areas:

- **Residences:** single-family and multi-family dwellings.
- **Parks and recreation areas:** lakes, recreation trails, parks, day-use areas, picnic areas, golf courses, and other public use areas.
- **Travel routes:** U.S. Highway 12 and state, county, and local highways.

Visual Sensitivity

Visual sensitivity is a measure of viewer concern for change to the landscape. Visual sensitivity is evaluated and documented based on public concerns, discussions with agency officials, and review of existing agency information. Methods outlined in the BLM VRM 8400 System were used as a guideline to evaluate viewer sensitivity, but were modified to address rural and suburban-related viewpoints and view areas. The visual sensitivity criteria used for the proposed Project's analysis are shown in Table 1.

Table 2 illustrates the combinations of the visual sensitivity criteria described in Table 1 and the resulting visual sensitivity level. Results of the visual sensitivity inventory were reviewed, refined and carried forward into the visual impacts analysis in Section 4.9.

Distance Zones

Mapping of distance zones is conducted from points, lines and areas of high or particularly sensitive human use. To account for variations in local conditions, the results of the distance zone mapping analyses are verified through site visits. The resulting analysis identifies areas by distance zones as follows: foreground, middleground, background and seldom seen. Viewpoints were inventoried in the vicinity of the plant site and near all of the proposed corridors. Viewpoints located beyond the background distance zone were not inventoried because the proposed Project would not be visually apparent.

Table 1. Visual Sensitivity Criteria

Criteria	High	Moderate	Low
Use volume	High level of use	Moderate level of use	Low level of use
User attitude	High expectations for maintaining scenic quality/visual integrity (e.g., recreation areas, scenic highways).	Users are concerned for scenic quality/visual integrity but are not the main focus of their experience (e.g., residences, golf courses, trails).	Areas where the public has low expectations for maintaining scenic integrity. Generally commercial, industrial areas where human-caused modifications diminish the landscape.
Duration of view	Fixed or contiguous views (e.g., residences, developed recreation sites, etc.).	Intermediate views (e.g., waysides, overlooks, rest areas, open highway views).	Brief or intermittent views (e.g., views in enclosed landscapes).

Source: BLM, 1984

Table 2. Visual Sensitivity Matrix

Use Volume[a]	User Attitude[b]	Duration of View[c]	Visual Sensitivity Level
High	High	Long	High
Moderate	High	Moderate	High
Low	High	Moderate	High
High	Low	Short	Moderate
High	Moderate	Moderate	Moderate
Moderate	Moderate	Moderate	Moderate
Moderate	Low	Moderate	Moderate
Low	Moderate	Short	Low
Low	Low	Short	Low

[a]Use volume is the number of visits to a particular site by the public.
[b]User attitude is the expectation or level of concern an individual has toward a particular visual setting.
[c]Duration of view is the amount of time spent viewing the subject landscape.

Source: BLM, 1984

Distance thresholds are established zones of visual perception. Essentially, form, line, color and textures are perceived differently with increasing distance from a viewpoint or view area. With increase in distance, changes in the landscape become less obvious and perception of detail is diminished. Elements of form and line become more dominant than color or texture. Threshold distance zones were selected based on the nature and appearance of the proposed Project where new steel or wooden transmission structures would potentially parallel existing steel lattice structures, wooden pole structures, or steel pole structures. The distance thresholds are defined as follows:

- **High Visibility Threshold** (0.25-mile distance): This is the distance at which fine details are obvious. Texture and color are vivid and clear. New features, such as electrical transmission structures and conductors, would dominate the view.
- **Moderate Visibility Threshold** (0.25- to one-mile distance): This is the threshold where changes in the landscape might be viewed in less detail. Texture, form, and other aesthetic qualities of vegetation are normally perceived in this zone. Fine details and the dominance of the new features, such as electrical transmission structures and conductors, diminish.

- **Low Visibility Threshold** (one- to two-mile distance): This zone is where details of foliage and fine textures cease to be perceptible, small features begin to appear as outlines or patterns, and the dominance of new features, such as electrical transmission structures and conductors, further diminish.
- **Seldom Seen Visibility Threshold** (beyond two-mile distance): Those areas of the landscape where elements are represented as outlines. Form and line are most obvious. Colors are diminished in most cases due to atmospheric haze, and appear washed out or muted. New features, such as electrical transmission structures and conductors, would have no dominance.

Visual Resource Classifications

Establishment of visual resource classifications results from combining scenery quality, viewer sensitivity and distance zones. Visual resource classifications are defined by BLM as follows:

- **Class I:** To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.
- **Class II:** To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.
- **Class III:** To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.
- **Class IV:** To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

Visual resource classifications are assigned through GIS spatial analysis based on combinations of scenic quality, sensitivity levels and distance zones as shown in Table 3.

Table 3. Visual Resource Classifications

		High Sensitivity			**Medium Sensitivity**			**Low Sensitivity**
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III[a] IV[a]	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
		f/m	b	s/s	f/m	b	s/s	s/s
		Distance zones						

[a] If adjacent areas is Class III or lower, assign Class III; if higher assign Class IV.

f/m – Foreground/Middleground
b – Background
s/s – Seldom Seen

Source: BLM, 1984

Appendix J

Big Stone II Final Report on the Social and Economic Assessment

BIG STONE II

FINAL REPORT

on the

Social and Economic Assessment

December 14, 2005

Prepared by the

Staff members of

The Greeter, Inc. and Venerts Investments, Inc.

for the

LOCAL REVIEW COMMITTEE

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I. Introduction

On July 20, 2005 Ottertail Power Company filed, on its behalf and other power users, the Energy Conversion Facility Permit Application with the South Dakota Public Utilities Commission for the Big Stone II project. That application submittal triggered a local review process that is required by South Dakota law. The local review process is detailed in SDCL 49-41b-6 to SDCL 49-41b-10.

Soon after the application was filed, as required by State Law (SDCL 49-41b-6), a Local Review Committee (LRC) was created. The LRC membership mirrored the requirements of State law (SDCL 46-41b-6) and a list of the members and the organizations that they represent is contained in Appendix A. Maps of the impact area taken from the Barr Engineering Study are in Appendix B.

The LRC organized and at its first meeting elected Steve Bull as the Chairman and Peggy Schuekle as Secretary. The Committee met again on September 15, 2005. During that meeting the LRC members saw a PowerPoint presentation on the background of the Big Stone II, State law and the LRC responsibilities/requirements, Otter Tail Power Company's Scope of Work and expectations, key Big Stone II construction milestones, Big Stone II workforce projections, the study area, implementation work plan including the details on the amount of consultant time needed and the cost to do the work. (This PowerPoint presentation is in Appendix C.) After review and discussion the LRC members unanimously approved The Greeter, Inc. (Barry Wilfahrt) and Venerts Investment, Inc. (Bill Folkerts) proposal to develop the social and economic assessment as required by State law.

The Committee's recommendation to approve The Greeter, Inc and Venerts Investments, Inc contract was forwarded to the South Dakota Public Utilities Commission (PUC) for their approval. See Chairman Bull's letter that was sent to the PUC in Appendix D.

The South Dakota PUC met and approved the LRC's application at its October 4, 2005 meeting. Copy of the e-mail confirming the PUC approval is in Appendix D.

Immediately following the LRC's approval of the consultant's contract, work on the assessment began.

II. Assessment Methodology and Data Collection

1. Meeting and Questionnaire Approval

The first action was to determine what the committee members needed to know in order to assess the impacts and issue a final report as required by State Law. They discussed what issues they expected to surface during development of Big Stone II and they discussed a methodology to obtain information about the possible impact to the area communities. Further, they discussed the information that they needed to have in order to determine what should be the mitigation measures, if any.

The consultant developed questionnaires that would be used to obtain the information. The questionnaires were developed to obtain a response about specific issues and the respondents' expectation of the Big Stone II impacts. Each questionnaire had ample space and questions to give the respondent the opportunity to provide verbal explanations. Several questions were open ended so that any issue could be raised and any opinion could be expressed.

The questionnaires were presented to the LRC for discussion. The members reviewed and approved the questionnaires and used the State laws as a guide to determine the various geographic locations to be included in the assessment, the specific city, school, health, law enforcement or county officials that were to be administered the questionnaire. Furthermore, the Local Review Committee felt it would be beneficial if several of the groups in the local review 20-mile target area could be interviewed in person in addition to filling out the questionnaire. It was decided this type of interaction among the consultants and other interviewees may yield a more thoughtful and comprehensive impact analysis, a better assessment of how the area could absorb the impacts and potential mitigation measures. Next a schedule for the interviews and meetings was developed.

2. a. Weston 4 Power Plant Trip

During the meeting reviewing the questionnaires, the LRC members had a number of questions about the number of workers that would come to the area, the type of workers, the number of families, the number of students to expect, the health of workers, language skills expected, the need for housing, opportunity for local workers, etc. Many of the Committee members remembered or heard what happened to the area when Big Stone I was built in the 1970's. While generally members thought that today's workers were different and more respectful, others were concerned about drinking and driving and still other members were concerned about housing for the workers families.

All of the members felt they needed information from other power companies that had a plant under construction. It was the LRC's opinion that touring another facility that had a similar power plant under construction would likely answer a number of questions they had and give them valuable information on the issues that may need mitigation.

Otter Tail Power staff members knew of a plant similar to Big Stone II under construction in Wisconsin. They arranged an on-site meeting at Weston 4 on October 5, 2005. The individuals that were able to make the trip to Wausau, Wisconsin were Steve Bull, Chairman LRC and Summit School Board, Mark Rolfes, Ottertail Power Company, Barry Wilfahrt, Consultant, Bill Folkerts, Consultant, Don Larson, Milbank City Council/Acting Mayor, Scott Schneider, Big Stone School Board member and Mel Rinke, Ortonville City Council member.

At the Weston 3 facility this delegation met with the Wisconsin Public Service Corporation officials, county and city officials to discuss the Weston 4 Power plant that was under construction. This 500 megawatt electric generating facility will use clean coal technology much like the Big Stone II plant. This new plant like Big Stone II is being built adjacent to their other existing generating plants.

Before they left on the trip, the LRC members developed a number of questions that they asked the officials at Weston 4. During the day-long meeting with plant personnel, touring the construction site/plant and meeting with a group similar to the LRC over lunch, the LRC members were able to ask many questions and gained an excellent understanding of what Weston 4 had experienced thus far in their plant development.

2 b. What the LRC learned from the Weston 4 visit and discussion:

Generally, while the Weston 4 plant site is located in an area that has a much more urban population than Big Stone area, the answers to the questions that were asked, told the LRC members much about today's worker and that they are certainly different than in the 1970's. They found that almost all of the Weston construction management type workers (about 40) came to work at Weston 4 leaving the family back home. These workers rented homes and apartments. Some purchased houses since they expected to be in the area for four or more years.

The construction type workers often had spouses that worked so instead of uprooting the entire family the workers either commuted or worked for a period of time and then went home over the weekends every two or three weeks. A few in this group purchased houses. Others rented apartments or houses and still others rented hotels rooms.

We learned that neither the construction managers nor the on-site construction workers brought children to the school system. The Wausau folks could think of only a single child that had moved to the area as a result of the construction project.

Importantly, the LRC members learned from County and City officials that the workers did not hang out at the local bars after work. They knew of no problems that had been reported by either the Sheriff's office or the Police Department.

When the lack of crime was noted, it was quickly followed by the Weston 4 officials stating that all of the construction workers were screened for drugs. And they told us that background checks were done. The Weston 4 officials claim that these actions had helped them greatly to reduce the crime but also, for them it was important because, they claim drug testing greatly reduced worker turnover.

In addition to protecting the workers, the construction site was "locked down" extremely tight for safety and security purposes. Everyone that wanted to enter had to have a reason to be on-site and an ID or be met at the gate by Weston personnel.

The LRC members found housing was not an issue at this stage in construction. The big worker influx will come later but currently there were about 400 workers on site. But the LRC members were cautioned that the number of workers changed day to day as the various skills needed on the site changed. Also, they were told that a great deal of the construction/fabrication was done off-site and the large pieces were shipped to the site for assembly. Fabrication of certain parts of the plant off site is a now a common practice.

Medical, fire protection, law enforcement and housing issues were discussed. The members were told that Weston 4 had experienced no issues in any of these areas.

Two important lessons were learned. One, Wisconsin Public Power had a full time PR person on the ground before the plant started construction. This person answered all the questions and was proactive in giving out information about what was happening and when it happened or was to happen. She answered all the impact concerns, issues and questions. She used a very effective web site to inform the public about the day to day construction activities. The web site also gave information to potential workers about jobs. It provided local companies with information about RPFs that they could use to bid on various parts of the construction project. She developed a very effective thick and informational packet for new employees coming to the area. This packet provided details about housing locations and contact persons, hotels, education services, recreation activities, area attractions, etc.

Second, the Committee members learned that the Weston 4 construction staff members scheduled informational meetings with local law enforcement department staff members, fire protection personnel, emergency medical staff members and local governmental officials. These meetings were not only to keep the local staff members informed of the changes that were scheduled on site but, it also gave them an explanation of the various phases of the project work schedule and an opportunity to ask questions and to voice concerns. The LRC members were told that these meetings were extremely valuable for the local officials.

The questionnaire that was used during this plant visit is in Appendix E. Also in Appendix E is a list of Wisconsin Attendees and a summary of the answers to questions that was prepared from notes taken during the meetings.

3. MidAmerica Energy - Council Bluffs Energy Center

The Committee learned that another plant was under construction near Council Bluffs, Iowa. The Committee asked the consultants to contact the utility company that was building the plant and ask the same questions that were asked of the Weston 4 people.

The plant at Council Bluffs is being built by MidAmerica Energy. The Council Bluffs Energy Center is part of a multi-unit generation site. The 790 megawatt facility that is under construction is also a coal fired unit. The project cost is expected to be $1.2 billion. Employment is expected to peak at more than 1,000 workers.

While the LRC did not visit they were able to collect some information about the facility and the impact the construction was having on the area. Again, the area is more urban than Big Stone area since Omaha is located immediately across the Missouri River to the west and north of the new plant. Generally, the information collected mirrors the information received from Weston 4.

More information is in Appendix I.

4. Questionnaire Mailings, E-mails, Telephone calls and Meetings.

The questionnaires were developed to inform the people answering the questions as well as to get information from them about what they expect the impact issues will be in the area. Generally, this information was sought out by a yes or no response. For more detail, the respondent was asked an open ended question about what they thought about a specific issue or question. Then the respondent was given an opportunity to tell the Committee what they thought and what measures they would propose. Again, they were asked to provide specific information.

For the community leaders in the immediate area, the consultants lined up meetings in their cities with their respective unit of governments. Over a period of several days the consultants met face to face, with 46 officials. Almost all those that attended these meetings filled out a questionnaire. During all of the meetings the consultant took notes and recorded the comments and needs expressed. See Appendix F for the Consultant's list of those interviewed. This interview process also included non-governmental personnel, such as hospital and clinic administrators, ambulance staff members and fire department personnel.

While Minnesota cities, school and county were not included in the immediate South Dakota impact area, the LRC members felt it was important to include information from across the border. The members recognized that Minnesota is outside the South Dakota PUC scope but they understood it was important from a mitigation perspective to include this area of Minnesota. Several members commented that crime does not stop at the border. They pointed out that the health needs do not stop at the border, either. Also, the consultants found that the Cities of Big Stone City and Ortonville cooperate in several important areas, such as law enforcement, emergency medical/health, and fire protection. The two school districts also cooperate on beneficial projects. And the new plant will be closer to Ortonville than to Milbank.

For the South Dakota community leaders outside the immediate impact area the consultants mailed questionnaires to the City or School officials. Follow-up mailings were then made to those that did not return the questionnaires. Last, personal telephone calls were made to the officials that did not return the questionnaires. In a few cases, neither the calls nor the questionnaires were returned.

All in all, a great deal of information was collected from government officials, hospitals, clinics, fire departments and units of government. In the outlying areas a few officials did not respond. In the immediate impact area, information was collected from all the units of government, medical services and local government officials. A total of 59 questionnaires were completed and all were made a part of this report. Copies of the completed questionnaires, summaries of the questionnaires and an overall summary of the quantifiable data included on the questionnaires are included in Appendix G.

5. The original Application and the Impact Studies that were done:

Prior to the LRC work, a Community Impact Study for the Big Stone II Power Plant was prepared by First District Association of Local Government. Other work done includes the Application for an Energy Conversion facility Siting Permit prepared by Barr Engineering for Otter Tail Power Company and the feasibility study that was completed by Burns & McDonnell, Inc.

With exception of maps and technical information gathered about the plant and its operation, all the information included in this report is first hand primary data. Where secondary source data are used it is noted.

III. Big Stone II Impacts, Assessment of the Area's Capacity to Absorb the Impacts, Recommended Action Needed and Recommended Mitigation Measures.

The LRC gathered and studied a great deal of information about the potential impact of Big Stone II. They learned much from company officials at the two coal fired plants that are under construction in Iowa and Wisconsin. But, the most important information came from local officials in the impact area. And as stated above some of that information came from Minnesota communities because of their proximity to the proposed plant.

The following summary prepared by the Local Review Committee is comprised of four distinct components.

First is the Local Review Committee's list of potential impacts of the Big Stone II Plant.

Second is the Local Review Committee's assessment of the area's ability to absorb those impacts.

Third is a list of action items needed, identified by the Local Review Committee to ensure a smooth project. These "needed action items" in essence become a major part of the job description of the Public Affairs Person recommended as the final mitigation measure recommended by the Local Review Committee.

Fourth is the list of specific mitigation measures the Local Review Committee is recommending to the South Dakota Public Utilities Commission.

The summary below is organized by the 12 assessment areas defined in South Dakota State law plus one.

1. i. Housing

A. Impacts

a. **Availability of Housing.** With 1,400 workers anticipated at the peak of the Big Stone II construction project, it is widely anticipated the availability of housing will be adversely impacted during construction, however, most of the people interviewed believe the area will be able to handle it. According to the 2000 US Census, Grant County had 3,482 housing units with 13.4% multiple family rentals and Big Stone County had 3,169 housing units with 9.3% multiple family rental units.

b. **Rental Unit Development.** Many of those interviewed indicated local developers had purchased the trailer parks in the Ortonville, Big Stone City and Milbank area. Local sources said they had purchased most of the apartments in the three communities as well. In Ortonville, another developer was reported to have purchased several single-family homes and was rehabbing them for use as rentals. We heard of several other specific cases where people were preparing to rent part of their home or have purchased a house to renovate and rent out.

c. **Increase in rental rates and lot rents.** Lot rents have already increased from $85 a month to $140 a month according to several of the people interviewed. The high concentration of rental property in the hands of one or two property owners could cause significant price impact on rental property and mobile home lot rents in the area as demand increases during construction.

d. **Impact of increased Rental Rates.** Concern was expressed that increased prices may drive some people out of the local rental market and possibly even out of the community. Further concern was expressed if this happens they will unlikely return to the area after Big Stone II is constructed and rates return to normal.

e. **Housing Development.** Several officials interviewed indicated there were several very capable area developers currently working on housing developments. There were also several other housing developments planned and several more being talked about and promoted by the various area communities as a way to gain populations and tax base. Based on what was learned from the trip to Weston 4 new single family housing will unlikely be used by the construction workers themselves. However, as area families move into the newly built units it would free up presumably smaller existing housing for transition to the rental market. People currently in rental housing may also move to the new housing development or the smaller starter homes as they become available improving the availability of rental housing.

B. Areas Capacity to Absorb Impacts.

In the First District Housing Survey conducted in March of 2005 as part of the Big Stone II application process the following accommodations itemization was developed:

Motel Beds	2,242	60 mile radius study area
Houses for sales	140	Primary and secondary areas
Houses for rent	23	Primary and secondary areas
Apartments for rent	140	Primary and secondary areas
Mobile Homes for Sale	10	Primary and secondary areas
Mobile Homes for rent	18	Primary and secondary areas
Mobile Home Pads for Rent	119	Primary and secondary areas
RV Pads for rent	83	Primary and secondary areas

No attempt to update these results was made by the consultants since the numbers fluctuate from day to day. The questionnaires and interviews by the consultants did however confirm many of the numbers. Since the information above was compiled a new 93-room hotel was opened September, 2005 in the study area.

During the interview process just about everyone interviewed talked about a house, basement apartment or some other additional living space that was being prepared for occupancy by construction workers and their families which will lead to more capacity to absorb the workforce.

This increasing supply notwithstanding, there is still much concern about two counties with an existing housing base of approximately 6,500 total units absorbing such a large workforce. Furthermore, there is additional concern about the impact such a demand will have on supply and thus price of housing particularly in the rental market.

We feel that additional capacity will be built as local developers see opportunity and gear up. The LRC was informed of two other housing developments coming to the area. The data above also evidences significant capacity to absorb a major workforce.

C. Action Needed.

a. **Areas Capacity to Absorb Impacts.** Information on various housing options needs to be assembled well in advance of the project including contacts and phone numbers so this information can be distributed to the construction workforce as they prepare to move to the area.

b. **Regular Communication.** Regular communication with motels, individuals that have rentals units and major property managers before the project starts and throughout the construction process will help channel the flow of workers to areas where capacity exists and help reduce the workforce impacts. This communication will also help officials determine what "real time" mitigation measures needs to be taken.

D. Recommended Mitigation Measures.

a. **Housing Contingency Plan.** There are two aspects of the housing issue. The first is the shear number of housing units that will be needed to house the workers that will come to the area. Currently, there is a capacity in South Dakota and Minnesota communities. We feel that additional capacity will be built as developers gear up and some home owners build out the upstairs or the basements. We are aware of two housing developments new to the area. But as a mitigation measure we feel Otter Tail needs to have a contingency plan in place that can be implemented quickly if the need arises to supply housing at a reasonable market rent for workers. The ability to bring in trailers quickly with an efficiency apartment configuration is an option that can be accomplished in 2 weeks to 60 days depending on the season according to an area manufactured home plant staff person. While this is not a firm measure we feel the development of a contingency plan needs to be brought to the PUC's attention and implemented.

b. **Rent Stabilization.** The second aspect of housing is the issue of pricing the local non-construction workers out of the market due to the high rent that the Big Stone II workers can afford to pay. There are reports, not verified by the LRC, of a mobile home park owner recently increasing lot prices. This owner currently has the mobile home parks in Milbank, Ortonville and Big Stone City. Again, while there is not a specific mitigation measure, The PUC needs to understand the issue and communicate the concern to the SD Housing Development Authority that could provide assistance to renters that may be faced with sudden and severe rent hikes. This may be a case where the market place rents used by the Authority to provide assistance may need to be adjusted frequently to keep pace with market tends. If the Authority is informed about the potential housing issues they may be able to proactively provide assistance to local renters.

1. ii. Labor Force

A. Impacts.

a. **Local Contractors.** There will be tremendous opportunity for local contractors and potential employees to work on various aspects of the project. Tradespersons like electricians, plumbers, etc will be in high demand. There will also be considerable opportunity for general laborers on the project.

B. Areas Capacity to Absorb Impacts.

a. **Labor Force.** There will be some ability to supply some of the necessary labor force to complete the project, however, the vast majority of the work will need to be completed by temporary workers who will need to come to the area to complete their tasks. Some of the work may also be completed in modules and shipped in for final assembly at the Big Stone II site.

C. Action Needed.

a. **Information.** Communications on the available jobs and specific sub contracting opportunities should be provided so contractors in the immediate area have an opportunity to bid for work on the project. Not only would this be good for the local economy, it would also serve to mitigate potential problems from having up to 1,400 workers working on the plant during the peak time. The more workers that are from the area in the first place, the less the impact.

b. **Web Site.** Jobs and Contractor opportunities should be made known via a web site including an RFP complete with timetable and all other requirements. (Weston 4 is a good model for an effective website.) South Dakota Job Service has an office in Milbank and they may be of assistance in coordination of available jobs offerings.

c. **Media, radio and newspaper.** The area is served by a variety of media each with its particular market and advantage in reaching potential employees and contractors. A public relations effort to hire local people and contractors should be made.

2. Educational Facilities and Manpower

A. Impacts.

a. **Additional Students.** The trip to Weston 4 indicates there will be far fewer workers bringing their families with them to the area. This resulted in fewer students than were hoped for. Only one of the first 400 workers at Weston 4 brought one child so the impact there has been almost zero. Because of the rural nature of this area and the likely need for more people to move into the area to work either short or long term, it is likely there will be slightly more children moving to the area than has been the case at Weston 4.

b. **English as a second language (ESL).** The primary concern among those interviewed was a possible need for additional personnel with ESL training skills. If more than a handful of non-English speaking students move to the area it would have a significant impact. Generally, the schools have the capacity to address much of anticipated need as they currently have some students in the ESL programs.

c. **Special Education.** The other area of concern expressed was in the area of special education. Any large number of special education students moving to the area would have a significant impact, but as indicated above few new students will be expected.

B. Areas Capacity to Absorb Impacts.

a. **Additional Students.** All of the area school districts have very significant capacity to absorb additional students. Most are 30% to 40% below their high enrollment points in the 60's and 70's. In fact, a large number of students could be absorbed without hiring any or just one or two staff members, depending on grade distribution and the school district where the student chose to attend. Most schools would welcome additional students.

C. **Action Needed.**

a. **ESL and Special Education.** As part of its public affairs process OTPC should closely monitor the incoming workforce to determine how many workers may be bringing school age children. This may alert the schools for any special education or ESL needs they may arise. Early communication and frequent communication throughout the construction process with the area school districts will be important for a smooth transition and adequate preparation by the school districts.

3. Water Supply and Distribution

A. Impacts.

a. **Plant.** Operationally, Big Stone II plant will use water from Big Stone Lake, which is stored in holding ponds, like it does for Big Stone I. It does use water provided by Grant Roberts Rural Water system for its employees. Grant Rural Water system is in the process of completing a significant upgrade to its system that will provide adequate supply for Big Stone II.

b. **Workforce.** The three major communities, Milbank, Big Stone City and Ortonville all have adequate water supplies to handle the potential influx of people working on the plant.

B. Areas Capacity to Absorb Impacts.

a. **Capacity.** Big Stone City, Milbank and Ortonville each indicated they have adequate capacity to handle additional demand for water even with significant additional development. Smaller communities in the area also have the ability to handle additional demand for water for the housing units they currently have and anticipate from development resulting from the Big Stone II Project.

C. Action Needed.

a. **No action needed.** There are adequate water resources available to supply the plant and the anticipated workforce.

4. Wastewater Treatment and Collection

A. Impacts.

a. **Plant and Workforce.** Minimal impact is anticipated from the plant (less than 300 gallons a day). Impact from the workforce needed to build the plant is well within the capacity of the three major communities; Milbank, Big Stone City and Ortonville.

B. Areas Capacity to Absorb Impacts.

a. **Capacity.** Big Stone City, Milbank and Ortonville each indicated they have adequate capacity to handle additional wastewater even with significant additional development. Smaller communities in the area also have the ability to handle wastewater for the housing units they currently have and anticipate from developments resulting from the Big Stone II Project.

C. Action needed.

a. **No action needed.** There is an adequate wastewater treatment system in place to accommodate potential additional users.

5. Solid Waste Disposal and Collection

A. Impacts.

a. **Plant.** There will be considerable construction refuse during the construction operation. An aggressive recycling plan is anticipated to mitigate much of the waste produced.

b. **Workforce.** There will also be some impact from the workforce in place during construction of the plant.

B. Areas Capacity to Absorb Impacts.

a. **Plant.** Otter Tail Power Company has proactive solid waste plan focusing on recycling and requiring contractors to remove their waste to non-regional waste management sites. Thus, there will be minimal impact to regional landfills resulting from construction.

b. **Workforce.** The regional landfills in the area have adequate capacity to handle the influx of additional workers to the area.

C. Action Needed.

a. **No action needed.**

6. Law Enforcement

A. Impact.

a. Significant impact in this area is anticipated by most of the people interviewed. Many people cited concerns based on the Big Stone I workforce. Most people felt the local authorities could handle the situation, but most also felt they needed additional help. Law enforcement personnel were particularly concerned about the potential impact.

b. Serving civil papers is expected to increase with the increased number of people in the area, resulting in a greater workload for the County Sheriff. Further, as the arrests and court case loads increase there will be a need for the Sheriff to transfer prisoners to other lock-up facilities because of the very limited local jail capacity. While the workers, expected to be on the site, will be different than the 1970's workers, just the increase in the number of workers will likely impact the crime and civil case loads. Taken together, the Sheriff's work load will increase.

c. City and County law Enforcement needs have changed as the workers' behavior changed for the better. But with the number of workers that will be in the area and the number of personnel that will be supplying materials to the plant, the increased traffic, the need for city and county law enforcement services over a three-year period will outstrip the current capacity.

B. Areas Capacity to Absorb Impacts.

a. **Cities - Minnesota.** Ortonville had 4 full-time officers. Ortonville had 6 full-time officers when Big Stone I was built.
b. **Counties- South Dakota.** Grant County had one full-time sheriff and two deputies.
c. **Cities South Dakota.** Big Stone City had only one officer. Milbank had 5 full-time officers and 8 reserves.
d. **Counties- Minnesota.** Big Stone County had one sheriff and 4 deputies.
e. S**outh Dakota Highway Patrol.** There was a member of the SD State patrol stationed in Milbank. In Minnesota, the nearest State patrol was in Appleton.
f. **Strong Interdepartmental Relationships.** Due to the limited numbers of officers in the area, the local law enforcement agencies interviewed all indicated they had very close working relationships with each other to ensure support when needed. This close working relationship between all law enforcement agencies in the region will be very beneficial and greatly enhance the areas ability to absorb the impact of the workforce needed to construct Big Stone II.

C. Action Needed.

a. **City Law Enforcement Staffing Levels.** No additional City staff, except for Big Stone City, is recommend provided the Grant County Sheriff's office has one additional full-time deputy and that position is shared with Big Stone City. At peak employment times, additional law enforcement staff will be needed.

b. **Background Checks.** Background checks should be conducted so local law enforcement officials are knowledgeable about the type of workforce being hired. This should be required of all workers that will be on the construction site.

c. **Communication With Law Enforcement Agencies.** Communication between Otter Tail Power Company and local law enforcement officials when there is a significant shift in the number of workers in the area and their patterns of movement in and out will be very helpful to local law enforcement officials.

d. **Familiarization Tours.** Law enforcement officials should be included in the periodic familiarization tours of the plants construction and any lay down area as the plant is built to ensure speedy response during any emergency situation at the plant and construction area itself.

e. **Workforce Expectations.** The Company needs to communicate to the workforce that when they are working on this project that they represent their company and Otter Tail Power Company- 24/7 and inappropriate behavior will not be tolerated.

D. Recommended Mitigation Measures.

a. **Grant County.** We recommend that one additional officer be added to the Grant County Sheriff's office delegated to the immediate impact area and shared 50% of the time with Big Stone City for a period of about three years. We recommend that this position be funded three months after construction starts in April 2007 and continue until Complete Steam Turbine Commissioning which is expected in July 2010. This staffing will increase the Departments' capacity however, during the very high peak of employment at Big Stone II additional part time officers will need to be budgeted for the Sheriff's office. This would occur when the number of workers exceeds the 750-1000 employee level.

The LRC members also urge the County and local municipalities to implement a reserve police officers program. This has been effective in other South Dakota communities including Milbank.

b. **Drug Testing.** Drug testing should be performed on all potential workers as part of a pre- employment screening process

c. **SDHP.** We recommend that the PUC alert the South Dakota Highway Patrol to the expected impact and urge the SDHP to budget additional staff time in the Milbank and Big Stone City area during the peak employment months.

7. Transportation

A. Impacts.

a. Increased traffic is anticipated during construction. Equipment, workers and materials for the plant are all expected to increase traffic.

B. Areas Capacity to Absorb Impacts.

a. **Road Conditions.** While we heard that some of the roads to the Plant site are in need of work we were not able to establish if the need arose because of the Big Stone I or because of traffic generated by the recently constructed ethanol plant which accounts for 75 to 80 grain trucks per day.

b. **Ingress/Egress.** Generally, the site is well situated with roads leading to and from the plant site in four directions. Only the road to the north is still a gravel road. All of the others have been upgraded to all weather surfaces and carry a great deal of traffic. Load limits may be an issue but the County and State have regulation is place to handle the situation

c. **Traffic.** The ethanol plant, Big Stone Cheese, and other businesses do not employ enough people to have a significant impact on traffic flow in the area even at shift change. Beyond additional traffic no significant impact is anticipated from construction of the Big Stone II plant the area will need to absorb. The roads leading to the plant all have adequate capacity to handle additional traffic.

C. Action Needed.

a. Monitor shift changes and communicate with other companies and construction workers to ensure smooth traffic flow if needed.

8. Fire Protection

A. Impacts.

a. The new plant will exceed 300 feet in height and staging and access areas during construction will change month to month. There may also be some hazardous materials on site during various phases of construction.

B. Areas Capacity to Absorb Impacts.

a. **First Response Mechanism.** Otter Tail Power Company has a first response mechanism in place for any plant fire or emergency situation. This group is also charged with assessing the situation and contacting additional authorities like the local fire departments, emergency management office or the state of South Dakota depending on the magnitude of the incident. Big Stone City Fire Department is the first line of defense to be called if outside assistance is necessary. Ortonville Fire Department is then next to be called followed by Milbank.

b. **High rescue.** The Fire Departments are well equipped and well trained. However, the Fire Department nearest to the Big Stone I and Big Stone II is Big Stone City and they are likely to be the quickest responder if needed so they need to have the equipment to do high angle rescues. The Big Stone Fire Department needs a high angle rescue kit. While they have had some training, additional training in its use for several of its volunteer fire fighters will be needed.

C. Action Needed.

a. **Familiarization Tours.** Conduct familiarization tours of the site every three to six months for Fire Department personnel in Big Stone City, Ortonville and Milbank to alert them of any potential hazards and to familiarize them with the layout of the facility and staging areas, and the procedures for accessing the facilities.

D. **Recommended Mitigation Measures.**

a. **Purchase High Angle Rescue Equipment.** Purchase a high angle rescue kit consisting of harness, rope and pulley system (Approximate cost $5,000) for the Big Stone Fire Department.

b. **Provide High Angle Rescue Training.** Adequately train several of the Big Stone City Fire Department members to use the high angle equipment.

9. Health

A. **Impacts.** The influx of a significant population group all potentially needing health care will have a significant impact on the areas health care providers.

B. **Areas Capacity to Absorb Impacts.**

a. The LRC learned from the two hospitals and the various medical staff members in the communities that ample and varied medical capability is available. Communication and coordination will be the key.

C. Action Needed.

a. Communicate with contractors that plan to work in the area in advance so local health providers can do advance work with the various health plans so the health insurance will be available when it is needed. The local providers are eager to help and to work with the contractors and the workers coming to the area. They stated and if they know in advance, what health care companies will be providing health insurance they can make arrangement for seamless health care and payment.

b. Conduct familiarization tours of the site every three to six months for ambulance and key emergency medical personnel in Big Stone City, Ortonville and Milbank to alert them of any potential hazards and then familiarize them with the layout of the facility and staging areas, and the procedures for accessing the facilities.

c. Communicate in advance with local health care providers. They are interested in providing a full menu of services (potentially on site) for the workforce during the entire construction period. Weston 4 had an on site medical EMT whenever there were more than 30 construction workers as a proactive measure. The local health care providers are trained and capable of providing drug testing, safety training, etc.

10. Recreation

A. **Impacts.** The influx of workers may increase the use of recreational facilities and the number of participants in various recreation programs.

B. Areas Capacity to Absorb Impacts.

a. There are many recreational opportunities offered in the area during all four seasons. All have room for expansion.

C. Action Needed.

a. Communication of the various recreational opportunities to the workforce is strongly recommended.

11. Government

A. **Impacts.**

a. None anticipated.

B. **Areas Capacity to Absorb Impacts.**

a. The various units of government have a very good understanding of the impact and have the staff members and plans in place to handle the situation.

C. **Action Needed.**

a. Continue to communicate with all units of local government throughout the planning and construction process.

b. Consider continuing the Local Review Committee or create another such committee of interested and impacted parties to continue to facilitate open lines of communication between all groups.

12. Energy

A. Impacts.

a. None identified.

B. **Areas Capacity to Absorb Impacts.**

a. The construction of the plant will only enhance the areas electric supply. Gas supplies and other heating sources all mirror the national trends and there is adequate capacity to accommodate the potential increase in demand because of the increase in the size of the workforce.

C. Action Needed.

a. None.

IV. MITIGATION SUMMARY

Recommendations of the Big Stone II Local Review Committee (LRC)

1. Housing and Manpower

Housing Contingency Plan. There are two aspects of the housing issue. The first is the shear number of housing units that will be needed to house the workers that will come to the area. Currently, there is a capacity in South Dakota and Minnesota communities. We feel that additional capacity will be built as developers gear up. We are aware of two housing developments new to the area. But as a mitigation measure we feel Otter Tail needs to have a contingency plan in place that can be implemented quickly if the need arises to supply housing at a reasonable market rent for workers. The ability to bring in trailers quickly with an efficiency apartment configuration is one option that can be accomplished in 2 weeks to 60 days depending on the season according to an area manufactured home manufacturer. While this is not a firm measure we feel this contingency plan needs to be brought to the PUC's attention and implemented.

2. Education - None Recommended.

3. Water Supply – None Recommended.

4. Wastewater Treatment and Collection – None Recommended.

5. Solid waste disposal and collection – None Recommended.

6. Law Enforcement

Grant County. We recommend that one additional officer be added to the Grant County Sheriff's office delegated to the immediate impact area and shared 50% of the time with Big Stone City for a period of about three years. We recommend that this position be funded three months after construction starts in April 2007 and continue until Complete Steam Turbine Commissioning which is expected in July 2010. This staffing will increase the Departments' capacity but, during the very high peak of employment at Big Stone II additional part time officers will need to be budgeted for the Sheriff's office. This would occur when the number of workers exceeds 750-1000.

Drug Testing. Drug testing should be performed on all potential workers as part of a pre-employment screening process

SDHP. We recommend that the PUC alert the South Dakota Highway Patrol to the expected impact and urge the SDHP to budget additional staff time in the Milbank and Big Stone City area during the peak employment months.

7. Transportation – None Recommended.

8. Fire Protection

Purchase High Angle Rescue Equipment. Purchase a high angle rescue kit consisting of harness, rope and pulley system, (Approximate cost $5,000) for the Big Stone Fire Department.

High Angle Rescue Training. Adequately train several of the Big Stone City Fire Department members to use the high angle equipment.

9. Health – None Recommended.

10. Recreation – None Recommended.

11. Government – None Recommended.

12. Energy – None Recommended

13. Communication

While this area is not listed in State Law we feel it is important to highlight. We learned a great deal from Weston 4 about the importance of communicating to the public and to the elected and appointed local officials. We recommend that Otter Tail have a Public Affairs "person on the ground" that can answer any and all questions, be available for meeting, such as Chamber, Farm Bureau, Farmers Union, service clubs-Kiwanis, Church groups, etc. This person would be the "go to person." The "Action needed items" listed in the Executive Summary could serve as a base job description for this person. We recommend this person be brought on board as soon as possible and remain in that position until the completion of the Big Stone II construction project.

We further recommend that Otter Tail develop an extensive robust web site that is kept interesting and dynamic. The "on the ground person" could do this important updating. We also see this site as a means of communicating to the potential workers and to the local companies that may want to bid on parts of the construction work.

In addition, we feel it is extremely important to have periodic meetings with local officials and the general public updating them on the construction progress and what to expect in the near term. This will not only inform them but it will give them an opportunity to express concerns that they may have heard and could be addressed.

V. Minority Reports

The LRC is not aware of any minority reports. None of the LRC committee member will be filing any reports or letters apart from this report.

Appendix K

Settlement Agreement between Co-owners and the Energy Planning and Advocacy Function of the Minnesota Department of Commerce

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SETTLEMENT AGREEMENT

HIGH VOLTAGE TRANSMISSION LINES-BIG STONE UNIT II

MINNESOTA PUBLIC UTILITIES COMMISSION DOCKET NO. CN-05-619

This Settlement Agreement ("Agreement") is executed by and between the electric utility companies set forth below and the Energy Planning and Advocacy function of the Minnesota Department of Commerce ("Department"). Together the aforementioned persons are regarded as the Parties ("Parties") to this Settlement Agreement ("Agreement"). The effective date of this Agreement is August 30, 2007 ("Effective Date"). The undersigned Parties recommend that the Minnesota Public Utilities Commission ("Commission") accept this Agreement and approve the Certificate of Need Application filed in the above matter, subject to this Agreement.

Certificate of Need Proceeding Background

A. On November 30, 2005, Otter Tail Power Company ("OTP"), Great River Energy ("GRE"), Missouri River Energy Services ("MRES") on behalf of Western Minnesota Municipal Power Agency, Montana-Dakota Utilities Co. ("MDU"), Southern Minnesota Municipal Power Agency ("SMMPA"), Central Minnesota Municipal Power Agency ("CMMPA"), and Heartland Consumers Power District ("HCPD") (hereinafter collectively referred to as "the Owners") applied to the Minnesota Public Utilities Commission ("Commission") for a Certificate of Need ("CON Proceeding") to construct two high voltage transmission lines located in Minnesota, Commission Docket No. CN-05-619, CON Application, Applicants' Exhibit 68A and 68B. The Owners with retail electric load in Minnesota are referred to as the "Minnesota Owners" and are as follows: Otter Tail Power Company, Great River Energy, Missouri River Energy Services, Southern Minnesota Municipal Power Agency, Central Minnesota Municipal Power Agency and Heartland Consumers Power District.

B. The high voltage transmission lines are proposed to connect a 630 MW super-critical, coal-fired power plant to be constructed near Big Stone City, South Dakota ("Big Stone Unit II"), adjacent to the existing Big Stone Unit I, to the transmission grid at substations located in Minnesota. The preferred option consists of a 230 kilovolt line that would run from the Big Stone 230 kV Substation in South Dakota to the Morris Substation near Morris, Minnesota, a distance of approximately 48 miles, approximately 43 miles of which would be within Minnesota (the "Morris Line"). A second line would run from a new substation at the Big Stone power plant to Granite Falls, Minnesota, a distance of approximately 90 miles, 54 miles of which would be within Minnesota (the "Granite Falls Line"). Although initially to be operated at 230kV, the Granite Falls Line would be constructed to 345 kV standards for the purpose of accommodating additional power, likely from wind generation units to be located in western Minnesota and eastern South Dakota. CON Application, Applicants' Exhibit 68A at page 72, attached as Appendix No. 1.

C. Big Stone Unit II is a supercritical, pulverized coal-fired generating plant to be built outside of Big Stone City, South Dakota, next to the existing Big Stone Unit I power plant. Big Stone Unit II is designed to have a nominal operating capacity of 630 MW (net).

Supplemental Direct Testimony of Mark Rolfes, Applicants' Exhibit 32, at page 10, attached as Appendix No. 2. Big Stone Unit II is designed to be a baseload facility. It will use sub-bituminous coal from the Powder River Basin in Wyoming and Montana, the same fuel presently being burned at Big Stone Unit I. CON Application, Applicants' Exhibit 68A, at page 74 and Direct Testimony of Mark Rolfes, Applicants' Exhibit 7, at pages 3-4, attached together as Appendix No. 3.

At the present time, each Owner's proposed share of Big Stone Unit II is as follows:

Owner	MW	Percent of Total BSII
MRES	157.5 MW	25.0 %
GRE	121.8 MW	19.33 %
MDU	121.8 MW	19.33 %
OTP	121.8 MW	19.33 %
SMMPA	49.35 MW	7.8 %
CMMPA	31.5 MW	5.0 %
HCPD	26.25 MW	4.2 %

The record in the CON Proceeding includes information showing that the costs for Big Stone Unit II are 10% to 18% lower than comparable lifetime costs for investor-owned utilities, and 29% to 44% lower for public power utilities compared to other baseload alternatives considered. These costs assume the following project features and are included in the CON Proceeding record (as cited below):

- Supercritical pulverized coal plant design as chosen by the Owners over alternatives for, among other reasons, its high fuel and operating efficiencies. Rebuttal Testimony of Mark Rolfes, Applicants' Exhibit 65, at pages 2-3, attached as Appendix No. 4, and Direct Testimony of Ward Uggerud, Applicants' Exhibit 6, at pages 13-14 and 21, attached as Appendix No. 5.

- Big Stone Unit II's estimated average fuel efficiency (heat rate) of 8,988 MMBtu/MWh, making it 20% more fuel-efficient (and thereby producing approximately 20% less carbon dioxide per unit of electric output) than existing regional coal plants. Rebuttal Testimony of Mark Rolfes, Applicants' Exhibit 65, at pages 1-2, attached as Appendix No. 6.

- Environmental wet scrubber equipment to serve both Big Stone Unit II and the existing Big Stone Unit I power plant, such that total SO_2 and NO_x emissions from the plant site including both units will not exceed current emissions of Big Stone Unit I alone, while site electric output will be more than doubled. Direct Testimony of Terry Graumann, Applicants' Exhibit 26, at pages 3-4**,** attached as Appendix No. 7.

- Optimized transmission lines with the Granite Falls Line built to 345 kV standards, rather than 230 kV standards that would otherwise be required to interconnect Big

Stone Unit II to the transmission grid. Together with other planned regional transmission developments, this will provide capacity for 800 MW - 1000 MW of future generation developments, likely renewable wind energy projects. Direct Testimony of Timothy Rogelstad, Applicants' Exhibit 2, at p. 4, and Dec. 5 Transcript at page 86 (Tim Rogelstad), attached as Appendix No. 8.

D. The Owners testified in the CON Proceeding that each utility's individual resource planning studies and proceedings have established a need for additional generation in the near future.

E. The Mid-Continent Area Power Pool (MAPP) 2006 Load and Capability Report predicts that continuing load growth in the Upper Midwest region will result in a deficit in summer 2011 for MAPP U.S. generating capacity even with the addition of Big Stone Unit II. Direct Testimony of Peter Koegel, Project Manager, MAPPCOR, Applicants' Exhibit 23, at page 6, attached as Appendix No. 9.

F. The Midwest Independent Transmission System Operator (MISO) testified in the CON Proceeding that the proposed transmission lines would benefit regional electric grid reliability in addition to providing optimal transmission interconnection facilities. Direct Testimony of Eric Laverty, MISO Exhibit 1, at pages 14-19, attached as Appendix No. 10.

G. The wholesale electricity generation market indicates that there is already a significant increase in the on-peak and off-peak wholesale prices of electricity; this situation supports the addition of transmission and new baseload resources as reasonable.

H. The Owners agree as part of this Agreement to install highly effective pollution control equipment to control emissions from both Big Stone Unit I and Unit II, to wit: emissions of sulfur dioxide (SO_2) from Big Stone Units I and II will be controlled by a common wet flue gas desulfurization system (i.e., wet scrubber). SO_2 emissions from both Big Stone Unit I and Big Stone Unit II are expected to be less than 15% of the present emissions from Unit 1 alone. Emissions of nitrogen oxides (NO_X) will also be reduced both by the use of a supercritical boiler and the installation of a selective catalytic reduction (SCR) NO_X emission control technology on Big Stone Unit II. The sum total of the Big Stone Unit I and Big Stone Unit II NO_X emissions will be equal to or less than Big Stone Unit I's historical NO_X emissions. Particulate matter will be controlled by a pulse-jet fabric filter, and Owners expect 99.9% removal. Direct Testimony of Terry Graumann, Applicants' Exhibit 26, at pages 3-4, attached as Appendix No. 7.

I. The Minnesota Owners have agreed to offset 100% of the emissions of carbon dioxide from the Big Stone Unit II that are attributable to the generation of electricity for Minnesota consumers, as described below. MDU, as the only non-Minnesota Owner, does not object to this provision.

J. Action by the State of Minnesota or the federal government to address the emissions of greenhouse gases such as carbon dioxide from power plants is anticipated within the timeframe required for construction of Big Stone Unit II.

K. The Owners submitted evidence in the CON Proceeding that they have considered and analyzed other alternative forms of generation including renewables, natural gas, and integrated gasification combined cycle, and additional demand-side alternatives including additional energy conservation and concluded these other alternatives are not capable of providing a baseload resource alone or are more expensive than the proposed Big Stone Unit II (including the consideration of reasonable costs imposed by future greenhouse gas regulation). The Owners contend such alternatives cannot be constructed within the timeframes required for the additional capacity and energy to be provided by Big Stone Unit II. Direct Testimony of Jeffrey Greig, Applicants' Exhibit 25, Direct Testimony of Kiah Harris, Applicants' Exhibit 24, CON Application, Applicants' Exhibit 68A, Appendix J, Supplemental Direct Testimony of Jeffrey Greig, Applicants' Exhibits 47 and 47A. Direct Testimony of Bryan Morlock (OTP), Applicants' Exhibit 15. Direct Testimony of Stan Selander (GRE), Applicants' Exhibit 17. Direct Testimony of Robert Davis (CMMPA), Applicants' Exhibit 22. Direct Testimony of Gerald Tielke (MRES), Applicants' Exhibit 18. Direct Testimony of Hoa Nguyen (MDU), Applicants' Exhibit 19. Direct Testimony of Larry Anderson (SMMPA), Applicants' Exhibit 20. Direct Testimony of John Knofczynski (Heartland), Applicants' Exhibit 21, collectively attached as Appendix No. 11.

L. The Minnesota Owners are subject to Minnesota's Renewable Energy Standard ("RES"), codified at 216B.1691, which was enacted after the close of the record in the CON Proceeding. Minn. Laws 2007, Ch. 3. As shown in Exhibit A, pursuant to that law, according to the current load forecasts of the Minnesota Owners, the Minnesota Owners will own or purchase more than 2600 GWh per year of renewable energy by the year 2012 (equivalent to approximately 750 MW of nameplate wind capacity at a 40% annual capacity factor) and approximately 5100 GWh per year of renewable energy by the year 2020 (equivalent to approximately 1460 MW of nameplate wind capacity at a 40% annual capacity factor). As discussed below, the Owners' decision to size the Granite Falls Line at 345 kV standards may allow additional renewable power to be delivered, which may assist the Minnesota Owners and other utilities in meeting the RES.

M. Recently enacted legislation in Minnesota imposes annual energy savings goals equivalent to 1.5 % of gross retail energy sales for each individual retail provider in Minnesota through energy conservation improvement programs and rate design, energy codes and appliance standards, programs designed to transform the market or change consumer behavior, energy savings resulting from efficiency improvements to the utility infrastructure and system, and other efforts to promote energy efficiency and energy conservation. Minn. Stat. §§ 216B.2401 and 216B.241, subd.1c. Achieving these goals would mean approximately 390 GWh per year of savings in Minnesota by the Minnesota Owners by the year 2020, as set forth in Exhibit B.

N. The high voltage transmission lines that are proposed to interconnect the Big Stone Unit II are intended to and likely will provide capacity for the transport of wind energy from South Dakota and North Dakota and southwestern Minnesota to the Twin Cities and other markets. See, e.g., Direct Testimony of Timothy Rogelstad, Applicants' Exhibit 2, at page 16, attached as Appendix No. 12.

O. The Commission's Wind Integration Study (Wind Integration Study, Dec. 2006), which shows the approximate cost to the transmission system of adding wind-sourced energy to the generation load in an amount roughly equal to 25% of Minnesota's electricity sales, includes in its base case the high voltage transmission lines in this docket. This information contributes to a showing of the importance of these transmission facilities to wind development in western Minnesota.

P. The Parties agree that Minnesota needs a diverse electric resource mix in the coming years, including additional renewables, additional energy conservation, and new conventional generation facilities. Recent actions by the Minnesota Legislature and Governor with regard to the RES and increased Conservation Improvement Program (CIP) goals are important elements in this future.

The Parties agree that a diverse and balanced resource plan including the Minnesota Owners' actions toward the RES, the increased CIP impacts, and Big Stone Unit II including the high voltage transmission lines proposed in the CON Proceeding, along with other resources is reasonable and prudent. In addition to its other benefits, Big Stone Unit II will help assure electric service reliability and reasonable costs for Minnesota consumers.

Q. The Parties acknowledge that the Administrative Law Judges, in their August 15, 2007 Findings of Fact, Conclusion of Law, and Recommendation, conclude that the Owners have demonstrated compliance with all the criteria for issuance of a Certificate of Need under Minn. Stat. § 216B.243 and other applicable statutes and Minn. R. 7849.0120.

NOW THEREFORE, THE UNDERSIGNED PARTIES HEREBY ENTER INTO THIS AGREEMENT in Commission Docket No. CN-05-619 and recommend that the Commission issue a Certificate of Need for the proposed two high voltage transmission lines intended to interconnect the proposed Big Stone Unit II power plant in South Dakota to substations in Minnesota, subject to this Agreement.

1.0 JURISDICTION AND PARTIES

1.1 *Minnesota Public Utilities Commission Jurisdiction.* The Owners have applied to the Commission for a Certificate of Need and Route Permits for the two proposed high voltage transmission lines. The Commission does not have jurisdiction to require a Certificate of Need for Big Stone Unit II.

1.2 *South Dakota Public Utilities Commission Approval*. On July 21, 2006, the South Dakota Public Utilities Commission issued an Energy Conversion Facility Permit and Route Permit for the proposed Big Stone Unit II in South Dakota. On January 16, 2007, the South Dakota Public Utilities Commission issued its order granting a permit to construct the associated transmission facilities in South Dakota. The South Dakota Public Utilities Commission does not have jurisdiction over this Certificate of Need for large energy facilities, such as these proposed transmission lines in Minnesota.

1.3 *Department of Commerce.* The Minnesota Department of Commerce is an agency of the state of Minnesota with statutory authority to represent the public interest in certificate of need and other proceedings before the Commission. The Department provides two separate and distinct roles with two separate and distinct staffs. The Department's Energy Planning and Advocacy function and staff serve as the state agency charged with advocating for the public interest and is a party to this CON Proceeding and to this Agreement. The Department's Energy Facilities Permitting function and staff do not serve as an advocate or a party in either the CON Proceeding, or in the related Route Permit proceeding, Docket No. TR-05-1275, or in this Agreement. However, the Energy Facilities Permitting staff does serve as the facilitators of the processes required in route permitting proceedings as well as ensuring that the route permitting record is complete for the Commission's decision.

1.4 *Otter Tail Power Company.* Otter Tail Power Company (OTP) is an investor-owned public utility organized under the laws of the state of Minnesota and is the utility division of Otter Tail Corporation. OTP provides electricity to over 128,000 customers throughout Minnesota, South Dakota, and North Dakota. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 3, attached as Appendix No. 13.

1.5 *Great River Energy.* Great River Energy (GRE) is a not-for-profit generation and transmission electric cooperative headquartered in Elk River, Minnesota, which provides electrical energy and related services to 28 member distribution cooperatives in Minnesota and Wisconsin. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 4, attached as Appendix No. 14.

1.6 *Missouri Basin Municipal Power Agency d/b/a Missouri River Energy Services.* Missouri River Energy Services (MRES) is a not-for-profit body politic and public agency organized under Iowa law and existing under the intergovernmental cooperation laws of Iowa, Minnesota, North Dakota and South Dakota. MRES is the agent for Western Minnesota Municipal Power Agency (Western Minnesota). Western Minnesota is a municipal corporation and political subdivision of the State of Minnesota, and will hold title to ownership in the Big Stone Unit II and the high voltage transmission lines proposed in the CON Proceeding, and will sell to MRES its entitlement to the power, energy and transmission capability associated with the Big Stone Unit II project. CON Application, Applicants' Exhibit 68A, at page 27, attached as Appendix No. 15, and Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 5, attached as Appendix No. 16. In addition, although not an owner of the project, Hutchinson Utilities Commission has rights to the capacity and energy of Big Stone Unit

II through a power purchase agreement with MRES. Direct Testimony of Gerald Tielke, Applicants' Exhibit 18, at pages 18-20, attached as Appendix No. 17.

1.7 *Southern Minnesota Municipal Power Agency.* Southern Minnesota Municipal Power Agency (SMMPA) is a not-for-profit municipal corporation and political subdivision of the state of Minnesota, headquartered in Rochester, Minnesota. SMMPA has 18 municipally-owned member utilities. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 5, attached as Appendix No. 18.

1.8 *Central Minnesota Municipal Power Agency.* Central Minnesota Municipal Power Agency (CMMPA) is a not-for-profit municipal corporation and political subdivision of the state of Minnesota, headquartered in Blue Earth, Minnesota. CMMPA has 12 municipally-owned member utilities; all located in Minnesota. In addition, although not a member of CMMPA, the City of Willmar Municipal Utilities is participating in the Big Stone II project through the agency. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 4, attached as Appendix No. 19.

1.9 *Heartland Consumers Power District.* Heartland Consumers Power District is a not-for-profit public corporation and political subdivision of the state of South Dakota, headquartered in Madison, South Dakota. Heartland supplies wholesale electric power and energy to 18 municipalities across eastern South Dakota, southwestern Minnesota, and northwestern Iowa. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 8, attached as Appendix No. 20.

1.10 *Montana-Dakota Utilities Co.* Montana-Dakota Utilities Co. (MDU) is an investor-owned public utility that operates an integrated electric system in parts of Montana, North Dakota, and South Dakota and a separate electric system in Wyoming. MDU provides electric and natural gas services to approximately 250 communities in these states. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 4, attached as Appendix No. 21.

2.0 RECOMMENDATION

2.1 *Compliance with Applicable Criteria.* The Parties hereby stipulate and agree that the record in this matter, as supplemented by this Agreement and all provisions hereof, along with the overarching new laws regarding energy efficiency and renewable energy combine to satisfy the Department's concerns expressed in the record pertaining to the applicable criteria for a Certificate of Need for the two proposed high voltage transmission lines, including those criteria set forth in Minnesota Statutes chapter 216B and Minnesota Rules chapter 7849.

2.2 *Recommendation.* The Parties jointly recommend that the Commission issue a Certificate of Need to the Owners for the two high voltage transmission lines proposed in the CON Proceeding, subject to this Agreement and all provisions hereof.

3.0 FACILITIES' COST AND COST RECOVERY

3.1 *Capital Cost of Transmission Lines.* The Owners estimate that the cost of the proposed high voltage transmission lines, including all substation costs with the exception of the 345 kV substation in South Dakota and the conversion of the Canby substation to 345 kV standards, is $109.8 million (in 2006 dollars), and not including costs for transmission facilities required to provide Delivery Service, for permitting, or for additional transmission studies and agreements. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at pages 18-20, attached as Appendix 22. The CON Proceeding record indicates that the costs will increase by approximately 6% for each year that construction is delayed past the estimated in-service date.

3.2 *Capital Cost of Big Stone Unit II.* The cost of Big Stone Unit II, as presented by the Owners in the CON Proceeding, exclusive of transmission costs, was estimated to be $1.4 billion based on a April 2012 commercial operation date ("COD"). The record indicates that the costs will increase by approximately 6% for each year that construction is delayed past the estimated in-service date. Report and Recommendation of the Administrative Law Judges, August 15, 2007, at page 17, attached as Appendix No. 23. Attached as Appendix No. 24, is a schedule that shows the cost of Big Stone Unit II on a monthly basis up to and through a proposed commercial operation date of April 2012.

3.3 *Operating Costs.* The estimated levelized annual cost over the lifetime of Big Stone Unit II, assuming the first full year of operation and a January 2012 COD, ranges from $69.6 to $74.5 per MWh for investor-owned utilities, to $56.4 to $61.2 per MWh for public power utilities. Supplemental Direct Testimony of Jeffrey Greig, Applicants' Exhibit 47, at pages 11-12, attached as Appendix 25. The cost per unit of output from Big Stone Unit II, including costs for both the plant and its transmission, will vary among the Owners depending upon their financing arrangements, capital structure, and other factors. See, e.g., Revised Analysis of Baseload Generation Alternatives, Applicants' Exhibit 47A, attached as Appendix No. 26.

3.4 *Final Capital Costs.* Within fourteen (14) months of Big Stone Unit II's COD, the Minnesota Owners will file a written report with the Commission and the Department containing the actual capital costs of the high voltage transmission lines and Big Stone Unit II and comparing the actual costs with the estimated costs set forth above and explaining the reasons for any differences. Reporting the costs, as required in this paragraph, contributes to but does not fulfill the Owners' obligation to demonstrate that the actual capital costs were reasonably and prudently incurred for purposes of cost recovery as contemplated in section 3.6 below.

3.5 *Periodic Reports.* The Minnesota Owners will report to the Commission and the Department on the annual costs ($/MWh) for each Minnesota Owner based on actual costs for the preceding twelve months and levelized lifetime carrying charges on the actual investment in the project, including Unit II and the transmission lines. The first report shall be due within thirty days after the first anniversary of Big Stone Unit II COD, and the Minnesota Owners shall file such a report along with the reporting requirements set forth in section 3.4, for a period of four (4) additional years.

3.6 *Cost Recovery.* The commitments made or to be made by the Owners with respect to this Agreement are made on the expectation that OTP and MDU will obtain cost recovery from the state commissions having jurisdiction of all reasonable and prudent costs and expenditures through a rate case, tariff, rate rider, or other applicable cost or rate recovery mechanism.

Costs attributed to Big Stone Unit II or the proposed high voltage transmission lines shall be set forth separately and distinctly in all applicable cost recovery requests to the Commission, accompanied by supporting documentation.

3.7 *Department Support of Cost Recovery.* The Department will support OTP's recovery of all reasonable and prudent costs and expenditures as long as they are materially consistent with the costs described in sections 3.1, 3.2, and 3.3, and with costs reasonably attributable to the actions required by sections 4.0, 5.0, and 7.0 (unless otherwise recovered through a separate rate recovery mechanism).

4.0 OFFSETS OF GREENHOUSE GAS EMISSIONS

4.1 *100% of Minnesota-Attributable Emission Offsets.* Using the offset methods set forth in section 4.3, the Minnesota Owners agree to offset 100% of the carbon dioxide emissions attributable to the generation of electricity at Big Stone Unit II for customers in Minnesota. For the purposes of this Agreement, the portion of energy output from Big Stone Unit II attributable to a Minnesota Owner's Minnesota customers in a given time period will be the Minnesota Owner's share of the output of Big Stone Unit II expressed in MWh multiplied by the ratio that the Minnesota Owner's Minnesota retail electric energy obligations in that time period bears to the Minnesota Owner's total retail electric energy obligations in the time period.

For example, for a given time period:

$$EO_{MN} = EO_{TOTAL} \ \text{X} \left[\frac{Retail_{MN}}{Retail_{TOTAL}} \right]$$

Where:

EO_{MN} = The portion of energy output (in MWh) from Big Stone II attributable to a Minnesota Owner's Minnesota customers;

EO_{TOTAL} = The Minnesota Owner's share of the output of Big Stone Unit II (in MWh);

Retail_{MN} = The Minnesota Owner's Minnesota retail electric energy obligations (in MWh); and

Retail_{TOTAL} = The Minnesota Owner's total retail electric energy obligations (in MWh).

4.2 *Timing and Calculation of Emissions to be Offset.*

4.2.1 *Offsets May Be Secured Ahead of Operations.* The Minnesota Owners may secure offsets using the methods in sections 4.3 at any time, but as soon as Big Stone Unit II begins commercial operation, the offsets must be made within one year of the emissions. The Minnesota Owners may secure offsets of future Big Stone Unit II carbon dioxide emissions prior to the COD of Big Stone Unit II, and may use offsets secured prior to the Unit's commercial operation date to offset future emissions.

4.2.2 *First Year of Operation.* Six months prior to the COD of Big Stone Unit II, the Minnesota Owners will forecast the amount of carbon dioxide that is projected to be emitted by Big Stone Unit II along with the Minnesota Owners' projected method(s) for obtaining offsets for carbon dioxide for the first twelve-months of operation and will request verification of the Minnesota Pollution Control Agency ("MPCA") of said emission and offset amounts, and will advise the Commission and Department of their actions.

4.2.3 *After Operations Have Begun.* As part of the Greenhouse Gas Management Plan under section 4.11, the Minnesota Owners will determine how many tons of carbon dioxide were emitted to generate electricity for their Minnesota customers in the previous twelve months and report this figure along with its estimated offset costs to the Commission, MPCA, and the Department. This amount will be the amount of carbon dioxide that will be used as the baseline forecast for offsets to be procured in the next ensuing twelve-month period, subject to reasonable adjustments based on actual operating history of Big Stone Unit II and other factors, as approved by the Commission.

4.2.4 *"Extra" Offsets Carry-Forward.* Any offsets obtained in one year that are greater than the emissions associated with serving customers in Minnesota for that year may be credited towards the offsets needed in the subsequent year or years unless they are sold, traded or otherwise transferred. In the event the credits are sold, traded, or otherwise transferred, any funds received from the sale by OTP (or any future utility or entity to which this Agreement applies and whose rates are regulated by the Commission) will be used for carbon offsets in subsequent years or credited to OTP's customers (or the customers of any future utility or entity to which this Agreement applies and whose rates are regulated by the Commission), as applicable.

4.2.5 *Emission Offset Calculation Termination.* The Minnesota Owners will continue the process set forth in sections 4.2.1 to 4.2.4 until this requirement is terminated pursuant to section 4.10.

4.3 *Offset Methods.* At the option of the Minnesota Owners, the carbon dioxide offsets required in section 4.1 may be achieved by any one or a combination of the following methods, with the goal being to achieve permanent (or at a minimum permanent during the entire specified time period the purchased credits are intended to apply), quantifiable, verifiable, and enforceable reductions in greenhouse gas emissions that would not otherwise have occurred:

a. Capture and sequestration;

b. Emission reductions in any of the Minnesota Owners' existing power plants or through other, verifiable efficiency improvements on the Minnesota Owners' systems that result in reductions in carbon dioxide emissions;

c. Trading on a recognized Greenhouse Gas ("GHG") exchange, consistent with section 4.4;

d. Purchases of carbon credits from a credible offset program, consistent with section 4.5;

e. Setting aside funds, consistent with section 4.6, in a separate, readily identifiable account on the Minnesota Owners' books of an amount equal to $10.00 per ton of carbon dioxide emissions;

f. Making investment in transmission that the Commission certifies will enhance renewable energy development, consistent with section 4.7;

g. Adding renewable energy beyond any amount required by law, consistent with section 4.8;

h. Achieving energy efficiency savings beyond any amount required by law, consistent with section 4.9; or

i. Any other method the Commission concludes will result in economic offsets that will achieve permanent, quantifiable, verifiable, and enforceable reductions in greenhouse gas emissions that would not otherwise have occurred.

4.4 *Carbon Trading.* If the Minnesota Owners offset greenhouse gas emissions through an established carbon trading exchange pursuant to section 4.3(c) above, the Minnesota Owners will inform the Commission and the Department of the exchange(s) to be used. While the presumption is that any exchange recognized by a state or federal government is acceptable, the Minnesota Owners have the burden of proving that this offset option should be recognized as credible in Minnesota, with the exception that the Parties agree that the Oregon Climate Trust and the Chicago Climate Exchange (CCX) and its successors are already acceptable without further proof by the Minnesota Owners. Any profits, interest or carrying charges on the monies received by OTP (or by any future Minnesota-regulated utility to which this Agreement applies) from carbon trading will be credited to OTP's ratepayers (or the ratepayers of any Minnesota-regulated utility to which this Agreement applies) or be deposited into the carbon offset fund established in section 4.6.

4.5 *Purchase of Carbon Credits.* If the Minnesota Owners offset greenhouse gas emissions through the purchase of carbon credits pursuant to section 4.3(d), the Minnesota Owners will inform the Commission and the Department of the program to be used. The Minnesota Owners will show that the program chosen will result in permanent (or at a minimum permanent during the entire specified time period the purchased credits are intended to apply), verifiable, quantifiable and enforceable reductions in greenhouse gas emissions.

4.6 *Carbon Offset Fund.* If the Minnesota Owners offset their greenhouse gas (i.e., carbon dioxide) emissions through payment of a specified sum per ton of carbon dioxide emissions pursuant to section 4.3(e), the Owners will inform the Commission and the Department of their election to do so, amounts paid, amount of carbon dioxide offset in this manner, and of the specifics of the accounts established. Each Owner may elect to establish its own account, or two or more Minnesota Owners may join together to establish one account jointly. No one Owner shall be a party to more than one account.

4.6.1 *Use of Funds.* Funds set aside pursuant to section 4.3(e) above, and any interest or carrying charges earned thereon, must be used by the Minnesota Owners only for offset methods identified in section 4.3 or research and development projects supporting the offset methods identified in section 4.3 for use by the Minnesota Owners. The Minnesota Owners will advise the Commission and the Department of the expenditure of any of these funds and the balance of the account, in the Greenhouse Gas Management Plan submitted in accordance with section 4.11.

4.6.2 *Accounting Practices and Review.* The Minnesota Owners agree that any accounts established and any account activity pursuant to this section 4.6 will be subject to reasonable accounting methods and to review by the Commission and the Department.

4.7 *Transmission Investments for Renewables.* The Minnesota Owners may seek to obtain offsets of greenhouse gas (i.e., carbon dioxide) emissions for each of the years in which the Minnesota Owners' incremental investment in transmission facilities enhances either the quantity or timing of renewable energy development beyond that which would have otherwise occurred. The Minnesota Owners will ask the Commission to determine in a later proceeding the amount of offset credit, if any. The Minnesota Owners will file with the Commission a proposed offset credit method for purposes of this section 4.7 within two years following Commission approval of the Certificate of Need in this matter. The offset method may include the following formula: if a utility's fixed charge rate is 12% and the utility's aggregate investment in a single project or number of projects is $7,000,000, then the utility will have an annual carbon offset credit of 84,000 tons (calculated as $7,000,000 x 0.12 = $840,000/$10/ton = 84,000 tons of carbon offset).

4.8 *Renewable Energy Investments*. The Minnesota Owners will be eligible to obtain offsets of greenhouse gas (i.e., carbon dioxide) emissions for each of the calendar years in which the Minnesota Owners add renewable energy in amounts beyond that required by law. These amounts will be determined by comparing the actual renewable energy achieved in any calendar year with the renewable energy requirements under the RES. The Parties agree that the Minnesota Owners shall be eligible for offsets on a MWh for MWh basis for any renewable energy the Minnesota Owners generate or otherwise obtain in excess of those levels required by the Minnesota RES. The Minnesota Owners will report to the Commission, as part of the Greenhouse Gas Management Plan under section 4.11, the actual amount of offsets.

4.9 *Energy Efficiency Investments*. The Minnesota Owners will be eligible to obtain offsets of greenhouse gas (i.e., carbon dioxide) emissions for each of the calendar years in which the Minnesota Owners, their distribution member systems, or both, make energy efficiency improvements in amounts beyond that required by law. These amounts will be determined by comparing the actual energy efficiency (kWh) impacts achieved in a particular calendar year, as determined by the Commissioner of the Department of Commerce, with the energy efficiency savings required by applicable law. Based on this determination, the Parties agree that the Minnesota Owners shall be eligible for offsets on a MWh-for-MWh basis for any energy efficiency impacts the Minnesota Owners achieve in excess of those levels required by Minnesota law. The Minnesota Owners will report to the Commission, as part of the Greenhouse Gas Management Plan under section 4.11, the actual amount of offsets.

4.10 *Termination of Offset Requirement.* The Parties agree that the greenhouse gas emissions offset requirement of section 4.1 will continue until the earlier of (1) the date on which a Minnesota or federal greenhouse gas (“GHG”) program intended to reduce the increase of GHG emissions has been implemented (and which program applies to GHG emissions from Big Stone Unit II), or (2) four (4) years after the Big Stone Unit II COD if a Minnesota or federal GHG program intended to reduce the increase of GHG emissions has not been adopted and implemented by that date. Upon the termination of the Minnesota Owners’ greenhouse gas emissions offset obligations under this section 4.0, the Minnesota Owners are obligated to provide the offsets for any emissions occurring prior to the termination date that have not yet been offset. It is the Parties’ understanding that the Minnesota Owners will not be obligated to offset GHG emissions under both a Minnesota and federal GHG program at the same time that the Minnesota Owners are required to make offsets under the terms of this Agreement. That is, the Minnesota Owners will be required to offset GHG emissions only according to the terms of this Agreement or either (1) a federal GHG program or (2) a Minnesota GHG program and provided the program applies to GHG emissions from Big Stone Unit II.

4.11 *Greenhouse Gas* (*GHG) Management Plan.* The Minnesota Owners agree that beginning fourteen (14) months from the Big Stone Unit II COD and annually thereafter until terminated according to section 4.10, the Minnesota Owners, individually or collectively, will submit a GHG Management Plan to the Commission, the MPCA, and the Department that will report the status of carbon dioxide offsets required under this Agreement in the previous year as well as any emissions occurring prior to the filing of the GHG Management Plan that have not yet been offset, and describe the Minnesota Owners' efforts to offset greenhouse gas emissions (i.e., carbon dioxide) in the upcoming year or years. The GHG Management Plan will also be used to verify GHG offsets that have been made in the past, and to review and approve the expenditure of funds as contemplated in section 4.1.

5.0 CONTROL OF MERCURY EMISSIONS

The Owners will control mercury emissions from Big Stone Unit I and Unit II through use of a wet scrubber and also through use of a pulse jet fabric filter. The Owners also agree to install such other control equipment so as to control emissions of mercury from both Big Stone Unit I and Unit II such that the control equipment is equivalent to what is required of certain large generating facilities in Minnesota (*i.e.*, Sherco, and Clay Boswell) under the Mercury Emission Reduction Act of 2006 (Minnesota Statutes §§ 216B.68 to 216B.688) and that is most likely to result in the removal of at least 90 percent of the mercury emitted from the units. The Owners agree to act in good faith to install such equipment as expeditiously as possible, but the parties recognize that given the construction schedule and commercial operation date of Big Stone Unit II, the Owners have until four (4) years after the commercial operation date of Big Stone Unit II for the Owners to achieve compliance with these requirements. On the same dates as required for the GHG Management Plan under section 4.11 above, or until the mercury control goal set forth in this section 5.0 is met, the Owners will also provide a report to the Commission and the Department on the progress of meeting the mercury control goal.

6.0 PROTECTION OF BIG STONE LAKE

Big Stone Lake is a treasured natural resource of both South Dakota and Minnesota. It is also important to the operation of the Big Stone Units I and II. As a result, the Owners understand the importance of not adversely affecting the long-term level or flow of the lake. Accordingly, the Owners agree to:

- utilize groundwater for drought protection at the Big Stone Unit II;
- provide to the South Dakota Department of Environment and Natural Resources ("SDDENR") and the Minnesota Department of Natural Resources ("MNDNR") by June 27, 2007 and will provide, on an on-going basis, all data used to evaluate the Veblen aquifer and the effect on Big Stone Lake of extended groundwater withdrawal;
- provide to the SDDENR and the MNDNR by June 27, 2007 and will provide, on an on-going basis, all data used to evaluate the effect on the Minnesota River of an extended period of withdrawal of water from Big Stone Lake;
- support the granting of party status to the Minnesota Department of Natural Resources before the South Dakota Water Management Board ("WMB") in its requested Water Permit No 6846-3; and

- perform tests on the groundwater supply to evaluate well production and impacts relative to the modeling conducted pursuant to Water Permit No. 6846-3, consistent with the Owners' actual construction schedule and process for Big Stone Unit II.

The Owners have participated in meetings between the staffs of the SDDENR and MNDNR to work through the data prior to the July 11, 2007 WMB hearing on Water Permit No. 6846-3.

If the groundwater tests performed by the Owners as part of its construction of Big Stone Unit II differ materially from the models relied on by the Owners in the Water Permit No. 6846-3 before the WMB, the Owners understand that the MNDNR may request and that the WMB may reconsider the terms and conditions of Water Permit No. 6846-3, should it be granted in the first place.

Finally, the Owners also believe that long-term management of Big Stone Lake can best be done through organized, frequent communications between the two states and urges the two states to establish such communications by December 31, 2007. To that end, the Owners agree when asked by the state agencies, to constructively participate in meetings to address the management of the Big Stone Lake water flow and level issues.

7.0 RENEWABLES

7.1 *Renewable Energy Standard.* The Minnesota Owners understand and are subject to Minnesota Statutes § 216B.1691 (2007), that direct utilities in Minnesota to obtain from renewable resources seven percent (7%) of their total retail electric sales to retail customers in Minnesota by the end of 2010; twelve percent (12%) by 2012; seventeen percent (17%) by 2016; 20 percent (20%) by 2020; and twenty-five percent (25%) by 2025. The Department expects that the Minnesota Owners will meet these obligations.

7.2 *Community-Based Energy Development.* The Minnesota Owners commit to own or procure from C-BED projects no less than twenty-four percent (24%) of their individual RES obligations for the year 2012 expressed on an annual energy basis, subject to commercially reasonable contract terms and price. The Minnesota Owners will achieve this level of C-BED energy output no later than four years following the Big Stone Unit II COD.

Although any C-BED qualified renewable technology may be used to fulfill this energy commitment, for purposes of illustration based on current load forecasts of the Minnesota Owners for the year 2012 this annual energy commitment would be equivalent to the output of 180 MW of C-BED wind energy projects, assuming an annual wind capacity factor of 40%. The actual amount of energy from C-BED projects will be determined by the Minnesota Owners' actual RES obligations in 2012, expressed on an annual energy basis. The actual megawatts of C-BED capacity will be based on the actual RES energy obligations of the Minnesota Owners in 2012, and on the types of qualifying C-BED projects chosen to fulfill this C-BED energy commitment.

The Minnesota Owners may fulfill this C-BED commitment either as individual utilities or in aggregate. All C-BED commitments will be accomplished as part of, and not in addition to, the Minnesota Owners' RES obligations.

In addition to this 24% of RES commitment, the Minnesota Owners will take reasonable steps to identify additional C-BED projects that can meet the Minnesota Owners' cost and reliability requirements to satisfy a portion of the Owners' RES obligations under Minnesota Statutes, section 216B.1691. The Minnesota Owners will file reports with the Department by July 1, of 2013 and 2018 describing how these C-BED commitments are being fulfilled.

8.0 ENERGY EFFICIENCY AND CONSERVATION

8.1 *Compliance with the Conservation Improvement Program Goal.* The Minnesota Owners understand and are subject to Minnesota Statutes §§ 216B.2401 and 216B.241 (2007). The Department expects that the Minnesota Owners will meet these obligations. By June 1, 2008, the Minnesota Owners will file with the Department a plan describing how each utility (and its members for GRE, SMMPA, MRES, and CMMPA) intends to meet its energy savings goal.

8.2 *Aggregated DSM.* SMMPA, CMMPA, MRES, and GRE will strive to aggregate the DSM filings of their respective Minnesota members. For example, SMMPA will strive to aggregate the DSM filings of its members, GRE its members, etc.

8.3 *Water Heater Incentives.* The Owners who have established electric water heater incentives greater than $50 per heater that are not part of a DSM program shall terminate such programs by July 1, 2008. The Minnesota Owners will work in good faith with any of their Minnesota members who also have such programs to eliminate such programs by July 1, 2010.

8.4 *Elimination of Block Rates.* OTP shall propose the phased elimination of its declining block rate program in its next Minnesota rate case.

9.0 GENERAL TERMS AND CONDITIONS

9.1 *Entire Agreement.* This Settlement Agreement constitutes the entire agreement and understanding between the Parties pertaining to the resolution of this matter.

9.2 *Not Precedential.* The Parties agree that no precedent is established by the resolution of issues made in this Agreement. The resolutions reached herein are for settlement purposes only and do not necessarily represent the positions the Parties would take in litigation, the Owners' respective Integrated Resource Plans (IRP), or otherwise. The Parties will not use this Agreement as evidence for impeachment of a party in any future proceeding before the Commission or for use in any other administrative or judicial body.

9.3 *Not Admissible.* Unless the Commission approves this Agreement, this Agreement, and any statements made in furtherance thereof, shall not be admissible in evidence in this proceeding or in any other administrative or judicial proceeding.

9.4 *Terms Binding on Project Participants*; *Assignment*. The commitments and obligations of the Owners have application to, and are binding on, only those individual Owners so long as the utility is an Owner of the Big Stone Unit II or otherwise has entitlement to the capacity and energy from Big Stone Unit II. No individual Owner is responsible for the obligations of any other individual Owner, unless the Owner agrees in writing to assume the obligations of another Owner or former Owner. Within thirty days of the execution of any changes to the ownership structure for either Big Stone Unit II or the transmission facilities at issue in this docket, the Owners will notify the Commission and the Department of the change and provide any regulatory filings that may be applicable to the change. This Agreement and all provisions hereof is binding upon and inure to the benefit of the Parties and their respective successors and assigns.

9.5 *Commission Action; No Construction.* In the event the Commission disapproves this Agreement or takes other action inconsistent with this Agreement, or changes materially the terms of this Agreement as a condition to its acceptance, or if the Commission does not approve the needed Route Permits for the proposed transmission facilities in Minnesota in Docket #TR-05-1275, or if the Big Stone Unit II generating plant is not constructed for any reason, all Parties retain the right to treat this Agreement as null and void, or to seek reconsideration to modify their positions. Each party shall notify the other parties and the Commission of its intention regarding this Agreement in such event.

9.6 *Amendment.* No amendment to this Agreement is effective unless in writing and signed by all the Parties.

9.7 *Preparation of the Agreem*ent. All parties to this Agreement have had the opportunity to participate in the drafting of the document. There shall be no legal presumption that any specific party was the drafter of any particular provision.

9.8 *Authority.* The signatory for each organization entering into this Agreement has the necessary authority to bind the party and agrees to be bound by the Agreement in the future.

9.9 *Counterparts.* This Agreement may be signed in counterparts.

Agreed to by the following Parties:

Edward A. Garvey Dated 8/30/07

Minnesota Department of Commerce
Edward A. Garvey
Deputy Commissioner – Energy and
Telecommunications Division

Dated

Otter Tail Power Company
Chuck MacFarlane
President

Dated

Great River Energy
David Saggau
Chief Executive Officer

Dated

Missouri River Energy Services
Thomas J. Heller
Chief Executive Officer

Dated

Southern Minnesota Municipal Power Agency
Ray Hayward
Chief Executive Officer

Dated

Central Minnesota Municipal Power Agency
Robert Elston
President

Dated

Heartland Consumers Power District
Mike McDowell
Chief Executive Officer

Dated

Montana-Dakota Utilities Co.
Bruce Imsdahl
Chief Executive Officer

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Chuck MacFarlane
President

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Great River Energy
David Saggau
Chief Executive Officer

Thomas J. Heller Dated 8/30/07
Missouri River Energy Services
Thomas J. Heller
Chief Executive Officer

MRES Legal Department
Approved: MWG Date: 8/30/07

____________________ Dated ____________
Southern Minnesota Municipal Power Agency
Ray Hayward
Chief Executive Officer

____________________ Dated ____________
Central Minnesota Municipal Power Agency
Robert Elston
President

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Great River Energy
David Saggau
Chief Executive Officer

____________________________ Dated ________________
Missouri River Energy Services
Thomas J. Heller
Chief Executive Officer

Raymond L. Hayward Dated 8/30/07
Southern Minnesota Municipal Power Agency
Ray Hayward
Chief Executive Officer

____________________________ Dated ________________
Central Minnesota Municipal Power Agency
Robert Elston
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Missouri River Energy Services
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Chief Executive Officer

Dated

Southern Minnesota Municipal Power Agency
Ray Hayward
Chief Executive Officer

Bob Dated 8-30-07

Central Minnesota Municipal Power Agency
~~Robert~~ Elston
President

Dated

Heartland Consumers Power District
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Dated

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President

Mike McDowell Dated 8/30/2007

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Ray Hayward
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Central Minnesota Municipal Power Agency
Robert Elston
President

____________________ Dated ________________

Heartland Consumers Power District
Mike McDowell
Chief Executive Officer

Bruce Imsdahl Dated 08/30/07

Montana-Dakota Utilities Co.
Bruce Imsdahl
Chief Executive Officer

Exhibit A
Current Energy Forecasts and Renewable Energy Standard Obligations of the Minnesota Owners[1] in the Years 2012 and 2020

Big Stone II Owner	Minnesota Retail Load in 2012 (GWh)	Renewable Energy Standard Obligation in 2012[2] (GWh)	Minnesota Retail Load in 2020 (GWh)	Renewable Energy Standard Obligation in 2020[3] (GWh)
CMMPA	588	71	777	155
GRE	12,868	1,544	14,937	2987
Heartland	836	100	493	99
MRES	1,603	192	2,340	468
OTP	2,489	299	2,860	572
SMMPA	3,536	424	4,158	832
Total	**21,920**	**2,630**	**25,565**	**5,113**

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[1] Montana-Dakota Utilities (MDU) has no retail electric load in Minnesota.

[2] 2012 RES obligation calculated at 12% of Minnesota retail load.

[3] 2020 RES obligation calculated at 20% of Minnesota retail load.

Exhibit B
Current Energy Forecasts and Legislative CIP Goals for the Minnesota Owners[4] in 2020

Big Stone II Owner	**Minnesota Retail Load in 2020 (GWh)**	**CIP Goal in Year 2020[5] (GWh/year)**
CMMPA[6]	1,181	18
GRE	14,937	224
Heartland	493	7
MRES	2,340	35
OTP	2,860	43
SMMPA	4,158	62
Total	**25,969**	**390**

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[4] Montana-Dakota Utilities (MDU) has no retail load in Minnesota.

[5] 2020 CIP goal calculated at 1.5% of Minnesota retail load.

[6] CMMPA forecast includes Willmar Municipal Utilities for purposes of illustrating CIP goals.

Appendix L

Biological Assessment

TABLE OF CONTENTS

B0402.BL

AUG 30 2007

Mr. Pete Gober
U.S. Fish and Wildlife Service
South Dakota Ecological Services Office
420 S. Garfield
Pierre, SD 57501

RE: Determination of no affect on the construction and operation of the proposed Big Stone II Power Plant (Project).

Dear Mr. Gober:

Missouri River Energy Services (MRES), on behalf of the seven Big Stone II Project co-owners (Co-owners), has submitted an interconnection request to Western Area Power Administration (Western) to interconnect the proposed Project to Western's power transmission system at the Granite Falls and Morris Substations. The Applicant's proposed Project includes construction and operation of a 630-megawatt coal-fired power plant. The proposed Big Stone II Power Plant would be located adjacent to the existing Big Stone Plant in Grant County, South Dakota, east of Milbank and northwest of Big Stone City. Western is the lead Federal agency for the purposes of the Endangered Species Act. The list of Endangered, Threatened, proposed and candidate species and designated Critical Habitat that may occur in the proposed Project vicinity was verified on February 7, 2007.

Construction of new transmission lines or upgrading existing lines would begin at the existing Big Stone Substation and end at Western's Granite Falls and Morris Substations, or the Granite Falls and Willmar Substations. Existing substations located in Morris, Granite Falls, and Willmar, Minnesota, would require modification or reconstruction to accept the interconnections to transfer the power from the plant to the transmission system. The transmission line and substation additions and modifications will be discussed in a separate Biological Assessment that will be completed after final routing corridors are developed. Except for Western's substations, the proposed Project would be owned and operated by the seven Co-owners.

Western has determined that the proposed action of the construction and operation of the Big Stone II Power Plant would not affect the western prairie fringed orchid, the Dakota skipper, or the Topeka shiner or its designated Critical Habitat. The Bald Eagle has been removed from the Endangered and Threatened species list, but will still receive protection from the Bald and Golden Eagle Protection Act. Please refer to the enclosed Biological Assessment and Bald Eagle Mercury Exposure Assessment for additional information.

If you have any questions regarding these determinations or the proposed Project, please feel free to telephone Mr. John Bridges at (720) 962-7255, or Mr. Dirk Shulund, of my staff at (406) 247-7402.

Sincerely,

/S/ Dirk W. Shulund

for Nicholas J. Stas
Environmental Manager

Enclosures

cc:
Ms. Natalie Gates, USFWS, Pierre, SD
Ms. Laurie Fairchild, USFWS, Bloomington, MN
(w/copy of enclosures)

bcc:
J. Bridges, A7400, Lakewood, CO
N. Werdel, A7400, Lakewood, CO
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BIOLOGICAL ASSESSMENT
BIG STONE II POWER PLANT
GRANT COUNTY, SOUTH DAKOTA
AUGUST 2007

INTRODUCTION

The U.S. Department of Energy (DOE), Western Area Power Administration's Upper Great Plains Customer Service Region (Western), owns, operates and maintains a 230-kilovolt (kV) high voltage transmission line system in western Minnesota. The Big Stone II Project Co-owners (Co-owners) have requested an interconnection with Western's transmission system at its Morris and Granite Falls substations. The Co-owners include: Central Minnesota Municipal Power Agency; Great River Energy; Heartland Consumers Power District; Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc.; Otter Tail Corporation dba Otter Tail Power Company; Southern Minnesota Municipal Power Agency; and Western Minnesota Municipal Power Agency. Western is the lead Federal agency for the project and has prepared a Draft Environmental Impact Statement (EIS) for the proposed action. In accordance with DOE Regulations for implementing the National Environmental Policy Act, Western evaluated the effects of the interconnection and all other connected actions directly associated with it.

Mid-Continent Area Power Pool (MAPP) data indicate a shortfall of baseload generating capacity may occur by 2011 with energy consumption in the region estimated to increase by 15 percent during the next decade. The purpose of the Project is to meet the Co-owners' anticipated electrical energy needs in a low-cost, environmentally responsible manner. The proposed action would help meet the projected demand of the Co-Owners and the needs of the MAPP for baseload generation early in the next decade. A highly efficient coal-fired plant in the 630-megawatt range is the most cost-effective choice for helping to meet the anticipated need for increased generation. The Co-owners "Application for a South Dakota Energy Conversion Facility Siting Permit" demonstrates the need for the proposed plant, and was approved by the South Dakota Public Utilities Commission on July 9, 2006.

PROJECT DESCRIPTION

The proposed Big Stone II Project (Project) includes constructing and operating the Big Stone II coal-fired power plant, transmission additions and modifications and substation modifications. This Biological Assessment (BA) focuses on the proposed Big Stone II power plant (proposed action). A separate BA would be prepared to address the transmission line and substation modifications once the Minnesota Public Utilities Commission issues a final decision regarding transmission line alternatives.

Proposed Action: General Description

The Co-owners propose to construct a nominal 630 MW (net) coal-fired electric generating station named Big Stone II. It would be located on an industrial site adjacent to the existing 450-MW Big Stone Plant in Grant County, South Dakota. The Big Stone Plant site is located on a 2,271-acre parcel, about eight miles northeast of Milbank and two miles northwest of Big Stone City, South Dakota, as shown in Figure 1. Otter Tail Power Company owns a 295-acre parcel adjacent to the existing site and has an option to purchase an additional 620 acres, on behalf of the proposed Project. Total acreage for the existing and proposed Big Stone II plants is approximately 3,200 acres.

Existing Big Stone plant infrastructure, such as the cooling water intake structure, pumping system and delivery pipelines, coal delivery and handling facilities, solid waste disposal facilities, and water storage ponds would be used for the proposed Big Stone II plant. Existing rail and road facilities would be used for access to the property and plant site.

New construction would include the proposed plant and ancillary facilities, and ground water wells and associated pipelines. Additional parking and laydown areas for construction would also be required. The proposed Big Stone II plant would be designed to meet baseload demand, and would normally operate at its maximum continuous rating output. Construction is scheduled to start in the spring of 2008, with commercial operation targeted for the spring of 2012.

Proposed Big Stone II Generating Facility Description

The proposed Big Stone II plant would use pulverized coal-fired, super-critical boiler technology and would burn low-sulfur, Powder River Basin (PRB) coal. The boiler would provide steam to a single steam turbine generator that would convert mechanical energy of the steam turbine to electrical energy. The super-critical boiler would use a single-reheat system with a condensing steam turbine configured with multiple stages for feedwater heaters and a steam condenser. The turbine would drive a hydrogen-cooled electric generator. Both the turbine and generator would be enclosed in a building. A water-cooled steam condenser would accept the steam exhausted from the turbine. A circulating water system would supply cooling water from a wet cooling tower to the water-cooled steam condenser to dissipate the energy in the condensing steam. Electricity produced by the steam turbine generator would be supplied to a step-up transformer and switching equipment for input to the transmission system.

Air Pollution Control Equipment

The emission control equipment for the proposed Big Stone II supercritical boiler would be subject to a final design and regulatory approval. Specific proposed controls would include:

Nitrogen Oxide Emission Controls

Boiler NO_x emission control would be achieved through boiler design and Selective Catalytic Reduction (SCR) treatment. The SCR system would be a specifically designed reactor vessel containing a catalyst, installed between the boiler economizer and air heater. Anhydrous ammonia would be injected into the SCR reactor and would react with the NO_x

on the surface of the catalyst to reduce NO_x to molecular nitrogen (an inert element) and water vapor. Operational controls would be used to minimize the amount of ammonia "slip" (i.e., unreacted ammonia) into the flue gas. Anhydrous ammonia is a liquid under pressure. It would be delivered by truck and stored on site in pressurized storage tanks.

Sulfur Dioxide Emission Controls

Boiler SO_2 emission control would be accomplished using a Wet Fuel Gas Desulfurization (WFGD) system with a design SO_2 control efficiency of 95 percent. The proposed Big Stone II plant would use a baghouse to first capture particulate matter from the flue gas. The system would then route the exhaust gas through the WFGD system, commonly referred to as a scrubber. The WFGD would be common to the existing Big Stone and the proposed Big Stone II plants and would control emissions of SO_2 from Big Stone I and Big Stone II. The existing chimney or stack would be retained to allow the existing Big Stone plant to continue to operate in scrubber bypass mode in the event the common scrubber is off-line. A new chimney would be required to support the proposed Big Stone II plant operations, and would also be used by the existing Big Stone plant. The SO_2 in the boiler exhaust gases would react with limestone slurry injected into the scrubber to form calcium sulfate or "gypsum." Gypsum is the predominate by-product of the WFGD and would be processed using a dewatering system; reclaimed water would be used for plant operations. The waste gypsum would either be used in manufacturing, such as wallboard, or disposed of at an on-site landfill. Limestone required by the WFGD system would be delivered to the plant site by truck or rail and stockpiled on-site.

Mercury Emission Controls

The baghouse and WFGD would reduce mercury emissions. Mercury is present in coal in trace amounts. When coal is combusted, mercury is volatilized and is found in very small concentrations in the uncontrolled flue gas exiting the boiler. The WFGD system would remove the water soluble oxidized mercury from the exhaust gases and collects it in the gypsum. The rate of mercury oxidation is dependent on many factors including temperature, flue gas composition and fly ash composition. A small fraction of the elemental mercury in the flue gas may condense onto the fly ash in the flue gas, which would be removed by the baghouse.

Fugitive Particulate Emission Controls

Controls would be applied to potential sources of fugitive particulate emissions. Particulate emission controls would be applied to cooling towers and materials handling operations for coal, fly ash and limestone. In general, particulate emissions from materials (coal, fly ash and limestone) at handling system drop points would be controlled by baghouses and/or passive dust control processes, or other devices with similar particulate removal efficiencies that would be connected to the enclosed handling system. Material collected from dust control systems would be fed back into the respective material handling system.

Diesel Generator Air Emissions Controls

Operational requirements include the installation of a diesel-fired internal combustion engine driven generator. The engine would include state-of-the-art engine technology to minimize emissions and is expected to meet all emissions limits without add-on controls.

Diesel Fire Pump Air Emissions Controls

A diesel-fired internal combustion engine-driven emergency fire water pump would be installed to support fire suppression in the event of a fire at the site. Similar to the diesel generator, the engine would include state-of-the-art engine technology to minimize emissions and would be expected to meet all emissions limits without add-on controls.

Water Supply and Plant Cooling System

The existing Big Stone plant water supplies and wastewater management facilities would be used to the extent practicable. The proposed Big Stone II plant would be a zero liquid discharge (ZLD) facility, which would utilize wastewater concentrating equipment and wastewater re-use to avoid discharges from the facility.

The proposed Big Stone II plant would use Big Stone Lake as the primary water supply source. Water from Big Stone Lake would be used to meet the immediate water needs of the plant and to keep the cooling pond (which would also serve as a make-up water storage pond) at near maximum capacity. Operation of the proposed Big Stone II plant would require an additional 8,800 acre-feet per year (afy) of fresh water. With a current water usage of approximately 4,200 afy for the existing plant, the total combined (both the existing Big Stone plant and the proposed Big Stone II plant) water consumption would be approximately 13,000 afy, assuming a wet cooling tower system is used for the proposed Big Stone II plant. The average surface water appropriation from Big Stone Lake would be approximately 9,317 afy.

It is anticipated that there may be certain periods when withdrawals from Big Stone Lake are restricted by permit or other operational constraints. A groundwater withdrawal system would be operated as a back-up water supply when Big Stone Lake or the cooling pond could not meet plant water needs. It would also be used to "top off" the cooling pond when that source has been drawn down, and water is not available from Big Stone Lake. Based on the current water use model estimates (and anticipated curtailments from Big Stone Lake), approximately 3,720 afy of groundwater would be needed (on an annual average) to supplement combined plant needs. On occasion (e.g., during extreme drought), when groundwater is the sole source of water supply, groundwater use would be 10,000 afy.

Groundwater resources would be produced from the Veblen Aquifer. Groundwater modeling and groundwater exploration activities conducted by the Co-owners indicates that approximately 7 to 14 wells would be needed to supply the existing plant and the proposed Big Stone II plant during periods of prohibited supply from Big Stone Lake. The wells would be installed within designated areas (Figure 2) including an area within approximately two miles of the proposed plant site and an approximately 7,694-acre, 12-section area approximately two to six miles west and southwest of the proposed plant site. Due to on-going groundwater investigations, the exact locations of the groundwater production wells are not known.

Each production well site area would consist of the well and a small building on an approximately 200 square-foot site. Graveled access roads would be constructed to each well site from the nearest local road, and would be approximately 50 feet long by 12 feet wide. Two possible well sites are located further out in agricultural fields, and would require access roads approximate 1,500 feet long. Each well would likely be constructed using 12-inch steel casing from the surface to approximately the top of the aquifer and a 10-inch diameter stainless steel screen over the aquifer zone. An observation well (installed using two-inch diameter polyvinyl chloride (PVC) casing) would be installed at selected locations. If observation wells are installed, the production well and the corresponding observation well would be approximately 400 to 500 feet apart, and both wells would be drilled to approximately 180 feet to 250 feet below ground level. Permanent facilities installed at production wells would include a small pre-engineered building on a concrete slab surrounding the well. The building would be weather tight and heated and ventilated, if appropriate. The building would house the power supply terminal and disconnect for the equipment, local controls and instrumentation, lighting, and enough free floor space to allow normal maintenance of the pumps.

A pipeline system would be required to convey the produced groundwater from the production wells to the proposed plant. The pipeline would be constructed of either high-density polyethylene (HDPE) or PVC materials. The pipeline would be buried approximately 7.5 feet deep to prevent the line from freezing. The pipeline would vary in diameter depending on the number of production wells connected to it. Based on anticipated flow rates, the pipe size would increase in diameter as each production well is added to the main pipeline. At this point in the design stage, piping from individual production wells are expected to be eight to 10 inches in diameter, and the main pipeline at its maximum diameter would be approximately 20 to 30 inches. The groundwater pipeline gathering system is still in design, therefore, the exact routes of pipelines connecting the groundwater production wells to the plant are not currently known. However, the most likely routes selected would be along existing road right-of-ways.

Groundwater would be pretreated in a new lime/soda softening process to reduce the scaling potential and ultimately reduce the Big Stone II cooling tower blowdown. This softening process would be required in order to efficiently utilize groundwater. The new lime/soda softening process would be located in a building with a dimension of approximately 96 feet by 240 feet with associated storage silos and water storage tanks located adjacent to the building. It would be sited between the cooling tower and the power plant. It would also be used with lake water make-up to optimize the water consumption of the existing and proposed plants. Groundwater would be routed directly to the proposed Big Stone II pretreatment system, when the back-up source is required.

A new high purity water treatment system known as BSP II Pretreatment System would provide softened water for the existing and new plants. Softened cooling pond water would be fed to a new reverse osmosis (RO) unit designed to remove approximately 98 percent of the dissolved salts. Additional reduction of dissolved salts would also occur in a mixed bed ion exchange unit that would follow the RO unit to produce water suitable for make-up to the plant's steam cycle. The RO reject stream would be routed back to the cooling pond for reuse. The neutralized regenerated wastewater from the mixed bed unit would also be routed back to the cooling pond for reuse.

Waste Water Management

The Proposed Action requires that the existing holding pond, a portion of the existing evaporation pond, and the existing brine concentrator remain as wastewater treatment facilities. However, it is not anticipated that a new brine concentrator would be needed in the proposed plant operation, and would not be constructed.

The construction work force domestic waste water would be handled by one or more of the following methods: holding tanks, portable treatment facilities and/or waste collection tank/drain field system.

Materials Handling and Waste Management

Fuel and Limestone Receiving, Handling and Storage

Construction of the proposed Big Stone II plant would require the addition of new ancillary material handling and storage facilities and upgrading of the existing facilities that are used for the existing Big Stone plant. All coal delivered to the Big Stone site is, and would be, delivered by rail via the existing Big Stone rail spur. The proposed Big Stone II plant would operate at a coal burn rate of approximately 376 tons per hour (tph); the existing Big Stone plant currently operates at approximately 270 tph. The coal requirements for both plants would total approximately 646 tph. Based on a maximum operating level at 100 percent of the time (100 percent plant capacity factor), the existing Big Stone plant and the proposed Big Stone II plant would require approximately 5.7 million tons per year of PRB coal. Assuming 100 percent capacity requirements and a unit train size of 14,400 tons (unit train is comprised of 120 cars, each car containing 120 tons), the unloading system would need to handle approximately seven unit trains per week. However, annual operational levels of the plants are expected to average approximately 88 percent, so the actual usage deliveries would be proportionally less.

A coal unloading rate of 3,600 tph, or approximately four hours per unit train, must be achieved to effectively integrate the proposed Big Stone II plant into the existing Big Stone operations. This criterion would require upgrades to existing vibrating feeders/conveyors and the existing transfer point structure.

Other coal handling improvements required for the proposed Big Stone II plant would include:

- Replacement of the existing emergency stock-out system that would deliver coal to a new 28,000 ton emergency stock-out coal storage pile.
- Installation of a new, dual reclaim hopper and new enclosed crusher house with assorted conveyor interconnections.

- Installation of three new concrete coal storage silos (70 feet in diameter and 196 feet in height) to provide 36,000 tons of dedicated storage (four days live storage for the proposed Big Stone II plant).
- Installation of new conveyor interconnections between the new crusher house and emergency stock-out pile and the proposed Big Stone II plant.

Limestone (required for the WFGD system) would be transported to the Big Stone site by rail or by truck, depending on which is most cost-effective. Rail transport would utilize 100 ton railcars; truck transport would utilize 22 ton trucks. When operating at 100 percent capacity, an estimated 94,000 tons of limestone would be required annually for the proposed Big Stone II plant and 91,000 tons for the existing Big Stone plant. Rail shipment to supply limestone for both units would require a maximum of 1,850 rail car loads per year; truck shipments would require a maximum of 8,409 truck loads per year.

Vibrating feeders would transfer limestone from a receiving hopper to an unloading conveyor at a rate of 500 tph. Approximately 15,000 tons of limestone, a 30-day supply, would be stored and covered using an umbrella cover measuring approximately 160 feet in diameter.

Solid Waste Management

Coal combustion by-products include bottom ash, fly ash and gypsum. Coal combustion by-products have been estimated based on consumption of 3.3 million tpy of coal for the proposed Big Stone II plant and 2.4 million tpy from the existing Big Stone plant. Maximum annual waste generation from each plant, and the total for both plants are provided in Table 1 (same as Table 2.2-2 in Draft EIS (Western, 2006)).

Table 1. Average and Maximum Waste Generation (tpy)

Waste Form	Proposed Big Stone II Plant Average[a]	Existing Big Stone Plant Average[a]	Proposed Big Stone II Plant Maximum[b]	Existing Big Stone Plant Maximum[b]
Bottom Ash	32,000	84,000	73,000	230,000
Fly Ash	127,000	45,000	293,000	124,000
Gypsum	62,000	51,000	183,000	177,000
Total	221,000	180,000-	549,000	531,000

[a] Assuming 88 percent capacity factor and average waste generation.
[b] Assuming 100 percent capacity factor and maximum waste generation.

Bottom ash would be disposed of at the existing on-site landfill. Fly ash would be conveyed to on-site storage silos. Fly ash that does not meet marketable specifications (or that which cannot be sold for other reasons) would be disposed of at the existing on-site landfill. Gypsum would be disposed of at the existing on-site landfill, or trucked off-site for use in manufacturing of sheetrock or wallboard. Fly ash disposal also could be achieved by hauling it off-site by rail.

Bottom ash could be used as structural fill. Fly ash could be used for soil stabilization, as a structural fill, or as a replacement for Portland Cement in concrete. Gypsum produced by a WFGD system could be used for making wall board or as a supplement for making wall board and cement. Secondary benefits from using fly ash could result in reduced CO_2 that would be generated as part of cement production.

On-Site Landfill

Waste disposal requirements for the on-site landfill would average 400,000 tons annually over 20 years. Future site requirements would total over eight million tons. Disposal of approximately eight million tons of bottom ash, fly ash and gypsum over 20 years would require a site capable of containing approximately eight million cubic yards of material. Requirements for containing the material would total a minimum of 145 acres of land surface (assuming typical compaction factors and an average disposal depth of 35 feet). Actual size of the disposal site would be contingent upon depth of disposal material, containment cover and other factors.

Based on these projections, the existing Big Stone plant landfill would accommodate approximately 10 years of disposal before it would need to be expanded. This projection is based on average coal characteristics, an 88 percent plant capacity factor and average ash and sulfur content of the coal. Any by-product sales would proportionately extend the remaining landfill life. An additional landfill would require permits in accordance with Federal, state and local requirements and is not included in the analysis, because the site is unknown at this time. Permitting would begin approximately three years prior to reaching capacity of the existing disposal site.

Chemicals Management

Operation of the existing Big Stone and proposed Big Stone II plants would require a range of chemicals and materials that are used by various plant systems. Table 2 lists the materials, quantities, delivery frequencies and delivery methods for the proposed Big Stone II plant (same as Table 2.2-3 in Draft EIS (Western, 2006)). Some of the chemicals and materials are considered hazardous substances and, as such, require appropriate handling and storage equipment and associated documentation.

Hazardous Wastes

Normal day-to-day operations of the proposed Big Stone II plant would generate minimal amounts of hazardous waste. Periodically, certain maintenance activities could generate hazardous waste (i.e., chemical metal cleaning of the boiler or other equipment). Such wastes would be appropriately contained and disposed of at an approved waste disposal site.

System Communications

Systems operations would require an extended bandwidth Ethernet communications to the plant site, either by microwave or optical ground wire (OPGW). The upgraded microwave system would require a new tower in the 400- to 450-foot range at the Big Stone plant site. Additional uses for the tower would be for upgraded microwave communications to the Blair Substation and upgraded microwave communications to

Table 2. Anticipated Proposed Big Stone II Plant Chemicals

Material	Annual Use[a]	Delivery Quantity and Frequency[c]		Storage Location and Amount	
		Quantity[a]	Frequency	Location	Amount[a]
Wastewater Treatment System					
Scale Inhibitor	1,000	250	4/year	Curbed Area	500
Sulfuric Acid (96%[b])	10,000	3,000	4/year	Bulk Tank[d]	6,000
Anti-foaming Agent	500	250	2/year	Curbed Area	500
Sodium Hydroxide (50%[b])	1,000	250	4/year	Curbed Area	500
Cooling Tower Chemicals					
Sulfuric Acid (98%[b])	310,000	3,000	2/week	Bulk Tank[d]	6,000
Dispersant	5,600	1,500	4/year	Bulk Tank[d]	3,000
Scale Inhibitor	13,400	1,500	9/year	Bulk Tank[d]	3,000
Biocide (12.5%[b] NaClO[e])	100,000	4,000	25/year	Bulk Tank[d]	6,000
Boiler Make-up Water Treatment					
Sodium Chloride (10%[b])	500	100 lb. bag	1/year	Chemical Storage	100 lb
Cycle Chemical Feed					
Oxygen	500 lb	150 lb. Cylinders.	1/year	Chemical Storage	500 lb
Other Chemicals and Fluids					
Anhydrous Ammonia	870,000	8,000	weekly	Bulk Tank	30,000
Hydrogen	2,000 lb	Bulk	weekly	Bulk Tank	25,000
Nitrogen	500 lb	Cylinders	Monthly	Cylinders	500 lb
Carbon Dioxide	2,500 lb	Cylinders	Monthly	Cylinders	2,500 lb
Lubricating Oil/Turbine Lubricant	Negligible	Barrels	As required	Tank[d]	5,000
Electro-hydraulic Fluid	Negligible	Barrels	As required	Tank[d]	500
Diesel Fuel (fire pump)	500		As required	Tank[d]	500
Diesel Fuel (emergency generator)	500		As required	Tank[d]	500

[A] Units are in gallons, unless otherwise specified.
[b] Percent of solution.
[c] All deliveries are by truck.
[d] With containment.
[e] Sodium Hypochlorite.

OTP's Milbank office. Use of the existing stub tower that is on top of the Big Stone facility is not technically feasible.

The use of OPGW would have an additional benefit of a possible interconnect with Western, which could be useful to provide communication links to other locations within the OTP service area. The additional bandwidth from either the microwave or OPGW also would be used for telephone service to the proposed Big Stone II plant, company Intranet, Supervisory Control and Data Acquisition (SCADA) communications and wireless network access.

The proposed Big Stone II plant would be wired for an office telephone system along with network system wiring. A separate SCADA unit would either be installed in the common plant control room or in the adjacent plant substation. The SCADA unit would likely be digitally linked to the plant control system for more precise remote monitoring from OTP's Fergus Falls System Operations Center.

Construction

Construction of the proposed plant would involve civil construction (site grading, excavation and foundations), structural construction (structural steel construction for boiler, WFGD system and other supporting facilities), and electrical construction (wiring and interconnections), all of which would be designed to accommodate the proposed plant's equipment received from manufacturers. The sequence of construction would generally progress as follows:

- Mobilization
- Site work and foundations
- Erection of structures and buildings
- Installation major equipment components
- Installation of supporting systems
- Electrical and Controls Testing and Functional Checkout
- Start-up of equipment and systems
- Initial operation
- Performance and Environmental Testing
- Commercial Operation

Plant construction would not require the addition of new off-site staging areas. Temporary equipment and material storage areas and similar staging sites would be within the confines of the existing plant site property. Other temporary facilities required to support construction would include potable water, sanitary and temporary warehouse facilities.

Heavy site grading and excavation equipment (bull dozers, excavators, track hoes, graders, and trenchers) would be used for the civil construction. Structural construction would require large cranes to erect the steel for the boiler superstructure which has a height of several hundred feet. Numerous smaller cranes would support construction of other facilities. A reinforced concrete stack would be constructed with a height of 498 feet.

During the site grading and excavation phase of construction, protective measures to control storm water construction runoff and erosion would be used, including sediment traps, diversion ditches, silt traps and parameter fabricate erosion protection, all in accordance with the Project Stormwater Pollution Prevention Plan (SWPPP).

Large equipment components would be delivered to the site by rail, while smaller components would be delivered by truck.

The proposed Big Stone II plant would be constructed over a four-year period with an initial mobilization in spring/summer 2008 and commercial operation date of March 2012. Construction of the proposed Big Stone II plant would require up to 1,400 workers during peak periods, in Spring/Summer, 2010.

Hazardous wastes generated during construction activities would be contained and disposed of in accordance with Federal, state, and local regulations. Hazardous materials would be transported and disposal would be in approved facilities.

Operational Work Force

The proposed Big Stone II plant would require an operating staff of 35 employees in addition to the existing 74 employees that presently work at the existing Big Stone plant. All 109 employees would be full time.

Project Decommissioning

Project decommissioning would take place following the expected life-span of the project (estimated at 30 to 50 years), unless an alternative use for the plant were to be identified. Decommissioning would adhere to Federal, state and local regulations that are in place at the time of decommissioning.

Mitigation

Construction activities would occur inside the plant site boundary as shown in Figure 1.

Mitigation measures would be implemented including:

- A ten mile per hour speed limit in areas that may contain sensitive species;
- All personnel would undergo environmental awareness and safety training prior to entering the construction area. Training would include:
  - A discussion of the sensitive species that may be present in the area, a brief description of the species, their status, the reason for that status, their natural history, and the mitigation measures that would be necessary to minimize adverse effects to the species of concern;
  - Contact information and what to do in case a species of concern is found.
- Personnel would be given proof of training completion; proof would be required to be carried while workers are in the construction area; and
- The applicant would maintain records of those attending the training and provide quarterly reports to Western listing the individuals that have gone through the environmental and safety training.

CONSULTATION HISTORY

September, 2004, the applicant's contractor contacted the U.S. Fish and Wildlife Service's Field Office in Pierre, South Dakota (Service) to request a list of endangered and threatened species.

June 2, 2005, Western sent a letter to the Service to initiate informal consultation on the project and to request a list of endangered, threatened, proposed, or candidate species or designated Critical Habitat that may occur in the project area.

June 14 and 17, 2005, Western met with the Service to discuss the project and conduct agency scoping meetings.

July 7, 2005, the Service responded to Western's request for a list of species and indicated that the Pierre, South Dakota, Ecological Services' Office would be the single point of contact for Section 7 consultation for the proposed Big Stone II power plant.

Preparation of the Biological Assessment began in September, 2005.

July 19, 2006, Western requested an update of the listed, proposed and candidate species that may occur in the project area.

August 8, 2006, the Service replied that the list had not changed.

The Service indicated the following species may occur in the project area:

Western prairie fringed-orchid (*Platanthera praeclara*)	Threatened
Dakota skipper (*Hesperia dacotae*)	Candidate
Topeka shiner (*Notropis topeka*)	Endangered
Bald eagle (*Haliaeetus leucocephalus*)	Threatened

February 5, 2007, Western contacted the Service to advise them of changes to the project that would delay the submission of the Biological Assessment. The changes included the source and storage of cooling water and the possible addition of support structures for the Big Stone-Hankinson 230-kV transmission line.

July 26, 2007, Western discussed the de-listing of the bald eagle with the Pierre, SD, Field Office, and received the National Bald Eagle Management Guidelines.

METHODS

Field surveys were conducted on the Big Stone property, including the proposed Big Stone II project area, by a certified ecologist in September 2004. A bald eagle nest was found more than one mile from the property boundary, northeast of Big Stone II. No surveys were conducted for the Topeka shiner. The September survey did not locate any individuals of the western prairie fringed-orchid. After additional consultation with Dr.

Carolyn Sieg, and Dr. Bonnie Alexander (2005) on the flowering phenology of the orchid, a second survey was conducted on July 11, 2005. The search area was selected based on the preferred habitat of the species, previously-conducted vegetation community type and community quality surveys, and presence of species commonly associated with the orchid. The surveys included an area that may be impacted by the proposed action. The search area included the unnamed tributary to the Whetstone River that begins in a 35-acre wetland and flows eastward to the Whetstone River. This unnamed tributary is a broad, meandering swale for most of its length, and develops a recognizable bed and bank only east of 484th Street. The entire tributary west of 484th Street was dry at the time of the survey, with several lengths of saturated soils and/or standing water.

SPECIES ACCOUNTS

The western prairie fringed-orchid was listed as a threatened species in 1989 (USFWS, 1994). This fringed-orchid may occur in Grant County, South Dakota, but there are no recent sightings (since 1970) of the species in South Dakota (USFWS, 1994). However, the life cycle of the plant often makes it difficult to detect. Although the plant is typically associated with intact native prairie, the orchid has also been found on disturbed sites. Suitable habitat generally includes mesic upland prairies, wet prairies, sedge meadows, sub-irrigated prairies and swales in sand dune complexes. Historically, the species was distributed throughout the tallgrass prairie west of the Mississippi River in the central United States and southern Canada. Populations currently exist in the neighboring states of Nebraska, Minnesota and North Dakota, and suitable habitat may still be found in South Dakota. Historic records in South Dakota include Minnehaha and Brookings counties. Reasons for the population decline include habitat alteration and possibly the use of herbicides. The nearest existing populations of the orchid are reported from Rock and Pipestone counties in Minnesota and Richland and Ransom counties in North Dakota. The species' preferred habitat of mesic prairie swales exists in several small areas within the proposed Big Stone II project area and a number of the known plant associates of the western prairie fringed-orchid are also present, including big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and several sedges (*Carex* spp.).

No western prairie fringed-orchids were located during field surveys, nor was suitable habitat found on the plant site. The eastern portion of the unnamed tributary to the Whetstone River flows through an area that is heavily grazed. The western end of the tributary is dominated by reed canary grass and cattails. Common associates of the orchid, including big bluestem and sedges, were isolated and sparsely distributed.

The southern edge of the Big Stone property, along the Whetstone River, has more of the known plant associates of the western prairie fringed-orchid but was drier than the species' preferred soil moisture range, and was separated from the river by 20 to 40-foot tall, steep banks.

The Dakota skipper is a small butterfly found in the tall grass and mixed grass prairies of the northern Great Plains. Loss and fragmentation of this habitat type has adversely affected the Dakota skipper population. The skipper was listed as a Candidate 2 species as early as 1982, but was removed from candidate status in 1995 when the candidate lists were revised. In June 2002, it was placed back on the list as a candidate that may warrant listing but was given a priority of 11 (USFWS, 2002).

Eggs are laid singly on broad-leaved plants from mid-June to early August, and the caterpillars must climb down into the grasses. Caterpillars eat grass leaves (i.e. little bluestem (*Schizachyrium scoparium*), bluegrass (*Poa* spp.), and panic grass (*Panicum* spp.)) at night and make shelters of silken tubes lined with grass. The caterpillar overwinters in shelters that are partially underground. Any activities that disturb the native prairie from June through August would adversely affect the skipper (Cochrane and Delphey, 2002).

Suitable habitat for the skipper occurs on the plant site; however, no individuals have been found. The applicant would conduct a pre-construction survey in appropriate habitat for the skipper in the July before construction starts. If the species is found, Western would re-initiate consultation with the Service.

<u>The Topeka shiner</u> was listed as an endangered species by the USFWS (USFWS, 1998) and is listed as a "possible" occurrence in Grant County. The South Dakota Department of Game, Fish and Parks (SDGFP) has no current or historic locations of the Topeka shiner in Grant County, and all known occurrences of the Topeka shiner in South Dakota are in streams south-southeast of Grant County (SDGFP, 2003).

The Topeka shiner is generally found in headwaters of rivers and in perennial prairie streams with good water quality, where the shiner usually inhabits the pool and run areas (USFWS, 1998). The reasons for listing the shiner include habitat degradation, modification, and fragmentation. Any change in stream flow or increase in silt load would adversely affect the shiner.

The only suitable habitat for the Topeka shiner in the vicinity of the proposed action is the Whetstone River, which is outside of the construction limits. The river would receive no discharge from the proposed Big Stone II plant because the plant would be operated as a zero discharge facility.

Critical Habitat has been proposed for the Topeka Shiner in Duel and Brookings counties, South Dakota, south of the proposed action. Big Stone II would not affect any of the water courses proposed as Critical Habitat.

<u>The bald eagle</u> was listed as an endangered species in March 1967 (USFWS, 1967). The bald eagle ranges across North America (Finch, 1992) and feeds on fish, waterfowl, small mammals and carrion. The main reasons for the nationwide decline include direct mortality, such as shootings, and poisonings and indirect mortality such as electrocutions and incidental accumulations of pesticides, heavy metals and trace elements. Eagle populations have recovered enough so that the species was downlisted to threatened (USFWS, 1995). The bald eagle has been removed from the endangered and threatened

species list (USFWS, 1999) as of August 8, 2007; however, it would still be protected by the Eagle Protection Act.

The bald eagle is known to occur in Grant County and throughout South Dakota and neighboring Minnesota. The birds may begin nesting in January with the young fledging usually in July. Additionally, bald eagles are known to winter in the vicinity of the plant site. A bald eagle nest was identified and mapped approximately 0.75 miles from the nearest construction of the proposed Big Stone II plant; however, the nest was lost in a storm on May 5, 2007. There would be no activity within 0.25 miles of the existing bald eagle nest, during the period of January through July.

Recently, bald eagles have been found in Montana that died of mercury poisoning (Milodragovich, 2006). The route of poisoning is unclear at this time. Methlymercury accumulates quickly in the top predator of an ecosystem through bioaccumulation. Western has prepared an assessment of the risk of mercury on the local bald eagle (see Appendix A).

DETERMINATIONS

The orchid was not found during surveys and suitable habitat is absent from the area of the proposed action. Western has determined the proposed action would not affect the western prairie fringed-orchid. Habitat surveys were undertaken for the Dakota skipper. There is suitable habitat for the skipper on the plant site, but no individuals were found during the July surveys. Western has determined that the proposed action would not affect the Dakota skipper. The Co-owners will conduct preconstruction surveys for the skipper during the July preceding construction to re-affirm their absence. If skippers are found, Western will request a conference with the Service. The Topeka shiner is also absent from the project area and Western has determined the proposed action would not affect the Topeka shiner. There is no Critical Habitat for the Topeka shiner in the vicinity of the proposed Big Stone II plant site. Western has determined that the proposed action may affect the bald eagle which had a nest about 3/4-mile from the proposed action (The bald eagle nest was destroyed in a wind storm on May 5, 2007). However, no construction activities would occur within ¼-mile of the nest and the proposed action is not likely to adversely affect the bald eagle, the nest, or any nestlings. If another nest is built in the vicinity of the Big Stone II construction, the Co-owners will follow the National Bald Eagle Management Guidelines issued by the Service to minimize impacts to this species. Western has determined that based on the amount of mercury scheduled to be released from both the existing and proposed Big Stone plants, the location of Big Stone Lake, and the fact that eagles have been nesting and fledged young for the last three years, that mercury from the proposed Big Stone II may affect, but is not likely to adversely affect the bald eagle.

CUMULATIVE EFFECTS

For purposes of this document, cumulative effects will follow the definition found at 50 CFR 402.02. That is ". . . those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area . . ."

Current and ongoing agricultural activities including plowing, planting and harvesting will continue in the vicinity of the project area.

Five ethanol plants are in various stages of permitting, construction, and/or operation in the vicinity of the Big Stone II project. These include the Northern Lights ethanol plant, Granite Falls Energy, LLC ethanol plant, Chippewa Valley Ethanol Company LLC, Great Lakes Energy ethanol plant, and North Country ethanol plant LLC. These plants all require water and fuel/energy for boilers and grain dryers. The additional infrastructure to operate these plants may require the construction of additional petroleum or water pipelines and overhead electrical transmission lines. They may also discharge waste water. These actions in turn may result in the alteration, degradation, or loss of habitat and adverse effects on species dependent on that habitat. It is not clear if the Bureau of Alcohol, Tobacco and Firearms permits these ethanol plants.

Several wind farms are also planned or are under construction in eastern South Dakota and western Minnesota (at least two of these will have a Federal connection). The wind farms themselves as well as the supporting infrastructure (i.e. access roads, collector systems, substations and transmission lines) would require some habitat alteration which may adversely affect listed species, particularly if these alterations occur in native prairie or along the headwaters of streams that support the Topeka shiner.

The South Dakota Department of Transportation will be conducting routine maintenance, including repairs and re-surfacing on state highways in the vicinity of the proposed action. They will also be building a new bypass on State Highway 20 around Watertown.

Minnesota Department of Highways will also be resurfacing State highways 3, 7, 10, 20, 29, 47, and 75. Five miles of the Prairie Wetlands trail along the Minnesota River and a pedestrian/bike trail in the Minnesota River Headwater Recreation area will be enhanced. Human activity, along with blading, grading, machinery noise and odors may displace wildlife and/or alter habitat in the vicinity of these actions.

References cited

Cochrane, Jean F. and P. Delphey. 2002. Status assessment and conservation guidelines: Dakota skipper (*Hesperia dacotae*). U.S. Fish and Wildlife Service, Twin Cities Field Office. 84p.

Finch, Deborah. 1992. Threatened, endangered, and vulnerable species of terrestrial vertebrates in the Rocky Mountain region. USDA, Forest Service General Technical Report RM-GTR-215, 38pp. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Milodragovich, S. 2006. Biologist with Northwestern Power, Personal communication with John Bridges, Western Area Power Administration.

Sieg, Carolyn and B. Alexander. 2005. Personal communication with D.W. Jones, Barr Engineering.

South Dakota Dept. of Game, Fish and Parks (SDGFP). 2003. Topeka Shiner Management Plan for South Dakota. SDGFP, Pierre, SD.

U.S. Fish and Wildlife Service (USFWS). 1967. Final rule to list the bald eagle as an endangered species. Fed. Reg.32: 4001.

______. 1994. *Platanthera praeclara* (western prairie fringed orchid) recovery plan. Technical/agency draft. USFWS, Ft, Snelling, MN. vi + 81p.

______. 1995. Endangered and Threatened Wildlife and Plants; Final rule to reclassify the bald eagle from endangered to threatened in all of the lower 48 states. Fed. Reg.60:35999-010.

______. 1999. Endangered and Threatened Wildlife and Plants: Proposed Rule To Remove the Bald Eagle in the Lower 48 States From the List of Endangered and Threatened Wildlife. Fed. Reg. 64:36454-464.

______. 1998. Endangered and Threatened Wildlife and Plants; Final rule to list the Topeka Shiner as Endangered. Fed. Reg. 63:69008-021.

______. 2002. Endangered and Threatened Wildlife and Plants; Review of species that are candidates or proposed for listing as endangered or threatened; Annual notice of findings on recycled petitions; annual description of progress on listing actions. Fed. Reg. 67:40657-679.

Western Area Power Administration. 2006. Draft Environmental Impact Statement Big Stone II Power Plant and Transmission Project. May 2006.

Proposed Big Stone II Power Plant
Bald Eagle Mercury Exposure Assessment
Prepared August 2006

The primary fuel source for the proposed Big Stone II generation unit is western subbituminous Powder River Basin (PRB) coal. This coal is a readily combustible black or brownish-black sedimentary rock, which is composed primarily of carbon, along with assorted other elements, including mercuric compounds. The amount of mercury in PRB coal is less than the mercury in coal sourced in other portions of the United States, as displayed in Table 1 (Laumb et al. 2006).

Table 1. Coal Analyses*

Coal Analysis, dry basis	Eastern Appalachian	Western Subbituminous
Hg, ppm	0.126	0.068
Cl, ppm	1064	124
S, %	1.67	0.48
Ash, %	11.65	7.92
Ca, ppm	2700	14,000
Btu/lb, dry	12,900	9300
Moisture, %	2.5	19.4

* Average values based on select group of ICR data.

When coal is used for electricity generation, it is usually pulverized and then burned in a furnace. The furnace heat converts boiler water to steam, which is then used to spin turbines which turn generators and create electricity, with about 35–40% thermodynamic efficiency for the entire process (Bent et al. 2002). Coal remains an enormously important fuel and is the largest single source of electricity world-wide. In the United States, for example, the coal power plants generate 50% of the electricity produced (EIA 2005).

The proposed Big Stone II plant would specifically include a pulverized coal-fired, super-critical boiler using low sulfur, PRB coal. The boiler would provide steam to a single steam turbine generator that would convert mechanical energy of the steam turbine to electrical energy. The super-critical boiler would use a single-reheat system with a condensing steam turbine configured with multiple stages for feed water heaters and a steam condenser. The turbine would drive a hydrogen-cooled electric generator. Both the turbine and generator would be enclosed in a building. A water-cooled steam condenser would accept steam exhausted from the turbine. A circulating water system would supply cooling water from a wet cooling tower to a water-cooled steam condenser to dissipate heat from the condensing steam. Electricity produced by the steam turbine generator would be supplied to a step-up transformer and switching equipment for input to the transmission system.

Pulverized coal (PC) super-critical boiler technology proposed for the proposed Big Stone II plant is a reliable, highly efficient method of energy conversion. The efficiency benefits of super-critical boiler technology results in lower fuel requirements and lower emissions of regulated air pollutants, such as particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and mercury (Hg). Studies also indicate that greater efficiencies for this technology result in substantial reductions in carbon dioxide (CO_2) emissions over the lifetime of plant operations as compared to other coal technologies (Viswanathan et al. 2004).

The bag-house and a Wet Flue Gas Desulfurization (WFGD) system would reduce mercury emissions. Mercury is present in coal in trace amounts. When coal is combusted, mercury is volatilized and is found in small concentrations in the uncontrolled flue gas exiting the boiler. The WFGD system would remove the water soluble oxidized mercury from the exhaust gases by combining it with limestone and collect it as gypsum. The rate of mercury oxidation depends on many factors including temperature, flue gas composition and fly ash composition. A small fraction of the elemental mercury in the flue gas may condense onto the fly ash. Based on data and emission testing of various coal-fired units nationwide for mercury content in coal and for mercury emissions, the U.S. Environmental Protection Agency concluded that using a bag-house followed by a WFGD exhibits greater mercury removal than other conventional emissions control configurations when firing sub-bituminous coal (Eddinger 2005). In addition to these two control methods, the Big Stone II co-owners have agreed to voluntarily commit to a site-wide mercury emissions cap of 189 lbs/year. Even though electrical output from the combined units will increase to 230% of current capacity, mercury emissions from both units will not increase above the amount emitted during 2004. This control measure attempts to avoid an incremental increase in mercury emissions.

Even given this high level of precaution and removal, mercuric compounds may still enter into the environment. The most common forms of mercury emitted from coal fired power plants include: oxidized (or ionic) mercury, which is water-soluble; elemental mercury, which is not very water-soluble; and particulate-bound mercury. Of the total mercury formed, the amount of elemental mercury varies from 10 percent to 90 percent. Almost all of the elemental mercury and most of the oxidized mercury are carried away by wind and enter the global mercury cycle (EEI 2005).

Mercuric compounds in the air may settle into water bodies (primarily oxidized forms) and affect water quality. This airborne mercury can fall to the ground in raindrops, in dust, or simply due to gravity (known as dry deposition). After the mercury falls, it can end up in streams, lakes, or estuaries, where it can be transformed to methylmercury (CH_3Hg^+) through microbial activity. Sulfate-reducing bacteria (SRB) have been identified as the primary biological mechanism for elemental mercury conversion into methylmercury (King et al. 2001). It is the metabolic process (respiration) that is involved with the formation of methylmercury compounds; see Figure 1, below. This means of obtaining chemical energy is not widely consistent across all species of SRB, and can vary from population to population. The presence of specific SRB and their subsequent production of methylmercury can be dependent upon sediment composition, microbial interactions, and macrophyte contributions.

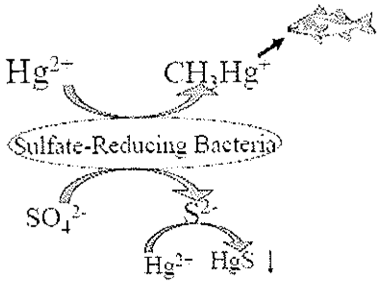

Figure 1. Conversion of elemental mercury into methylmercury for bioavailability.

Mercury deposition in a given area depends on mercury emitted from local, regional, national, and international sources. The amount of methylmercury in fish is a function of a number of factors, including the amount of mercury deposited from the atmosphere, local non-air releases of mercury, naturally occurring mercury in soils, the biogeochemical properties of the aquatic system, presence or abundance of sulfate reducing bacteria, and the age, size and types of food the fish consumes. This explains why different species of fish from the same lake or the same species of fish from different lakes with similar local sources of mercury can have significantly different methylmercury concentrations.

Birds and mammals that eat fish have a higher exposure risk to methylmercury than any other animals in aquatic ecosystems. This increased risk can be attributed to the process of bioaccumulation up the food chain. Mercury and its various species amass in tissues, and remain bonded to protein compounds (generally muscle and liver tissue). The organisms at the upper levels of the food chain are consuming prey items that have already concentrated mercury within their own tissues, increasing the effective dose. Analyses conducted for the Mercury Study Report to Congress suggest that some highly-exposed wildlife species are being harmed by methylmercury (EPA 2006).

Effects of methylmercury exposure on wildlife can include mortality, reduced fertility, slower growth and development, mutations, cancer, or abnormal behavior that affects survival. The effects are dependent upon the level of exposure. In addition, research indicates that the endocrine system of fish, which plays an important role in fish development and reproduction, may be altered by the high levels of methylmercury found in the environment (EPA 2006).

The bald eagle is considered to be at an elevated level of exposure risk as it is a long-lived, upper tropic level piscivore. The members of the population with the greatest risk are the pre-nesting female, developing embryos, and fledging eaglets (Rumbold 2005). As methylmercury has an affinity for muscle and fatty tissue (lipophilic (King et al. 2001)), it accumulates in the bodies of the birds. Mercury has also been shown to accumulate within the feathers. This accumulation does little to hinder the eagle as feathers are routinely lost through molting (Harmata per. comm.). This ability to shed the heavy metal may help to decrease the interstitial build up, reducing the chance of effects to mortality, fertility, development, and behavior.

Since 2003, there has been a nesting pair of bald eagles within a two mile radius of the existing power plant. The eagles have fledged four chicks since establishing the nesting site. It has been observed that the eagles feed from Big Stone Reservoir, located approximately one mile northeast of the power plant site. In order to estimate the exposure risk to the eagles, data regarding the mercury levels in fish taken from the reservoir were analyzed. The mercury data was collected by the Minnesota Department of Health, Environmental Health Division at locations along the lake near Ortonville, Minnesota.

The collection protocols and analysis techniques were completed for a wide array of fish species, ranging from benthic feeders to piscivores. A comparison of these tissue mercury levels to other tissue levels within similar fish species in lakes in other areas of Minnesota indicates that the mercury levels within fish tissues from Big Stone Reservoir are, on average, less than the concentrations in other water bodies. Averaged concentrations based on fish species for both the state and Big Stone Reservoir can be found in Table 2, below.

Table 2. Parts per million concentrations for mercury within sampled species.

Species	Big Stone Reservoir (ppm)	State-Wide Average (ppm)
Bass	0.23633	0.38722
Carp	0.03775	0.11768
Catfish	n/a	0.24901
Northern Pike	0.12333	0.37083
Perch	0.0675	0.15750
Sunfish	0.11300	0.09016
Trout	n/a	0.26619
Walleye	0.16795	0.38722

The risk of exposure to mercury by eagles which may forage in Big Stone Reservoir is lower than the risk that may be encountered elsewhere within the state of Minnesota. The mercury levels from both the existing and proposed plans would be no higher than the 2004 levels from the existing plant. Therefore, there would not be an increase in mercuric compounds that may settle into Big Stone Reservoir. As evidenced by the successful reproduction and fledging of multiple chicks from multiple years, the levels of mercury have not yet impacted the reproductive capabilities of the nesting pair. It is difficult to predict the future fecundity based on many unknown factors, but given the propensity for the eagles to shed mercury through molting, and the lower levels of mercury onsite, it is probable that the pair will not experience an impact from the mercury. Western has determined that the proposed action may affect but is not likely to adversely affect the bald eagle.

References

Bent, R., R. Baker and L. Orr. 2002. Energy: Science, Policy, and the Pursuit of Sustainability, Island Press, Washington, D.C.

Eddinger, J. 2005. Memorandum from J. Eddinger, Combustion Group, OAQPS, EPA to R. Wayland, Group Leader, Combustion Group, OAQPS, EPA dated March 15, 2005. Statistical Analysis of Mercury Test Data to Determine BDT for Mercury Emissions.

Edison Electric Institute (EEI). 2005. Straight answers about electric utilities and mercury. August 2005. http://www.eei.org/industry_issues/environment/air/mercury/straight_answers_mercury.pdf

Energy Information Administration (EIA). 2005. Available online at: http://www.eia.doe.gov/

Environmental Protection Agency (EPA). 2006. Available online at: http://www.epa.gov/mercury/eco.htm

Harmata, A. 2006. Montana State University. Personal Communication with J.M. Bridges. June 2006.

King, J.K., J.B. Gladden, S.M. Harmon, and T.T. Fu. 2001. Mercury removal, methylmercury formation, and sulfate-reducing bacteria profiles in wetland mesocosms containing gypsum-amended sediments and *Scirpus californicus*. U.S. Deparmtent of Commerce, National Technical Information Service. Available on line at: http://sti.srs.gov/fulltext/tr2001063/tr2001063.html

Laumb, J.D., L. Yan, and J.J. Stanislowski. 2006. Large-scale testing of enhanced mercury removal at W.A. Parish Unit 8. Final draft report. Energy and Environmental Research Center at the University of North Dakota. April 2006.

Rumbold, D. 2005. A Probabilistic Risk Assessment of the Effects of Methylmercury on Great Egrets and Bald Eagles Foraging at a Constructed Wetland in South Florida Relative to the Everglades. Human and Ecological Risk Assessment, Volume 11, Number 2, April 2005, pp. 365-388(24).

Viswanathan, R., A. F. Armor, and G. Booras. 2004. A critical look at supercritical power plants. Power Magazine, April 2004.

Western Area Power Administration. 2006. Draft Environmental Impact Statement Big Stone II Power Plant and Transmission Project. May 2006.

MARCH 3, 1849

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
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Pierre, South Dakota 57501-5408

October 9, 2007

Nicholas J. Stas, Environmental Manager
Department of Energy
Western Area Power Administration
Upper Great Plains Region
P.O. Box 35800
Billings, Montana 59107-5800

Re: Biological Assessment and Impacts on Federally Listed Species on the Construction and Operation of the Big Stone II Power Plant, Grant County, South Dakota

Dear Mr. Stas:

This is in response to your correspondence dated August 30, 2007, with the determination that the proposed Big Stone II coal-fired power plant and operations will have no effect on federally listed species. Your correspondence included a cover letter, a Biological Assessment (BA), and an additional analysis of mercury level impacts to the bald eagle, a species which has been recently removed from the endangered species list but remains protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act (MBTA). We note that the proposed new transmission lines associated with this project will be discussed in a separate BA at a later date.

Your BA on the Bigstone II Power Plant includes very specific details regarding the technical operations of the plant; however, we suggest that clearer associations between these operations and anticipated biological and environmental impacts be outlined for the reader. For example, Table 1 of the BA provides data on annual tons of waste generation; however, without any frame of reference, it is not clear to what degree these levels may impact the environment nor whether appropriate efforts have been made to minimize these levels. We recommend implementation of the most effective pollution control measures at the Big Stone II Power Plant using the latest technology to reduce waste as much as possible. It is not apparent that highly protective measures to protect air, land, and water quality have been incorporated into the plans for this plant.

Very little information is provided regarding hazardous waste generation and disposal. As an example, the additional information attached to the BA regarding mercury levels in solid waste - such as fly ash to be disposed of in the onsite landfill - will likely contain mercury. We suggest elaborating on the overall topic of hazardous wastes and relating the issue as directly as possible to biological and environmental concerns.

A new communications tower, 400-450 feet tall, is proposed with little description of its final form. Without additional information, we presume that a tower of this height would be of lattice design, lighted, and supported with guy wires. The primary concern of the U. S. Fish and Wildlife Service (Service) regarding communication towers is the potential threat posed to migratory birds. Collisions with these towers are estimated to kill approximately four to five million birds each year. In order to minimize the hazards posed to birds by establishment of additional communication towers, the Service strongly encourages collocation of equipment on existing towers or other structures such as billboards, water towers, or buildings. This has minimal, if any, impact on migratory birds. If collocation is not at all possible, siting of any new communication towers within the vicinity of existing towers (antennae farm) is recommended, thereby limiting the area of risk.

As you likely know, the Service has formulated guidelines regarding communications towers in a document entitled "Service Guidance on the Siting, Construction, Operation and Decommissioning of Communications Towers." These guidelines include the above mentioned recommendations and others that may apply to your proposed project. These guidelines may be accessed via the Service's web site at: http://www.fws.gov/habitatconservation/communicationtowers.htm.

The BA outlines that groundwater withdrawals for operations of the Big Stone II Power Plant are likely to occur; however, it is not clear whether these withdrawals have the potential to affect surface water within the Whetstone River, which has been classified by the Service as a Type II, High Priority Fisheries Resource. Riverine and riparian areas are among the highest resource priorities in this region of the Service. We recommend that the Western Area Power Administration conduct further analysis of the potential effects of this groundwater extraction and implement measures to avoid, minimize, or (if necessary) mitigate for actions resulting from the Big Stone II Power Plant that might affect this waterway and its fishery status.

The "Cumulative Effects" section of the BA includes general information on other projects in the vicinity of the Big Stone II Power Plan; however, there is no discussion of other coal-fired plants. Pollutants from these plants are known to travel significant distances; thus, we submit that expansion of the area of consideration and inclusion of other similar plants may be appropriate for this analysis.

Regarding the bald eagle, the BA states that no activity will occur within 0.25 miles of the existing bald eagle nest from January through July. However, please note that, if the project area is over 0.25 miles away but within clear view of any bald eagles utilizing the nest (or an alternate nest in the vicinity), the potential exists for abandonment of the site. The 0.25 mile distance may be adequate to preclude disturbance; however, abandonment risk ultimately depends on a variety of factors including the birds' tolerance to the activities, or perhaps the degree of concealment of the nest from construction actions. Heavy equipment moving to and from the site could also disturb the birds if increased disturbances from this traffic would occur within the vicinity of the nest. We encourage you to review the guidelines issued by the Service that are intended to assist the public in precluding take of this species under the BGEPA and the MBTA. The guidelines may be viewed at: http://www.fws.gov/migratorybirds/baldeagle.htm.

Additionally, regarding the bald eagle and mercury concerns, we suggest that more direct links be made between anticipated mercury discharge levels and the potential impacts to bald eagles. For example, per your document, a site-wide mercury emissions cap of 189 pounds per year is proposed for the plant. However, again lacking a frame of reference, it is not clear whether this is effective in precluding adverse impacts to bald eagles or the environment in general. Similarly, "highly-exposed" wildlife species are stated to be harmed by methylmercury, but the level of exposure was not defined nor related to the levels anticipated to be released by the Big Stone II Power Plant. When speaking of mercury levels in tissues of fish species from the Big Stone Reservoir, your document states they are "on average, less than the concentrations in other water bodies [in Minnesota]." However, clarification regarding the threshold at which these levels become significant to wildlife is not provided, nor is data provided to support whether this difference detected in Big Stone Reservoir fish is significant. Also, while data on current levels of mercury in fish are provided, anticipated levels that may accumulate in fish after the Big Stone II Power Plant begins operation are lacking. Realizing that mercury contamination can be highly variable and difficult to ascertain (as explained in your document), we reiterate the need to implement the most effective, efficient, and recent technology available to minimize discharge of this element into the environment.

Please note that a single statement in the mercury assessment portion of your correspondence says "the mercury levels from both the existing and proposed plans would be no higher than the 2004 levels from the existing plant" (page 4). This implies that the Big Stone II addition will discharge zero mercury, which does not appear to correspond with previous discussions of mercury output in the same document.

The Service concurs with your conclusion that the described project will not adversely affect listed species. If changes are made in the project plans or operating criteria, or if additional information becomes available, the Service should be informed so that the above determinations can be reconsidered.

The Service appreciates the opportunity to provide comments. If you have any questions regarding these comments, please contact Natalie Gates of this office at (605) 224-8693, Extension 234.

Sincerely,

Pete Gober
Field Supervisor
South Dakota Field Office

cc: USFWS/ESFO; Bloomington, MN
(Attention: Laurie Fairchild)

DOE/EIS-0377

Final Environmental Impact Statement

Volume III - Appendices

June 2009

Big Stone II Power Plant and Transmission Project

Prepared for:

Lead Agency:
Western Area Power Administration

Cooperating Agency:
U.S. Army Corps of Engineers

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Appendix M1

Groundwater Supply Evaluation, Barr, March 27, 2007

Groundwater Supply Evaluation

Big Stone II Project
Grant County, South Dakota

Prepared for
Otter Tail Power Company

March 27, 2007

Groundwater Supply Evaluation

Big Stone II Project
Grant County, South Dakota

Prepared for
Otter Tail Power Company

March 27, 2007

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Groundwater Supply Evaluation
Big Stone II Project
Grant County, South Dakota

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1.0 Introduction

1.1 Project Scope

This report describes the hydrogeologic evaluation of water-transmitting glacial drift deposits in northeastern Grant County, South Dakota for characterizing their use as a back-up water supply for a proposed 630-megawatt net capability coal-fired electric power generating station named Big Stone II. The proposed Big Stone II plant would be located adjacent to the existing Big Stone plant in Grant County, South Dakota, about eight miles northeast of Milbank and two miles northwest of Big Stone City, South Dakota.

The proposed Big Stone II plant would typically require withdrawal of an additional 7,500 acre-feet per year of fresh water from Big Stone Lake primarily to replace water losses due to evaporation in the power plant cooling system and the wet flue gas desulfurization system. Under extreme drought conditions, withdrawals from Big Stone Lake may be limited to preserve lake levels and plant cooling water may need to be supplemented by groundwater for short periods of time. As part of this hydrogeologic evaluation, a groundwater supply capable of supplying a maximum of 6,200 gallons per minute (gpm) (10,000 acre-feet per year) for a period of one year was assumed to be necessary to meet the cooling demands of the plant under extreme conditions.

This hydrogeologic evaluation consists of the following elements:

1. Installation of pilot borings to obtain continuous cores of unconsolidated deposits at potential sites for future water-supply wells;
2. Installation of test wells and observation wells at selected locations for the purpose of performing aquifer ("pumping") tests;
3. Aquifer testing at selected locations and water quality analysis of aquifer-samples; and
4. Groundwater flow modeling to predict the hydrogeologic effects of pumping of future water-supply wells.

1.2 Study Location

The hydrogeologic evaluation was performed in the area shown on Figure 1. Locations of pilot borings and wells are also shown on Figure 1. The nomenclature for the pilot borings and wells includes the phase number, a hyphen, and the boring/well number. For example, pilot hole 2-3 is the third pilot hole in Phase 2.

1.3 Investigation Schedule

The field investigation, which consisted of pilot borings, well installation, and aquifer testing, was performed in phases. A phased approach was used to make adjustments to the investigation approach as data were collected and evaluated. A work plan for installing five test wells on the Big Stone II Project Site, five monitoring wells, and aquifer testing of the wells was submitted in September 2006. The Western Area Power Administration (Western) and their consultant, R.W. Beck, provided comments and the Work Plan was revised. Western gave approval for drilling in early October 2006. Technical specifications for drilling were developed and bids for drilling were obtained. Boart Longyear Company of Little Falls, Minnesota was hired to drill pilot boreholes, and install the test and monitoring wells.

1.3.1 Phase 1 Pilot Holes

Drilling of the first pilot hole began on November 27, 2006. Pilot holes were drilled at locations 1-1, 1-2, 1-3, 1-4, and 1-5, shown on Figure 1. Based on the subsurface conditions encountered in these pilot holes, locations 1-2 and 1-4 were selected for installation of pumping wells. A 12-inch diameter pumping well was installed at the Well PW1-2 location on January 16 and 17, 2007 using mud rotary drilling method. A second 12-inch diameter pumping well was installed at the Well PW1-4 location on January 29 and 30, 2007. Along with each pumping well, a 2-inch diameter monitoring well was installed, approximately 400 feet from each pumping well for use in monitoring groundwater levels during aquifer testing.

1.3.2 Phase 1 Aquifer Tests

A step-drawdown test was conducted on January 26, 2007 in Well PW1-2 to estimate the approximate maximum sustainable pumping rate. The aquifer test of Well PW1-2 commenced at 9 pm on January 26, 2007, after aquifer recovery. The well was pumped continuously at 550 gallons per minute (gpm) for 82 hours, until the test was ended at 7 am on January 30th.

A step-drawdown test was conducted on February 27, 2007 in Well PW1-4 to estimate the approximate maximum sustainable pumping rate. The aquifer test of Well PW1-4 commenced, at 4:30 pm on February 27, 2007 after aquifer recovery. The well was pumped continuously at rates of 210 to 355 gpm until the test was ended at 4:30 pm on March 2, 2007.

1.3.3 Phase 2 Pilot Holes

A second phase of pilot-hole drilling took place February 6 through 14, 2007 in areas southwest of the Phase 1 pilot-hole locations. The locations of the Phase 2 pilot holes (designate as 2-"number") are shown on Figure 1. These pilot-hole locations were approved by Western on January 25, 2007, as an Interim Action Determination with drilling methods to follow the procedures outlined in the Work Plan for the Phase 1 drilling.

1.3.4 Phase 3 Pilot Holes

A third phase of pilot-hole drilling took place from March 6 through March 14, 2007 in the area encompassed by the Phase 2 pilot holes and in additional areas south of Phase 2 pilot-hole locations. The locations of the Phase 3 pilot holes (designate as "3-"number") are shown on Figure 1. The drilling activity was approved by Western on March 6, 2007, as an Interim Action Determination with drilling to conform with the procedures outlined in the Work Plan for the Phase 1 drilling. The March 6, 2007 letter from Western gave approval of up to 40 additional pilot holes. Pilot-hole drilling was terminated on March 14, 2007 when spring thaw conditions made access to the drilling sites extremely difficult. A fourth phase of drilling is planned for April 2007 to complete the Phase 3 pilot holes that could not be completed prior to spring thaw and to confirm the presence of aquifer material at these locales.

2.0 Regional Hydrogeology

2.1 Previous Studies

Previous studies with relevance to groundwater supply in northeastern Grant County include the following:

- *The Geology of Grant County, South Dakota, SD State Geological Survey, E.P. Rothrock, 1952.* This document details the geology in Grant County. Very little information is given on water in the area.

- *Groundwater Study for the City of Milbank, University of South Dakota, Barari, 1976.* The purpose of this study was to assist the city in locating a future water supply. Two areas are outlined. Some water quality and quantity data is given.

- *Groundwater Investigation for Big Stone City, South Dakota, University of South Dakota, Green and Gilbertson, 1987.* The purpose of this investigation was to identify alternative ground water supply for Big Stone City because of high total dissolved solid concentrations, particularly iron and manganese. Water quality data is given in this report.

- *Water Resources of Codington and Grant Counties, South Dakota, USGS, Hansen, 1990.* This document outlines the quantity and quality of both surface and groundwater in Codington and Grant Counties. Water quality is also is presented in this report.

- *ProGold, LLC water permit application and DENR report, 1995.* Water appropriations permit application for an fructose plant near the Big Stone plant (the fructose plant was not constructed).

- *Investigation of Groundwater Resources in Portions of Roberts County, SD, University of South Dakota, Gilbertson, 1996.* This document outlines both the geology and hydrogeology of Roberts County. Water quality data for the Veblen aquifer is provided.

- *Water Resources of the Lake Traverse Reservation, South and North Dakota, and Roberts County, USGS, Water-Resources Investigation Report 01-4219, Thompson 2001.* Addresses unconsolidated, water-bearing deposits primarily in Roberts County, SD.

- *First Occurrence of Aquifer Materials in Grant County, South Dakota, South Dakota Geological Survey, Aquifer Materials Map 17, Jensen, 2004.* Map of Grant County, showing approximate shallowest aquifer material, based on lithologic logs.

- *First Occurrence of Aquifer Materials in Roberts County, South Dakota, South Dakota Geological Survey, Aquifer Materials Map 22, Tomhave, 2006.* Map of Roberts County, showing approximate shallowest aquifer material, based on lithologic logs.

In addition to these studies, lithologic logs were examined and evaluated. Approximately 1,250 lithologic logs for wells in Roberts, Codington, Deuel, and Grant Counties were obtained from the South Dakota Geological Survey and 520 lithologic logs from the Minnesota County Well Index (CWI) were also included. From each log, the elevation of the top and bottom of the major water-transmitting units (if any) were recorded, along with the approximate saturated thickness (i.e. the total thickness of water-transmitting units). The elevations of the top and bottom of the water-transmitting units were contoured using kriging methods.

2.2 Overview of Regional Geology

The study area is located within the Coteau des Prairies plateau of the Central Lowlands physiographic province. The topography is characterized by rolling moraines, formed by deposition of glacial debris upon a bedrock highland during the Pleistocene. The Minnesota River lowlands is a somewhat flat ground moraine that consists of isolated areas of debris left by retreating glaciers (Thompson, 2001).

The geologic units in the area include, from oldest to youngest, (1) Precambrian-age crystalline bedrock, (2) Cretaceous sedimentary bedrock, and (3) Quaternary-age unconsolidated deposits. The unconsolidated deposits include alluvium, glacial till, glacial outwash deposits, and glacial lake sediments. Precambrian rocks rise to land surface at an elevation of 1,100 feet near Milbank, southwest of the study area but are deeper to the east, into Minnesota (Thompson, 2001).

The Cretaceous sedimentary rocks include sandstone with interbedded layers of shale and siltstone (Dakota Sandstone), interlayered beds of limestone (Niobrara and Greenhorn), and shales (Pierre, Carlile, and Graneros). The Dakota Sandstone directly overlies the Precambrian crystalline rocks. Depending upon the pre-glacial erosional surface, any of these three Cretaceous bedrock units may be the uppermost bedrock unit at a given locale in the study area. The depth to bedrock can vary from a few feet to over 300 feet, or more.

Glacial deposits or drift consist of till, glacio-fluvial, and glacio-lacustrine (lake) sediments were deposited in the area over bedrock. Glacial till is a heterogeneous mixture of clay, silt, sand, gravel, and boulders. Glacio-fluvial sediments include glacial outwash deposits of sand and gravel deposited by flowing glacial meltwaters. Glacial-outwash deposits may be stratified to semi-stratified, and consist of poorly sorted fine sand to coarse gravel. Glacio-lacustrine sediments are composed of layered deposits of clay, silt, and sand transported into Pleistocene lakes by glacial meltwaters. Alluvium may be found along recent flood plains or lake beds, and generally consists of semi-stratified deposits of silt, sand, and gravel (Thompson, 2001).

2.3 Unconsolidated Aquifers

An aquifer is a water-transmitting geologic unit capable of yielding usable quantities of water to awell. An unconsolidated aquifer refers to Pleistocene or younger water-transmitting units, mostly made up of sand and/or gravel. Unconsolidated aquifers typically were formed by glacial meltwaters or by recent fluvial activity (in the case of alluvial aquifers). Because of the complex nature of glacio-fluvial deposition, the lateral continuity and interconnectedness of unconsolidated aquifers in a setting such as the vicinity of the Big Stone II project is difficult to delineate precisely using existing lithologic information. It is for this reason that a site-specific boring program was undertaken as part of this evaluation.

Aquifers are typically given informal names. In Grant County, the aquifers named in Hansen (1990) are: the Big Sioux aquifer; the Antelope Valley aquifer; the Prairie Coteau aquifer; the Veblen aquifer; the Lonesome Lake aquifer; the Revillo aquifer; the Granite Wash aquifer; and the Altamont aquifer. Thompson (2001) identifies seven named aquifers in Roberts and northwestern Grant Counties: the Coteau Lakes aquifer system; the Big Sioux aquifer; the Altamont aquifer; the Revillo aquifer; the James aquifer; the Veblen aquifer system; and the Spiritwood aquifer. Thompson (2001) also describes "outwash" units, differentiating them from named aquifers by their qualitatively less defined aerial extent. These outwash units are: the Prairie Coteau outwash unit; the Lonesome Lake outwash unit; the Marday outwash unit; the Eden outwash unit; the Roslyn outwash unit, and the Wilmot outwash unit. The Wilmot outwash unit is closest to the Big Stone II project area.

The above-described unconsolidated aquifers and outwash units were considered in the planning process for the field investigation as part of this study as a guide to beginning the investigation. However, the "naming" of unconsolidated units is not particularly relevant to whether or not usable quantities of groundwater can be obtained from a particular local – this can only be confirmed by site-specific investigation. Contradictions in how various investigators have interpreted and named particular units can distract from the objective of this study, which is to identify a groundwater supply and to estimate the effects of withdrawals for the project.

For example, the Wilmot Outwash, as described in Thompson (2001), may be part of the Veblen Aquifer in Grant County, as described by Hanson (1990). The apparent contradiction seems to be a matter of different nomenclature used by Thompson (2001) for unconsolidated, water-transmitting materials in Roberts County, SD and the southeast corner of North Dakota, compared to the nomenclature used by Hanson (1990). The evaluation of Thompson (2001) did not include the area of the Big Stone II project or areas south of the project, whereas Hanson (1990) focused on these areas. Thompson (2001, p. 26) discusses the contradicting nomenclature:

> *The glacial history of the study area has led to a rather complex system of glacial aquifers. On the Coteau, especially, an uneven bedrock surface coupled with as many as seven sand and gravel layers in a single test hole can make aquifer delineation difficult. Additionally, localized ground-water investigations done in adjacent counties, and even specific locales within the study area, have given names to aquifers that may not match the naming convention assigned to the same aquifer in another study.* And.... *In some aquifers, the thickness of aquifer material at a specific test hole may not be the same as given in a previous report. This is either due to additional data and subsequent reinterpretation of cross sections, or not including adjacent outwash lenses as part of the aquifer.*

Thompson (2001, p. 33) specifically addresses the differences in the nomenclature of the Veblen aquifer in his report and in Hansen (1990):

> *Hansen (1990) proposed that the Veblen aquifer extended from northeast Marshall County across Roberts County and into Codington and Grant Counties. However, drilling and water-level data collected for this study indicate that it is not one continuous aquifer. Therefore, the Veblen aquifer mapped by Hansen in Codington and Grant Counties is not the same as the Veblen aquifer mapped by Koch in Marshall County. The Veblen aquifer mapped by Hansen does extend into southeast Roberts County, but it generally is very thin and may be discontinuous between test holes where it is found. For this reason, it is mapped as outwash deposits in this report.*

On page 56 of Thompson (2001), he notes that "the Wilmot outwash group may be what Hansen (1990) mapped as the Veblen aquifer. Test holes penetrating the Wilmot outwash had thicknesses ranging from 2 to 54 feet at depths from 2 to 78 feet below land surface." It is important to reiterate that the Thompson (2001) study does not evaluate conditions in eastern Grant County.

The subsurface investigations conducted for this evaluation have generally found sand and gravel deposits at two intervals in the pilot holes for the Big Stone II groundwater evaluation. The shallower sand and gravel is generally less than about 50 feet in depth. In many borings, deeper sand and gravel is found with thicknesses ranging from about 40 to 170 feet and depths ranging from about 80 to 250 feet below ground surface. Due to the complex glacio-fluvial depositional environment, some interconnection between the two sand units is likely in places. We hypothesize that the shallow sand is likely the equivalent of Thompson's Wilmont outwash and the deeper sand is the equivalent of Hansen's Veblen aquifer.

Jensen (2004) interprets that there is a shallow (less than 50 feet deep) alluvial aquifer approximately 0.5 miles wide that parallels the Whetstone River and that this alluvium consists of clay and silt with minor amounts of sand and gravel. Deeper water-transmitting units (generally greater than 100 feet below the ground surface) are also present in the vicinity of the proposed Big Stone II plant site (Jensen, 2004).

The Veblen aquifer of Hansen (1990) consists of unconsolidated coarse sand and gravel and likely underlies the portions of the proposed plant site. This water-transmitting unit has an approximate thickness of 150 feet near Milbank, South Dakota, southwest of the proposed project area, but thins to the north and east, with a thickness of 20 to 30 feet at the Grant County and Minnesota boundary (Hansen, 1990). It is likely that a thinner section of this unit underlies the remainder of the proposed project area. Hydraulic head in Hansen's Veblen aquifer indicate confined conditions. Municipal wells for Milbank and domestic and stock water wells are supplied by this aquifer. Recharge to the this unit is by direct infiltration and percolation of precipitation where the aquifer is at the land surface, and possibly by leakage through the till (Hansen, 1990). Water in the aquifer is of mixed chemistry, with calcium and sulfate predominating, but with significant concentrations of magnesium and bicarbonate. Total dissolved solids (TDS) concentrations average 1,300 milligrams per liter (mg/l).

Additional groundwater resources in the vicinity of the proposed Big Stone II plant site are the Milbank granite wash aquifer and the Dakota Sandstone (Hansen, 1990; Jensen, 2004). The granite wash aquifer is described by Hansen (1990) as consisting of uncemented coarse sand, derived from the weathering of the Milbank granite. The extent and water supply capability of this aquifer are relatively unknown; some stock watering and domestic wells use this unit. The thickness of this aquifer at the proposed plant site is approximately 40 feet. Depth to the granite wash aquifer varies widely. Water quality is dominated by sodium and sulfate.

The Cretaceous Dakota Sandstone is a regional aquifer that underlies much of South Dakota, western North Dakota, and Nebraska. It's easternmost extent is in the vicinity the proposed Big Stone II plant site. The Dakota Sandstone in this area generally consists of fine-grained sandstone and interbedded shale. Younger Cretaceous rocks that overlying the Dakota Sandstone are the Pierre Shale and Carlile Shale. The Dakota Sandstone is expected to have relatively poor water quality in this area, which makes it less attractive as a water supply.

2.4 Groundwater Use

All drinking water supplies in Grant County come from groundwater a portion of which is provided by a rural water system. According to Hansen (1990), the major withdrawals of groundwater come from gravel mining operations. The Big Sioux aquifer (in the western part of Grant County) is the major groundwater supply. The City of Milbank uses groundwater, presumably from the Granite Wash aquifer. In the vicinity of the proposed Big Stone II project, irrigation water is obtained from wells near the Whetstone River. Some of these wells are reported to have production rates of over 1,000 gpm with minimal drawdown in the pumping well.

Unconsolidated glacial aquifers vary in thickness and hydraulic conductivity (permeability). The greatest yields (wells with yields greater than 800 gallons per minute) are in the Big Sioux aquifer, the Antelope aquifer, and Prairie Coteau aquifer (Hansen, 1990). These higher yields have been attributed, in part, to the aquifers' good hydraulic connection with lakes and rivers, which provide rapid recharge.

3.0 Field Investigations

Field investigations as part of this hydrogeologic evaluation included: pilot borings to obtain core samples of unconsolidated deposits; installation of pumping wells and observation wells at two pilot-boring locations; and aquifer (pumping) tests in the two pumping wells. This section describes the methodologies and findings of the field investigations.

3.1 Site Access

Drilling activities were performed in accordance with a Work Plan developed by Barr Engineering Company in September 2006. The Western Area Power Administration (Western) and their consultant, R.W. Beck, provided comments and the Work Plan was revised. Western approved the field investigation procedures as described in the Work Plan with the following stipulations:

- No trees or shrubs shall be removed.
- All access shall be by rubber-tired vehicles.
- All access shall be accomplished when the ground is dry and firm (this was later modified to include frozen ground).
- Access shall be on existing roads or trails to the extent possible. Where there are no existing routes, access shall be along fence lines and field borders wherever possible. Access across grassland and pastureland shall be minimized.
- Access routes shall avoid all wetlands and streams. Drainages shall be avoided to the extent possible, except for existing access roads and where the drainage is under active cultivation. All incurred damage to drainages shall be repaired.
- The discovery of any Federally-protected species, including carcasses, requires that all work in the vicinity be stopped and the discovery shall be reported immediately to Western who will contact the Service.
- Drilling activities and site access shall be conducted so as to minimize any erosion. Drill cuttings from the boreholes shall be spread out in the vicinity of each well.

- Pumping must comply with the requirements of the temporary water appropriation permit issued by the State of South Dakota and the temporary water discharge permit.

- The drilling contractor shall develop and implement a hazardous materials safety protocol. All temporary storage of fuel, oil, hydraulic fluid, and other lubricants, fuels, oils and chemicals shall be positioned to prevent accidental spills from entering wetlands, streams or drainages.

- The contractor shall have hazardous materials spill clean-up and storage materials available at each activity location, and promptly clean up all spills. Personnel shall be trained in spill response and the use of the materials on hand.

- Prior to the completion of the hydrogeologic investigations, OTP shall reclaim disturbed ares to pre-drilling conditions in sonsultation with landowners. (Added at time of subsequent approval)

- Upon completion of the drilling activities, OTP shall provide Western with a report on the location of drilling sites and test results. (Added at time of subsequent approval)

All invasive activities included an archeological/cultural assessment by an archeologist. Access permission for all drilling locations were obtained from the land owners by Otter Tail Power Company. Technical specifications for drilling were developed and bids for drilling were obtained.

3.2 Pilot Holes

3.2.1 Methodology

Pilot holes were drilled at the locations shown on Figure 1. Pilot holes were drilled using Rotosonic methods, which provide a continuous core of unconsolidated materials and rock (where encountered). Drilling was performed by Boart Longyear of Little Falls, Minnesota. Drill core were logged on-site by a Barr Engineering Co. geologist. The drilling logs for each pilot hole are in Appendix A of this report. Each hole was advanced until it was determined by the on-site geologist that unconsolidated water-transmitting materials (namely sands and/or gravels) were unlikely to be encountered at deeper depths. Upon completion of each pilot hole, the borehole was filled with grout using a tremie pipe from the bottom of the hole to the ground surface. Cuttings and core were thin spread around the boring location.

3.2.2 Summary of Findings on Subsurface Conditions

Logs of pilot holes are in Appendix A. A total of 19 pilot holes were drilled, as of March 14, 2007. Table 1 summarizes the pilot holes' ground surface elevations, total depths, and depths at which relatively continuous water-transmitting zones (primarily sand, gravel and sandy silt) were encountered.

The shallowest pilot hole was PH3-9 (95 feet) and the deepest pilot hole was PH2-1 (260 feet). Pilot holes were advanced either into granitic or shaley bedrock or into a thick sequence of clay. Termination of each pilot hole was at the judgment of the on-site geologist.

Three of the 19 pilot holes (PH-2-2, PH2-4a, and PH2-4b) did not encounter any continuous sand and gravel layers greater than about 5 feet thick. Seven of the 19 pilot holes (PH1-4, PH1-5, PH-2-2, PH-2-7, PH3-1, PH3-3, AND PH3-9) encountered two zones of continuous sand and gravel. Samples from zones of relatively thick, continuous sand and/or gravel were retained for future grain-size analyses to design well screen in the event that a particular pilot hole will be over-drilled to install a production or test well.

Geologic cross sections were developed for the unconsolidated deposits in the study area using the pilot-hole logs and lithologic logs of wells obtained from the South Dakota Geological Survey website (http://www.sddenr.net/lithdb/). The location of the cross sections are shown on Figure 2. Cross-section A-A' and cross-section B-B' are on Figures 3 and 4, respectively.

3.3 Pumping and Observation Well Installation

3.3.1 Pumping Wells PW1-2 and PW1-4

Twelve-inch diameter wells were installed using mud-rotary drilling methods at the same locations as pilot holes PH1-2 and PH1-4. These pumping wells are designated as PW1-2 and PW1-4 and their locations are shown on Figure 1. Well construction logs for these wells are in Appendix B. The purpose of these wells was to perform aquifer (pumping) tests to evaluate the transmissivity and well yield. Samples were also collected and analyzed to assess water quality.. These wells were designed to be turned into production wells as part of a back-up water supply for the proposed Big Stone II project.

Well PW1-2 was installed on January 16 and 17, 2007. Well cuttings were contained within a portable steel mud recirculation container and were thin-spread around the well upon completion of well installation. Development was by jetting and pumping until well discharge appeared clear and free of sediment. The total depth of Well PW1-2 is 178 feet. The well consists of steel casing down to 143 feet below ground surface. A #40 slot wire-wound stainless steel screen, 35-feet in length, extends from 143 feet to 178 feet. The borehole annulus around the screen is filled with American Materials filter pack, sized for the #40-slot screen. Above the screen, the borehole annulus is filled with neat cement grout to ground surface.

Well PW1-4 was installed on January 29 and 30, 2007. Drilling procedures and equipment were identical to those used to install Well PW1-2. The well consists of steel casing down to 140 feet below ground surface. A #40 slot wire-wound stainless steel screen, 45-feet in length, extends from 140 feet to 185 feet. A tight-wind screen section was installed between 158 to 172 feet, where a clayey zone was encountered in drilling. The borehole annulus around the screen is filled with American Materials filter pack, sized for the #40-slot screen. Above the screen, the borehole annulus is filled with neat cement grout to ground surface. The total depth of PW1-4 is 185 feet below ground surface.

3.3.2 Observation Wells MW1-2 and MW1-4

Two-inch diameter observation wells were installed using mud-rotary drilling methods 400 feet from each of the two pumping wells for the purpose of collecting water-level data during aquifer tests. These wells are designated MW1-2 (located 400 feet south of PW1-2) and MW1-4 (located 400 feet south from PW1-4). Each well is constructed of 2-inch nominal diameter schedule 40, flush-threaded PVC riser/casing with 10-foot long, #10-slot PVC well screens. The borehole annuli around the screens is filled with a filter pack and the remainder of the borehole annuli to the ground surface is cement grout. Each observation well is fitted with a protective steel casing, equipped with a locking cap. Observation well MW1-2 is 180 feet deep and observation well MW1-4 is 185 feet deep. Construction logs for these two wells are in Appendix B.

3.4 Aquifer Testing

Separate aquifer tests (a.k.a. "pumping tests") were performed on wells PW1-2 and PW1-4 for the purpose of estimating aquifer parameters and well yield. Water levels in observations wells MW1-2 and MW1-4 were monitored, along with the water levels in the pumping wells, during the tests.

Both aquifer tests involve controlled pumping of one well close to the maximum sustainable rate and monitoring how groundwater levels in the pumping well and in the nearby observation well (located approximately 400 feet from the pumping well) change in response to the pumping. Conventional analytical methods are used to estimate two key aquifer parameters: storativity and transmissivity. These parameters are used in the groundwater flow model.

The maximum sustainable rate is estimated by a step-drawdown test prior to the controlled pumping test. The step-drawdown test systematically changes the pumping rate (typically from lower rates to higher rates) while monitoring water levels in the pumped well. Rates are increased until the water level in the pumping no longer reaches an equilibrium condition. The step-drawdown test is performed primarily because it is desirable to pump water at near maximum rates during the controlled pumping test in order to produce the highest degrees of drawdown.

Water levels in wells were monitored during the tests using a combination of *In Situ* Troll pressure transducer/data loggers and *Solonist* electronic measuring devices (for manual readings). The data loggers were set to read on a logarithmic scale during the early portion of the test (in order to collect water-level data during the period of the test when water levels change quickly) and arithmetically (at approximately 5-minute intervals) during the later portions of the test. The pressure transducers automatically adjust for changes in barometric pressure.

Groundwater samples were collected at approximately six-hour periods from the discharge end of the pump during the pumping phase of the aquifer test and analyzed for temperature, dissolved oxygen, pH and specific conductance. Daily, during the pumping phase of the aquifer test, groundwater samples were collected and submitted to a laboratory to be analyzed for analytes listed in Table 2. These analyses are for use in identifying water-treatment requirements for plant use. Results of the analyses are shown in Appendix B.

A totalizing flow meter was fitted to the discharge line of the pump to record pumping rates during the test period. The discharge line consisted of 100-feet of 6-inch nominal diameter, flexible hose connected to PVC pipe. At PW1-2, the total discharge length was 1,000 feet, with the effluent directed to a 5-foot diameter, 6-inch thick gravel pad to prevent erosion and drop the discharge velocities. From the gravel pad, the discharge flowed over a natural drainage in a farm field to a ditch along a County road. At PW1-4, the discharge was piped directly to the Big Stone plant cooling pond, located about 800 feet from the pumping well.

3.4.1 Aquifer Test of Well PW1-2

Well development of pumping well PW1-2 was completed on January 23, 2007. Well development is performed to remove residual drilling muds and assist in the development of gradational grain sizes in the filter pack, adjacent to the well screen, in order to minimize the infiltration of sand into the well (which can damage pumps) while maximizing the hydraulic connection between the well and the surrounding aquifer. Well development included a combination of jetting and "over-pumping".

A step-drawdown test was performed in well PW1-2 on January 26, 2007. A 1,000-gpm pump was temporarily installed in well PW1-2. Pumping rates for the step-drawdown test were selected based on: (1) conversations with the drillers from Boart Longyear who conducted the well development; (2) characteristics of the aquifer sand as measured in the core samples; and (3) past experience with similar wells. The well was pumped at stepped rates of 150 gpm, 300 gpm, 450 gpm, 550 gpm, 650 gpm, and 790 gpm for 30 to 45 minutes at each rate. Water levels at the end of the step-drawdown test reached 90 feet below casing, 14 feet lower than at the start of the test. The aquifer was then allowed to recover by turning the pump off for approximately 4.5 hours. Over that time, the aquifer recovered to a depth of 77 feet below casing, 0.65 feet lower than at the start of the test.

The pumping test commenced at 9 pm on January 26, 2007, after the well was allowed to recover. A pumping rate of 550 gpm was used. This rate was chosen based on the drawdown observed during the step-drawdown test. The objective was to use the highest sustainable pumping rate over the duration of the planned pumping period. A pumping rate that is too low may not "stress" the aquifer sufficiently, resulting in low measurable drawdowns in the observation well. Conversely, a pumping rate that is too high may draw the water level below the pump intake line, thereby ending the test prematurely and complicating the data analysis

The well was pumped continuously at 550 gpm for 82 hours, until the test was ended at 7 am on January 30, 2007. At that time the water level in the pumping well had dropped to a level of 83.95 feet below the top of the casing. The water level in the 2-inch diameter observation well MW1-2, located 400 feet to the south and screened at approximately at the same depth as the pumping well, was monitored continuously during the course of the test using a pressure transducer and automated data logger. Water levels in the observation well dropped from 83.25 feet below riser to 91.4 feet below riser (a total maximum draw down of 8 feet).

Observation well water-level data are generally preferred over pumping well water-level data in analyzing aquifer tests. This is because turbulence, cavitation, and small-scale pumping rate fluctuations in the pumping well result in short-term temporal fluctuations in water levels in pumping wells. Water levels in pumping wells are also subjected to "well losses" that are the result of less than 100% well efficiency (no well is 100% efficient). Observation well water-level data are generally not affected by these conditions.

Water-level data are collected to calculate drawdown and recovery. Drawdown is the change in water levels with respect to the pre-pumping, steady-state water level. Recovery is similar to drawdown but refers to the relative water level with respect to pre-pumping conditions after the pump is turned off. Drawdown and recovery are used in the analytic solutions to estimate aquifer parameters. Drawdown data for observation well MW1-2 are shown on Figure 5.

The observation-well data from MW1-2 were analyzed using the aquifer analysis program AQTESOLV (Hydrosolve, Inc., 2000). Attempts were made to match the drawdown data using the Theis solution for confined aquifers but only the early-time data could be satisfactorily matched. A good match, using the Theis solution (Theis, 1935), was obtained by including an image well and the method of superposition to simulate the effects of a nearby impermeable barrier, such as a thick clay sequence of low transmissivity. Logs for existing wells located about a mile to the north and northeast of site 1-2 were found to have encountered clay from land surface to bedrock, supporting the supposition that a relatively impermeable boundary is close to Well PW1-2. Image wells with pumping rates equal to Well PW1-2 were oriented from west-northwest to east-southeast at distances varying from 1,500 to 5,000 feet from the pumping well. A barrier located about 3,000 feet north of the site was found to best explain the high late-time drawdown at monitoring well MW1-2. The plot of the curve match, using the Theis equation and an image well, are shown on Figure 6.

The resulting solution yielded an estimated transmissivity of 1,200 m^2/day (96,600 gpd/ft) and a storativity value of 0.00047, which is indicative of a confined aquifer. The saturated thickness at Well PW1-2 is estimated to be 81 feet, based on the drilling information. Therefore, the estimated average hydraulic conductivity for this portion of the aquifer unit is 157 feet/day. This value of hydraulic conductivity is characteristic of gravelly sand – which is the type of material encountered in the boring for Well PW1-2. Therefore, in the absence of a nearby low-permeability barrier, the sustained yield from this well would be much higher – the low-permeability barrier reduces the overall ability of this well to produce at high rates.

The shape of the drawdown curve for monitoring well MW1-2 did not show any indication of leakage effects or the effects of a hydraulic barrier, such as a stream, lake or river. The results from this pumping test indicate that in this area, the aquifer unit is not in good hydraulic connection with the nearby Whetstone River. The thick layer of clay that overlies the aquifer unit likely acts as an aquiclude or very low permeability aquitard.

3.4.2 Aquifer Test of Well PW1-4

Well development of pumping well PW1-4 was completed on February 26, 2007. Well development is performed to remove residual drilling muds and assist in the development of gradational grain sizes in the filter pack, adjacent to the well screen, in order to minimize the infiltration of sand into the well (which can damage pumps) while maximizing the hydraulic connection between the well and the surrounding aquifer. Well development included a combination of jetting and "over-pumping".

A step-drawdown test was performed in well PW1-4 on February 27, 2007. A 1,000-gpm pump was temporarily installed in well PW1-4. Pumping rates for the step-drawdown test were selected based on: (1) conversations with the drillers from Boart Longyear who conducted the well development; (2) characteristics of the aquifer sand as measured in the core samples; and (3) past experience with similar wells. The well was pumped at stepped rates of 80 gpm, 110 gpm, 140 gpm, 200 gpm, 250 gpm, 300 gpm, 350 gpm, and 550 gpm for 15 to 45 minutes at each rate. Water levels at the end of the step-drawdown test reached 140 feet below casing, 18.7 feet lower than at the start of the test. The aquifer was then allowed to recover by turning the pump off for approximately 3.3 hours. Over that time, the aquifer recovered to a depth of 122.7 feet below casing, 1.6 feet lower than at the start of the test.

The pumping test commenced at 4:30 pm on February 27, 2007, after the well was allowed to recover. A pumping rate of 355 gpm was used. This rate was chosen based on the drawdown observed during the step-drawdown test. The objective was to use the highest sustainable pumping rate over the duration of the planned pumping period. A pumping rate that is too low may not "stress" the aquifer sufficiently, resulting in low measurable drawdowns in the observation well. Conversely, a pumping rate that is too high may draw the water level below the pump intake line, thereby ending the test prematurely and complicating the data analysis

The well was pumped continuously at 355 gpm for 5.5 hours. The pumping rate was reduced to 310 gpm at 10:02 pm on February 27, 2007 as drawdown in the well began to increase. The well was pumped at 310 gpm for 13 hours and the rate was dropped again to 210 gpm, where it remained for the remainder of the test until the test was ended at 4:30 pm on March 2, 2007. At that time the water level in the pumping well had dropped to a level of 14.67 feet below pre-pumping static water levels. The water level in the 2-inch diameter observation well MW1-4, located 400 feet to the south and screened at approximately at the same depth as the pumping well, was monitored continuously during the course of the test using a pressure transducer and automated data logger. Water levels in the observation well dropped from 115.7 feet below riser to 121.0 feet below riser (a total maximum draw down of 5.3 feet).

The data logger used to record the drawdown data in the monitoring well was found to have water in it and was sent to the manufacturer (In Situ Inc.) for data retrieval. Fortunately, these data were backed-up by roughly hourly manual measurements.. Manual drawdown and data for observation well MW1-4 are shown on Figure 7.

The observation-well data from MW1-4 were analyzed using the aquifer analysis program AQTESOLV (Hydrosolve, Inc., 2000). Variable pumping rates were accounted for in the analysis, which used the Theis solution (Theis, 1935). A good curve match to the data was achieved using the Theis solution, which indicates negligible leakage was induced from overlying deposits, even though the Big Stone cooling pond was located less than 800 feet from the pumping well. The plot of the curve match, using the Theis equation and an image well, are shown on Figure 8.

The resulting solution yielded an estimated transmissivity of 1,2e m^2/day (9,874 gpd/ft) and a storativity value of 0.0147, which is indicative of a confined aquifer. The saturated thickness at Well PW1-2 is estimated to be 64 feet, based on the drilling information. Therefore, the estimated average hydraulic conductivity for this portion of the aquifer unit is 21 feet/day. This value of hydraulic conductivity is characteristic of fine to medium sand – which is the type of material encountered in the boring for Well PW1-2. The transmissivity of the aquifer materials at PW1-4 is about 10-times less than the transmissivity at PW1-2. This appears to be due to the finer-grained deposits at PW1-4 and the smaller saturated thickness.

4.0 Groundwater Flow Modeling

A numerical groundwater flow model was developed for the aquifer system in northeastern Grant County for the purpose of predicting the effects of pumping a groundwater supply for the proposed Big Stone II plant for a period of one year. The primary focus of the model is to predict drawdown, which can be used to evaluate the effects of pumping on existing groundwater users (i.e. wells) and surface waters.

4.1 Code Selection

The U.S. Geological Survey's code MODFLOW was used for the groundwater flow modeling (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996). MODFLOW was selected for the following reasons:

- MODFLOW is widely used, extensively benchmarked, and widely accepted by scientific and regulatory entities;
- MODFLOW is capable of simulating non-uniform, unsteady flow in multi-aquifer systems and can simulate the interactions between surface water and groundwater in several ways; and
- MODFLOW is amenable to both regional groundwater flow simulations and detailed simulation of local areas through the method of telescoping mesh refinement (TMR).

The graphical user interface GMS Version 6.0 was used to prepare input files and evaluate results for groundwater flow.

4.2 Conceptual Hydrogeologic Model

The conceptual hydrogeologic model describes the hydrostratigraphic units that are included in the numerical model, the primary mechanisms for water to get into and out of the units (i.e. sources and sinks), and the general direction of flow of groundwater as it moves from sources to sinks. The conceptual hydrogeologic model also defines the problem that the numerical model is being designed to address. Different conceptual models may be required for different types of problems in the same area and the same groundwater flow system.

The conceptual model is shown on a schematic cross section on Figure 9. The aquifer system is defined in this evaluation as water-transmitting sands and gravels of glacial origin within a discontinuous matrix of low-permeability glacial tills. Some of these sand and gravel units have been named by others as aquifers or outwash. In general, there is shallow, discontinuous sand and gravel that is made up of outwash and/or alluvium and deeper, discontinuous sand and gravel that generally overlies bedrock (or is separated from the bedrock by till). Continuity of flow is dependent upon the interconnectedness of the sand and gravel units. There likely is flow in the till units, as well, but the quantity and rate of groundwater flow in the till units is much smaller than in the sand and gravel.

Recharge to the sand and gravel units is primarily by infiltrating precipitation where these units crop out or where there is a relatively thin cover of till. Much lesser amounts of recharge originate as vertical leakage of infiltrated precipitation through thicker till units.

Groundwater generally flows from west to east, discharging into the Minnesota River and Big Stone Lake. The Minnesota River is the major locale of regional discharge for the entire groundwater system. Wells pumping in the sand and gravel units are secondary discharge locales. Portions of the Whetstone River, where the stream is gaining, are secondary discharge locales.

This conceptual hydrogeologic model is a regional generalization that was developed in consideration of the problem at hand: namely, to predict (to the extent that data and information will allow) the hydraulic response of the aquifer system to pumping by a series of wells that serve as a back up water supply for the proposed Big Stone II project.

4.3 Model Domain and Discretization

The domain of the groundwater model covers an area approximately 40 miles across from east to west and about 30 miles across from north to south, as shown on Figure 10. The model is bordered on the east by Big Stone Lake and the Minnesota River; and on the west by the Prairie Coteau. The model domain extends approximately 10 miles north and 20 miles south of the Big Stone Plant site. The model domain was selected to accommodate the region's natural hydrologic boundaries to the extent feasible.

The model's discretization scheme was chosen in order to maximize the amount of numerical detail the model could simulate while also minimizing the time needed to run and calibrate the model. To meet both of these criteria, a varying grid discretization was used, with cells 250 m close to pumping well sites, and cells up to 2,500 m at the outermost boundaries of the model. This level of discretization was deemed satisfactory because particle tracking is not anticipated (avoiding weak sink problems) and the pumping rates that the model is intended to simulate are relatively high.

The model contains one layer to represent the deeper sand and gravel units (the Veblen aquifer of Hansen, 1990). The bottom of the model is delineated by extensive clay or bedrock. The top of the model is clayey till, where present.

4.4 Boundary Conditions

Big Stone Lake and similar lakes on the Minnesota River were assumed to act as constant head boundaries, which may act as either sources or sinks, depending on nearby groundwater levels. Big Stone Lake and the Minnesota River represent the primary mechanism for removing water from the aquifer system, through natural discharge of groundwater flow from west to east. The Whetstone River and Yellow Bank Rivers were simulated with the River Package, which accounts for the interaction between aquifer and surface-water feature, based on the relative water elevation and a conductance value to simulate the bottom sediments of the surface water.

Recharge from infiltrating rainfall is the primary mechanism for adding water to the aquifer system. There are no site specific data for recharge. Recharge was therefore conservatively estimated at 1 inch/year. It is likely that recharge rates are greater than 1 inch/year – in Minnesota, recharge values of 4 to 8 inches/year are commonly used for regional groundwater modeling. Conservatively estimating recharge is important because recharge limits the extent of the cone of depression that develops when a well is pumping.

4.5 Model Parameters

4.5.1 Aquifer Thickness and Elevation

To determine the thickness and depth of the modeled aquifer system, relevant U.S. Geological Survey reports were reviewed. It was concluded that the Veblen aquifer of Hansen (1990) is not as well-defined as suggested by Hansen (1990) and that a detailed review of the region's well logs would be useful. Approximately 1,500 well logs in Roberts, Grant, and Deuel Counties in South Dakota (from the South Dakota Geological Survey Well Database) and Lac qui Parle County in Minnesota (from the Minnesota County Well Index) were reviewed. Aquifer thickness and depth were recorded from each well log where available. Based on these known data, aquifer thicknesses and depths were interpolated throughout the entire model domain. The elevation of the top of the aquifer system was found to range from 275 to 602 meters elevation; the aquifer thickness ranges from 0 m thick (at places where the bedrock surfaces or a sand/gravel unit does not exist) to 272 m thick (along the margin of the Prairie Coteau, where there exist thick alluvial deposits). Information from the pilot holes drilled and logged in this evaluation where included in the interpolation.

The data were geostatistically interpolated over the model domain to define the top and bottom elevations of the aquifer unit in the model. The saturated thickness within the model is defined automatically as the difference between these two surfaces. Maps of the interpolated top elevations and the saturated thickness are shown on Figures 11 and 12, respectively

4.5.2 Hydraulic conductivity

Hydraulic conductivity was estimated from drawdown data at Monitoring Well MW1-2 measured during the pumping test. As previously discussed the data were fit to a Theis type-drawdown curve, which illustrates idealized drawdown in a perfectly confined aquifer. Assuming an aquifer thickness of 81 feet, a hydraulic conductivity of 157 ft/day (or 48 m/day) was calculated. This value was applied over the entire model domain. Though this is an oversimplification of actual conditions, the high variation in aquifer thickness makes it undesirable to use a high variation in hydraulic conductivity.

4.6 Model Calibration

The groundwater flow model was first run at a steady-state condition, in order to calculate the unstressed groundwater levels without the proposed wells pumping. The resulting simulated groundwater levels were compared to water levels reported for wells in the area as a check to ensure that water levels were approximately the same. An exhaustive calibration to existing head conditions was not performed for this study - what is of interest is the relative change (lowering) of groundwater levels in response to pumping of all of the wells.

The steady-state solution was used as the starting heads for a transient solution of one year duration with the wells pumping at constant rates (described in the next section).

4.7 Model Simulation of Well Fields

The groundwater flow model was used to predict drawdown (i.e. changes in the hydraulic head of the aquifer system) during one year of pumping of proposed wells. The drawdown is relative to the steady-state condition, previously described.

The following assumptions were used in assigning well locations and pumping rates in the simulation:

- The total withdrawal rate for all wells combined equaled 6,200 gpm. Pumping is distributed among the proposed wells uniformly, except for locations PW1-2 and PW1-4, where pumping test information provided data to further limit maximum sustainable rates. In addition, pumping rates were redistributed during preliminary simulation runs if at a particular well location drawdown was deemed to be to high to be sustainable – in these cases, pumping rates of these wells were reduced and pumping rates of other wells were increased.

- Pumping takes place for 365 days, beginning from a non-pumping condition.
- Wells are located only where pilot holes have been drilled and deeper unconsolidated, water-transmitting deposits were encountered or where future pilot borings are planned. Only approximately half of the future pilot borings are assumed to be at locations where water-transmitting sands and gravels are of sufficient thickness to warrant a well.

Transient simulations used a single stress period of 365 days and 100 time steps, with time-step increments increasing in length over the stress period (the largest time step is the last – 24 days). Internal convergence and numerical water-balance requirements were met within each time step. The model simulated the resulting drawdown at the end of each time step; however only selected time-step results are reported herein for purposes of brevity.

4.8 Results of Model Simulations

Two transient simulations of one-year in length were performed, each representing a slightly different set of pumping wells. Two different configurations were used because the results of the Phase 4 pilot borings are not yet available (these will be completed in April 2006). For the simulations, it was assumed that some of these Phase 4 pilot boring locations would be found to not be suitable for production wells.

The first configuration assumes seven wells will be capable of producing the requisite 6,200 gpm. The second configuration assumes that 14 wells will be needed to produce 6,200 gpm. These two configurations represent the minimum and maximum number of wells – the actual number of wells will likely be some number between 7 and 14. Additional field investigations should be able to verify this range and identify the actual number of wells.

4.8.1 Well Configuration 1

Well configuration 1 consists of seven well locations and pumping at the following rates:

Well Location	Pumping Rate (gpm)
1-2	300
1-4	150
2-1	1,353
2-6	1,353
3-1	1,353
3-5	1,353
3-9	1,353
Total	6,200

The seven well locations represent places where wells have been installed and tested (i.e. PW1-2 and PW1-4) or where geologic conditions encountered in the pilot holes showed favorable conditions. Locations in this scenario do not include planned pilot-hole locations that will be drilled in April 2006. While it is yet to be verified that locations 2-1, 2-6, 3-1, 3-9, and 3-5 are capable of yielding 1,313 gpm, the coarse-grained texture of the sands and gravel and their saturated thickness suggest that these locations would have high transmissivity. Within this area, an existing irrigation well has been shown to yield over 1,000 gpm with about 1-4 feet of total drawdown in the well – the performance of this well suggests that yields will be relatively high.

The model's prediction of drawdown (in feet) at 3 months, 6, months, and 1 year are shown on Figures 13 through 15. The maximum drawdown is approximately 40 feet after one year of pumping (in the vicinity of PH2-6 and PH3-9). Within the well field area, the typical maximum drawdown is predicted to be 20 to 30 feet. The 5-foot drawdown extent is predicted to be approximately 3 miles from the center of the well field.

4.8.2 Well Configuration 2

Well configuration 2 consists of seven well locations and pumping at the following rates:

Well Location	Pumping Rate (gpm)
1-2	300
1-4	150
2-1	300
2-6	495
3-1	495

3-5	495
3-7	495
3-9	495
4-1	495
4-3	495
4-5	495
4-7	495
4-9	495
4-11	495
Total	6,200

The 14 well locations represent places where wells have been installed and tested (i.e. PW1-2 and PW1-4), where geologic conditions encountered in the pilot holes showed favorable conditions (PH-2-6, PH-3-1, PH-3-5, PH-3-7, and PH3-9) and six locations that will be drilled in April 2007. This configuration represents a maximum-expected number of well and assumes no one well will produce sustainable yields greater than about 500 gpm.

The model's prediction of drawdown (in feet) at 3 months, 6, months, and 1 year are shown on Figures 16 through 18. The overall drawdown is very similar to Configuration 1 (this is likely because the total withdrawal rates are the same). The maximum drawdown is less (about 35 feet in the immediate vicinity of PH4-1). Most of the well field area is predicted to have drawdowns of between 15 and 25 feet. The 5-foot drawdown extent is predicted to be approximately 4 miles from the center of the well field.

5.0 Summary and Conclusions

5.1 Summary of Hydrogeologic Evaluation

A hydrogeologic evaluation of water-transmitting glacial drift deposits in northeastern Grant County, South Dakota was performed in order to characterizing their use as a back-up water supply for a proposed 630-megawatt net capability coal-fired electric power generating station named Big Stone II. The proposed Big Stone II plant would be located adjacent to the existing Big Stone plant in Grant County, South Dakota, about eight miles northeast of Milbank and two miles northwest of Big Stone City, South Dakota. As part of this hydrogeologic evaluation, a groundwater supply capable of supplying a maximum of 6,200 gallons per minute (gpm) (10,000 acre-feet per year) for a period of one year was assumed to be necessary to meet the cooling demands of the plant under extreme conditions.

This hydrogeologic evaluation consists of the following elements:

1. Installation of pilot holes (borings) to obtain continuous cores of unconsolidated deposits at potential sites for future water-supply wells;
2. Installation of test wells and observation wells at selected locations for the purpose of performing aquifer ("pumping") tests;
3. Aquifer testing at selected locations and water quality analysis of aquifer samples; and
4. Groundwater flow modeling to predict the hydrogeologic effects of pumping of future water-supply wells.

The field investigation was performed in three phases, with a fourth phase to be completed in April 2007. A phased approach was used to make adjustments to the investigation approach as data were collected and evaluated. The field activities were performed in accordance with a work plan for that was approved by the Western Area Power Administration (Western) and their consultant, R.W. Beck, in October 2006. Technical specifications for drilling were developed and bids for drilling were obtained. Boart Longyear Company of Little Falls, Minnesota was hired to drill pilot boreholes, and install the test and monitoring wells.

Two 12-inch diameter pumping wells and two 2-inch diameter monitoring wells were installed to perform aquifer tests at two locations. The tests provided data to estimate transmissivity, hydraulic conductivity, and storativity.

The pilot-hole data, the well installations, and the aquifer tests results were incorporated with existing data from well logs and regional groundwater studies to develop a numerical groundwater flow model using the code MODFLOW. Aquifer geometry (elevation and thickness) were geostatistically interpolated from over 1,000 lithologic logs, including logs of the pilot holes drilled in this study. The model was approximately calibrated to steady-state conditions and then used to predict the effects of pumping of the back-up groundwater supply for the proposed Big Stone II project.

5.2 Conclusions

The results of this hydrogeologic investigation indicate the following:

1. There are generally two sand and gravel units in the glacial deposits that overlie bedrock in the vicinity of the proposed Big Stone II project. They are typically separated by about 10 to 50 feet of glacial till. In some locations, they may be connected.

2. The sand and gravel units are not continuous throughout the study area and their thickness is variable. This lack of continuity reflects the complex glacio-fluvial environment in which they were deposited. More recent alluvium is likely also part of the shallow sand and gravel. However, the general occurrence of sand and gravel does appear to agree reasonably well with other regional studies for the area.

3. Aquifer testing at two sites indicates that the deeper sand and gravel unit is confined and does not display characteristics indicative of leakage through overlying till deposits. These results suggest that the overlying till is an effective confining layer and that there is not a good hydraulic connection between the deeper sand and gravel and surface waters (lakes, rivers, ponds, etc.).

4. Aquifer hydraulic conductivity values (i.e. permeability) of the sand and gravel evaluated in the study area is in the range of 21 feet/day (PW1-2 – a fine to medium sand) to 157 feet/day (PW1-2, a sand and gravel). These value corresponds to the types of material encountered in the pilot holes and the type of material described in many of the logs for wells in the area. Storativity values agree with well logs for the area the unit is confined.

5. Even though the transmissivity of the aquifer can be relatively high (e.g., 96,600 gpd/ft at Well PW1-2), sustained pumping (i.e. pumping for a period of 1 year) from Well PW1-2 is likely limited to the 150-250 gpm range, although yields of 550-650 gpm would be realized for periods of pumping of 1 to 2 weeks. The sand and gravel deposits are likely in discontinuous lenses and stringer, bounded by clay till that can function as an impermeable boundary that limits sustained yields.

6. The groundwater flow model that was developed for this evaluation includes the variable thickness and continuity of the sand and gravel to the level allowable by both the newly collected data and pre-existing data. This model was used to simulate two well configurations with withdrawal rates equal to 6,200 gpm for a period of one year – one configuration with 7 wells and one configuration with 14 wells.

7. The maximum drawdown is predicted to be between 35 feet (14 well configuration) and 40 feet (7 well configuration) below existing static water level at the end of one year of pumping. Within the well-field area, the drawdown is predicted to be approximately 15 to 35 feet. The 5-foot drawdown is predicted to extend 3 miles (7 well configuration) to 4 miles (14 well configurations) from the approximate center of the well field.

8. The aquifer system is confined and recovery of groundwater levels will be approximately the inverse of pumping – i.e. water-levels will rebound quickly and then slowly approach pre-pumping conditions after approximately a year.

In summary, the field investigations and the groundwater-flow modeling indicate that the aquifer system should be capable of yielding 6,200 gpm for at least 1 year of pumping without significant regional drawdown. The connect of the aquifer to the surface (and therefore, to streams, such as the Whetstone River) was found to be negligible. The total number of wells required to produce 6,200 gpm will likely be in the range of 7 to 14.

6.0 References Cited

Barari, A., 1976. Groundwater study for the City of Milbank, University of South Dakota, Open File Report No. 9-UR, 4p.

Gilberston, J.P, 1996. Investigation of groundwater resources in portions of Roberts County, SD, University of South Dakota, Open File Report 81-UR, 28 p.

Green, S. and J.P. Gilbertson, 1977. Groundwater investigation for Big Stone City, South Dakota, University of South Dakota, Open File Report No. 43-UR, 96 p.

Hansen, D.S., 1990. Water resources of Codington and Grant Counties, South Dakota, USGS Water-Resources Inv. Report 89-41-47, 47 p.

Harbaugh, A.W., and McDonald, M.G., 1996. User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Hydrosolve, Inc., 2000. AQTESOLV for Windows, User's Guide.

Jensen, A.R., 2004 First Occurrence of Aquifer Materials in Grant County, South Dakota, South Dakota Geological Survey, Aquifer Materials Map 17.

ProGold, LLC, 1995. Water permit application and DENR report, 1995.

Rothrock, R.P, 1952. The geology of Grant County, South Dakota, SD State Geol. Survey, Report of Invest. 20, 47 p.

McDonald, M.G., and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Groundwater Flow Model, U.S. Geological Survey Techniques of Water Resource Investigations, TWRI 6-A1, 575 p.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, American Geophysical Union Transactions, Vol. 16, p. 519 524.

Thompson, R.F., 2001. Water resources of the Lake Traverse Reservation, South and North Dakota, and Roberts County, USGS, Water-Resources Investigation Report 01-4219, 110 p.

Tomhave, D.W., 2006. First Occurrence of Aquifer Materials in Roberts County, South Dakota, South Dakota Geological Survey, Aquifer Materials Map 22.

Table 1

Summary of Continuous Sand and Gravel Layers in Pilot Borings

Pilot Boring	Approximate Ground Surface Elevation (ft, MSL)	Total Depth (ft)	Depth (ft) to top of first continuous sand/gravel	Depth (ft) to bottom of first continuous sand/gravel	Depth (ft) to top of second continuous sand/gravel	Depth (ft) to bottom of second continuous sand/gravel
PH1-1	1122	215	152	181	NA	NA
PH1-2*	1079	196	81	196	NA	NA
PH1-3	1089	198	96	104	NA	NA
PH1-4*	1102	200	67	75	121	185
PH1-5	1112	208	85	94	145	184
PH2-1	1102	260	85	95	104	254
PH2-2	1067	185	NA	NA	NA	NA
PH2-4a	1085	175	NA	NA	NA	NA
PH2-4b	1053	140	NA	NA	NA	NA
PH-2-5	1064	130	35	99	NA	NA
PH2-6	1106	155	5	151	NA	NA
PH2-7	1129	155	20	43	78	84
PH3-1	1064	115	7	37	61	98
PH3-2	1047	173	11	20	35	40
PH3-3	1050	182	7	20	NA	NA
PH3-4	1122	210	15	57	NA	NA
PH3-5	1102	225	15	202	NA	NA
PH3-8	1073	153	0	40	NA	NA
PH3-9	1079	95	4	19	53	82

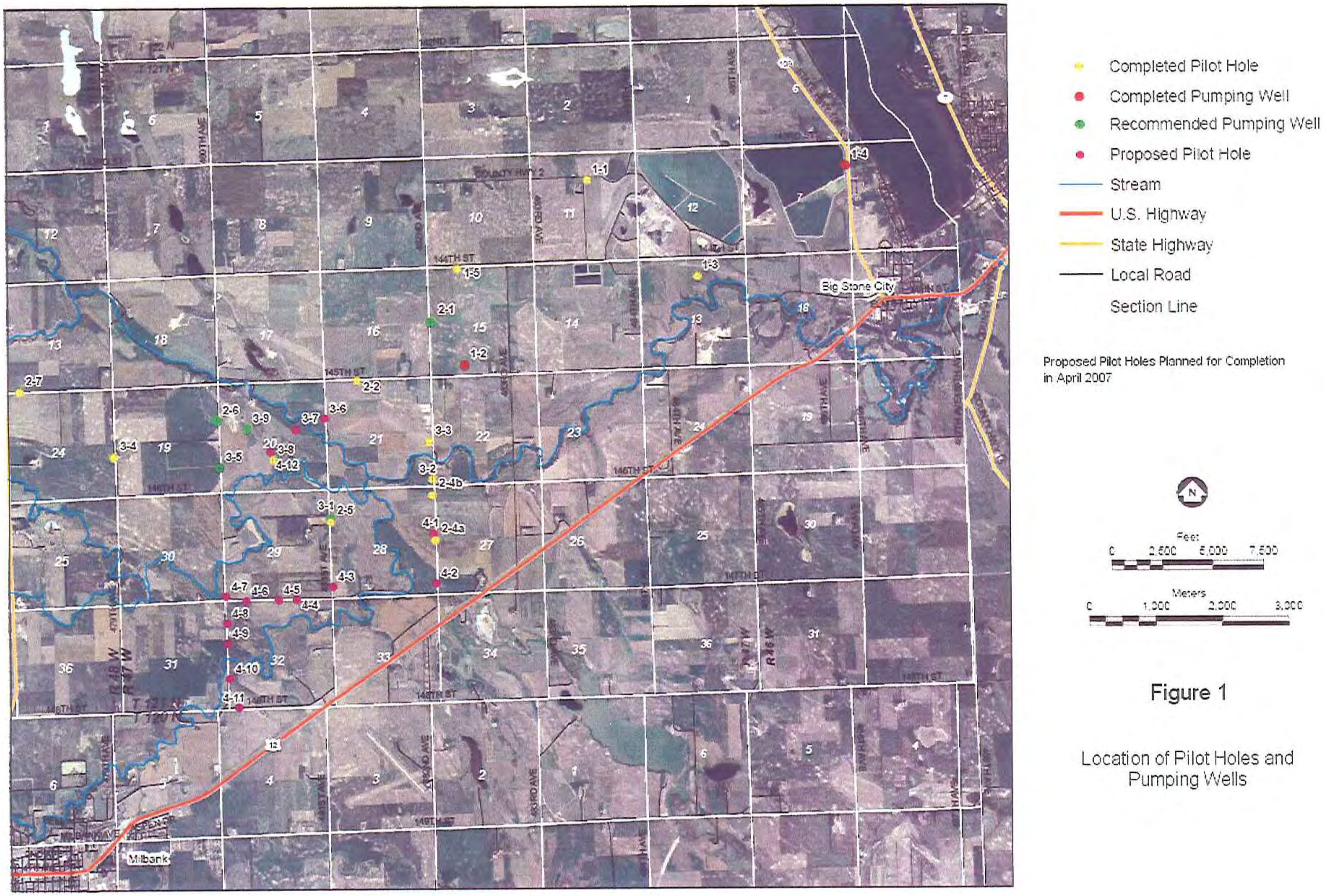
PH1-2 and PH1-4 were completed as pumping wells PW1-2 and PW1-4, respectively

NA: not applicable – zone not present

Table 2

Analytical Parameters – Groundwater

Alkalinity
Aluminum (dissolved)
Aluminum (pH 6.5-9.0)
Arsenic
Arsenic (III) (dissolved)
Barium
Beryllium (dissolved)
BOD_5
Boron
Boron (dissolved)
Cadmium
Cadmium (dissolved)
Calcium
Chloride
Chromium
Chromium (Hex) (dissolved)
Chromium (III) (dissolved)
Cobalt
Cobalt (dissolved)
COD
Color
Copper
Copper (dissolved)
Cyanide
DOC (Dissolved Organic Carbon)
Fecal Coliforms
Fine Sediments
Fluoride
Hardness, Non-Carbonate
Hardness, Total
Iron
Iron (dissolved)
Lead
Lead (dissolved)
Lithium
Lithium (dissolved)
Magnesium
Manganese
Manganese (dissolved)
Mercury
Mercury (II) (dissolved)
Molybdenum
Molybdenum (dissolved)
N, (dissolved)
NH_4 (dissolved)
Nickel (dissolved)
NO_3, (dissolved)
Ortho-Phosphate
P, (dissolved)
pH
Phosphate
Phosphorus, Total
PO4, (dissolved)
Potassium
Potassium (dissolved)
Selenium
Selenium (dissolved)
Silica, Colloidal
Silica, Reactive
Silica, Total
Silicon
Silt Density Index
Silver
Silver (dissolved)
Sodium
Sodium (dissolved)
Strep
Strontium
Strontium (dissolved)
Sulfate
TDS - Evaporation
TDS - Sum of ions
TKN, (dissolved)
TKN, Total
TOC
TSS
Turbidity
Vanadium
Vanadium (dissolved)
Zinc
Zinc (dissolved)



Proposed Pilot Holes Planned for Completion in April 2007

Figure 1

Location of Pilot Holes and Pumping Wells

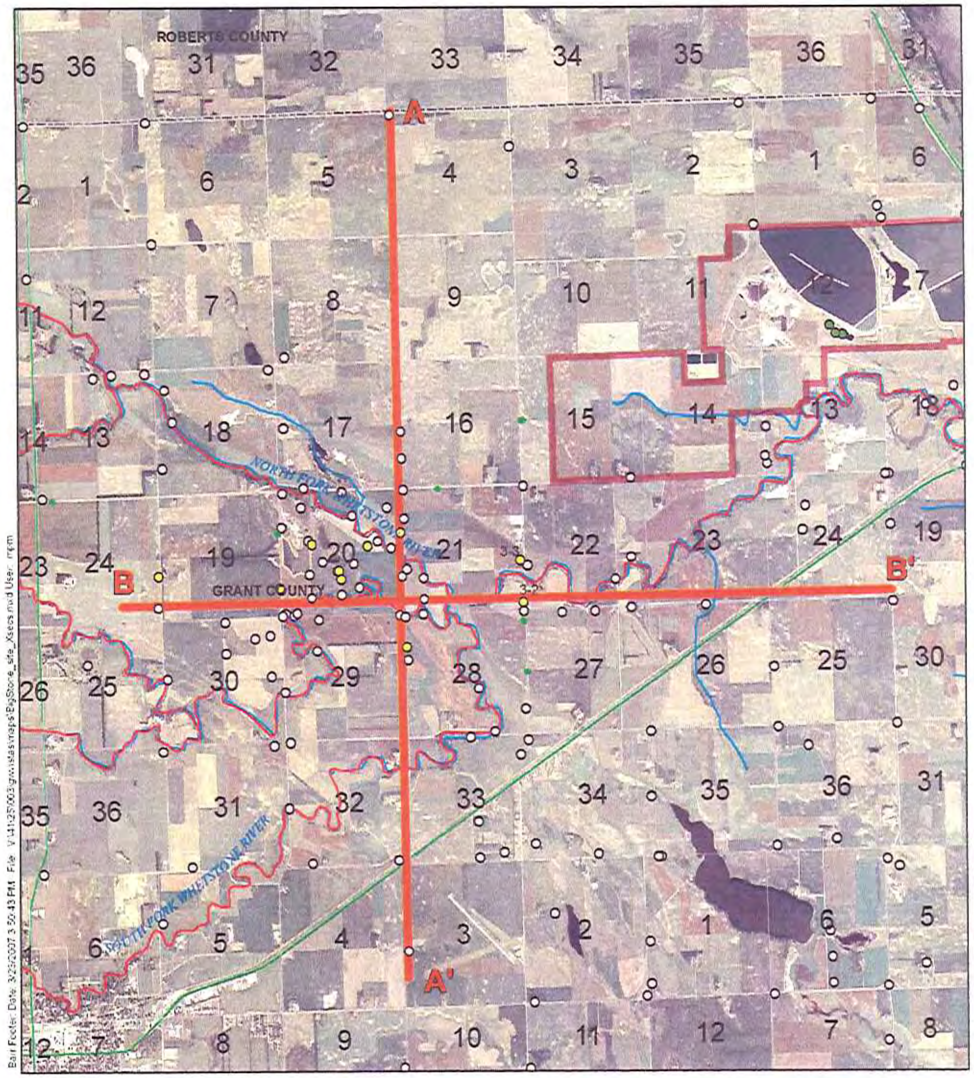


Figure 2

Locations of Cross-Sections
A-A' and B-B'

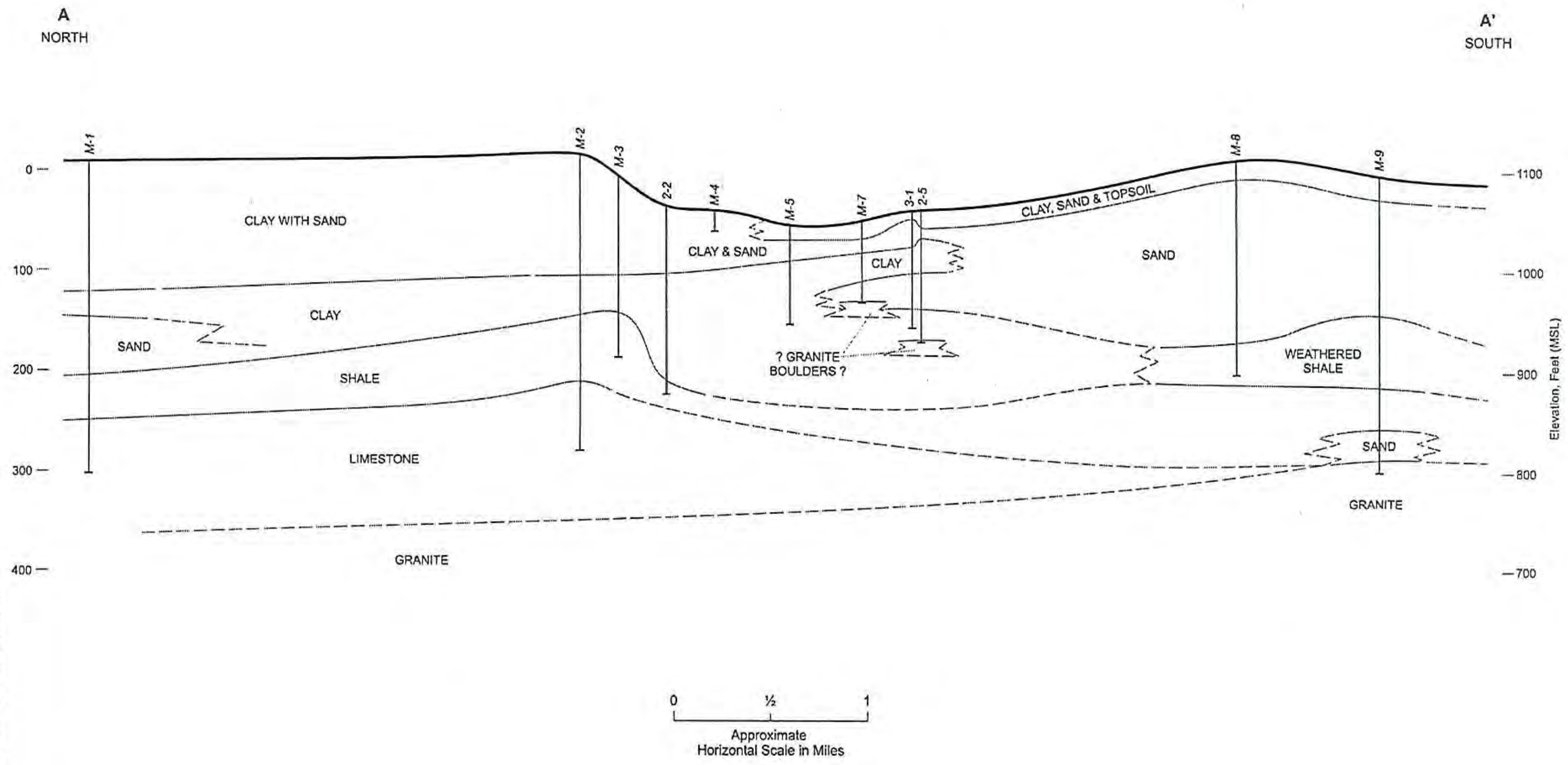


Figure 3

CROSS SECTION A-A'

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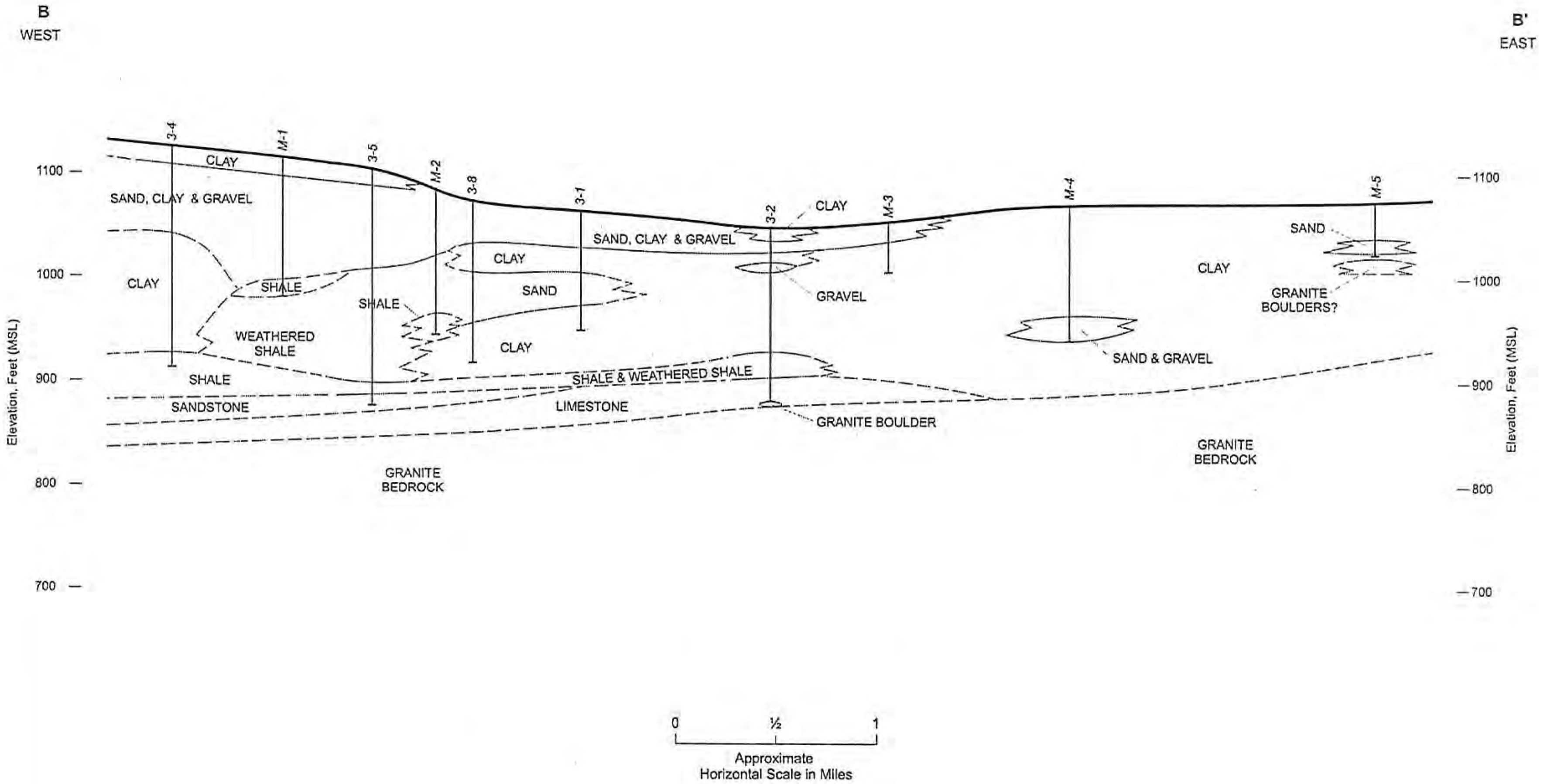

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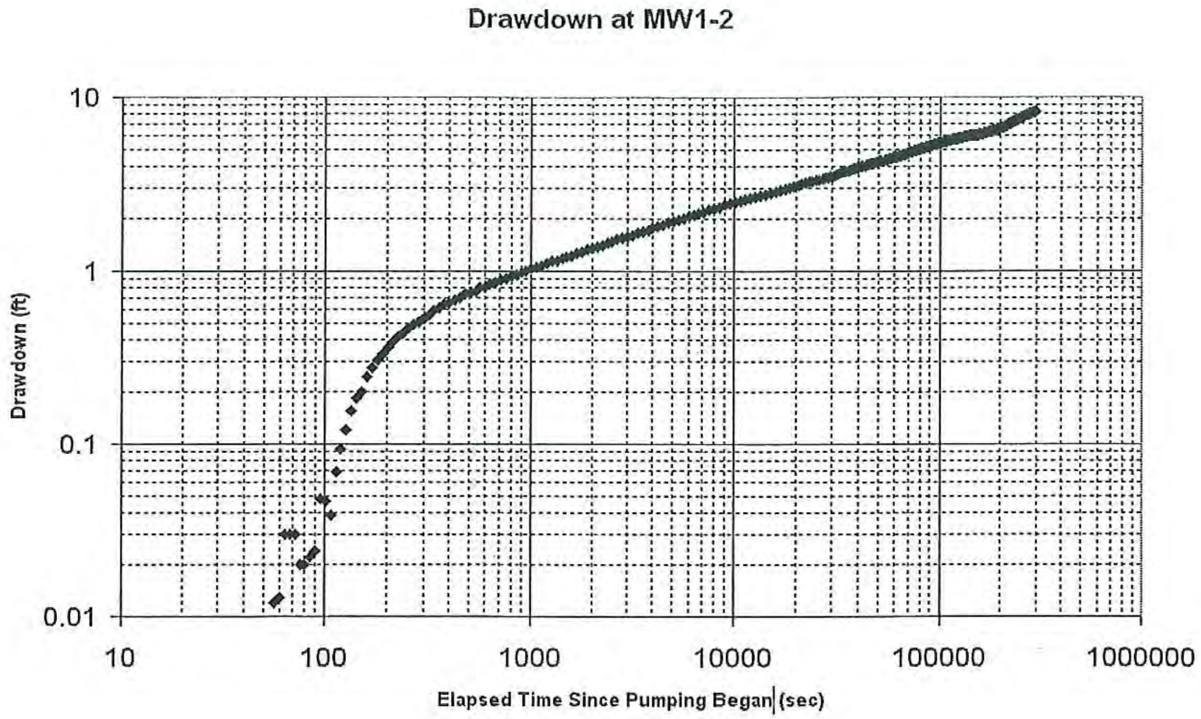
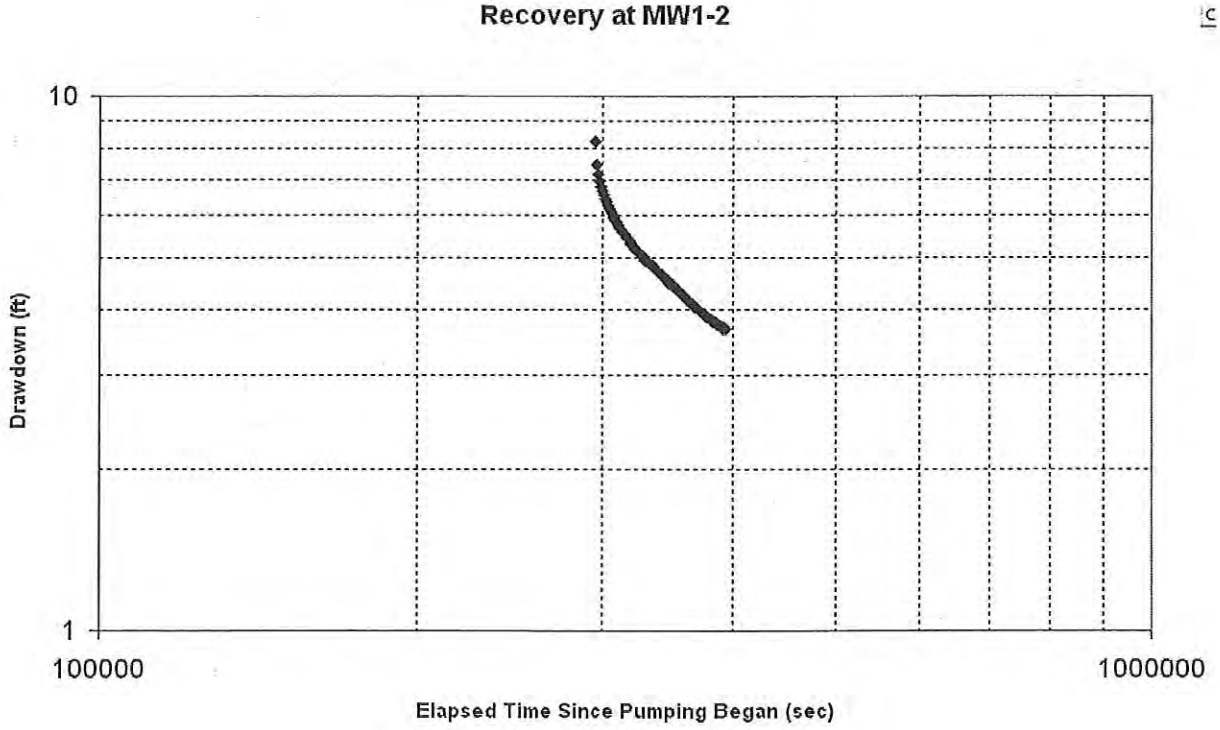
Figure 4

CROSS SECTION B-B"



Drawdown at MW1-2



Recovery at MW1-2

Figure 5

Drawdown and Recovery Plots for Observation Well MW1-2

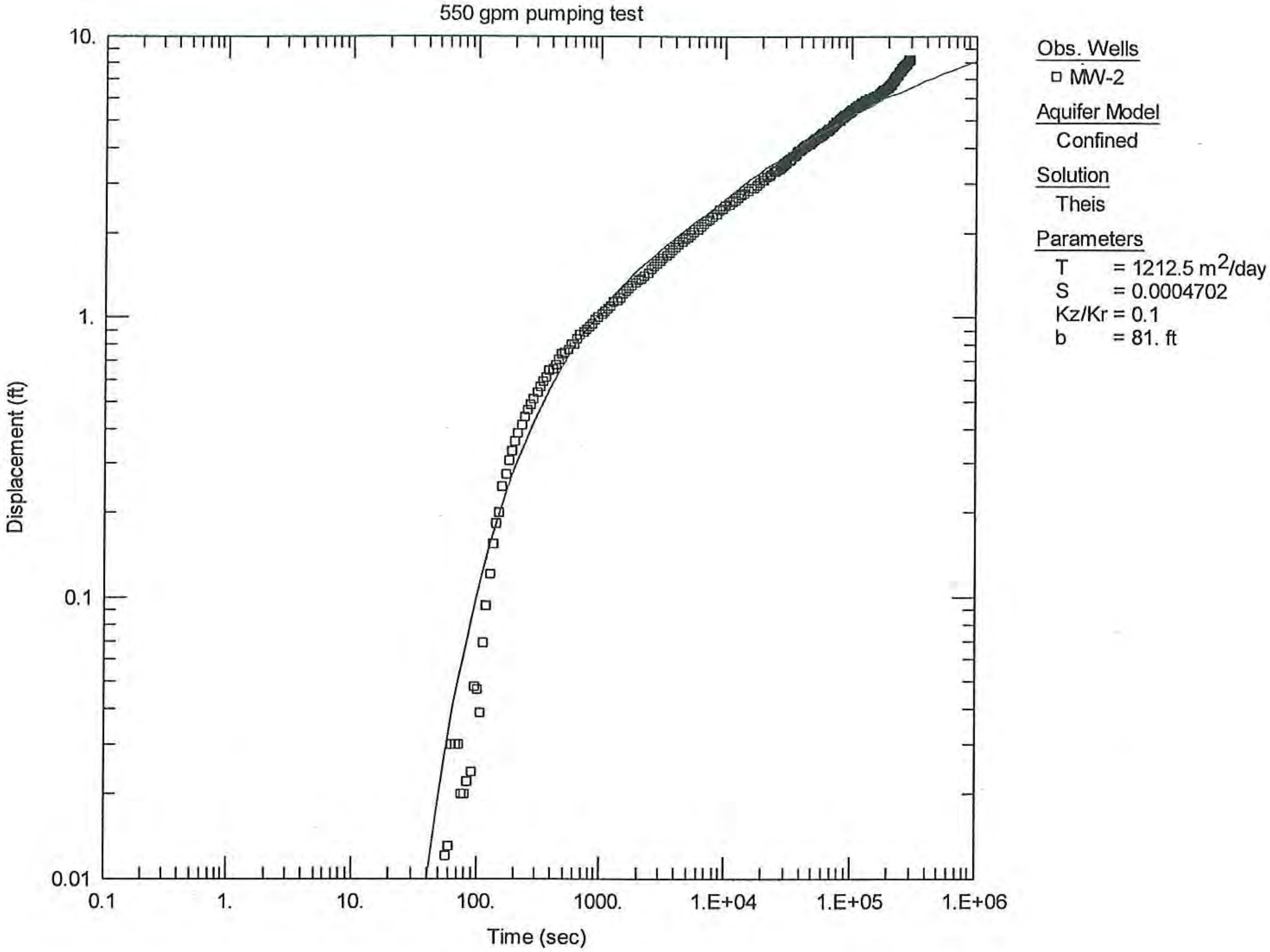


Figure 6

Curve-Match Plot of Drawdown Data from Observation Well MW1-2, With Resulting Aquifer Parameter Estimates

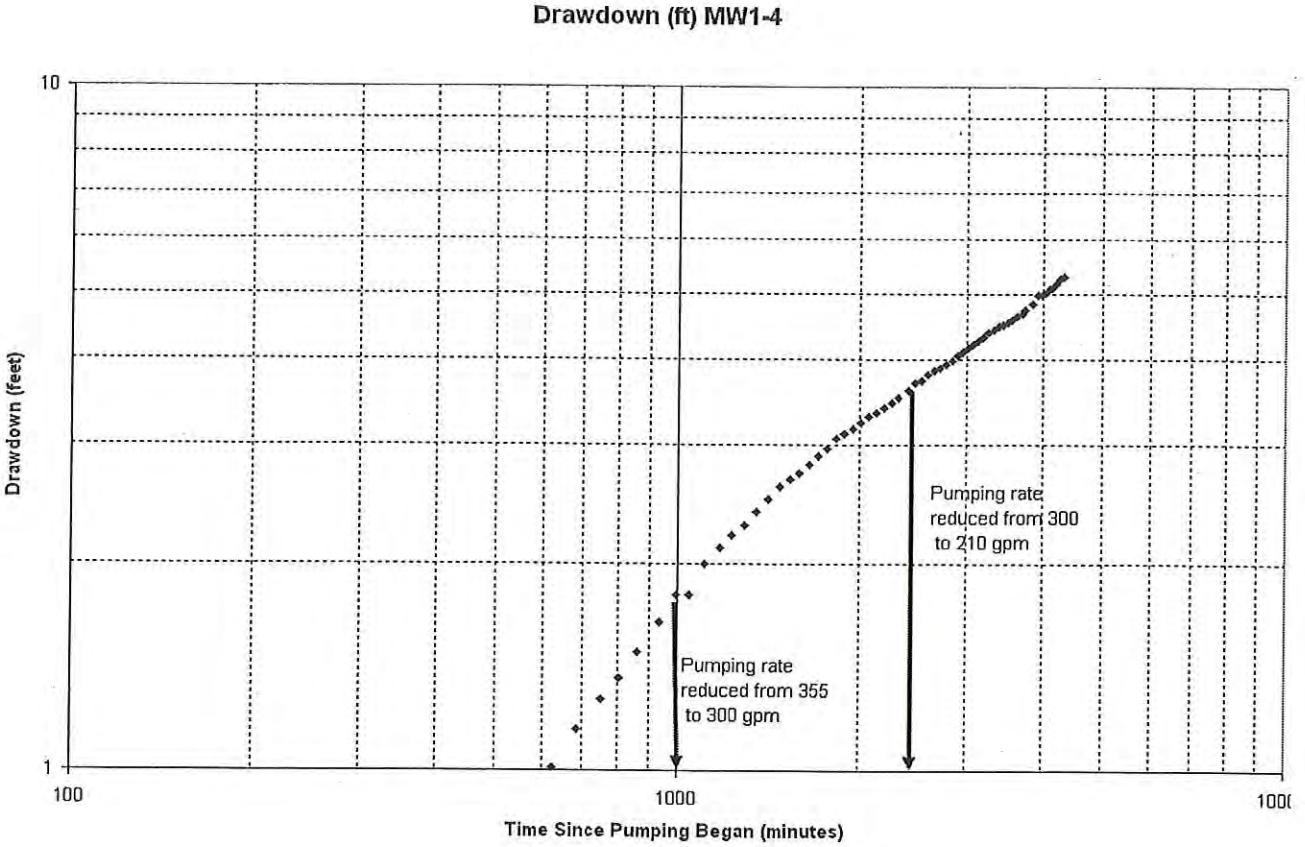


Figure 7

Drawdown for Observation Well MW1-4 (Manual Measurements)

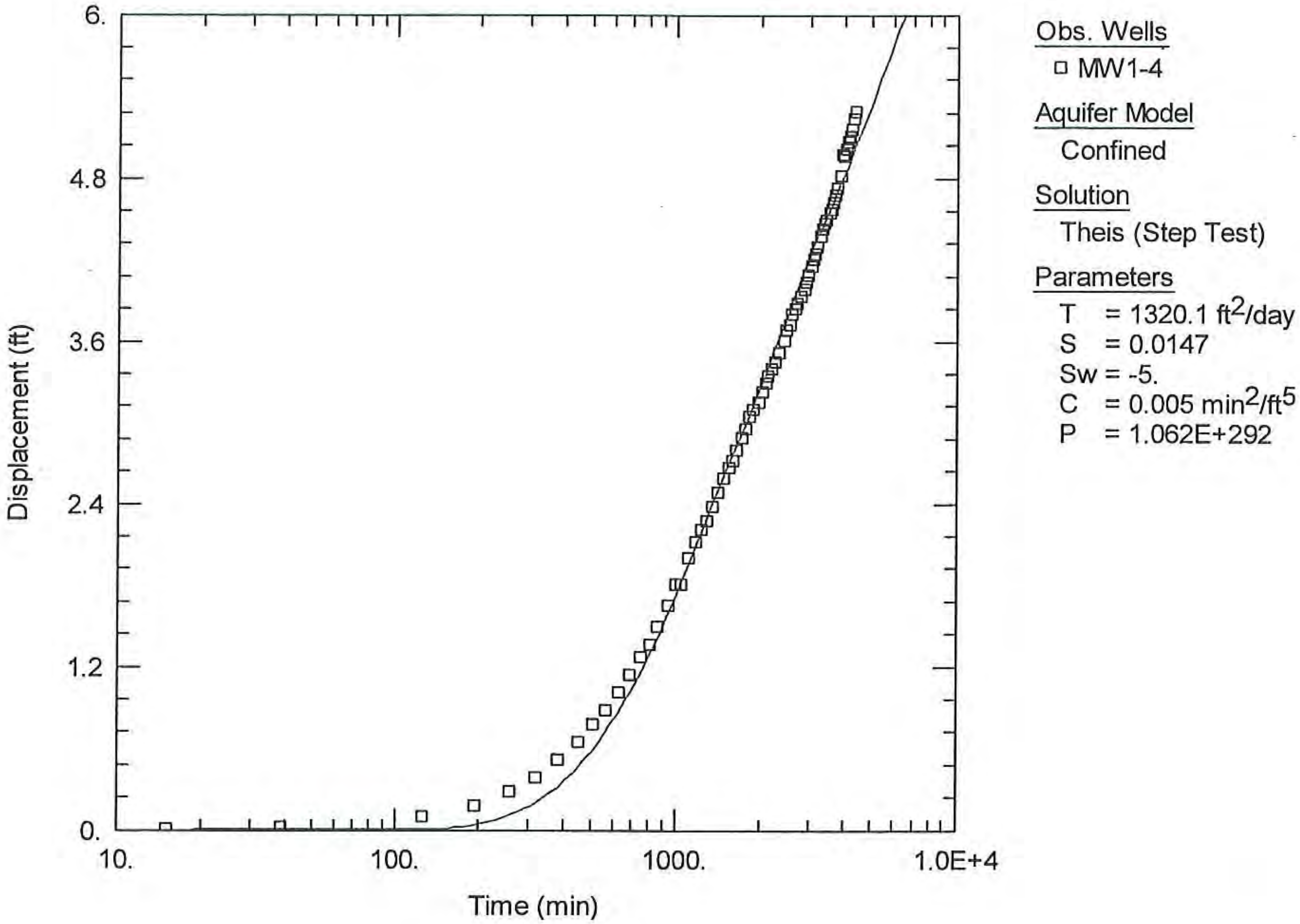


Figure 8

Curve-Match Plot of Drawdown Data from Observation Well MW1-4, With Resulting Aquifer Parameter Estimates

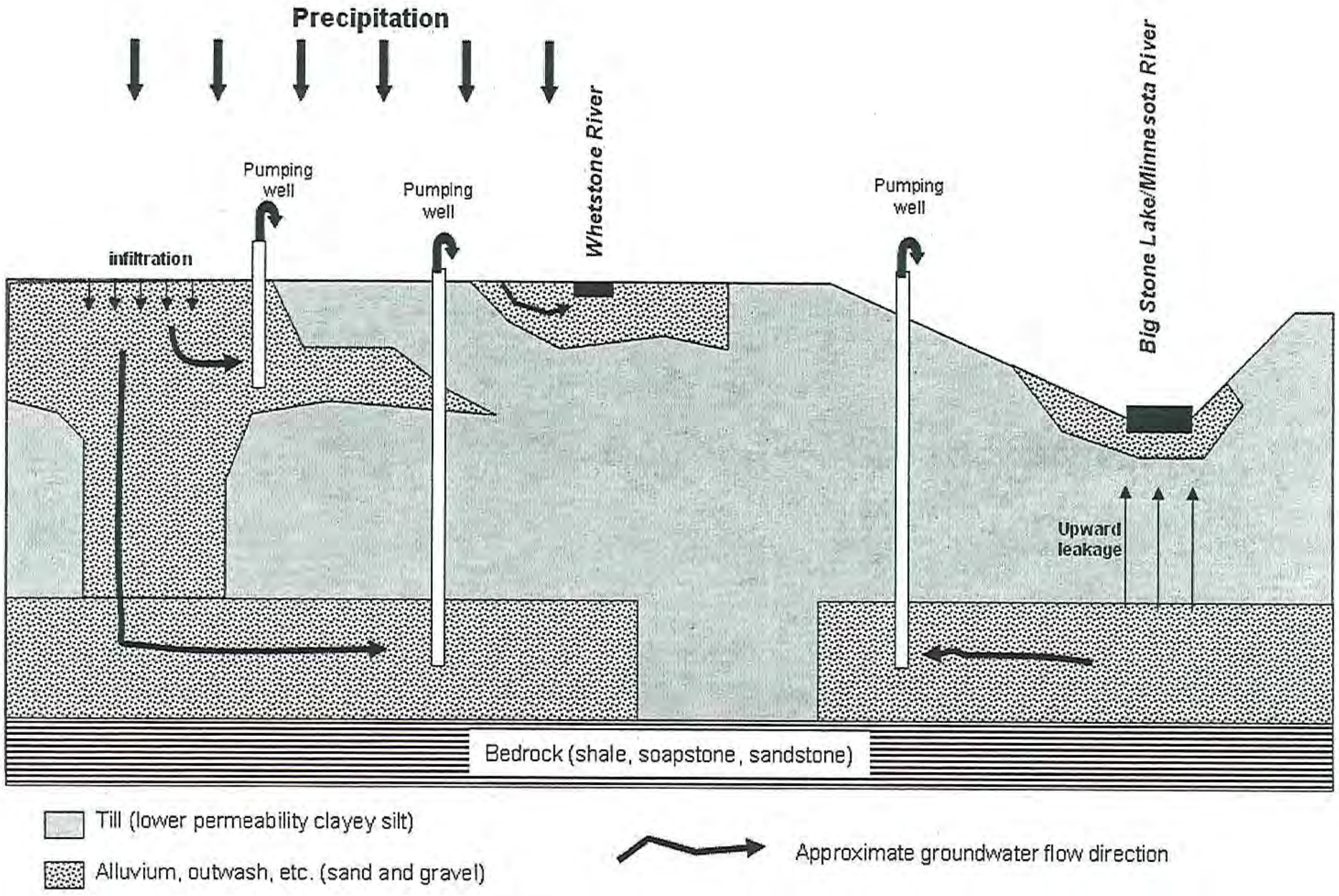


Figure 9

Conceptual Hydrogeologic Model of Groundwater Flow

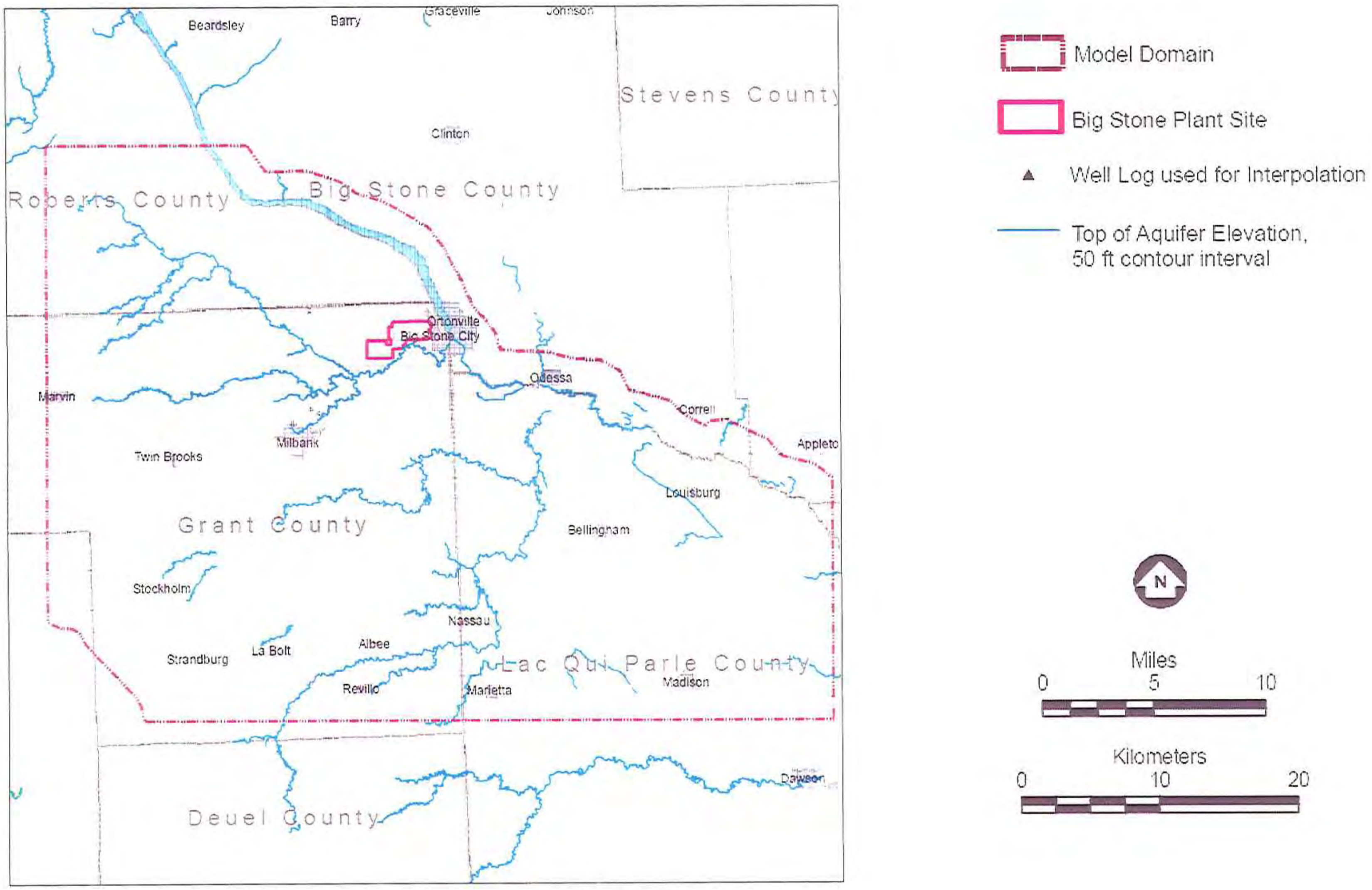


Figure 10

Model Domain and Grid Discretization

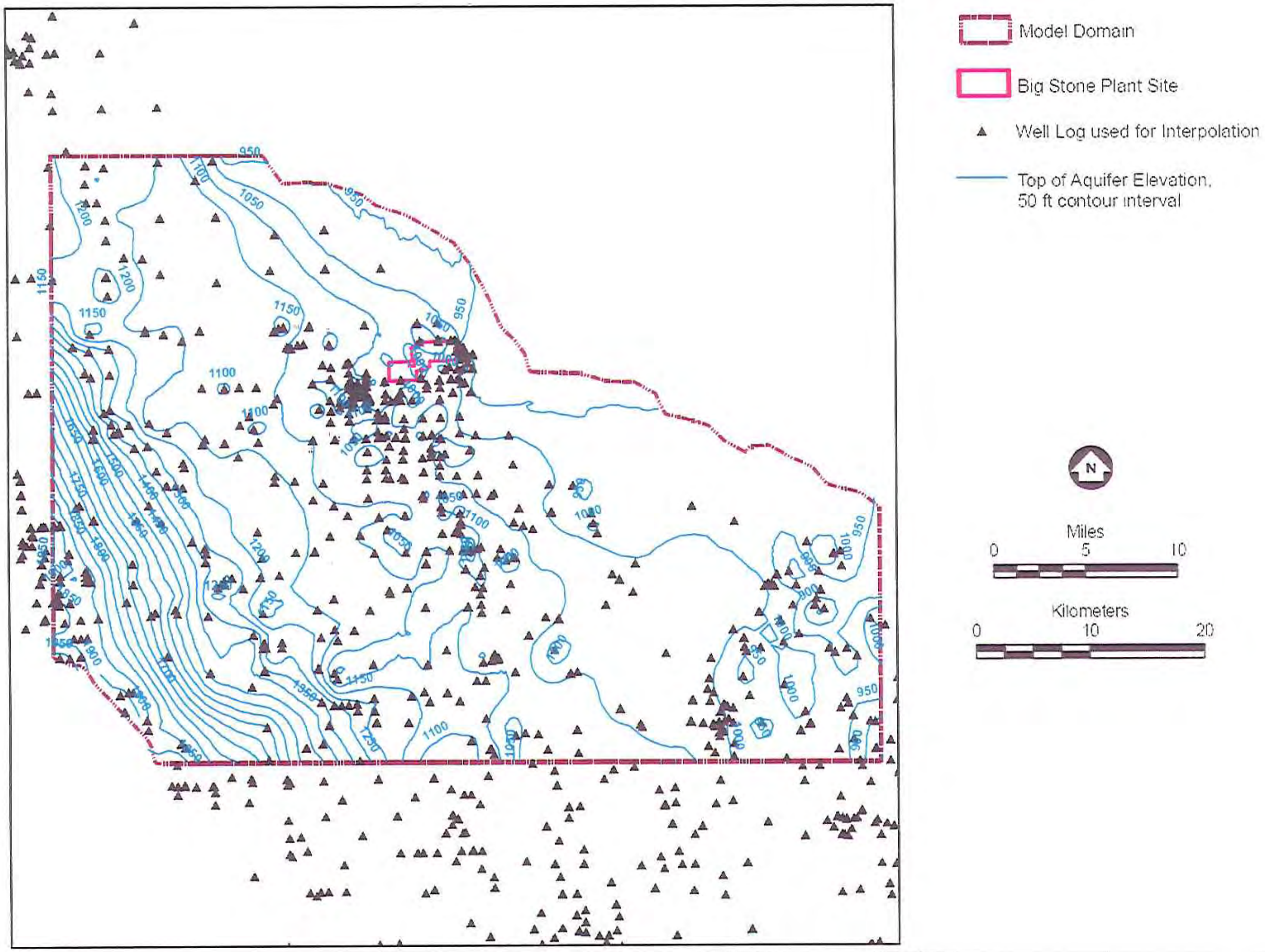


Figure 11

Interpolated Elevation of Top of Aquifer Unit

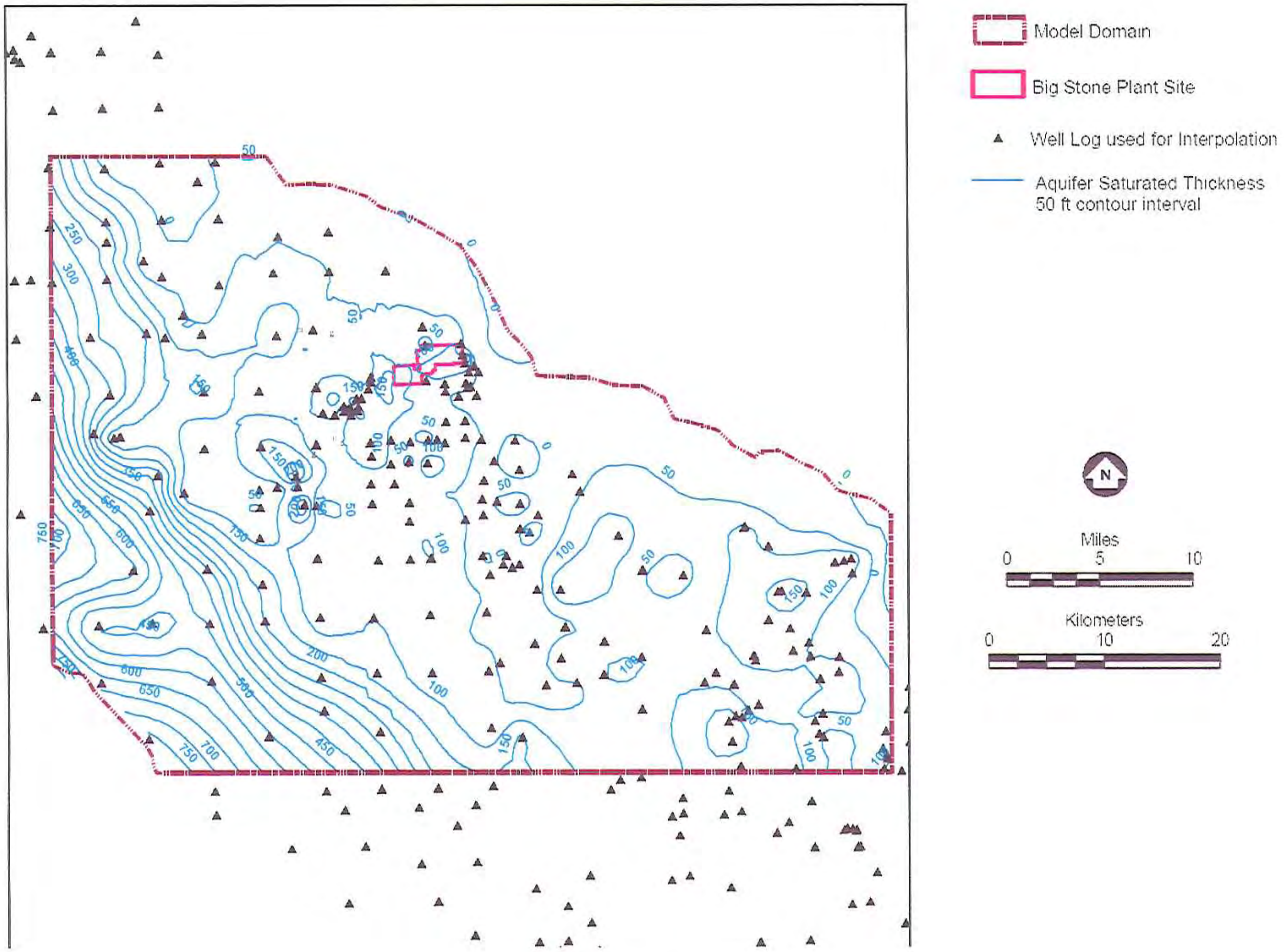


Figure 12

Interpolated Saturated Thickness of Aquifer Unit

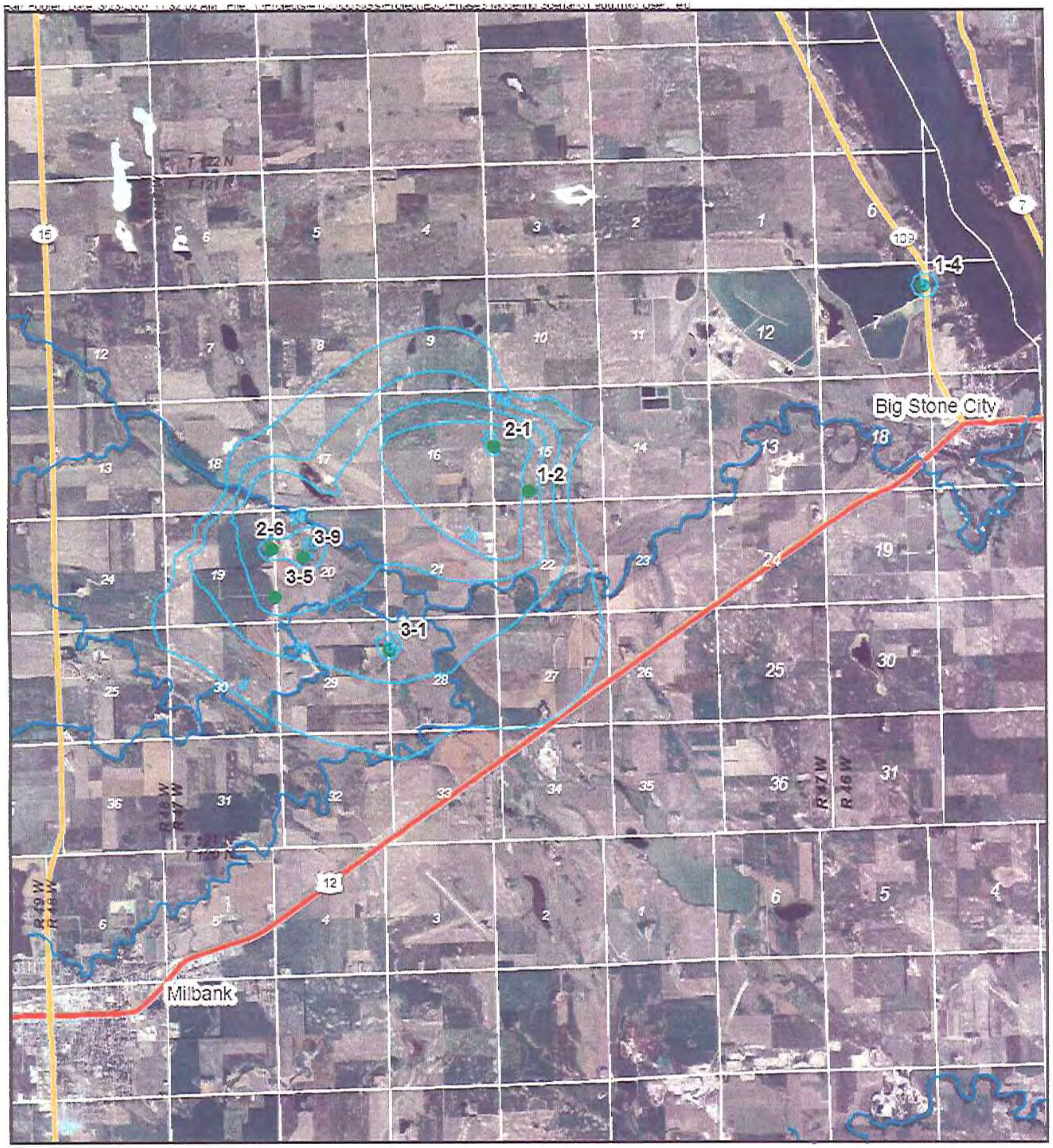


Figure 13

Configuration 1 (7 Wells)
Predicted Drawdown (feet)
after 90 Days of Pumping

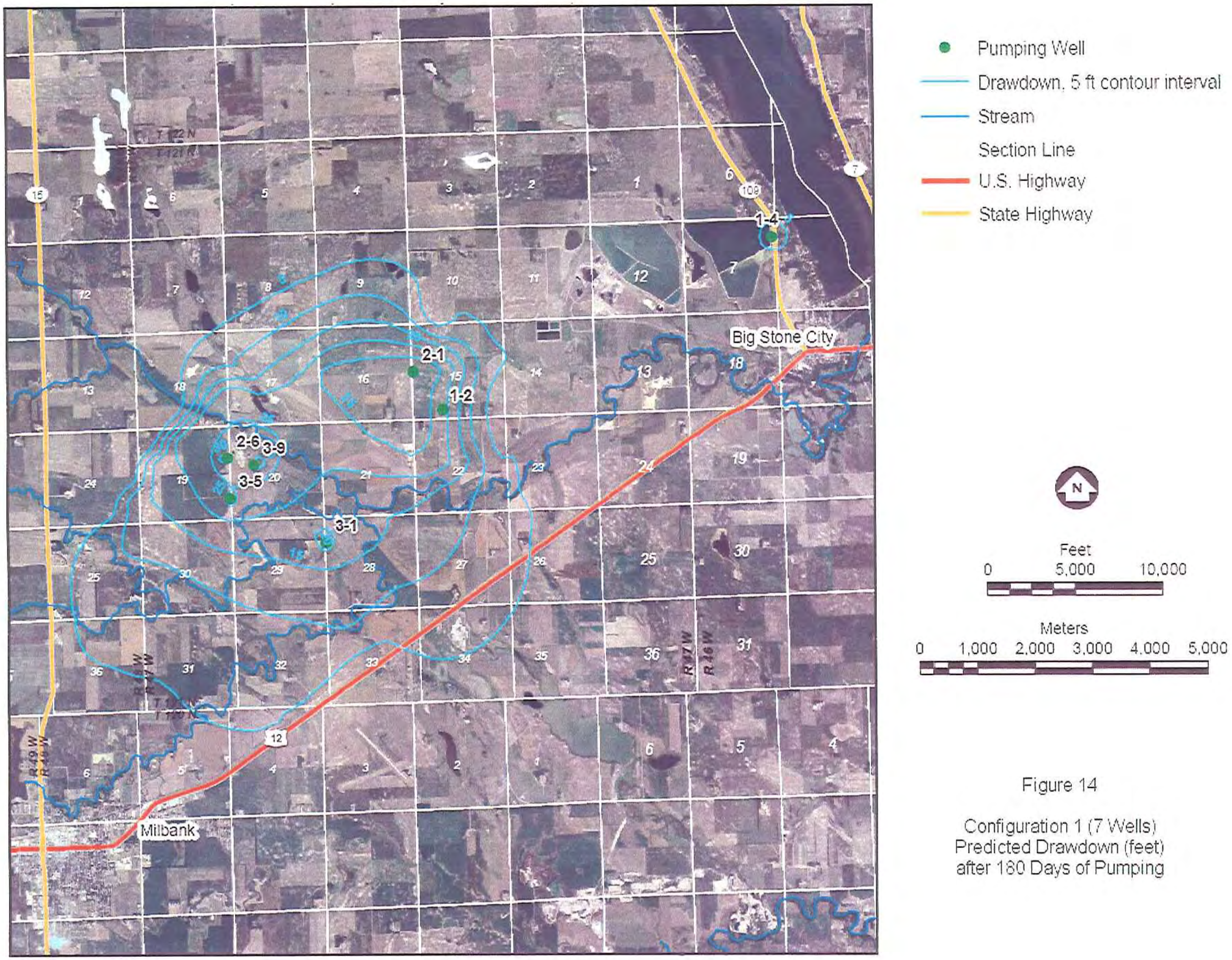


Figure 14

Configuration 1 (7 Wells)
Predicted Drawdown (feet)
after 180 Days of Pumping

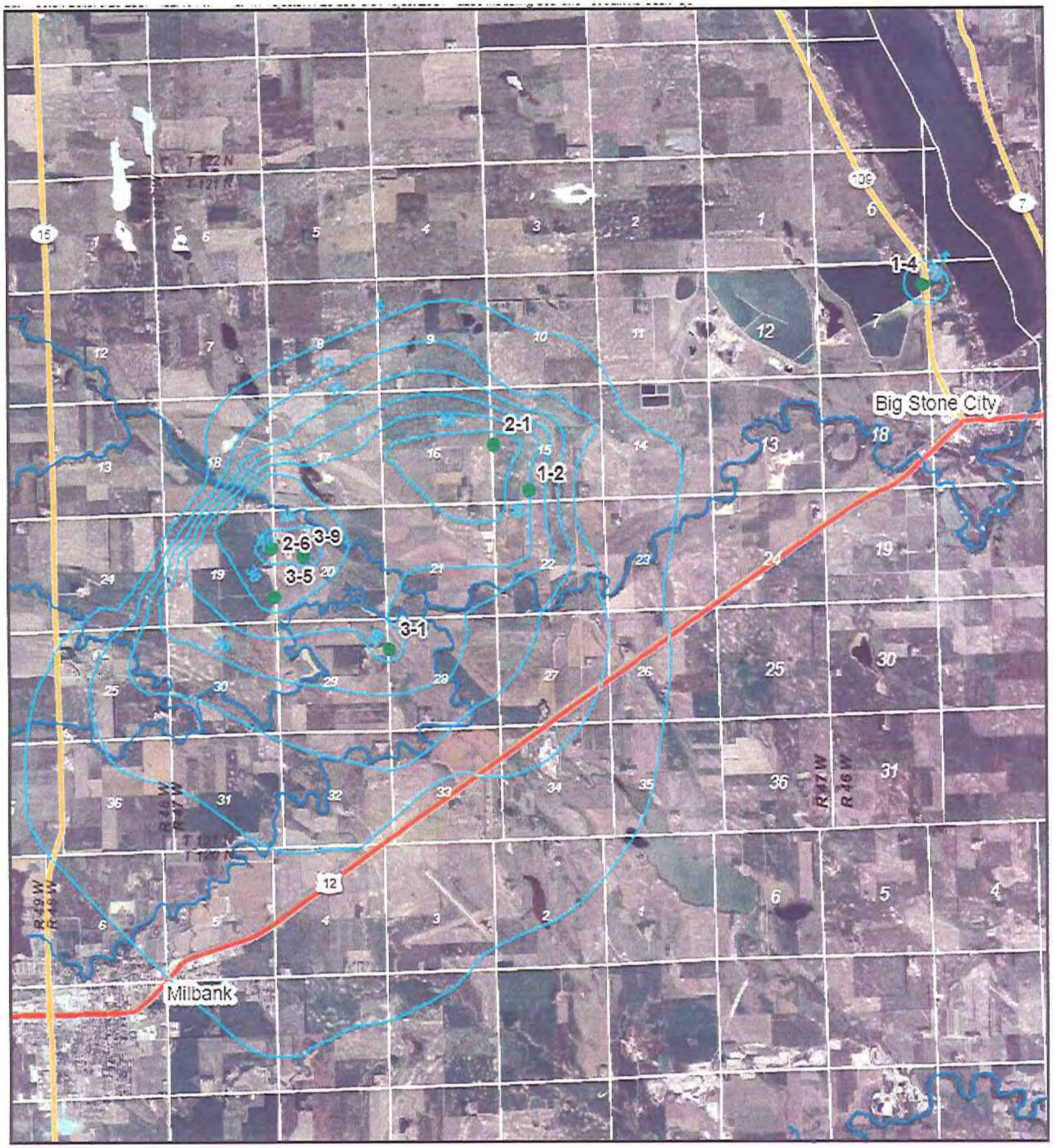


Figure 15

Configuration 1 (7 Wells)
Predicted Drawdown (feet)
after 365 Days of Pumping

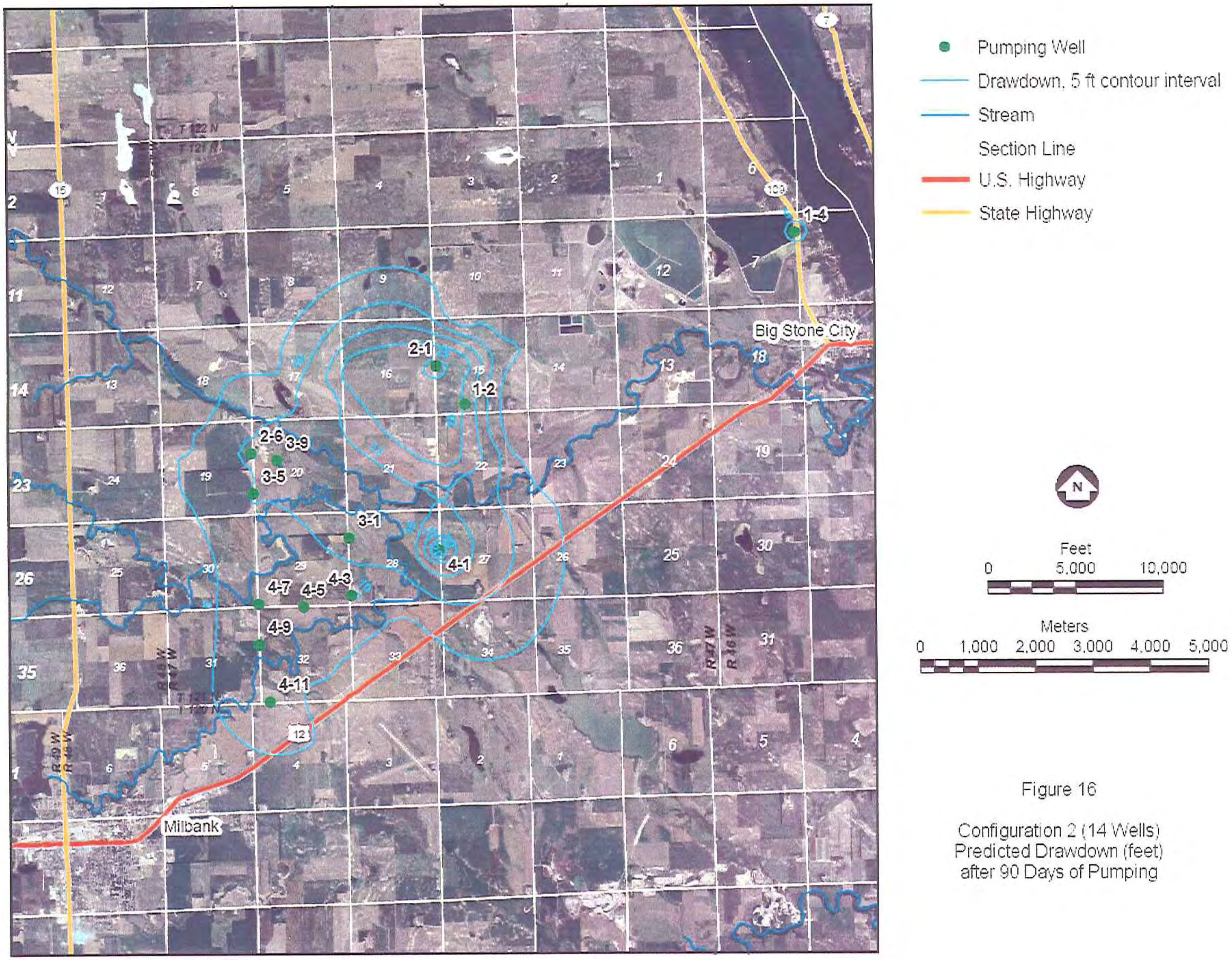


Figure 16

Configuration 2 (14 Wells)
Predicted Drawdown (feet)
after 90 Days of Pumping

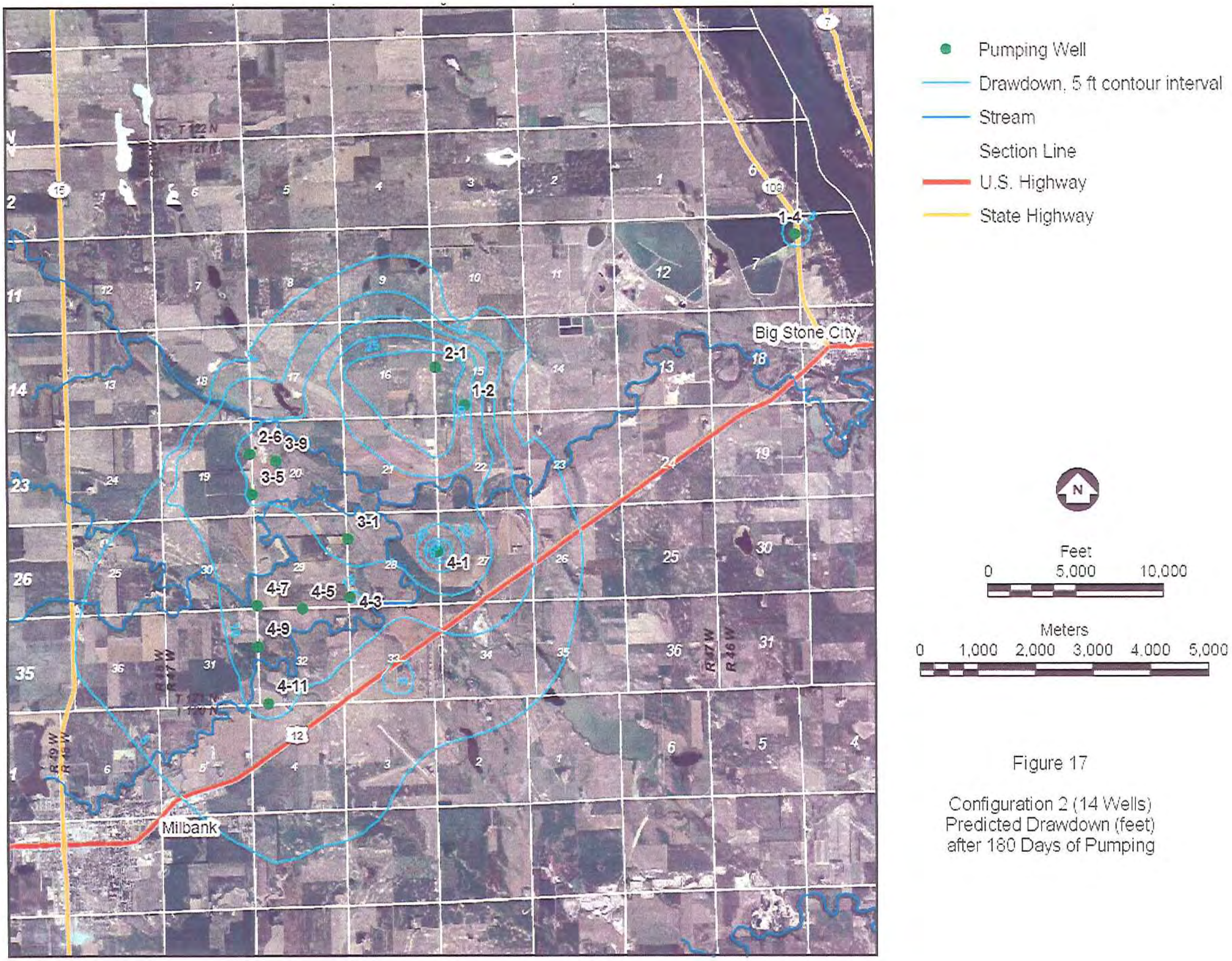


Figure 17

Configuration 2 (14 Wells)
Predicted Drawdown (feet)
after 180 Days of Pumping

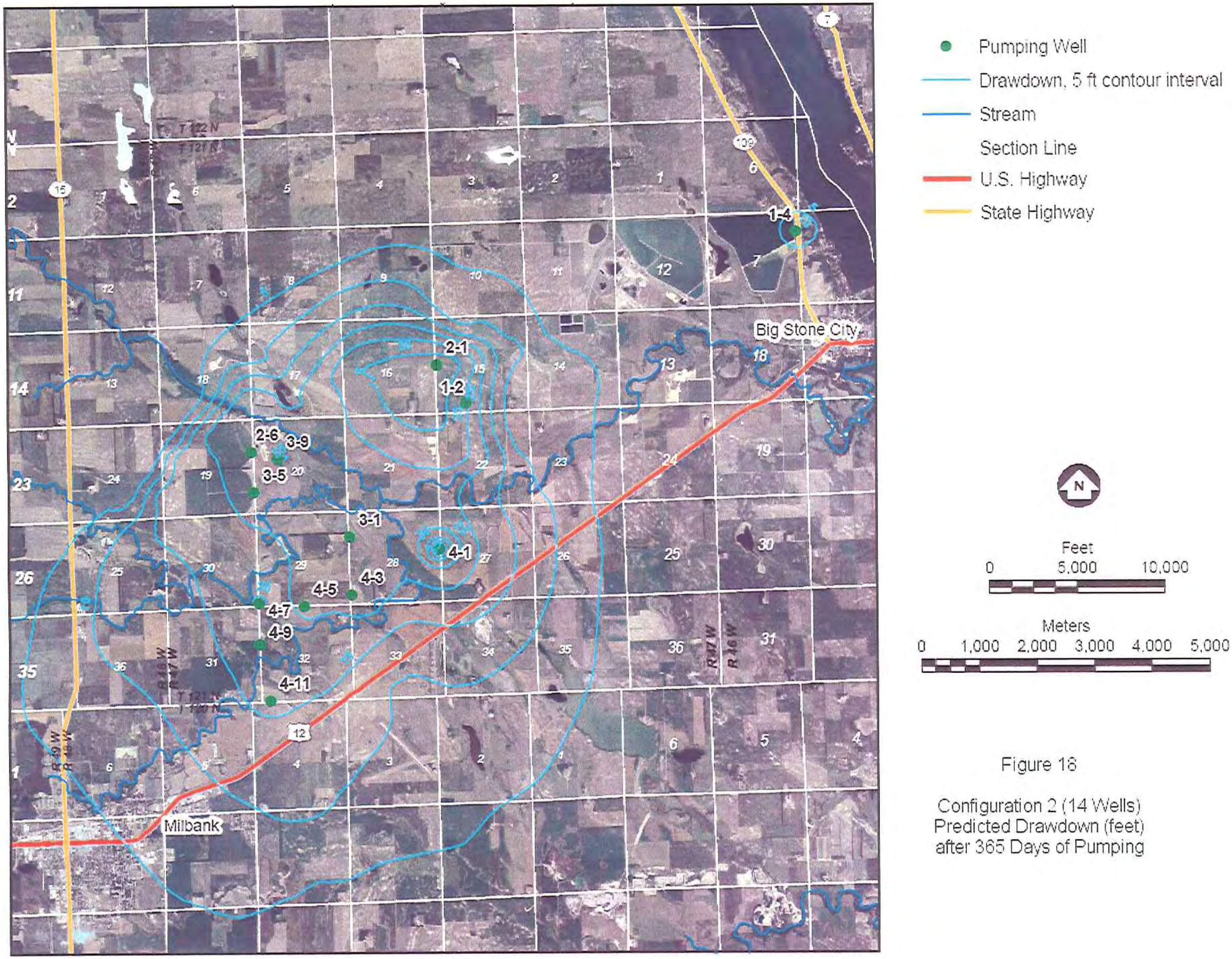


Figure 16

Configuration 2 (14 Wells)
Predicted Drawdown (feet)
after 365 Days of Pumping

Appendix A

Pilot Hole Boring Logs

LOG OF BORING PH1-1

SHEET 1 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/29/06 Ended 12/1/06
Logged By Barr, EJC

Elevation 1122.076199
Total Depth 215.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/30/70	.5YR/2.5/	Wet	OL/OH		Topsoil Black organic-rich sandy silt w/ fg-mg sand	
									●	Red granite boulder Crystals ~2mm in diameter	
5				---	10/15/75	10YR/4/6	Moist		▨	Dark yellowish brown lean clay w/ gravel and some sand Charcoal Oxidation along fractures Mottled w/ red	5
10									▨		10
15				---	5/5/90	10YR/4/6	Moist		▨		15
20								CL	▨		20
25				---	5/5/90	10YR/4/6	Moist		▨		25
30									▨		30
35				---	5/0/95	2.5Y/4/1	Moist		▨		35
									▨	Dark gray diamicton clay w/ gravel Angular to subrounded; up to 2 cm in diameter	
40									▨		40
								CH	▨		
45									▨		45

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH1-1

SHEET 2 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/29/06 Ended 12/1/06
Logged By Barr, EJC

Elevation 1122.076199
Total Depth 215.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
55		---	0/10/90	2.5Y/4/1	Moist	CH	▨	Dark gray diamicton clay w/ gravel Angular to subrounded; up to 2 cm in diameter*(continued)*	55
						ML	‖	Dark diamicton silt 10% sand	
						SP SM	⁘	Dark gray diamicton sand FG w/ 10% silt	
						ML	‖	Dark gray diamicton silt	
60 65		---	0/5/95	2.5Y/4/1	Moist	CH	▨	Dark gray diamicton clay w/ 5% gravel	60 65
						ML	‖	Dark gray diamicton silt	
70						SP SM	⁘	Grayish brown sand, mg	70
						ML	‖	Dark gray diamicton silt	
75		---	5/40/55	10YR/3/1	Moist	CH	▨	Dark gray fat clay; diamicton 5% gravel	75
80						CL	▨	V dark gray sandy lean clay w/ 5% gravel Angular to subrounded	80
						SM	⁘	V dark gray silty sand w/ 20% gravel and cobbles Up to 3" in diameter	
85		---	5/15/80	10YR/3/1	Moist	CL	▨	V dark gray lean clay w/ sand 5% gravel to 1" in diameter	85
						ML	‖	Dark reddish brown sandy silt	
90						SP	⁘	Dark reddish brown sand, cg	90
						ML	‖	Dark reddish brown sandy silt	
95		---	2/33/65	5YR/3/3	Moist	CL	▨	Dark reddish brown sandy lean clay	95
						CL	▨	V dark gray sandy lean clay	

(continued)

Remarks

LOG OF BORING PH1-1

SHEET 3 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/29/06 Ended 12/1/06
Logged By Barr, EJC

Elevation 1122.076199
Total Depth 215.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CL		V dark gray sandy lean clay*(continued)*	
105											105
								CL		Reddish brown lean clay w/ some sand, fg-mg	
								CH		Mottled w/ red	
								CL		V dark grayish brown fat clay	
										V dark grayish brown silty clay	
110				---	0/90/10	GLEY1/4/56Y	Wet	SP SM		Dark greenish gray sand w/ silt fg-mg	110
115								CL		Bluish black lean clay	115
								SP SM		Dark greenish gray sand w/ silt fg-mg	
								CL		Bluish black lean clay	
								SP SC		Dark greenish gray sand w/ clay and 5% gravel	120
120								SM		Dark greenish gray silty sand, fg	
								CH		Bluish black fat clay	
125				---	0/60/40	GLEY1/4/10Y	Wet	SM		Dark greenish gray silty sand, fg	125
								CH		Bluish black fat clay w/ fg gravel; diamicton	
130											130
135				---	5/0/95	GLEY1/3/10Y	Moist				135
140											140
145				---	5/0/95	GLEY1/3/10Y	Wet				145

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/29/06 Ended 12/1/06
Logged By Barr, EJC

LOG OF BORING PH1-1

SHEET 4 OF 5

Elevation 1122.076199
Total Depth 215.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Bluish black fat clay w/ fg gravel; diamicton *(continued)*	
								SP		Dark greenish gray sand, fg-cg Water-bearing	
155				--	0/95/5	GLEY1/4/10Y	Wet				155
								ML		Dark greenish gray sandy silt fg-mg	
								CL		Bluish black lean clay w/ fg gravel	
								ML		Dark greenish gray sandy silt, fg	
160											160
165				--	0/100/0	5Y/5/1	Wet	SP		Clean gray sand, fg-mg	165
170											170
								ML		Dark greenish gray sandy silt, fg sand	
								ML		Dark greenish gray sandy silt w/ clay; fg	
175				---	0/95/5	5Y/5/1	Wet	SP		Clean gray sand, fg-mg	175
								ML		Dark greenish gray silt	
180								CH		Bluish black fat clay, shaley	180
185				---	0/0/100	GLEY1/3/10Y	Wet				185
190											190
195				---	0/0/100	GLEY1/3/10Y	Wet				195

(continued)

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Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH1-1

SHEET 5 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/29/06 Ended 12/1/06
Logged By Barr, EJC

Elevation 1122.076199
Total Depth 215.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/0/100	GLEY1/3/10Y	Wet	CH	▨	Bluish black fat clay, shaley*(continued)*	
205											205
210											210
215											215
220											220
225											225
230											230
235											235
240											240
245											245

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PW1-2

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/3/06 Ended 12/5/06
Logged By Barr, EJC
Elevation 1079.39636
Total Depth 196.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION
				---	0/40/60	2.5Y/3/2	Wet	OL		V dark grayish brown organic-rich sandy clay; topsoil
								ML		V dark brown to olive gray silt with sand
								SP-SM		V dark olive gray sand w/ silt, mg-cg
5				---	15/15/70	10YR/4/4	Wet	CH		Dark yellowish brown sandy fat clay w/ gravel; fg Mottled w/ reddish oxidation; charcoal
								CH		Yellowish red fat clay Dark red oxidation
10				---	5/25/70	5YR/4/6	Moist	CL		Yellowish red sandy lean clay; fg-mg Charcoal
15				---	5/25/70	5YR/4/6	Moist			
								CL		Brown sandy lean clay; fg-mg
25				---	10/25/65	5YR/3/3	Moist	CL		Dark reddish brown sandy lean clay; fg-cg
35				---	2/0/98	5Y/2.5/2	Moist	CH		Black fat clay w/ fg gravel; diamicton
40				---	5/15/80	10YR/3/2	Moist	CL		V dark grayish brown lean clay w/ sand; fg-mg
								CH		Dark reddish brown fat clay w/ fg-mg sand
								CH		V dark grayish brown fat clay
								ML		Dark gray silt
								SM		Very dark gray silty sand, fg

(continued)

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Remarks Sampled from 89' to 178'

LOG OF Boring PW1-2

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/3/06 Ended 12/5/06
Logged By Barr, EJC
Elevation 1079.39636
Total Depth 196.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						SM		Very dark gray silty sand, fg*(continued)*	
						ML		Dark gray silt	
						CL		V dark gray lean clay	
55		---	5/5/90	2.5Y/3/1	Moist	CH		V dark gray fat clay	55
60									60
65									65
70		---	5/5/90	2.5Y/3/1	Moist				70
75									75
80		---	30/20/50	2.5Y/2.5/1	Moist	CL		Black fat gravely clay w/ sand, fg-mg	80
						SP SM		Dark grayish brown sand w/silt; fg-cg	
85									85
						CH		V dark gray fat clay w/ lenses of SP-SM	
						ML		V dark gray silt	
90						SP		Dark grayish brown sand; mg-cg	90
95		---	0/0/100	10YR/4/2	Moist	ML		Dark grayish brown silt	95
						SP		Dark grayish brown sand mg-cg at top, grading to fg at bottom	

(continued)

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Remarks Sampled from 89' to 178'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PW1-2

SHEET 3 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 12/3/06 Ended 12/5/06

Logged By Barr, EJC

Elevation 1079.39636

Total Depth 196.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Dark grayish brown sand mg-cg at top, grading to fg at bottom*(continued)*	
105				---	0/98/2	5Y/4/1	Wet	SP		Dark gray sand; mg	105
110											110
115				---	0/98/2	5Y/4/1	Wet	SP		Dark gray sand; mg-cg	115
120											120
125											125
								SP		Gray sand, fg-mg	
130											130
								GP		Dark gray gravel (fg-cg) w/ sand (mg-cg)	
								SP		Gray sand; mg-cg	
135				---	0/100/0	2.5Y/4/1	Wet	SP		Clean gray sand; mg	135
140											140
145											145

(continued)

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Remarks Sampled from 89' to 178'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PW1-2

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/3/06 Ended 12/5/06
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 196.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Clean gray sand; mg*(continued)*	
								SP		V dark gray sand (mg-cg) w/ gravel (fg-cg)	
155				---	15/85/0	2.5Y/4/1	Wet	SP		Gray sand (cg) w/ gravel (fg)	155
160 165 170								SP		Grayish brown sand; mg	160 165 170
								SP		Grayish brown sand; cg	
175				---	0/100/0	5Y/4/1	Wet	SP		Dark gray sand; mg-cg	175
								CH		Black sandy fat clay; fg-cg	
180								SC		V dark gray clayey sand w/ gravel and cobbles 3" in diameter	180
185								SC		Greenish gray clayey sand mg-cg at top, grading to fg-mg at bottom w/ increasing cementation	185
190 195				---	0/80/20	GLEY1/6/10Y	Moist	SC		Greenish gray sandstone; fg	190 195

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Remarks Sampled from 89' to 178'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-3

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/5/06 Ended 12/6/06
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 198.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				--	0/0/100	10YR/2/2	Wet	OL		V dark brown organic-rich clay; topsoil	
								CL		Dark yellowish brown lean clay	
										Yellowish brown fat clay w/ gravel Mottled w/ gray; reddish oxidation	
5				---	10/2/88	10YR/4/4	Moist				5
10											10
15				---	5/10/85	10YR/4/4	Moist				15
								CH			
20											20
25				---	5/10/85	10YR/4/4	Moist				25
30											30
								SP-SM		Dark yellowish brown sand w/ silt; mg	
35				---	5/15/80	2.5Y/3/2	Moist	CH		V dark grayish brown fat clay w/ sand	35
										Brown fat clay w/ sand	
								CH			
40											40
										Dark reddish brown fat clay w/ sand; fg	
45				---	5/10/85	5YR/3/2	Moist	CH			45

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/5/06 Ended 12/6/06
Logged By Barr, EJC

LOG OF Boring PH1-3

SHEET 2 OF 4

Elevation 1079.39636
Total Depth 198.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH	▨	Dark reddish brown fat clay w/ sand; fg*(continued)*	
55				---	2/10/88	5YR/3/1	Moist	CL	▨	Black lean clay; diamicton	55
60											60
65											65
70				---	0/0/100	5Y/2.5/1	Moist	CH	▨	Black fat clay	70
75											75
								SP	▨	Dark gray sand; mg-cg	
80								CL	▨	V dark gray lean clay; diamicton	80
85				---	10/5/85	5YR/3/1	Moist				85
								SP	▨	V dark gray sand; mg-cg	
90								CH	▨	Black fat clay; diamicton	90
95				---	5/0/95	5Y/2.5/1	Moist				95
								SP	▨	Dark gray sand; mg-cg	

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-3

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/5/06 Ended 12/6/06
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 198.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Dark gray sand; mg-cg*(continued)*	
								CH		Fat black clay w/ 5% gravel; diamicton	
105											105
110				---	5/2/93	5Y/2.5/2	Moist				110
115				---	2/5/93	5Y/2.5/1	Moist				115
120											120
125											125
130											130
				---	2/0/98	5Y/2.5/1	Moist				
								ML		Black silt	
135								CH		Fat black clay	135
								CL		Black lean clay w/ up to 5% gravel; diamicton	
140											140
				---			Dry			Grano-diorite boulder	
145				---	5/5/90	5Y/3/1	Moist	CH		V dark gray fat clay w/ 10% sand and gravel	145
								CH		V dark gray fat clay	

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-3
SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/5/06 Ended 12/6/06
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 198.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH	▨	Black fat clay, shaley	
155				---	0/0/100	5Y/2.5/1	Dry				155
								CH	▤	Black claystone w/ 5% silt	
160											160
165											165
				---	0/0/100	5Y/2.5/1	Moist				
								CH	▤	Fat black clay; shaley	
170											170
175											175
				---	0/0/100	5Y/2.5/1	Moist				
								CH	▨	Fat black clay	
180											180
185											185
				---	0/0/100	5Y/2.5/1	Dry				
190											190
								CH	▩	Light greenish gray soapstone	
195											195

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PW1-4

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/27/06 Ended 11/29/06
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 200.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/10/90	2.5Y/2/1	Dry	OL/OH		Black organic-rich topsoil	
								CL	▨	Pale yellow mottled clay w/ up to 10% fg-cg gravel Gravel is various lithologies, chert-carbonate; med-high toughness; rounded to angular	
5				---	5/10/85	2.5Y/7/3	Dry	ML		Clay w/ some silt; mottled w/ gray and red; dark yellowish brown Low toughness	5
10								CL	▨	Clay w/ silt; light olive brown. Gravel is various lithologies, fg-cg, angular to subrounded.	10
15				---	4/2/94	2.5Y/4/3	Moist				15
20								CL	▨	Light olive brown clay w/ silt Sand is fg-mg Oxidation along cracks in clay, can be up to 1 mm thick Gravel is fg-cg, angular to subrounded	20
25				---	2/15/83	2.5Y/4/3	Moist	CL	▨	Olive brown med-fat clay w/ up to15% fg sand	25
30								CH	▨	Light olive brown clay w 5% fg-mg gravel	30
35				---	2/10/88	2.5Y/3/1	Moist	CL	▨	Homogeneous very dark gray diamicton Medium plasticity Medium toughness Clay w/ up to 15% fg sand	35
40											40
45				---	2/5/93	2.5Y/3/1	Moist				45

(continued)

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Remarks Sampled from 121' to 185'

LOG OF BORING PW1-4

SHEET 2 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 11/27/06 Ended 11/29/06

Logged By Barr, EJC

Elevation 1102.36224

Total Depth 200.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CL		Homogeneous very dark gray diamicton Medium plasticity Medium toughness Clay w/ up to 15% fg sand*(continued)*	
55				---	2/5/93	2.5Y/3/1	Moist				55
60											60
65				---	2/5/93	2.5Y/3/1	Moist				65
								SP		Sand fg - cg w/ 5% gravel up to 1 1/2" in diameter Light olive brown	
70											70
75				---	2/5/93	2.5Y/3/1	Moist	CL		V dark gray diamicton Medium plasticity High toughness	75
80								SC		Fine clayey sand w/ 5% gravel and cobbles to 2" in diameter Dark reddish brown	80
85				---	5/80/15	5YR/4/2	Moist				85
90								ML		Silt w/ fg-cg sand Mottled red and gray Very tough	90
								CH		V dark gray fat clay Lenses containing up to 15% fg-cg sand	
95				---	0/0/100	10YR/3/1	Moist				95

(continued)

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Remarks Sampled from 121' to 185'

LOG OF BORING PW1-4

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/27/06 Ended 11/29/06
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 200.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		V dark gray fat clay Lenses containing up to 15% fg-cg sand*(continued)*	
105				--	0/5/95	10YR/3/1	Moist				105
110											110
115				---	0/5/95	10YR/3/1	Moist				115
120											120
								SP		Clean gray sand, fg-cg w/ some gravel some cementation	
125				---	2/98/0	10YR/4/1	Wet	SP		Gray sand, mg, grading into cg V little gravel	125
130											130
135				---	5/95/0	10YR/4/1	Wet	SP		Gray sand, grading to 30% gravel at 140'	135
140								SP		Gray sand, mg, and gravel, grading to 0% gravel by 145'	140
145				---	0/100/0	10YR/4/1	Wet	SP		Dark gray sand, mg-fg	145

(continued)

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Remarks Sampled from 121' to 185'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PW1-4

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 11/27/06 Ended 11/29/06
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 200.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Dark gray sand, mg-fg*(continued)*	
155				---	0/100/0	10YR/4/1	Sat.	SP		Gray sand, mg-cg, v. clean, grades to fg b/t 163' and 166', then grades back to mg-cg by 175'	155
160											160
165											165
170											170
175				---	0/100/0	10YR/4/1	Sat.	SP		Gray sand, mg-cg, v. clean Changes to clay w/in 6" at 185'	175
180											180
185								CH		Greenish black shaley clay V tough Med-high plasticity	185
190											190
195				---	0/0/100	GLEY1/3/2.5Y	Wet				195

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Remarks Sampled from 121' to 185'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-5

SHEET 1 OF 5

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 12/1/06 Ended 12/3/06

Logged By Barr, EJC

Elevation 1112.20476

Total Depth 208.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	5/2/93	10YR/3/3	Moist	OL		Dark brown organic-rich clay; topsoil	
5				---	10/10/80	2.5Y/5/4	Dry	CH		Light olive brown fat clay w/ sand and gravel Mottled w/ gray; charcoal	5
10 15 20				---	1/2/97	10YR/4/4	Moist	CH		Dark yellowish brown fat clay Reddish oxidation	10 15 20
25				---	2/2/96	10YR/4/4	Moist				25
30								CH		Dark yellowish brown fat clay w/ gravel Reddish oxidation	30
35				---	5/2/93	5Y/3/2	Moist	CL		Dark olive gray lean clay Reddish oxidation	35
40								CH		Yellowish brown fat clay Reddish oxidation	40
								CL		Olive brown lean clay Reddish oxidation; charcoal	
45				---	20/70/10	7.5Y/4/3	Wet	SP SM		Brown sand w/ silt; mg-cg Reddish oxidation; charcoal	45
								SP SM		Brown sand w/ wilt and gravel; mg-cg	
								CL		V dark gray lean clay w/ sand and gravel; diamicton	

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-5

SHEET 2 OF 5

Client: Otter Tail Power Company
Project Name: Big Stone II
Number: 41/25-003 GWTR 200
Location: Big Stone City, SD
Drill Contractor: Boart Longyear
Drill Method: Rotasonic
Drilling Started: 12/1/06 Ended: 12/3/06
Logged By: Barr, EJC
Elevation: 1112.20476
Total Depth: 208.0

DEPTH FEET	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	DESCRIPTION
					CL	V dark gray lean clay w/ sand and gravel; diamicton*(continued)*
55	---	10/10/80	10YR/3/1	Moist		
					SP SM	Dark grayish brown sand w/ silt and 30% gravel
60					ML	Dark grayish brown silt w/ sand; fg-mg
					SP	Light olive gray sand; fg-mg Clay and silt lenses
					CL	V dark gray lean clay w/ gravel; diamicton Sand lenses
65	---	5/5/90	10YR/3/1	Moist	CL	V dark gray lean clay; diamicton Red granite boulder b/t 66.5' and 67'
70						
75	---	5/2/93	10YR/3/1	Moist		
					GP	Grayish brown gravel w/ sand
80					CL	V dark gray lean clay; diamicton
85	---	40/50/10	2.5Y/5/2	Wet	SP	Grayish brown sand w/ gravel Water-bearing
90						
					CL	V dark gray lean clay; diamicton
95	---	2/5/93	5YR/3/2	Moist	CL	Dark reddish brown lean clay
					CL	V dark gray sandy fat clay

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-5

SHEET 3 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/1/06 Ended 12/3/06
Logged By Barr, EJC
Elevation 1112.20476
Total Depth 208.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
105				---	5/10/85	10YR/3/1	Wet				105
110											110
115				---	5/5/90	10YR/3/1	Moist			V dark gray fat clay; diamicton	115
120											120
125								CH			125
130											130
135				---	2/15/83	10YR/3/1	Moist	CL		V dark gray fat clay w/ 15% sand	135
								SP SM		Dark gray sand w/ silt; mg-cg Water-bearing	
140								CH		V dark gray fat clay Cobbles to 3" in diameter	140
145				---	0/50/50	10YR/3/1	Wet	SM		V dark gray sandy silt; fg	145
								SM		V dark gray silty sand; fg	

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 4 (LOGS CREATED PRE 5/24/04) 4125003.GPJ BARRLOG.GDT 3/21/07

LOG OF Boring PH1-5

SHEET 4 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/1/06 Ended 12/3/06
Logged By Barr, EJC

Elevation 1112.20476
Total Depth 208.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SM		V dark gray silty sand; fg*(continued)*	
155				---	0/60/40	5Y/3/1	Wet				155
160											160
165											165
170											170
175				---	0/60/40	5Y/3/1	Wet				175
180								ML		V dark gray silt w/ sand; fg-cg	180
								CH		V dark gray fat clay	
185				---	5/20/75	5Y/3/1	Moist	CH		V dark gray sandy fat clay Increasing shale with depth	185
190											190
195				---	0/0/100	5Y/3/1	Moist				195

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH1-5

SHEET 5 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 12/1/06 Ended 12/3/06
Logged By Barr, EJC

Elevation 1112.20476
Total Depth 208.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
205								CH	▨	V dark gray sandy fat clay Increasing shale with depth*(continued)*	205
210											210
215											215
220											220
225											225
230											230
235											235
240											240
245											245

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 1 OF 6

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/6/07 Ended 2/7/07

Logged By Barr, EJC

Elevation 1102.36224

Total Depth 260.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/2/98	10YR3/2	Frozen	OL		V dark grayish brown organic-rich topsoil w/ <5% sand, fg	
								CL		Light olive brn sandy lean clay, fg-cg; reddish oxication; charcoal	
5				---	0/35/65	2.5Y5/4	Moist				5
								SW		Light yellowish brn sand, fg; fg-cg w/ 10% gravel	
10				---	0/20/80	2.5Y5/4	Moist				10
								CL		Light olive brown lean clay w/ sand, fg-mg; reddish oxication; charcoal	
								SP		Yellowish brn sand, fg	
								CL		Yellowish brn lean clay w/ 10% sand, fg; reddish oxidation	
								CL		Dark yellowish brn lean clay w/ 10% sand, cg; reddish oxidation; sand lens, mg, @ 14'; charcoal	
15				---	0/10/90	10YR1/4	Moist				15
								SP		Dark yellowish brn sandy lean clay	
								CL		Dark yellowish brn sandy lean clay, mg-cg; charcoal; reddish oxidation	
20											20
								SP		Dark yellowish brn sand, cg, w/ fg gravel; <5% fines; charcoal;	
25				---	0/80/20	10YR4/3	Moist				25
								SP		Alternating lenses of fg-cg sand and fg gravel	
30								SC		Dark yellowish brn gravel and sand cemented in low-med plasticity fines	30
								CH		V dark gray clay w/ 5% angular gravel; diamicton	
35				---	5/1/94	10YR3/1	Moist				35
40											40
45				---	5/1/94	10YR3/1	Moist				45

(continued)

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Remarks Sampled from 85' to 253'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 2 OF 6

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/6/07 Ended 2/7/07
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 260.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										V dark gray clay w/ 5% angular gravel; diamicton*(continued)*	
55				---	5/1/94	10YR3/1	Moist				55
60								CH			60
65				---	5/1/94	10YR3/1	Moist				65
70											70
								SP		Dark gray sand, fg-mg	
75				---	0/100/0	GLEY14/N	Moist				75
								ML		Dark gray silt w/ 10% sand, cg	
								CL		V dark gray lean clay w/ 5% angular gravel; diamicton	
80											80
								ML		Dark gray silt w/ 10% fg-mg sand	
								CH		V dark gray fat clay w/ sand and gravel; diamicton	
85				---	5/90/5	2.5Y3/1	Wet	SP		V dark gray sand; cg	85
								GC		V dark gray gravel to 2" in diameter w/ fg-cg sand and 20% fines	
90											90
95				---	5/20/75	2.5Y3/1	Moist	CH		V dark gray fat clay w/ 20% sand, mg; diamicton	95

(continued)

ENVIRO LOG 4 (LOGS CREATED PRE 5/24/04) 4125003.GPJ BARRLOG.GDT 3/21/07

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Remarks Sampled from 85' to 253'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 3 OF 6

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/6/07 Ended 2/7/07
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 260.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		V dark gray fat clay w/ 20% sand, mg; diamicton*(continued)*	
								SP		Olive brown sand, cg	
105				---	0/98/2	2.5Y4/4	Wet	SP		Olive brown sand, mg-cg	105
110											110
115				---	0/95/5	2/5Y4/1	Wet	SP		Dark gray sand, mg-cg	115
120											120
								SP		Dark gray sand, fg	
125								SP		Dark gray sand, mg-cg	125
130								ML		V dark gray silt w/ 5% sand, fg	130
								SP		V dark gray sand, mg-cg	
								SP		V dark gray sand, grading from cg to fg at bottom	
135				---	0/100/0	2.5Y4/1	Wet	SP		V dark gray sand, fg to cg	135
140											140
145											145

(continued)

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Remarks Sampled from 85' to 253'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 4 OF 6

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/6/07 Ended 2/7/07
Logged By Barr, EJC
Elevation 1102.36224
Total Depth 260.0

DEPTH FEET	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	DESCRIPTION
					SP	V dark gray sand, fg to cg *(continued)*
155	---	0/98/2	2.5Y4/2	Wet	SP	Olive gray sand, mg-cg
175	---	0/95/5	5Y3/1	Wet	SP	V dark gray sand, cg
					ML	V dark gray sandy silt, fg
180					SP	V dark gray sand, v. fg
					SP	Dark gray sand, mg-cg
195	---	0/98/2	5Y4/1	Wet	SP	Dark gray sand, cg
					CH	V dark gray fat clay w/ 5% v. fg sand
					SP	V dark gray sand, fg
					SP	Dark gray sand, mg

(continued)

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Remarks Sampled from 85' to 253'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 5 OF 6

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/6/07 Ended 2/7/07
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 260.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						SP		Dark gray sand, mg*(continued)*	
205 210						SP		Dark gray sand, fg-mg	205 210
						SP		Dark gray sand, cg	
215 220 225		---	25/75/0	5Y4/2	Sat.	SP		Olive gray sand, cg, w/ 25% fg gravel	215 220 225
230						SP		Olive gray sand, cg w/ 10% fg gravel	230
						SP		Gray sand, fg	
						SP		Olive gray sand, mg-cg w/ 35% gravel to 2" in diameter	
235 240 245		---	60/40/0	5Y4/2	Sat.	GP		Olive gray gravel w/ cobbles to 4" in diameter and sand, cg	235 240 245

(continued)

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Remarks Sampled from 85' to 253'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-1

SHEET 6 OF 6

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/6/07 Ended 2/7/07
Logged By Barr, EJC
Elevation 1102.36224
Total Depth 260.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								GP		Olive gray gravel w/ cobbles to 4" in diameter and sand, cg*(continued)*	
				--			Dry	GP		Heterogeneous cobbles to 1 1/2" in diameter in a sand/silt matrix; conglomerate?	
255										Granite bedrock	255
260											260
265											265
270											270
275											275
280											280
285											285
290											290
295											295

Barr Engineering Co

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Telephone:
Fax:

Remarks Sampled from 85' to 253'

LOG OF Boring PH2-2

SHEET 1 OF 4

Client: Otter Tail Power Company
Project Name: Big Stone II
Number: 41/25-003 GWTR 200
Location: Big Stone City, SD

Drill Contractor: Boart Longyear
Drill Method: Rotasonic
Drilling Started: 2/8/07 Ended: 2/8/07
Logged By: Barr, EJC

Elevation: 1067.283548
Total Depth: 185.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/5/95	10YR3/2	Frozen	OL		V dark grayish brown organic-rich topsoil 5% fg sand	
								CL		Light olive brown lean clay w/ sand 10% fg-mg sand Reddish oxidation; charcoal	
5				---	5/30/65	10YR5/6	Moist	CL		Yellowish brown sandy lean clay 30% mg sand; 5% cg gravel to 2" in diameter Reddish oxidation; charcoal	5
10				---	10/20/70	10YR4/6	Moist			Granite boulder	10
								CL		Dark yellowish brown sandy lean clay 20% sand; 10% fg-mg gravel Charcoal	
15				---	10/90/0	10YR3/6	Wet	SP		Dark yellowish brown sand, cg 10% fg gravel	15
								CL		Brown sandy lean clay 20% mg-cg sand; 10% gravel to 1" in diameter Charcoal	
20											20
25				---	5/20/75	7.5YR3/3	Moist	CL		Dark brown sandy lean clay 20% sand; 5% fg gravel Charcoal	25
30											30
35				---	5/10/85	5YR3/1	Moist	CH		Diamicton: v dark gray fat clay 10% fg-cg sand; 5% fg angular gravel	35
40											40
45				---	2/5/93	5YR3/1	Moist	CH		Diamicton: v dark gray fat clay 5% fg sand; 2% fg gravel	45

(continued)

ENVIRO LOG 4 (LOGS CREATED PRE 5/24/04) 4125003.GPJ BARRLOG.GDT 3/21/07

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Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-2

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/8/07 Ended 2/8/07
Logged By Barr, EJC
Elevation 1067.283548
Total Depth 185.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Diamicton: v dark gray fat clay 5% fg sand; 2% fg gravel*(continued)*	
55				---	7/3/90	5YR3/1	Moist	CH		Diamicton: v dark gray fat clay 3% sand; 7% gravel to 1" in diameter	55
60											60
65				---	2/2/96	5YR2.5/1	Moist	CH		Diamicton: black fat clay 2% fg gravel; 2% sand	65
70											70
75				---	2/2/96	5YR2.5/1	Moist				75
80											80
85				---	5/2/93	5YR2.5/1	Moist				85
90											90
95											95
								SP		V dark gray sand; fg	
								CH		Diamicton: black fat clay 2% sand; 5% gravel	

(continued)

Remarks

LOG OF Boring PH2-2

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/8/07 Ended 2/8/07
Logged By Barr, EJC

Elevation 1067.283548
Total Depth 185.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Diamicton: black fat clay 2% sand; 5% gravel*(continued)*	
105				--	0/0/100	GLEY12.5/N	Moist			Black fat clay; tough	105
110								CH			110
115				--	0/0/100	GLEY12.5/N	Moist			Black shaley fat clay; tough	115
120											120
125											125
130								CH			130
135				--	0/0/100	GLEY12.5/N	Moist				135
140											140
145				--	0/0/100	GLEY12.5/N	Moist				145

(continued)

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Remarks

Additional data may have been collected in the field which is not included on this log.

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/8/07 Ended 2/8/07
Logged By Barr, EJC

LOG OF Boring PH2-2

SHEET 4 OF 4

Elevation 1067.283548
Total Depth 185.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						CH		Black shaley fat clay; tough*(continued)*	
155		---	0/0/100	GLEY12.5/N	Moist				155
160									160
165		---	0/0/100	GLEY12.5/N	Moist				165
170									170
175		---	0/0/100	GLEY12.5/N	Dry	CH		Black weathered shale	175
180									180
185									185
190									190
195									195

Barr Engineering Co

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Remarks

Additional data may have been collected in the field which is not included on this log.

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/9/07 Ended 2/10/07
Logged By Barr, EJC

LOG OF BORING PH2-4a

SHEET 1 OF 4

Elevation 1085.95804
Total Depth 175.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/20/80	7.5YR3/2	Frozen	OL		Brown organic-rich topsoil	
								CL	▨	Grayish brown gravelly lean clay w/ sand 20% sand; 15% gravel Reddish oxidation Charcoal	
5				---	20/5/75	10YR6/6	Dry	CL	▨	Brownish yellow lean clay w/ gravel 20% gravel; 5% sand	5
									●	Granite boulder	
10				---	10/15/75	7.5YR4/4	Moist	CL	▨	Brownish yellow lean clay w/ gravel 20% gravel; 5% sand Charcoa; reddish oxidation	10
15				---	10/3/87	7.5YR4/4	Moist	CL	▨	Brown lean clay w/ gravel 10% gravel; 15% sand	15
20											20
25				---	10/90/0	7.5YR4/6	Wet	SP	░	Strong brown sand; mg-cg 10% gravel	25
								CL	▨	Brown lean clay	
								SP	░	Strong brown sand; mg-cg	
30								CL	▨	Brown lean clay	30
35				---	3/2/95	7.5YR4/6	Moist				35
40								CH	▨	Diamicton: v dark gray fat clay	40
45				---	5/0/95	7.5YR3/1	Moist				45

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4a

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/9/07 Ended 2/10/07
Logged By Barr, EJC

Elevation 1085.95804
Total Depth 175.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						CH		Diamicton: v dark gray fat clay*(continued)*	
						SW		V dark gray sand; fg-cg	
						CH		Diamicton: v dark gray fat clay	
55		---	0/0/100	2.5Y3/1	Moist	CH		V dark gray fat clay fg-mg sand lenses from 64' to 65', up to 3" thick	55
60									60
65		---	0/80/20	2.5Y3/1	Wet	SM		V dark gray silty sand; fg-cg	65
						CH		Diamicton: v dark gray fat clay	
70									70
75		---	5/0/95	2.5Y3/1	Moist				75
80									80
85		---	5/0/95	2.5Y3/1	Moist				85
90									90
95									95

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4a

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/9/07 Ended 2/10/07
Logged By Barr, EJC

Elevation 1085.95804
Total Depth 175.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										Diamicton: v dark gray fat clay*(continued)*	
105				---	5/0/95	2.5Y3/1	Moist				105
110											110
115				---	5/0/95	2.5Y3/1	Moist				115
								CH			
120											120
125											125
130											130
135				---	0/0/100	5Y2.5/1	Moist			Black fat clay; somewhat shaley	135
140											140
								CH			
145				---	0/0/100	5Y2.5/1	Moist				145

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4a

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/9/07 Ended 2/10/07
Logged By Barr, EJC
Elevation 1085.95804
Total Depth 175.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
							▨	Black fat clay; somewhat shaley*(continued)*	
155		---	0/0/100	5Y2.5/1	Moist		▨		155
						CH	▨		
160							▨		160
165		---	0/0/100	5Y2.5/1	Moist		☰	Weathered black shale	165
170						CH	☰		170
175									175
180									180
185									185
190									190
195									195

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4b

SHEET 1 OF 3

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/10/07 Ended 2/11/07

Logged By Barr, EJC

Elevation 1053.316764

Total Depth 140.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
		---	0/30/70	10YR3/3	Frozen	OL		Dark brown organic-rich topsoil 30% fg sand	
						SM		Dark yellowish brown silty sand 60% fg sand	
5		---	20/60/20	10YR4/6	Moist	SM		Dark yellowish brown silty sand 60% mg sand	5
10						SC		Dark yellowish brown clayey sand; mg-cg	10
15		---	15/5/80	5YR4/4	Moist	CH		Fat clay w/ gravel 15% gravel; 5% sand	15
20						SM		Olive to olive gray silty sand; fg-mg Reddish oxidation	20
						SP SM		Dark gray sand w/ silty; mg-cg Silt and clay lenses to 4"thick from 23' to 25'	
25		---	0/0/100	5Y3/1	Moist	CH		V dark gray fat clay	25
30									30
						SP		V dark gray sand, mg 5% fines	
35		---	0/0/100	5Y3/1	Moist	CH		V dark gray fat clay	35
40									40
45		---	10/0/90	5Y3/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% fg gravel	45

(continued)

Barr Engineering Co

BARR

Telephone:

Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4b

SHEET 2 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/10/07 Ended 2/11/07
Logged By Barr, EJC

Elevation 1053.316764
Total Depth 140.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
55				---	10/0/90	5Y3/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% fg gravel*(continued)*	55
60											60
65				---	50/40/10	2.5Y3/1	Wet	GW		V dark gray gravel w/ sand, cg	65
70								CH		Diamicton: v dark gray fat clay w/ cobbles to 3" in diameter 10% gravel & cobbles	70
75				---	10/0/90	2.5Y2.5/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% gravel to 1" in diameter	75
								SP		V dark gray sand, mg-cg	
80								CH		Diamicton: v dark gray fat clay w/ 5% gravel	80
85				---	10/0/90	2.5Y2.5/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% gravel	85
90				---	5/0/95	2.5Y2.5/1	Moist	CH		Diamicton: v dark gray fat clay w/ 5% gravel	90
95											95

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-4b

SHEET 3 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/10/07 Ended 2/11/07
Logged By Barr, EJC

Elevation 1053.316764
Total Depth 140.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Diamicton: v dark gray fat clay w/ 5% gravel*(continued)*	
105				---	0/0/100	2.5Y2.5/1	Moist			V dark gray fat clay, somewhat shaley	105
110								CH			110
115				---	0/0/100	2.5Y2.5/1	Moist			V dark gray fat clay; shaley	115
120								CH			120
125				---	0/0/100	2.5Y2.5/1	Moist				125
										Shale, pulverized by bit Smells like motor oil	
130								CH			130
								CH		V dark gray fat clay; shaley	
135				---	0/0/100	2.5Y2.5/1	Moist			V dark gray shale	135
								CH			
140											140
145											145

Barr Engineering Co

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Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-5

SHEET 1 OF 3

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/11/07 Ended 2/12/07

Logged By Barr, EJC

Elevation 1063.842474

Total Depth 130.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
		---	20/0/80	10YR2/1	Moist	OL		Black organic-rich topsoil 20% fg gravel	
5		---	0/40/60	10YR3/2	Wet	CL		Dark grayish brown lean clay 5% gravel Mottled yellowish brown	5
						ML		V dark brown sandy silt	
10						GC		Dark yellowish brown clayey gravel 10% sand	10
15		---	0/100/0	10YR4/4	Wet	SP		Dark yellowish brown clean sand; cg	15
20						SP		Dark gray sand, cg	20
						SP SM		Dark gray sand, fg-mg 10% silty fines	
25 30						CH		Diamicton: v dark gray fat clay	25 30
35 40 45		---	5/0/95	10YR3/1	Moist	SP SM		Dark gray sand w/ silty, mg-cg	35 40 45
								Dark gray sand w/ silt, fg	

(continued)

BARR

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 35.5' to 99'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-5

SHEET 2 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/11/07 Ended 2/12/07
Logged By Barr, EJC

Elevation 1063.842474
Total Depth 130.0

DEPTH FEET	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	DESCRIPTION
					SP SM	Dark gray sand w/ silt, fg*(continued)*
55	--	0/80/20	10YR4/1	Moist	SM	Dark gray silty sand, fg
					SM	Dark gray silty sand, fg-mg
					ML	Dark gray silt and clay w/ 20% sand
					SM	Dark gray sand w/ silt, fg-mg
					CL ML	Alternating lenses of dark gray silt and clay
					SP SM	Dark gray sand w/ silt, fg
65	---	0/95/5	10YR4/1	Wet	SP	Dark gray sand, fg-mg
					CH	V dark gray fat clay
85	---	10/85/5	10YR3/1	Wet	SP	V dark gray sand, cg 10% fg gravel
					SP	V dark gray sand, mg
					SP	V dark gray sand, mg-mg
					SP	V dark gray sand, mg-cg
					CH	V dark gray fat clay, somewhat shaley

(continued)

Barr Engineering Co

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Telephone:
Fax:

Remarks Sampled from 35.5' to 99'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-5

SHEET 3 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/11/07 Ended 2/12/07
Logged By Barr, EJC

Elevation 1063.842474
Total Depth 130.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
									▨	V dark gray fat clay, somewhat shaley*(continued)*	
105				---	0/0/100	10YR3/1	Moist		▨		105
110									▨		110
								CH	▨		
115				---	0/0/100	10YR3/1	Moist		▨		115
120									▨		120
125				---	0/0/100	10YR3/1	Moist		▨	V dark gray shaley clay	125
								CH	▨		
130										Granite bedrock	130
135											135
140											140
145											145

Barr Engineering Co

BARR
Telephone:
Fax:

Remarks Sampled from 35.5' to 99'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-6

SHEET 1 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/12/07 Ended 2/12/07

Logged By Barr, EJC

Elevation 1106.329856

Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/0/100	5.YR2.5/2	Frozen	OL		V dark brown organic-rich medium plasticity clayey topsoil	
5				---	25/75/0	10YR5/4	Moist	CL		Dark brown lean clay 5% fg gravel; 5% fg sand	5
								SP		Yellowish brown sand w/ gravel to 2" in diameter	
10											10
15				---	20/80/0	10YR5/4	Wet	SP		Yellowish brown sand, cg 20% fg gravel	15
								SP		Yellowish brown sand, mg	
								SP		Yellowish brown sand, fg	
20											20
										Gray sand, fg-mg	
25											25
30											30
35				---	0/100/0	10YR5/1	Wet	SP			35
40											40
45											45

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 25' to 151'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-6
SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/12/07 Ended 2/12/07
Logged By Barr, EJC
Elevation 1106.329856
Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Gray sand, fg-mg*(continued)*	
55				---	0/100/0	10YR5/1	Wet			Gray sand, mg	55
								SP			
60											60
										Gray sand, fg-mg	
65											65
								SP			
70											70
75				---	0/100/0	10YR5/1	Wet			Gray sand, mg-cg	75
80											80
85											85
								SP			
90											90
95				---	0/100/0	10YR5/1	Wet				95

(continued)

Remarks Sampled from 25' to 151'

LOG OF Boring PH2-6

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/12/07 Ended 2/12/07
Logged By Barr, EJC

Elevation 1106.329856
Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										Gray sand, mg-cg*(continued)*	
105											105
110											110
115				--	0/100/0	10YR5/1	Wet				115
								SP			
120											120
125											125
130											130
135				--	5/95/0	10YR5/1	Wet			Gray sand, mg	135
140											140
								SP			
145											145

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 25' to 151'

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring PH2-6

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/12/07 Ended 2/12/07
Logged By Barr, EJC

Elevation 1106.329856
Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP	⁙	Gray sand, mg*(continued)*	
								CH	▨	Fat black clay, v shaley	
155								CH		Shale bedrock	155
160											160
165											165
170											170
175											175
180											180
185											185
190											190
195											195

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 25' to 151'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-7

SHEET 1 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/13/07 Ended 2/14/07

Logged By Barr, EJC

Elevation 1128.60896

Total Depth 155.0

DEPTH FEET	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	DESCRIPTION	DEPTH FEET
	---	0/0/100	10YR2/2	Frozen	OL	V dark brown organic-rich topsoil	
					CL	Light olive brown lean clay 2% cg sand	
5	---	10/0/90	2.5Y5/4	Moist	CL	Light olive brown lean clay 10% fg gravel Reddish oxidation; gray mottling	5
10							10
15	---	2/10/88	10YR5/4	Moist	CL	Yellowish brown lean clay 10% cg sand Reddish oxidation; gray mottling	15
20					GC	Yellowish brown clayey gravel	20
					GC	Yellowish brown clayey gravel	
					GC	Yellowish brown clayey gravel and sand Charcoal; reddish oxidation	
25	---	30/60/10	10YR5/4	Wet	SP SC	Yellowish brown sand w/ clay and gravel	25
30							30
					CL	Diamicton: dark gray lean clay w/ 10% fg gravel	
35	---	40/60/0	10YR4/4	Wet	SP	Dark yellowish brown sand w/ 40% fg-cg gravel	35
					SP	Dark gray sand, mg-cg 20% fg gravel	
40							40
					CL	Diamicton: v dark gray lean clay 5% fg gravel	
45	---	5/0/95	2.5Y3/1	Moist	CL	Diamicton: v dark gray lean clay 5% gravel	45

(continued)

Barr Engineering Co

BARR

Telephone:

Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-7

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/13/07 Ended 2/14/07
Logged By Barr, EJC

Elevation 1128.60896
Total Depth 155.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
55		--	5/0/95	2.5Y3/1	Moist	CL		Diamicton: v dark gray lean clay 5% gravel*(continued)*	55
60									60
65		--	5/5/90	5YR4/2	Moist	CL		Dark reddish gray lean clay 5% fg gravel; 5% fg sand	65
70									70
75		--	0/0/100	10YR3/1	Moist	ML		V dark gray silt	75
						SP		V dark gray sand, mg 10% gravel; 10% silt, grading to cg gravel at 83'	
80									80
						CL		Diamicton: v dark gray lean clay	
85		--	0/0/100	10YR3/1	Moist				85
90									90
95		--	5/0/95	2.5Y2.5/1	Moist	CL		Black lean clay Smells like motor oil	95

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-7

SHEET 3 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 2/13/07 Ended 2/14/07

Logged By Barr, EJC

Elevation 1128.60896

Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CL	▨	Black lean clay Smells like motor oil*(continued)*	
105				---	5/80/15	10YR3/1	Wet	SM	░	V dark gray sand, cg 5% gravel, 15% silt	105
								CL	▨	V dark gray lean clay	
								SP	░	V dark gray sand, fg-mg	
110									▨	Black fat clay	110
115				---	0/0/100	2.5Y2.5/1	Moist		▨		115
120									▨		120
125				---	0/0/100	2.5Y2.5/1	Moist		▨		125
130								CH	▨		130
135				---	0/0/100	2.5Y2.5/1	Moist		▨		135
140									▨		140
145				---	0/0/100	2.5Y2.5/1	Moist		▨		145

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH2-7

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 2/13/07 Ended 2/14/07
Logged By Barr, EJC

Elevation 1128.60896
Total Depth 155.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH	▨	Black fat clay*(continued)*	
155											155
160											160
165											165
170											170
175											175
180											180
185											185
190											190
195											195

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-1

SHEET 1 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/6/07 Ended 3/6/07
Logged By Barr, EJC

Elevation 1064.112378
Total Depth 115.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
		---	0/0/100	2.5Y3/1	Frozen	OL		V dark gray organic-rich topsoil	
						CH		Light olive brown faty clay Reddish oxidation; charcoal	
5		---	0/0/100	2.5Y5/3	Moist				5
						SP		Light olive brown sand, cg	
						GP		Black sandy gravel w/ cobbles to 2" in diameter 70% fg gravel; 30% cg sand	
10									10
15		---	70/30/0	10YR4/1	Wet	GP		Dark gray gravel w/ sand 70% gravel; 30% sand	15
20									20
						ML		Dark gray silt	
25									25
30									30
						SP		Gray sand, fg-mg	
35		---	10/85/5	10YR5/1	Wet	SP		Gray sand, mg-cg Decreasing grain size w/ depth 10% gravel; 5% fines	35
						CH		Diamicton: v dark gray fat clay w/ 10% sand, cg	
40									40
45									45

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 60' to 98'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-1

SHEET 2 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/6/07 Ended 3/6/07
Logged By Barr, EJC

Elevation 1064.112378
Total Depth 115.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION
55				---	0/10/90	10YR3/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% sand, cg*(continued)*
60								SP		V dark gray sand, mg-cg
65				---	0/100/0	10YR4/1	Wet	SP		Dark gray sand, mg
								GP		Dark gray gravel and cobbles from 1/4" to 2" in diameter Granite, limestone, shale
								SP		Dark gray sand, mg Faint petroleum odor
								SP		
70								SP		Dark gray sand, cg 20% gravel Faint petroleum odor Dark gray sand, mg-cg Faint petroleum odor
75								SP		Dark gray sand, fg-mg Faint petroleum odor
80								SP		Dark gray sand, mg 20% gravel Faint petroleum odor
85				---	20/80/0	10YR4/1	Wet	SP		Dark gray sand, mg-cg 20% gravel
								SM		Dark gray sand, fg 30% fines
90								SP		Dark gray sand, mg, and cg gravel
95				---	0/90/10	10YR4/1	Wet	SP		Dark gray sand, mg 10% fines
								CH		Shaley black clay

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 60' to 98'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-1

SHEET 3 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/6/07 Ended 3/6/07
Logged By Barr, EJC
Elevation 1064.112378
Total Depth 115.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
105 110 115	↓	■		---	0/0/100	10YR2/1	Moist	CH	▨	Shaley black clay*(continued)*	105 110 115
120 125 130 135 140 145											120 125 130 135 140 145

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 60' to 98'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-2

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/7/07 Ended 3/8/07
Logged By Barr, EJC

Elevation 1046.58796
Total Depth 173.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/5/95	10YR3/2	Frozen	OL		V dark grayish brown organic-rich topsoil w/ 5% sand, fg	
								CL		Light olive brown lean clay; mottled w/ gray	
5				---	0/5/95	2.5Y3/4	Moist				5
10								SM		Light olive brown silty sand, fg	10
15				---	10/85/5	10YR4/4	Wet	SP		Dark yellowish brown mg sand, grading to cg w/ fg gravel	15
								SP		Dark gray sand, cg, w/ 10% fg gravel	
20								CH		Diamicton: dark gray fat clay w/ 10% fg gravel Gravel lenses to 3" thick	20
25											25
30											30
35				---	40/60/0	10YR4/1	Wet	SP		Dark gray gravel to 3" in diameter; grading to very cg sand	35
40								CH		Diamicton: dark gray fat clay w/ 10% fg gravel	40
45											45

(continued)

BARR

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 140' to 169.5'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-2

SHEET 2 OF 4

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 3/7/07 Ended 3/8/07

Logged By Barr, EJC

Elevation 1046.58796

Total Depth 173.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Diamicton: dark gray fat clay w/ 10% fg gravel*(continued)*	
55				---	10/0/90	10YR3/1	Moist			Diamicton: V dark gray fat clay w/ 10% fg-mg angular gravel Gravel lenses up to 6" thick	55
60											60
65											65
70											70
75				---	10/0/90	10YR3/1	Moist	CH			75
80											80
85											85
90											90
95				---	0/0/100	10YR3/1	Moist			V dark gray fat clay; shaley	95
								CH			

(continued)

Barr Engineering Co

BARR

Telephone:

Fax:

Remarks Sampled from 140' to 169.5'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-2

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/7/07 Ended 3/8/07
Logged By Barr, EJC

Elevation 1046.58796
Total Depth 173.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		V dark gray fat clay; shaley*(continued)*	
115				--	0/0/100	10YR2/1	Dry	CH		Black weathered shale; faint petroleum odor	115
135				--	0/0/100	10YR2/1	Moist				135
140										Greenish gray sandy soapstone V soft and friable	140

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 140' to 169.5'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-2

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/7/07 Ended 3/8/07
Logged By Barr, EJC
Elevation 1046.58796
Total Depth 173.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										Greenish gray sandy soapstone V soft and friable*(continued)*	
155											155
				--	0/60/40	GLEY16/10Y	Moist				
160											160
										Granite boulder, well rounded	
										Greenish gray soapty sandstone Somewhat friable	
165				--	0/60/40	GLEY16/10Y	Moist				165
170										Granite bedrock	170
175											175
180											180
185											185
190											190
195											195

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 140' to 169.5'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-3

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/8/07 Ended 3/9/07
Logged By Barr, EJC

Elevation 1049.8688
Total Depth 182.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/0/100	10YR2/2	Frozen	OL		V dark brown organic-rich topsoil	
5				---	0/0/100	2.5Y4/4	Moist	CL		Olive brown lean clay Mottled w/ gray	5
10								SP		Dark grayish brown mg sand, grading to cg w/ 5% gravel to 2" in diameter at 12'	10
15				---	10/90/0	10YR4/6	Wet	SP		Dark yellowish brown cg sand w/ 10% fg gravel	15
20										Diamicton: v dark gray fat clay w/ 10% sand, cg	20
25											25
30											30
35				---	0/10/90	10YR3/1	Moist	CH			35
40											40
45											45

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

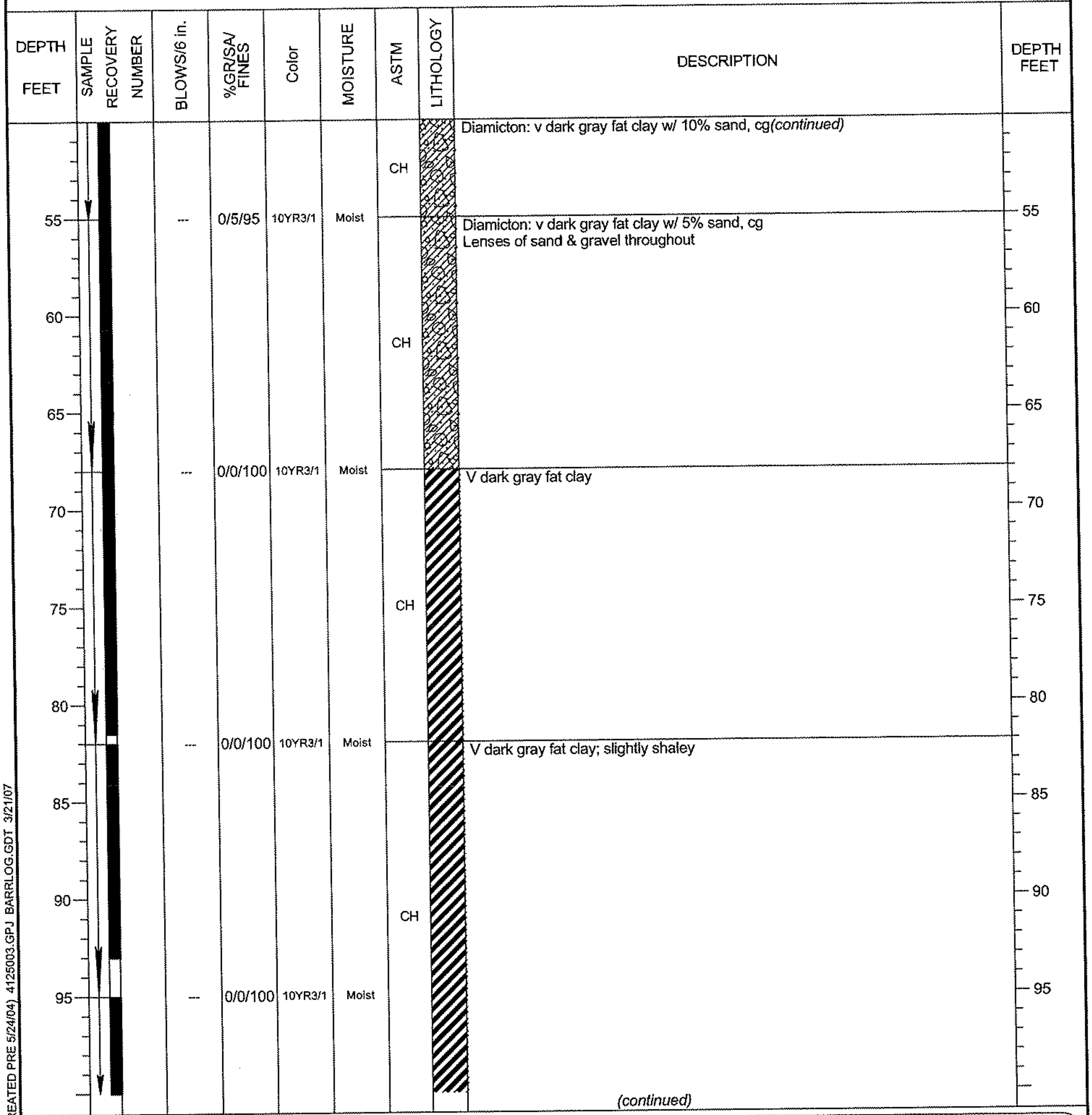
LOG OF BORING PH3-3

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/8/07 Ended 3/9/07
Logged By Barr, EJC

Elevation 1049.8688
Total Depth 182.0



DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH		Diamicton: v dark gray fat clay w/ 10% sand, cg*(continued)*	
55				---	0/5/95	10YR3/1	Moist				55
								CH		Diamicton: v dark gray fat clay w/ 5% sand, cg Lenses of sand & gravel throughout	
60											60
65											65
				---	0/0/100	10YR3/1	Moist				
								CH		V dark gray fat clay	
70											70
75											75
80											80
				---	0/0/100	10YR3/1	Moist				
								CH		V dark gray fat clay; slightly shaley	
85											85
90											90
95				---	0/0/100	10YR3/1	Moist				95

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-3

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/8/07 Ended 3/9/07
Logged By Barr, EJC

Elevation 1049.8688
Total Depth 182.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH	▨	V dark gray fat clay; slightly shaley*(continued)*	
105											105
110											110
115				---	0/0/100	GLEY12.5/N	Dry	CH	☰	Black weathered shale	115
120											120
125											125
130											130
				---	0/0/100	GLEY12.5/N	Dry				
135											135
140											140
				---	0/5/95	GLEY17/10GY	Dry			Light bluish gray soapstone 5-25% sand V soft and friable	
145											145

(continued)

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-3

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/8/07 Ended 3/9/07
Logged By Barr, EJC

Elevation 1049.8688
Total Depth 182.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/10/90	LEY17/10GY	Dry			Light bluish gray soapstone 5-25% sand V soft and friable*(continued)*	
155											155
160											160
				---	0/10/90	LEY17/10GY	Dry				
165										Green metamorphosed sandstone/soapstone, like soft quartzite	165
170										Red granite bedrock	170
175											175
180											180
185											185
190											190
195											195

Barr Engineering Co

Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-4

SHEET 1 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/9/07 Ended 3/10/07
Logged By Barr, EJC

Elevation 1122.04728
Total Depth 210.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				--	0/5/95	10YR2/2	Frozen	OL		V dark brown organic-rich topsoil w/ 5% cg sand	
5								CL		Yellowish brown leean clay Reddish oxidation; charcoal	5
10								CL		Yellowish brown lean clay 5% gravel Reddish oxidation; charcoal	10
15 20 25 30				--	0/100/0	10YR7/4	Dry	SW		V pale brown sand Well graded from v fg to cg	15 20 25 30
								CL		Olive brown sandy lean clay 10% mg sand	
35				--	0/100/0	10YR6/6	Moist	SP		Yellowish brown sand, cg	35
40								SP		Yellowish brown sand, mg	40
								SP		Yellowish brown sand, cg	
								ML		Yellowish brown silsty sand, fg	
45								SP		Yellowish brown sand, cg, w/ gravel to 2" in diameter	45

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 35' to 50'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-4

SHEET 2 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/9/07 Ended 3/10/07
Logged By Barr, EJC

Elevation 1122.04728
Total Depth 210.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SM		V dark gray silty sand w/ 20% gravel	
								ML		Sandy silt w/ gravel	
55				---	70/30/0	10YR4/1	Wet	GP		Dark gray cg gravel w/ 30% mg-cg sand	55
										V dark gray medium plasticity clay w/ 10% gravel to 1 1/2" in diameter and 10% mg sand Gravel and sand lenses up to 6" thick @ 64', 66', 67', 74'	
60											60
65											65
70								CL			70
75				---	10/10/80	10YR3/1	Moist				75
80											80
								SM		V dark gray silty sand	
85											85
								GP		Cobbles to 4" in diameter in a v dark gray silt/clay matrux	
										Diamicton: v dark gray fat clay w/ 20% fg-mg gravel	
90								CH			90
95				---	10/0/90	10YR3/1	Moist			Diamicton: v dark gray fat clay w/ 10% fg-mg gravel	95
								CH			

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 35' to 50'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-4

SHEET 3 OF 5

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 3/9/07 Ended 3/10/07

Logged By Barr, EJC

Elevation 1122.04728

Total Depth 210.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										Diamicton: v dark gray fat clay w/ 10% fg-mg gravel*(continued)*	
105											105
110											110
115				--	10/0/90	10YR3/1	Moist	CH			115
120											120
125											125
130											130
135				--	0/0/100	10YR3/1	Moist	CH		V dark gray fat clay	135
140											140
145											145

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 35' to 50'

LOG OF BORING PH3-4

SHEET 4 OF 5

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 3/9/07 Ended 3/10/07

Logged By Barr, EJC

Elevation 1122.04728

Total Depth 210.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								CH	▨	V dark gray fat clay*(continued)*	
155				---	0/0/100	10YR3/1	Moist		▨	V dark gray fat clay w/ seams of silty sand < 5mm thick	155
160									▨		160
165									▨		165
170									▨		170
175				---	0/0/100	10YR3/1	Moist	CH	▨		175
180									▨		180
185				---	0/0/100	10YR3/1	Moist		▨		185
190									▨		190
195				---	0/0/100	GLEY12.5/10Y	Moist		▤	Greenish black shale	195
								CH	▤		

(continued)

BARR

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 35' to 50'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-4

SHEET 5 OF 5

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 3/9/07 Ended 3/10/07

Logged By Barr, EJC

Elevation 1122.04728

Total Depth 210.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
										Greenish black shale *(continued)*	
205								CH			205
210											210
215											215
220											220
225											225
230											230
235											235
240											240
245											245

Barr Engineering Co

BARR

Telephone:

Fax:

Remarks Sampled from 35' to 50'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-5

SHEET 1 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/12/07 Ended 3/13/07
Logged By Barr, EJC
Elevation 1102.36224
Total Depth 225.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/5/95	10YR3/3	Frozen	CL		Dark brown organic-rich topsoil 5% fg-mg sand	
								ML		Light yellow brown clayey silt	
5				---	0/10/90	2.5Y4/4	Dry	ML		Olive brown silt w/ 10% fg sand Calcified fragments	5
10											10
15				---	5/20/75	10YR5/4	Moist	CL		Yellowish brown sandy lean clay 20% mg sand Reddish oxidation	15
								SM		Yellowish brown silty sand, fg	
20											20
25				---	0/90/10	10YR6/6	Moist	SP SM		Brownish yellow sand, fg w/ 10% silt	25
30											30
35				---	0/95/5	10YR5/6	Moist	SP		Yellowish brown sand, fg w/ 5% silt	35
40											40
45											45
								SP		Yellowish brown sand, mg-cg	

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 55' to 202'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-5

SHEET 2 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/12/07 Ended 3/13/07
Logged By Barr, EJC
Elevation 1102.36224
Total Depth 225.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						SP		Yellowish brown sand, mg-cg*(continued)*	
55		---	0/100/0	10YR5/6	Wet	SP		Yellowish brown sand, mg	55
						SP		Gray mg-cg sand	
						GP		Gray gravel, fg-cg, w/ 40% mg-cg sand	
						SP		Gray sand, mg w/ 30% fg gravel	
60						SP		Gray sand, mg-cg	60
						GP		Gray gravel w/ 40% cg sand	
75		---	50/50/0	10YR5/1	Wet	GP		Gray cg sand and fg-cg gravel	75
						SP		Gray mg-cg gravel	
						SP		Gray cg sand & fg gravel	
95		---	5/80/0	10YR5/1	Sat.	SM		Gray silty sand, fg	95
						GP		Gray gravel, fg-cg	
						SM		Gray silty sand, mg	

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 55' to 202'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-5

SHEET 3 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/12/07 Ended 3/13/07
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 225.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION
						SP		Gray sand, cg
115		---	60/40/0	10YR5/1	Sat.	GP		Gray gravel, cg, w/ 40% cg sand
						SP		Gray sand, cg Faint petroleum odor
						SP		Gray gravel, fg-cg, and sand, mg-cg
135		---	70/30/0	10YR5/1	Sat.	GP		Gray gravel, cg, w/ 30% sand Faint petroleum odor
						SP		Gray sand, mg Faint petroleum odor
						SP		Gray sand, cg Faint petroleum odor
						SP		Gray sand, mg Faint petroleum odor
						GP		

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 55' to 202'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-5

SHEET 4 OF 5

Client Otter Tail Power Company

Project Name Big Stone II

Number 41/25-003 GWTR 200

Location Big Stone City, SD

Drill Contractor Boart Longyear

Drill Method Rotasonic

Drilling Started 3/12/07 Ended 3/13/07

Logged By Barr, EJC

Elevation 1102.36224

Total Depth 225.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						GP		Gray gravel & sand, mg-cg Faint petroleum odor *(continued)*	
		--	90/10/0	10YR5/1	Sat.	GP		Gray gravel, fg	
155						SP		Gray sand, cg, w/ 30% fg gravel	155
160						SP		Gray sand, cg	160
						GP		Gray gravel, cg, to 3" in diameter	
165		--	70/30/0	10YR5/1	Sat.	GP		Gray gravel, fg-cg, w/ 30% cg sand	165
170						SP		Sand, cg, w/ 20% cg gravel	170
						GP		Gravel, cg, w/ 30% sand	
175						SP		Sand, cg, w/ 10% fg gravel	175
						SP		Sand, mg, w/ 5% fg gravel	
180						SP		Sand, mg, and mg gravel	180
						SP		Sand, mg-cg, w/ 5% fg gravel	
185		--	90/10/0	10YR5/1	Sat.	GP		Gravel, fg	185
						ML		Cemented fg gravel (40%) w/ 10% sand	
190						SP		Sand, cg, to fg gravel	190
195						SP		Sand, mg-cg	195

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 55' to 202'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-5

SHEET 5 OF 5

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/12/07 Ended 3/13/07
Logged By Barr, EJC

Elevation 1102.36224
Total Depth 225.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
								SP		Sand, mg-cg*(continued)*	
								CL		Shaley cemented siltstone w/ alternating black, gray, and white layers to 5 mm thick Faint petroleum odor	
205				---	0/10/90	GLEY17/10Y	Dry				205
210											210
										Soapy gray sandstone	
215											215
220											220
225											225
230											230
235											235
240											240
245											245

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 55' to 202'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-8

SHEET 1 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1072.83468
Total Depth 153.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				---	0/10/90	10YR2/2	Frozen	OL		V dark brown organic-rich topsoil 10% sand	
								CL		Dark yellowish brown lean clay 10% mg sand	
								SP		Yellowish brown sand, mg-cg 10% fg gravel	
5				---	10/90/0	10YR5/4	Dry	SP		Yellowish brown gravelly sand, mg-cg 10% gravel Gravel and cobbles from 2.5' to 3', 10.5' to 11', and 17' to 18'	5
10				---	15/85/0	10YR5/4	Dry				10
15				---	20/80/0	10YR5/4	Dry				15
20				---	20/80/0	10YR5/4	Moist				20
								GP		Yellowish brown fg-cg gravel	
25				---	70/30/0	10YR5/4	Sat.				25
30											30
35				---	60/30/10	2.5Y4/3	Sat.	GP		Olive brown gravel & sand 10% fines	35
40								CH		V dark gray fat clay w/ sand & gravel 4% fg gravel; 10% cg sand	40
45				---	0/5/95	5Y4/1	Wet	ML		V dark gray silt w/ 10% sand, cg	45

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 25' to 35'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-8

SHEET 2 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1072.83468
Total Depth 153.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
						ML		V dark gray silt w/ 10% sand, cg*(continued)*	
55		---	0/10/90	5Y3/1	Moist	CH		Diamicton: v dark gray fat clay w/ 10% sand, cg	55
60									60
65									65
70									70
75		---	0/10/90	5Y3/1	Moist				75
80									80
85									85
90									90
95		---	0/30/70	5Y3/1	Moist	ML		V dark gray sandy silt, fg	95
						SP		V dark gray silty sand, mg	

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 25' to 35'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-8

SHEET 3 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1072.83468
Total Depth 153.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
105, 110								ML	‖	V dark gray sandy silt, fg	105, 110
115, 120, 125, 130				---	0/0/100	5Y3/1	Moist	CH	▨	V dark gray fat clay w/ silt	115, 120, 125, 130
135, 140, 145				---	0/0/100	5Y3/1	Moist	CH	▨	V dark gray fat clay	135, 140, 145

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 25' to 35'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-8

SHEET 4 OF 4

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1072.83468
Total Depth 153.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
	↓	▮						CH	▨	V dark gray fat clay*(continued)*	
155											155
160											160
165											165
170											170
175											175
180											180
185											185
190											190
195											195

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 25' to 35'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-9

SHEET 1 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD
Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC
Elevation 1079.39636
Total Depth 95.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
0				---	0/10/90	10YR2/2	Frozen	OH		V dark brown organic-rich topsoil 10% mg sand	
								CL		Yellowish brown sandy lean clay 10% mg sand	
5				---	30/70/0	10YR4/4	Dry	SP		Dark yellowish brown clean sand, cg 30% gravel to3 1/2" inches in diameter	5
10											10
15				---	30/70/0	10YR4/4	Dry				15
20								ML		Diamicton: Dark gray clayey silt w/ 35% mg-cg sand	20
25				---	2/35/63	2.5Y4/1	Moist				25
30											30
35				---	5/55/40	2.5Y4/1	Moist	SM		Diamicton: dark gray sand w/ clayey silt	35
40											40
45											45

(continued)

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 53' to 82'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-9

SHEET 2 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 95.0

DEPTH FEET	SAMPLE RECOVERY NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION
						SM		Diamicton: dark gray sand w/ clayey silt*(continued)*
		---	50/50/0	2.5Y4/1	Sat.	SP		Dark gray sand & gravel to 3" in diameter
65		---	40/55/5	2.5Y4/1	Sat.	SP		Dark gray sand & gravel to 3" in diameter 5% fines
						SP SM		Olive gray sand w/ 10% silt
						SP		Dark gray sand, cg 30% gravel to 1 1/2" in diameter
75		---	40/60/0	5Y4/1	Sat.	SP		Dark gray sand, cg 40% gravel
						CL		Dark gray sandy lean clay w/ silt 40% mg sand 10% gravel
85						CH		Dark gray fat clay w/ sand and gravel 10% fg sand; 10% gravel
95								

(continued)

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks Sampled from 53' to 82'

Additional data may have been collected in the field which is not included on this log.

LOG OF BORING PH3-9

SHEET 3 OF 3

Client Otter Tail Power Company
Project Name Big Stone II
Number 41/25-003 GWTR 200
Location Big Stone City, SD

Drill Contractor Boart Longyear
Drill Method Rotasonic
Drilling Started 3/11/07 Ended 3/11/07
Logged By Barr, EJC

Elevation 1079.39636
Total Depth 95.0

DEPTH FEET	SAMPLE	RECOVERY	NUMBER	BLOWS/6 in.	%GR/SA/ FINES	Color	MOISTURE	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
105											105
110											110
115											115
120											120
125											125
130											130
135											135
140											140
145											145

Barr Engineering Co

Telephone:
Fax:

Remarks Sampled from 53' to 82'

Additional data may have been collected in the field which is not included on this log.

Appendix B

Pumping Well and Observation Well Construction Logs

BOART LONGYEAR
Well Construction Report

Job Name Otter Trail
Job Number 34101442
Location Big Stone City, SD

Well Name MWI-2
Driller M. Hansen
Date Installed 01/17/07

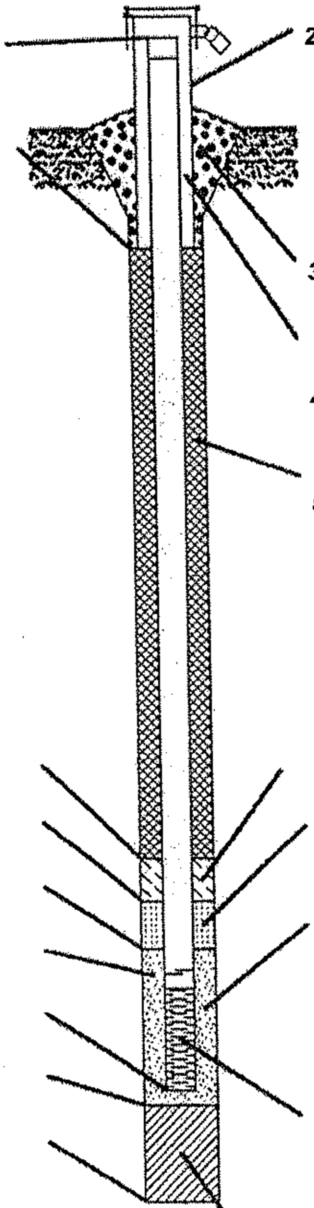
Type of Well:
- x **Water Table Observation**
- **Piezometer**
- **Other**

A. Height of Well Casing above ground 2.0 **ft.**

B. Diameter of Well Casing 2.0 **in.**

C. Surface Seal Bottom 0.0 **ft.**

D. Well Casing: Flush Threaded PVC
- x **Schedule 40**
- **Schedule 80**
- **Other**



E. Bentonite Seal Top 164.0 **ft.**
F. Fine Sand Top NA **ft.**
G. Filter Pack Top 166.0 **ft.**
H. Screen Joint Top 168.0 **ft.**
I. Well Bottom 178.0 **ft.**
J. Filter Pack Bottom 180.0 **ft.**
K. Borehole Bottom 180.0 **ft.**

1. Locking Cap? x **Yes** **No**

2. Protective Cover:
- **a. Inside diam.** 4.0 **in.**
- **b. Length** 7.0 **ft.**
- **c. Material**
  - x **Steel**
  - **Other**
- **d. Bumper Post**
  - **3"**
  - **4"**

3. Surface Seal:
- **Bentonite**
- x **Concrete**
- **Other**

4. Material between Casing and Protop:
- **Bentonite**
- **Other**

5. Annular Space Seal:
- **Granular Bentonite**
- **Bentonite Slurry**
- x **Cement-Bentonite Groute**
- **Other**

How Installed:
- **Gravity**
- x **Tremie Pumped**

6. Bentonite Seal:
- x **Granules**
- **Pellets**

7. Type of Fine Sand: NA

8. Type of Filter Pack: Red Flint 35/45

9. Screen Material: PVC
Type:
- x **Factory Cut**
- **Continuous Slot**

Slot Size: 0.010 **in.**
Length: 10.0 **ft.**

10. Backfill Material: (Below filter pack)
- **None**
- x **Other** Red Flint #40

Boart Longyear
101 Alderson Street
Schofield WI 54476
Phone (715) 359-7090
Fax (715) 355-5715

BOART LONGYEAR

Well Construction Report

Job Name Otter Trail

Job Number 34101442

Location Big Stone City, SD

Well Name MW 1- 4

Driller M. Hansen

Date Installed 01/19/07

Type of Well:

x **Water Table Observation**

___ **Piezometer**

___ **Other** ________

A. Height of Well Casing above ground 2.0 **ft.**

B. Diameter of Well Casing 2.0 **in.**

C. Surface Seal Bottom 0.0 **ft.**

D. Well Casing: Flush Threaded PVC

x **Schedule 40**

___ **Schedule 80**

___ **Other** ________

E. Bentonite Seal Top 171.0 **ft.**

F. Fine Sand Top NA **ft.**

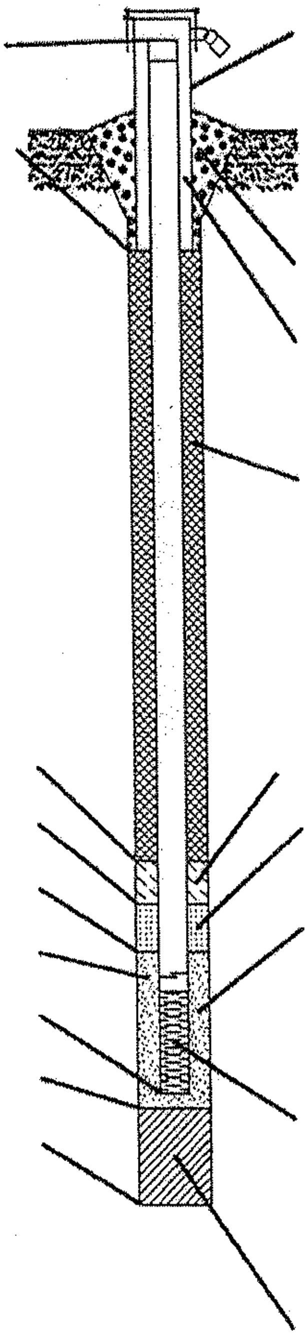
G. Filter Pack Top 173.0 **ft.**

H. Screen Joint Top 175.0 **ft.**

I. Well Bottom 185.0 **ft.**

J. Filter Pack Bottom 186.0 **ft.**

K. Borehole Bottom 186.0 **ft.**



1. Locking Cap? x **Yes** ___ **No**

2. Protective Cover:

a. Inside diam. 4.0 **in.**

b. Length 7.0 **ft.**

c. Material

x **Steel**

___ **Other** ________

d. Bumper Post ________

___ **3"** ___ **4"**

3. Surface Seal:

___ **Bentonite**

x **Concrete**

___ **Other** ________

4. Material between Casing and Protop:

___ **Bentonite**

___ **Other** ________

5. Annular Space Seal:

___ **Granular Bentonite**

___ **Bentonite Slurry**

x **Cement-Bentonite Groute**

___ **Other** ________

How Installed:

___ **Gravity**

x **Tremie Pumped**

6. Bentonite Seal:

___ **Granules**

___ **Pellets**

7. Type of Fine Sand: NA

8. Type of Filter Pack: Red Flint 35/45

9. Screen Material: PVC

Type: x **Factory Cut**

___ **Continuous Slot**

Slot Size: 0.010 **in.**

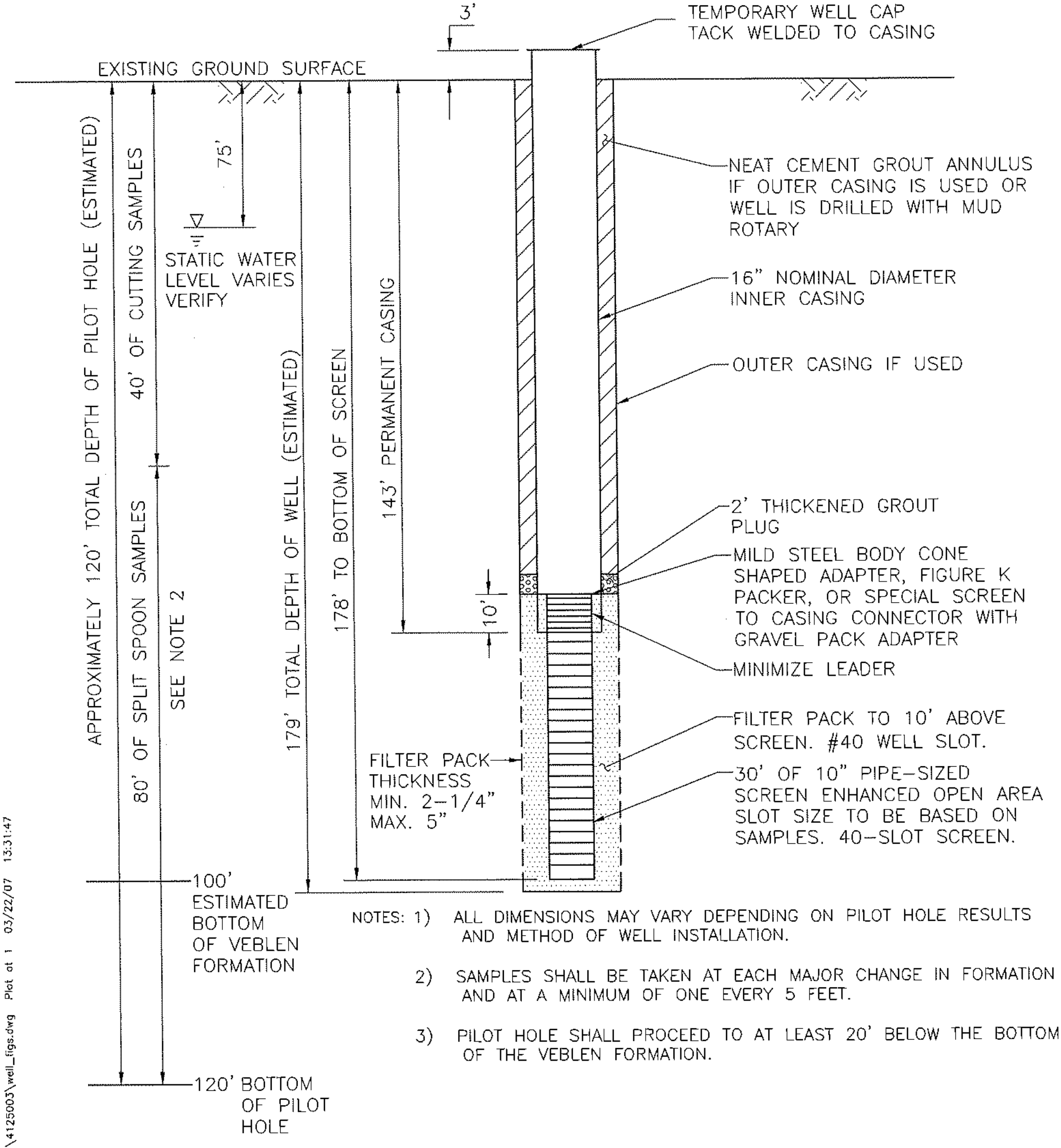
Length: 10.0 **ft.**

10. Backfill Material: (Below filter pack)

___ **None**

x **Other** Red Flint 35/45

Boart Longyear
101 Alderson Street
Schofield WI 54476
Phone (715) 359-7090
Fax (715) 355-5715



NOTES:
1) ALL DIMENSIONS MAY VARY DEPENDING ON PILOT HOLE RESULTS AND METHOD OF WELL INSTALLATION.

2) SAMPLES SHALL BE TAKEN AT EACH MAJOR CHANGE IN FORMATION AND AT A MINIMUM OF ONE EVERY 5 FEET.

3) PILOT HOLE SHALL PROCEED TO AT LEAST 20' BELOW THE BOTTOM OF THE VEBLEN FORMATION.

mpm M:\cad\4125003\well_figs.dwg Plot at 1 03/22/07 13:31:47

BARR
Corporate Headquarters:
Minneapolis, Minnesota
Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
55435-4803
Ph: 1-800-632-2277
Fax: (952) 832-2601
www.barr.com

NOT TO SCALE

PW1-2
PRODUCTION WELL LOGS

P.W. 2

SOUTH DAKOTA WATER WELL COMPLETION REPORT

07-92

Location 5 SW Sec. 15 Twp 121 n Rg 47 W

County Grant

Please mark well location with an X

North

W E

1 Mile

Well Construction Data

Well Owner Otter Tail Power Company

Business Name

Address

WELL LOG:

FORMATION		DEPTH FROM	DEPTH TO
clay	Reddish Brown	0	26
clay	Gray	26	90
Sand	Gray	90	180

LOCATION:
Distance from nearest potential pollution source (septic tank, abandoned well, feed lot, etc.) N/A ft. from (identify source)

PROPOSED USE:
☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☒ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:
Mud Rotary

CASING DATA: ☒ Steel ☐ Plastic ☐ Other

If other describe

WEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
49.56 lbs/ft	12 in	+2 ft	-143 ft	16 3/4 in
lbs/ft	in	ft	ft	in
lbs/ft	in	ft	ft	in

GROUTING DATA

Grout Type	No. of Sacks	Grout Weight	From	To
Neat Cement	100	lbs/gal	0 ft	-105 ft
		lbs/gal	ft	ft

Describe grouting procedure Pressure Grouted from 105 To Ground level

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 10" in Length 35 FEET

Material 304 stainless steel

Slot Size 40 Set from 143 Feet to 178 Feet

Fittings/other information 12" x 10" CS Concentric Weld Reducer to connect pipe to SC.

WAS A PACKER OR SEAL USED? ☐ YES ☒ NO

If so, what material?

Describe material and location?

DISINFECTION Was well disinfected upon completion?

___ YES, How

Water sample sent to lab for water quality analysis? X NO, Why Not? It was going to be test pumped

STATIC WATER LEVEL 75' Feet

If flowing: closed in pressure PSI

GPM flow through inch pipe

Controlled by: ☐ Valve ☐ Reducers ☐ Other

Reduced Flowrate GPM

Can well be completely shut off?

WELL TEST DATA:

☒ Pumped Describe 50 hp test pump Set at 140'

☐ Bailed

☐ Other

Pumping Level Below Land Surface

93.6 ft. After 83 hrs pumped 550 GPM

ft. After hrs pumped GPM

If pump installed, pump rate GPM

REMARKS
Well cleaned up very nice no Sand.

This well was drilled under license # 424

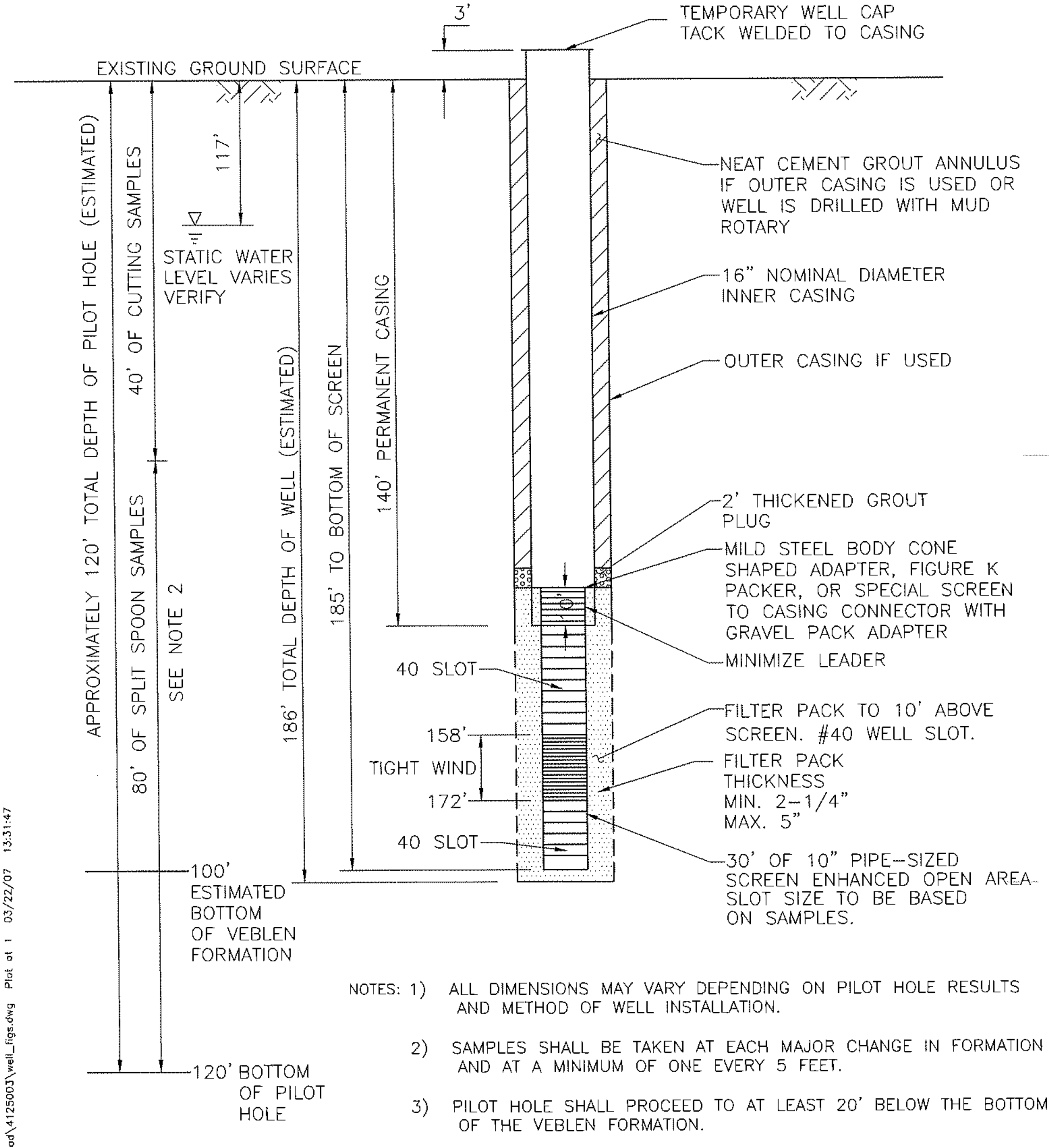
And this report is true and accurate

Drilling Firm

Signature of License Representative

Signature of Well Owner or Equitable Property Holder

Date:



NOTES:
1) ALL DIMENSIONS MAY VARY DEPENDING ON PILOT HOLE RESULTS AND METHOD OF WELL INSTALLATION.
2) SAMPLES SHALL BE TAKEN AT EACH MAJOR CHANGE IN FORMATION AND AT A MINIMUM OF ONE EVERY 5 FEET.
3) PILOT HOLE SHALL PROCEED TO AT LEAST 20' BELOW THE BOTTOM OF THE VEBLEN FORMATION.

mpm M:\cad\4125003\well_figs.dwg Plot at 1 03/22/07 13:31:47

BARR

Corporate Headquarters:
Minneapolis, Minnesota
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Project Office:
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MINNEAPOLIS, MN.
55435-4803
Ph: 1-800-632-2277
Fax: (952) 832-2601
www.barr.com

NOT TO SCALE

PW1-4
PRODUCTION WELL LOGS

D.W 4

SOUTH DAKOTA WATER WELL COMPLETION REPORT

07-92

Location NE ¼ NE ¼ Sec. 7 Twp 121 N Rg 46 W

County Grant

North

Please mark well location with an "X"

W E

Well Completion Date

1 Mile

LOCATION:
Distance from nearest potential pollution source (septic tank, abandoned well, feed lot, etc.)? N/A ft. from ___ (identify source)

PROPOSED USE:
☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☒ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:
Mud Rotary

CASING DATA: ☒ Steel ☐ Plastic ☐ Other

If other describe

PIPE WEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
49.56 lb/ft	12 in	+2 ft	-140 ft	18 3/4 in
lb/ft	in	ft	ft	in
lb/ft	in	ft	ft	in

GROUTING DATA

Grout Type	No. of Sacks	Grout Weight	From	To
Neat	120	lb/gal	0 ft	126 ft
Cement		lb/gal	ft	ft

Describe grouting procedure Pressure grouted From 105 to ground level.

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 10" in Length 45 FEET

Material 304 Stainless steel

Slot Size 40 Set from 140 Feet to 185 Feet

Other information tight wrapped screen from 158 to 172

WAS A PACKER OR SEAL USED? ☐ YES ☒ NO

If so, what material?

Describe packer(s) and location?

DISINFECTION: Was well disinfected upon completion?
☒ YES, How
☐ NO, Why Not?

Laboratory sent to for water quality analysis:

Well Owner Otter Tail Power Company

Business Name

Address

WELL LOG:

FORMATION		DEPTH FROM	DEPTH TO
clay	yellow	0	35
Clay	Dark Gray	35	67
Sand	Brown	67	75
Clay	Dark Gray	75	79
clay	Red	79	93
Clay	Gray	93	121
Sand	Gray	121	185

STATIC WATER LEVEL 117 feet

If flowing, closed in pressure ___ PSI

GPM flow ___ through ___ inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced Flowrate ___ GPM

Can well be completely shut off?

WELL TEST DATA:
☐ Pumped Describe
☐ Bailed
☐ Other

Pumping Level Below Land Surface
___ ft. After ___ hrs. pumped ___ GPM
___ ft. After ___ hrs. pumped ___ GPM

If pump installed, pump rate ___ GPM

REMARKS

This well was drilled under license # 424

And this report is true and accurate

Drilling firm

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder

Date:

Appendix C

Groundwater Analytical Results

Nalco Analytical Resources
1601 West Diehl Road, Naperville, Illinois 60563-1198
Phone: (630) 305-2315, Fax: (630) 305-2946, Analytical.Lab.Naperville@Nalco.com

Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 2 Sample #1
SAP SoldTo Number: 0001008566

Sample Number: NW0701367
Date Sampled: 8:50 am 29-Jan-2007
Date Received: 30-Jan-2007
Date Completed: 12-Feb-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.030	mg/L
Arsenic (As) Filtered		<0.030	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	140	140	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	<0.01	0.02	mg/L
Iron (Fe)	0.01	1.9	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.06	0.06	mg/L
Magnesium (Mg)	50	50	mg/L
Manganese (Mn)	0.10	0.10	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	6.8	6.8	mg/L
Selenium (Se)		<0.010	mg/L
Selenium (Se) Filtered		<0.010	mg/L
Silica (SiO2)	38.0	38.0	mg/L
Silver (Ag)		<0.030	mg/L
Silver (Ag) Filtered		<0.030	mg/L
Sodium (Na)	19.0	19.0	mg/L
Strontium (Sr)	0.59	0.59	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.09	0.12	mg/L
Calcium (CaCO3)	340	340	mg/L
Magnesium (CaCO3)	210	210	mg/L
Sodium (CaCO3)	42.0	42.0	mg/L
Calculated Hardness (CaCO3)	550	550	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	0.30 mg/L	0.70 mg/L
Phosphate (PO4) - Ortho	0.30 mg/L	0.70 mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0701367
Big Stone City SD USA		**Date Sampled:**	8:50 am 29-Jan-2007
Sample Marked:	Well 2 Sample #1	**Date Received:**	30-Jan-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	12-Feb-2007

Water Analysis Report

Anions		
Bromide (Br)	<0.20	mg/L
Chloride (Cl)	1.9	mg/L
Nitrate (NO3)	<0.20	mg/L
Nitrite (NO2)	<0.20	mg/L
Sulfate (SO4)	190	mg/L
Chloride (CaCO3)	2.7	mg/L
Nitrate (CaCO3)	<0.16	mg/L
Sulfate (CaCO3)	200	mg/L
ALK - Alkalinity		
Bicarbonate (CaCO3)	330	mg/L
Methyl Orange (CaCO3)	330	mg/L
Phenolphthalein (CaCO3)	<10	mg/L
Others		
pH	7.9	pH Units
Conductivity	930	µS/cm
Organic Carbon (C) - Total	5.0	mg/L
Ammonia (NH3)	1.2	mg/L
Ammonia (CaCO3)	3.4	mg/L
Suspended Solids (Total @ 105C)	< 2.0	mg/L
Sulfide	< 0.01	mg/L
Organic Carbon (C) - Filtered	< 2.0	mg/L
BOD at 5 days (mg/l or ppm)	3	
Chemical Oxygen Demand (O2)	<5.0	mg/L
Nitrogen (N) - Kjeldahl	<1.0	mg/L
Oil and Grease	<1.0	mg/L
Soluble Fluoride (F)	0.34	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Silica (SiO2) - Colloidal	7.0	mg/L
Silica (SiO2)-Molybdate Reactive	31	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0701367
Big Stone City SD USA		**Date Sampled:**	8:50 am 29-Jan-2007
Sample Marked:	Well 2 Sample #1	**Date Received:**	30-Jan-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	12-Feb-2007

Water Analysis Report

Authorized by : Cheryl Y. Heard

Nalco Analytical Resources
1601 West Diehl Road, Naperville, Illinois 60563-1198
Phone: (630) 305-2315, Fax: (630) 305-2946, Analytical.Lab.Naperville@Nalco.com

Otter Tail Power	**Sample Number:**	NW0701483
Big Stone City SD USA	**Date Sampled:**	10:00 pm 30-Jan-2007
Sample Marked: Well 2 Sample #2	**Date Received:**	31-Jan-2007
SAP SoldTo Number: 0001008566	**Date Completed:**	12-Feb-2007

AMENDED REPORT, Replaces report issued: 08-Feb-2007 2:48 pm

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Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 2 Sample #2
SAP SoldTo Number: 0001008566

Sample Number: NW0701483
Date Sampled: 10:00 pm 30-Jan-2007
Date Received: 31-Jan-2007
Date Completed: 12-Feb-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.030	mg/L
Arsenic (As) Filtered		<0.030	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	120	130	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	0.02	0.11	mg/L
Iron (Fe)	0.03	1.8	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.04	0.05	mg/L
Magnesium (Mg)	44	47	mg/L
Manganese (Mn)	0.09	0.10	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	6.2	6.5	mg/L
Selenium (Se)		<0.010	mg/L
Selenium (Se) Filtered		<0.010	mg/L
Silica (SiO2)	34.0	36.0	mg/L
Silver (Ag)		<0.030	mg/L
Silver (Ag) Filtered		<0.030	mg/L
Sodium (Na)	16.0	17.0	mg/L
Strontium (Sr)	0.51	0.55	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.21	0.30	mg/L
Calcium (CaCO3)	310	320	mg/L
Magnesium (CaCO3)	180	190	mg/L
Sodium (CaCO3)	35.0	38.0	mg/L
Calculated Hardness (CaCO3)	490	510	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	0.30 mg/L	0.30 mg/L
Phosphate (PO4) - Ortho	0.20 mg/L	0.20 mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0701483
Big Stone City SD USA		**Date Sampled:**	10:00 pm 30-Jan-2007
Sample Marked:	Well 2 Sample #2	**Date Received:**	31-Jan-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	12-Feb-2007

Water Analysis Report

Anions

Bromide (Br)	<0.20	mg/L
Chloride (Cl)	1.1	mg/L
Nitrate (NO3)	<0.20	mg/L
Nitrite (NO2)	<0.20	mg/L
Sulfate (SO4)	190	mg/L
Chloride (CaCO3)	1.5	mg/L
Nitrate (CaCO3)	<0.16	mg/L
Sulfate (CaCO3)	200	mg/L

ALK - Alkalinity

Bicarbonate (CaCO3)	330	mg/L
Methyl Orange (CaCO3)	330	mg/L
Phenolphthalein (CaCO3)	<10	mg/L

Others

pH	8.1	pH Units
Conductivity	910	µS/cm
Organic Carbon (C) - Total	3.4	mg/L
Ammonia (NH3)	1.1	mg/L
Ammonia (CaCO3)	3.3	mg/L
Suspended Solids (Total @ 105C)	< 2.0	mg/L
Organic Carbon (C) - Filtered	< 2.0	mg/L
Sulfide	< 0.01	mg/L
BOD at 5 days (mg/l or ppm)	3	
Chemical Oxygen Demand (O2)	8.0	mg/L
Nitrogen (N) - Kjeldahl	1.1	mg/L
Oil and Grease	<1.0	mg/L
Soluble Fluoride (F)	0.33	mg/L
Silica (SiO2) - Colloidal	3.4	mg/L
Silica (SiO2)-Molybdate Reactive	33	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0701483
Big Stone City SD USA		**Date Sampled:**	10:00 pm 30-Jan-2007
Sample Marked:	Well 2 Sample #2	**Date Received:**	31-Jan-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	12-Feb-2007

Water Analysis Report

Authorized by : Cheryl Y. Heard

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Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 2 Sample #3
SAP SoldTo Number: 0001008566

Sample Number: NW0701482
Date Sampled: 7:00 am 30-Jan-2007
Date Received: 31-Jan-2007
Date Completed: 12-Feb-2007

AMENDED REPORT, Replaces report issued: 08-Feb-2007 2:48 pm

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Otter Tail Power		**Sample Number:**	NW0701482
Big Stone City SD USA		**Date Sampled:**	7:00 am 30-Jan-2007
Sample Marked:	Well 2 Sample #3	**Date Received:**	31-Jan-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	12-Feb-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.030	mg/L
Arsenic (As) Filtered		<0.030	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	130	130	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	<0.01	0.03	mg/L
Iron (Fe)	<0.01	1.8	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.04	0.04	mg/L
Magnesium (Mg)	46	47	mg/L
Manganese (Mn)	0.10	0.10	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	6.4	6.4	mg/L
Selenium (Se)		<0.010	mg/L
Selenium (Se) Filtered		<0.010	mg/L
Silica (SiO2)	35.0	36.0	mg/L
Silver (Ag)		<0.030	mg/L
Silver (Ag) Filtered		<0.030	mg/L
Sodium (Na)	17.0	17.0	mg/L
Strontium (Sr)	0.53	0.54	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.13	0.18	mg/L
Calcium (CaCO3)	320	320	mg/L
Magnesium (CaCO3)	190	190	mg/L
Sodium (CaCO3)	37.0	38.0	mg/L
Calculated Hardness (CaCO3)	510	510	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	0.60 mg/L	0.80 mg/L
Phosphate (PO4) - Ortho	0.60 mg/L	0.80 mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 2 Sample #3
SAP SoldTo Number: 0001008566

Sample Number: NW0701482
Date Sampled: 7:00 am 30-Jan-2007
Date Received: 31-Jan-2007
Date Completed: 12-Feb-2007

Water Analysis Report

Anions

Bromide (Br)	<0.20	mg/L
Chloride (Cl)	1.4	mg/L
Nitrate (NO3)	<0.20	mg/L
Nitrite (NO2)	<0.20	mg/L
Sulfate (SO4)	190	mg/L
Chloride (CaCO3)	2.0	mg/L
Nitrate (CaCO3)	<0.16	mg/L
Sulfate (CaCO3)	200	mg/L

ALK - Alkalinity

Bicarbonate (CaCO3)	340	mg/L
Methyl Orange (CaCO3)	340	mg/L
Phenolphthalein (CaCO3)	<10	mg/L

Others

pH	8.2	pH Units
Conductivity	910	µS/cm
Organic Carbon (C) - Total	3.5	mg/L
Ammonia (NH3)	1.1	mg/L
Ammonia (CaCO3)	3.3	mg/L
Suspended Solids (Total @ 105C)	< 2.0	mg/L
Organic Carbon (C) - Filtered	< 2.0	mg/L
Sulfide	< 0.01	mg/L
BOD at 5 days (mg/l or ppm)	3	
Chemical Oxygen Demand (O2)	6.7	mg/L
Nitrogen (N) - Kjeldahl	1.1	mg/L
Oil and Grease	<1.0	mg/L
Soluble Fluoride (F)	0.32	mg/L
Silica (SiO2) - Colloidal	3.5	mg/L
Silica (SiO2)-Molybdate Reactive	33	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power	**Sample Number:** NW0701482
Big Stone City SD USA	**Date Sampled:** 7:00 am 30-Jan-2007
Sample Marked: Well 2 Sample #3	**Date Received:** 31-Jan-2007
SAP SoldTo Number: 0001008566	**Date Completed:** 12-Feb-2007

Water Analysis Report

Authorized by : Cheryl Y. Heard

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Otter Tail Power		**Sample Number:**	NW0703827
Big Stone City SD USA		**Date Sampled:**	7:30 am 28-Feb-2007
Sample Marked:	Well 4 Sample #1	**Date Received:**	06-Mar-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	20-Mar-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.030	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	180	190	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	0.02	0.07	mg/L
Iron (Fe)	<0.01	2.2	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.08	0.09	mg/L
Magnesium (Mg)	72	75	mg/L
Manganese (Mn)	0.19	0.20	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	9.2	9.6	mg/L
Selenium (Se)		<0.010	mg/L
Silica (SiO2)	31.0	32.0	mg/L
Silver (Ag)		<0.030	mg/L
Sodium (Na)	18.0	19.0	mg/L
Strontium (Sr)	1.1	1.1	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.05	0.07	mg/L
Calcium (CaCO3)	460	480	mg/L
Magnesium (CaCO3)	300	310	mg/L
Sodium (CaCO3)	40.0	42.0	mg/L
Calculated Hardness (CaCO3)	760	790	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	<0.2 mg/L	<0.2 mg/L
Phosphate (PO4) - Ortho	<0.10 mg/L	<0.10 mg/L

Anions	
Bromide (Br)	<2.0 mg/L
Chloride (Cl)	<2.0 mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0703827
Big Stone City SD USA		**Date Sampled:**	7:30 am 28-Feb-2007
Sample Marked:	Well 4 Sample #1	**Date Received:**	06-Mar-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	20-Mar-2007

Water Analysis Report

Anions

Nitrate (NO3)	<2.0	mg/L
Nitrite (NO2)	<2.0	mg/L
Sulfate (SO4)	400	mg/L
Chloride (CaCO3)	<2.8	mg/L
Nitrate (CaCO3)	<1.6	mg/L
Sulfate (CaCO3)	410	mg/L

ALK - Alkalinity

Bicarbonate (CaCO3)	330	mg/L
Methyl Orange (CaCO3)	330	mg/L
Phenolphthalein (CaCO3)	<10	mg/L

Others

pH	7.3	pH Units
Conductivity	1400	µS/cm
Organic Carbon (C) - Total	4.2	mg/L
Ammonia (NH3)	1.5	mg/L
Ammonia (CaCO3)	4.4	mg/L
Suspended Solids (Total @ 105C)	5.4	mg/L
Soluble Fluoride (F)	0.26	mg/L
Silica (SiO2) - Colloidal	2.4	mg/L
Silica (SiO2)-Molybdate Reactive	30	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Sulfide	< 0.01	mg/L
Organic Carbon (C) - Filtered	2.7	mg/L
BOD at 5 days (mg/l or ppm)	2	
Chemical Oxygen Demand (O2)	<5.0	mg/L
Oil and Grease	<1.0	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L
Nitrogen (N) - Kjeldahl	<5.0	mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 4 Sample #2
SAP SoldTo Number: 0001008566

Sample Number: NW0703829
Date Sampled: 7:20 am 02-Mar-2007
Date Received: 06-Mar-2007
Date Completed: 22-Mar-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.032	mg/L
Arsenic (As) Filtered		<0.032	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	170	180	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	<0.01	<0.01	mg/L
Iron (Fe)	<0.01	2.5	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.07	0.09	mg/L
Magnesium (Mg)	68	73	mg/L
Manganese (Mn)	0.17	0.19	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	8.5	9.6	mg/L
Selenium (Se)		<0.011	mg/L
Selenium (Se) Filtered		<0.011	mg/L
Silica (SiO2)	29.0	35.0	mg/L
Silver (Ag)		<0.032	mg/L
Silver (Ag) Filtered		<0.032	mg/L
Sodium (Na)	17.0	20	mg/L
Strontium (Sr)	0.99	1.2	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.03	0.04	mg/L
Calcium (CaCO3)	440	460	mg/L
Magnesium (CaCO3)	280	300	mg/L
Sodium (CaCO3)	37.0	44	mg/L
Calculated Hardness (CaCO3)	720	760	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	<0.2 mg/L	0.20 mg/L
Phosphate (PO4) - Ortho	<0.10 mg/L	<0.10 mg/L

Authorized by : Karen B Harriman

Otter Tail Power		**Sample Number:**	NW0703829
Big Stone City SD USA		**Date Sampled:**	7:20 am 02-Mar-2007
Sample Marked:	Well 4 Sample #2	**Date Received:**	06-Mar-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	22-Mar-2007

Water Analysis Report

Anions		
Bromide (Br)	<2.0	mg/L
Chloride (Cl)	<2.0	mg/L
Nitrate (NO3)	<2.0	mg/L
Nitrite (NO2)	<2.0	mg/L
Sulfate (SO4)	380	mg/L
Chloride (CaCO3)	<2.8	mg/L
Nitrate (CaCO3)	<1.6	mg/L
Sulfate (CaCO3)	400	mg/L
ALK - Alkalinity		
Bicarbonate (CaCO3)	380	mg/L
Methyl Orange (CaCO3)	380	mg/L
Phenolphthalein (CaCO3)	<10	mg/L
Others		
pH	6.8	pH Units
Conductivity	1400	µS/cm
Organic Carbon (C) - Total	2.5	mg/L
Ammonia (NH3)	1.5	mg/L
Ammonia (CaCO3)	4.5	mg/L
Suspended Solids (Total @ 105C)	4.3	mg/L
Soluble Fluoride (F)	0.26	mg/L
Silica (SiO2) - Colloidal	4.9	mg/L
Silica (SiO2)-Molybdate Reactive	30	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Sulfide	< 0.01	mg/L
Organic Carbon (C) - Filtered	3.6	mg/L
BOD at 5 days (mg/l or ppm)	1	
Chemical Oxygen Demand (O2)	8.3	mg/L
Nitrogen (N) - Kjeldahl	<5.0	mg/L
Oil and Grease	<1.0	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L

Authorized by : Karen B Harriman

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Otter Tail Power
Big Stone City SD USA
Sample Marked: Well 4 Sample #3
SAP SoldTo Number: 0001008566

Sample Number: NW0703828
Date Sampled: 2:00 pm 02-Mar-2007
Date Received: 06-Mar-2007
Date Completed: 20-Mar-2007

Water Analysis Report

Cations/Metals	**Filtered**	**Total**	
Aluminum (Al)	<0.1	<0.1	mg/L
Arsenic (As)		<0.030	mg/L
Barium (Ba)	<0.4	<0.4	mg/L
Boron (B)	0.2	0.2	mg/L
Cadmium (Cd)	<0.04	<0.04	mg/L
Calcium (Ca)	180	180	mg/L
Chromium (Cr)	<0.01	<0.01	mg/L
Copper (Cu)	<0.01	<0.01	mg/L
Iron (Fe)	0.06	2.2	mg/L
Lead (Pb)	<0.2	<0.2	mg/L
Lithium (Li)	0.07	0.07	mg/L
Magnesium (Mg)	68	69	mg/L
Manganese (Mn)	0.17	0.18	mg/L
Molybdenum (Mo)	<0.1	<0.1	mg/L
Nickel (Ni)	<0.1	<0.1	mg/L
Phosphorus (P)	<1.1	<1.0	mg/L
Phosphorus (PO4)	<3.2	<3.1	mg/L
Potassium (K)	8.5	8.8	mg/L
Selenium (Se)		<0.010	mg/L
Silica (SiO2)	29.0	30.0	mg/L
Silver (Ag)		<0.030	mg/L
Sodium (Na)	17.0	17.0	mg/L
Strontium (Sr)	1.00	1.0	mg/L
Vanadium (V)	<0.53	<0.50	mg/L
Zinc (Zn)	0.02	0.03	mg/L
Calcium (CaCO3)	440	440	mg/L
Magnesium (CaCO3)	280	280	mg/L
Sodium (CaCO3)	37.0	38.0	mg/L
Calculated Hardness (CaCO3)	720	720	mg/L

Phosphates	**Filtered**	**Total**
Phosphate (PO4) - Total	<0.2 mg/L	<0.2 mg/L
Phosphate (PO4) - Ortho	<0.10 mg/L	<0.10 mg/L

Anions

Bromide (Br)	<2.0 mg/L
Chloride (Cl)	<2.0 mg/L

Authorized by : Cheryl Y. Heard

Otter Tail Power		**Sample Number:**	NW0703828
Big Stone City SD USA		**Date Sampled:**	2:00 pm 02-Mar-2007
Sample Marked:	Well 4 Sample #3	**Date Received:**	06-Mar-2007
SAP SoldTo Number:	0001008566	**Date Completed:**	20-Mar-2007

Water Analysis Report

Anions		
Nitrate (NO3)	<2.0	mg/L
Nitrite (NO2)	<2.0	mg/L
Sulfate (SO4)	400	mg/L
Chloride (CaCO3)	<2.8	mg/L
Nitrate (CaCO3)	<1.6	mg/L
Sulfate (CaCO3)	420	mg/L
ALK - Alkalinity		
Bicarbonate (CaCO3)	380	mg/L
Methyl Orange (CaCO3)	380	mg/L
Phenolphthalein (CaCO3)	<10	mg/L
Others		
pH	7.0	pH Units
Conductivity	1400	µS/cm
Organic Carbon (C) - Total	2.8	mg/L
Ammonia (NH3)	1.5	mg/L
Ammonia (CaCO3)	4.4	mg/L
Suspended Solids (Total @ 105C)	2.7	mg/L
Soluble Fluoride (F)	0.26	mg/L
Silica (SiO2) - Colloidal	0.40	mg/L
Silica (SiO2)-Molybdate Reactive	30	mg/L
Mercury (Hg) - Total	<0.00050	mg/L
Sulfide	< 0.01	mg/L
Organic Carbon (C) - Filtered	3.7	mg/L
BOD at 5 days (mg/l or ppm)	2	
Nitrogen (N) - Kjeldahl	<5.0	mg/L
Oil and Grease	<1.0	mg/L
Acetic Acid	<3	mg/L
Butanoic Acid	<3	mg/L
Propionic Acid	<3	mg/L
Chemical Oxygen Demand (O2)	5.7	mg/L

Authorized by : Cheryl Y. Heard

Appendix M2

Technical Memorandum, Big Stone II Groundwater Modeling Revisions and Simulations, Barr, May 16, 2007

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Technical Memorandum

To: Terry Graumann, Otter Tail Power Company
From: Ray Wuolo, Ellen Considine and Daniel Jones
Subject: Big Stone II Groundwater Modeling Revisions and Simulations
Date: May 16, 2007
Project: 41/25-003

1 Introduction

This memorandum describes additional groundwater modeling results of the hydrogeologic evaluation of water-transmitting glacial drift deposits in northeastern Grant County, South Dakota for characterizing their use as a back-up water supply for a proposed 630-megawatt net capability coal-fired electric power generating station named Big Stone II. The proposed Big Stone II plant would be located adjacent to the existing Big Stone plant in Grant County, South Dakota, about eight miles northeast of Milbank and two miles northwest of Big Stone City, South Dakota. This technical memorandum is supplemental to the March 27, 2007 Barr Engineering Company report titled *Groundwater Supply Evaluation, Big Stone II Project, Grant County, South Dakota*.

A numerical groundwater flow model, using the code MODFLOW, was developed for the aquifer system in northeastern Grant County for the purpose of predicting the effects of pumping a groundwater supply for the proposed Big Stone II plant for a period of one year. The primary focus of the model is to predict drawdown, which can be used to evaluate the effects of pumping on existing groundwater users (i.e. wells) and surface waters, including wetlands. As discussed in the March 27, 2007 report, a rigorous calibration to existing head (i.e. groundwater level) conditions was not performed as part of that effort because the focus of the model's predictions was on the relative change (lowering) of groundwater levels in response to pumping of all of the wells. The results of the model, as presented in the March 27, 2007 report, raised questions concerning: (1) the impact of pumping on wetlands in the vicinity of the proposed wells, (2) the impact of pumping on base flows (i.e. groundwater inflows) to the Whetstone River and Big Stone Lake, and (3) pumping impacts over longer periods of time, reflective of changing water needs.

In order to address these questions, the groundwater model needed to be much more rigorously calibrated to groundwater levels – especially in the vicinity of the pumping wells, the Whetstone River, and the wetlands. This is because the relationship between groundwater levels and these water bodies may control the hydraulic interaction under pumping and non-pumping conditions. An automated inverse optimization procedure was employed using the code PEST to calibrate the groundwater model to groundwater levels in wells.

The calibrated groundwater flow model was then used to simulate a 55-year period of groundwater use, based on the results of previously conducted surface-water modeling over the period 1945 through 2000. This period includes drought conditions, normal precipitation, and periods of above-normal precipitation. The period 1930 through 1945 was not included in the simulations because this would force the simulation of unrepresentative groundwater use conditions at the very beginning of the simulation period, making the model's predictions unrepresentative of future conditions.

2 Wetland Conditions

Wetlands in the area of the groundwater modeling study are typically small (<1.0 acre) isolated depressions in the flat to gently rolling landscape. The landscape southwest of the Big Stone plant and northeast of Milbank has relatively few wetlands, especially compared to the area north of the Big Stone plant, which is dotted with numerous small wetlands.

Most of the study area wetlands are small depressions that collect precipitation and local surface runoff. Precipitation is the main source of water in these wetlands, and runoff from snowmelt is the next most important source (Sloan 1972).It is possible that some of the wetlands also have shallow groundwater contributing to their hydrology. However, regardless of the degree to which a wetland basin is hydraulically connected to the groundwater, the principal source of water for the wetlands in the study area is surface runoff, especially early season snowmelt and spring precipitation.

The Cowardin system of classifying wetlands (Cowardin et al 1979) includes a range of seven modifiers for the general water regime of nontidal wetland basins such as those in the Big Stone area, from intermittently flooded to permanently flooded. In the groundwater modeling study area, the majority of the wetlands are in the mid-range to drier end of this spectrum, classified either "temporarily flooded" or "seasonally flooded." These water regime modifiers have specific meanings that are relevant to the discussion of the impact of groundwater pumping on local wetlands. The definition of the two principal water regime modifiers is as follows:

> "Temporarily flooded – Surface water is present for brief periods during the growing season, but the water table usually lies well below the ground surface for

> most of the season. Plants that grow in both uplands and wetlands are characteristic of the temporarily flooded regime.
>
> Seasonally flooded – Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface." (Cowardin et al 1979)

Of the 133 wetland basins lying within the 0.5 meter minimum drawdown boundary (discussed in detail below), 72 (54%) are classified "temporarily flooded" and 41 (31`%) are classified "seasonally flooded." There are no permanently flooded wetlands in the study area, and only 19 (14%) semipermanently flooded basins. There is one intermittently flooded wetland.

The water regime of a wetland influences a wetland's hydroperiod. The hydroperiod of a wetland is the annual variation of the water level in a basin, and is defined by the rise and fall of surface and subsurface water in the wetland. (Mitsch and Gosselink 2000). Based on the Cowardin classifications and water regime modifiers, the hydroperiod for 85% of the wetlands in the study area is typified by early wetness followed by later-season dry down, with the water table near or well below the ground surface by the end of the growing season. The hydroperiod in a given basin may rise and fall with precipitation events over the course of the growing season, but the general trend for most of the wetlands is to dry down on an annual basis.

The hydroperiod of a wetland is further influenced by periodic climate extremes. Wetlands have historically gone through cyclical periods of drought and excessive wetness, following variation in annual precipitation and/or snowmelt. Historical Farm Service Agency (FSA) aerial crop photographs of the wetlands in the groundwater modeling study area were evaluated to determine the variability in area and estimated hydrology of wetlands during wet and dry years going back 25 years (the oldest aerials available). The FSA aerial photos suggest that many of the wetlands in the groundwater modeling study area dry down during periods of drought, to the point where they are farmed for a period of years until drought conditions ease. This is especially true of smaller wetlands, ~1.5 acres or less, which includes the majority of the basins in the area. Larger wetlands show a reduction in area, but tend to persist through drought periods.

Another important factor in considering the hydrology of wetlands in the groundwater modeling study area is the thickness of clay layers beneath the surface soils. The thickness of the clay layer was mapped from soil boring data to define the extent of soils underlain by less than 10 feet of clay (methods described in following section). These are areas where wetlands would potentially be in hydraulic contact with groundwater, and would be more strongly influenced by variability in the water table. Conversely, the water table has little if any influence on wetlands sitting above thicker clay deposits. These wetlands are likely perched above the potentiometric surface and would likely not be affected by changes in groundwater levels.

3 Groundwater Modeling Approach

3.1 Modifications and Calibration

The groundwater flow model described in the March 27, 2007 report *Groundwater Supply Evaluation, Big Stone II Project, Grant County, South Dakota* underwent the following modifications:

- The model grid in the vicinity of the proposed wells was substantially refined, with the smallest grid-cell size equal to approximately 30 meters on a side. This allowed for more accurate representation of wetlands and the Whetstone River.
- The Whetstone River (represented by River Package boundary conditions in MODFLOW) was substantially refined in terms of width and location within the model.
- Areas in the vicinity of the proposed wells where surficial clay is absent or the bottom of the clay is above the top of the potentiometric surface were delineated and assigned a storativity value of 0.1 to ensure that these areas had unconfined storage properties. The model automatically switches from confined to unconfined storage when and where the potentiometric surface drops below the top of the aquifer.

The model was calibrated to 162 groundwater-level measurements, distributed over the model domain, as shown on Figure 1. These groundwater levels were obtained from three sources: (1) well logs in Roberts, Grant, and Deuel Counties in South Dakota (from the South Dakota Geological Survey Well Database); (2) Minnesota County Well Index; and (3) boring logs from the pilot holes drilled for this project in late-2006, early 2007 (described in the March 27, 2007 report). These groundwater-level measurements are from different time periods and the measurements themselves are likely of differing levels of accuracy. In general, the combination of temporal variability and measurement error is likely in the range of +/- 10 feet. The water levels from the pilot holes are of higher reliability (+/- 5 feet).

The calibration was performed using automated inverse optimization techniques implemented in the code PEST (Watermark Numerical Computing, 2005). PEST adjusts selected model parameters, within specified minima and maxima, until the weighted sum of the squared differences between model-predicted water levels and observed water levels is minimized. The "weighting" gives higher priority to matching certain observations over others – in this evaluation, highest weights were given to those observations in the vicinity of the Whetstone River and the proposed pumping wells (weight of 5), compared to "far-field" observations (weight of 1). PEST solves for the minimum sum-of-squared errors (i.e. the "objective function") through a numerical approximation of derivatives.

In this calibration, the hydraulic conductivity zonation that is described in the March 27, 2007 report was replaced by 122 pilot points, distributed over the model domain. The pilot points represent locations where PEST adjusts hydraulic conductivity values during the optimization process. Hydraulic conductivity values are interpolated between pilot points, the model is run 122 to 244 times (to solve for the Jacobian matrix), and the derivative is calculated. Based on the improvement of the calibration, further changes are made to model parameters at the pilot points and the optimization process continues until no further improvement in calibration can be obtained.

The optimization is controlled by the minimum and maximum limits placed on the hydraulic conductivity values (generally in the range of 0.48 to 90 m/day). It is also controlled by two other conditions: (1) prior knowledge and (2) regularization. Prior knowledge further limits the allowed variability of hydraulic conductivity in areas where aquifer tests have been performed (e.g., location PW1-2 and PW1-4) by requiring the honoring of these estimates. Regularization is a user-imposed condition that requires PEST to also minimize the variability of hydraulic conductivity from one location to the next. Regularization can be thought of as telling PEST to keep the hydraulic conductivity field as homogeneous as possible while minimizing the sum-of-squared errors.

The calibration/optimization process was performed multiple times. The final optimization process involved 1,566 model runs. The mean residual (difference between observed and simulated heads) was -0.95 meters, the standard deviation of the residual was 17.9 meters, the standard deviation of the residual over the range of observations was 0.062, and the sum of squares of the residuals was 52,145. A plot of observed versus simulated values is shown on Figure 2 and a map of the distribution of the residuals and contours of the calibrated potentiometric head are shown on Figure 3. These figures show that the large residuals are in the "far field"; that is, outside of the main area of interest. The resulting calibrated hydraulic conductivity values are shown on Figure 4 and the transmissivity values are shown on Figure 5.

It is important to note that the hydraulic conductivity values and transmissivity values are of primary importance only in the vicinity of the proposed pumping wells.

The resulting hydraulic conductivity distribution is one realization that produces a calibrated model, based on the model's conceptualization. It is important to recognize that there may be other possible realizations that are equally valid.

The river-bed conductance (a measure of the hydraulic connection between a river and the aquifer in the model) for the Whetstone River was computed with an assumed hydraulic conductivity value of 50 m/day and a thickness of 1 meter. This is a common modeling assumption that allows the aquifer material and not the river bed material to be the controlling factor in the water exchange between aquifer and river. The calibrated model predicts a total base flow into the Whetstone River, upstream of Big Stone Lake (combine base flow from all tributaries) of approximately 2 cubic feet per second (cfs). During January and February (when runoff is minimal), total stream flows approach base-flow conditions. Average monthly stream flows in the Whetstone River at Big Stone City for the period 1932 through 1988 are shown on Figure 6, along with the model's prediction of base-flow conditions. The model's prediction of base flow (@ 2 cfs) falls within the range of values of stream flow for January and February.

3.2 Transient Simulations of Groundwater Pumping

Transient (i.e. pumping changes with time and water in storage changes with time) simulations of groundwater pumping were performed to predict drawdown of groundwater levels at wetlands and changes in groundwater flow to the Whetstone River and Big Stone Lake. Groundwater pumping over a 55-year period was estimated for the Big Stone II project from the surface-water model for the project, which includes precipitation, Big Stone lake levels, evapotranspiration, and other hydrologic factors for the period 1930 through 2000. The surface-water model provides predicted groundwater and surface-water use for the project on a weekly basis. As discussed above, the period 1930 through 1945 was not used.

Total groundwater demand for the project was simulated in the model by converting the weekly groundwater demands from the surface-water model to stress periods ranging in length from 7 days to several months, depending upon the uniformity of demand. The total withdrawal rate for all wells combined equaled 6,200 gpm. Pumping was distributed among the proposed wells uniformly, except for locations PW1-2, PW1-4, and PW2-1, where pumping test information provided data to further limit maximum sustainable rates. Other wells were adjusted proportionally to meet the total groundwater demand for a given period, with total groundwater withdrawal rate of 6,200 gallons per minute (gpm) set as a maximum. Over the simulation period, pumping rates are typically at 6,200 gpm or there is no pumping – only about 6% of the simulation period has pumping rates greater than 0 gpm but less than 6,200 gpm. A plot of pumping rates is shown on Figure 7.

Transient simulations require the inclusion of two storage parameters – specific yield (for those portions of the aquifer that are unconfined) and storativity (for confined conditions). A storativity value of 0.015 was used, based on the aquifer test results from well PW1-2. A specific yield value of 0.15 was used where unconfined conditions are present. This specific yield is typical for unconsolidated deposits, such as those found in pilot holes as part of the hydrogeologic evaluation (Freeze and Cherry, 1979). As described in the March 27, 2007 report, lithologic logs for South Dakota and Minnesota were used to define the elevation of the top and bottom of the aquifer system. With a calibrated model, the MODFLOW code automatically switches from confined to unconfined storage anywhere and at any time during the simulation as potentiometric head drops below the top of the aquifer.

4 Results

4.1 Predicted Effects of Pumping on Groundwater at Wetlands

4.1.1 Predicted Effects on Wetlands in 0.5m DDB

Wetland basins evaluated in this study lie within the groundwater model's minimum 0.5 meter drawdown boundary (referred to here as "0.5m DDB"). This is an approximately 8,960 acre area for which the model predicts a minimum drawdown in the water table of 0.5 meters over the 55-year simulation. There are three cones of depression within this area. Most of the predicted drawdown in this area is 2 meters or less; however, the model predicts drawdown of up to 5 meters near the southeastern lobe of the 0.5m DDB.

There are 133 wetland basins totaling 218.6 acres in the 0.5m DDB (2.4% of the 8,960 acre area). These wetlands were evaluated for their water regimes, the thickness of clay layers beneath the basins, and Corps jurisdiction. As discussed above, the water regimes of 85% of the wetlands in the 0.5m DDB are typified by early wetness, annual late-season drydown and progressive drop in the water table over the course of the growing season. In other words, the baseline condition of 85% of the wetlands in the 0.5m DDB includes annual variability in wetland hydroperiod, with a tendency to dry down by the end of the growing season. Vegetation in these wetlands is characterized by species capable of withstanding the annual variation in hydroperiod. The Cowardin water regimes of the wetlands in the 0.5m DDB are summarized in Table 1.

Table 1. Cowardin Water Regimes of Wetlands in 0.5m DDB

Cowardin Water Regime	No. of Basins	% of Total Basins	Total Area	Percent of 0.5m DDB wetland area
Temporarily Flooded	72	54	64.1	29.3
Seasonally Flooded	41	31	105.3	48.2
Semipermanently Flooded	19	14	40.7	18.6
Intermittently Flooded	1	<1	8.5	3.9
TOTAL	133	100	218.6	100.0

The thickness of the clay layer beneath a given basin governs the influence of groundwater on the basin’s hydroperiod. Wetlands with little or no clay beneath them are potentially in greater hydraulic contact with the water table. Changes in the water table level are more likely to manifest themselves in these wetlands. The extent of the 0.5m DDB was projected in GIS over the mapped thickness of clay layers in the Big Stone area. The intersection of the 0.5m DDB and the clay layer thickness showed that 110 wetland basins in the 0.5m DDB are perched above thick clay, and have little or no hydraulic contact with groundwater. The total areas of these basins is 141.2 acres, or 65% of the total.

The other 23 of the 133 wetlands are underlain by clay less than 10’ thick, and are therefore potentially influenced by changes in the water table level. These 23 basins total 77.4 acres, or 35% of the total wetland area in the 0.5m DDB. However, none of these wetlands would be permanently lost due to groundwater pumping. This is because these wetlands also have seasonal surface runoff inputs from snowmelt and precipitation. As with most of the wetlands in the 0.5m DDB, these wetlands have hydroperiods characterized by wetness early in the growing season and gradual drying down. A drop in the water table beneath these wetlands could potentially accelerate the seasonal drying down, but it would have no effect on the surface water inputs that are the principal early-season water source for these wetlands.

The most likely impact of groundwater pumping on wetlands in hydraulic contact with groundwater (i.e., not perched over clay) would be a shift in the wetlands’ water regime toward a shorter duration of seasonal surface water. “Seasonally flooded” wetlands over thin clay layers may potentially become “Temporarily flooded” wetlands. These basins would most likely continue to hold surface runoff early in the growing season, and would dry down annually, as most of them normally do. The length of time with surface water or soil saturation present may be shortened by pumping of groundwater.

Of the 77.4 acres of wetlands that have a hydraulic connection to groundwater, 58.7 acres (76%) are in wetland basins classified as "seasonally flooded." These are basins where "the water table is often near the land surface…when surface water is absent." (Cowardin et al 1979). A potential impact of groundwater pumping on these wetlands would be to shift their water regime toward "temporarily flooded," where "the water table usually lies well below the ground surface for most of the season." Approximately 12 acres (16%) of wetlands with a hydraulic connection to groundwater are currently classified as semipermanently flooded. These basins typically have surface water throughout the growing season, with the water table at or near the surface. Groundwater pumping could eventually shift the water regime of these toward "seasonally flooded."

The effects of pumping groundwater would be attenuated by periodic storms and/or seasonal wet cycles. This is because the wetlands in the 0.5m DDB, regardless of hydraulic connection to the water table, are primarily fed by surface runoff. Heavy rainfall, extensive snowmelt or a prolonged series of wetter-than-normal years would reduce the impact of groundwater pumping on wetlands with a hydraulic connection to the water table. Conversely, periods of drought would exacerbate the effect of groundwater pumping on wetlands with a hydraulic connection to the water table.

Based on an evaluation of local topography and the relative position of a given basin to navigable waters of the U.S. and/or their tributaries, it is estimated that 23 of the 133 basins (roughly 17%) may be under the jurisdiction of the U.S. Army Corps of Engineers. [Note: Corps jurisdiction is not necessarily a relevant criterion for the evaluation of the effects of groundwater pumping on wetlands. This is because Corps jurisdiction applies to Section 404 of the Clean Water Act, which regulates the placement of fill into wetlands. Potential alteration of hydrology is not a Section 404 issue.] Of the 23 wetlands potentially under Corps jurisdiction, sixteen are perched above thick clay layers, and are therefore unlikely to be affected by groundwater pumping. Seven potentially jurisdictional wetlands, totaling 26.1 acres, are over thin clay layers and may have their hydroperiods altered by groundwater pumping, as discussed above.

The distribution of wetland basins and acreages relative to Corps jurisdiction and hydraulic contact with the water table are summarized in Table 2 below.

Table 2. Distribution of Wetland Basins and Acreages
Relative to Corps Jurisdiction and Hydraulic Contact with the Water Table

	Corps Jurisdictional	**Isolated (Non-Corps jurisdictional)**	
Hydraulic connection to groundwater	7 basins, 26.1 ac	16 basins, 51.3 ac	**23 basins underlain by thin clay, 77.4 ac (35% of wetland area in 0.5m DDB)**
Little or no hydraulic connection to groundwater	16 basins, 20.0 ac	94 basins, 121.2 ac	**110 basins perched above thick clay, 141.2 ac (65% of wetland area in 0.5m DDB)**
	23 Corps Jurisdictional basins, 46.1 ac (21% of total wetland area in DDB)	**110 Isolated basins, 172.5 ac (79% of total wetland area in DDB)**	

4.1.2 Predicted Effects of Drawdown on Listed Species

The wetlands in the vicinity of the groundwater modeling study derive their hydrology principally, if not entirely, from surface water runoff, regardless of hydraulic contact with groundwater. The majority of these wetlands have water regimes that involve annual cycles of early season surface water followed by drying down. This cycle typifies not only the wetlands in the 0.5m DDB, but of the overall Prairie Pothole region. Sensitive species that utilize wetlands in this part of North America have adapted their life cycles to the water regime and annual hydroperiod of the wetlands.

110 of the 133 of the wetlands in the 0.5m DDB are perched above thick clay layers, and are unlikely to be affected by groundwater pumping. In these wetlands, there would be no shift in water regime anticipated, hence no effect on listed species. In the remaining 23 wetland basins with hydraulic contact with the water table, groundwater pumping could shift the water regime to one with a shorter period of surface water and more accelerated dry down later in the growing season. However, these basins would not be permanently lost. Moreover, since early growing season hydrology in these wetlands comes primarily from surface runoff, water levels in these wetlands should continue to be sufficient to support listed species in the early growing season.

Finally, the only federally-listed species that utilizes depressional wetlands in Grant County is the western prairie fringed-orchid. Field surveys were conducted on the Big Stone II site in July 2005 for this species and potential habitat. No individuals or populations were found, and potential habitat was marginal at best, and largely absent. Since land use in the 0.5m DDB is essentially the same as the Big Stone II area (primarily agricultural and grazed), it is unlikely that western prairie fringed-orchid is present. In addition, the majority of wetlands in the area are either dominated by dense cattail and reed canary grass, or are farmed. Neither of these conditions promote utilization by listed species.

4.1.3 Results of Detailed Modeling on a Subset of Wetlands in the 0.5m DDB

A subset of 14 basins (approximately 10% of the 133 basins in the 0.5m DDB)were selected for a detailed analysis of the effects of pumping on groundwater. Wetlands were selected based on their proximity to one or more of three cones of depression. A map of the fourteen wetlands evaluated in this study is shown on Figure 8. Wetlands BSLE-1, BSLE-2, BSLE-3, and BSLE-4 are in an area lacking near-surface clay, i.e. these four wetlands are thought to be hydraulically connected to groundwater and could be affected by drawdown due to pumping.

The model predicts the changes in groundwater elevation at the wetland locations over the 55-year simulation period. Predicted groundwater hydrographs at the 14 selected wetland locations are in Appendix A to this memorandum. Table 1 summarizes the predicted changes in groundwater levels at the 14 selected wetlands. Groundwater elevations at all fourteen wetlands are affected by pumping, with drawdown at the end of the modeling period ranging from 2.3 to 11.3 feet. At the four wetlands believed to be hydraulically connected to groundwater, drawdown ranged from 4.8 to 8.1 feet, indicating that those wetlands will be affected by long-term pumping. The other ten wetlands evaluated are not believed to be hydraulically connected to groundwater, because they are perched above the potentiometric surface. The effect of long-term pumping on these and similar wetlands cannot be known with certainty; however, the lack of a hydraulic connection to groundwater makes it unlikely that pumping will effect a change in the water regime of these wetlands.

4.2 Predicted Effects of Pumping on the Whetstone River

The model was used to predict changes in base flows (i.e. groundwater flows) into four reaches of the Whetstone River – the reaches are shown on Figure 9 and are designated reach A, B, C, and D. In general, as groundwater levels drop, base flows will tend to also drop. Base flows in reaches A and B respond to pumping because the predicted non-pumping groundwater levels are above the bed of the river in at least a portion of reaches A and B. Reach A is predicted to lose 19% of its baseflow (about 0.13 cfs) due to pumping. Reach B is predicted to change from a gaining reach (i.e. a reach in which the stream flow increases due to inflows of groundwater to a losing reach (i.e. a reach in which stream flow decreases because of seepage out of the stream and into the groundwater). However, base flows in reaches C and D do not react to pumping because the predicted non-pumping groundwater levels are below the bed of the river. In other words, reaches C and D are perched above the aquifer system's potentiometric surface and are not in hydraulic connection with the aquifer. Reaches C and D are predicted to naturally be losing segments of the Whetstone River that are perched above the regional water table. The predicted changes in base flows for reaches A and B are shown on Figures 10 and 11 and are compared to the model's prediction of non-pumping (steady-state) base flows.

4.3 Predicted Effects of Pumping on Big Stone Lake

The model was also used to predict changes in groundwater flow rates into Big Stone Lake. The model simulates Big Stone Lake as constant head cells. Flow into these constant head cells can vary as groundwater levels change. The model's prediction of changes in groundwater flows into Big Stone Lake are shown on Figure 12 for the simulation period. The model predicts no significant change in groundwater flows into Big Stone Lake as a result of the pumping.

4.4 Extent of Drawdown

The March 27, 2007 report presented maps of drawdown for various portions of one-year of continuous pumping. It is important to note that those predicted drawdowns were based on a model that was not as rigorously calibrated as the revised model described in this memorandum and used only confined storage (which tends to over-predict drawdown for portions of the aquifer system that are unconfined). The results described herein supersede the predictions in the March 27, 2007 report because of the updates to the model and because this model uses a more realistic groundwater demand scenario. A map showing the maximum drawdown during the 55-year simulation period is shown on Figure 13.

5 Summary and Conclusions

The groundwater flow model that was developed to predict the effects of groundwater pumping of the Big Stone II project underwent a rigorous calibration procedure. A 55-year period of changing pumping conditions was modeled. Based on this revised and calibrated groundwater flow modeling, the following are concluded:

- Groundwater pumping will form a cone of depression in the potentiometric surface in the vicinity of the pumping wells. This cone of depression is less extensive and of lower magnitude than previously predicted. The pumping impacts over longer periods of time is reflective of changing water needs and the necessity to meet those needs with groundwater.
- No wetlands are anticipated to be permanently lost from the impact of groundwater pumping.

- 85% of the wetlands in the 0.5m DDB are typified by annual cycles of early wetness with surface water present, followed by drying down by the end of the growing season. Vegetation in the wetlands is characterized by species tolerant of this water regime. The principal source of water for all wetlands in the area is surface runoff from precipitation and spring snowmelt.
- Groundwater pumping could potentially alter the water regime of 23 wetland basins totaling 77.4 acres. These wetlands would not be lost or permanently de-watered by groundwater pumping. These wetlands would likely shift to water regimes with shorter periods of surface water presence and water table levels further beneath the land surface. This impact would be attenuated by extreme precipitation events, extensive snowpacks and periods of higher-than-normal annual precipitation. This impact would be exacerbated by periods of drought.
- Alteration of water regime in wetlands that have hydraulic contact with groundwater could potentially slow or shift back during non-pumping intervals.
- Of the 23 wetlands with potential alteration of wetland water regimes by groundwater pumping, seven wetlands totaling 26.1 acres are likely under Corps jurisdiction. (Final jurisdictional determination for all wetlands would be made by the Corps.) There are 16 additional wetlands that are likely under Corps jurisdiction; however, these are perched above thicker clay layers and are not in contact with groundwater. There would be no loss of Corps jurisdictional wetland area.
- Groundwater pumping is not anticipated to affect listed species. This is because 83% of the wetland basins (65% of the wetland area) in the 0.5m DDB are perched above thick clay and not influenced by groundwater. The remaining 23 basins (35% of the wetland area) derive their early-season hydrology from surface runoff, and would continue to sustain utilization by listed species.
- Groundwater pumping, over time, is predicted to reduce the average base flow (i.e. the groundwater contribution to total stream flow) in the Whetstone River by approximately 1.2 cfs (from approximately 2 cfs to 0.8 cfs, or approximately 60 percent of total base flow). The source of water in the Whetstone River is primarily surface runoff of precipitation – during low precipitation periods over the last 75 years, total stream flow in the Whetstone River has dropped below 0.8 cfs several times.
- Groundwater pumping is predicted to not affect groundwater inflows into Big Stone Lake.

6 References

Barr Engineering Co., March 27, 2007, Groundwater Supply Evaluation, Big Stone II Project, Grant County, South Dakota, 29 p.

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Office of Biological Services, U.S. Fish and Wildlife Service. U.S. Dept. of the Interior. Washington, D.C.

Freeze, R.A. and J.A. Cherry, 1979, Groundwater. Prentice-Hall, Inc; 789 p.

Harbaugh, A.W., and M.G. McDonald, 1996. User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Mitsch, W.J. and J.G. Gosselink. 2000. Wetlands, 3rd Ed. John Wiley & Sons. New York.

Sloan, C. 1972. Groundwater Hydrology of Prairie Potholes in North Dakota. Geological Survey Professional Paper 585-C.

Watermark Numerical Computing, 2005. PEST: Model-Independent Parameter Estimation. User Manual. 5th edition.

Appendix M3

Technical Memorandum, Big Stone II Groundwater Modeling – Wet-Dry Cooling Alternative, Barr, July 23, 2007

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Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

Technical Memorandum

To: Terry Graumann, Otter Tail Power Company
From: Ray Wuolo and Ellen Considine
Subject: Big Stone II Groundwater Modeling – Wet-Dry Cooling Alternative
Date: July 23, 2007
Project: 41/25-003

Introduction

This memorandum describes additional groundwater modeling results of the hydrogeologic evaluation of water-transmitting glacial drift deposits in northeastern Grant County, South Dakota for characterizing their use as a back-up water supply for a proposed 630-megawatt net capability coal-fired electric power generating station named Big Stone II, assuming that the power generating station was designed as a wet-dry cooling plant with groundwater backup water supply rather than as a wet cooling plant with a groundwater backup supply. This technical memorandum is supplemental to two previous documents: the March 27, 2007 Barr Engineering Company report titled *Groundwater Supply Evaluation, Big Stone II Project, Grant County, South Dakota* and the May 16, 2007 Barr Engineering memorandum titled *Big Stone II Groundwater Modeling Revisions and Simulations.* These previous documents described the groundwater usage for a water-cooled generating station.

A numerical groundwater flow model, using the code MODFLOW, was developed for the aquifer system in northeastern Grant County for the purpose of predicting the effects of pumping a groundwater supply for the proposed Big Stone II plant for a period of one year. The primary focus of the model is to predict drawdown, which can be used to evaluate the effects of pumping on existing groundwater users (i.e. wells) and surface waters, including wetlands. Model construction and calibration are described in the March 27, 2007 report and the May 16, 2007 memorandum.

Water Use

The annual water demand for Big Stone I and II (assuming wet-dry cooling) and the ethanol plant is 7,300 acre-feet. This demand would be met first with surface-water withdrawals from Big Stone Lake (when permitted) and water from plant storage ponds. Groundwater would be used when Big Stone Lake withdrawals were not permitted because of low water-level conditions. Surface-water model predictions of annual water use of surface water and groundwater under climatic conditions similar to the period 1930 through 2000 is shown on Figure 1. Average annual groundwater appropriation is predicted by the surface-water model to be 2,036 acre-feet per year and the maximum annual groundwater appropriation is predicted to be 6,984 acre-feet per year. The model assumes a maximum pumping rate from groundwater of 6,200 gallons per minute (gpm).

Groundwater Model Simulations of Pumping

The effect of pumping groundwater for a wet-dry cooling generating station on groundwater levels, groundwater influx into the Whetstone River, and groundwater interaction with Big Stone Lake were simulated in a manner identical previous simulations for a wet cooling generating station. The only difference between the two simulations is the pumping rate. Fourteen (14) wells were assumed to be necessary to meet the maximum instantaneous water demands, which is 6,200 gpm. Thus, the location and the total number of wells required for a wet-dry cooling generating station and a wet cooling generating station would be identical – the duration of pumping and the average pumping rate is generally less for the wet-dry cooling generating station.

Maximum Groundwater Level Drawdown

The maximum drawdown predicted at any location in the study area over the course of the pumping simulation period is shown on Figure 2.

Figure 3 shows the predicted extent of drawdown for groundwater use by a wet-dry cooling generating station and a wet cooling generating station. The extent of the area of maximum drawdown for the wet cooling station is approximately 1.8 times larger than the area of maximum drawdown for the wet-dry cooling station.

The maximum drawdown from pumping for the wet cooling station is predicted to be 37 feet immediately adjacent to one of the simulated pumping wells. The maximum drawdown for the wet-dry cooling station is 19.5 feet, which is immediately adjacent to one of the simulated pumping wells.

Effect on Base Flow of the Whetstone River

The groundwater model was used to predict changes in groundwater contributions to base flow in the Whetstone River for non-pumping conditions, pumping for a wet cooling station, and pumping for wet-dry cooling station. For these predictions, the Whetstone River was divided into different reaches in order to predict where in the Whetstone River any pumping effects might be expected. The locations of these reaches (described as “A”, “B”, “C”, and “D”) are defined in the March 27, 2007 report.

The Whetstone River is primarily is losing stream in its upper reaches; i.e., water flow is from the river to into the aquifer. Along reaches C and D, the Whetstone River is perched above the water table and pumping has no effect on flows. Along reaches A and B, the Whetstone River interacts with the aquifer by leaking stream flow into the aquifer. Pumping is expected to increase this amount of leakage by causing drawdown in the aquifer and thereby increasing vertical hydraulic gradients between stream and aquifer in some locations.

The effects of pumping for wet-cooling and wet-dry-cooling demands are shown on Figure 4. Both the wet-cooling demand and the wet-dry-cooling demand are predicted to cause decreases in the flows in the Whetstone River by increasing leakage from the River to the aquifer. The model predicts that the wet-cooling option will result in a maximum total decrease in base flows in the Whetstone River of approximately 0.64 cfs[1]. The model predicts that the wet-dry cooling option will result in a maximum total decrease in base flows in the Whetstone River of approximately 0.34 cfs. Therefore, the mode predicts that the wet cooling option will result in a decrease in base flow of the Whetstone River that is approximately 0.3 cfs more (47% more) than the wet-dry cooling option. The predicted reductions in base flow for both of these options is a very small percent of the annual average flow in the Whetstone River (about 110 cfs).

Effect on Groundwater Inflow to Big Stone Lake

The model predicted that pumping for the wet-cooling option and the wet-dry cooling option would not cause reductions in groundwater inflow to Big Stone Lake.

Summary of Findings

In summary, the modeling described in this memorandum found the following:

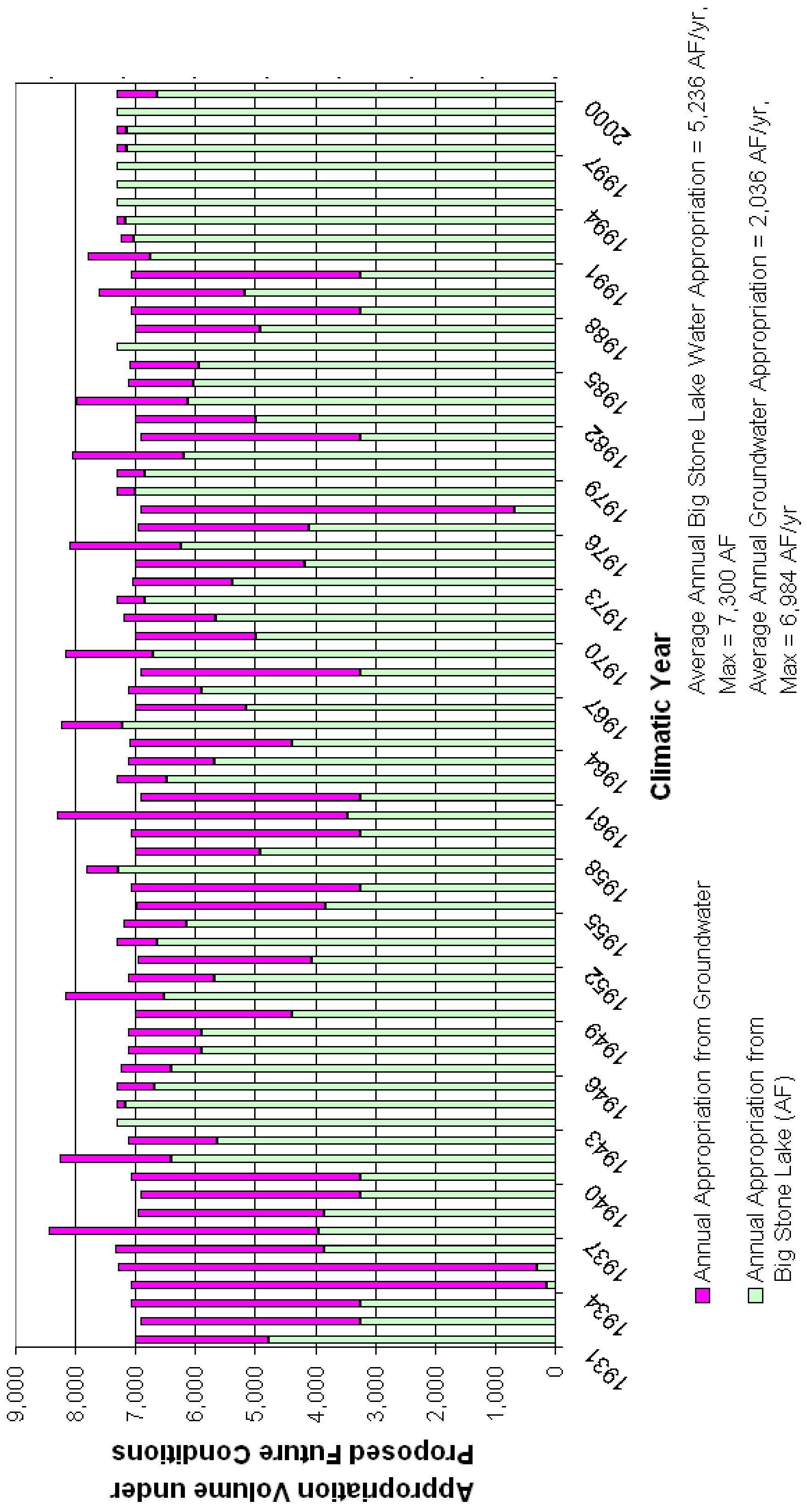
---

[1] The predicted effect on base flow reported here is less that the value reported in the May 16, 2007 Memorandum (0.64 cfs, compared to the previous prediction of 1.2 cfs). The reason for this difference is that the model has undergone additional refinement and calibration as a result of additional geologic information collect and analyzed after the publication of the May 16, 2007 Memorandum. The new estimate is deemed to be more reliable than the previous estimate.

1. The maximum cone of depression under pumping conditions for a wet-cooling generating station would be approximately 1.8 times larger than for a wet-dry cooling station.
2. The maximum drawdown at the wells under pumping conditions for a wet-cooling generating station would be approximately 37 feet (adjacent ton one of the pumping wells) compared to 19.5 feet adjacent to the same pumping well for wet-dry cooling generating station.
3. The maximum reduction in base flow in the Whetstone River for a wet-cooling generating station would be approximately 0.64 cfs, compared to 0.3 cfs for a wet-dry cooling generating station.
4. Pumping for a wet-cooling station and wet-dry cooling station would not result in changes in groundwater inflows into Big Stone Lake.

Figure 1

Water Year Appropriation Volume under Proposed Future Conditions Given Past Climatic Conditions: Wet-Dry Cooling Option



Average Annual Big Stone Lake Water Appropriation = 5,236 AF/yr, Max = 7,300 AF

Average Annual Groundwater Appropriation = 2,036 AF/yr, Max = 6,984 AF/yr

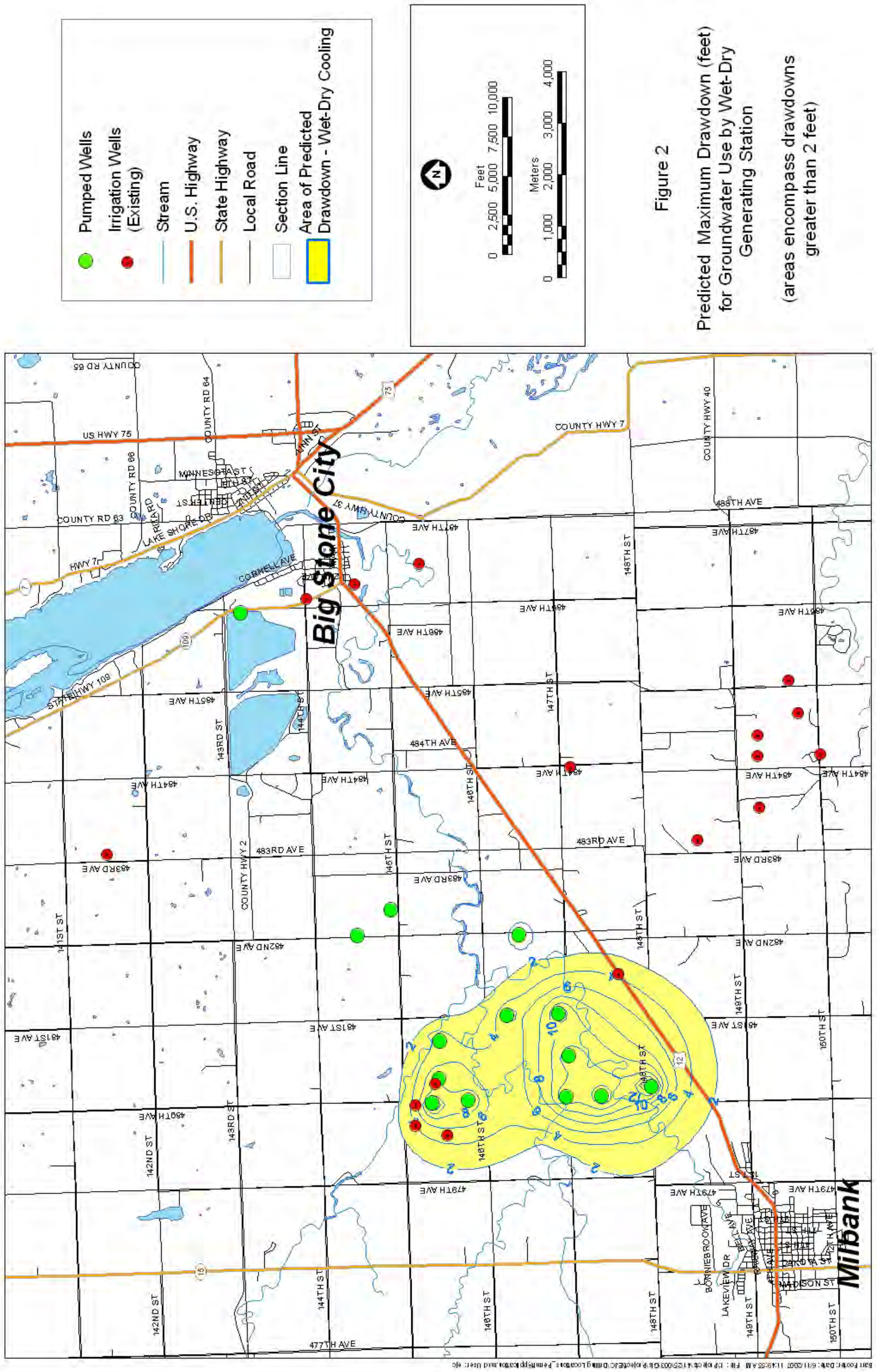


Figure 2

Predicted Maximum Drawdown (feet) for Groundwater Use by Wet-Dry Generating Station

(areas encompass drawdowns greater than 2 feet)

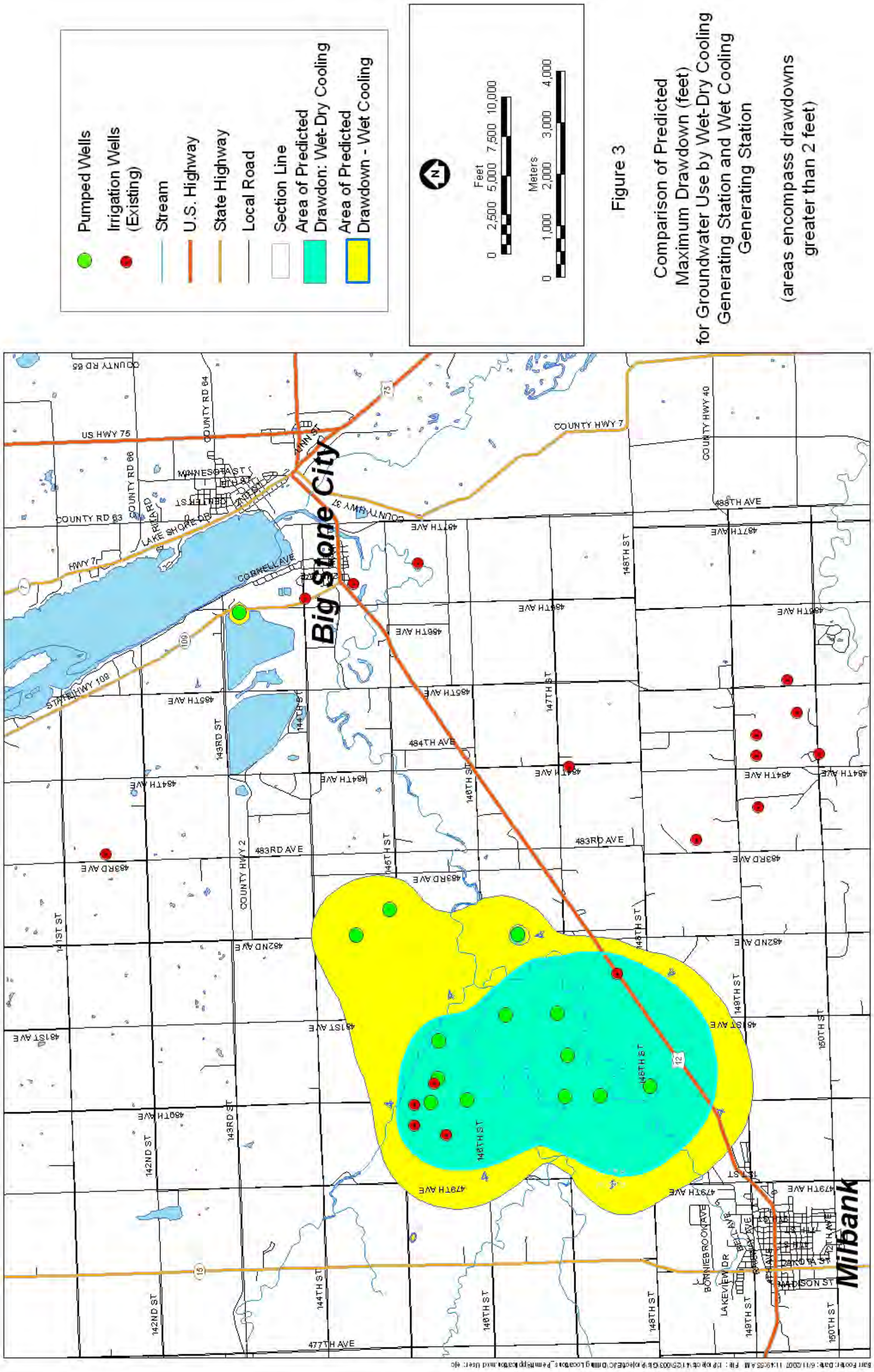


Figure 3

Comparison of Predicted Maximum Drawdown (feet) for Groundwater Use by Wet-Dry Cooling Generating Station and Wet Cooling Generating Station

(areas encompass drawdowns greater than 2 feet)

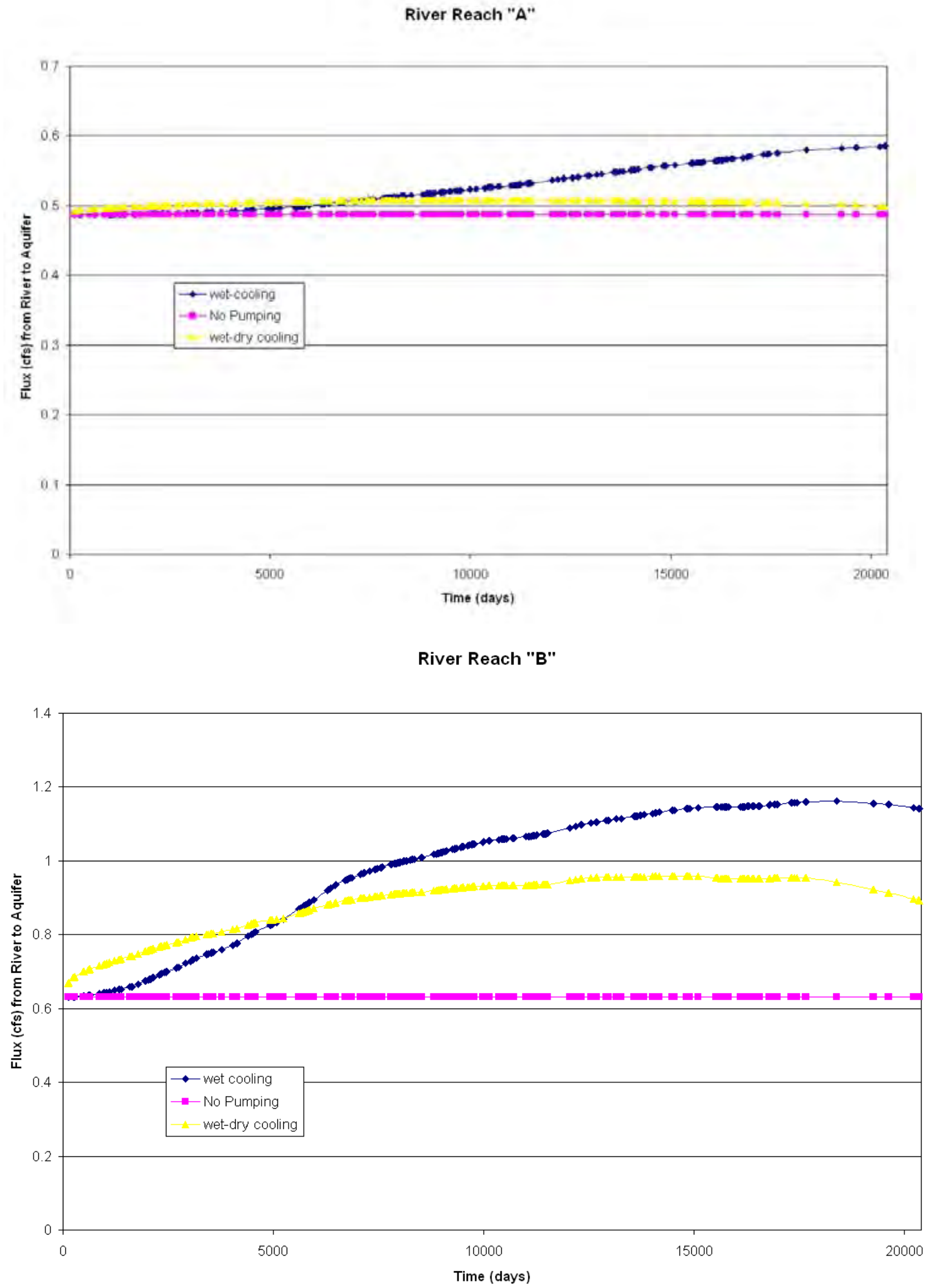


Figure 4

Predicted Increases in Flow from Whetstone River to Aquifer for Wet and Wet-Dry Cooling Groundwater Demands

DOE/EIS-0377

Final Environmental Impact Statement

Volume III - Appendices

June 2009

Big Stone II Power Plant and Transmission Project

Prepared for:

Lead Agency:
Western Area Power Administration

Cooperating Agency:
U.S. Army Corps of Engineers

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Appendix N

Government Agencies, Organizations, and Individuals to Receive the Final EIS

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APPENDIX N

Government Agencies, Organizations, and Individuals to Receive the Final EIS

Federal Agencies

- U.S. Fish and Wildlife Service
  - Bloomington, Minnesota
  - South Dakota Field Office
- U.S. Army Corps of Engineers
  - Omaha District
  - St. Paul District
- U.S. Department of Agriculture
  - Rural Utilities Service
  - Natural Resources Conservation Service
  - Farm Service Agency
- U.S. Environmental Protection Agency
  - Office of Federal Activities
  - NEPA Program
  - Environmental Planning & Evaluation
  - Region 8
- U.S. Department of Health and Human Services -Centers for Disease Control
- U.S. Department of the Interior
  - Office of Environmental Policy & Compliance
- Federal Aviation Administration
- Federal Highway Administration
  - Office of NEPA Facilitation
- Federal Energy Regulatory Commission
- Federal Emergency Management Agency
  - Regional Environmental Officer

Tribal Governments

- Cheyenne River Sioux Tribe
- Crow Creek Sioux Tribe
- Flandreau Santee Sioux Tribe
- Fort Peck Assiniboine and Sioux Tribes
- Leech Lake Tribe of Ojibwe
- Lower Brule Sioux Tribe
- Lower Sioux Indian Community
- Mille Lacs Band of Ojibwe
- Northern Cheyenne Tribe
- Prairie Island Indian Community
- Rosebud Sioux Tribe
- Santee Sioux Nation
- Shakopee Mdewakanton Sioux Community
- Sisseton-Wahpeton Oyate of the Lake Traverse Reservation
- Spirit Lake Tribe
- Standing Rock Sioux Tribe
- Upper Sioux Indian Community
- Yankton Sioux Tribe

Minnesota State Government

Minnesota Department of Agriculture
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Environmental Quality Board
Minnesota Pollution Control Agency
Minnesota Public Utilities Commission
Minnesota State Historic Preservation Office

Minnesota Local Government

Big Stone County, Minnesota
City of Clinton
City of Correll
City of Graceville
City of Johnson
City of Odessa
Akron Township
Big Stone Township
Malta Township
Moonshine Township
Odessa Township
Ortonville Township
Otrey Township
Marysland Township
Moyer Township
Pillsbury Township
Shible Township
Six Mile Grove Township
Torning Township

Chippewa County, Minnesota
City of Granite Falls

Kandiyohi County, Minnesota
City of Kandiyohi
City of New London
City of Pennock
City of Spicer
City of Willmar
Mamre Township
Green Lake Township
Harrison Township

Swift County, Minnesota
City of Appleton
City of Benson
City of Clontarf
City of Danvers
City of DeGraff
City of Holloway
City of Kerkhoven
City of Murdock
Dublin Township
Hayes Township
Kildare Township

Stevens County, Minnesota
City of Alberta
City of Chokio
City of Morris
Baker Township
Darnen Township
Oshkosh Township

Yellow Medicine County, Minnesota
City of Canby
City of Clarkfield
City of Hazel Run
City of St. Leo
Florida Township
Friendship Township
Hammer Township
Minnesota Falls Township
Omro Township
Stony Run Township
Tyro Township
Yellow Medicine Soil & Conservation District

South Dakota State Government

South Dakota Department of Environment and Natural Resources
South Dakota Department of Game, Fish, and Parks
  Natural Heritage Program
  Natural Resources Administration
South Dakota Department of Transportation
South Dakota Public Utilities Commission
South Dakota State Historical Society

South Dakota Local Government

<u>Deuel County, South Dakota</u>
City of Gary
Antelope Valley Township
Glenwood Township
Herrick Township

<u>Grant County, South Dakota</u>
City of Big Stone City
City of Milbank
Grant County Highway Department
Adams Township
Alban Township
Big Stone Township
Vernon Township

Nongovernmental Organizations

Advisory Council on Historic Preservation
American Petroleum Institute
American Public Power Association
Clean Up the River Environment
Clean Water Action Alliance
  Minnesota
  South Dakota
Coal Exporters Association
Dakota Resource Council
Energy Communities Alliance
Environmental Defense
Friends of the Earth
Hawk Creek Watershed Project
Lignite Energy Council
Midwest Clean Energy Campaign
Minnesota Center for Environmental Advocacy
Minnesota Renewable Energy Society
National Center for Environmental Health
National Coal Council
National Rural Electric Cooperative Association
National Resources Defense Council
Rose Creek Anglers
Sierra Club
  Midwest Office
  North Star Chapter
  Northern Plains
Stewards of the Land
The Minnesota Project
U.S. Energy Association
Western Clean Energy Campaign

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