REPORT OF THE
WISCONSIN RELIABILITY
ASSESSMENT ORGANIZATION
ON
TRANSMISSION SYSTEM REINFORCEMENT
IN WISCONSIN

June 14, 1999

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Executive Summary

The Wisconsin Reliability Assessment Organization (WRAO) was formed to coordinate the planning of generation and transmission facilities to ensure the reliability of Wisconsin's electric supply system. This report describes the WRAO's recent study of transmission system reinforcement plans and the abilities of those plans to achieve numerous technical, environmental, and policy criteria. Based upon the findings of this examination, the WRAO has developed a recommendation for the Public Service Commission of Wisconsin (PSCW) which it believes will significantly enhance the reliability of the regional transmission system at a reasonable financial cost and environmental impact.

The technical analysis underlying our recommendation was performed by the Wisconsin Interface Reliability Enhancement study (WIREs) group under WRAO direction. Governmental agency participants in the WIREs group included members of the staffs of the Illinois Commerce Commission, the Iowa Utilities Board, the Minnesota Department of Public Service, the Minnesota Public Utilities Commission, as well as the PSCW. The WIREs group had as a fundamental objective the identification and specification of transmission plans which would increase Wisconsin's electrical transfer capability to 2000 megawatts from both the west and the south and 3000 megawatts simultaneously. This level was basis for the transmission improvements the level identified in PSCW's report to the Wisconsin legislature dated September 1, 1998.

The WIREs group's Phase I report, dated August 1998, identified twelve potential representative system reinforcement plans to meet this transfer capability objective. More detailed analysis further refined this "short list" to seven plans which met the minimum transfer capability requirement. Quantification of the performance levels and costs of these seven plans was subsequently performed and summarized in matrix form. The performance matrix is included in the body of this report; the entire Phase II WIREs report is attached as an attachment. A paper supporting the transfer capability levels described above is also attached as an attachment.

The environmental screening analysis underlying our recommendation was performed by second group of WRAO-member personnel. The intent of the screening was to provide a reconnaissance-level analysis and description of potential transmission line study areas. With the assistance of a consultant and input from the staffs of the PSCW, the Minnesota Environmental Quality Board (MEQB), the Iowa Utilities Board, and other stakeholders, a report was produced which provides a visual review of the study areas and a general review of major environmental issues that will need to be addressed as system expansion progresses. A summary of the environmental findings is included in the body of this report; the entire report is attached as an attachment.

Beyond the technical and environmental considerations of transmission expansion are policy considerations which must be taken into account in arriving at a recommended course of action. Issues such as geographic diversity and ability to construct, while not

easily quantified, are nevertheless highly relevant. A discussion of the policy criteria is also included in the body of this report. An examination of the importance of geographical diversity is attached as an attachment.

After careful consideration of the implications of the seven transmission plans, based upon the Phase II WIREs group analysis of performance and cost, the environmental screening analysis, and several policy criteria, the WRAO concluded that plan 3j (Arrowhead – Weston 345 kV) is the best plan for achieving the multiple objectives of this study effort. Plan 3j meets all technical criteria and appears to have reasonable routing alternatives. It also provides geographic diversity, low system losses, and is capable of being constructed with an acceptable cost and schedule.

In order to achieve the benefits which construction of plan 3j would provide, it must be constructed in its entirety. For all of the plans presented, several significant additions or upgrades to the underlying transmission system are required. Notably, the Chisago – Apple River 230 kV project presently under regulatory review in Wisconsin and Minnesota is considered a critical requirement for all of the plans (except plan 5a, Chisago – Weston 345 kV). The Chisago – Apple River project is an integral system reinforcement and is also critical for local load serving. If transmission plan 3j ultimately is not constructed in its entirety, the WRAO has identified transmission plan 5b (Apple River – Weston 230 kV) as an alternative.

Introduction

History of Reliability Coordination in Wisconsin

In response to the energy crisis of the early 1970's and growing environmental awareness and activism, the State of Wisconsin enacted the Power Plant Siting Act of 1975. This Act required the Public Service Commission of Wisconsin (PSCW) to periodically conduct a statewide planning docket examining the need for major new electric generation and transmission facilities. This planning process was known as the Advance Plan and eight such dockets took place since their inception, the last of which was completed in January 1999.[1] The appropriate method of addressing the needs identified within the Advance Plan was subsequently taken up in Certificate of Public Convenience and Necessity (CPCN) construction application dockets.

During this time, utilities in eastern Wisconsin and much of Upper Michigan were organized as a subregion of the MAIN (Mid-America Interconnected Network) region of the North American Electric Reliability Council (NERC). NERC was formed to coordinate planning and operation of the continental electrical transmission grid in the wake of massive blackouts on the East Coast in the late 1960's and 1970's. The Wisconsin – Upper Michigan System (WUMS) subregion of MAIN was designated as the entity responsible for coordinated planning in eastern Wisconsin.

In 1997, events combined to raise concern about electric supply reliability within the Midwest. Several large nuclear generating units were in extended outages for maintenance work during critical peak and near-peak demand periods. At the same time, the transmission system, which had been constructed primarily to transport power within a utility's own system and provide access to outside sources in emergencies, was straining under new bulk loads resulting from recently enacted federal legislation which opened the interstate grid to competition. At times, the regional electric system was operating in a state close to precipitating cascading blackouts if any disturbance occurred.

In recognition of this situation, Wisconsin utilities and regulators formed an ad hoc group which came to be known as the Wisconsin Reliability Assessment Group. This group was dedicated to coordinating the operation and planning of generation and transmission

[1] Since the late 1980's, the Advance Plan process has been the primary forum for studies of the need for new transmission interconnections. Studies of the need for new transmission interconnections and of alternative interconnection projects were conducted in Advance Plans 5, 6 and 7, with a detailed assessment of needs and alternatives being performed as part of Advance Plan 6.

to ensure the reliability of Wisconsin's electric supply system. It reconstituted itself in 1998 as the Wisconsin Reliability Assessment Organization (WRAO).[2]

One of the early actions taken by the WRAO and its predecessor group was to assemble a group of transmission planners from its members and their counterparts in surrounding states to examine measures which could be taken to alleviate the strain on the region's transmission system. This technical subgroup formed into the Wisconsin Interface Reliability Enhancement study (WIREs) group.[3] The WIREs group has been operating under the direction of the WRAO since that time.

The 1997 Wisconsin Act 204 (Act 204) was signed into law in early 1998. To address the immediate transmission aspects of the reliability issue, Act 204 ordered the PSCW to issue a report to the Legislature identifying constraints and recommending alternatives for enhancing the State's transmission capacity. Act 204 also eliminated the Advance Plan process and replaced it with a Strategic Energy Assessment (SEA), the details of which are presently under development.

Since the WIREs group was already in the process of conducting a study of plans for relieving the constraints on Wisconsin's transmission system, it was decided that the WIREs group's Phase I report should be used as the basis of the PSCW's report to the Legislature, which was issued September 1, 1998. The PSCW's report described a "short list" of twelve representative system reinforcements to address the State's transmission constraints. It also included a list of all associated projects which must be completed in order for the twelve reinforcements to achieve their goals. The twelve system reinforcements described in the PSCW report were reduced to seven transmission plans in the WIRES Group's Phase II study.

It should be recognized that the focus of the study effort described in this report was on the evaluation of transmission system expansion plans that relieve constraints on Wisconsin's transmission system. The alternative of attempting to relieve transmission constraints by constructing strategically placed generation integrated with minimal transmission development in lieu of major new transmission facilities was not evaluated. This generation/transmission approach was not evaluated because it introduces too much uncertainty in terms of producing a dependable solution to the state's transmission problems. Given the nature of the emerging deregulated generation market, there is no

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[2] The WRAO utility participants are Alliant Energy, Dairyland Power Cooperative, the Municipal Electric Utilities of Wisconsin, Madison Gas and Electric, Minnesota Power, Northern States Power, Wisconsin Electric, the Wisconsin Federation of Cooperatives, Wisconsin Public Power Inc., and Wisconsin Public Service. Staff of the Public Service Commission of Wisconsin participate regularly in an *ex officio* capacity.

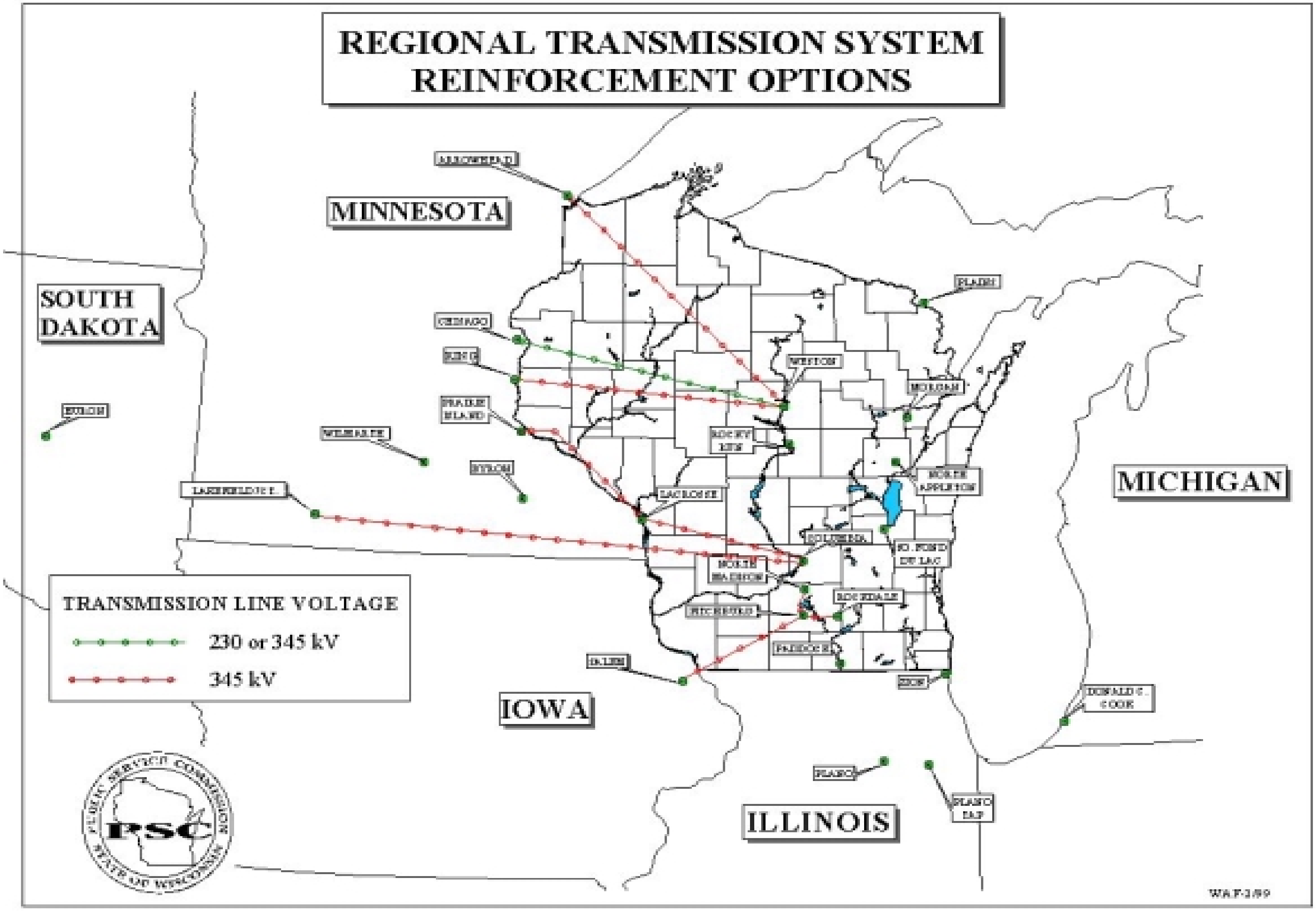
[3] WIREs group utilities are Alliant Energy, Commonwealth Edison, Dairyland Power Cooperative, Madison Gas and Electric, Manitoba Hydro, Minnesota Power, Northern States Power, Wisconsin Electric, Wisconsin Public Power Inc., and Wisconsin Public Service. Public power agency participants are the Badger Power Marketing Authority and the Municipal Electric Utilities of Wiscsonsin. Regulatory agency participants include the Illinois Commerce Commission, the Iowa Utilities Board, the Minnesota Department of Public Service, the Minnesota Public Utilities Commission, and the Public Service Commission of Wisconsin. Input was also provided by the Mid-America Interconnected Network, Inc. and the Mid-Continent Area Power Pool regional reliability councils of the North American Electric Reliability Council.

means of assuring the amount, timing or location of potential new generation facilities that would relieve transmission constraints. In addition, given the nature of the transmission constraints in Wisconsin, this approach would result in more costly and less robust options than any of the transmission plans considered in this study. Further, this type of approach to relieving transmission constraints could leave Wisconsin with limited flexibility in resource procurement in the event the generation market does not develop as needed in terms of amount, timing and location to relieve the constraints.

This document incorporates the results of the second phase of the WIRES group study efforts which led to the development of the seven transmission plans which were subjected to detailed review by the WRAO. The WIRES Phase II Report is provided as Attachment A to this report.

Plan[4]	Plan Description
1c	**Salem–Fitchburg, No. Madison–Fitchburg-Rockdale, 345 kV**
2e	**Prairie Island–La Crosse–Columbia, 345 kV**
2f	Salem–Paddock, 345 kV
3e	Arrowhead–Weston–So. Fond du Lac, So. Fond du Lac–Plano, 345 kV
3j	**Arrowhead–Weston, 345 kV**
3k	Arrowhead–Weston, 230 kV
5a	**Chisago–Weston, 345 kV**
5b*	**Apple River–Weston, 230 kV**
6c	Chisago–Rocky Run, Rocky Run–So. Fond du Lac, 345 kV
8b	Wilmarth–Byron–Columbia, 345 kV
9a	Huron-Split Rock-Lakefield Jct–Adams, Adams–Genoa–Columbia, 345 kV
9b*	**Lakefield Jct- Adams, Adams–Genoa–Columbia, 345 kV**
10*	**King–Weston, 345 kV**
12	Plano–Plano Tap, 345 kV
13c	Arrowhead–Plains, Morgan–No. Appleton, 345 kV

[4] The plans denoted with an asterisk (*) were added after Phase I. The plans listed in bold type were examined in detail in Phase II. The Plano – Plano Tap 345 kV project or an equivalently effective operating procedure is eventually required in all of the plans shown above, except for option 3e. An operating procedure is expected to delay the need for a physical solution beyond 2002 which is the target year of the WIREs analysis.


REGIONAL TRANSMISSION SYSTEM
REINFORCEMENT OPTIONS
MINNESOTA
SOUTH DAKOTA
MICHIGAN
IOWA
ILLINOIS
TRANSMISSION LINE VOLTAGE
230 or 345 kV
345 kV
ARROWHEAD
WESTON
LACROSSE
COLUMBIA
NORTH MADISON
ROCKDALE
PADDOCK
NORTH APPLETON
SO. FOND DU LAC
MORGAN
BYRON
PLANO
ZION
DONALD C. COOK
PSC

Study Approach and Scope

A workplan for WIREs Phase II was developed which included several “analysis paths”. The analysis paths were essentially examinations of each option’s capabilities in various technical categories. The short list of options was refined to seven candidates.

In order to address anticipated concerns for environmental issues, the WRAO commissioned a study of each remaining option’s environmental impacts. In the process of developing the specifications of this study, the environmental dissimilarity of two alternate study areas with generally similar electrical capabilities resulted in the expansion of the list of remaining options from six to seven.

The fundamental requirement for any option to be examined was its ability to result in a transfer capability of 2000 megawatts from both the west and south and a simultaneous transfer capability of 3000 megawatts. In support of this requirement, an assessment of Wisconsin’s transfer capability requirements was conducted. As part of this assessment, a Loss of Load Expectation (LOLE) study was conducted which employed industry-standard methods and reliability criteria and two alternative sets of assumptions regarding internal generation plans in order to produce bounds around the minimum reliability-based transfer capability requirement. The first set of assumptions increases internal generation at any time that reserves fall below the state-mandated 18% requirement. The second set of assumptions caps internal generation at presently approved levels and forces shortfalls to be addressed with imports. A similar study conducted earlier provided quantification of additional transfer capability requirements which would result from extended plant outages needed to retrofit existing facilities with NOx regulation compliance equipment.

WRAO and Stakeholder Input

One of the aims of the WRAO’s efforts in its coordination of planning is to take into consideration the diversity of expertise and opinion held by non-utility parties who may be affected by its recommendations. Toward that end, the WRAO has held meetings of “stakeholders” to discuss the progress of its work. Three stakeholder meetings have taken place since November of 1998, and they have been attended by representatives of governmental agencies, consumer groups, renewable resource advocates, environmental groups, independent power producers, power marketers, neighboring utilities, and reliability councils. As one might expect, a broad range of opinions was expressed at the meetings. Environmental representatives expressed concerns relating to the potential impacts of river crossings in environmentally sensitive areas. Large customer representatives expressed interest in increasing transfer capability to enhance reliability and facilitate economic transactions. Stakeholders were invited to comment on the draft of this report and their written comments are attached. The licensing processes in Wisconsin and affected surrounding states will provide additional forums for expression of support and opposition.

In recognition of bulk power system reliability as inherently a regional concern, the WRAO has encouraged and actively participated in five Regional Reliability Symposia since September 1997. They have taken place in Wisconsin, Minnesota, Iowa, and South Dakota.

Evaluation Summary

Technical Analysis

(Note to reader: this section of the WRAO report is nearly identical to the Executive Summary of the WIREs Phase II report. Minor stylistic changes have been made to facilitate incorporation into the WRAO report. The entire WIREs Phase II report appears as Attachment A to the WRAO report.)

The technical analyses were performed by the Wisconsin Interface Reliability Enhancement study (WIREs) group. The WIREs group was formed under the auspices of the Wisconsin Reliability Assessment Organization (WRAO) in the spring of 1998 in response to transmission reliability concerns stemming from events in 1997 and 1998 which caused reliability margins to drop below historically observed levels. The WIREs group consists of participants from utilities in Illinois, Iowa, Minnesota, Wisconsin, and the Canadian Province of Manitoba and the Mid-Continent Area Power Pool (MAPP) and Mid-America Interconnected Network (MAIN) reliability councils. Regulatory agencies in Illinois, Iowa, Minnesota, and Wisconsin also participated as ex officio members.

The second phase of this two-phase study effort was designed to identify transmission constraints on the regional bulk power transmission system and to evaluate transmission reinforcement alternatives to alleviate those constraints. The Phase I study effort, culminating in August of 1998 with the release of the *Wisconsin Interface Reliability Enhancement Study Phase I* report, consisted of a screening analysis to determine regional transmission constraints and the identification of a set of representative transmission reinforcement alternatives that would increase the simultaneous transfer capability into Wisconsin to 3000 MW. The 3000 MW simultaneous import capability was achieved by importing 2000 MW across transmission interconnections to the west and 1000 MW across transmission interconnections to the south or 1000 MW from the west and 2000 MW from the south. To the north and east Wisconsin has no transmission interconnections because of Lakes Superior and Michigan.

The Phase I study effort also constituted the basis for a report developed by the Public Service Commission of Wisconsin (PSCW) for the Wisconsin Legislature on the regional electric transmission system.

The WRAO, in its *REPORT OF THE WISCONSIN RELIABILITY ASSESSMENT ORGANIZATION ON TRANSMISSION SYSTEM REINFORCEMENT IN WISCONSIN*, has considered the technical analyses of the WIREs group along with environmental screening studies, policy considerations, geographical diversity, and ability to construct to formulate a recommended transmission reinforcement plan.

Alternative Transmission Reinforcement Plans Considered

The Phase II study effort refined the Phase I study results by further defining relative performance differences between alternative transmission reinforcement plans. The set of twelve original representative system reinforcements, which were identified in the Phase I study effort, were refined into seven transmission reinforcement plans. The reinforcements are referred to as "plans" because several projects, in addition to a major high voltage transmission line, are required to achieve the transfer capability objective. All of the projects associated with a particular "plan" are included in the cost estimates detailed in Chapter 8 of this report.

The major transmission system additions associated with each of the seven reinforcement plans evaluated in this study are:

- Plan 1c (Salem – Fitchburg 345 kV)
- Plan 2e (Prairie Island – Columbia 345 kV)
- Plan 3j (Arrowhead – Weston 345 kV)
- Plan 5a (Chisago – Weston 345 kV)
- Plan 5b (Apple River – Weston 230 kV)
- Plan 9b (Lakefield – Columbia 345 kV)
- Plan 10 (King – Weston 345 kV)

Performance Evaluation

The relative performance differences of the reinforcement alternatives were established with multiple evaluation techniques. Those evaluation techniques included the following:

- *Detailed power flow simulations*
- *Generator response to transmission line switching operations*
- *Dynamic stability*
- *Voltage stability*
- *Impact on the MAPP transmission system*
- *Construction cost estimates*
- *Impact on system losses*
- *Evaluated cost proxy*

The study group utilized a 2002 summer power flow model to evaluate the characteristics of each reinforcement plan. The 2002 model was chosen due to the lead time required to evaluate, license, engineer, and construct a transmission reinforcement of these magnitudes.

Detailed Power Flow Simulations

Several detailed power flow simulations were performed on each reinforcement plan to determine:

- the reactive voltage support required to achieve the 3000 MW simultaneous import capability
- the maximum transfer capability
- the sensitivity of the 3000 MW import capability to modeling assumptions

The detailed power flow simulations verify that each of the reinforcement plans is capable of supporting 3000 MW of simultaneous import capability. However, some plans provide more incremental transfer capability above the 3000 MW target than others. In addition, the maximum transfer capability of some plans is more sensitive to changes in modeling assumptions than others. The Table 1 (rows a-d) summarizes the power flow simulation results and shows the maximum transfer capability of each reinforcement plan under different modeling assumptions.

Generator Response to Transmission Line Switching Operations

The ability to transfer power across the western interface is currently limited by the Arpin phase angle. The Arpin phase angle limitation is a proxy for the maximum amount of stress introduced to the Weston generators when any portion of the King – Eau Claire – Arpin 345 kV line is switched. A sudden loss of any portion of the King – Eau Claire – Arpin 345 kV line results in a system “separation” between MAPP and eastern Wisconsin. When the line is re-closed across this “separation” an instantaneous change in power output is experienced on the Weston generator units which places mechanical stress on the shaft of each unit. The Weston units experience this phenomena due to their physical proximity to the western interface. The current Arpin phase angle limitation is 60 degrees (the maximum “separation”).

Rather than focus on the Arpin phase angle as a proxy measurement for the impact on the Weston generating units, the WIREs group focused on a direct measurement; the instantaneous change in power output of the Weston units upon the closure of the Eau Claire – Arpin 345 kV line. Analysis of the present day system calculated the Weston "delta P" corresponding to the re-close of the Eau Claire - Arpin 345 kV line with a phase angle difference of 60 degrees demonstrated that Weston Unit #3 would experience a “delta P” of 37.2% (or 0.372 per unit).

Analysis of each of the seven reinforcement plans at the target simultaneous transfer capability of 3000 MW (2000 MW west/1000MW south) indicates that each plan except for Plan 1c (Salem – Fitchburg 345 kV) results in a “delta-P” less than 37.2% limit. The Weston “delta-P” results for each of the seven reinforcement plans are shown in Table 1 (row e)

Dynamic Stability

Dynamic stability is the measure of the system's ability to react to a major system disturbance such as a short circuit on a transmission line, the opening of a line, the loss of a large generator, or the switching of a major load. Dynamic stability evaluates the ability of the system's generation units to remain synchronized and to "recover" from a system disturbance.

The dynamic stability analyses performed in this study considered the following:

1. WUMS and MAPP area disturbances
2. New facility disturbances
3. Maximum Columbia & Weston generation output sensitivities
4. Breaker failure performance (Rocky Run area)
5. Damping of the ¼ Hertz mode of oscillation
6. Incremental transfer capability assessment based on ¼ Hertz mode of oscillation.
7. Dynamic reactive support requirements

In general, all plans met established transient voltage and rotor angle criteria for the WUMS 2000 MW west – 1000 MW south import transfer condition. No additional reactive voltage support (VAr) requirements, over and above those identified through the power flow analyses, were identified.

The most pronounced difference between the reinforcement plans was observed for disturbances involving a loss of a major Twin Cities 345 kV outlet facility. For a loss of either the King – Eau Claire – Arpin 345 kV or the Prairie Island – Byron 345 kV transmission line, differences in transient voltage performance within MAPP and WUMS and damping of the MAPP/MAIN ¼ Hertz mode of oscillation were observed. Damping of the ¼ Hertz mode of oscillation is currently a stability limiting condition for the Twin Cities export (TCEX) limitation.

The damping of the ¼ Hertz (Hz) oscillation mode is dependent on transfer levels. To determine the maximum transfer capability at which the ¼ Hz mode is a limit, an incremental transfer capability (ITC) number was calculated based on the loss of either the King or Prairie Island 345 kV lines. The dynamic stability results of the ¼ Hz mode of oscillation are shown in Table 1 (row f).

Some generator stability problems were identified in the Rocky Run area for delayed clearing breaker failure cases studied with maximum generation at the Weston generating plant. These were found to be problems inherent in the base case and can be corrected with reduced failed breaker clearing times.

Voltage Stability

Voltage stability is the measure of a system's ability to maintain adequate voltage profiles following a major system disturbance such as the loss of a critical transmission line. Without adequate voltage support, a system could experience "voltage collapse", a condition characterized by declining voltages that cannot support customer load. The results of this analysis show that voltage instability is not encountered at a western interface transfer of 2000 MW.

The WIREs group undertook the voltage stability assessment with the MAPP Transmission Reliability Assessment Working Group and Power Technologies Inc. (PTI), a power system study consultant. The consultant's study work focused on western interface transfers because the western interface is more susceptible to voltage collapse than the southern interface. Past operating experience indicates that the southern interface is limited by thermal overload constraints rather than by voltage stability concerns.

In order to determine the maximum western interface transfer at which voltage instability is encountered, transfers were increased beyond the 2000 MW level (all other limitations were ignored). Results of this sensitivity are shown in Table 1 (row g) and demonstrate that some reinforcement plans provide more western interface transfer capability before voltage instability is exhibited.

Impact on the MAPP Transmission System

The impact of the seven reinforcement plans on the neighboring MAPP system was evaluated by considering the change in flow on the MAPP flowgates. Flowgates are a set of transmission lines with a single flow capability that define a thermal, voltage, or stability limitation. The geographical areas represented by the MAPP flowgates are shown in the figure below.

The change in flow on each flowgate due to the addition of a reinforcement plan to the system was determined by measuring the before and after reinforcement flow at a transfer level of 3000 MW (2000 MW western transfer / 1000 MW southern transfer). These results demonstrate that most reinforcement plans reduce flow on the MAPP flowgates as they are defined today[5]. The results are shown in Table 1 (rows h-l).

[5] It is important to note that some flowgate definitions and ratings may change when a major transmission reinforcement is added to the system.

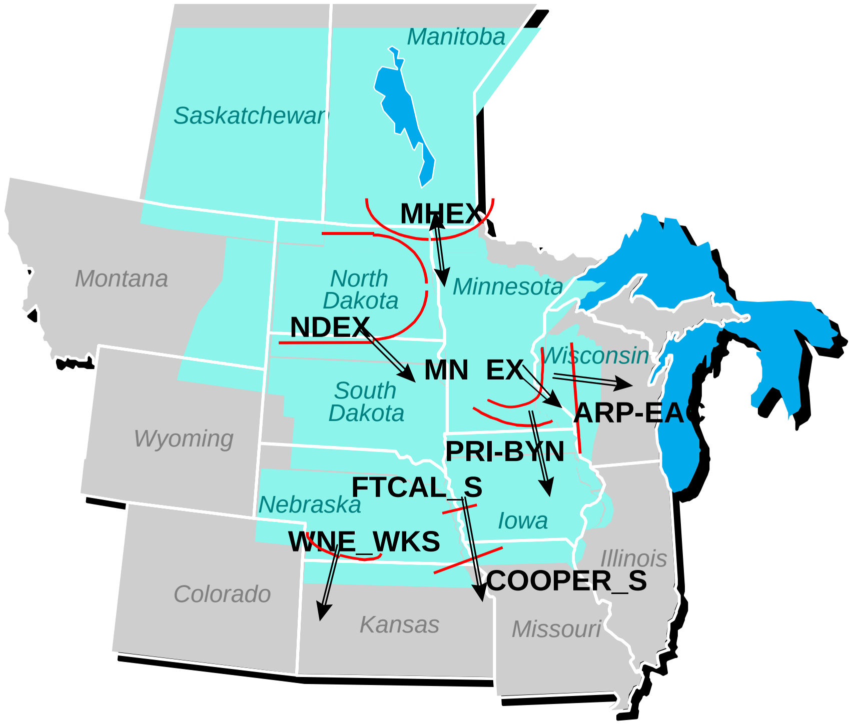


Figure ES- 1

Impact of System Losses

An analysis was undertaken to quantify the relative cost of system losses among the reinforcement plans. The costs associated with losses are summarized as an equivalent capital investment adjustment to the initial capital construction cost for each alternative. An equivalent capital cost adder is calculated for each reinforcement plan that is relative to the plan with the least losses. The capital cost adder for each reinforcement plan is shown in Table 1 (row m).

The process computes the lifetime costs for the installed generating capacity and associated energy to serve the losses that would prevail for each alternative. Transmission losses are included for the MAPP, MAIN, and SPP Regions. The cost adder is based on subtracting the life time costs of the lowest cost alternative, from the cost of all alternatives. Three components of adjusted capital cost were computed. These are due to generation capacity to supply the losses, annual energy losses to serve load, and annual energy losses due to point-to-point transactions.

<u>Capacity Cost</u>

Each plan causes the greatest demand for losses at some anticipated transfer level condition. In the cost evaluation, the maximum amount of loss caused by a plan is assigned a cost of 400 $/kW. The resulting cost represents the cost for installed generating capacity that would be required to serve the losses.

Energy Loss for Load
Each plan has energy losses associated with the annual hourly loss that occurs as the load pattern is served. An annual load pattern is sufficiently predictable, so that the resulting cost for Energy Loss for Load is a constant for each plan. The annual energy to serve load in each plan has been set at 30 % of the energy that would be lost if the peak load occurred all hours in the year. The annual energy lost as a consequence of serving load is priced out at 15 $/MWh. The resulting annual energy cost is equated to a levelized annual carrying charge. The annual carrying charge dollars are then converted to an equivalent capital investment, by dividing by 15 %.

Energy Loss for Transactions
Each plan has energy losses that are required to support the various point-to-point transactions that are planned. After determining the annual energy associated with the point-to-point transactions, a capital investment is computed by dividing by 15 %. Due to the varying degrees that future point-to point usage can occur, the annual Energy Loss for Transactions have been computed over a range of operating conditions. For example 5% of the time a 2000 MW import into WUMS from the West and a 1000 MW import from the South is one operating point along with, 40% of the time at a 1000 MW West import and 0 MW South import, etc.

Construction Cost Estimates

The cost estimates for the WIREs reinforcement plans are comprised of three parts. These three parts are cost of transmission lines, cost of substation terminal additions, and the cost of associated projects. The total construction cost, expressed as a range of values for each reinforcement plan, is shown in Table 1 (rows n and o). The construction cost estimates contain a range to account for discrete “study areas” between substation end-points. A team of environmental analysts retained by the WRAO to examine the seven reinforcement plans developed the “study areas”.

The three segments of the construction cost estimates are discussed below.

Cost of Transmission Lines
Black & Veatch, an engineering consultant retained by WRAO for this purpose, developed the cost estimates for the transmission lines. The transmission line cost estimates were based on the study areas defined for each plan by an environmental consultant working with WRAO and the WIREs group. For each study area, a single circuit cost estimate and a cost estimate that utilized all potential double

circuiting opportunities were developed. In most cases, four cost estimates were developed for each reinforcement plan (two study areas times two cost estimates).

Cost of Substation Terminal Additions
The cost estimates for the substation terminal additions and enhancements required for each WIREs plan were developed by the utilities whose service territories contained the substations under consideration. Black & Veatch supplied standard substation "component costs" which were used by each utility in determining the estimated cost for these improvements. The component costs used are listed in a subsequent section.

Cost of Associated Projects
The associated projects are various system improvements which were required enhancements in order for the WIREs plan under consideration to achieve the stated power transfer goals. The cost estimates for these projects were developed by the utilities whose service territories contained the system elements under consideration.

Evaluated Cost Proxy

An evaluated cost proxy, which merged the construction cost, the equivalent capital cost adder for losses, and other savings from avoided local load serving projects is included in Table 1 (row p and q). The evaluated cost proxy is a portrayal of the overall economic impact of each reinforcement plan based on construction cost, the cost of losses, and a credit for avoided facilities. As with the construction cost estimates, the evaluated cost proxy is shown as a range to account for the different "study areas" for each reinforcement plan (the "study areas" were developed by the WRAO's environmental team).

Table ES-1 WIRE Study - Summary of Plans' Performance Evaluation

	Performance Results All Reinforcement Plans Satisfy 3000 MW Simultaneous Import Objective *ver3- 4/9/99*	**Salem-Fitchburg 345 kV** **1c**	**Prairie Island-Columbia 345 kV** **2e**	**Arrowhead-Weston 345 kV** **3j**	**Chisago-Weston 345 kV** **5a**	**Apple River-Weston 230 kV** **5b**	**Lakefield Jct-Columbia 345 kV** **9b**	**King-Weston 345 kV** **10**
	Southern Interface Transfer Capability (with 1000 MW western bias)							
a	**Transfer Capability - Southern Interface**	**2450**	**2370**	**2130**	**2150**	**2010**	**2400**	**2140**
	Western Interface Transfer Capability (with 1000 MW southern bias)							
b	**Transfer Capability - Western Interface (MW)**	**2210**	**2580**	**2280**	**2270**	**2120**	**2750**	**2300**
c	**Transfer Capability - Source Sensitivity (MW)**	**2110**	**2550**	**2190**	**2190**	**2140**	**2810**	**2200**
d	**Transfer Capability - Sink Sensitivity (MW)**	**2160**	**2720**	**1860**	**1880**	**2160**	**2590**	**1890**
e	**Weston Delta P (per unit improvement from existing limit @ 2000 MW)**	**-0.013**	**0.015**	**0.036**	**0.166**	**0.064**	**0.009**	**0.247**
f	**Dynamic Stability - .25 Hz Damping (MW incremental xfer through WUMS)**	**50**	**720**	**450**	**670**	**220**	**120**	**480**
g	**Voltage Stability (western transfer level MW - no southern import)**	**2615**	**3245**	**2615**	**2865**	**2865**	**3105**	**2865**
	Other Factors							
h	**MAPP OPPD Flowgate Loading (avg % loading change from base case)**	**-1.2%**	**-9.3%**	**-7.9%**	**-8.6%**	**-5.5%**	**-12.4%**	**-7.9%**
i	**MAPP COOPER_S Flowgate Loading (% loading change from base case)**	**-7.9%**	**-18.1%**	**-14.7%**	**-16.1%**	**-11.6%**	**-22.3%**	**-15.4%**
j	**MAPP ECL-ARP Flowgate Loading (% loading change from base case)**	**-0.8%**	**-6.3%**	**-19.7%**	**-24.3%**	**-10.6%**	**-7.5%**	**-20.2%**
k	**MAPP PRI-BYR Flowgate Loading (% loading change from base case)**	**1.3%**	**-26.1%**	**-15.5%**	**-18.3%**	**-9.0%**	**7.0%**	**-16.5%**
l	**MAPP MN EX Flowage Loading (% loading change from base case)**	**0.3%**	**-17.6%**	**-17.0%**	**-20.6%**	**-6.7%**	**8.1%**	**-20.2%**
	Economic Factors							
m	**Losses (Capital Cost Adder w/r to Plan 3j - million $)**	**$50.2**	**$27.2**	**$0.0**	**$1.4**	**$38.7**	**$29.0**	**$20.8**
n	**Construction Cost Range (single ckt - million $)**	**$116 - $145**	**$169 - $176**	**$177 - $210**	**$172 - $205**	**$118 - $144**	**$227 -**	**$136 - $139**
o	**Construction Cost Range (doubl ckt - million $)**	**$158 - $227**	**$243 - $265**	**$266 - $310**	**$240 - $284**	**$171 - $208**	**$395 -**	**$210 - $262**
p	**Evaluated Cost Proxy Range (single ckt - million $)**	**$166 - $195**	**$195 - $202**	**$177 - $199**	**$126 - $149**	**$157 - $173**	**$256 -**	**$157 - $160**
q	**Evaluated Cost Proxy Range (double ckt - million $)**	**$208 - $277**	**$269 - $291**	**$266 - $299**	**$194 - $228**	**$210 - $237**	**$424 -**	**$231 - $283**

Table 1

<u>Summary of Technical Study Results</u>

The evaluation techniques utilized in this study demonstrate that each reinforcement plan, with the exception of Plan 1c, is capable of supporting a simultaneous transfer of 3000 MW over the western and southern interfaces into Wisconsin. The Weston delta-P performance of Plan 1c (Salem – Fitchburg 345 kV) is slightly less than criteria which indicates that Plan 1c could not sustain a simultaneous import of 3000 MW without adding additional facilities to the plan.

Each of the evaluation techniques considered in this study were considered in isolation. In other words, the voltage stability transfer capability did not consider thermal limitations and vice-versa. The absolute transfer capability of each reinforcement plan is a function of all potential limitations including thermal, voltage, dynamic stability, and Weston delta-P. The following "radar-plot" attempts to capture how a different type of system limitation limits the transfer capability of each reinforcement plan.

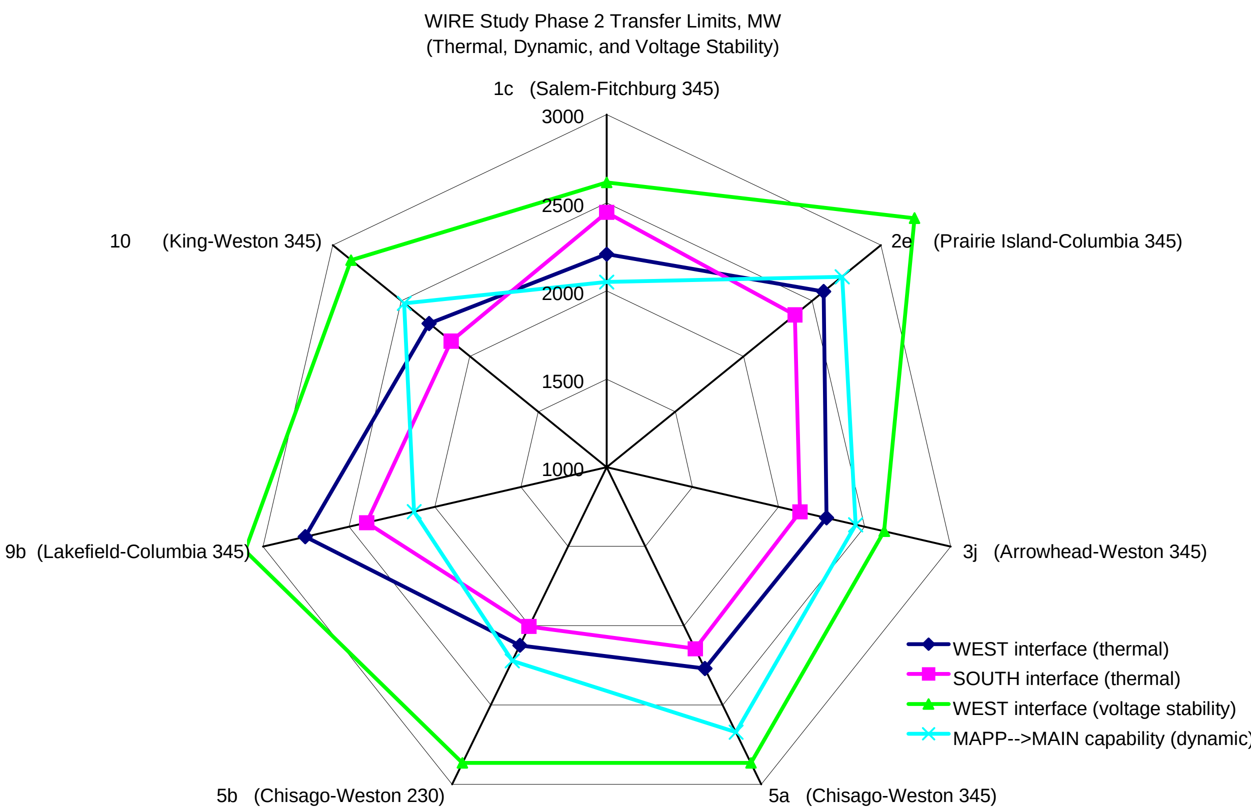


Figure ES- 2

Environmental Screening

An environmental screening for the various options was developed for WRAO by a consultant (Resource Strategies, Inc., or RSI) under the direction of representatives of the various member utilities, and with input from staff of the Public Service Commission of Wisconsin, Minnesota Environmental Quality Board and the Iowa Utilities Board. The report was developed from January 1999 to March 1999.

The intent of the screening was to provide a reconnaissance-level environmental analysis and description of potential transmission line study areas. The study areas were determined by using the most efficient routing from substation to substation and primary corridor sharing opportunities (major transportation or energy corridors) with generally a five-mile width. The study areas described in this report do not represent specific transmission line routes and alternative study areas might exist for each of these options which may have comparable economic and environmental feasibility. Within each of the study areas, several specific routes for a transmission line potentially exist.

This report provides a first glance of the potential study area the proposed system solution would occupy and primary environmental considerations within that study area that are most likely to influence a particular option's overall economic and siting feasibility. The report is useful to provide a visual review of study areas, a general review of major environmental issues that will need to be addressed and to begin communication between planning, engineering and environmental areas.

There were no comparisons done between the options analyzed. Comparisons are difficult to do at this stage because they would be largely subjective. Only general data is reviewed and this information needs to be evaluated along with other data (cost, performance, regulatory/permitting issues, etc.). Each of the options covers a large area of the region with various issues associated with the landscape the powerline would pass through. It is extremely difficult at this reconnaissance-level analysis to make any type of objective comparison of the information provided in the tables of the report.

The following table provides a summary of environmental considerations, opportunities and percentages of public land for each of the options and their segments. The percentage provided for corridor sharing with existing transmission assumes corridor sharing could be accomplished using either side by side construction or double circuit construction, unless otherwise noted.

More detailed information for each option is contained in Attachment B which contains the complete environmental screening. Each option segment is summarized in a table containing information that describes the study areas' length, land use, public lands, cultural resources and sensitive resources.

It should be noted that the locations of the transmission line and gas pipeline locations on the GIS (geographic information system) maps in the attachment may not be exact. For the most part, these facilities are depicted on the map in close proximity to their actual location on the landscape. However, corrections to any inaccuracies were not done due the difficulty and amount of time and labor needed to provide exact locations in GIS.

It should also be noted that the base case itself, upon which all of the reinforcements studied are based, requires significant additional facilities. The environmental impacts of the base case additions are outside the scope of this environmental screening analysis.

Segment	Length (Miles)	Public Lands	Considerations	Opportunities
1c Salem-Fitchburg (1)	77	2%	Upper Mississippi River crossing Urban and suburban Madison, WI Hilly Topography of SW Wisconsin	Corridor sharing with railroad, interstate highway, existing transmission—all intermittent. Corridor sharing with existing transmission: 10%
Salem-Fitchburg (2)	118	3%	Upper Mississippi River crossing Urban and suburban Madison, WI Hilly topography of SW Wisconsin	Corridor sharing of river crossing with existing transmission. Corridor sharing with existing transmission in Wisconsin and Iowa. Corridor sharing with state highway in Wisconsin. Total approximate and potential corridor sharing with existing transmission: 50%
Fitchburg-Rockdale	21	2%	Urban and suburban Madison, WI	Corridor sharing with existing transmission (side by side only) 100%
Fitchburg-North Madison	25	3%	Urban and suburban Madison, WI	Corridor sharing with existing transmission: 100%
2e Prairie Island-La Crosse 1	94	18%	Upper Mississippi River crossing Numerous wildlife refuges associated with the Mississippi River Urban and suburban La Crosse, WI	Corridor sharing with existing transmission, including river crossing. Corridor sharing with railroad. Total approximate and potential corridor sharing with existing transmission: 70%
Prairie Island - La Crosse 2	104	16%	Upper Mississippi River crossing Numerous wildlife refuges associated with the Mississippi River Urban and suburban La Crosse, WI	Corridor sharing with existing transmission and railroad. Total approximate and potential corridor sharing with existing transmission: 80%
La Crosse - Columbia	101	5%	Wisconsin River crossing Tourist and natural area attractions associated with Wisconsin Dells	Corridor sharing with existing transmission and Interstate Highway. Total approximate and potential corridor sharing with existing transmission: 20%
3j Arrowhead-Ladysmith	109	9%	Lac Courte Oreilles Reservation St. Croix National Scenic Riverway (Namekagon River crossing)	Corridor sharing with existing transmission, railroad and pipeline. Total approximate and potential corridor sharing with existing transmission: 60%
Ladysmith-Weston 1	119	1%	Urban and suburban Ladysmith, WI	Corridor sharing with existing transmission and state highway. Total approximate and potential corridor sharing with existing transmission: 50%
Ladysmith – Weston 2	92	4%	Urban and suburban Ladysmith, WI	Corridor sharing with existing transmission, pipeline and state highway. Total approximate and potential corridor sharing with existing transmission: 50%

Segment	Length (Miles)	Public Lands	Considerations	Opportunities
5a & b Chisago – Apple River	36	4.4%	St. Croix National Scenic Riverway (St.Croix River crossing)	Corridor sharing with pipeline and with existing transmission. Total approximate and potential corridor sharing with existing transmission: 40%
Apple River - Ladysmith	59	2%	Urban and suburban Ladysmith, WI	Corridor sharing with existing transmission and state highway. Total approximate and potential corridor sharing with existing transmission: 40%
Ladysmith-Weston 1	119	1%	Urban and suburban Ladysmith, WI	Corridor sharing with existing transmission and state highway. Total approximate and potential corridor sharing with existing transmission: 50%
Ladysmith – Weston 2	92	4%	Urban and suburban Ladysmith, WI	Corridor sharing with existing transmission, pipeline and state highway. Total approximate and potential corridor sharing with existing transmission: 50%
9b Lakefield - Adams	125	4%		Corridor sharing with highway and existing transmission. Total approximate and potential corridor sharing with existing transmission: 100%
Adams – Genoa	75	1%	Upper Mississippi River crossing	Corridor sharing with existing transmission: 100%
Genoa - Columbia	92	4%	Baraboo & Wisconsin Dells tourist attractions and natural areas Hilly topography of SW Wisconsin Wisconsin River crossing	Corridor sharing with existing transmission and interstate highway. Total approximate and potential corridor sharing with existing transmission: <5%
10 King-Eau Claire10 (1)	65	7%	Lower St. Croix National Scenic Riverway (St. Croix crossing)	Corridor sharing with highway and existing transmission. Total approximate and potential corridor sharing with existing transmission: 10%
King-Eau Claire (2)	69	9%	Lower St. Croix National Scenic Riverway (St. Croix crossing)	Corridor sharing with highway and existing transmission. Total approximate and potential corridor sharing with existing transmission: 100%
Eau Claire - Weston	91	1%	Urban and suburban Eau Claire, WI	Corridor sharing with highway and existing transmission. Total approximate and potential corridor sharing with existing transmission: 95%

Policy Criteria

In addition to the technical, economic and environmental evaluations previously described, there are several policy criteria that were considered in the selection of the preferred transmission plan. These policy criteria are:

Geographic Diversity
This criterion is an assessment of the ability of any given contingency to affect multiple facilities needed for reliability. Ideally, a new major interconnection between MAPP and MAIN would be located with enough geographic separation between it and the existing interconnection to avoid loss of both critical lines to a common problem, such as storms. Please see Attachment D for a discussion of the importance of geographic diversity.

Constructability
This criterion is an assessment of possible complications likely to affect existing system operation during the construction period of the new line. This would encompass items like the impact and timing of key line outages which may be required for construction, temporarily decreased transfer ratings of existing lines as a result of construction, and other such considerations. Existing lines which are in the study corridors of the proposed options are affected most, and the impact of the effects on those lines, along with the lines' importance to overall system operation, are the major determinants of constructability.

Political Ramifications of Routing
This criterion is an assessment of the extent to which an option is likely to raise concerns with various stakeholders, and the likelihood of being able to reasonably mitigate those concerns. This encompasses potentially controversial elements like river crossings, past reactions to attempts to locate electrical facilities in particular areas, political climate at different levels of government in study areas, and related matters.

Timing
This criterion focuses on the element of timing on two fronts -- regulatory process and construction. On the regulatory side, this is an assessment of the relative time that options would need to proceed through the necessary licensing processes. On the construction side, this is an assessment of how long it would take to physically construct the plan being considered with respect to the other options.

System Development Benefits
This criterion examines the relative abilities of the options to provide "building blocks" for future system enhancements. Some options may provide a better foundation for further system development to address pending future needs than other options, and will be better positioned for a longer term beneficial impact. Inclusion of a perspective on how the transmission system is likely to be operated in the future, as opposed to how it has been designed in the past and operates now in the present, is an important consideration.

<u>Regional Reliability Benefits</u>
This criterion is an assessment of the regional benefits associated with the options under consideration. This incorporates the relative abilities of options to address immediate focused regional needs, like local load serving, as well as more diffuse benefits like increased reliability for a larger area. This also includes a relative evaluation of benefits to MAPP, and to the MAPP-MAIN interaction and mutual system support on an overall regional reliability basis.

<u>Multi-Jurisdictional Concerns</u>
This criterion looks at issues related to the multiple jurisdictions involved with each option. This includes the impacts of multiple state/city/local governments with different concerns, multi-state regulatory processes with different timelines, multi-state environmental agencies and groups, and varying population attitudes and concerns.

<u>Regional Economic Impact</u>
This criterion looks at the impacts of the various options on the utilities involved. This includes not only the utilities whose service territories are impacted by the proposed construction, but also the utilities who would like to be involved from an ownership or other participation standpoint. Some utilities may be more willing or able than others to participate financially in the direct permitting and construction process. The key consideration is choosing an option which utilities are willing to build.

Summary of Recommendation

The WIRES phase II study effort identified seven transmission plans that would provide 3000 MW of simultaneous transfer capability into eastern Wisconsin. The WRAO incorporated the results of that study into a comprehensive review of each transmission plan that included environmental screening data and stakeholder input . It was the goal of that review to identify which transmission plan(s) provided the best balance among the evaluation criteria discussed in the previous section including such interests as performance, future flexibility, cost and potential environmental impacts, and ultimately make a final recommendation. The WRAO has identified one transmission plan which satisfies the evaluation criteria and meets the region's transmission system needs. The consensus and recommendation of the WRAO is to construct transmission plan 3j (Arrowhead-Weston 345kV). The WRAO also has identified transmission plan 5b (Apple River-Weston 230kV) as an alternate construction plan if plan 3J ultimately is not constructed.

Transmission plan 3j is a robust and flexible transmission configuration. It offers geographical diversity, low system losses, and the ability to meet much of the future needs of Wisconsin through transmission modifications or extensions solely within the state. Plan 3j involves several critical transmission system additions, upgrades, or operating guides that include:

- The construction of a new 345kV transmission line from the Arrowhead substation located in the Duluth, Minnesota area to the Weston substation located near Wausau, Wisconsin.
- The construction of a new 230kV transmission line from the Chisago substation located in Chisago County, Minnesota to the Apple River substation located near Amery, Wisconsin.*
- Conversion of the Oak Creek-Arcadian 230kV transmission line located in the Milwaukee area to 345kV.*
- The solution of the constraint at and around Plano-Plano Tap.*
- Rebuild the Kelly-Whitcomb 115kV transmission line located east of Wausau, Wisconsin.
- Numerous other extensive base case additions as shown in Attachment A.

Alternate transmission plan 5b is less robust and flexible than plan 3j, yet provides for the immediate needs of local load serving in northwestern Wisconsin and 3000 MW of simultaneous transfers into eastern Wisconsin. It offers low cost, relatively lower environmental impacts, and

* Several of these projects are required for local load serving as well as regional reliability.

could be in-service perhaps sooner than any other transmission plan considered. Plan 5b also involves several critical transmission system additions or upgrades that include:

- The construction of a new 230kV transmission line from the Chisago substation located in Chisago County, Minnesota to the Weston substation located near Wausau, Wisconsin.

- Conversion of the Oak Creek-Arcadian 230kV transmission line located in the Milwaukee area to 345kV.*

- The solution of the constraint at and around Plano-Plano Tap.*

- Rebuild the Kelly-Whitcomb 115kV transmission line located east of Wausau, Wisconsin.

- Numerous other extensive base case additions as shown in Attachment A.

The WRAO considered and weighed a myriad of variables and issues in forming its recommendation. The process required much discussion and cooperation. Many issues could not be simplified to mere numbers, but rather required the collective operational experience and judgement of the WRAO membership to resolve. Specific emphasis was given to the following areas:

- Interface Improvement: How well does the transmission plan meet the target of 3000MW of simultaneous transfers? To what degree does it improve system stability?

- Transmission Plan Cost: What are the up front costs to construct the plan?

- Doability: What are the potential environmental, societal and regulatory impacts and impediments associated with the transmission plan? What are the physical constraints for construction? Who is willing to construct? What might be the construction schedule?

- Third Party Impacts: What effect, if any, does the transmission plan have on other areas of MAPP/MAIN? Does it relieve existing transmission constraints or aggravate them?

- System Losses: How efficient is the transmission plan in moving energy around the regions system?

- Geographical Diversity: How well might the transmission plan perform when challenged by severe storms? What future flexibility does it provide?

Justification of Recommendation

The WIRE study team and the environmental study team did not identify any "fatal flaws" that would exclude any of the seven reinforcement plans from further consideration. Therefore, the WRAO considered the relative performance of the seven reinforcement plans along with a number of qualitative assessments to develop a recommended plan.

The WRAO recognizes that Plan 1c (Salem - Fitchburg 345 kV) did not meet all of the criteria established by the WIRE study team. Plan 1c (Salem - Fitchburg 345 kV) did not quite meet the criteria established for the Weston delta-P value which is a measure of the current "Arpin phase angle" problem. In addition, Plan 1c (Salem - Fitchburg 345 kV) did not exhibit robust dynamic stability performance with respect to the ¼ Hz. inter-area oscillation which causes the MAIN and MAPP system to "swing" against the remainder of the eastern interconnection. However, Plan 1c (Salem - Fitchburg 345 kV) is carried through the comparison process to demonstrate the differences between it and the remaining six plans.

Each of the five factors listed below were used in the evaluation of the seven plans. What follows is a description of each factor along with how the recommended plan, 3j (Arrowhead - Weston 345 kV), performed under each factor.

<u>Interface improvement.</u>

This factor considers each of the quantitative measures considered by the WIRE study group such as transfer capability, Weston delta-P performance, and dynamic and voltage stability performance.

Plan 3j (Arrowhead - Weston 345 kV) clearly met the minimum criteria established for transfer capability, dynamic and voltage stability, and the Weston delta-P criteria. While other plans contributed additional interface transfer capability above the established criteria, the WRAO found this incremental capability to be negligible and within accepted modeling tolerances. Plan 3j (Arrowhead - Weston 345 kV) demonstrated robust dynamic stability and voltage stability performance is acceptable.

<u>Environmental and social impact</u>

This factor considers several issues related to the ability to license and construct a new high voltage transmission line. Included are measures such as line length, potential for corridor sharing, proximity to population centers, environmental and jurisdictional impact, and river crossings. The WRAO recognizes that these measures are qualitative in nature. None of the transmission plans are devoid of the potential for environmental and social impacts.

After review of the environmental study work it was the judgement of the WRAO that Plan 3j (Arrowhead - Weston 345 kV) is reasonable in line length; offers significant potential for corridor sharing; and reasonably avoids population centers.

Construction cost

This factor is also based on the work of the WIRE study group. The WIRE study group identified a range of construction cost estimates based on the study areas determined by the environmental analysis team. The construction cost estimate ranges also considered double circuit opportunities. The WRAO recognizes that although construction cost estimates are useful when considering the relative cost of each plan, the ultimate construction cost of any system reinforcement is dependent on a number of factors including construction type, conductor size, routing (terrain differences), double circuit requirements, mitigation requirements, etc.

Plan 3j (Arrowhead - Weston 345 kV), while not having the lowest construction cost, was deemed to have reasonable costs based upon the performance under the other factors.

System losses

The WIRE study group evaluated the relative electrical loss profiles of each reinforcement plan in terms of capacity and energy. Each reinforcement plan changes the electrical characteristics of the regional transmission system differently which results in different loss profiles. The WRAO considered each reinforcement plans' ability to minimize on-peak losses and yearly energy losses.

Plan 3j (Arrowhead - Weston 345 kV) clearly was the most superior performing plan with respect to this factor.

Geographical diversity

This factor considers the geographical separation of each reinforcement plan from the existing western interface facilities (the King – Eau Claire – Arpin 345 kV). Of primary concern to the WRAO is the ability to guard against common-mode failure of the entire interface. For example, the greater the geographical separation between major transmission facilities, the less likely it is that one single event, such as a tornado, will result in the loss of both facilities.

In terms of geographical diversity, the WRAO considers Plan 3j (Arrowhead - Weston 345 kV) to be a superior performing plan because of its physical separation from the existing King – Eau Claire – Arpin 345 kV line.

Plan 3j (Arrowhead - Weston 345 kV) demonstrates superior loss characteristics, provides for geographical diversity, has the potential to avoid significant environmental issues and is cost competitive with the alternative plans. From a technical performance standpoint, Plan 3j (Arrowhead - Weston 345 kV) meets all of the criteria established by the WIRE study team including the Weston delta-P (the current Arpin phase angle problem), dynamic stability, and voltage stability. Plan 3j (Arrowhead - Weston 345 kV) also has the ancillary benefit of demonstrated local load serving benefits in the north-central area of Wisconsin (WPS's Upperwestern area).

Plan 3j (Arrowhead - Weston 345 kV) will provide a significant improvement to the transmission system in the MAIN and MAPP regions and provide crucial support to an interface that is limited by thermal, voltage, and dynamic stability constraints. Relative to the other reinforcement plans considered, plan 3j (Arrowhead - Weston 345 kV) is robust, minimizes environmental concerns, minimizes system losses, and provides for exceptional geographical diversity. For these reasons, the WRAO recommends that the transmission reinforcements within Plan 3j (Arrowhead - Weston 345 kV) are in the best interest of regional reliability and transmission interface expansion.

As demonstrated numerous times in the last several years, the opening of the existing Western Interface places the remaining electric transmission system in a precarious position. Formal application, regulatory approvals, and construction for Plan 3j should be expedited to reduce the risk of a widespread system outage.

Chisago Electric Transmission Line Project In the Base Case

The report developed by the WIREs group assumed the construction of the Chisago Electric Transmission Line Project ("Chisago Project"), as proposed in the September 6, 1996 filing of Dairyland Power Cooperative and Northern States Power Company, for all plans other than plan 5a (Chisago-Lawrence Creek-Apple River-Weston 345 kV Line). Such inclusion is consistent with good planning practice, as a reference point must be established for all planning studies. Such inclusion is not intended to suggest a presumption of favorable regulatory review, but is simply based on a knowledge of what is filed and what is assumed to be needed for provision of service to local loads. The assumption of need is based on the results of the Wisconsin Advance Plan process and, in particular, Advance Plans 7 and 8.

The fact that one of the evaluated plans, plan 5a (Chisago-Lawrence Creek-Apple River-Weston 230 kV Line), includes the proposed Chisago Project facilities is no accident. The Interface Collaborative Committee (consisting of all major Wisconsin electric utilities) in 1996 endorsed the filing of the Chisago Project, understanding that it is driven primarily by a need to improve the reliability of load serving in northwestern Wisconsin and east central Minnesota. The Collaborative also was aware that there is an ancillary benefit to the transfer capability into eastern Wisconsin resulting from the construction of the line. Booth & Associates, the consultant engaged by the Minnesota Environmental Quality Board (MEQB) to review the need for the Chisago Project, noted that the Project, as proposed, is inadequate as a long-term solution to the shortage of transfer capability into eastern Wisconsin. The inadequacy for meeting the ultimate transfer capability goals was also documented by the applicants in studies submitted in support of the Chisago Project applications. Extending the project from Apple River to Weston, as proposed in plan 5b, provides the additional transfer capability necessary to meet the criteria set forth for the WIRE study.

Testimony has been provided in the Chisago Project dockets that extending the project beyond Apple River may be necessary at some point in the future to maintain the benefit of the Project as load continues to grow. The WRAO did not undertake analysis of the specific long term short-comings of the Project for load serving purposes. The project, as reviewed and approved by the Interface Collaborative Committee, however, did not extend beyond the Apple River Substation. Transmission plans submitted for regulatory review are based on the best information at the time. The critical need being addressed by the WIREs Phase I and II studies was emphasized after the energy shortages experienced in eastern Wisconsin in1997, despite the fact that various bulk transfer options for eastern Wisconsin have been under study for more than ten years

None of the proposed plans, with the exception of 5a, eliminates the need for the Chisago Project as proposed. With the exception of option 5b, none of the projects, even if they could be modified to provide benefit to northwestern Wisconsin load serving, could be constructed quickly enough to address the immediate need for improvements to load serving in western Wisconsin. Plan 5a is problematic from a load serving perspective because it precludes the Chisago Project (that is, the load serving project proposed by Dairyland and NSP) from being constructed, and plan 5a itself could not be constructed quickly enough to address the immediate load serving need. Consequently, the Chisago Project is an integral system reinforcement of every plan presented (except plan 5b as previously noted) and is also critical for local load serving. It is therefore important that it proceed. Plan 5a is not receiving further consideration, in part, because it does not provide in an appropriate time frame for the need to improve the reliability of load service in northwestern Wisconsin and east central Minnesota.