October 2009 10-Year Assessment
www.atc10yearplan.com

Zones & Study Results

Introduction

For system planning purposes, we have defined five planning zones representing distinct geographic areas within our overall service territory. Within each zone, we compile and assess the transmission system needs. This zone-level planning is one of four levels at which transmission system needs are assessed and potential solutions developed. ATC's five planning zones are shown in Figure ZS-21.

In March 2008, Federal Energy Regulatory Commission (FERC) Order 890-A took effect. As part of this order, FERC requires a coordinated, open, and transparent transmission planning process on both a local and regional level. To comply with these requirements, ATC submitted a compliance filing on Order 890-A that provides a timeline of actions to ensure that the economic planning process is both coordinated and open.

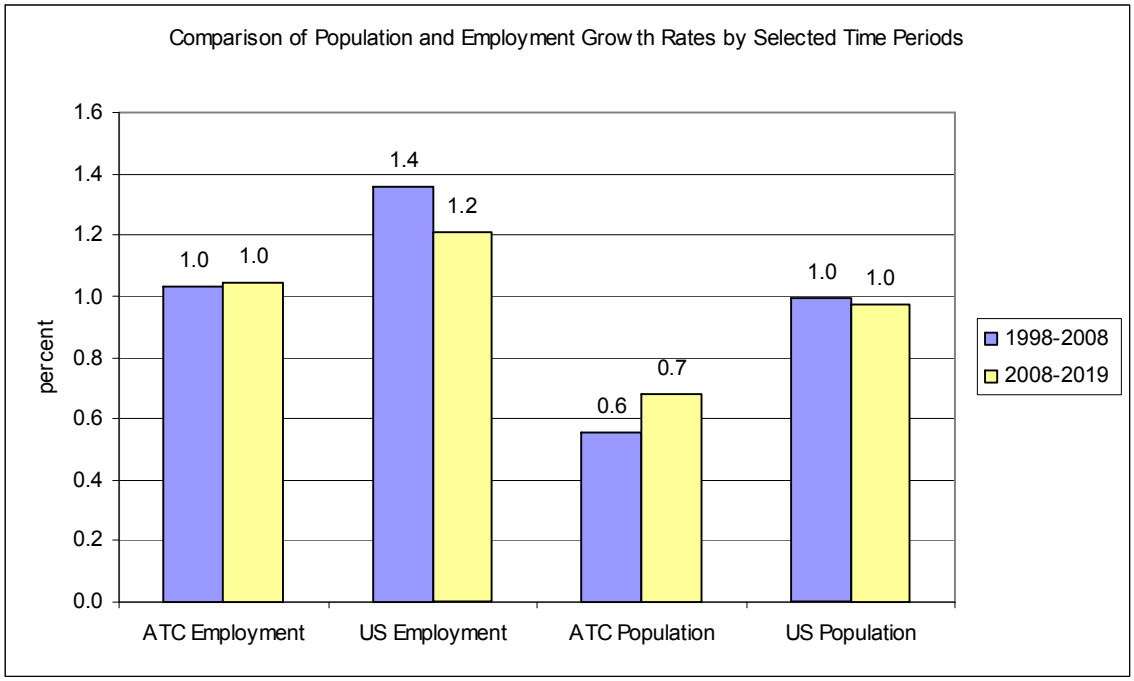
For each zone, we have compiled recent information on:

- ❑ demographics,
- ❑ future population and employment projections,
- ❑ environmental considerations,
- ❑ electricity demand and generation,
- ❑ transmission system issues,
- ❑ 2010 study results,
- ❑ 2014 study results,
- ❑ 2019 study results, including 20% Wind and Slow Growth Futures and
- ❑ 2024 study results.

Demographics – Long-term overview

For the 10-year period 1998 to 2008, population and employment for the American Transmission Company (ATC) service area, which owns approximately 80 percent of the transmission lines in the state of Wisconsin, has grown steadily, but not as fast as both employment and population for the United States. The population of the service area grew at an annual rate of 0.6 percent, while the United States increased 1.0 percent over that same period. The annual employment growth rate was 1.0 percent, while again the United States grew faster at 1.4 percent.

Population in the ATC service area is projected to grow at 0.7 percent annually between 2008 and 2019, while the United States is projected to grow 1.0 percent. Employment in the ATC service area for the same period is projected to grow at 1.0 percent annually, while the growth in employment for the United States is projected to increase slightly faster (1.2 percent).



Within the ATC service area over the historical period, the highest annual growth rate for both population (1.0 percent) and employment (1.6 percent) occurred in the ATC Zone 3, which is defined as South Central/Southwest Wisconsin and North Central Illinois (Please refer to Zone 3 study results for a list of counties).

The Zone 3 historical annual growth rates are in line with the Rest-of-Wisconsin and the United States growth rates for population and employment. In addition, Zone 3 over the 2008-2019 period is projected to have the highest growth rates for both population and employment and again are in line with the Rest-of-Wisconsin and the United States projected growth rates.

Population Growth Rates				
	1998-2008	2008-2014	2014-2019	2008-2019
Zone 1	0.3	0.6	0.7	0.7
Zone 2	-0.1	0.2	0.2	0.2
Zone 3	1.0	1.1	1.0	1.0
Zone 4	0.6	0.7	0.7	0.7
Zone 5	0.5	0.5	0.5	0.5
ATC Total	**0.6**	**0.7**	**0.7**	**0.7**
Rest of MI	0.3	0.3	0.4	0.4
Rest of WI	0.8	1.0	1.0	1.0
Michigan	0.3	0.3	0.4	0.4
Wisconsin	0.6	0.7	0.8	0.8
United States	1.0	1.0	1.0	1.0

Employment Growth Rates				
	1998-2008	2008-2014	2014-2019	2008-2019
Zone 1	1.0	1.0	1.0	1.0
Zone 2	0.6	0.8	0.8	0.8
Zone 3	1.6	1.3	1.4	1.4
Zone 4	1.2	1.0	1.0	1.0
Zone 5	0.6	0.9	0.9	0.9
ATC Total	**1.0**	**1.0**	**1.0**	**1.0**
Rest of MI	0.4	0.9	0.9	0.9
Rest of WI	1.5	1.2	1.2	1.2
Michigan	0.4	0.9	0.9	0.9
Wisconsin	1.1	1.1	1.1	1.1
United States	1.4	1.2	1.2	1.2

While the growth in population and employment has been steady, annual growth rates have been historically slower than both the growth in the Rest of Wisconsin as well as the United States. This trend is projected to continue for the period 2008 to 2019.

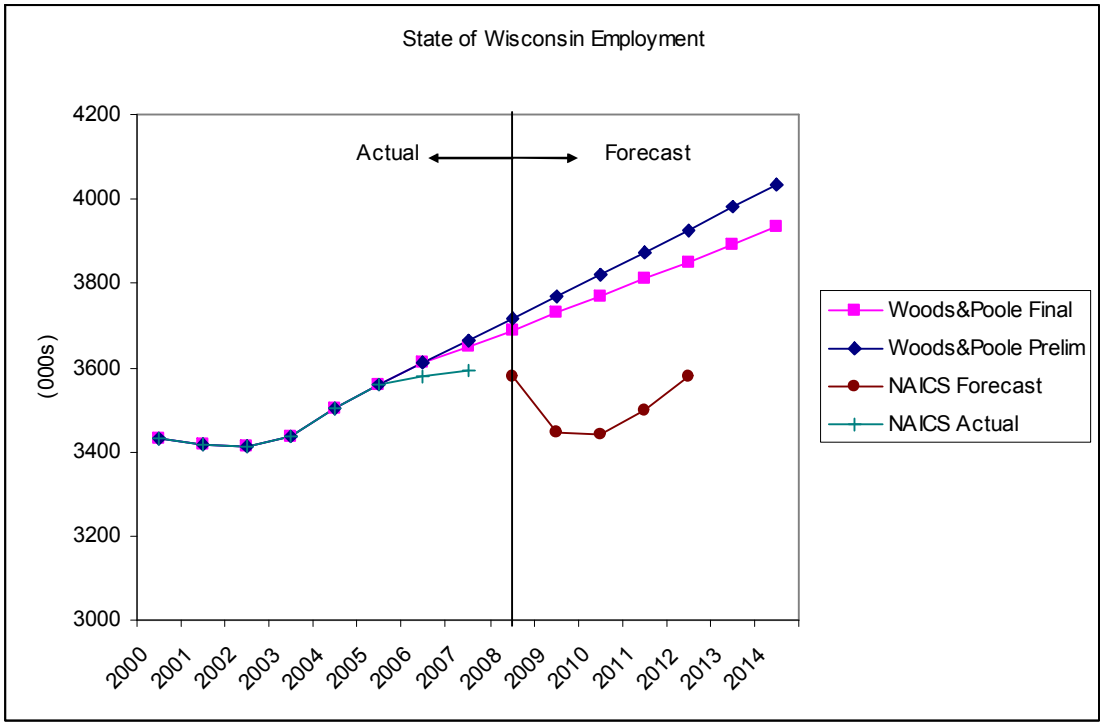
Population (000s)				
	1998	2008	2014	2019
Zone 1	503.1	519.4	539.7	557.8
Zone 2	335.2	330.6	334.4	338.2
Zone 3	1,080.9	1,190.6	1,268.1	1,335.3
Zone 4	1,034.4	1,098.9	1,142.9	1,181.8
Zone 5	1,825.0	1,912.0	1,972.9	2,027.7
ATC Total	**4,778.7**	**5,051.4**	**5,258.0**	**5,440.8**
Rest of MI	9,548.3	9,809.1	10,013.3	10,204.2
Rest of WI	818.7	885.3	939.7	986.9
Michigan	9,847.9	10,102.9	10,309.5	10,503.0
Wisconsin	5,297.7	5,643.0	5,901.6	6,128.9
United States	275,854.1	304,579.4	322,897.0	338,796.2

Employment (000s)				
	1998	2008	2014	2019
Zone 1	296.8	328.9	348.1	365.2
Zone 2	167.5	178.0	187.1	195.1
Zone 3	711.8	833.6	903.2	966.2
Zone 4	654.4	739.4	784.4	824.3
Zone 5	1,143.9	1,216.3	1,284.6	1,344.0
ATC Total	**2,974.4**	**3,296.3**	**3,507.4**	**3,694.7**
Rest of MI	5,266.2	5,485.2	5,797.7	6,070.8
Rest of WI	477.9	552.5	593.5	629.9
Michigan	5,415.6	5,644.9	5,965.6	6,245.8
Wisconsin	3,303.0	3,689.1	3,933.0	4,149.5
United States	159,628.1	182,657.7	196,274.3	208,393.4

Demographics – Short-term overview
"The national economy has been in recession for 15 months now, starting in December 2007 as dated by the National Bureau of Economic Research. Current trends of key indicators of the Wisconsin economy show that Wisconsin is also in a recession, with the same start date of

December 2007."[1] The current recession in Wisconsin has had short-term economic impacts on the growth in employment in our service area.

As the graph below illustrates, Wisconsin employment has dramatically declined relative to the long-term trend in employment. "Getting back" to the long-term trend will require several years of strong economic growth; as a result, the estimates of future growth in both employment and population should be viewed as "upper bound" estimates.



Sources: *Woods & Poole Prelim - Woods & Poole 2008 State Profile (May 2008 release)*
Woods & Poole Final - Woods & Poole 2008 State Profile (October 2008 release)
NAICS Actual - Bureau of Economic Analysis Regional Economic Accounts Table SA25N
NAICS Forecast - Wisconsin Economic Outlook March 2009 page 35

About the study results
For each zone, system performance criteria limits that are exceeded (overloads, low voltages, etc.) are identified from the results of each base model and associated contingency models along with their causes. In addition, system constraints (known transmission service/import limiters) also are identified. The identified needs and exceeded limits are categorized by ATC planning zone. Tables ZS-1 through ZS-4 list the combined limitations and instances where performance criteria limits are exceeded that were identified in the 2010, 2014, 2019 and 2024 analyses. The same information is

[1] Wisconsin Economic Outlook Executive Summary, March 2009, page 1.

shown graphically in Figures ZS-1 through ZS-20. Table ZS-3a lists information compiled from our 2019 20% Wind and Slow Growth futures power flow contingency analyses.

Note: The results for each zone in many cases are similar to the results presented in our Update of the 2008 10-Year Assessment issued in October 2008. Where new results or changes have been found, the new information is identified as such.

Beginning in April, 2005, the Midwest Independent System Operator began to monitor market constraints in both the Real Time and the Day Ahead markets. These market constraints may be lines, transformers or other equipment whose ratings would be exceeded when generation is dispatched in the most economic manner possible. These constraints are taken into consideration when developing solutions to the limits and needs identified above.

A summary of the top 20 constraints that occurred in the Day Ahead and the Real Time markets on the ATC system during the past year of market operation is provided in Tables ZS-5 and ZS-6, respectively. ATC uses the market shadow price of transmission constraints (the amount generating costs could be reduced if the transmission constraint were relieved by one megawatt) as the screening indicator to rank the severity of transmission constraints. From a planning perspective, we are concerned about market constraints that that are more severe as these constraints hinder the delivery of economic energy and drive locational marginal pricing (LMP).

In the LMP market, potential transmission equipment overloads are identified as constraints and are "bound" by the market in order to alleviate high loading levels. The binding of constraints results in a market-based redispatch of generation that is less than ideal from an economic standpoint.

Constraints that occur in the Day Ahead and Real Time markets facilitate the ability to recognize where our system may require reinforcements. The Day Ahead limitations, found in Table ZS-5, are anticipated on the system when the Day Ahead generation offers and load bids are settled. The Day Ahead market constraints can be the result of virtual transactions and are the basis of the Financial Transmission Rights (FTR) market. The Real Time limitations, found in Table ZS-6 are the result of unforeseen system conditions, which can result from load variation, unplanned outages, or market bids and offers that are not submitted in the Day Ahead. The Day Ahead and Real Time market constraints are taken into account when developing solutions. These constraints may point out potential problems but must be investigated further in order to determine if there are cost-effective solutions to mitigate the constraints in the future.

The primary (currently preferred) solution and the alternative solutions to the system performance criteria limits exceeded in the analyses are described for each zone. For limits exceeded in the 2010 model where the limit must be resolved in the near term and the preferred solution or a potential solution can reasonably be expected to be completed by 2014, such solutions are included in the 2014 model. For criteria limits exceeded in the 2010 analysis where the preferred or potential solutions require further verification or more analysis, such solutions are not included in the 2014 model, but the need is further investigated in the 2014 analysis. In instances where the need is further verified by the 2014 analyses, primary and alternative solutions are listed as part of the plan, with in-service dates based on reasonably likely completion dates. The same type of analyses was conducted for 2019 and 2024, with planned and several proposed projects being

included in the 2019 and 2024 models. This linking of results across the four study years allows us to begin to optimize the solutions to problems within a zone and also within the entire ATC system. As a result, the specific discussion of results for each study year will sometimes include discussion of issues identified in a future study year because of the need to utilize an optimized solution in the earlier study year.

The solutions ultimately selected to address the needs and limitations identified will reflect the input of transmission planning process stakeholders, including customers, state and local officials, the public, and coordination with other planning processes to the extent possible. Please refer to Methodology & assumptions for a better understanding of the basis for the results discussed by zone.

We continue to focus more attention on dealing with unexpected conditions. For instance, it is important to have appropriate reactive power reserves to manage system conditions that differ from the norm. While many capacitor bank installations are proposed in each zone to meet specific system needs, it should be noted that these additions also increase our flexibility to deal with extreme system conditions. See the reactive power analysis and multiple outage studies discussions for more information about the ability of the ATC system to manage unexpected conditions.

In the multiple outage studies section, we summarize the status of the studies that we have been conducting. This includes a summary of stability analyses reviewed or recently completed, providing insights into current stability margins of major generating stations on our system.

Zone 1 overview

Zone 1 includes the Wisconsin counties of:

- Adams
- Forest (southwestern portion)
- Fond du Lac (northwest portion)
- Green Lake
- Juneau
- Langlade
- Lincoln
- Marathon
- Marquette
- Monroe (eastern portion)
- Oneida
- Portage
- Shawano (western portion)
- Vernon (eastern portion)
- Vilas (southern portion)
- Waupaca
- Waushara
- Winnebago (western portion)
- Wood

The physical boundaries of Zone 1 and transmission facilities located in Zone 1 are shown in Figure ZS-22.

Land use in Zone 1 is largely rural, including agricultural and forested areas.

Zone 1 typically experiences peak electric demands during the summer months, with some winter peaks appearing in the northern portion. Primary electricity users in Zone 1 include a number of large paper mills and food processing plants.

Demographics
The population of the counties in Zone 1 grew at an annual rate of 0.3 percent from 1998 to 2008. The highest growth rate occurred in Adams County, which grew at 1.5 percent, while the highest increase in population occurred in Marathon County, which increased 6,000 people over the period.

Population in Zone 1 is projected to grow at 0.7 percent annually for the 2008 to 2019 period. Marathon County will realize the largest increase in population, while Adams County will have the highest growth rate.

During the historical period of 1998 to 2008, the annual employment growth rate was 1.0 percent. The highest growth rate occurred in Adams County, while the largest increase in employment occurred in Marathon County.

Employment in Zone 1 is projected to grow at 1.0 percent annually between 2008 and 2019. From 2008 to 2019, Marathon County is projected to realize the largest increase in employment, while Adams County is projected to have the highest growth rate.

Employment

Annual Growth Rate

	1998-2008		2008-2019
Zone 1	1.0	Zone 1	1.0
Adams, WI	3.4	Adams, WI	2.1

Total Increase

	1998-2008		2008-2019
Zone 1	32,106	Zone 1	36,234
Marathon, WI	14,357	Marathon, WI	9,625

Population

Annual Growth Rate

	1998-2008		2008-2019
Zone 1	0.3	Zone 1	0.7
Adams, WI	1.5	Adams, WI	2.1

Total Increase

	1998-2008		2008-2019
Zone 1	16,241	Zone 1	38,458
Marathon, WI	6,065	Marathon, WI	8,489

Zone 1 environmental considerations
Zone 1 covers the central and north-central portions of Wisconsin and spans a wide range of ecological landscapes varying from the Northern Highland and North Central Forest regions in the northern part of the zone through the Forest Transition, Central Sand Plains and Central Sand Hills regions to the Western Coulee and Ridges region in the southern portions of the zone. Descriptions of the characteristics of each of these ecological landscapes may be found on the Wisconsin Department of Natural Resources Web site: http://dnr.wi.gov/landscapes/

The northern portion of the zone contains numerous lakes and woodlands, while the southern portion is more agricultural in nature. Lands in this zone primarily are located in the Upper and Central Wisconsin River drainage basins with smaller portions of the zone located in the Fox and Wolf River drainage basins. The Necedah and Fox River National Wildlife Refuges, a small portion of the Nicolet National Forest and several Indian reservations are located in this planning zone.

Zone 1 electricity demand and generation

The coincident peak load forecasts for Zone 1 for 2010, 2014, 2019 and 2024 are shown in Table ZS-8. Existing generation, along with proposed generation based on projected in-service year, also is shown. The resultant difference between load and generation, with or without the proposed generation, is shown as well.

The table shows that load is projected to grow at roughly 1.8 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 1 is a net importer of power during peak load periods.

Zone 1 transmission system issues

Key system performance issues in Zone 1 include:

- the load serving capability and voltage stability of the 115-kV loop in northern Zone 1 (Rhinelander Loop)
- the load serving capability of the 138-kV and 69-kV network in southern Zone 1
- the temporary overloading of 69-kV and 138-kV network lines along the interface with Xcel Energy and Dairyland Power Cooperative for the loss of either the King-Eau Claire, Eau Claire-Arpin or Arpin-Rocky Run 345-kV lines during high west-to-east transfer conditions. In particular, the Monroe County-Council Creek 69-kV line, the Hillsboro-Hilltop 69-kV line and the Lublin-Lakehead 69-kV line are susceptible to overload for loss of the King-Eau Claire or Eau Claire-Arpin 345-kV lines or loss of the Arpin-Rocky Run 345-kV line during high transfers. Additionally, for the loss of the Arpin-Rocky Run 345-kV line, the 138-kV system from Arpin to Port Edwards is susceptible to overloads. These overloads are mitigated through the use of a Special Protection System on the 138-kV network at Port Edwards Substation and overload tripping schemes on the 69-kV network at Council Creek and Hilltop Substation. With the Arrowhead-Stone Lake-Gardner Park 345-kV line in service and the commercial operation of Weston 4 generation during 2008, the Wien Special Protection System has been retired. However, the tripping of above mentioned lower voltage facilities strains the load serving capability of the network in Zone 1.
- A large generator was added in 2008 at the existing Weston generation station in the Wausau area. Generator interconnection studies indicated that additional 345-kV lines are required along with upgrades to existing lower voltage facilities. These reinforcements were recently implemented.

Zone 1 - 2010 study results

Refer to Table ZS-1 and Figure ZS-1

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Summary of key findings

- The Rhinelander Loop will require completion of the proposed interconnection to other portions of the system in order to reliably serve load in the 2010 and beyond timeframe.
- Continued low voltages and overloads on the transmission facilities around the Tomah area. The 69-kV transmission corridor in the central part of Monroe County is particularly sensitive to a west-to-east system bias. Thus, this area will require reinforcements be implemented to reliably serve load in the future.

Several potential reinforcements have been evaluated to address the low voltage and thermal overload issues in the Tomah area. Furthermore, there is a need for periodic separation of the ATC-Dairyland Power Cooperative facilities at the Council Creek Substation. We worked in cooperation with Dairyland Power Cooperative and Xcel Energy to develop a more comprehensive long-term solution to address reliability issues in the Tomah area as well as the limitations along the Monroe County-Council Creek transmission corridor. The proposed solution will be to replace the existing 69-kV circuit between the Monroe County and Council Creek Substations with a new 161/69-kV double-circuit line in 2013.

The portion of the transmission system referred to as the Rhinelander Loop consists of the 115-kV facilities in north central Wisconsin or, more specifically, the 115-kV network north of Wausau. The Rhinelander Loop is particularly sensitive to low voltage during certain contingencies. A primary reason for this condition is that summer loads within the Rhinelander Loop have exceeded what had been forecasted prior to ATC's formation. This higher-than-anticipated load growth has accelerated the potential for such low voltages under single contingency conditions.

As part of the analyses of potential solutions for the Rhinelander Loop, we considered additional system issues that needed to be addressed on the adjacent 69-kV network to the north of the Rhinelander Loop (in Zone 2) and transfer capability needs between Wisconsin and Michigan's Upper Peninsula.

Based on the prior analyses, ATC's preferred longer-term solution is to construct a new Cranberry-Conover 115-kV line and rebuild the Conover-Iron River-Plains 69-kV line and convert to 138-kV operation. This alternative addresses the longer-term reliability issues of the Rhinelander Loop, provides substantial voltage support to the 69-kV system in the western portion of the Upper Peninsula and addresses potential long-term condition issues due to the age of the existing 69-kV system. The new 115-kV line between Cranberry and Conover was completed in June 2008, with the remainder of the project to be completed by June 2010 to meet reliability needs for serving the Rhinelander Loop. The 2010 date for the Conover-Plains portion of the project is only permissible by implementing some interim procedures and solutions. Without the Conover-Plains portion of this solution, overloads and voltage issues begin to reappear in the Wausau/Rhinelander Loop area in this timeframe.

To address low voltages elsewhere in Zone 1 and Zone 3, capacitor bank upgrades were installed at the Kilbourn Substation in 2009. To address facility overloads, the Metomen 69-kV breaker will be replaced in 2010, and the existing 47 MVA Metomen 138/69-kV transformer will be replaced with a 100 MVA transformer in 2017. Overloads on the Arpin 345/138-kV transformer and Arpin-Sigel 138-kV line are being addressed by the Port Edwards Special Protection System. The low voltages

at the Council Creek 138-kV Substation are being addressed through manual control of load tap changers on the Council Creek 138/69-kV transformer.

In response to customer requests for a new distribution interconnection, a new 69-kV transmission line for the Warrens Substation (formerly known as Mill Creek) will be placed in-service in 2010 by interconnecting to the Council Creek-Tunnel City 69-kV line. In 2012, a new 115-kV transmission line is needed from Clear Lake to the new Arnett Road distribution interconnection. The proposed Fairwater Substation distribution interconnection in the greater Ripon area will require a new radial 69-kV line be extended from the Brandon 69-kV Substation in 2010.

To improve reliability, ensure safety and compliance with current code requirements, a maintenance-driven rebuild of the Arpin-Rocky Run 345-kV circuit is proposed. Subsequent to an extensive study, our Asset Management organization concluded that the Arpin–Rocky Run 345-kV transmission line is structurally deficient and is capacity limited due to insufficient conductor-to-ground clearances. ATC received regulatory approval for this project in 2009 and anticipates that the completion date for the rebuild will be 2010.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 1 - 2014 study results

Refer to Table ZS-2 and Figure ZS-2

Summary of key findings

- ❑ Potential voltage and loading issues on the transmission facilities in the Stevens Point and Wisconsin Rapids areas are beginning to appear under certain contingencies. Further analysis and study work is required to define the need and identify potential reinforcements.
- ❑ Low voltages and overloads for critical outages in the Castle Rock Lakes area may be adequately addressed in the short term with generation redispatch. However, transmission reinforcements such as the expansion of existing capacitor banks and the rebuilding of existing 69-kV transmission lines will eventually need to be implemented.
- ❑ Low voltages and overloaded 69-kV facilities around the Berlin\Ripon area will necessitate that a combination of reinforcement projects be implemented.

Marginal voltages were observed in the Wisconsin Rapids area on the 138-kV system between the Sigel and Saratoga Substations for most critical contingencies. Also, at the Rocky Run Substation one of the three bulk power transformers is becoming heavily loaded under contingency. Although further study is still needed to better understand the system issues behind these new findings, they appear to be associated with local load-serving issues.

Low voltages and overloads in the Castle Rock Lakes area will necessitate a combination of reinforcement projects be implemented. The proposed reinforcements include the expansion of the

existing McKenna capacitor bank, the rebuild of the Castle Rock–McKenna 69-kV circuit and the load shift associated with an ACEC Badger West T-D interconnection. Also, to help with the low voltage issues in the Castle Rock area, the Necedah distribution substation will be converted from 69-kV to 138-kV operation. Additionally, redispatch of local generation may help alleviate these issues.

To address low voltages and overloads elsewhere within Zone 1 and 3, additional capacitor banks will be needed at the Ripon Substation, and an additional transformer will be installed at the Wautoma Substation. Additionally, as noted in the 2010 study results, the Metomen 138/69-kV transformer will be replaced with a 100 MVA transformer in the year 2017.

In response to a customer request for a new distribution interconnection, a new 69-kV transmission line will be placed in-service in 2014 from the Ripon Substation to the Metomen Substation to connect the new Southwest Ripon Substation.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 1 - 2019 study results
Refer to Table ZS-3, Table ZS-3a and Figure ZS-3

Summary of key findings

- ❑ The Rhinelander Loop will require additional reinforcements sometime after 2020. The Cranberry-Conover-Plains project provides considerable improvement of the load serving capability of the Rhinelander Loop's transmission system. However, it is anticipated that another source into the Loop, in addition to the Cranberry-Conover-Plains project, will be needed at some point beyond the current planning horizon.
- ❑ Maintenance, voltage and thermal issues exist in the greater Berlin and Ripon areas that need to be addressed.

To address maintenance, voltage and thermal issues in the greater Berlin/Ripon area a reconfiguration of the North Randolph-Ripon 69-kV line is proposed. A new 69-kV line will connect the Fairwater and Mackford Prairie substations forming a new 69-kV line from North Randolph to Metomen Substation. The northern portion of the existing Mackford Prairie Tap-Ripon 69-kV line will then be extended into a vacant terminal position at Metomen Substation, creating a second Ripon-Metomen 69-kV line. This will allow for the retirement of a portion of the North Randolph-Ripon circuit between Metomen and Mackford Prairie substations which is where a significant portion of the maintenance issues are located.

To address low voltage situations under contingency, a 12.2 MVAR capacitor bank will be installed at the Hilltop Substation in 2023.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 1 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- ❑ 20% Wind Future
- ❑ Slow Growth Future

Please refer to the Methodology & Assumptions for details about how these futures models were developed.

In the 20% Wind Future, voltages generally improved 2-to-3 percent in Zone 1. Furthermore, transformer overloads usually worsened and line overloads generally improved. This occurred as a result of the generation dispatch and the associated change in the flow of power associated with the 20% wind scenario.

In the Slow Growth Future, voltages improved throughout Zone 1. In addition, transformer and line overloads generally improved. This result is consistent with the reduced loading throughout the zone.

Please refer to Table ZS-3a for the limitations and performance criteria exceeded for these futures.

Zone 1 - 2024 study results

Refer to Table ZS-4 and Figure ZS-4

Summary of key findings

- ❑ Voltage and thermal issues remain in Zone 1 under contingency conditions.

The results of the 2024 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 1 can be found in Table ZS-4. Please note that because this is a 15-year projected scenario, new projects were not necessarily added to the Assessment based upon these results. However, we will continue to monitor these situations in future scenarios to determine which project(s) may solve these potential issues.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Summary of Compliance with NERC Standards
The mitigation plans, planned, proposed and provisional projects identified for Zone 1 in this Assessment will allow the ATC system in Zone 1 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

Zone 2 Overview

Zone 2 includes the counties of:

- Alger, Mich.
- Baraga, Mich.
- Chippewa, Mich.
- Delta, Mich.
- Dickinson, Mich.
- Florence, Wis.
- Forest, Wis. (northern portion)
- Gogebic, Mich. (eastern portion)
- Houghton, Mich.
- Iron, Mich.
- Keweenaw, Mich.
- Luce, Mich.
- Mackinac, Mich.
- Marinette, Wis. (northern portion)
- Marquette, Mich.
- Menominee, Mich. (northern portion)
- Ontonagon, Mich. (eastern portion)
- Schoolcraft, Mich.
- Vilas, Wis. (northern portion)

The physical boundaries of Zone 2 and transmission facilities located in Zone 2 are shown in Figure ZS-23.

Land use in Zone 2 is largely rural and heavily forested.

Zone 2 typically experiences peak electric demands during the winter months. Ore mining and paper mills are the largest electricity users in the zone.

Demographics
The population of the counties in Zone 2 experienced slightly negative growth from 1998 to 2008. The highest growth rate of 0.8 percent per year and the largest increase in population of 1,700 occurred in Vilas County.

Population in Zone 2 is projected to grow on an annual basis of 0.2 percent between 2008 and 2019. For the same period, Vilas County is projected to realize the largest increase in population, as well as the highest growth rate.

During the same period, the annual employment growth rate was 0.6 percent. The highest growth rate and the highest increase in employment occurred in Marquette County (Michigan).

Employment in Zone 2 is projected to grow at 0.8 percent annually between 2008 and 2019. During this time period, Marquette County (Michigan) is projected to realize the largest increase in employment, while Luce County (Michigan) is projected to have the highest growth rate.

Employment			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 2	0.6	Zone 2	0.8
Marquette, MI	1.7	Luce, MI	1.6

Population			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 2	-0.1	Zone 2	0.2
Vilas, WI	0.8	Vilas, WI	0.7

Total Increase			
	1998-2008		2008-2019
Zone 2	10,525	Zone 2	17,030
Marquette, MI	5,676	Marquette, MI	5,201

Total Increase			
	1998-2008		2008-2019
Zone 2	-4,619	Zone 2	7,595
Vilas, WI	1,732	Vilas, WI	1,834

Zone 2 environmental considerations

Zone 2 includes a small part of the far northeast portion of Wisconsin and approximately the eastern two-thirds of the Upper Peninsula of Michigan. The Wisconsin portions of the zone fall into the Northeast Sands and North Central Forest ecological landscape regions. The portions of the zone located in Michigan are part of the Eastern Upper Peninsula eco-region. A description of the characteristics of the Eastern Upper Peninsula eco-region may be found on the Michigan Department of Environmental Quality Web page at http://www.michigan.gov/dnr/0,1607,7-153-10366_11865-31471--,00.html.

Large expanses of this zone are forested and there are large numbers of streams, lakes and wetlands throughout the zone. The Niagara Escarpment is situated in the Eastern Upper Peninsula. Lakes Superior, Huron and Michigan form the northern and eastern boundaries of the zone. Two Michigan State Natural Rivers (Fox and Two-Hearted) and nine National Wild and Scenic Rivers (Tahquamenon, Indian, Sturgeon, Whitefish, Yellow Dog, Ontonagon, Paint, Carp and North Sturgeon) are found in this zone. Portions of the Nicolet, Ottawa, and Hiawatha national forests, and numerous state forests and parks are found in this zone. Several Indian reservations are found in this zone. The Seney National Wildlife Area, Pictured Rocks National Lakeshore and numerous federal wilderness areas also are found in this zone.

Zone 2 electricity demand and generation

The coincident peak load forecasts for Zone 2 for 2010, 2014, 2019 and 2024 are shown in Table ZS-9. Existing generation along with proposed generation based on projected in-service year also are shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

This table shows that load is projected to decrease at roughly 0.6 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that

Zone 2 has more generation than peak load, though actual operating experience indicates that during most periods, Zone 2 is a net importer of power.

Zone 2 transmission system issues

Key transmission facilities in Zone 2 include:

- the Morgan-Plains and Plains-Dead River 345-kV lines,
- the Plains-Stiles 138-kV double-circuit line and
- the 138-kV facilities tying the Upper Peninsula of Michigan to the Lower Peninsula.

Transmission study drivers

An overriding general characteristic of the Zone 2 transmission system is the fact that it consists of load islands dispersed over a broad area and numerous components are near limits. Both the local and interconnecting components of this network have been generally adequate by historic standards, however, modern performance requirements, coupled with load increases or generation reductions of "modest" magnitudes could result in reinforcement needs. Furthermore, inability to immediately serve nominal growth or generation changes could emerge. This indicates the need for extensive Strategic Flexibility analysis including the varied internal and external factors. This is the basis for conducting the ATC Energy Collaborative – Michigan study process which constitutes the bulk of the Zone 2 analysis in this 10-Year Assessment.

Key system performance issues in Zone 2 include:

- proposed renewable generation source increases,
- proposed point load increases,
- proposed generation retirements,
- limited import and export capability,
- aging 69-kV and 138-kV infrastructure throughout the Upper Peninsula,
- generator stability at the Presque Isle Power Plant,
- parallel path flow around Lake Michigan that contributes to heavy loading on the 138-kV and 69-kV systems, and results in the need for transmission loading relief incidents and reconfiguration of the system,
- record low Lake Superior water levels in the last few years have resulted in potentially reduced hydro generation,
  output in the eastern U.P., magnifying reliability concerns in this area,
- low voltages, most pronounced in the western and eastern Upper Peninsula,
- potential low voltages and overloads in the northwestern U.P. due to recent load increases, and
- potential marginal voltages and overloads in the central U.P. due to *potential* load increases.

Please refer to the ATC Energy Collaborative – Michigan for more information on the application of strategic flexibility planning to Zone 2.

Zone 2 - 2010 study results
Refer to Table ZS-1 and Figure ZS-5

Summary of key findings

- In the 2010 study year, potential constraints were identified occurring broadly across the U.P. All identified issues have either a mitigation plan or project associated with them. Please refer to Table ZS-1 (Project or Mitigation column) for details.

We have completed or are currently constructing a series of significant upgrades across Michigan's Upper Peninsula. The most notable projects are:

- The Eastern Upper Peninsula Reliability and Operating Enhancement Phase 1 (EUROPE) projects completed in 2006.
- The Northern Umbrella Projects (NUP) scheduled for completion in 2010.
- Three urgent projects in the Eastern Upper Peninsula completed at the start of the winter of 2007-08. These projects provided a hedge for the risk of low water availability for hydroelectric generation.

Even with these significant upgrades, operational challenges remain in this region due to the delicate balance among generation, load, market flows and transmission facilities that currently exists. There are also continuing asset renewal needs.

Longer term, more robust solutions, involving upgrades, rebuilds, and/or new construction is possible. These results are presented fully in the ATC Energy Collaborative - Michigan section. This section presents a strategic flexibility approach to the multiple factors emerging across the U.P.

Zone 2 - 2014 study results
Refer to Table ZS-2 and Figure ZS-6

Summary of key findings

- In the 2014 study year, potential constraints were identified occurring broadly across the U.P. Most of the identified issues have either a mitigation plan or project associated with them. Please refer to Table ZS-2 (Project or Mitigation column) for details.

Low bus voltages emerge in the eastern U.P. for the outage of the Livingston-Emmett 138-kV line or the Keystone-Ludington 345-kV line. In the short term, these constraints can be mitigated by adjustments taken at existing facilities as modeled:

- available generation increases,
- transformer tap adjustments,
- capacitor bank regulation, and/or
- the currently utilized procedure of splitting the system in the eastern U.P. (for several contingencies in the U.P. and Lower Peninsula of Michigan).

Longer term, more robust solutions, involving upgrades, rebuilds, and/or new construction is

possible, and will be presented fully in the ATC Energy Collaborative - Michigan section. This section presents a Strategic Flexibility approach to the multiple factors emerging across the U.P.

Zone 2 - 2019 study results
Refer to Table ZS-3, Table ZS-3a and Figure ZS-7

Summary of key findings

- In the 2019 study year, potential constraints were identified occurring broadly across the U.P. All identified issues have either a mitigation plan or project associated with them. Please refer to Table ZS-3 (Project or Mitigation column) for details.

Longer term, more robust solutions, involving upgrades, rebuilds, and/or new construction is possible. These results are presented fully in the ATC Energy Collaborative - Michigan section. This section presents a Strategic Flexibility approach to the multiple factors emerging across the U.P.

Zone 2 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- 20% Wind Future
- Slow Growth Future

Please refer to the Methodology & Assumptions for details about how the futures models were developed.

In the 20% Wind Future, voltages and line overloads in the Escanaba area worsen, but increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario.

In the Slow Growth Future, voltages improve throughout Zone 2. In addition, line overloads generally improve, but worsen under certain contingencies. This result is consistent with the reduced loading and associated generation redispatch throughout the zone.

The Pine River-Straits 69-kV line overload, which occurs under single contingency in the 2019 Summer Peak model, does not appear in either the 20% Wind or Slow Growth Future. Please refer to Table ZS-3a for the limitations and performance criteria exceeded for these futures.

Zone 2 - 2024 study results
Summary of key findings

Please refer to the ATC Energy Collaborative – Michigan.

Summary of Compliance with NERC Standards
The mitigation plans, planned, proposed and provisional projects identified for Zone 2 in this Assessment will allow the ATC system in Zone 2 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

Zone 3 overview

Zone 3 includes the Wisconsin counties of:

- Columbia
- Crawford (southern portion)
- Dane
- Dodge
- Grant
- Green
- Iowa
- Lafayette
- Jefferson
- Richland
- Rock
- Sauk
- Walworth and
- Winnebago, Ill. (northern portion)

The physical boundaries of Zone 3 and transmission facilities located in Zone 3 are shown in Figure ZS-24.

Land use in Zone 3 is a mix of rural, urban and agricultural. The major population centers are the Madison metropolitan area and the Janesville/Beloit area.

Zone 3 typically experiences peak demands during the summer months. Manufacturing, food processing, state government and institutional loads are among the largest electricity users in the zone.

Demographics

The population of the counties in Zone 3 grew at an annual rate of 1.0 percent from 1998 to 2008. The highest growth rate of 1.4 percent per year and the largest increase in population of 64,000 occurred in Dane County.

Population in Zone 3 is projected to grow at 1.0 percent annually for the 2008 to 2019 period. From 2008 to 2019, Dane County is projected to realize the largest increase in population and is projected to have the highest growth rate.

During the same period, the annual employment growth rate was 1.6 percent. The highest growth rate and the largest increase in employment occurred in Dane County.

Employment in Zone 3 is projected to grow at 1.4 percent annually between 2008 and 2019. Dane County is projected to realize the largest increase in employment and Sauk County the highest growth rate.

Employment			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 3	1.6	Zone 3	1.4
Dane, WI	2.0	Sauk, WI	1.6

Population			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 3	1.0	Zone 3	1.0
Dane, WI	1.4	Dane, WI	1.5

Total Increase			
	1998-2008		2008-2019
Zone 3	121,815	Zone 3	132,610
Dane, WI	71,834	Dane, WI	73,382

Total Increase			
	1998-2008		2008-2019
Zone 3	109,633	Zone 3	144,764
Dane, WI	64,189	Dane, WI	86,382

Zone 3 environmental considerations

Zone 3 covers the south central and southwestern portions of Wisconsin and the Illinois county of Winnebago.

The ecological landscapes in this zone vary from Southeast Glacial Plains in the east through the Central Sand Hills area to areas that are part of the Southwest Savanna and Western Coulee and Ridges landscapes in the west. The eastern portions of the zone generally are level to gently rolling terrain, while the western areas are characterized by the ridges and valleys of the drift less area.

The northern and western portions of this zone are located in the Lower Wisconsin River Drainage Basin, and the Mississippi River forms the zone's western boundary. Other portions of this zone are located in the Grant-Platte, Sugar River-Pecatonica, Upper and Lower Rock and Fox Illinois drainage basins. Horicon Marsh National Wildlife Refuge is located in the northeast part of the zone, and the Upper Mississippi River Wildlife and Fish Refuge is located along the zone's western edge. The Baraboo Hills are located in the north-central portion of the zone. The Lower Wisconsin River State Riverway also is found in this zone.

Zone 3 electricity demand and generation

The coincident peak load forecasts for Zone 3 for 2010, 2014, 2019 and 2024 are shown in Table ZS-10. Existing generation, along with proposed generation based on projected in-service year, also are shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

The table shows that load is projected to grow at roughly 2.4 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 3 has more generation than peak load during peak load periods. However, actual operating experience indicates that during most load periods, Zone 3 is a net importer of power.

Zone 3 transmission system issues

Key transmission facilities in Zone 3 include:

- the Columbia-North Madison 345-kV lines,
- the Columbia-Rockdale-Paddock-Wempletown 345-kV line
- the Paddock-Wempletown 345-kV line and
- the 138-kV facilities from the Nelson Dewey Power Plant, around the Madison area, and in the northwest and southeast portions of Zone 3.

Key system performance issues in Zone 3 include:

- import capability into the Madison area, whether from sources internal or external to the zone,
- contingency thermal overloads on the Fitchburg-Royster 69-kV line,
- contingency low voltage issues on the Sheepskin-Bass Creek-Brodhead 69-kV line,
- low voltages and line overloads on the 69-kV system in Monroe area,
- contingency thermal overloads on the Spring Green 138/69-kV transformer,
- insufficient 69-kV line capability in Dodge and Walworth Counties,
- low voltages and line overloads on the 69-kV system in the Dam Heights area,
- potential contingency overloads on the West Middleton 345/138-kV transformer and West Middleton-Blackhawk 69-kV line in the 2018 timeframe,
- contingency low voltages in northern Rock County and eastern Dane County,
- widespread intact system 138- and 69-kV low voltages in Jefferson, and Dane Counties are a serious emerging problem in 2014 and beyond, and
- impact of new generation.

Zone 3 - 2010 study results
Refer to Table ZS-1 and Figure ZS-9

Summary of key findings

- Low voltages throughout Zone 3 require a total of 245 MVAR of capacitor banks be installed by 2010.
- A significant number of lines and substation terminals will be uprated to avoid overloads under single contingency.
- Maintaining reliability of service to load in and around the Madison area requires that system reinforcements be implemented in the near term. Longer term, a 345-kV source on the west side of Madison will be required.
- Load growth in Rock and Walworth counties, higher than the ATC average, is driving the need for several system reinforcements in these counties.
- Import capability from Illinois can be severely limited by transmission facilities outside of our system for loss of the Wempletown-Paddock 345-kV line (ATC/Commonwealth Edison facility). This limitation has been addressed to some degree by installing a second 345-kV line between Wempletown and south central Wisconsin (Paddock Substation). The underlying 138-kV transmission system in the Janesville area and to the north still poses limitations for transfers into the Madison area.

Import capability from the areas to the south and southwest of Zone 3 has been a major concern. To help address this, ATC proposed the first transmission project within the Midwest Independent System Operator (MISO) footprint driven by economics. This project, the Paddock-Rockdale 345-kV transmission line, significantly reduces congestion and enhances import capability into Zone 3 and ATC as a whole.

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ATC received approval May 30, 2008, from the Public Service Commission of Wisconsin to construct this additional circuit primarily on an existing transmission line corridor between the Paddock Substation in the town of Beloit and the Rockdale Substation in the town of Christiana. (approximately 35 miles).

This project benefits electric consumers differently from other electric transmission projects that ATC has proposed in recent years, which largely have been in response to weaknesses on the system and related reliability issues. The primary purpose of a high-voltage transmission line to the south is to give local distribution utilities improved access to lower cost power from other areas in the region and bring it into Wisconsin. While this project is largely driven by economics, it also benefits electric consumers with a stronger, more stable electric system.

Wisconsin has limited transmission line connections to other states compared to its neighboring states. This limits the ability of electric utilities to access wind energy or sources of lower-cost electricity from other regions.

ATC submitted a construction application to the PSC in the spring of 2007 outlining its proposal and seeking regulatory approval. The route the PSC approved was ATC's designated preferred (recommended) route along an existing utility corridor where a 345-kilovolt line is located. A second route alternative along another utility corridor approximately two miles east of the approved route was rejected by the PSC.

In response to low voltages throughout Zone 3, a total of 245 MVAR of capacitor banks distributed at the Sheepskin, Richland Center, Brewer, Beaver Dam, Kilbourn, Artesian, Lamar, Union Townline, Dickinson, and Spring Green substations were deemed to be the most feasible solutions in the 2009-2010 timeframe. In 2009, 182 MVAR of reactive compensation was installed. The remaining 63 MVAR will be in service (Sheepskin, Lamar and Spring Green) in 2010.

We currently mitigate several of the identified 138-kV low voltages through remote control of the 138/69-kV transformers in the affected areas. In certain instances, transformer load tap changers are adjusted to bring the 138-kV contingency voltages above the planning criteria limits while maintaining the 69-kV bus voltages above criteria limits. This is a balancing act, and as loads continue to grow the process will no longer be effective.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2010 analysis. Many projects are either planned or proposed to address these near-term thermal problems by 2010. As a result, we propose to uprate three 69-kV lines and two 69-kV substation terminals.

Overloads for outages of the Dane-Waunakee, Blount-Ruskin or West Middleton-Pheasant Branch 69-kV lines or the North Madison 138/69-kV transformer highlight the need for additional transmission reinforcements in this area. The first phase of the reinforcements is complete. This included uprating the Dane-Waunakee, Waunakee-Huiskamp and West Middleton-Pheasant Branch 69-kV lines as well as uprating the North Madison 138/69-kV transformer. The second phase of the reinforcements includes the construction of a new 138-kV line, North Madison-Huiskamp, and the construction of a new substation with a 138/69-kV transformer near Huiskamp, which was completed in 2009.

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Several pending overloads and low voltages in southern Dane and Green counties are prompting the need for additional transmission system support in the area. The existing 69-kV line between Oregon and Verona substations will be rebuilt on new structures with larger conductor in part because of its deteriorated condition. This rebuild will help relieve some of the voltage and loading problems in the near term. In addition, a new 138-kV line from the Fitchburg area (Oak Ridge Substation) to Verona (previously Montrose Substation) is being planned to provide additional support that is needed as loads continue to grow in southern Dane County at a rate of twice the ATC system average. The Montrose endpoint was changed to the existing Verona Substation due to routing issues, public input and the Oregon-Verona rebuild plan.

The western portion of Jefferson County and the eastern portion of Dane County have also experienced high residential, commercial, and industrial load growth. Much of the area is served by the Rockdale Substation. Studies conducted by Planning indicate that by 2009, unacceptable voltages could be experienced in the Academy, Boxelder, London, Cambridge, Lakehead, and Jefferson substation areas with the outage of any segment of the Rockdale-Boxelder or Rockdale-Jefferson 138-kV lines. In order to provide reliable service to the area, a new Jefferson-Lake Mills-Stony Brook 138-kV line has been planned.

There are several pockets of low voltages and some overloads in eastern Rock and western Walworth counties. The recently completed maintenance rebuild of the Turtle-West Darien 69-kV line with initial operation at 69 kV remedies this situation. In conjunction with this project, a new line from West Darien through a new Southwest Delavan Substation to the Delavan area is planned. This project allows ATC to retire a portion of the existing Turtle-Bristol line, which is routed through an environmentally sensitive area, and to provide service to requested transmission-to-distribution interconnections (Southwest Delavan and North Shore substations).

Walworth County will require additional support to accommodate transmission-to-distribution interconnections, mitigate impending overloads on various facilities and support voltages at numerous substations under contingency. The conversion of the Rock River-Elkhorn line from 69-kV to 138 kV was recently completed to resolve these issues. The 138-kV Rock River to Elkhorn line conversion project will not only address thermal overloads but also make the system ready for rebuilding both Colley Road to Brick Church 138- and 69-kV lines. These two lines have condition issues that require they be rebuilt in the near future. In addition, the current operating guide which is to open the Colley Road to Brick Church 69-kV line for the loss of the Colley Road to Brick Church 138-kV line can be eliminated.

ATC and the city of Madison have proposed to bury part of the two Blount-Ruskin 69-kV overhead lines underground. This project will be completed in 2011.

In the 2008 Assessment, ATC planned to install a 12.24 MVAR 69-kV mobile capacitor bank at the Brick Church Substation. Due to the new load forecast changes, the plan has been changed. The new location for the mobile capacitor bank is Spring Green substation. It will not only help to support the area 69-kV system voltages under the Spring Green transformer outage, but also reduce load curtailment risk during several planned line construction outages in this area during 2009-2010 timeframe.

Projects whose "Need date" precedes the "In-service date"

- *Construct Oak Ridge-Verona 138-kV line*
  The need year is listed as 2009. However, due to regulatory delays, the in-service year is 2010. The mitigation measures for the potential 2009 system violations include upgrading the existing Verona and New Glarus 69-kV capacitor banks (2007), rebuilding the Stoughton 69-kV bus (2009) and distribution load shifting at Stoughton.
- *Uprate McCue-Lamar 69-kV line*
  Due to an enhanced generation dispatch scenario utilized in the 2008 Assessment[2], potential single-contingency low voltage problems in the Lamar area and an overload of the McCue-Lamar 69-kV line were observed in the 2009 summer peak model. Considering reasonable project lead times, the 2010 in-service date was chosen for this provisional project of uprating the McCue-Lamar line and installing capacitor banks at Lamar. In the interim, dispatching Sheepskin generation could be one possible mitigation strategy to address these constraints.
- *Jefferson-Tyranena-Stony Brook 138-kV line and associated line uprates*
  The construction of a new 138-kV line from Jefferson Substation to Stony Brook Substation has previously been identified as the long-term solution to the voltage problems in this area. The PSCW issued an order to ATC in August of 2006 for the construction of this line with an expectation that it would be completed by 6/1/2008. However, several legal challenges have limited ATC's ability to complete the detailed design, procure necessary materials, and procure the necessary easements to support start of construction in the fall of 2007 in order to meet this in-service date. As an interim measure, ATC decided to install a temporary 24.5 MVAR 138-kV capacitor bank at Boxelder in 2008 to address the imminent voltage violations.

Projects whose "In-service date" precedes the "Need date"
As a result of in-service date flexibility and corresponding alignment with other ATC project needs, the following project will be in service prior to the need date. Additionally, the project listed below is asterisked in the Annual Project Tables.

- Uprate X-23 Colley Road-Marine 138-kV terminals

Zone 3 - 2014 study results
Refer to Table ZS-2 and Figure ZS-10

Summary of key findings

- The numerous low voltages and line overloads along with the potential for voltage collapse in the Madison area signal the need for another new 345-kV source on the west side of Madison.
- Significant load growth in the Rock and Green Counties, along with the mismatch of load to generation in the area, will result in the Monroe area 69-kV network being subjected to unacceptably low voltages and thermal overloads under both normal and contingency

[2] Please refer to Methodology & Assumptions for a designation of the dispatch scenario

conditions in the summer of 2011. Rebuilding the 69-kV line Y-33 from Brodhead to South Monroe will address these issues.

- ❑ Load growth in Green County, west of Rock County and south of Dane County requires one additional 138-kV source into the area. Adding Bass Creek 138/69-kV transformation will address a number of potential low voltage problems and transformer overloads.
- ❑ As a result of the recent completion of the Rock River-Elkhorn 138-kV conversion project, it is feasible to uprate/rebuild the existing Colley Road-Brick Church 69-kV line for both reliability and maintenance needs.
- ❑ Potential thermal overloads and low voltage issues on the Fitchburg-Royster 69-kV line will require system reinforcements.

In response to low voltages in certain Zone 3 areas, a total of 165 MVAR of capacitor banks distributed at the Brick Church, Femrite and Verona substations in the 2011-2014 timeframe were proposed as preliminary solutions.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2014 analysis. Several projects are either planned or proposed to address these near-term thermal problems. As a result, we propose to uprate two 69-kV lines (Sheepskin-Dana line Y-61 and McCue-Milton Lawns Y-79). In addition, the Verona-Oregon 69-kV line and part of the Colley Road-Brick Church 69-kV line will be rebuilt due to reliability and condition issues (refer to Zone 3 2010 study results).

The Rockdale-West Middleton 345-kV line will address line overloads and low voltage issues in Dane County and is planned to be in-service in 2013. Demand in Dane County is projected to grow at an above-average rate for the ATC system. Above-average growth in demand coupled with potential generation retirements, concerns about the age, high cost, and limited amount of remaining generator capacity, and stress on the transmission lines that are critical for importing power to Dane County will continue to increase. By the end of 2011 Madison Gas and Electric (MGE) has plans to stop burning coal at the Blount Power Plant and MGE intended to retire units 3, 4 and 5 at the same time. However, due to reliability needs, the Midwest ISO is requiring that MGE defer retirement of these units, which would reduce the capacity of this power plant by 90 megawatts, until after the Rockdale-West Middleton 345kV line project is implemented. The remaining two units at Blount will remain in service and will use natural gas as the primary fuel.

Significant load growth in the Rock and Green Counties, along with the mismatch of load to generation in the area, will result in unacceptable low voltages in the Monroe area. Under several single contingency conditions, thermal overloads also arise on the 69-kV line Y-33 sections Brodhead-Spring Grove, Spring Grove-Blacksmith, and Blacksmith-South Monroe. The preferred solution to address these issues is to rebuild the Brodhead-South Monroe 69-kV line (Y-33) using 138-kV construction standards and initially operate the line at 69 kV.

The Evansville and Brodhead areas are facing unacceptably low voltages under single contingency conditions. In addition, the North Monroe 138/69-kV transformer loading is approaching to its summer normal rating under system intact conditions. In conjunction with the rebuild of line Y-33 from Brodhead to South Monroe (2011), a new Bass Creek 138/69-kV transformer and the Townline Road–Bass Creek 138-kV line uprate in 2013 will address these problems and provide

one additional 138-kV source into Green and Rock County. This project will also allow us to delay a new Brooklyn to Evansville 69-kV line project outside of our 10-year planning horizon.

The Fitchburg to Royster 69-kV line is susceptible to thermal overloads and the area experiences low voltages at Syene, Nine Springs, and Pflaum for loss of either end of the line. Looping the Nine Springs to Pflaum 69-kV line in and out of the Femrite Substation was proposed to address these issues. However, due to the project schedule constraints and Femrite substation constraints, it has been replaced by uprating Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, moving AGA to Femrite-Royster line and installing capacitor banks at the Nine Springs Substation.

A portion of the 69-kV Dane-Dam Heights line Y-8 will be rebuilt in the year 2012 as a part of an asset renewal project that addresses first contingency overloads in the year 2015. To address thermal overloads, the rating of the Portage-Trienda 138-kV line will be increased in 2016.

In addition, the withdrawal of the Nelson Dewey third generator and its associated transmission projects does not cause significant impact on the transmission system in Zone 3. Based on generation merit order in Alliant's control area, the dispatch scenario without the Nelson Dewey third generator facilitates a reduction of thermal loads on the following lines and transformers:

- ❑ McCue-Sheepskin 69-kV line,
- ❑ Stoughton-Sheepskin 69-kV line,
- ❑ Gran Grae-Boscobel 69-kV line,
- ❑ Spring Green 138/69-kV transformer, and the
- ❑ Hillman 138/69-kV transformer.

It has also been observed that the West Middleton-Stage Coach 69-kV line loading increases when the Nelson Dewey third generator is not in the model.

Projects whose "Need date" precedes the "In-service date"

- ❑ *Rebuild the Y-119 Verona-Oregon 69-kV line*
  The need year is listed as 2008. The in-service year is 2011. Distribution load shifting at Stoughton will eliminate potential system violations in the 2008-2010 timeframe.
- ❑ *Bass Creek transformer and uprate Town Line Road-Bass Creek 138-kV line X-12*
  The need year is listed as 2010. The in-service year is 2013. Mitigation measures for the potential 2010-2012 system violations include installing a 5.7 MVAR distribution capacitor bank at the Union Townline 69-kV Substation (2009) and upgrading the existing Sheepskin capacitor bank from 10.8 MVAR to 16.2 MVAR (2009).
- ❑ *Uprate Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, move AGA to the Femrite-Royster 69-kV line and install Nine Springs capacitor bank*
  The need year is listed as 2006. The in-service year is 2013. Post-contingency distribution l load bridging will be utilized as an interim mitigation measure to alleviate potential single-contingency thermal and voltage issues.

Projects whose "In-service date" precedes the "Need date"
As a result of in-service date flexibility, project cost saving and corresponding alignment with other ATC project needs, the following projects will be in service prior to the need date. Additionally, the projects listed below are asterisked in the Annual Project Tables.

- ❑ Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
- ❑ Rebuild part of the Y-8 Dane-Dam Heights 69-kV line

Our asset renewal team initially identified 116 structures on the Gran Grae-Boscobel line to be replaced due to various maintenance issues. Based on the Y-40 thermal rating analysis, it was determined that the additional scope for uprating the line from 200 degrees F to 300 degrees F would be to replace an additional 19 structures. It makes sense to combine this uprate with the previously identified maintenance project because these structures are very close to the previously identified poles. There are significant cost savings that can be obtained from performing the additional work as part of the maintenance project rather than completing the work as a separate future project.

Zone 3 - 2019 study results
Refer to Table ZS-3, Table ZS-3a and Figure ZS-11

Summary of key findings
- ❑ Additional reactive support is needed throughout the Zone 3.
- ❑ Under single contingency, all three Columbia 345/138-kV transformers are approaching to their maximum summer emergency ratings.
- ❑ Load growth in Lake Geneva area causes several single-contingency thermal overloads and low voltages.
- ❑ Potential single-contingency thermal overloads on the Dane-Lodi 69-kV line and the Kirkwood-Artesian 138-kV line will require system reinforcements.
- ❑ The existing Hillman 138/69-kV transformer potentially overloads under single contingency in the Dairyland Power system.
- ❑ With no generation running at Concord Substation, severe low voltages are observed under both system intact and single-contingency conditions. Economic benefit analysis may be performed to evaluate whether new transmission projects can be justified.
- ❑ Several projects in the Madison area were on hold due to a potential large T-D project development although the project need years were delayed based on the 2009 analysis.
- ❑ Potential single-contingency thermal overloads on the Gran Grae-Boscobel 69-kV line will require system reinforcements.
- ❑ The in-service date for a second 138/69-kV transformer at the Spring Green Substation is delayed due to other project and load changes.

In response to low voltages throughout Zone 3, a total of 362 MVAR of capacitor banks distributed at the Eden, Mazomanie, Concord, Sun Prairie, Dam Heights, North Monroe and Boscobel substations in the 2015-2019 timeframe were deemed to be the preliminary solutions.

The provisional project of constructing a Hubbard-East Beaver Dam 138-kV line will address not only several 69-kV thermal overloads, but also the low voltages in the Beaver Dam area for an outage of the North Randolph-North Beaver Dam 138-kV line.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2019 analysis. Three line uprate projects (one 138-kV uprates and two 69-kV uprates) and one 138/69-kV transformer upgrade (Hillman Substation) have been proposed to address these thermal problems.

The Columbia and Sauk County areas are experiencing high load growth, especially in Wisconsin Dells. A total of 98 MVAR of capacitor banks were installed at the Kilbourn and Artesian substations in 2009. However, potential Kirkwood to Artesian line overloads and serious post-contingency low voltages around the Reedsburg loop call for additional transmission reinforcements. The Lake Delton-Birchwood 138-kV project in 2017 will not only interconnect a new T-D substation, but also address impending low voltages and overloads identified on the transmission system.

Back In the 2008 Assessment, the West Middleton 138/69-kV transformers and West Middleton-Blackhawk 69-kV line were observed to be potentially overloaded under single-contingency conditions in the 2017 timeframe. To address these thermal overloads, a West Middleton to Blount 138-kV line project was being considered. In conjunction with the Rockdale-West Middleton 345-kV line project (2013), the West Middleton-Blount 138-kV line could eliminate the thermal overload issues in the long term and provide additional transfer capability to into downtown Madison. The status of this project was provisional for several reasons.

- ❑ The West Middleton 345/138 kV transformer ratings need to be validated.
- ❑ The 2017 in-service date driver needs to be confirmed, to determine whether the summer normal overloads can be mitigated by other means.
- ❑ Project alternatives have not been thoroughly developed and evaluated.

Since the 2008 Assessment, the West Middleton 345/138 kV transformer ratings have been validated with higher ratings. In addition, with the new load forecast used for the 2009 Assessment, the needs for the West Middleton-Blount 138-kV project were out of 10-year planning horizon. However, due to a potential large T-D project development in Madison area, the in-service date for this project will be kept as 2017 in the project table along with the following three projects until the T-D project development is finalized.

- ❑ Femrite capacitor bank project (2014),
- ❑ Sun Prairie capacitor bank project (2016), and
- ❑ Royster-Sycamore line uprate project (2016).

Constructing a 5.13-mile 138-kV line from North Lake Geneva to South Lake Geneva and installing a 138/69-kV transformer at South Lake Geneva substation will address several potential system violations in Lake Geneva area. Potential violations include the single-contingency thermal overloads on the Cobblestone-Zenda and North Lake Geneva-South Lake Geneva lines, and low voltage issues at Cobblestone and Lake Geneva. The status of this project is also provisional because Planning has not thoroughly compared it with other project alternatives in a long term study.

Significant load growth near the Lamar area causes numerous system constraints. Near term solutions are developed. They include:

1. Uprating Stoughton Substation terminal equipment to achieve a 169 MVA summer emergency rating on Y46 in 2009 (recently completed).
2. Uprating the McCue-Lamar section of the Y-61 to a minimum summer emergency rating of 115 MVA in 2010.
3. Installing 2-12.45 MVAR 69-kV capacitor banks at Lamar Substation in 2010.

However, these near-term solutions will not be sufficient after approximately six years. Subsequently, a longer term plan will be developed and implemented before 2017 to address emerging McCue-Lamar and Bass Creek-Footville thermal overloads and voltage issues at Lamar Substation under single-contingency conditions. A second 69-kV line from McCue-Lamar is currently being considered as a placeholder to resolve the issues in this area.

Based on the 2009 Assessment and due to the following three reasons, the need for the second Spring Green transformer has been delayed from 2013 to 2016.

1. The Nelson Dewey third generator project and supporting projects have been canceled.
2. The load forecast in the area was reduced; speculative load at Arena was removed.
3. Spring Green 2-16.33 MVAR capacitor banks also reduces var flow through the existing Spring Green 138/69-kV transformer.

A project to construct a Spring Valley-North Lake Geneva 138-kV line is being considered in 2018. Please refer to Zone 5 – 2019 study results for details.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 3 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- ❑ 20% Wind Future
- ❑ Slow Growth Future

Please refer to the Methodology & Assumptions for details about how the futures models were developed.

In the 20% Wind Future, line overloads and bus voltages generally improve in Zone 3. However, line overloads and bus voltages worsen significantly in the Lamar/Fulton/Harmony, Richland Center, Boscobel, Sheepskin and Monroe areas. Future projects, adjusting area phase shifters and/or increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario.

In the Slow Growth Future, voltages generally improve throughout Zone 3. In addition, line overloads generally improve, but worsen under certain contingencies. This result is consistent with the reduced loading and associated generation redispatch throughout the zone. Please refer to Table ZS-3a for the limitations and performance criteria exceeded for these futures.

Zone 3 - 2024 study results
Refer to Table ZS-4 and Figure ZS-12

Summary of key findings

- ❑ Load growth in the Green and Rock County areas will drive the need for additional 138/69-kV transformer capacity and 69-kV line uprate.
- ❑ Several 69-kV lines in the West Middleton and Waunakee area are approaching their summer emergency ratings under single contingency conditions.
- ❑ Potential terminal or line uprates may be needed in the 2023 timeframe for the Sun Valley-Oregon 69-kV line and the Stoughton-Stoughton South 69-kV line.
- ❑ System intact low voltages exist on the 138-kV system in Dane County and on the 138-kV system from Nelson Dewey to Kilbourn.
- ❑ System intact low voltages exist on the 69-kV system in the Boscobel and Mazomanie areas.
- ❑ Numerous low voltage violations exist under single-contingency conditions throughout the Zone 3 system.

The 2024 results suggest that further study of Zone 3, particularly around Dane, Green and Grant Counties, is needed to identify an appropriate long-term solution for this area that may be required beyond the year 2019.

Both of the Columbia 200 MVA, 345/138-kV transformers are close to their summer emergency ratings for the loss of the Columbia 400 MVA, 345/138-kV transformer. In addition, the Columbia-Portage 138-kV line is overloaded for the loss of the other Columbia to Portage 138-kV line by 2021. Adding a North Randolph 345/138-kV transformer along with an uprate of the Columbia 345/138-kV transformer T22 are proposed to relieve these overloads. This project is also expected to provide needed voltage support for Dodge and Jefferson Counties.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Summary of Compliance with NERC Standards
The mitigation plans, planned, proposed and provisional projects identified for Zone 3 in this Assessment will allow the ATC system in Zone 3 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

Zone 4 overview

Zone 4 includes the Wisconsin counties of:

- Brown
- Calumet
- Dodge (northeast corner)
- Door
- Fond du Lac (eastern portion)
- Manitowoc
- Marinette (southern portion)
- Menominee, Mich. (southern portion)
- Menominee, Wis.
- Oconto
- Outagamie
- Kewaunee
- Shawano (eastern portion)
- Sheboygan
- Winnebago (eastern portion)

The physical boundaries of Zone 4 and transmission facilities located in Zone 4 are shown in Figure ZS-25. Zone 4 land use is a mix of agricultural, forest and urban.

Major population centers in Zone 4 include Appleton, Green Bay, Fond du Lac, Sheboygan, Marinette/Menominee and Manitowoc.

Zone 4 typically experiences peak electric demands during the summer months, though the northern portion of Zone 4 typically experiences nearly equal summer and winter peaks. Paper mills and foundries in the metropolitan areas are some of the largest electricity users in the zone.

Demographics
The population of the counties in Zone 4 grew at an annual rate of 0.6 percent from 1998 to 2008. The highest growth rate occurred in Calumet County, while the largest increase in population over the period occurred in Brown County, which increased 23,000 people.

Population in Zone 4 is projected to grow annually at 0.7 percent for the 2008 through 2019 period. Brown County is projected to realize the largest increase in population, while Calumet County the highest growth rate.

During the same period, the annual employment growth rate was 1.2 percent. The highest growth rate occurred in Calumet County. In addition, the largest increase in employment also occurred in Calumet County, which increased 26,400 employees.

Employment in Zone 4 is projected to grow at 1.0 percent annually for the 2008 to 2019 period. Calumet County is projected to realize the largest increase in employment, while Door County is projected to have the highest growth rate.

Employment			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 4	1.2	Zone 4	1.0
Calumet, WI	3.6	Door, WI	1.3

Population			
Annual Growth Rate			
	1998-2008		2008-2019
Zone 4	0.6	Zone 4	0.7
Calumet, WI	1.3	Calumet, WI	1.3

Total Increase			
	1998-2008		2008-2019
Zone 4	85,066	Zone 4	84,882
Calumet, WI	26,384	Calumet, WI	21,838

Total Increase			
	1998-2008		2008-2019
Zone 4	64,531	Zone 4	82,870
Brown, WI	22,787	Brown, WI	23,634

Zone 4 environmental considerations

Zone 4 includes lands in the Southeast Glacial Plains, Central and Northern Lake Michigan Coastal, and Northeast Sands ecological landscape regions.

The area drains towards Lake Michigan via the Milwaukee, Sheboygan, Manitowoc, Twin-Door-Kewaunee, Wolf and Lower Fox drainage basins. Lake Winnebago and the Fox Valley are located in the central part of this zone. The eastern boundary of the zone is formed by the shorelines of Lake Michigan and Green Bay. The Niagara Escarpment runs through the center of the zone and out the Door County Peninsula.

Portions of the Kettle Moraine State Forest and the Horicon National Wildlife Refuge are found in the southern end of the zone. Navarino State Wildlife Area and a segment of the Wolf River, classified as a Federal Wild and Scenic River, are located in the northwest part of the zone. Several Indian reservations are also located in this zone.

Zone 4 electricity demand and generation

The coincident peak load forecasts for Zone 4 for 2010, 2014, 2019 and 2024 are shown in Table ZS-11. Existing generation, along with proposed generation based on projected in-service year, are also shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

This table shows that load is projected to grow at roughly 1.5 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 4 has more generation than load during peak load periods. Actual operating experience indicates that during lighter load periods, Zone 4 is a net exporter of power.

Zone 4 transmission system issues

Key transmission facilities in Zone 4 include:

- four 345-kV lines extending from the Kewaunee and Point Beach nuclear units, 138-kV network in the Fox River Valley/Green Bay area,
- two 345-kV lines extending from the Edgewater Power Plant,
- the eastern portion of the Gardner Park – Hwy 22 345-kV circuit along with the Hwy 22 – Werner West 345-kV circuit and the Werner West - North Appleton 345-kV circuit,
- 345-kV lines from South Fond du Lac to Columbia, Edgewater and Fitzgerald and
- a 345-kV line from Fitzgerald to North Appleton.

Key system performance issues in Zone 4 include:
- heavily loaded and aging 138 and 69-kV facilities in the Green Bay area, north of Green Bay and the Fox River Valley,
- low voltages and heavily loaded 138/69-kV transformers in the northern Door County area,
- heavily loaded 138-kV lines west of Green Bay and Appleton,
- heavily loaded 69-kV facilities in the Oshkosh area and,
- the limited import capability of northeast Wisconsin and Michigan's Upper Peninsula, resulting in uneconomic dispatch of generating units.

Zone 4 - 2010 study results
Refer to Table ZS-1 and Figure ZS-13

Summary of key findings
- By 2010, the recently completed construction of the new 345-kV line from Morgan to Werner West will significantly increase transfer capability between Wisconsin and the Upper Peninsula, avert overloads in and around the Green Bay area, improve 138-kV voltage profiles in the Fox Valley and Green Bay areas and significantly lower system losses.

As noted in the Northern Umbrella Plan discussion in previous 10-Year Assessments, the most chronic problem plaguing day-to-day operation of ATC's transmission system is the limited transfer capability during non-peak periods between Wisconsin and Michigan's Upper Peninsula. The resulting effects include:
- uneconomic dispatch of generation,
- interruption or curtailment of transmission service,
- operating near thermal and voltage limits for extended periods of time and
- limited ability to schedule maintenance without invoking redispatch, system reconfiguration or other measures.

Most of the solutions discussed in earlier 10-Year Assessments are already in-service. Those are:
- rebuilding the Morgan-Falls-Pioneer-Stiles 138-kV line (2005),
- rebuilding the Plains-Amberg 138-kV line (2005),
- rebuilding/converting the West Marinette-Amberg 69-kV line to 138 kV (2005),
- rebuilding the Amberg-Crivitz-Stiles 138-kV line (2006), and
- constructing a 345/138-kV Substation at Werner West (2006).

As discussed in the 2008 10-Year Assessment, the following projects have been planned as longer-term solutions to the Zone 4 issues as discussed above:
- construct a new 345/138-kV substation at Werner West (in service 2006),
- construct a Cranberry-Conover 115-kV line (in service 2007),
- rebuild and convert the Conover-Plains 69-kV line to 138-kV (2008 to 2010), and
- and
- construct a new Morgan-Highway 22-Werner West 345-kV line (in service 2009).

The recently completed Morgan-Werner West 345-kV line will aid the transmission system by reducing the south to north loading on the 138-kV lines through the Green Bay area, thus deferring or eliminating the need for numerous 138-kV transmission line upgrades/rebuilds in and around Green Bay. The planned project will also provide the extra transmission capacity needed to fully utilize the upgrades to the Wisconsin-Upper Peninsula transmission corridor which are scheduled to be completed before this project (i.e., Plains-Stiles and Cranberry-Conover).

The recently completed Clintonville-Werner West 138-kV line was strung primarily on Morgan-Highway 22 345-kV line structures. This project will provide significant system benefits. These benefits include additional reduced loading on the Highway V-Preble-Tower Drive 138-kV line, the North Appleton-Lawn Road-White Clay 138-kV line, the Badger 138/115-kV transformer, the Badger-Caroline 115-kV line and facilitating a future de-energized rebuild of the Pulliam-Stiles double-circuit 138-kV line, which would not be possible under current system conditions. In addition, the Clintonville-Werner West line will provide a second 138-kV source to the city of Clintonville.

Because the non-coincident nature of the load in northern Door County usually does not occur during ATC's typical system peak, two additional 1.2 MVAR distribution capacitor banks were placed in service at the Sister Bay 69/24.9-kV Substation in 2008. The addition of these capacitor banks bolsters the voltages in the area under normal and single-contingency conditions until longer term solutions are in place (See Zone 4 – 2014 study results for details regarding the long-term plan).

As discussed in earlier Assessments, the rebuild of the Sunset Point-Pearl Avenue 69-kV line would address the potential overload of the circuit under single-contingency conditions. The project is currently planned for 2011 in-service date.

Installing a second 138-kV reserve auxiliary transformer at Kewaunee and removing the existing tertiary auxiliary transformer (TAT) load from the Kewaunee 345/138-kV transformer is proposed for 2009. Implementing the project will increase the offsite power reliability and provide better operations and maintenance flexibility.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 4 - 2014 study results

Refer to Table ZS-2 and Figure ZS-14

Summary of key findings

- ❑ Additional reinforcements could be required in Northern Door County to facilitate maintenance outages and improve system intact as well as voltages under contingency conditions.

- Additional reinforcements are being considered at the Kewaunee Substation to improve offsite power reliability of the nuclear plant, provide operations and maintenance flexibility and provide more economical base generation to the network and marketplace under certain transmission outage conditions.

Two Northern Door County projects are being considered to address potential low voltages under normal and single contingency conditions and potential thermal overloads under single contingency conditions. The two projects consist of:

- Construct a Canal-Dunn Road 138-kV line (roughly 7.7 miles) and install a new 138/69-kV transformer at Dunn Road Substation by June 2012.
- Construct a second Dunn Road-Egg Harbor 69-kV line (roughly 15 miles) by June 2016.

The rebuild of the Canal-Dunn Road 69-kV line as a 138/69-kV double-circuit line will provide an additional link to northern Door County. The placement of a third 138/69-kV transformer in Door County at a different substation from the other two will provide geographic diversity for the transformation.

The proposed long-term solution in Door County includes implementing reinforcements in two phases. The first phase includes the Canal-Dunn Road 138-kV line (2012) described above, and the second phase includes a new provisional 69-kV circuit between the Dunn Road and Egg Harbor 69-kV substations (2016). The in-service dates for both phases were able to be deferred to their current in-service dates as a result of installing the distribution capacitor banks at Sister Bay in 2008 (See Zone 4 – 2010 study results).

This long-term solution will address not only the potential low voltages in the area under normal and single-contingency conditions but also the potential overloads of the 138/69-kV transformers at Canal and various 69-kV lines in the area under single-contingency conditions. The second 69-kV line between Dunn Road and Egg Harbor substations will provide a second source to the area and facilitate maintenance outages of the existing Dunn Road-Egg Harbor 69-kV line. The projects will provide more capacity and improve voltages to northern Door County. The Dunn Road-Egg Harbor 69-kV line is a provisional project pending Best Value Planning to determine how best to support maintenance outages, voltage and radial load served by the Egg Harbor and Sister Bay Substations.

The reconfiguration of the Kewaunee switchyard along with the addition of a second 345/138-kV transformer is being proposed in order to increase offsite power reliability for the nuclear plant, facilitate switchyard maintenance, provide more generation to the ATC footprint under certain transmission outages and to bring more economical base load generation to the marketplace. This project is being considered as a joint effort with Dominion Energy with a tentative in-service date of 2011.

A provisional project for replacing the two existing Glenview 138/69-kV transformers has been delayed from 2014 and is now scheduled for 2016. It would address the potential overload of the transformers under single contingency conditions. The transformer overloads are primarily due to the potential for higher load demand at Brillion Iron Works (BIW). This project may be able to be

deferred several years by transferring load from the Glenview 69-kV bus to the 138-kV buses, depending upon the foundry's load cycle.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 4 – 2019 study results

Refer to Table ZS-3, Table ZS-3a and Figure ZS-15

Summary of key findings

- ❑ The updated load forecasts have resulted in the deferral or cancellation of several projects identified in prior 10-Year Assessments.
- ❑ Additional reinforcements may be needed in the Manitowoc and eastern Calumet County areas.
- ❑ Zone 4 is an active study area for potential wind generation additions.

A provisional project to rebuild and convert the Bayport-Pioneer 69-kV line to 138-kV operation has been deferred from 2016 to 2020. The reason for the deferral of this project is that the previously forecasted load addition in this area is no longer included in the load forecasts. One of the benefits of this project would be to provide network service to the currently radially-served Bayport, Suamico and Sobieski substations. As identified in prior assessments, this project would also address potential low voltages and thermal overloads under single-contingency conditions.

A new provisional 138-kV line project could address potential heavy flows on the Shoto-Mirro-Northeast-Revere 69-kV line or the Shoto 138/69-kV transformer under single- contingency conditions during non-peak periods under certain generation patterns. The project includes constructing a new Shoto to Custer 138-kV line and installing a new 138/69-kV transformer at Custer Substation. This project has been deferred from 2016 to 2020 based upon updated load and generation assumptions utilized in our studies. In addition, the in-service date may need to be adjusted after a more detailed study is completed (such as economic benefit analysis).

The Melissa-Tayco 138-kV line uprate project (0.16 miles) was deferred from 2016 to 2020. The project was developed in a prior Assessment to address the line overload under single contingency conditions and certain generation patterns. The circuit was recently validated by ATC to have higher normal and emergency ratings, thus the deferral of the prior in-service date. Because of the increase in the circuit ratings, the need for this uprate project did not show up in any of the models studied for the 2009 10-Year Assessment. Since this is the first occurrence of the need not appearing, ATC choose to delay the proposed project instead of canceling it. The status and in-service date of this project may need to be adjusted further depending on the results of the system studies performed for the 2010 10-Year Assessment along with any additional economic benefit analysis.

Due to updated load forecast information, several projects have been cancelled. Those projects are:

- ❑ Installing 2-16.3 MVAR capacitor banks at Mears Corners,
- ❑ Installing 2-16.3 MVAR capacitor banks at Rosiere,
- ❑ Replacing the 345/138-kV breaker at the Edgewater Substation, and
- ❑ Installing 2-16.3 MVAR capacitor banks at Aviation.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 4 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- ❑ 20% Wind Future
- ❑ Slow Growth Future

Please refer to the Methodology & Assumptions for details about how the futures models were developed.

In the 20% Wind Future, line overloads and bus voltages generally improve in Zone 4. However, line overloads and bus voltages worsen in the Door County peninsula and line overloads worsen in the Manitowoc area. Future projects and/or increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario.

In the Slow Growth Future, line overloads and bus voltages generally improve throughout Zone 4. This result is consistent with the reduced loading and associated generation redispatch throughout the zone. Please refer to Table ZS-3a for the limitations and performance criteria exceeded for these futures.

Zone 4 – 2024 study results

Refer to Table ZS-4 and Figure ZS-17

Summary of key findings

- ❑ The updated load forecasts have resulted in the deferral or absence of system performance issues identified in prior 10-Year Assessments.
- ❑ The transmission facilities in Sheboygan and northern Ozaukee County areas are becoming heavily loaded and as such may drive the need for system reinforcements.
- ❑ Additional reinforcements may be needed in central Kewaunee County due to load growth or potential increase in generation.

Prior assessments have shown the need for potential transmission reinforcements in the Sheboygan, Kewaunee, and Green Bay areas. Although system needs in the 2024 timeframe have

diminished with the updated load forecasts used in the 2009 10-Year Assessment, we still want to the below discussion kept in mind in case system needs re-emerge in the next Assessment. The reinforcements listed below are based upon preliminary analysis to address system issues under single-contingency conditions. Further adjustments will be made to reflect system needs as well as in-service dates in future 10-Year Assessments.

- In the 2024 and beyond timeframe, additional transmission reinforcements such as installing capacitor banks may be needed to boost the voltages at the Holland, Plymouth #4 and Howards Grove 138-kV substations under single contingency conditions.
- Uprating the Edgewater-Washington 69-kV line may be needed in the 2024 plus timeframe to address line overloads under single-contingency conditions.
- Additional transmission reinforcements such as adding a second 138/69-kV transformer at the East Krok Substation may be needed in the 2024 timeframe to boost voltages along the East Krok-Beardsley Street-Barnett 69-kV line under single-contingency conditions.
- Depending on the load forecasted in downtown Green Bay, additional transmission reinforcements such as rebuilding the older sections of the existing Oak Street-Ashland 69-kV line may be needed in the 2024 timeframe to address line overloads under single-contingency conditions.

With the Kewaunee bus reconfiguration and the addition of a second 345/138-kV transformer project expected to be in-service by 2011, the next equipment limiting the generation at the Kewaunee Nuclear Power Plant under certain transmission outage conditions is the Kewaunee-East Krok 138-kV line. If additional generation from Kewaunee is desired, transmission reinforcements may include uprating the Kewaunee-East Krok 138-kV line.

Projects whose "Need date" precedes the "In-service date"

- None

Projects whose "In-service date" precedes the "Need date"

- None

Summary of Compliance with NERC Standards

The mitigation plans, planned, proposed and provisional projects identified for Zone 4 in this Assessment will allow the ATC system in Zone 4 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

Zone 5 overview

Zone 5 includes the Wisconsin counties of:

- Kenosha
- Milwaukee
- Ozaukee
- Racine
- Washington
- Waukesha

The physical boundaries of Zone 5 and transmission facilities located in Zone 5 are shown in Figure ZS-26. Zone 5 encompasses southeast Wisconsin. Land use in Zone 5 is largely urban, though some agricultural uses exist.

The major population center in Zone 5 is the metropolitan Milwaukee area.

Zone 5 typically experiences peak demands during the summer months. Large industrial loads in the Milwaukee metropolitan area (such as Charter Steel, Miller Brewing) are among the largest electricity users in the zone.

Demographics

The population of the counties in Zone 5 grew at an annual rate of 0.5 percent from 1998 to 2008. The highest growth rate occurred in Washington County, while the largest increase in population occurred in Waukesha County, which increased about 32,000 people over the period.

Population in Zone 5 is projected to grow at 0.5 percent annually for the 2008 through 2019 period. Waukesha County is projected to realize the largest increase in population, while Washington County is projected to have the highest growth rate.

During the same period, the annual employment growth rate was 0.6 percent. The highest growth rate was in Kenosha County and the highest increase in employment occurred in Waukesha County.

Employment in Zone 5 is projected to grow at 0.9 percent annually between 2008 and 2019. Waukesha County is projected to realize the largest increase in employment, while Ozaukee County the highest growth rate.

Employment

Annual Growth Rate

	1998-2008		2008-2019
Zone 5	0.6	Zone 5	0.9
Kenosha, WI	2.1	Ozaukee, WI	1.6

Total Increase

	1998-2008		2008-2019
Zone 5	72,400	Zone 5	127,610
Waukesha, WI	39,165	Waukesha, WI	44,211

Population

Annual Growth Rate

	1998-2008		2008-2019
Zone 5	0.5	Zone 5	0.5
Washington, WI	1.3	Washington, WI	1.6

Total Increase

	1998-2008		2008-2019
Zone 5	86,959	Zone 5	115,739
Waukesha, WI	31,634	Waukesha, WI	60,878

Zone 5 environmental considerations

Zone 5 encompasses the southeastern portion of the state and is the most densely populated of the zones. The area lies in the Southern Lake Michigan Coastal and Southeast Glacial Plains ecological landscape regions. Most of the zone lies in the drainage basins of the Milwaukee, Root or Fox rivers. The Kettle Moraine State Forest lies in the western portions of the zone, and Lake Michigan forms its eastern boundary. Pre-settlement vegetation varied from prairie and oak

savanna in the south, to southern mesic forest in the northern portions of the zone. Agricultural land uses are common throughout this zone.

Zone 5 electricity demand and generation

The coincident peak load forecasts for Zone 5 for 2010, 2014, 2019 and 2024 are shown in Table ZS-12. Existing generation, along with proposed generation based on projected in-service year, are also shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

The table shows that load is projected to grow at roughly 1.7 percent annually from 2010 through 2019. Comparing load with generation (at maximum output) within the zone indicates that Zone 5 has less generation than load during peak load periods.

Zone 5 transmission system issues

Key transmission facilities in Zone 5 include:

- the southern portion of 345-kV lines from Point Beach and Edgewater,
- the Saukville, Arcadian, Granville, Oak Creek, and Racine 345/138-kV substations,
- the transmission lines emanating from the Pleasant Prairie and Oak Creek power plants,
- 230 kV facilities near Milwaukee, and
- a significant 138-kV network in the Milwaukee area, a portion of which is underground.

Key system performance issues in Zone 5 include:

- heavy flows on aging facilities,
- new generation projects expected to be placed in service in 2009 and 2010 that may influence the solutions to load-serving needs in the zone,
- heavy flows from the west (Zone 3) resulting in heavily loaded 138-kV facilities in the western portion of Zone 5,
- heavy market flows from the south, resulting in high 345- and 138-kV line loadings and the need to monitor potential multiple contingency conditions, and
- sagging voltage profile in portions of Washington, Waukesha and Jefferson counties.

The proposed rebuild of the Zoo interchange will necessitate some review of the existing 138-kV lines originating from the Bluemound Substation. This review could result in new projects within the next few years.

Oak Creek generation: We Energies has placed in service one 615-megawatt (net) coal powered generator in 2009 and another 615-megawatt (net) plant is under construction at Oak Creek with an in-service date of 2010. The following projects have been or will be constructed as a result of this new generation.

2009 - Oak Creek generation Phase 1

The following projects were completed prior to the first Oak Creek generator being placed in service in 2009.

- Construct a new Oak Creek 345-kV switchyard to interconnect one new 615-megawatt (net) generator,

- ❑ Reconductor a segment of the Oak Creek-Ramsey 138-kV line,
- ❑ Terminate the Ramsey–Harbor line into the Kansas/Norwich substations creating a Kansas–Harbor 138-kV line and a Norwich–Ramsey 138-kV line,
- ❑ Reconductor the Oak Creek-Allerton 138-kV line,
- ❑ Replace current transformers at the Racine 345-kV Substation,
- ❑ Replace two 345-kV circuit breakers at Pleasant Prairie Substation on the Racine and Zion lines with IPO breakers and upgrade relaying, and
- ❑ Expand Oak Creek 138-kV switchyard to connect the 345/138-kV, 500 MVA transformer.

2010 - Oak Creek generation Phase 2
The second phase of new generation at Oak Creek is scheduled to be placed in service in 2010. The following projects will need to be completed prior to the second unit being placed in service.

- ❑ Expand 345-kV switchyard at Oak Creek Power Plant to interconnect a second new 615-megawatt (net) generator,
- ❑ Reconductor the Oak Creek-Root River 138-kV line,
- ❑ Uprate terminal equipment and increase line clearances on the Oak Creek-Nicholson 138-kV line to permit operation at 230 degrees, and
- ❑ Increase line rating of the Kansas – Ramsey 138-kV line.

In response to customer requests for new distribution interconnections, new 138-kV bus sections were recently constructed at the Pleasant Valley, Shorewood and Brookdale Substations.

Zone 5 – 2010 study results
Refer to Table ZS-1 and Figure ZS-17

Summary of key findings

- ❑ Some of the line loading and low voltage issues in Zone 5 occur as a result of opening substation bus tie breakers.
- ❑ New generation in the greater Milwaukee area will drive many system improvements in Zone 5 within the next decade.

In addition to the new Oak Creek generation, two-32.4 MVAR capacitor banks are scheduled to be placed in service at the Summit Substation by June of 2010 to improve area bus voltages. In the interim, dispatching Concord and/or Germantown generation will provide reactive support to improve area voltage.

A project to install a second Shorewood-Humboldt underground cable in 2010 is under consideration to accommodate additional distribution load (2009) at the Shorewood Substation under contingency conditions. The Shorewood load is served by two 138-kV underground cables. An underground cable can be out of service for weeks or months for repair in the event a cable is damaged. If one cable is out of service for repair and the second cable experiences a fault, the Shorewood load would have to be bridged elsewhere while repairs are made. Due to geography constraints, the ability to bridge Shorewood load elsewhere is limited. Installing a parallel

Shorewood-Humboldt underground line will reduce the likelihood of two cable failures occurring which could cause a load shedding situation at Shorewood.

Thermal and low voltage issues also are expected to occur elsewhere in Zone 5. Following are results of the 2010 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Bus outages at Pleasant Prairie and Oak Creek cause transformers at Bain and Oak Creek to exceed their summer emergency ratings. Bus outages are low probability events. Loading relief can be achieved by backing down generation at Pleasant Prairie for Bain transformer relief or Oak Creek for Oak Creek transformer relief.

An outage of the Bain–Kenosha 138-kV line will cause the Bain–Albers 138-kV line to load to 96.4 percent of its summer emergency rating. Increasing line conductor clearances will alleviate this situation by permitting operation above 167 degrees.

An outage of the Arcadian 345/138-kV transformer #1 causes Arcadian transformer #3 to load to 99.0 percent of its summer emergency rating. Project development is underway to replace the Arcadian transformers #2 and #3 with a single 500 MVA transformer. Other alternatives are also being considered. The 345/138-kV windings of the existing transformers are rated at 239/239 MVA (SN/SE). The summer emergency rating of the new transformer will be 640 MVA.

An outage of either one of the Arcadian–Waukesha 138-kV lines (KK9962 and KK9942) results in the other Arcadian–Waukesha 138-kV line loading to between 98 and 99 percent of their summer emergency ratings. The limiting element is the line conductor with clearances set for operation at 200 degrees. The line conductor clearances will be increased to permit higher flows under contingency conditions. Other alternate solutions are being considered.

An outage of the Hartford – St. Lawrence 138-kV line results in Hartford bus voltage dropping to 91.6 percent of the nominal bus voltage. Running generation at Concord improves bus voltage at Hartford.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

As a result of in-service date flexibility, project cost saving and corresponding alignment with other ATC project needs, the following projects will be in service prior to the need date. Additionally, the projects listed below are asterisked in the Annual Project Tables.

- ❑ Construct second Shorewood-Humboldt 138-kV underground cable (need 2012, in service 2010). This project is being constructed in 2010 to take advantage of synergies with area road construction.

Zone 5 – 2014 study results
Refer to Table ZS-2 and Figure ZS-18

Summary of key findings

- Additional reactive support is required in the greater Milwaukee area.
- Potential thermal violations indicate the need for facility upgrades in the Waukesha and Kenosha areas.
- Thermal, voltage, and load serving issues in Kenosha and Walworth might be resolved with a 138-kV line between Spring Valley and North Lake Geneva.

Additional reactive sources are required in the greater Milwaukee area. In addition to the Summit capacitor banks, 225 MVAR of capacitance will be installed at the Bluemound Substation in 2012.

Following are the results of the 2014 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

An outage of either one of the Arcadian–Waukesha 138-kV lines or Arcadian transformer #1 create overloads in 2014 compared to heavily loaded facilities as seen in the 2010 analysis. Running generation at Concord and Germantown provides relief until line clearances are increased and transformers are replaced. Other alternatives are also being investigated.

The Albers-Bain 138-kV line loads to 113 percent of its summer emergency limit for an outage of the Bain-Kenosha 138-kV line. The limiting element is line conductor clearances. Increasing line clearances is being considered.

Splitting the Pleasant Prairie 345-kV bus between bus sections 3 and 4 will cause Bain transformer #5 to exceed its summer emergency rating by 59 percent. Bus outages are low probability events. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 megawatts.

An outage of the Hartford – St. Lawrence 138-kV line results in the Hartford 138-kV bus voltage dropping to 90.0 percent of the nominal bus voltage. Running generation at Concord improves bus voltage at Hartford.

The intact system bus voltage at Cooney is at 95.9 percent of nominal voltage. This is approaching the 95.0 percent limit as specified by NERC Category A requirements. An outage of Cooney – Summit results in the Cooney bus voltage dropping to 91.5 percent of the nominal bus voltage. Running generation at Concord will provide relief. In addition, 138-kV capacitors at Concord and Summit will improve the voltage in Waukesha and Jefferson Counties.

Thermal, voltage, and load serving issues in Kenosha and Walworth County might be resolved by constructing a 138-kV line from Spring Valley to Twin Lakes, continuing on to South Lake Geneva. This would entail acquiring new right-of-way between Spring Valley and Twin Lakes. The remaining segment between Twin Lake and North Lake Geneva could make use of an existing right-of-way. Studies are underway to determine the course of action to alleviate the issues in the area. This

project would also coordinate with a Zone 3 project, the North Lake Geneva-South Lake Geneva 138-kV line with a 2016 in-service date. Please refer to Zone 3 – 2014 study results for details about this project.

Projects whose "Need date" precedes the "In-service date"

- ❑ Uprate Arcadian-Waukesha 138-kV lines KK9942/KK9962 (need 2010, in service 2013)
- ❑ Replace two existing 345/138-kV transformers at Arcadian Substation with 1-500 MVA transformer (need 2010, in service 2013)

Considering reasonable project lead times, the 2013 in-service date was chosen for these provisional projects. In the interim, dispatching area generation could be one possible mitigation strategy to address the Arcadian area constraints.

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 5 – 2019 study results

Refer to Table ZS-3, Table ZS-3a and Figure ZS-19

Summary of key findings

- ❑ Heavy load growth in Waukesha, Washington, Dodge and Jefferson counties will require voltage and load support. A new 345-kV line from Rockdale to Mill Road (formerly Lannon Junction) is one option being considered to solve these problems.
- ❑ Voltage and thermal issues remain in Zone 5 under contingency conditions.
- ❑ Thermal, voltage, and load serving issues in Kenosha and Walworth might be resolved with a 138-kV line between Spring Valley and North Lake Geneva

Three 138-kV buses in Waukesha and Washington County experience marginal bus voltages under NERC Category A or TPL-001-0 conditions (intact system) in 2019. The buses are Bark River (95.8 percent), Germantown (95.5 percent), and Maple (95.7 percent). Modeling the Bluemound and Mukwonago capacitors in service as well as running additional generation at Germantown will improve the voltage profile in Washington County.

Following are the results of the 2019 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Low probability bus outages at Pleasant Prairie continue to be a problem. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 megawatts.

An outage of the Bain–Kenosha 138-kV line will result in the Albers–Kenosha 138-kV line loading to 97.8 percent of its summer emergency rating.

Loading issues on the Arcadian–Waukesha 138-kV lines and Arcadian transformers under contingency conditions get worse when compared to 2014. Increasing line clearances and replacing the two smaller transformers are potential solutions. Running generation at Concord and Germantown provides relief.

An outage of the Oak Creek–Pennsylvania 138-kV line will cause the Branch–Kansas 138-kV line (100.5 percent) to exceed its summer emergency ratings. Increasing line conductor clearances on the Branch–Kansas 138-kV line will provide relief.

A low probability bus outage at Burlington 138-kV bus will result in marginal 138-kV bus voltages at Tichigan (91.4 percent).

An outage of the Bark River – Sussex 138-kV line causes the Bark River 138-kV bus voltage to drop to 91.8 percent.

An outage of the Maple – Saukville 138-kV line causes the Germantown (88.7 percent) and Maple (88.2 percent) 138-kV bus voltages to be constrained under NERC Category B requirements. Running generation at Germantown will provide relief.

Past studies have shown low bus voltages in eastern Jefferson, western Waukesha, and southern Washington counties, all areas where load growth has been and is expected to remain high. To provide relief, a new 345-kV line connecting the Madison area with the Milwaukee area is being considered. The components of the project could include:

- ❑ Construct a new 345/138-kV Mill Road Substation (formerly known as Lannon Junction) at the intersection of the Cypress-Arcadian 345-kV line, the Arcadian-Granville 345-kV line, Germantown-Bark River 138-kV line and Sussex-Tamarack 138-kV line. This project will improve the 138-kV voltage profile in the area and facilitate expansion of the 345-kV network to the west of this substation. A 500 MVA, 345/138-kV transformer will be installed.
- ❑ Construct a Rockdale-Concord 345-kV line adjacent to the existing Rockdale-Jefferson-Concord 138-kV line on existing double-width right-of-way and install a 500 MVA, 345/138-kV transformer at Concord.
- ❑ Convert the Bark River-Mill Road 138-kV line (currently built to 345-kV standards) to 345-kV operation and install a 500 MVA, 345/138-kV transformer at Bark River.
- ❑ Construct a new 345-kV line from Concord to Bark River.

In addition to improving the voltage profiles in Jefferson, Waukesha and Washington counties, reducing loadings on parallel 138-kV circuits and reducing system losses, the above reinforcements will improve ATC's existing east-west transfer capability in this region. Such a project is not being proposed in this Assessment, but may be justified in future Assessments for analysis beyond the current 10-year horizon. Potential economic benefits will need to be reviewed as the future develops.

Provisional projects to install 2-32 MVAR of capacitance at the Mukwonago Substation and uprating the Oak Creek-Pennsylvania 138-kV line are being considered in the 2015-2019 timeframe in order to address remaining voltage and thermal issues.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Zone 5 - 2019 futures study results

Two potential 2019 futures were studied as part of this Assessment:

- ❑ 20% Wind Future
- ❑ Slow Growth Future

Please refer to the Methodology & Assumptions for details about how the futures models were developed.

In the 20% Wind Future, line overloads and bus voltages generally improve in Zone 5. However, bus voltages worsen in the Germantown area. Additionally, the Arcadian transformer overload worsens. Future projects and/or increasing area generation mitigates the situation(s). These results occur because of area generation dispatch and the associated change in the flow of power associated with the 20% Wind scenario. Please refer to Table ZS-3a for the limitations and performance criteria exceeded for these futures.

In the Slow Growth Future, line overloads and bus voltages generally improve throughout Zone 5. This result is consistent with the reduced loading and associated generation redispatch throughout the zone.

Zone 5 – 2024 study results

Refer to Table ZS-4 and Figure ZS-20

Summary of key findings

- ❑ Heavy load growth in Waukesha, Washington, Dodge and Jefferson counties will require voltage and load support. A new 345-kV line from Rockdale to Mill Road (formerly Lannon Junction) is one option being considered but not yet proposed to solve these problems.
- ❑ Voltage and thermal issues remain in Zone 5 under contingency conditions.

Ten 138-kV buses in Waukesha and Washington County experience low or marginal bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2024. The buses are Bark River (94.8 percent), Chinook (95.2 percent), Cooney (94.9 percent), Cottonwood (94.1 percent), Edgewood (95.2 percent), Glacier (95.9 percent), Hartford (95.5 percent), Merrill Hills (95.1 percent), Mukwonago (95.0 percent), St. Lawrence (95.9 percent), Arthur Road (95.8 percent), and Summit (94.6 percent). Installing capacitor banks at Summit and Mukwonago will help alleviate these voltage issues.

Following are the results of the 2024 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

The Oak Creek–Pennsylvania 138-kV line will load to 99.0 percent of its summer normal rating under intact system conditions. Under a number of contingencies, the line will approach or exceed it summer emergency rating.

Contingencies in eastern Jefferson and western Waukesha Counties create voltage issues at numerous locations in northern Waukesha and southern Washington Counties. Running generation at Concord and Germantown as well as capacitor additions at Summit, Concord, Mukwonago, and Bluemound should improve voltage profiles.

An outage of the Saukville–Fredonia 138-kV line will cause the bus voltage at Fredonia to drop to 91.9 percent.

Low probability bus outages at Pleasant Prairie, Oak Creek, and Burlington continue to create thermal and voltage problems as described in 2010 and 2014.

An outage of the Bain–Kenosha 138-kV line will cause the Albers–Kenosha 138-kV line to exceed its summer emergency rating by 1.3 percent.

Contingencies on 138-kV lines terminating at Oak Creek create thermal and voltage issues in southern Milwaukee County. Possible solutions are being developed.

Thermal issues in the Arcadian – Waukesha area continue. Solutions have been described above.

An outage of the Edgewood – St. Martins 138-kV line will result in low voltages at Edgewood (90.1 percent), Chinook (90.1 percent, and Mukwonago (91.6 percent).

An outage of the Pleasant Valley-Saukville 138-kV line will result in marginal voltages (91.5 percent) at the Pleasant Valley 138-kV bus.

In the previous 2019 results section, a potential Rockdale–Mill Road 345-kV line was discussed as a way improving bus voltages in Waukesha, Washington, and Jefferson Counties. Through 2019, the ATC planning models indicated there is generation available at Concord and Germantown that could provide support to the three county region. At some point between 2019 and 2024, all of the generation at Concord and Germantown will be dispatched. Dispatching generation at Concord and Germantown has been able to provide voltage and thermal relief. When all the generation has been dispatched, no additional relief will be available and it will be time to consider other system improvements to provide relief.

Projects whose "Need date" precedes the "In-service date"

- ❑ None

Projects whose "In-service date" precedes the "Need date"

- ❑ None

Summary of Compliance with NERC Standards
The mitigation plans, planned, proposed and provisional projects identified for Zone 5 in this Assessment will allow the ATC system in Zone 5 to meet NERC standards TPL-001, TPL-002, TPL-003 and TPL-004 in each of the four years 2010-2014, and for the 2015-2019 planning horizon.

Reactive power analysis
Appropriate availability of Reactive Power (VArs) is necessary to keep a transmission system operating robustly. Many of the VArs on our system are provided by generators that are interconnected with ATC. Our computer load flow models list a minimum and maximum VAr output for each machine connected to the system. The maximum and minimum reactive capability values are determined by the generation owners. Midwest Reliability Organization (MRO) and Reliability First Corporation (RFC), in order to comply with NERC reliability standard MOD-025-1 (Verification of Reactive Power Capability) require their generation owners to verify reactive capability of all generators for a period of five years. Factors which may affect the maximum reactive capabilities of the generators, such as actual hydrogen pressure used or number of units on-line in multi-unit stations or time passed since the last test, add to the uncertainty of the maximum reactive capabilities of the generators.

ATC's Planning criteria considers uncertainties such as those mentioned by promoting a reasonable dynamic VAr margin on the generating units connected to the ATC system. To support the adequacy of reactive power planning, ATC's Planning criteria specifies that intact system bus voltage requirements be met while limiting net generator reactive power output to 90 percent of the reported reactive power capability. Likewise, under contingency conditions, all system buses must meet voltage criteria requirements with the net generator reactive power limited to 95 percent of the applicable reactive power capability**.** These planning criteria were applied to all power flow analysis performed in this 2009 10-Year Assessment. All projects developed in this Assessment assure that the ATC system meets these planning criteria for the appropriate system conditions analyzed.

Multiple Outage Analysis
In 2004, ATC began a multiple outage assessment with Commonwealth Associates (CAI) in order to perform more extensive analyses of our transmission system to identify NERC Category C type contingencies that could potentially lead to cascading. NERC Category C contingencies are specific sets of multiple outages including lines, transformers and generators.

ATC's intent is to review multiple outage impacts across its footprint at a minimum of once every five years. As part of the continuing NERC compliance process, we have enhanced our review in succeeding years. We revisited Category C contingency Analysis in 2005, 2006 and 2008. In 2006, additional Category C events were evaluated by screening Zone 3 (100-kV and above) facilities and ATC 345-kV transmission facilities in addition to the severe contingencies selected in 2005.

As part of our effort to continue to be aware of multiple outage impacts on our system, ATC performed additional Category C analyses and assessments in 2008 by screening Zone 5 (100-kV and above) facilities and a combination of ATC 345-kV facilities (including ATC 345/138-kV transformers) and generators (100 megawatts and above).

For the 2009 study, ATC used the 2014 and 2019 summer peak models with 95 percent Q_{max} including all projects identified in the 10-Year Assessment for additional steady state multiple outage analysis. Initial screening of the contingencies was done by using PTI's PSS/E software. Physical Operational Margin (POM) – Optimal Mitigation Measures (OPM) software was then used to determine available mitigation measures to alleviate violations that could potentially cause problems.

From the 2008 study, a set of 162 potentially critical Category C contingencies were selected for restudy in 2009. In addition to re-evaluation of previously defined multiple outages in 2009, we performed additional Category C analyses by screening all 345-kV branches and generators connected to ATC Bulk Electric System including all double ties into our service territory (100-kV and above). Furthermore, we performed NERC Category C bus section and breaker failure outages for our 100-kV and above system. Finally, we performed detailed multiple contingency analyses for the Zone 1 100-kV and above system branches and ATC generation connected to the Bulk Electric System including all double ties to Zone 1 (100-kV and above).

The total number of events tested in the initial screening using 2014 model was 28,876 which included:

- 105 potentially critical multiple outages, 98 of which were previously selected and tested in 2005, 2006 and 2008. Seven extra contingencies resulted from subsequent changes in system configuration.
- 23 multiple outages associated with 345-kV transmission facilities identified in 2006 as severe contingencies.
- 28 multiple outages associated with Zone 3 which were identified as severe in 2006.
- Six multiple outages from Zone 5 identified during 2008 study as severe.
- 31 Category C section outages from an existing ATC list for 100-kV and above.
- 104 Category C breaker failure outages from an existing ATC list for ATC 100-kV and above.
- 18,657 multiple outages associated with:
  - all ATC 345-kV branches and generators connected to the Bulk Electric System, and
  - all double ties to ATC (100-kV and above).
- 9,922 multiple outages associated with Zone 1 comprising of a combination of all branches plus ties (100-kV and above), and ATC generators connected to the Bulk Electric System.

Out of the 28,876 events analyzed, 343 events caused system limitations (both thermal and voltage limitations plus unsolved cases). Physical Operational Margin (POM) – Optimal Mitigation Measure (OPM) software was used to mitigate the resulting system problems. Of the 343 contingencies, 11 contingencies were found to be invalid, 297 were mitigated fully without load shedding through generation re-dispatch, capacitor bank adjustment, under load tap changing and/or phase shifter adjustment. 35 contingencies required load shedding to mitigate in addition to other remedial actions. As we did in 2008, we found that cascading could be ruled out for Category C contingencies on our 2014 system through the use of generation redispatch and load shedding. Ranked based on the amount of load shedding, the top 5 category C events for the 2014 system are:

- Fitzgerald 345/138-kV T1 and Wooden Shoe - Neevin 138-kV line #1

- ❑ Hoover - Arnott 138-kV line #1 and White Lake - Waupaca 138-kV Line #1
- ❑ Rocky Run 345/115-kV T1 and Rocky Run 345/115-kV transformer #2
- ❑ Whiting Avenue - Hoover 115-kV line #1 and Harrison - Waupaca 138-kV line #1, and
- ❑ White Lake 1 - Waupaca 138-kV line #1 and Whiting Avenue - Hoover 115-kV line #1.

To reassess the long-term planning horizon, the 35 Category C events resulting in load shedding to mitigate potential system problems in 2014 were repeated using the 2019 summer peak model including all projects identified in the 2009 10-Year Assessment.

Of the 35 events analyzed, one event caused no system violations while 34 events had potential system problems in 2019. Twenty nine of the 35 events resulted in system problems that were potentially more severe in 2019 than in 2014.

Following are the 29 Category C contingencies that worsened in 2019 and the additional load that needed to be shed compared to 2014:

Category C contingency	*MW load shed in 2014*	*MW load shed in 2019*	*Difference in MW*
M-38 - NORTH LAKE 138-kV LINE #1 AND M-38 - PERCH LAKE 138-kV LINE #1	54.42	84.13	29.71
FITZGERALD 345/138-kV T1 AND WOODEN SHOE - NEEVIN 138-kV LINE #1	126.00	158.00	32.00
WERNER - WHITE LAKE 138-kV LINE #1 AND WHITNG AV- ROCKY RUN 115-kV LINE #1	5.60	16.90	11.30
MAINE -PINE 115-kV LINE #1 AND GARDNER PARK - BLACK BROOK 115-kV LINE #1	27.20	67.20	40.00
MAINE - PINE 115-kV LINE #1 AND KELLY - BUNKER HILL 115-kV LINE #1	24.10	65.30	41.20
ARPIN 345/138-kV T1 AND BAKER W - COYNE 115-kV LINE #1	1.00	87.90	86.90
MAINE - HILLTOP 115-kV AND GARDNER PARK - BLACK BROOK 115-kV LINE #1	3.20	12.80	9.60
SARATOGA 138/115-kV T1 AND SIGEL 138 - ARPIN 138-kV LINE #1	1.20	24.30	23.10
SIGEL - ARPIN 138-kV LINE #1 AND BAKER W - SARATOGA 115-kV LINE #1	1.20	21.50	20.30
ROCKY RUN 345/115-kV T1 AND ROCKY RUN 345/115-kV T2	64.70	95.20	30.50
ROCKY RUN 345/115-kV T1 AND ROCKY RUN 345/115-kV T3	4.20	38.60	34.40
ROCKY RUN 345/115-kV T2 AND ROCKY RUN 345/115-kV T3	35.00	69.60	34.60
HOOVER 138/115-kV AND HARRISON - WAUPACA 138-kV LINE #1	4.20	24.90	20.70

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Category C contingency	*MW load shed in 2014*	*MW load shed in 2019*	*Difference in MW*
HOOVER – ARNOTT 138-kV LINE #1 AND HARRISON – WAUPACA 138-kV LINE #1	7.60	37.20	29.60
SUMMIT LAKE - VENUS 115-kV LINE #1 AND ANTIGO - BLACK BROOK 115-kV LINE #1	15.94	16.92	0.98
MAINE - PINE 115-kV LINE #1 AND BUNKER HILL - PINE 115-kV LINE #1	20.80	137.50	116.70
HOLYWOOD - SARATOGA 138-kV LINE #1 AND BAKER W - COYNE 115-kV LINE #1	19.60	39.90	20.30
HOLYWOOD - PORT EDWARDS 138-kV LINE #1 AND BAKER W - COYNE 115-kV LINE #1	23.00	46.50	23.50
HOOVER 138/115-kV T1 AND WHITE LAKE - WAUPACA 138-kV LINE #1	59.30	122.60	63.30
HOOVER - ARNOTT 138-kV LINE #1 AND WHITE LAKE - WAUPACA 138-kV LINE #1	77.20	96.98	19.78
SIGEL - ARPIN 138-kV LINE #1 AND BAKER W - COYNE 115-kV LINE #1	33.10	117.30	84.20
WHITE LAKE 1 - WAUPACA 138-kV LINE #1 AND WHITING AV – HOOVER 115-kV LINE #1	64.33	75.87	11.54
WHITE LAKE - WAUPACA 138-kV LINE #1 AND GOLDEN SANDS - ARNOTT 138-kV LINE #1	7.60	36.30	28.70
WHITNG AV- HOOVER 115-kV LINE #1 AND GOLDEN SANDS-HARTMAN CREEK 138-kV LINE #1	29.77	31.60	1.83
WHITING AV - HOOVER 115-kV LINE #1 AND HARRISON – WAUPACA 138-kV LINE #1	64.50	103.58	39.08
WHITING AV- HOOVER 115-kV LINE #1 AND HARRISON – HARTMAN CREEK 138-kV LINE #1	29.77	55.00	25.23
M-38 138-kV BUS BREAKER FAILURE	54.42	55.46	1.04
STRAITS 138-kV BUS BREAKER FAILURE	60.50	130.50	70.00
ROCKY RUN 115-kV BUS BREAKER FAILURE	59.80	97.90	38.10

Although it is estimated that cascading could be ruled out for Category C contingencies on our 2014 and 2019 systems through the use of specific load shedding and generation redispatch, study results are subject to further review by ATC Planning and System Operations to develop or confirm appropriate and more specific operating procedures.

System stability analysis

Introduction

ATC also designs its system to meet stability criteria that are more stringent than NERC Standards. In the Planning Criteria section of this report, the Transient and dynamic stability performance assessment discussion gives details about the ATC's criteria for assessing system stability.

Reviewing compliance with NERC Standards and ATC stability criteria is a continuous process. Each year ATC adds to its library of studies. There are two components to consider in assessing system stability. One component is the angular stability of the system or often more generally referred to as generator stability. The second component is the system's voltage stability. Our approach to assessing both of the system stability components is described below.

Generator Stability

For each 10-Year Assessment, generator stability is assessed at all major generator stations connected to the ATC system. Numerous generator interconnection studies add to our knowledge of the ATC system stability response to Category B2, C3 and selected C8 outages. A MRO/RFC joint on-site review completed in December 2008 determined that ATC was fully complaint with NERC Standards that cover multiple outages (Category C), including the system's stability response to multiple outages.

In the 2009 10-Year Assessment, we have revisited a select list of generator stations as described below. As generator stability concerns arise they are evaluated and appropriate corrective actions are developed and implemented. Generator stations with total net output above 100 megawatts and associated transmission lines operating usually above 100 kV are generally selected to assess system angular stabilities.

The methodology used in assessing the major generator stations includes a review to determine that no significant system topological changes have occurred near the generator stations other than local load growth. The methodology also includes a review of the parameter values and the model types used to represent the dynamic response of the units at the generator stations in system angular stability simulations to determine that no significant changes have occurred. In addition, this methodology includes a review of the date of the last stability study conducted for each of the major generator stations to determine that the elapsed time does not exceed 5-years. Considering the number of existing major generator stations shown in Table ZS-7 - ATC System Angular Stability Assessment this requires that at least six major generator stations be included in the system angular stability analysis for each 10-Year Assessment in order to complete a study of all major generator stations in a five-year sequence.

If these criteria are confirmed, the generator stability results of existing studies are still applicable and are acceptable in the following years with proposed system upgrades. If any of these criteria are not met then generator stability is reviewed and/or restudied.

In this Assessment, power flow models were compared with the 2008 power flow models. In addition, the parameter values and types of dynamic models (e.g. generator, exciter, power system stabilizer, governor etc.) currently used to represent the major generator stations in dynamic

simulations were compared with those in the 2008 10-Year Assessment studies. The review identified six (6) generator stations that had either:

a) Significant system topological change near the station,
b) A significant change in the parameter values or type of dynamic model used to represent the unit responses during simulation,
c) Were at or approaching the five-year elapsed time criteria or
d) A combination of these criteria.

The six (6) generator stations identified are: Valley, Port Washington Combined Cycle Block 1 (CC1) and Combined Cycle Block 2 (CC2), Kewaunee, West Marinette, Cypress and West Campus. These stations are shown high-lighted in Table ZS-7 - ATC System Angular Stability Assessment.

The Valley, Port Washington and Kewaunee plant selection involved changes in a dynamic model or parameter changes within a dynamic model. With the Valley plant the existing exciter models were replaced on each of the units with the new exciter model and data provided by the generator owner. Port Washington combustion turbine units had the governor models replaced as part of the RFC model standardization project, as well as, parameter changes for the generator models representing the Block 1 units that were provided by the generator owner. Kewaunee involved a change in the governor model from a standard model to a user-developed model provided by the generator owner.

The West Marinette and West Campus plant selection involved significant system topological changes near the plants, while Cypress involved both dynamic model changes as well as topological changes. West Marinette significant system changes included addition of the Menominee 138/69-kV transformer as well as re-configuration of the 69-kV system between Pioneer, Pound, Sandstone, Crivitz, High Falls and Thunder substations; plus addition of the Wells Street-Ogden 69-kV line. West Campus significant system changes included the conversion of the two Blount-Ruskin 69-kV lines to a single 138-kV line, plus re-configuration of the 69-kV lines involving Mendota Substation. In addition, the installation of the North Madison-Huiskamp 138-kV line and loop-in of North Madison-Yahara River 138-kV line into the new Vienna Substation.

Cypress involved generator model parameter changes due to a change in the generator manufacturer and the number of machines from 41 to 44, plus a significant a change in models used in the control of the supplemental reactive compensation. In addition, the system near the plant also had significant topological system changes. These included the addition of the Werner West-Highway 22, Highway 22-Gardner Park, and Highway 22-Morgan 345-kV lines, plus a second Kewaunee transformer and connection of two wind farms totaling 198 megawatts to the 138-kV system in the area.

All these major generator stations were re-studied as part of the system angular stability analysis of the 2009 10-Year Assessment with the ATC stability criteria applied. All the assessed generators met the ATC stability criteria with the exception of the Valley plant and the West Marinette plant for a three-phase fault with delayed clearing. As shown in Table ZS-7 - ATC System Angular Stability Assessment, all assessed generators in the ATC area met the applicable NERC Category B2, C3, and C8 criteria.

In the case of Valley, stability simulations meet NERC requirements for phase-ground fault with delayed clearing (C8), but do not meet ATC requirements for a three-phase fault with delayed clearing. One possible mitigation being developed to reduce clearing times from existing 14.1 cycles to 11.5-11.7 cycles to meet ATC stability criteria for the Valley plant includes replacement of the breaker failure relays on lines 301, 302 and 311 plus replacement of the existing three-cycle oil breakers with two-cycle gas breakers at positions 314, 321, and 324. Existing phase-ground fault duty at the Valley plant would have to nearly increase by 35 percent under present clearing times before the NERC requirements would be exceeded. This provides an adequate margin in order to plan and implement system improvements needed to meet ATC stability criteria.

In the case of West Marinette, stability simulations meet NERC requirements for phase-ground fault with delayed clearing (C8), but do not meet ATC requirements for a three-phase fault with delayed clearing. Possible mitigation being developed to reduce the existing 14-18 cycle clearing time to that of 7.75-11.5 cycle clearing time in order to meet ATC stability criteria would involve replacement of circuit breakers and breaker relaying as well as possibly a re-configuration of the substation and are planned to be taken into consideration as other system improvements are needed in the area. Existing phase-ground fault duty at the West Marinette plant would have to nearly double under present clearing times before the NERC requirements would be exceeded. This provides an adequate margin in order to plan and implement system improvements needed to meet ATC stability criteria.

Voltage Stability
ATC is still developing a rigorous process for assessing voltage stability across the system. Currently we monitor voltages for single and multiple contingency events throughout the ATC system to screen for indications of where voltage stability may be an issue.

A detailed voltage stability analysis was last performed in the Rhinelander area of Zone 1 in 2003 that covered the period from 2003 to 2005. As a result of this study, solutions were developed and implemented in the Rhinelander area to address the voltage stability concerns that were found. These solutions included the following:

- ❑ Installation of two new, high speed 115 kV breakers (2 cycle) at Aurora Street on A-313 and Highway 8 on D-56 with maximum primary clearing time of 3.75 cycles in 2003.
- ❑ Installation of a 16.9 MVAR, 115-kV capacitor bank at Summit Lake Substation in 2003.
- ❑ Relocation of the Reedsburg 6.0 MVA D-SMES unit to the Clear Lake Substation in 2004.
- ❑ Conversion of the Pine to Eastom 46-kV line to 115 kV in 2004.
- ❑ Installation of a new 115-kV line from Skanawan to Highway 8 in 2005.

In the 2008 10-Year Assessment, it was decided that a new detailed voltage stability analysis be performed in the Rhinelander area of Zone 1 to cover the period from 2008 to 2013 to assess the impact of these improvements along with the addition of a new Cranberry-Lakota Road (Conover) 115-kV line in 2008 and the rebuild/conversion of the Lakota Road (Conover)-Plains 69 kV path to 138 kV in 2010. The Lakota Road Substation includes a 138/115 kV transformer to interconnect the 115 kV and 138-kV lines together and includes a 138/69 kV transformer to connect to the Conover 69 kV system. The Lakota Road (Conover) -Twin Lakes - Iron Grove segment of the Lakota Road

(Conover)-Plains 138-kV line is scheduled for completion in 2009 and the Iron Grove-Aspen-Plains 138 kV segment is scheduled for completion in 2010. In addition, the study also includes evaluation of the continued need for the D-SMES units and Undervoltage Load Shedding (UVLS) relaying in the Rhinelander area.

As indicated in the 2008 Assessment, the results on this study were to be reported in either an update of this Assessment or in a future Assessment. The work on this study was continued for the 2009 10-Year Assessment, but due to a recent change in the load breakdown used for the Rhinelander area as well as an expansion in the study scope the study has not been completed and will, in fact, need to re-done. It is expected that the work on this study will be reported in a future Assessment.

The MRO/RFC joint on-site review completed in December 2008 determined that ATC was fully compliant with the voltage stability assessment requirements in the applicable NERC standards.

Conclusion
Based on these assessments and numerous other studies, the ATC network will meet NERC System Stability Standards assuming reinforcements contemplated in this 10-Year Assessment, operating procedures, and special protection systems are implemented.

All Projects model analysis
The load flow models built for the 10-Year Assessment are specially built models used exclusively for the Assessment. Projects are purposely left out of these models in order to verify system problems exist and which ones get worse over time. After the 10-Year Assessment analysis is completed, models are built that include all planned, proposed and some provisional projects. These new models are called “All Projects” models and are more indicative of the expected system configurations for 2010, 2014 and 2019 study years. These models are more appropriate for internal planning studies performed throughout the year. As part of the 10-Year Assessment, zone planners perform system intact and required Reliability Standard contingency analyses on each of the “All Projects” models. The contingency analysis includes systematically removing each line, generator, transformer, and modeled bus ties individually to determine the affect on the transmission system. The analysis will verify whether all of the planned, proposed, and provisional projects will resolve issues revealed in the Assessment process.

The zone analysis discussions presented in this Assessment provides a list of reinforcements that are beginning to optimize our reinforcement plans, at least at the one- or maybe two-zone level. Three important questions regarding this plan include the following:

- ❑ How do the reinforcements for all the zones perform together?
- ❑ Does applying a solution in one zone create a problem that was not seen before in another zone?
- ❑ Are some zone solutions redundant when all the solutions are applied to the system?

As we did in previous Assessments, this year we have tried to address the first two questions. We have built year 2010, 2014 and year 2019 models that include reinforcements reflecting our best thoughts on all of the most likely planned, proposed, and provisional projects to deal with

the identified issues. These projects are those identified in the project tables for this Assessment with specific in-service dates. First contingency analysis was performed on these two new models, including selected outages on neighboring systems. This analysis showed that the reinforcements in total did indeed deal with the issues identified and did not create any new issues to be resolved. Some details for each zone are summarized below.

Zone 1

In the 2010, 2014 and 2019 summer peak "All Projects" models, most of the system overloads or low voltages in Zone 1 are addressed although a few issues still exist under single contingency conditions in our 2014 and 2019 models. The system issues remaining in the 2014 and 2019 "All Projects" models are:

- ❑ The Petenwell transformer is overloaded in the 2014 model under system intact conditions. The transformer is not overloaded in the 2019 All Projects model.
  - The issue can be addressed by redispatching the Big Pond generator.
- ❑ The Castle Rock – McKenna 69-kV circuit is overloaded in the 2014 model for the various 69-kV line outages.
  - The issue can be addressed by redispatching the Castle Rock generator.
- ❑ The system intact voltage for the Council Creek 161-kV bus is nearing the low voltage threshold in the 2014 and 2019 models.
  - Voltage can be improved by including the two Xcel Energy proposed capacitor bank projects at Monroe County and La Crosse Substations.
- ❑ Low voltages exist at the Sigel and Lakehead Vesper substations for the Arpin–Sigel 138-kV circuit outage in the 2019 model.
  - Voltages can be substantially improved by including the recently announced load reductions in the Wisconsin Rapids area.

Zone 2

With all projects in the 2010, 2014 and 2019 summer peak models, most of the system overloads and low voltages in Zone 2 are addressed, although system problems still exist under single contingency conditions in all three study years. The system issues remaining in the 2010, 2014 and 2019 all project models are:

- ❑ Low voltages at the Engadine, Newberry, and Roberts 69-kV buses are observed for various 69-kV line outages
  - These violations can be mitigated by running the Newberry Village and Dafter diesel generators.

Zone 3

With all projects in the 2010, 2014 and 2019 summer peak models, most of the system overloads and low voltages in Zone 3 are addressed, although several system problems still exist under single contingency conditions in 2010, 2014 and 2019. The system issues remaining in the 2010, 2014 and 2019 all project models are:

- ❑ The Verona-Oregon 69-kV line overloads and low voltages for the loss of Stoughton-Aaker Road 69-kV line. (2010)

- Load bridging capability between Stoughton and Aaker Road substations can address this overload. The transmission solution for this problem is to rebuild the Verona-Oregon 69-kV line in 2011.

- ❑ The Fitchburg-Royster 69-kV line overloads for the loss of either end of the line (2010)
  - These violations will be also addressed by local load bridging. The transmission solution for this problem is to uprate Fitchburg-Nine Springs and Royster-Pflaum 69kV lines, move AGA to Femrite-Royster line and install Nine Springs Cap Bank.
- ❑ The Huiskamp-Mendota-Ruskin 69-kV line overloads for the loss of the North Madison-Vienna 138-kV line in the 2010 70 percent peak all project model (2010)
  - The short term mitigation plan is to bypass the line switch at Mendota. The long term transmission solution for this problem is to remove the line switch at Mendota tap by 2011 with the Mendota substation retirement project.
- ❑ The Darlington-North Monroe 138-kV line overload for the loss of the Paddock 345/138-kV transformer in the 2014 70 percent peak all project model (2014)
  - Possible mitigation plan is to dispatch Riverside generation.
- ❑ The Verona 138-kV bus is slightly below 90 percent for the loss of Oak Ridge-Verona 138-kV line in the 2019 summer peak all project model (2019).
  - Possible mitigation plan is to adjust the Verona 138/69-kV transformer to boost the 138-kV bus as necessary.
- ❑ One East Campus-Walnut 69-kV line is overloaded for the loss of the second East Campus-Walnut 69-kV line in the 2019 summer peak all project model (2019).
  - Possible mitigation plan is to redispatch West Campus, Nine Springs, Fitchburg and Sycamore generation.
  - This potential issue was mainly caused by the provisional West Middleton-Blount 138-kV project. Considering the on-going major D-T load development in Madison area, no project is created at this point to address this overload due to the uncertainty of the need year for the West Middleton-Blount 138-kV project.
- ❑ Low 138-kV voltages at Hubbard and Hustisford for the loss of Rubicon-Hustisford
  - Possible operating procedure is to adjust the 138/69-kV Hubbard transformer load tap changer setting to boost the 138-kV bus voltage. The proxy transmission solution to this issue is to construct a Horicon-East Beaver Dam 138-kV line in 2019.

Zone 4

A contingency analysis was performed on the 2010, 2014, and 2019 “All Projects” models. With all of the planned, proposed, and some provisional projects modeled, no new Zone 4 facility overloads or voltage problems occurred.

Zone 5

A contingency analysis was performed on the 2010, 2014, and 2019 “All Projects” models. With all of the planned, proposed, and some provisional projects modeled, no new Zone 5 facility overloads or voltage problems occurred. Low bus voltage issues persist in Waukesha and Washington Counties. The expected addition of capacitors at Summit, Mukwonago, and Bluemound Substations is improving the situation. Running generation at Concord and Germantown also rectifies the situation. Further system improvements are still needed and under investigation.

Conclusion
We recognize that we need to continue to develop our reinforcement optimization processes. The analyses described are not the only methods we use to optimize our plans and do not begin to address the third question. Also, access-driven reinforcements, (with the exception of the second Paddock-Rockdale 345-kV line) were not included in this analysis as we await more definition of the most likely projects. However, our project development process, including development of the access projects, does look to optimize the projects that are finally built.

Load sensitivity analysis
The analysis that we perform for each 10-Year Assessment is based on power flow analysis using specific load forecast assumptions. The load forecast assumes there is some probability of exceeding the load forecast on the peak day. A traditional practice for generation and transmission planning in Wisconsin has been to use a load forecast probability of 50 percent (also known as a 50/50 forecast). This means that there is a 50 percent chance that the actual system peak load will exceed the forecasted value in any given year or, to state it another way, it is expected that on the average the forecast will be exceeded once every two years. The problem with analysis based on the traditional method is that it does not indicate the reliability risk of the actual system peak exceeding the forecasted value. The question then is, what is the risk to reliable system operation in the ATC footprint if the forecast is exceeded and what, if anything, should be done to mitigate some or all of the risk?

One way to assess this risk is to increase the load forecast and determine whether or not ATC's proposed projects can reliably serve this increased electricity usage. To accomplish this purpose, some utilities use a 90/10 forecast[3], as opposed to the 50/50 forecast. ATC has relied on its customers to provide the load forecasts for our analysis, so we currently do not have a 90/10 forecast available for the risk assessment in the 2009 Assessment. However, general discussions have found that a 5 percent increase in certain peak loads may be a reasonable assumption for a 90/10 versus a 50/50 forecast. Therefore, for the 2009 Assessment, ATC used a 5 percent increase in certain peak loads as a proxy for the higher 90/10 forecast.

ATC applied a 5 percent increase to scalable[4] peak hour loads in the power flow models representing the year 2014. In Zones 1, 3, 4 and 5, ATC found that the increased load did not have a significant impact on the need for projects. While we did not see that he increased load had a major impact on voltages, we did see areas where voltage is expected to be marginal for the 5 percent increased forecast. These voltages will need to be considered more carefully to determine if any mitigation should be considered for higher than expected load.

In Zone 2, ATC found that the increased load did have a significant impact on the need for proposed projects. To address this and other area needs, ATC has completed an Energy Collaborative discussion in Zone 2 to identify reasonable futures and drivers that should be

[3] A 90/10 forecast generally means that there is a 90 percent chance that the load will be less than the forecasted value. Thus, a load based on a 90/10 forecast load would be higher than a load based on a 50/50 forecast where there is only a 50 percent chance that the load will be less than the forecasted value
[4] Scalable means that these loads follow some predictable load cycle pattern throughout the year that may or may be sensitive to extreme weather conditions.

considered in developing appropriate plans for Zone 2. Table ZS-2 compares the results of the 50/50 and proxy 90/10 analyses for 2014 for Zones 1-5.

We saw some additional areas where previously marginal voltage worsened and/or thermal overloads were aggravated as loads increased. In Zone 3, the in-service dates of at least three projects become more critical if loads are higher than expected:

- Bass Creek 138/69-kV transformer and Bass Creek-Town Line Road 138-kV rebuild (2013),
- Uprate Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, move AGA to Femrite-Royster 69-kV line and install Nine Springs capacitor bank (2013), and
- Horicon (Hubbard)-East Beaver Dam 138-kV line (2019).

Futures (2019)
ATC planning decided to explore the impact of using a security constrained economic dispatch (SCED), in addition to a merit order dispatch, in its reliability analyses. To do this, output from the PROMOD model for the peak load hour from ATC's 2018 Slow Growth and DOE 20% Wind Futures was provided. Please refer to the Methodology & Assumptions section for descriptions of these Futures. This output included ATC's total load, flows on all of ATC's tie lines, and dispatch of all of the generators within our footprint for the peak hour in each of the two futures. The PROMOD Analysis Tool (PAT) was used to extract the data. This extracted PROMOD data was then incorporated into 2018 summer peak load flow models for study purposes. A summary of the data provided from PROMOD/PAT is listed below.

PROMOD simulates random forced outages of generators and these are also listed for each future. PROMOD models for ATC's futures are developed from MISO models. MISO added some wind plants within the ATC footprint to its 20% DOE PROMOD model to achieve the mandate. The total amount of wind power added by MISO to its 20% DOE PROMOD model and dispatched on peak within ATC is listed below. Table ZS-3a lists the impact of the 20% Wind and Slow Growth futures vs. our typical 50/50 Summer Peak models for Zones 1-5.

At this time, ATC is not proposing to advance any project timings to anticipate higher loads, potential futures or load growth. However, we will continue to evaluate these conditions in future Assessments.

TABLE ZS-1

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship 69-kV buses		89.5 - 91.9%		--		90.8 - 91.6%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	Redispatch generation or McKenna capacitor expansion
1	Petenwell, Council Creek 138-kV bus		90.5 - 91.4%		--		91.3%	Saratoga - Petenwell 138-kV line	Monroe County – Council Creek 161-kV line
1	Harrison 69-kV bus		--		105.0%		--	System Intact	Take Harrison 69-kV capacitor out of service
1	Whitcomb 115-kV bus		--		--		105.5%	System Intact	Take Badger 138-kV capacitor out of service
1	Caroline 115-kV bus		105.1%		105.1%		105.6%	System Intact	Take Badger 138-kV capacitor out of service
1	Coloma 69-kV bus		91.9%		--		--	Chaffee Creek - Coloma Tap 69-kV line	
1	Metomen 138/69-kV transformer #31	93.0% - 100.2%		--		--		System Intact North Randolph - Markesan Tap 69-kV line North Fond du Lac - Rosendale 69-kV line Sunset Point - Winneconne 69-kV line	Metomen transformer replacement
1	Petenwell 138/69-kV transformer #31	89.0%		--		--		System Intact	
1	Whitcomb 115/69-kV transformer #31	91.0%		--		--		System Intact	
1	Castle Rock - ACEC Quincy 69-kV Line	96.2%		--		--		Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah Tap - Big Pond 69-kV line	
2	Pine River - Straits 69-kV line Straits - Evergreen 69-kV line Straits - Evergreen 69-kV line	--		--		98.1 - 124.2%		Brevort - Lakehead 138-kV line Lakehead - Hiawatha 138-kV line Brevort - Straits 138-kV line Pine River - Evergreen 69-kV line Evergreen - Straits 69-kV line ATC_B2_9902	Rebuild Straits-Pine River 69-kV lines
2	Straits - McGulpin 138-kV line #3	--		--		100.2%		Straits - McGulpin 138-kV line #1	Uprate Straits - McGulpin 138-kV line #3
2	Straits - McGulpin 138-kV line #1	--		--		100.3%		Straits - McGulpin 138-kV line #3	Uprate Straits - McGulpin 138-kV line #1
2	Nordic - Mountain 69-kV line	--		107.9%		--		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	Delta – Mead 69-kV line	99.0 - 157.1 %		102.0 - 108.7%		112.4 - 140.8%		System Intact Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	Uprate Delta – Mead 69-kV line, Increase generation at Mead/Gladstone
2	Chandler – Delta 69-kV #1 line	106.5%		117.1%		--		Chandler-Delta 69-kV #2 line	Uprate Chandler – Delta 69-kV #1 line

TABLE ZS-1									
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases									
Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	Chandler – Delta 69-kV #2 line	101.7%		111.7%		--		Chandler-Delta 69-kV #1 line	Uprate Chandler – Delta 69-kV #2 line
2	Atlantic – M38 69-kV line	117.5 - 118.1%		95%		115.3 - 115.4%		Atlantic 138/69-kV transformer #1 Atlantic - M-38 138-kV line ATC_B2_ATLAN (both of the above)	Uprate Atlantic – M38 69-kV line
2	Chandler – Lakehead Tap 69-kV line Masonville – Lakehead Tap 69-kV line Masonville – Gladstone 69-kV line Gladstone – North Bluff 69-kV line North Bluff – Bay Tap 69-kV line Mead – Bay Tap 69-kV line	119.1 - 159.0%		97.3 - 107.3%		106.3 - 142.0%		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, North Bluff-Mead 69-kV lines
2	Lakota Road 69-kV bus		--		--		105.4% - 118.5%	System Intact Conover - Lakota 69-kV line	Adjust 138/69-kV transformer taps at Lakota Road
2	Engadine, Straits, St. Ignace, Hiawatha, Manistique, Valley, Glen Jenks, Indian Lake, Evergreen 69-kV buses		--		105.2% - 105.5%		105.1% - 105.8%	System Intact	Adjust 138/69-kV transformer taps at Indian Lake, Hiawatha, and Straits
2	WE-Greenstone, Barnum Tap, Barnum Sub, Humboldt Tap, Foundry, North Lake 69-kV buses		--		105.3 - 105.5%		--	System Intact	Adjust 138/69-kV transformer taps at North Lake
2	Munising, Alger, Alger Delta Hiawatha 69-kV buses		--		105.1 - 105.5%		--	System Intact	Adjust 138/69-kV transformer taps at Munising
2	Cornell Tap, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West Tap, West, Lakehead Tap, Lakehead, Bay Tap, Bay View, North Bluff, Cornell, Harris, Harris Tap 69-kV buses		90.5 - 91.9%		88.3 - 91.5%		--	Chandler 138/69-kV transformer #1	Increase local generation at Gladstone/Mead/Escanaba
2	Engadine, Newberry, Newberry Hospital, Newberry Hospital Tap, Newberry Village, Louisiana Pacific, Roberts, Hulbert, Eckerman, Raco, Talentino, Talentino 6950, Goetzville, Brimley, DeTour 69-kV buses		71.8 - 91.6%		--		--	Hiawatha – Engadine 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Straits, Brevort, Lakehead, Hiawatha 138-kV buses		89.3 - 91.1%		--		--	Livingston – Emmett 138-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus		88.0%		--		89.0%	Atlantic-M38 138-kV line	Adjust 138/69-kV transformer taps at Atlantic

TABLE ZS-1									
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases									
Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	No criteria limits exceeded or constraints	--	--	--	--	--	--	System Intact	
3	Hubbard and Hustisford 138-kV busges		84.4 – 86.9%		86.6 – 87.3%		86.7 – 87.3%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138 kV line	Local Operating Steps
3	Crawfish River 138-kV bus		91.4%		--		--	Jefferson – Crawfish River 138-kV line	Increase Concord generation
3	Verona - Sun Valley 69-kV line	110.9%-101.3%		--		101.3%		Stoughton - Stoughton South 69-kV line Kegonsa - Stoughton North 69-kV line Kegonsa 138/69-kV transformer #31	Y119 Verona-Oregon 69-kV line rebuild
3	McCue - Harmony - Lamar 69-kV line	98%-95.4%		--		--		Kegonsa - Stoughton North 69-kV line	Y61 McCue - Lamar line uprate
3	Fitchburg - Syene 69-kV line	109.6%		--		98.8%		Royster - AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap 69-kV line	106.7%		--		96.6%		Fitchburg - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Verona 138-kV bus		90.1%		-		90.7%	Verona - Oak Ridge 138-kV line	Adjust Verona 138/69-kV transformer setting
3	Harmony, Lamar, Fulton and Saunders Creek 69-kV buses		87.8-91.9%		--		90.1-91.3%	McCue - Harmony 69-kV line Harmony - Lamar 69-kV line	Lamar 2-16.33 MVAR 69-kV capacitor banks
3	Huiskamp – Mendota - Ruskin 69-kV line	--		101.6%-97.7%		--		North Madison - Vienna 138-kV line Vienna - Yahara River 138-kV line Yahara River - American Center 138-kV line	Bypass the Mendota line switch as a short term solution; the 2011 Mendota Substation retirement project will remove the line switch limitation
3	Paddock – Townline 138-kV line	--		97%-95.2%		--		Blackhawk – Northwest Beloit Tap 138-kV line Northwest Beloit Tap – Paddock 138-kV line	Increase Rock River generation
4	Chalk Hills and Alger Delta Nathan 69-kV buses		105.1 – 105.8%		–		106.4 – 107.1%	System Intact	Modeling Corrections
4	Bell Plaine and Badger 115-kV buses		105.4%		–		105.7%	System Intact	Local Operating Steps
5	Germantown 138-kV bus		--		95.8%		--	System Intact	Run Germantown generation
5	Bain 345/138-kV transformer #5	158.5%		131.2%		158.6%		Pleasant Prairie 345-kV 3-4 bus tie	Reduce Pleasant Prairie #2 generation

TABLE ZS-1

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010 Summer Peak, Shoulder and E-W Bias Cases

Planning Zone	Criteria Exceeded/Need	2010 Summer Peak Case		2010 Shoulder Case		2010 E-W Bias Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
5	Albers – Bain 138-kV line	96.4%		--		101.6%		Bain-Kenosha 138-kV line	Upgrade Bain – Albers 138-kV line
5	Albers – Kenosha 138-kV line			114.6%		106.3%		Albers – Bain 138-kV line	Upgrade Albers – Kenosha 138-kV line
5	Oak Creek8 – Elm Road 345/230-kV transformer #884	101.8%		--		--		Oak Creek 230-kV 6-7 bus tie	Reduce Oak Creek generation on units 7 or 8.
5	Arcadian4- Waukesha1 138-kV line	98.8%		105.1%		114.9%		Arcadian6 – Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian 345/138-kV transformer #3	99.0%		95.1%		103.9%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Arcadian 345/138-kV transformer #2	--		--		95.1%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Hartford 138-kV bus		91.6%		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation
5	Oak Creek8 – Elm Road 345/230-kV transformer #884	95.8		--		--		Oak Creek 230-kV 6-9 bus tie	Reduce Oak Creek generation on 6, 7, or 8
5	Harbor – Kansas 138-kV line	--		95.4% 96.3% 96.5% 99.3%		--		Montana – Dewey 138-kV line Dewey 138-kV bus Dewey – Norwich 138-kV line Kansas – Norwich 138-kV line	Replace 138-kV underground segment of the Kansas – Harbor 183kV line
5	Arcadian6 – Waukesha3 138-kV line	97.9%		104.2%		114.0%		Arcadian4 - Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives

Table ZS-2
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake 69-kV bus		91.3 - 91.7%		90.7 - 91.7%		--		--		90.0 - 91.1%	Wautoma - Silver Lake Tap 69-kV line	No project needed at this time
1	Dartford, Northwest, Ripon Industrial Park, Ripon, Southwest Ripon 69-kV bus		--		91.9%		--		--		91.0 - 91.8%	Metomen - Ripon 69-kV line Ripon - Northwest Ripon Tap 69-kV line	No project needed at this time
1	Winneconne 69-kV bus		--		--		--		--		91.5%	Sunset Point - Winneconne 69-kV line	No project needed at this time
1	Aurora Street 115-kV bus Antigo 115-kV bus		--		--		--		--		90.4 - 90.5%	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock 69-kV buses		88.1 - 91.7%		87.8 - 91.5%		--		89.3 - 91.9%		87.3 - 91.9%	Petenwell 138/69-kV transformer #31 Petenwell - Big Pond 69-kV line Big Pond - Necedah Tap 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line	McKenna capacitor bank expansion
1	Petenwell, Council Creek 138-kV buses		90.5% - 91.6%		90.3 - 91.4%		--		91.8%		95.4 - 95.6% 90.0 - 91.9%	System Intact Saratoga - Petenwell 138-kV line	Monroe County - Council Creek 161-KV line
1	Caroline 115/69-kV transformer #61	95.5%		--		--		--		101.6%		Whitcomb 115/69-kV transformer #31	No project needed at this time
1	Castle Rock - ACEC Quincy 69-kV line	96.1%		103.0%		--		--		97.5%		Petenwell 138/69-kV transformer #31 Petenwell - Big Pond 69-kV line Big Pond - Necedah Tap 69-kV line	Uprate Castle Rock - McKenna 69-KV line
1	Council Creek - Tomah Industrial Park Tap 69-kV line	97.7%		98.1%		--		--		--		System Intact	No project needed at this time
1	Northwest Ripon - Ripon 69-kV line	--		--		--		--		98.7%		Sunset Point - Winneconne 69-kV line	No project needed at this time
1	Whitcomb 115/69-kV transformer #31	--		--		--		--		96.4%		System Intact	No project needed at this time
1	Metomen 138/69-kV transformer #31	99.0 - 104.0%		103.3% 97.6%				100.8 - 107.4%		109.0%		System Intact North Fond du Lac - Rosendale Tap 69-kV line Metomen - Rosendale Tap 69-kV line North Randolph - Markesan Tap 69-KV line Sunset Point - Winneconne 69-KV line	Metomen transformer replacement

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	DeTour, Goetzville, Talentino, Mich Limestone, Rockview, Magazine, Pickford, Talentino, Talentino 6950 69-kV buses Straits, Brevort, Lakehead, Hiawatha 138-kV buses		86.3 - 91.8%		89.2 - 91.9%		--		Did not converge		Did not converge	Livingston – Emmett 138-kV line	
2	Straits, Brevort, Lakehead, Hiawatha 138-kV buses		90.1 - 92.0%		--		--		Did not converge		Did not converge	Keystone – Ludington 345-kV line	
2	Pine River - Straits 69-kV, Straits-Evergreen 69-kV, Pine River-Evergreen 69-kV lines	--		--		--		96.2 -135.8%		--		Brevort - Lakehead 138-kV Line Lakehead - Hiawatha 138-kV Line Brevort - Straits 138-kV Line Pine River - Evergreen 69-kV Line Evergreen - Strait 69-kV line ATC_B2_9902	Rebuild Straits-Pine River 69 kV lines
2	Straits - McGulpin 138-kV line #3	--		--		--		112.6%		--		Straits - McGulpin 138-kV line #1	Uprate Straits - McGulpin 138-kV line #3
2	Straits - McGulpin 138-kV line #1	--		--		--		112.6%		--		Straits - McGulpin 138-kV line #3	Uprate Straits - McGulpin 138-kV line #1
2	Delta – Mead 69-kV line	100.0 - 157.2%		100.0 - 158.0%		--		112.7 - 141.8%		105.8 - 165.2%		System Intact Chandler - Lakehead Tap 69-kV line Lakehead Tap - Masonville 69-kV line Masonville - Gladstone 69-kV line Gladstone - North Bluff 69-kV line North Bluff - Bay Tap 69-kV line Bay Tap - Mead 69-kV line	Uprate Delta - Mead 69-kV line, increase generation at Mead/Gladstone
2	Chandler – Delta 69-kV #1 line	108.1%		108.1%		117.9%		95.7%		97.9 - 117%		Chandler - Delta 69-kV #2 line, Chandler - Lakehead Tap 69-kV line	Uprate Chandler - Delta 69-kV line #1
2	Chandler – Delta 69-kV #2 line	102.6%		102.4%		112.6%				111.7%		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2
2	Atlantic – M38 69-kV line	117.6 - 118.2%		118.2 - 118.8%		96.3%		116.8%		119.7 - 120.0%		Atlantic - M-38 138-kV line, Atlantic 138/69-kV transformer #1, Both	Uprate Atlantic-M38 69-kV line or increase local generation at Portage
2	Chandler - Lakehead Tap, Lakehead Tap - Masonville, Masonville - Gladstone, Gladstone - North Bluff, North Bluff - Bay Tap, Bay Tap - Mead 69-kV lines	120.2 - 160.5%		120.3 - 160.7%		98.0 - 108.3%		106.8 - 142.6%		128.4 - 171.4%		Delta-Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, North Bluff-Mead 69-kV lines; increase generation at Mead/Gladstone
2	Nordic – Mountain 69-kV line	110.8%		--		106.1%		--		119.7%		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	Ontonagon - UPPSCo Tap 69-kV line	--		--		--		--		105.9% - 106.9%		Victoria - Rockland Junction 2 69-kV, Rockland Junction 2 - Rockland 69-kV, Rockland - Mass 69-kV lines	Uprate Ontonagon - UPPSCO Tap 69-kV line Reduce generation at White Pine Mine/Victoria Hydro
2	New Quinnesec - Kingsford Tap 69-kV line	--		--		--		--		95.2 - 95.3%		Twin Falls North-Twin Falls South Twin Falls South-Bass Lake 69-kV lines	Uprate New Quinnesec -Kingsford Tap 69-kV line
2	WE-Greenstone, Barnum Tap, Barnum Sub, Humboldt Tap,Foundry, North Lake 69-kV buses		--		--		105.0 - 105.6%		--		---	System Intact	Adjust 138/69-kV transformer taps at North Lake

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	Straits, St Ignace, Manistique, Valley, Glen Jenks, Indian Lake, Evergreen 69-kV buses		--		--		105.1 - 105.6%		104.7 - 105.4%		--	System Intact	Adjust 138/69-kV transformer taps at Indian Lake, Hiawatha, and Straits
2	Lakota Rd 115-kV bus		--		--		105.2%		105.0%		--	System Intact	Adjust 138/69-kV transformer taps at Lakota Road
2	Hiawatha, Lakehead, Brevort 138-kV buses		--		--		--		88.8 % - 92.0%		--	Morgan - Highway 22 345-kV line Morgan - Plains 345-kV line Remove Weston Unit 4, Livingston – Vanderbilt 138-kV line Riggsville – Rondo 138-kV line McGulpin – Oden 138-kV line, Remove Kewaunee unit 1, Gallagher – Gallagher Tap, Gallagher – Livingston, Gallagher – Tittabawassee 345-kV lines	Adjust 138/69-kV transformer taps at Hiawatha
2	Atlantic 138-kV bus		--		--		105.8%		--		--	System Intact	Reduce capacitor bank MVAR at Atlantic 69 kV bus
2	Centennial Mine, Centennial Tap, MTU, Osceola, Henry Sub, Henry Tap 69-kV buses		--		--		--		--		90.8 - 91.7%	Atlantic - M38 138-kV line Atlantic 138/69-kV transformer #1	Increase generation at Portage
2	Aspen, Iron Grove 138-kV buses		--		--		--		--		91.0%	Aspen - Plains 138-kV Line	Adjust 138/69-kV transformer taps at Aspen, Iron Grove
2	Iron Grove 138-kV bus		--		--		--		--		91.2 - 91.5%	Aspen - Iron Grove 138-kV Line	Adjust 138/69-kV transformer taps at Iron Grove
2	Lakehead, Strawberry Hill, Strawberry Hill Tap, Iron Grove 69-kV buses		--		--		--		--		91.7 - 91.9%	Iron Grove 138/69-kV transformer #G1	Add second Iron Grove 138/69-kV transformer
2	Land O Lakes, Conover, Lakota Road 69-kV buses		--		--		90.5 - 90.9%		--		--	Conover-Lakota 69-kV line, Lakota Road 138/69-kV transformer #G2	Utilize available capacitance at Conover
2	Lakota Road 69-kV, 115-kV buses		110.3 - 118.8%		110.1 - 118.8%		--		--		117.4%	Eagle River Muni - Lakota Road 115-kV line Eagle River Muni - Cranberry 115-kV line	Adjust 138/69-kV transformer taps, 138-kV capacitor banks at Lakota Road
2	Chandler, Delta, West Side, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead Tap, Lakehead, Bay View, North Bluff, Cornell, Harris, Harris Tap 69-kV buses		89.0 - 91.9%		89.2 - 91.2%		88.3 - 91.5%		--		87.0 - 90.4%	Chandler 138/69-kV transformer #1	Increase generation at Mead/Gladstone/Escanaba
2	Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Hulbert, Eckerman, Raco, Brimley, Goetzville 69-kV buses		80.0 - 91.8%		80.6 - 91.8%		80.6 - 91.9%		Did not converge 87.1 - 91.8%		80.4 - 92.0%	Hiawatha - Engadine 69-kV line, Engadine-Newberry 69-kV line, Newberry - Newberry Village 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
2	DeTour, Goetzville, Talentino 6906, Mich Limestone, Rockview 69-kV buses Brevort, Lakehead, Hiawatha 138-kV buses		--				--		89.4 - 92.0%		--	Brevort - Straits 138-kV line Brevort - Lakehead 138-kV line Hiawatha - Lakehead 138-kV line, Remove US Hydro Unit 1	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus		87.2%		87.0%		--		88.4%		84.8%	Atlantic-M-38 138-kV line	Adjust taps at Atlantic 138/69-kV transformer #1
3	Kirkwood - Rock Springs 138-kV line	--		--		--		--		95.1%		Trienda – Lewiston ACEC 138-kV line	No project needed at this time
3	Kilbourn 138/69-kV transformer #1	--		--		--		100.3%		--		Kilbourn 138/69-kV transformer #2	
3	Fitchburg –Syene - Ninesprings 69-kV line	114.9 - 96%		115 - 96.1%		--		103.2%		120.8 - 100.8%		Royster - AGA Tap 69-kV line; AGA Tap - Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster-AGA Tap-Pflaum 69-kV line	112.6 - 98.2%		112.6 - 98.3%		--		101.1 - 96.9%		118.3 - 96.8%		Fitchburg - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Dana – Sheepskin 69-kV line	104.7 - 100%		104.7 - 100%				--		111.3 - 107.2%		McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA SE
3	McCue – Harmony - Lamar 69-kV line	104.0 - 95.4%		103.0 - 96.4%		--		--		112.2 - 97.6%		Kegonsa - Stoughton North 69-kV line ; Kegonsa 138/69-kV transformer; Stoughton North - Stoughton East 69-kV line	Y61 McCue-Lamar line uprate
3	Harmony, Lamar, Fulton, Saunders Creek, Dana, Sheepskin, Evansville 69-kV buses		84.2 -91.9%		84.3 -91.9%		--		88 -91.7%		83.1 -91.3%	McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV capacitor banks
3	Verona 138-kV bus		89.1%		89.0%		--		90.1%		88.5%	Verona - Oak Ridge 138-kV line	Lock the Verona 138/69-kV transformer setting at 1.0 to achieve 98%
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead and REC Orfordville 69-kV buses		91 - 91.8%		91 - 91.8%		--		--		89.4 - 91.7%	Brodhead Switching Station-Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Muscoda 69-kV bus		--		91.9%		--		--		91.8%	Lone Rock-Spring Green 69-kV line	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	AGA, Pflaum 69-kV buses		91.9%		91.8 - 91.9%		--		--		91.4 - 91.5%	Royster-AGA Tap 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Paddock-Townline 138-kV line	--		--		97.8 – 96.0%		--		--		Paddock-Northwest Beloit Tap 138-kV line; Northwest Beloit Tap-Black Hawk 138-kV line	Possible mitigation is to dispatch Riverside generation

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Rockdale - Wempletown 345-kV line	--		--		98.0%		--		--		Wempletown - Paddock 345-kV line	Possible mitigation is to dispatch Riverside generation
3	McCue – Harmony - Lamar 69-kV line	--		--		--		--		95.8%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	North Monroe - Idle Hour 69-kV line	--		--		--		--		97.1%		Paddock - Newark 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Stoughton - Sheepskin 69-kV line	--		--		--		--		99.2%-95.6%		McCue - Harmony 69-kV line; Harmony - Lamar 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Gran Grae – Wauzeka - Boscobel 69-kV line	--		--		--		--		95.7%-95.4%		Spring Green - Lone Rock 69-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton - Timberlane 69-kV line	--		--		--		--		98.3%		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Waunakee Switching Station - Waunakee 2 69-kV line	--		--		--		--		96.3%		West Middleton - Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Academy – Columbus Muni #3 Tap 69-kV line	95.0 – 99.7%		98.4 – 102.8%		–		98.3%	–	98.6%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Model corrections
3	Columbus Muni #3 Tap – Columbus 69-kV line	98.1%		96.8 – 101.2%		–		96.8%	–	96.9%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Model corrections
3	Koch Oil Tap – Waupun 69 kV line	–		–		–		–		99.3%		North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138 kV line project
3	Koch Oil Tap – South Fond du Lac 69 kV line	–		–		–	–	–	–	98.5%	–	North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138 kV line project
3	Hubbard and Hustisford 138-kV buses		86.4 – 90.8%		86.0 – 90.2%		86.6 – 86.9%		86.4 – 87.1%		85.8 – 86.3%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Hartford – St. Lawrence 138-kV line	Local operating steps
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		–		88.9 – 90.0%		–		–		–	North Randolph – Fox Lake 138-kV line	Local operating steps
3	Fort Atkinson 138-kV bus		91.9%		91.6%		--		--		--	Jefferson – Lakehead – Rockdale 138-kV line	Increase generation at Concord
3	Concord 138-kV bus		95.5% 91.6%		95.3% 91.2% 91.9%		--		--		--	System Intact Jefferson – Crawfish River 138-kV line Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
3	Rubicon 138-kV bus		91.0%		90.4%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
3	Lake Geneva 69-kV bus		91.9%		91.9%		--		--		90.9%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Twin Lakes 69-kV bus		--		--		--		--		91.4%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Dickinson 138-kV bus		91.5%		91.6%		--		91.3%		91.1%	Colley Road – Dickinson 138-kV line	Brick Church capacitors
3	Brick Church 138-kV bus		--		--		--		91.9%		91.8%	Colley Road – Dickinson 138-kV line	Brick Church capacitors
3	Crawfish River 138-kV bus		90.2%		89.8%		--		91.7%		--	Jefferson – Crawfish River 138-kV line	Increase Concord generation
3	South Lake Geneva 69-kV bus		--		--		--		--		91.5%	North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line

TABLE ZS-2

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 Summer Peak without Nelson Dewey, with Nelson Dewey, Shoulder, E-W Bias and High Load Cases

Planning Zone	Criteria Exceeded/Need	2014 Summer Peak Case Without Nelson Dewey		2014 Summer Peak Case With Nelson Dewey		2014 Shoulder Case		2014 E-W Bias Case		2014 High Load Case		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal Voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Lake Geneva – South Lake Geneva 69-kV line	99.0%		98.9%		--		--		104.3%		Cobblestone – Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Cobblestone – Zenda Tap 69-kV line	--		--		--		--		98.7%		North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Williams Bay, Bristol, Delavan, North Shore, Rock River, Blackhawk, Paddock, Colley Road, Dickinson, Brick Church, Elkhorn 69-kV buses		--		--		92.0 – 91.0%		--		--	Paddock 345/138-kV transformer #21	
3	Colley Road 138/69-kV transformer #31	--		--		--		--		95.7%		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
4	Chalk Hills and Alger Delta Nathan 69-kV buses		–		–		105.8 – 106.3%		–		–	System Intact	Model corrections
4	Bell Plaine 115-kV bus		–		–		105.3%		–		–	System Intact	Local operating steps
5	Harbor – Kansas 138-kV line	--		--		107.3% 107.1% 106.1% 103.3% 102.3% 99.2%		--		--		Dewey – Norwich 138-kV line Split Dewey 138-kV bus Montana – Dewey 138-kV line Kansas – Norwich 138-kV line Montana – Valley 138-kV line Harbor – Norwich 138-kV line	increase Valley generation
5	Arcadian4-Waukesha1 138-kV line	113.8%		115.7%		118.5%		131.1%		112.9%		Arcadian 6–Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian transformer #3 Arcadian transformer #2	106.9% 96.9%		108.1% 97.4%		99.8%		111.7% 102.8%		109.5% 98.2%		Arcadian transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Pleasant Valley 138-kV bus		--		91.8%		--		--		--	Pleasant Valley – Saukville 138-kV line	Increase Concord generation
5	Arcadian6 – Waukesha3 138-kV line	112.9%		114.8% 96.7%		117.6% 105.6%		130.1% 114.2%		111.9%		Arcadian4- Waukesha1 138-kV line Waukesha 138-kV 1-2 bus tie	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Bain 345/138-kV transformer #5	158.9% 100.5%		158.9% 98.9% 95.3%		147.0%		158.8%		159.2% 99.8% 96.8%		Pleasant Prairie 345-kV 3-4 bus tie Pleasant Prairie 345-kV 2-3 bus tie Bain 345/138-kV transformer #4	Reduce Pleasant Prairie generation
5	Bain 345/138-kV transformer #4	--		--		--		--		96.0%		Bain 345/138-kV transformer #5	Reduce Pleasant Prairie generation
5	Albers – Bain 138-kV line	112.5%		114.0%		102.9% 96.2%		116.6%		115.4%		Bain - Kenosha 138-kV line Albers – Kenosha 138-kV line	Upgrade Bain – Albers 138-kV line
5	Albers – Kenosha 138-kV line	--		--		124.9%		112.8%		--		Albers – Bain 138-kV line	Increase Paris generation
5	Edgewood – St. Martins 138-kV line	--		--		102.0% 95.5% 97.2%		--		--		Merrill Hills - Waukesha 138-kV line Paris – Air Liquide - Burlington 138-kV line Paddock – Wempletown 345kV line	Increase Concord generation
5	Tichigan 138-kV bus		--		--		91.3%		--		--	Burlington 138-kV 1-2 bus tie	Increase University generation
5	Burlington 138-kV bus		--		--		91.6%		--		--	Burlington 138-kV 1-2 bus tie	Increase University generation
5	Germantown 138-kV bus		--		--		--		89.8%		--	Maple – Saukville 138-kV line	Increase Germantown generation
5	Maple 138-kV bus		--		--		--		89.4%		--	Maple – Saukville 138-kV line	Increase Germantown generation
5	Nicholson – Ramsey 138-kV line	--		--		--		95.0%		--		Oak Creek – Pennsylvania 138-kV line	Increase Germantown generation
5	Hartford 138-kV bus		90.0%		89.5%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
5	Butler Ridge 138-kV bus		90.5%		89.9%		--		--		--	Hartford – St. Lawrence 138-kV line	Increase Concord generation Install Concord capacitors
5	Cooney 138-kV bus		95.9% 91.5%		95.7% 91.0%		--		--		--	System Intact Cooney – Summit 138-kV line	Increase Concord generation Install Concord capacitors

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV buses		86.8 - 91.9%		86.6 - 91.9%	Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line ACEC Spring Lake - Redgranite 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	Ripon capacitor bank expansion & Metomen transformer replacement
1	Dartford, Northwest Ripon, Industrial Park, Ripon, Southwest Ripon 69-kV buses		86.6 - 91.6%		86.5 - 91.8%	Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	Ripon capacitor bank expansion
1	Winneconne, Omro Industrial Park 69-kV buses		86.3 - 91.9%		85.7 - 91.9%	Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Winneconne - Omro Tap 69-kV line	Ripon capacitor bank expansion, Metomen transformer replacement and Wautoma 2nd transformer
1	Lincoln Pumping Station, Grand Marsh (PP&L), ACEC Brooks 69-kV buses		91.1 - 91.9%		90.7 - 91.8%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69 kV transformer	No project needed at this time
1	Sigel 138-kV bus		91.8%		91.8%	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV buses		94.6 - 95.0% 88.4 - 91.6%		94.5 - 94.8% 88.0 - 91.7%	System Intact Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line	Monroe County – Council Creek 161-kV line
1	Baker, Saratoga 115-kV buses		91.6%		91.4%	Baker - Coyne 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV buses		84.0 - 91.1%		83.6 - 91.7%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer Necedah Tap – Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	ACEC Coloma 69-kV bus		--		91.9%	Chaffee Creek - Coloma Tap 69-kV line	No project needed at this time
1	Fairwater 69-kV bus		91.9%		91.8%	Metomen 138/69-kV transformer	No project needed at this time
1	Antigo, Aurora Street 115-kV buses		90.0 - 90.1%		90.0 - 90.2%	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell 138/69-kV transformer #31	98.1% 95.7%		99.8% 95.7%		System Intact McKenna - Houghton Rock 69-kV line	No project needed at this time
1	McKenna - ACEC Quincy 69-kV line Castle Rock - ACEC Quincy 69-kV line	97.8 - 113.8%		97.0 - 120.7%		Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69 kV transformer Necedah - Whistling Wings Tap 69-kV line Kilbourn - Winnebago ACEC 69-KV line	Uprate Castle Rock - McKenna 69-KV line
1	Caroline 115/69-kV transformer #61	109.0%		108.6%		Whitcomb 115/69-kV transformer #31	Reduce area capacitor banks and redispatch area generation.

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal Bus voltage		
1	Council Creek - Tomah Industrial Park Tap 69-kV line	103.5%		103.8%		System Intact	Monroe County – Council Creek 161-kV line
1	Harrison 138/69-kV transformer	--		99.9%		System Intact	No project needed at this time
1	Metomen - Ripon 69-kV line	98.4% 98.1 - 105.8%		93.0% 97.3 - 101.9%		System Intact Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69-kV line Winneconne - Omro Tap 69-kV line	Reconfigure the North Randolph-Ripon 69-kV line to form a second Ripon-Metomen 69-kV line and retire the circuit between Metomen and the Mackford Prairie tap
1	Metomen 138/69-kV transformer #31	113.6% 108.7 - 130.9%		111.7% 107.7 - 126.5%		System Intact Ripon - Southwest Ripon Tap 69-kV line Southwest Ripon - Mackford Prairie 69-kV line North Randolph - Markesan Tap 69-kV line North Fond du Lac - Rosendale 69-kV line	Metomen transformer replacement
1	Northwest Ripon - Ripon 69-kV line	101.3 - 113.4%		98.2 - 110.5%		Sunset Point - Winneconne 69-kV line Winneconne - Omro Tap 69-kV line	SW Ripon T-D interconnection
1	Omro - Winneconne 69-kV line Winneconne - Sunset Point 69-kV line	97.0 - 103.3%		95.4 - 107.5%		Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	Load forecast variations
1	Rocky Run 345/115-kV transformer #4	95.9 - 97.1%		96.3 - 97.5%		Rocky Run 345/115-kV transformer #1 Rocky Run 345/115-kV transformer #2	No project needed at this time
1	Whitcomb 115/69-kV transformer #31	101.1%		101.6%		System Intact	Reduce area capacitor banks and redispatch area generation
1	Wautoma 138/69-kV transformer #31	112.0% 95.6 - 99.8%		108.2% 95.2 - 99.2%		System Intact Portage - Lakehead Pipeline Portage 69-kV line Sand Lake Tap - Sand Lake 69-kV line Sand Lake 138/69-kV transformer #31 Endeavor - Lakehead Pipeline 69-kV line Ripon - Northwest Ripon Tap 69-kV line	Install a second 138/69-kV transformer at Wautoma Substation
2	Delta – Mead 69-kV line	101.0 – 158.1%		100.9 – 158.1%		System Intact Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	Uprate Delta-Mead-North Bluff 69-kV line
2	Chandler-Delta 69-kV #1 line	109.5%		109.6%		Chandler-Delta 69-kV #2 line	Uprate Chandler-Delta 69-kV line #1
2	Chandler – Delta 69-kV #2 line	103.4%		103.4%		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2
2	Atlantic - M38 69-kV line	121.3 - 122.4%		121.9 - 122.0%		Atlantic - M-38 138-kV line Atlantic 138/69-kV transformer #1	Uprate Atlantic - M38 69-kV line

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
2	Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	121.6 - 162.2%		121.4 - 162.0%		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, Delta-Mead-North Bluff 69-kV lines
2	Pine River - Straits 69-kV line Straits-Evergreen 69-kV line Pine River-Evergreen 69-kV line	98.0 - 109.2%		96.1 - 106.5%		Brevort - Straits 138-kV line Brevort - Lakehead 138-kV line Hiawatha - Lakehead 139-kV line Straits - Evergreen 69-kV line	Rebuild Straits-Pine River 69 kV lines
2	Pine River-Rudyard 69-kV line Rudyard-Tone 69-kV line	97.3%		99.8% - 103.9%		Hiawatha - Engadine 69-kV line, Pine River - 9 Mile 69-kV line	Uprate or rebuild Pine River - Rudyard - Tone 69-kV line
2	Nordic - Mountain 69-kV line	111.4%		--		Chandler 138/69-kV transformer #1	Uprate Nordic-Mountain 69-kV line
2	New Quinnesec – Kingsford Tap 69-kV line	100.0% - 100.3%		99.7% - 99.9%		Twin Falls North -Twin Falls South 69-kV line Twin Falls South - Bass Lake 69-kV line	Uprate New Quinnesec - Kingsford Tap 69-kV line
2	Lakota 69-kV bus		117.1%		117.2%	Conover - Lakota 69-kV line	Adjust 138/69-kV transformer taps at Lakota Road
2	Chandler, Cornell Tap, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead, Bay View, North Bluff, Cornell, Harris 69-kV buses		88.4% - 91.4%		88.2% - 91.2%	Chandler 138/69-kV transformer #1	Increase generation at Escanaba/Mead/Gladstone
2	Hulbert, Eckerman, Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Raco 69-kV buses		78.9% - 91.9%		76.0% - 92.0%	Hiawatha-Engadine, Engadine-Newberrry, Newberry-Newberry Hospital Tap, Newberry Hospital Tap-Roberts 69-kV lines	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus Keweenaw 69-kV bus		86.1 - 91.8%		86.0%	Atlantic-M-38 138-kV line ATC_B2_ATLAN	increase generation at Portage
2	Munising 138-kV bus		91.8%		91.8%	Forsyth-Munising 138-kV line	Adjust 138/69-kV transformer taps at Munising
2	Aspen, Iron Grove 138-kV buses		91.1% - 91.5%		91.0% - 91.3%	Aspen-Plains 138-kV line	Adjust 138/69-kV transformer taps at Aspen, Iron Grove
2	Iron Grove 138-kV bus		91.0%		91.3%	Aspen-Iron Grove 138-kV line	Adjust 138/69-kV transformer taps at Iron Grove
2	Lakehead 69-kV bus		91.9%		--	Iron Grove 138/69-kV transformer	Add second Iron Grove 138/69-kV transformer
3	Artesian - Rock Springs 138-kV line Rock Springs - Kirkwood 138-kV line	100.3 - 104.4%		99.0 - 103.4%		Trienda - Lewiston ACEC 138-kV line Lewiston - Kilbourn ACEC 138-KV line	Construct a Lake Delton-Birchwood 138-kV line
3	Dane - Lodi Tap 69-kV line	100.6%		100.9%		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage – Trienda 138-kV line	96.1%		--		Portage – Trienda1 138-kV line	No project needed at this time.
3	Lake Geneva – South Lake Geneva 69-kV line	126.3% 104.7%		126.3% 104.8%		Cobblestone–Brick Church 69-kV line Cobblestone–Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg - South Lake Geneva 69-kV line	96.7%		96.7%		Cobblestone–Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Colley Road 138/69-kV transformer #31	103.6%		103.2%		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
3	Enzyme – RC3 69-kV line	95.4%		--		Brick Church 138/69-kV transformer #31	Rebuild Y-32 Colley Road-Brick Church 69-kV line
3	Colley Road – Marine 138-kV line			99.6%		Paddock-Northwest Beloit 138-kV line	Upgrade Colley Road – Marine 138-kV line
3	Cobblestone – Brick Church 69-kV line	102.2%		102.2%		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138kV line

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Cobblestone – Zenda Tap 69-kV line	123.3%		123.4% 95.0%		North Lake Geneva – Lake Geneva 69-kV line Lake Geneva – South Lake Geneva 69kV line	Spring Valley – Twin Lakes line
3	Katzenberg – Zenda Tap 69-kV line	109.5%		109.5%		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone 69-kV bus		89..9%		89.8%	Cobblestone–Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Zenda 69-kV bus		91.4% 90.9%		91.3% 90.8%	North Lake Geneva-Lake Geneva 69-kV line Cobblestone–Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Brick Church 138-kV bus		91.2% 90.4%		91.2% 90.5%	Beloit Gateway–Dickinson 138-kV line Colley Road–Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes line
3	Williams Bay 138-kV bus		91.9%		91.9%	Colley Road–Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Lake Geneva 69-kV bus		83.5%		83.5%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg 69-kV bus		85.1%		85.1%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes 69-kV bus		84.4%		84.3%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	South Lake Geneva 69-kV bus		84.2%		84.2%	North Lake Geneva–Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Dickinson 138-kV bus		89.4%		89.4%	Colley Road–Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Concord 138-kV bus		90.2%		89.7%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Butler Ridge 138-kV bus		--		91.7%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Rubicon 138-kV bus		91.9%		91.4%	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Academy – Columbus Muni #3 Tap 69-kV line	--		106.7 – 112.2%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Columbus Muni #3 Tap – Columbus 69-kV line	--		104.9 – 100.4%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Beaver Dam – Center Street 69-kV line	--		98.3%		North Randolph – Fox Lake 138-kV line	
3	South Fond du Lac – Koch Oil Tap 69-kV line	--		97.3 – 102.2%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil Tap – Waupun 69-kV line	--		97.9 – 103.1%		North Randolph – Fox Lake 138-kV line Fox Lake – North Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard and Hustisford 138-kV buses		--		96.0 – 96.2% 85.0 – 90.6%	System Intact Rubicon – Hustisiford 138-kV line Hustisiford – Hubbard 138-kV line Concord 138-kV 4-5 bus tie	Horicon – East Beaver Dam 138-kV line project
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		--		90.2 – 90.4%	North Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil 69-kV bus		--		92.0%	South Fond du Lac – Koch Oil Tap 69-kV line	No project identified. Additional study needed.
3	Horicon Industrial Park 69-kV bus		--		91.9%	Hubbard – Horicon Ind. Park 69-kV line	No project identified. Additional study needed.
3	McCue – Harmony - Lamar 69-kV line	--		104.1 - 101%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer #31	101.3 - 98.5%		105.5 - 96.7%		DPC Galena - Pilot 69-kV line Pilot -Terr Tap 69-kV line Terr Tap-LNGHLLW8 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	McCue – Harmony - Lamar 69-kV line	102.5 - 95.0%		123.0 - 96.0%		Various outages	Y61 McCue-Lamar line uprate and 2017 Construct double-circuit line between McCue and Lamar substations

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	North Monroe – Idle Hour 69-kV line	103.1 - 95.8%		107.2 - 97.4%		Darlington- Gratiot 69-kV line; Darlington 138/69-kV transformer; Browntown -Jennings Rd 69-kV line; Gratiot - Wiota 69-kV line; Wiota – Jennings Road 69-kV line; Brodhead - Newark 69-kV line; Paddock -Newark 69-kV line; Paddock 138/69-kV transformer #31	Install a 138/69-kV transformer at Bass Creek Substation
3	Dana – Sheepskin 69-kV line	115.2 - 110.8%		133.4 - 127.4%		McCue - Harmony 69-kV line Harmony -Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA and 2017 Construct double-circuit line between McCue and Lamar substations
3	Stoughton - Sheepskin 69-kV line	--		114.9 - 110.1%		McCue - Harmony 69-kV line Harmony-Lamar 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Spring Green 138/69-kV transformer #31	--		95.2%		Gran Grae-Wauzeka 69-kV line	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Gran Grae – Wauzeka - Boscobel 69-kV line	100 - 96.2%		105.6 - 100.4%		Spring Green 138/69-kV transformer #31; Lone Rock-Spring Green 69-kV line; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Spring Green-Wyoming Valley 138-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	Boscobel - Blue River 69-kV line	--		96.3 - 95.2%		Spring Green 138/69-kV transformer #31 Nelson Dewey-Lancaster 138-kV line	No project identified
3	West Middleton - Timberlane 69-kV line	106.5%		97.9%		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Waunakee Industrial Park - Huiskamp 69-kV line	95.3%		94.0%		North Madison 138/69-kV transformer #31	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE out of ten years
3	Waunakee Switching Station - Waunakee 2 69-kV line	101.3%		101.5%		West Middleton - Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Fitchburg-Syene - Ninesprings 69-kV line	126.2 - 107.9%		129.2 - 107.7%		Royster - AGA Tap 69-kV line AGA Tap - Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap - Pflaum 69-kV line	126.5 - 102.8%		126.5 - 103%		Fitchburg - Syene 69-kV line Ninesprings - Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	West Middleton - West Town 69-kV line	--		95%		West Middleton - Pleasant View 138-kV line	Potential 1.98 miles West Middleton-West Town 69-kV line (6997) uprate and terminal uprate to achieve 106 MVA SE out of ten years
3	Royster - Sycamore 69-kV line	96.5%		96.8%		Femrite 138/69-kV transformer #31	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA
3	Verona, Oak Ridge, Fitchburg and Cross Country 138-kV buses		95 - 95.7%		94.6 - 95.9%	System intact	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138kV cap banks at Oak Ridge
3	Harmony, Lamar, Fulton, Saunders Creek , Dana, Sheepskin, Bass Creek, Footville, Center, Union Townline, Orfordville and Evansville 69-kV buses		88.9 - 90.6%		76.2 - 91.3%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV cap banks; 2017 Construct double-circuit line between McCue and Lamar substations
3	Verona 138-kV bus		86.3%		85.5%	Verona-Oak Ridge 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank / Adjust Verona 138/69-kV transformer setting
3	Verona 138-kV bus		--		91.9%	Rockdale-West Middleton 345-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138kV capacitor banks at Oak Ridge
3	Southwest Verona 69-kV bus		90.4%		90%	Verona-Southwest Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		--		87 - 91.8%	Brodhead Switching Station-Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Muscoda, Lone Rock, Avoca, and Blue River 69-kV buses		90.3 - 91.8%		90 - 91.8%	Lone Rock-Spring Green 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank

TABLE ZS-3

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2019 Summer Peak with Nelson Dewey and without Nelson Dewey

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case without Nelson Dewey		2019 Summer Peak Case with Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Burke, Reiner and Colorado 69-kV buses		91.9%		91.5 - 91.6%	Reiner 138/69-kV transformer #31 Reiner-Burke Tap 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	AGA, Pflaum 69-kV buses		90.5 - 90.7%		90.6 - 90.8%	Royster-AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Lancaster, Wyoming Valley and Eden 138-kV buses		90.9 - 91.9%		89.8 - 90.8%	Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Pleasant View, Hawk, Fitchburg and Cross Country 138-kV buses		91.5 - 91.9%		91.2 - 91.6%	West Middleton-Pleasant View 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2018 2-49 Mvar 138kV cap banks at Oak Ridge
4	Bluestone 69-kV bus		--		91.4%	Finger Road – Bluestone 69-kV line	???
4	Sister Bay 69-kV bus		--		95.9%	System Intact	Canal – Dunn Road 138-kV line project
5	Bain 345/138-kV transformer #5	159.1%		159.1%		Pleasant Prairie 345-kV 3-4 bus tie	Reduce Pleasant Prairie generation
5	Albers – Kenosha 138-kV line	97.8%		95.9%		Bain – Kenosha 138-kV line	Increase Paris generation
5	Arcadian4- Waukesha1 138-kV line	113.6%		115.2%		Arcadian 6 – Waukesha3 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Arcadian 345/138-kV transformer #3 Arcadian 345/138-kV transformer #2	108.7% 97.6%		109.7% 98.8%		Arcadian 345/138-kV transformer #1	Replace Arcadian transformers or investigate other alternatives
5	Branch – Kansas 138-kV line	100.5%		100.5%		Oak Creek – Pennsylvania 138-kV line	Load shift – investigate future projects to resolve loading on the Branch – Kansas 138kV line.
5	Arcadian 6 – Waukesha3 138-kV line	112.6%		114.3%		Arcadian 4- Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Bark River 138-kV bus		95.8% 91.8%		95.7% 91.7%	System Intact Bark River–Sussex 138-kV line	Increase Germantown generation
5	Hartford 138-kV bus		--		91.9%	Concord 138-kV 3-4 bus tie	Install Concord capacitors
5	Tichigan 138-kV bus		91.4%		91.3%	Split Burlington 138-kV bus	Load shift – Investigate future projects for voltage support at Tichigan
5	Cottonwood 138-kV bus		--		95.3% 91.9%	System Intact Bark River–Sussex 138-kV line	Install Summit & Concord capacitors
5	Germantown 138-kV bus		95.5% 88.7%		95.4% 88.6%	System Intact Maple – Saukville 138-kV line	Increase Germantown generation
5	Maple 138-kV bus		95.7% 88.2%		95.6% 88.1%	System Intact Maple – Saukville 138-kV line	Increase Germantown generation

Table ZS-3a
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV buses		86.8 - 91.9%		88.3% - 91.9%		--	Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line ACEC Spring Lake - Redgranite 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	
1	Dartford, Northwest Ripon, Industrial Park, Ripon, Southwest Ripon 69-kV buses		86.6 - 91.6%		88.2% - 91.6%		--	Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Winneconne, Omro Industrial Park 69-kV buses		86.3 - 91.9%		89.4% - 90.0%		--	Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Winneconne - Omro Tap 69-kV line	
1	Lincoln Pumping Station, Grand Marsh (PP&L), ACEC Brooks 69-kV buses		91.1 - 91.9%		--		--	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	No project needed at this time
1	Sigel 138-kV bus		91.8%		--		--	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV buses		94.6 - 95.0% -- 88.4 - 91.6%		95.4% 90.6 - 91.9%		96.9% --	System Intact Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line	Monroe County – Council Creek 161-kV line
1	Baker, Saratoga 115-kV buses		91.6%		91.0%		--	Baker - Coyne 115-kV line	No project needed at this time
1	Petenwell, Big Pond, Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV buses		84.0 - 91.1%		88.5 - 91.8%		89.4% - 91.9%	Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah Tap – Whistling Wings Tap 69-kV line	McKenna capacitor expansion
1	Fairwater 69-kV bus		91.9%		--		--	Metomen 138/69-kV transformer #31	No project needed at this time
1	Antigo, Aurora Street 115-kV buses		90.0 - 90.1%		89.0 - 91.9%		--	Antigo - Black Brook 115-kV line	No project needed at this time
1	Petenwell 138/69-kV transformer #31	98.1% 95.7%		112.9% --		97.0% --		System Intact McKenna - Houghton Rock 69-kV line	No project needed at this time
1	McKenna - ACEC Quincy 69-kV line Castle Rock - ACEC Quincy 69-kV line	97.8 - 113.8%		99.2 - 100.0%		97.6%		Necedah Tap - Big Pond 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer #31 Necedah - Whistling Wings Tap 69-kV line Kilbourn - Winnebago ACEC 69-kV line	Uprate Castle Rock - McKenna 69-KV line
1	Arnott 138/69-kV transformer #31	--		102.0%		--		Harrison 138/69-kV transformer #31	
1	Caroline 115/69-kV transformer #61	109.0%		95.9%		--		Whitcomb 115/69-kV transformer #31	
1	Council Creek - Tomah Industrial Park Tap 69-kV line	103.5%		99.3%		91.0%		System Intact	
1	Harrison 138/69-kV transformer	--		113.3%		90.0%		System Intact	
1	Hartman Creek - Harrison 138-kV line	--		101.7 - 96.6%		--		Port Edwards - Sand Lake 138-kV line Wautoma 138/69-kV transformer #31 Sigel - Arpin 138-KV line	

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2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
1	Metomen - Ripon 69-kV line	98.4%		--		--		System Intact	
		98.1 - 105.8%						Sunset Point - Winneconne 69-kV line	
		--						North Randolph - Markesan Tap 69-kV line	
		--						Winniconne - Omro Tap 69-kV line	
1	Metomen 138/69-kV transformer #31	113.6%		100.4%		--		System Intact	Metomen Transformer Replacement
		--		--				Ripon - Southwest Ripon Tap 69-kV line	
		108.7 - 130.9%		99.1%				Southwest Ripon - Mackford Prairie 69-kV line	
		--		--				North Randolph - Markesan Tap 69-kV line	
		--		--				North Fond du Lac - Rosendale 69-kV line	
1	Rocky Run - Plover 115-kV line		96.9%		--		--	Rocky Run - Whiting Avenue 115-kV line	
	Rocky Run - Whiting Avenue 115-kV line		97.4%					Rocky Run - Plover 115-kV line	
1	Northwest Ripon - Ripon 69-kV line	101.3 - 113.4%		--		--		Sunset Point - Winneconne 69-kV line	
								Winniconne - Omro Tap 69-kV line	
1	Omro - Winneconne 69-kV line	97.0 - 103.3%		--		--		Ripon - Northwest Ripon Tap 69-kV line	
	Winneconne - Sunset Point 69-kV line							Metomen - Ripon 69-kV line	
1	Rocky Run 345/115-kV transformer # 4	95.9 - 97.1%		112.6 - 96.0%		--		Rocky Run 345/115-kV Transformer #2 Rocky Run 345/115-kV Transformer #1 Sigel - Arpin 138-KV line Arpin 345/138-kV transformer Werner West - Rocky Run 345 KV line	
1	Sand Lake - Sand Lake Tap 69-kV line	--		96.3%		--		Wautoma 138/69-kV transformer #31	
1	Sigel - Arpin 138-kV line	--		97.1%		95.5%		Baker - Coyne 115-kV line	
1	Whitcomb 115/69-kV transformer	101.1%		105.5%		95.3%		System Intact	
1	Wautoma 138/69-kV transformer	112.0%		112.8%		--		System Intact	
								Portage - Lakehead Pipeline Portage 69-kV line	
		95.6 - 99.8%		104.7% - 95.5%				Sand Lake Tap - Sand Lake 69-kV line	
								Sand Lake 138/69-kV transformer #31	
								Endeavor - Lakehead Pipeline 69-kV line	
								Ripon - Northwest Ripon Tap 69-kV line	
2	Delta – Mead 69-kV line	101 - 158.1%		--		--		System Intact	Uprate Delta-Mead-North Bluff 69-kV line, or increase generation at Mead/Gladstone
								Chandler - Lakehead Tap 69-kV line	
								Lakehead Tap - Masonville 69-kV line	
								Masonville - Gladstone 69-kV line	
								Gladstone - North Bluff 69-kV line	
								North Bluff - Bay Tap 69-kV line	
								Bay Tap - Mead 69-kV line	
2	Chandler – Delta 69-kV #1 line	109.5%		--		--		Chandler - Delta 69-kV #2 line	Uprate Chandler-Delta 69-kV line #1,
									or increase generation at Escanaba/Mead/Gladstone
2	Chandler – Delta 69-kV #2 line	103.4%		--		--		Chandler - Delta 69-kV #1 line	Uprate Chandler-Delta 69-kV line #2,
									or increase generation at Escanaba/Mead/Gladstone
2	Atlantic - M38 69-kV line	121.3 - 122.4%		--		--		Atlantic - M-38 138-kV line	Uprate Atlantic - M38 69-kV line
								Atlantic 138/69-kV transformer #1	or increase generation at Portage
								Both	

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2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
2	Chandler-Lakehead Tap 69-kV line Lakehead Tap-Masonville 69-kV line Masonville-Gladstone 69-kV line Gladstone-North Bluff 69-kV line North Bluff-Bay Tap 69-kV line Bay Tap-Mead 69-kV line	121.6 - 162.2%		--		--		Delta - Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, Delta-Mead-North Bluff 69-kV lines; or increase generation at Mead/Gladstone
2	Pine River-Straits 69-kV line Straits-Evergreen 69-kV line Pine River-Evergreen 69-kV line	98 - 109.2%		--		--		Brevort - Straits 138-kV line Brevort - Lakehead 138-kV line Hiawatha - Lakehead 138-kV line	Rebuild Pine River-Straits 69-kV lines
2	Rudyard - Tone 69-kV line	97.3%		--		--		Hiawatha - Engadine 69-kV line	Uprate Rudyard - Tone 69-kV line, Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Nordic - Mountain 69-kV line	111.4%		--		--		Chandler 138/69-kV transformer #1	Uprate Nordic – Mountain 69-kV line, Increase generation
2	New Quinnesec - Kingsford Tap 69-kV line	100.0% 100.3%		--		--		Twin Falls North - Twin Falls South 69-kV line Twin Falls South - Bass Lake 69-kV line	Uprate New Quinnesec - KFM Tap 69-kV line
2	Lakota 69-kV bus		117.1%		--		--	Conover - Lakota 69-kV line	Change controlled bus for Lakota 138/69-kV tcul transformer to Lakota 69-kV bus instead of Conover 69-kV bus
2	Chandler, Delta, Escanaba 1, Escanaba 2, Masonville, Mead, Gladstone, West, Lakehead, Bay View, North Bluff, Cornell,		88.4-91.4%		--		--	Chandler 138/69-kV transformer #1	Increase generation at Escanaba/Mead/Gladstone
2	Hulbert, Eckerman, Newberry Village, Louisiana Pacific, Newberry, Newberry Hospital, Roberts, Raco 69-kV buses		87.2 - 90.3%		--		--	Engadine - Newberry 69-kV line	Increase generation at Newberry, Dafter, DeTour, US Hydro, Edison Sault
2	Newberry Village, Louisiana Pacific, Newberry Hospital, Roberts, Hulbert, Eckerman 69-kV buses		78.9 - 91.9%		--		--	Newberry - Newberry Hospital Tap 69-kV line Hiawatha - Engadine 69-kV line Newberry Hospital Tap-Roberts 69-kV lines	Increase generation at Dafter, DeTour, US Hydro, Edison Sault
2	Atlantic 138-kV bus Keweenaw Tap, Keweenaw 69-kV buses		86.1 - 91.8%		--		--	Atlantic - M-38 138-kV line ATC_B2_ATLAN	Adjust taps at Atlantic 138/69-kV transformer increase generation at Portage
2	Munising 138-kV bus		91.8%		--		--	Forsyth - Munising 138-kV line	Adjust taps at Munising 138/69-kV transformer
2	Aspen, Iron Grove 138-kV buses		91.1 - 91.5%		--		--	Aspen - Plains 138-kV line	Adjust taps at Iron Grove, Aspen 138/69-kV
2	Iron Grove 138-kV bus		91.0%		--		--	Aspen - Iron Grove 138-kV line	Adjust taps at Iron Grove 138/69-kV transformers
2	Lakehead 69-kV bus		91.9%		--		--	Iron Grove 138/69-kV transformer #G1	Add second Iron Grove 138/69-kV transformer
3	Artesian - Rock Springs 138-kV line Rock Springs - Kirkwood 138-kV line	100.3 - 104.4%		--		--		Trienda - Lewiston ACEC 138-kV line Lewiston - Kilbourn ACEC 138-kV line	
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138-kV line	96.1%		--		--		Portage - Trienda1 138-kV line	No project needed at this time
3	Artesian - Rock Springs 138-kV line Rock Springs - Kirkwood 138-kV line	100.3 - 104.4%		--		--		Trienda - Lewiston ACEC 138-kV line Lewiston - Kilbourn ACEC 138-KV line	

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2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138-kV line	96.1%		--		--		Portage - Trienda 138-kV line	No project needed at this time
3	Academy – Columbus Muni #3 tap 69-kV line	112.2%		108.6%		–		North Randolph – Fox Lake 138-kV line	
		107.1%		102.9%				North Randolph–Fox Lake–North Beaver Dam 138-kV line	
		106.7%		102.5%				Fox Lake – North Beaver Dam 138-kV line	
3	Columbus Muni #3 Tap – Columbus 69-kV line	110.4%		106.8%		–		North Randolph – Fox Lake 138-kV line	
		105.4%		101.1%				North Randolph – Fox Lake – North Beaver Dam 138-kV line	
		104.9%		100.7%				Fox Lake – North Beaver Dam 138-kV line	
3	South Beaver Dam – Center Street 69-kV line	98.3%		–		–		North Randolph – Fox Lake 138-kV line	
3	South Fond du Lac – Koch Oil Tap 69-kV line	102.2%		104.1%		–		North Randolph – Fox Lake 138-kV line	
		97.5%		99.0%				Fox Lake – North Beaver Dam 138-kV line	
		97.3%		98.8%				North Randolph – Fox Lake – North Beaver Dam 138-kV line	
3	Koch Oil Tap – Waupun 69-kV line	103.1%		105.0%		–		North Randolph – Fox Lake 138-kV line	
		98.1%		99.7%				Fox Lake – North Beaver Dam 138-kV line	
		97.9%		99.5%				North Randolph – Fox Lake – North Beaver Dam 138-kV line	
3	Hubbard and Hustisford 138-kV buses		96.0 – 96.2%		96.8%		95.7 - 96.1%	System Intact	
			85.0 – 85.1%		84.9 - 85.0%		86.7 - 86.8%	Rubicon – Hustisiford 138-kV line	
			85.7%		85.6%		87.2%	Hustisiford – Hubbard 138-kV line	
			85.7%		85.6%		87.4%	North Randolph–Fox Lake–North Beaver Dam 138-kV line	
			90.6 – 90.9%		91.0 - 91.3%		–	Concord 138-kV 4-5 bus tie	
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses		90.2 – 90.4%		90.5 - 90.6%		–	North Randolph – Fox Lake 138-kV line	
3	Koch Oil 69-kV bus		92.0%		–		–	South Fond du Lac – Koch Oil Tap 69-kV line	
3	Horicon Industrial Park 69-kV bus		91.9%		–		–	Hubbard – Horicon Ind. Park 69-kV line	
3	Artesian - Rock Springs 138-kV line	100.3 - 104.4%		--		--		Trienda - Lewiston ACEC 138-kV line	
	Rock Springs - Kirkwood 138-kV line							Lewiston - Kilbourn ACEC 138-KV line	
3	Dane - Lodi Tap 69-kV line	100.6%		--		--		Island Street - Kirkwood 69-kV line	Rebuild Dane-Dam Heights 69-KV line
3	Portage - Trienda 138 kV line	96.1%		--		--		Portage - Trienda1 138 kV line	No project needed at this time
3	Lake Geneva – South Lake Geneva 69-kV line	126.3%		122.5%		101.4%		Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
		104.7%		101.8%		--		Cobblestone – Zenda Tap 69-kV line	
3	Katzenberg-South Lake Geneva 69-kV line	96.7%		--		--		Cobblestone – Brick Church 69-kV line	Spring Valley – Twin Lakes line
3	Colley Road 138/69-kV transformer #31	103.6%		98.0%		--		Paddock 138/69-kV transformer #31	Install Bass Creek transformer
3	Enzyme – RC3 69-kV line	95.4%		--		--		Brick Church 138/69-kV transformer #31	Line Y-32 rebuild
3	Cobblestone – Brick Church 69-kV line	102.2%		96.3%		--		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Cobblestone – Zenda Tap 69-kV line	123.3%		116.0%		--		North Lake Geneva – Lake Geneva 69-kV line	Spring Valley – Twin Lakes line
3	Katzenberg – Zenda Tap 69-kV line	109.5%		102.7%		--		North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Cobblestone 69-kV bus		89..9%		90.4%		--	Cobblestone – Brick Church 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Zenda 69-kV bus		91.4%		--		--	North Lake Geneva - Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
			90.9%		91.5%			Cobblestone – Brick Church 69-kV line	

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2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Brick Church 138-kV bus		91.2% 90.4%		-- 91.1%		--	Beloit Gateway – Dickinson 138-kV line Colley Road – Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes
3	Williams Bay 138-kV bus		91.9%		--		--	Colley Road – Dickinson 138-kV line	Brick Church capacitors or Spring Valley – Twin Lakes line
3	Lake Geneva 69-kV bus		83.5%		86.8%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Katzenberg 69-kV bus		85.1%		88.2%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Twin Lakes 69-kV bus		84.4%		87.5%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	South Lake Geneva 69-kV bus		84.2%		87.4%		--	North Lake Geneva – Lake Geneva 69-kV line	North Lake Geneva – South Lake Geneva 138-kV line
3	Dickinson 138-kV bus		89.4%		89.9%		--	Colley Road – Dickinson 138-kV line	Brick Church caps or Spring Valley – Twin Lakes line
3	Concord 138-kV bus		90.2%		90.0%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Crawfish River 138-kV bus		--		--		91.0%	Jefferson - Crawfish River 138-kV line	
3	Butler Ridge 138-kV bus		--		91.8%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	Rubicon 138-kV bus		91.9%		91.6%		--	Concord 138-kV 4-5 bus tie	Install Concord capacitors
3	McCue - Harmony - Lamar 69-kV line	102.5 - 95%		116.4 - 97.2%		96.9%		Kegonsa - Stoughton North 69-kV line Kegonsa 138/69-kV transformer #31 Stoughton North - Stoughton East 69-kV line	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer #31	101.3%-98.5%		96.7%		--		DPC Galena - Pilot 69-kV line Pilot - Terr Tap 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	North Monroe - Idle Hour 69-kV line	103.1 - 95.8%		114.7 - 98.1%		101%-96.2%		Darlington- Gratiot 69-kV line Darlington 138/69-kV transformer #31 Browntown-Jennings Rd 69-kV line Gratiot-Wiota 69-kV line Wiota-Jennings Rd 69-kV line Brodhead-Newark 69-kV line Paddock-Newark 69-kV line Paddock 138/69-kV transformer #31 Whistling Wind-Black Smith 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Dana – Sheepskin 69-kV line	115.2 - 110.8%		126.4 - 121%		97.4%		McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA and 2017 Construct double-circuit line between McCue and Lamar substations
3	Gran Grae-Wauzeka-Boscobel 69-kV line	100%-96.2%		--		--		Spring Green 138/69-kV transformer #31 Lone Rock-Spring Green 69-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton - Timberlane 69-kV line	106.5%		--		--		Spring Green 138/69-kV transformer #31	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating

Table ZS-3a
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	Waunakee Industrial Park - Huiskamp 69-kV line	95.3%		--		--		North Madison 138/69-kV transformer #31	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE out of ten years
3	Waunakee Switching Station - Waunakee 2 69-kV line	101.3%		99.6%		--		West Middleton-Pheasant Branch 69-kV line	Potential Waunakee Switching Station-Waunakee 2 69-kV 0.58 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE
3	Fitchburg - Syene - Ninesprings 69-kV line	126.2 - 107.9%		106.5%		106.0%		Royster-AGA Tap 69-kV line AGA Tap-Pflaum 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV cap banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - AGA Tap - Pflaum 69-kV line	126.5 - 102.8%		104.8%		104.6 - 101.8%		Fitchburg-Syene 69-kV line Ninesprings-Syene 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Royster - Sycamore 69-kV line	96.5%		--		--		Femrite 138/69-kV transformer #31	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA
3	Verona, Oak Ridge, Fitchburg and Cross Country 138-kV buses		95.0 - 95.7%		95.2%		--	System intact	Verona 1-16.33 Mvar 69-kV capacitor bank and potential 2-49 Mvar 138-kV capacitor banks at Oak Ridge
3	Harmony, Lamar, Fulton 69-kV buses		88.9 - 90.6%		78.6 - 91.8%		86.4 - 91.8%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV cap banks; Construct double-circuit line between McCue and Lamar substations
3	Verona 138-kV bus		86.3%		86.2%		88.5%	Verona-Oak Ridge 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank / Adjust Verona 138/69-kV transformer setting
3	Southwest Verona 69-kV bus		90.4%		90.6%		--	Verona-Southwest Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Muscoda, Lone Rock, Avoca, and Blue River 69-kV buses		90.3 - 91.8%		--		--	Lone Rock - Spring Green 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Reiner, Burke 69-kV buses		91.9%		91.8 - 91.9%		--	Reiner 138/69-kV transformer #31 Reiner - Burke Tap 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie

Table ZS-3a
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
3	AGA and Pflaum 69-kV buses		90.5 - 90.7%		--		--	Royster - AGA Tap 69-kV line	Uprate Fitchburg-Nine Springs line, uprate Pflaum - Royster line, install 2-16.33 MVAR 69 kV capacitor banks at Nine Springs and move the AGA load onto Femrite - Royster line
3	Lancaster and Eden 138-kV buses		90.9 - 91.9%		90.2 - 90.8%		--	Nelson Dewey - Lancaster 138-kV line Lancaster - Eden 138-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Pleasant View and Hawk 138-kV buses		91.5 - 91.9%		91.8%		--	West Middleton - Pleasant View 138-kV line	Verona 1-16.33 Mvar 69-kV cap bank and potential 2-49 Mvar 138-kV capacitor banks at Oak Ridge
3	Lone Rock - Pine River - Brewer - Richland Center 69-kV line and Lone Rock phase shifter	--		121.0 -193.0%		177.9 - 113.7%		System intact	Adjust Lone Rock phase shifter to 0 deg
3	Gran Grae - Hillside 69-kV line	--		103.4%		95.3%		Seneca - Bell Center 161-kV line	Adjust Lone Rock phase shifter to 0 deg
3	Sun Valley - Oregon 69-kV line	--		97.0%		--		Kegonsa - Stoughton North 69-kV line	Potential Oregon substation uprate
3	Stoughton - Sheepskin 69-kV line	--		113.6 - 109.5%		--		McCue - Harmony 69-kV line Harmony - Lamar 69-kV line	2017 Construct double-circuit line between McCue and Lamar substations
3	West Middleton - West Towne 69-kV line	--		101.1%		--		West Middleton - Pleasant View 138-kV line	Potential ~2 mile line uprate from 83 MVA to 106 MVA
3	Lone Rock - Pine River - Brewer - Richland Center 69-kV line and Lone Rock phase shifter	--		224.6 -103.4%		203.5 - 95.2%		Gran Grae - Wauzeka 69-kV line Wauzeka - Boscobel 69-kV line Boscobel - Blue River 69-kV line Blue River - Muscoda 69-kV line Muscoda - Avoca 69-kV line	Adjust Lone Rock phase shifter to -10 deg
3	Lone Rock, Pine River, Brewer, Richland Center 69-kV buses		--		84.1 - 87%		87.2 - 89.5%	System intact	Adjust Lone Rock phase shifter to 0 deg
3	Eden 138-kV bus		--		95.8%		--	System intact	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Miner, Shullsburg and Benton 69-kV buses		--		89.4 - 91.6%		--	DPC Galena - Pilot 69-kV line Pilot -Terr Tap 69-kV line	DPC outage. Potential capacitor bank on Y130
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		--		87.4 - 91.9%		--	Brodhead Switching Station - Brodhead Muni 3 69-kV line Brodhead Muni 3 - Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Wauzeka, Boscobel, Blue River, Muscoda, Avoca 69-kV buses		--		88.2 - 91.8%		91.3 - 91.7%	Gran Grae - Wauzeka 69-kV line Wauzeka - Boscobel 69-kV line Spring Green 138/69-kV transformer #31	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Spring Green, Wyoming Valley and Eden 138-kV buses		--		91.5 - 91.7%		--	Lake Delton - Trienda 138-kV	Install 2-16.33 Mvar 69-kV capacitor banks at Eden Substation
3	Gays Mills 69-kV bus		--		90.9%		--	Seneca - Bell Center 161-kV line	Adjust Lone Rock phase shifter to 0 deg
3	Lone Rock Phase shifter	--		--		120.4 - 119.3%		Nelson Dewey - Lancaster 138-kV line Lancaster - Eden 138-kV line	Adjust Lone Rock phase shifter to 0 deg
5	Arcadian 345/138-kV transformer #3	108.7%		111.4%		98.2%		Arcadian 345/138-kV transformer #1	Replace Arcadian

Table ZS-3a
2009 10-Year Assessment - 2019 Futures Constraints

Planning Zone	Criteria Exceeded/Need	2019 Summer Peak Case		2019 DOE 20% Wind Future		2019 Slow Growth Future		Facility Outage(s)	Project/Mitigation
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage		
	Arcadian 345/138-kV transformer #2	97.6%		100.7%		95.2%			transformers or investigate
5	Branch – Kansas 138-kV line	100.5%		--		--		Oak Creek – Pennsylvania 138-kV line	Load shift – investigate future projects to resolve loading on the Branch - Kansas 138kV line.
5	Arcadian 6 – Waukesha3 138-kV line	112.6%		111.9%		103.1%		Arcadian4- Waukesha1 138-kV line	Upgrade Arcadian – Waukesha 138-kV lines or investigate other alternatives
5	Oak Creek - Elm Road 345/138-kV transformer #844	--		99.5%		98.4%		Bain - Kenosha 138-kV line	
5	Granville 345/138-kV transformer #3	--		97.5%		--		Granville 345-kV 1-2 bus tie	
5	Maple - Saukville 138-kV line	--		100.7%		--		Bark River – Sussex 138-kV line	
5	Kenosha - Lakeview 138-kV line	--		--		95.2%		Pleasant Prairie - Zion 345-kV line	
5	Bark River 138-kV bus		95.8%		95.6%		--	System Intact	Increase Germantown generation
			91.8%		90.3%			Bark River – Sussex 138-kV line	
			--		89.2%			Maple – Saukville 138-kV line	
5	Hartford 138-kV bus		--		--		91.6%	Hartford - St. Lawrence 138-kV line	
5	Tichigan 138-kV bus		91.4%		--		--	Burlington 138-kV 1-2 bus tie	Load shift – Investigate future projects for voltage support at Tichigan
5	Germantown 138-kV bus		95.5%		93.3%		95.5%	System Intact	Increase Germantown generation
			88.7%		--		88.7%	Maple – Saukville 138-kV line	
			--		89.8%		--	Bark River -Germantown 138-kV line	
			--		89.6%		--	Bark River -Sussex 138-kV line	
			--		88.8%		--	Germantown - Maple 138-kV line	
			--		80.0%		--	Maple – Saukville 138-kV line	
5	Maple 138-kV bus		95.7%		93.7%		95.7%	System Intact	Increase Germantown generation
			--		90.5%		--	Bark River - Sussex 138-kV line	
			--		90.8%		--	Bark River - Germantown 138-kV line	
			88.2%		79.3%		88.3%	Maple – Saukville 138-kV line	
5	Cottonwood 138-kV bus		95.3%		95.3%		--	System Intact	
					91.1%			Bark River - Sussex 138-kV line	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Berlin, River Run, Fountain Valley, Redgranite, ACEC Spring Lake, Silver Lake, Fox River 69-kV bus		93.9% - 95.4% 80.1% - 91.9%	Intact System Wautoma - Silver Lake Tap 69-kV line Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line	
1	Dartford, Northwest Ripon, Ripon Industrial Park, Ripon, Southwest Ripon 69-kV bus		92.6% - 95.9% 77.5% - 91.8%	Intact System Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Sunset Point - Winneconne 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Winneconne, Omro, Omro Industrial Park 69-kV bus		94.3% - 94.7% 75.4% - 91.9%	Intact System Sunset Point - Winneconne 69-kV line Winneconne - Omro Tap 69-kV line Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line	
1	Grand Marsh (PP&L), ACEC Brooks, Lincoln Pumping Station, ACEC Quincy 69-kV bus		87.5% - 91.7%	Necedah Tap - Big Pond 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Chaffee Creek - Coloma Tap 69-kV line Lincoln Pumping Station - Coloma Tap 69-kV line	
1	Sigel, Lakehead Pipeline, Vulcan, Port Edwards, Hollywood, Saratoga 138-kV bus		90.6% - 91.9%	Sigel - Arpin 138-kV line	No project needed at this time
1	Petenwell, Council Creek 138-kV bus		93.9% - 94.2% 91.1% - 91.9%	Intact System Saratoga - Petenwell 138-kV line Sigel - Arpin 138-kV line Council Creek - Council Creek DPC 69-kV line Baker - Coyne 115-kV line	Monroe County – Council Creek 161-kv line
1	Baker, Saratoga 115-kV bus		95.8% - 95.9% 90.1% - 91.2%	Intact System Baker - Coyne 115-kV line	No project needed at this time

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Necedah, Whistling Wings, ACEC Dellwood, Friendship, ACEC Friendship, Houghton Rock, McKenna 69-kV bus		78.8% - 91.9%	Necedah Tap - Big Pond 69-kV line Big Pond – Petenwell 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Whistling Wings Tap - Dellwood ACEC 69-kV line	McKenna Capacitor Expansion
1	Lakehead Pipeline, Endeavor, Roslin ACEC, Montello ACEC 69-kV bus		88.2% - 90.9%	Portage - Lakehead Pipeline 69-kV line Lakehead Pipeline - Endeavor 69-kV line Endeavor - Roslin ACEC - 69-kV line	
1	Sand Lake, Wautoma 138-kV bus		94.7% - 94.9% 91.4% - 91.7%	Intact System Sigel - Arpin 138-kV line Port Edwards - Sand Lake 138-kV line	
1	Green Lake , Roeder 138-kV bus		95.6% - 95.9%	Intact System	No project needed at this time
1	ACEC Winnebago, ACEC Glen, Neenah Creek, ACEC Chateau 69-kV bus		90.1% - 91.7%	Kilbourn - Winnebago ACEC 69-kV line	
1	Plainfield, Sand Lake, ACEC Hancock, Hancock, Coloma, Chaffee Creek, ACEC Coloma 69-kV bus		88.9% - 91.9%	Sand Lake 138/69-kV transformer Sand Lake Tap - Sand Lake 69-kV line Necedah Tap - Big Pond 69-kV line	
1	Castle Rock 69-kV bus		90.9%	Necedah Tap - Big Pond 69-kV line	No project needed at this time
1	Fairwater, Brandon, Metomen 69-kV bus		88.4% - 91.4%	Metomen 138/69-kV transformer Sunset Point - Winneconne 69-kV line	
1	Antigo, Aurora Street 115-kV bus		90.6% - 90.7%	Antigo - Black Brook 115-kV line	No project needed at this time

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Harrison, Manawa 69-kV bus		91.8% - 91.9%	Harrison 138/69-kV transformer	No project needed at this time
1	Wittenburg 69-kV bus		91.3%	Whitcomb - Wittenberg CWEC 69-kV line	No project needed at this time
1	Arnott 69-kV bus		91.5%	Arnott 138/69-kV transformer	No project needed at this time
1	Metomen 138-kV bus		95.1% 91.6%	Intact System North Fond du Lac - Metomen 138-kV line	No project needed at this time
1	Turtle ACEC 69-kV bus		91.9%	Portage - Lakehead Pipeline Portage 69-kV line	No project needed at this time
1	Council Creek - Tunnel City Tap 69-kV line Petenwell 138/69-kV transformer	94.0% - 96.0%		Intact System	
1	North Randolph - Markesan - Mackford Prairie - Ripon 69-kV line	97.3% - 113.9%		Metomen - Ripon 69-kV line	
1	Arnott 138/69-kV transformer	107.1%		Harrison 138/69-kV transformer	
1	Berlin - Dartford 69-kV line	105.8% - 108.5%		Sunset Point - Winneconne 69-kV line Ripon - Northwest Ripon Tap 69-kV line	
1	Caroline 115/69-kV transformer	123.0%		Whitcomb 115/69-kV transformer	
1	Chaffee Creek - Coloma Tap 69-kV line	101.2%		Necedah Tap - Big Pond 69-kV line	
1	Council Creek - Tomah Industrial Park Tap 69-kV line	108.0%		Intact System	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Harrison 138/69-kV transformer	116.0% 95.9% - 100.2%		Intact System Arnott 138/69-kV transformer Whitcomb - Rosholt Tap 69-kV line Iola - Iola CW Tap 69-kV line Wautoma 138/69-kV transformer	
1	McKenna - ACEC Quincy - Castle Rock 69-kV line	102.9% - 130.6%		Necedah Tap - Big Pond 69-kV line Necedah Tap - Whistling Wings Tap 69-kV line Dellwood ACEC - Whistling Wings Tap 69-kV line Petenwell - Big Pond 69-kV line Petenwell 138/69-kV transformer	Uprate Castle Rock - McKenna 69-kV line
1	Metomen - Ripon 69-kV line	112.1% 95.1% - 128.7%		Intact System Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69-kV line Winniconne - Omro Tap 69-kV line Mackford Praire - Markesan Tap 69-kV line	
1	Metomen 138/69-kV transformer	106.0% 101.6% - 125.4%		Intact System North Fond du Lac - Rosendale Tap 69-kV line Metomen - Rosendale Tap 69-kV line Sunset Point - Winneconne 69-kV line North Randolph - Markesan Tap 69-kV line	Metomen Transformer Replacement
1	Northwest Ripon - Ripon 69-kV line	96.1% - 138.5%		Sunset Point - Winneconne 69-kV line Winniconne - Omro Tap 69-kV line Omro - Omro Industrial Tap 69-kV line Wautoma - Silver Lake Tap 69-kV line Silver Lake - ACEC Spring Lake 69-kV line	
1	Northwest Ripon - Dartford 69-kV line	107.5%		Sunset Point - Winneconne 69-kV line	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
1	Omro - Omro Industrial 69-kV line	101.1%		Ripon - Northwest Ripon Tap 69-kV line	
1	Omro - Winneconne 69-kV line Winneconne - Sunset Point 69-kV line	105.7% 96.8% - 134.5%		Intact System Ripon - Northwest Ripon Tap 69-kV line Metomen - Ripon 69-kV line Northwest Ripon Tap - Dartford Tap 69-kV line Wautoma - Silver Lake Tap 69-kV line	
1	Plover - Coyne 115-kV line	96.1%		Rocky Run - Coyne 115-kV line	No project needed at this time
1	Rocky Run 345/115-kV transformer T4	96.2% - 104.5%		Rocky Run 345/115 kV Transformer T2 Rocky Run 345/115 kV Transformer T1 Sigel - Arpin 138-kV line Werner West - White Lake 138-kV line Arpin 345/138-kV transformer	
1	Rosendale - North Fond du Lac 69-kV line	101.4%		Metomen 138/69-kV transformer	
1	Sand Lake - Sand Lake Tap 69-kV line	96.2% - 99.2%		Wautoma 138/69-kV transformer Necedah Tap - Big Pond 69-kV line	No project needed at this time
1	Wautoma 138/69-kV transformer	120.0% 96.0% - 110.5%		Intact System Sand Lake Tap - Sand Lake 69-kV line Sand Lake 138/69-kV transformer Portage - Lakehead Pipeline Portage 69-kV line Ripon - Northwest Ripon Tap 69-kV line	
1	Whitcomb 115/69-kV transformer	112.2% 101.4%		Intact System Caroline 115/69-kV transformer	
3	North Monroe 138/69-kV transformer	100%		System intact	Bass Creek transformer project

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	McCue-Harmony-Lamar 69-kV line	102%-99%		System Intact	Construct double-circuit line between McCue and Lamar substations
3	Hillman 138/69-kV transformer	111.4%-100.4%		DPC Galena-Pilot 69-kV line; Pilot-Terr TP 69-kV line; Terr Tap-LNGHLLW8 69-kV line; LNGHLLW8-Galna T8 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	McCue-Harmony-Lamar 69-kV line	119.8%-96.1%		Several single contingency outages	McCue-Lamar line uprate and construct double-circuit line between McCue and Lamar substations
3	North Monroe-Idle Hour 69-kV line	118.5%-95.8%		Paddock-Newark 69-kV line; Brodhead Switching-Spring Grove 69-kV; Spring Grove-Whistling Wind 69-kV line; Whistling Wind-Black Smith 69-kV line; North Monroe-Monticello 69-kV; Monticello-New Glarus 69-kV; Darlington- Gratiot 69-kV line; Darlington 138/69-kV transformer; Browntown-Jennings Road 69-kV line; South Monroe-Browntown 69-kV line; Gratiot-Wiota 69-kV line; Wiota-Jennings Rd 69-kV line; Brodhead-Newark 69-kV line; Paddock 138/69-kV transformer	Bass Creek transformer project
3	Stoughton South-Stoughton 69-kV line	103.3%		Oak Ridge-Verona 138-kV line; Verona 138/69-kV transformer	Potential Y-127 line uprate
3	Sun Valley-Oregon 69-kV line	100.9%		Stoughton South-Stoughton 69-kV line	Potential Oregon terminal uprate
3	North Monroe 138/69-kV transformer	97.1%-96.6%		Darlington 138/69-kV transformer; Paddock-Newark 69-kV line	Bass Creek transformer project
3	Paddock-Newark 69-kV line	96.8%		North Monroe-Idle Hour 69-kV line	Bass Creek transformer project
3	Dana – Sheepskin 69-kV line	144.2%-139.1%		McCue-Harmony 69-kV line; Harmony-Lamar 69-kV line	Sheepskin substation project which will uprate Y-61 Sheepskin-Dana 69-kV line to 95 MVA
3	Spring Green 138/69-kV transformer	96.3%		Gran Grae-Wauzeka 69-kV line	2nd Spring Green transformer project

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Gran Grae-Wauzeka-Boscobel 69-kV line	107.3%-99.4%		Spring Green 138/69-kV transformer; Lone Rock-Spring Green 69-kV line; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Spring Green-Wyoming Valley 138-kV line	Uprate Y-40 Gran Grae-Boscobel 69-kV line to achieve a 99 MVA summer emergency rating
3	West Middleton-Timberlane-Stage Coach 69-kV line	121.4%-96.2%		Spring Green 138/69-kV transformer; Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Verona-Oak Ridge 138-kV line; Verona 138/69-kV transformer; Verona-SW Verona 69-kV line; Gran Grae-Wauzeka 69-kV line; Wauzeka-Boscobel 69-kV line; Trienda-Lake Delton 138-kV line	Short term: uprate the West Middleton-Timberlane section from 83 MVA to 106 MVA (need check the underground cable ratings) and uprate the Timberlane-Stage Coach section from 95 MVA to 115 MVA SE. Long term: potential 2nd 69-kV line between West Middleton-Stage Coach (built for future 138 kV) ; Potential new 138-kV line from West Middleton-Stage Coach and install a 138/69-kV transformer at Stage Coach
3	Stage Coach-Black Earth 69-kV line	104.4%		Spring Green 138/69-kV transformer;	2nd Spring Green transformer project
3	Waunakee Industrial Park-Huiskamp 69-kV line	108.7%-98.7%		North Madison 138/69-kV transformer ; West Middleton-Pheasant Branch 69-kV line	Potential Y132 line switch replacement project at Waunakee Industrial Park to achieve 170 MVA SE
3	West Middleton-Pheasant Branch 69-kV line	96.9%		Waunakee Switching Station-Waunakee 2 69-kV line	A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Waunakee Switching Station-Waunakee 2-West Port 69-kV line	113.9%-102.2%		West Middleton-Pheasant Branch 69-kV line	Short term: potential 2017 Waunakee Switching Station-Waunakee 2-West Port 69-kV 3.73 miles of line (Y-131) and terminal uprate to achieve 115 MVA SE Long term: A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch
3	West Middleton 138/69-kV transformer	97%		2nd West Middleton 138/69-kV transformer	Potential project to remove the CT, relay and RTU limitations for the transformer T3 to improve the SE rating from 191 MVA to 239 MVA
3	Fitchburg-Syene-Ninesprings 69-kV line	125.7%-102.3%		Royster-AGA tap 69-kV line; AGA tap-Pflaum 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Royster-AGA tap-Pflaum 69-kV line	122.7%-97.8%		Fitchburg-Syene 69-kV line; Ninesprings-Syene 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	West Middleton-West Town 69-kV line	97.7%		West Middleton-Pleasant View 138-kV line	Potential ~2 mile line uprate from 83 MVA to 106 MVA
3	Royster-Sycamore 69-kV line	99.5%		Femrite 138/69-kV transformer	Uprate the 6986 Royster to Sycamore 69-kV line to 115 MVA or potential 2nd Femrite transformer
3	Verona, Oak Ridge, Fitchburg, Pleasant View, McFarland, Sprecher, Kegonsa, Reiner, West Middleton, Femrite, Sycamore and Cross Country 138-kV buses, Gaston Rd 69-kV bus		92.5%-95.8%	System intact	Dane County voltage support project which potentially include capacitor banks at Verona, Oak Ridge, Femrite, Reiner Road
3	Eden, Wyoming, Spring Green, and Troy 138-kV buses		93.8%-94.4%	System intact	Eden capacitor banks; Mazomanie capacitor banks; Boscobel capacitor banks; or Potential 138-kV line from West Middleton-Spring Green substation
3	Miner, Benton and Shullsburg 69-kV buses		89.8%-91.9%	DPC Galena-Pilot 69-kV line; Pilot-Terr TP 69-kV line;	Need to discuss with DPC
3	Spring Green and Wyoming Valley 138-kV buses		91.7%	Gran Grae 138/69-kV transformer	Eden capacitor bank project
3	Harmony, Lamar, Fulton, Saunders Creek , Dana, Sheepskin, Bass Creek, Footville, Center, Union Townline, Orfordville and Evansville 69-kV buses		80.3%-91.8%	McCue-Harmony 69-kV line; Harmony-Lamar 69-kV line	Lamar 2-16.33 Mvar 69-kV capacitor banks;

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Verona 138-kV bus		83.2%	Verona-Oak Ridge 138-kV line;	Verona 1-16.33 Mvar 69-kV capacitor bank / Adjust Verona 138/69-kV transformer setting
3	Verona, Sun Valley and SW Verona 69-kV buses		91.1%-91.7%	Verona-Oak Ridge 138-kV line; Verona 138/69-kV transformer	Verona capacitor bank project
3	Oak Ridge 138-kV bus		91.6%	Kegonsa-Oak Ridge 138-kV line	Dane County capacitor bank support project
3	SW Verona, Mount Horeb 69-kV buses		87.1%-91.1%	Verona-SW Verona 69-kV line	Potential Mount Horeb capacitor bank upgrade or addition
3	Hillman, Elmo, McGregor, Platteville and Cuba City 69-kV buses		91 %-91.7%	Hillman 138/69-kV transformer	Potential 2nd Hillman transformer instead of the existing Hillman transformer replacement project
3	Hooterville 69-kV bus		91.8%	Eden 138/69-kV transformer	Eden capacitor bank project
3	Idle Hour, Monroe, South Monroe 69-kV buses		91.3%-91.8%	North Monroe-Idle Hour 69-kV line	Bass Creek transformer project
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead Muni 1, Brodhead, RCEC Orfordville, Bass Creek, Footville, Center, Union Townline and Evansville 69-kV buses		88.6%-91.4%	Brodhead Switching Station-Brodhead Muni 3 69-kV line; Brodhead Muni 3-Brodhead Muni 2 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation
3	Evansville and Union Townline 69-kV buses		91.1%-91.5%	Sheepskin-Evansville 69-kV line	Bass Creek transformer project
3	Wauzeka, Boscobel, Blue River, Muscoda 69-kV buses, Spring Green, Eden, Wyoming Valley and Troy 138-kV buses		88.8%-91.8%	Gran Grae-Wauzeka 69-kV line; Wauzeka-Boscobel 69-kV line	Boscobel capacitor bank project
3	Muscoda 69-kV bus		91.9%	Muscoda-Avoca 69-kV line	Boscobel capacitor bank project
3	Avoca, Muscoda 69-kV buses		90.4%-90.7%	Lone Rock-Avoca 69-kV line	Boscobel capacitor bank project
3	Muscoda, Lone Rock, Avoca, Boscobel, Blue River 69-kV buses		88.4%-91.8%	Lone Rock-Spring Green 69-kV line	Install 1-8.16 MVAR capacitor bank at Boscobel 69-kV Substation and upgrade existing 5.4 MVAR bank with an 8.16 MVAR bank
3	Muscoda, Lone Rock, Avoca, Boscobel, Blue River, Spring Green, Arena, Mazomanie, Black Earth 69-kV buses		87.3%-91.7%	Spring Green 138/69-kV transformer	2nd Spring Green transformer
3	Arena 69-kV bus		91.7%	Spring Green-Arena 69-kV line	Mazomanie capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.6%	West Middleton-Timberlane 69-kV line	Eden capacitor banks; Mazomanie capacitor banks; Boscobel capacitor banks; or Potential 138-kV line from West Middleton-Spring Green substation
3	Gaston Road and Cottage Grove 69-kV buses		90.6%-91.4%	Kegonsa-Cottage Grove 69-kV line	Sun Prairie capacitor banks
3	McFarland, Femrite and Sprecher 138-kV buses		91%-91.9%	Kegonsa-McFarland 138-kV line; McFarland-Femrite 138-kV line	Femrite capacitor banks

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Burke, Reiner, Sun Prairie, Bird St and Colorado 69-kV buses		89.1%-91.9%	Reiner 138/69-kV transformer; Reiner-Burke Tap 69-kV line; Colorado-Burke Tap 69-kV line	Sun Prairie capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.7%	Birchwood-Loch Mirror 138-kV line	Eden capacitor banks
3	Spring Green 138-kV bus		91.9%	Necedah Tap-Big Pond 69-kV line	Eden capacitor banks
3	Pheasant Branch 69-kV bus		90.8%	West Middleton-Pheasant Branch 69-kV line	Short term: potential capacitor banks at Pheasant Branch. Long term: A potential new 69-kV line between West port and Huiskamp or a potential voltage conversion from West Middleton-Huiskamp or a new 138-kV line from West Middleton-Huiskamp and step down transformer at West Port or Pheasant Branch
3	AGA tap, AGA, Pflaum, Ninesprings and Pflaum tap 69-kV buses		90%-91.9%	Royster-AGA tap 69-kV line; AGA tap-Pflaum 69-kV line	Loop Ninesprings-Pflaum line in and out of Femrite
3	Lancaster, Wyoming Valley, Spring Green, Troy and Eden 138-kV buses		86.4%-91.7%	Nelson Dewey-Lancaster 138-kV line; Lancaster-Eden 138-kV line; Eden-Wyoming Valley 138-kV line; Wyoming Valley-Spring Green 138-kV line	Eden capacitor banks
3	Potosi, Hillman, Lafayette Wind, Darlington, Eden, North Monroe 138-kV buses		87.5%-91.9%	Nelson Dewey-Potosi 138-kV line; Potosi-Hillman 138-kV line; Hillman-Lafayette Wind 138-kV line; Lafayette Wind-Darlington 138-kV line	North Monroe capacitor banks
3	Albany, North Monroe and Darlington 138-kV buses		87.9%-91.8%	Townline-Albany 138-kV line; North Monroe-Albany 138-kV line	North Monroe capacitor banks
3	Spring Green 138-kV bus		91.3%-91.7%	Spring Green-Troy 138-kV line; Spring Green-Wyoming Valley 138-kV line	Eden capacitor banks; Boscobel capacitor banks; Mazomanie capacitor banks
3	Troy, Spring Green, Eden and Wyoming Valley 138-kV buses		89.2%-91.5%	Troy-Kirkwood 138-kV line	Eden capacitor banks
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country , Spring Green, Troy and Wyoming Valley 138-kV buses, West Middleton 345-kV bus		90%-91.6%	Rockdale-West Middleton 345-kV line	Dane County voltage support project

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Lewiston, East Dells, Kilbourn, Loch Mirror, Birchwood, Zobel, Nishan, Artesian, Rock Springs, Kirkwood, City View , Kirkwood, Lake Delton, Spring Green, Wyoming Valley and Troy 138-kV bus voltages		86.0%-91.9%	Lake Delton-Kirkwood 138-kV line, Lake Delton-Trienda 138-kV line, Trienda-Lewiston 138-kV line, Lewiston-Kilbourn 138-kV line and Trienda-Kilbourn 138-kV line (ATC_B2_X-68 outage)	Potential Lake Delton-Birchwood 138-kV line or a new 138-kV line source into the Reedsburg loop
3	Spring Green and Wyoming Valley 138-kV buses		91.9%	Portage-Columbia 138-kV line	Eden capacitor banks
3	Spring Green and Wyoming Valley 138-kV buses		91.6%-91.7%	Columbia 345/138-kV transformer 2	Eden capacitor banks
3	Reiner 138-kV bus		91.8%	Reiner –Sycamore 138-kV line	Sun Prairie capacitor banks
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country 138-kV buses		88.8%-91.3%	West Middleton-Pleasant View 138-kV line	Dane County voltage support project
3	Verona, Oak Ridge, Fitchburg, Hawk, Pleasant View, West Middleton and Cross Country , Spring Green and Wyoming Valley 138-kV buses		90.2%-91.9%	West Middleton 345/138-kV transformer	Dane County voltage support project
3	Spring Green, Eden, Wyoming Valley and Troy 138-kV buses		89.5%-91.9%	Columbia Unit 1 outage; Columbia Unit 2 outage; King-Eau Claire-Arpin 345-kV line; King-Eau Claire-Arpin 345-kV Operating guide; Eau Claire-Arpin 345-kV line; Eau Claire-Arpin 345-kV Operating guide; Columbia 345/138-kV transformer 1 and 3 outage	Eden capacitor banks
3	Eden 138-kV bus		91.9%	Outage of DPC Genoa-Seneca 161-kV line plus Genoa-Lansing 136 kV line plus Genoa 161/69-kV transformer plus Genoa-Lac Tap 161-kV line	Eden capacitor banks
3	Colley Road 138/69-kV transformer	99.1% 97.5% 104.3% 117.9% 101.4% 99.4% 100.9%		Intact System Beloit Gateway-Dickinson 138-kV line Paddock-Shirland 69-kV line Paddock 138/69-kV transformer Shaw - Shirland 69-kV line Brick Church 138/69-kV transformer Colley Road - Dickinson 138-kV line	
3	Brick Church 138/69-kV transformer	111.8%		North Lake Geneva 138/69-kV transformer	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Enzyme Bio-RC3 69-kV line	98.5% 106.4% 105.3%		Beloit Gateway – Dickinson 138-kV line Brick Church 138/69-kV transformer Colley Road – Dickinson 138-kV line	Y-32 Line Rebuild
3	RC3-Clinton Tap 69-kV line	95.4% 103.0% 102.1%		Beloit Gateway – Dickinson 138-kV line Brick Church 138/69-kV transformer Colley Road – Dickinson 138-kV line	Y-32 Line Rebuild
3	North Lake Geneva – Lake Geneva 69-kV line	113.1% 95.7%		Cobblestone – Brick Church 69-kV line Cobblestone – Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Paddock 138/69-kV transformer	105.2% 103.7%		Intact System Colley Road 138/69-kV transformer	Bass Creek transformer project
3	Lake Geneva - South Lake Geneva 69-kV line	156.0% 129.2% 102.5% 108.2%		Cobblestone – Brick Church 69-kV line Cobblestone – Zenda Tap 69-kV line Brick Church 138/69-kV transformer Katzenberg-Zenda Tap 69-kV line	North Lake Geneva – South Lake Geneva 138kV line
3	Katzenberg-South Lake Geneva 69-kV line	117.4		Cobblestone – Brick Church 69-kV line	Uprate / Rebuild Brick Church – South Lake Geneva 69kV line
3	Shaw – East Rockton 69-kV line	108.7%		Paddock 138/69-kV transformer	
3	Colley Road – Park Street Tap 69-kV line	98.7%		Paddock 138/69-kV transformer	
3	Paddock - Shirland 69-kV line	102.1%		Colley Road 138/69-kV transformer	
3	North Lake Geneva 138/69-kV transformer	97.7%		Brick Church 138/69-kV transformer	
3	Brick Church - Walworth 69-kV line	113.8%		North Lake Geneva 138/69 transformer	
3	Cobblestone-Brick Church 69-kV line	106.5%		Lake Geneva - South Lake Geneva 69-kV line	Uprate / Rebuild Brick Church – South Lake Geneva 69kV line
3	Williams Bay 138-kV bus		89.0% 90.0% 91.6%	Colley Road - Dickinson 138-kV line Beloit Gateway – Dickinson 138-kV line Beloit Gateway – Brick Church 138-kV line	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Brick Church 138-kV bus		88.7% 90.5%	Beloit Gateway – Dickinson 138-kV line Beloit Gateway – Brick Church 138-kV line	
3	Fort Atkinson 138-kV bus		95.7% 91.9%	Intact System Split Concord 138-kV bus between buses G and 4	
3	Crawfish River 138-kV bus		91.9%	Split Concord 138-kV bus between buses G and 4	
3	Butler Ridge 138-kV bus		95.8% 89.3% 90.8%	Intact System Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Katzenberg 69-kV bus		84.3% 90.8%	Lake Geneva - South Lake Geneva 69-kV line Cobblestone – Brick Church 69-kV line North Lake Geneva 138/69-kV transformer	
3	Twin Lakes 69-kV bus		83.4% 91.5% 89.9%	Lake Geneva - South Lake Geneva 69-kV line Katzenberg-South Lake Geneva 69-kV line North Lake Geneva 138/69-kV transformer Cobblestone – Brick Church 69-kV line	
3	Cobblestone - Zenda tap 69-kV line	126.6%		Lake Geneva - South Lake Geneva 69-kV line	
3	Katzenberg – Zenda tap 69-kV line	109.1%		Lake Geneva - South Lake Geneva 69-kV line	
3	Zenda 69-kV bus		90.5% 88.1%	Lake Geneva - South Lake Geneva 69-kV line Cobblestone – Brick Church 69-kV line	
3	South Lake Geneva 69-kV bus		83.7%	Lake Geneva - South Lake Geneva 69-kV line North Lake Geneva 138/69-kV transformer	
3	North Lake Geneva 138-kV bus		91.8% 91.6%	Split Burlington 138-kV bus Colley Road - Dickinson 138-kV line	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Concord 138-kV bus		86.8% 89.3%	Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Rubicon 138-kV bus		88.9% 90.6%	Split Concord 138-kV bus between buses 4 and 5 Split Concord 138-kV bus between buses G and 4	
3	Bristol 138-kV bus		91.3%	Colley Road - Dickinson 138-kV line	
3	Delavan 138-kV bus		91.2%	Colley Road - Dickinson 138-kV line	
3	Dickinson 138-kV bus		86.2%	Colley Road - Dickinson 138-kV line	
3	Elkhorn 138-kV bus		90.6% 91.5%	Colley Road - Dickinson 138-kV line Beloit Gateway – Dickinson 138-kV line	
3	Cobblestone 69-kV bus		86.8%	Cobblestone – Brick Church 69-kV line	
3	West Darien 138-kV bus		91.9% 91.9%	REC LaPrairie – REC Bradford 138-kV line RCEC LaPrairie – Rock River 13-8kV line	
3	RC2 (RCEC Bradford) 138-kV bus		91.9% 91.9%	REC LaPrairie – REC Bradford 138kV line REC LaPrairie – Rock River 138-kV line	
3	RC9 (RCEC LaPrairie) 138-kV bus		91.9%	REC LaPrairie – Rock River 138-kV line	
3	Southwest Delavan 138-kV bus		91.9%	REC LaPrairie – Rock River 138-kV line	
3	Lake Geneva 69-kV bus		91.7%	North Lake Geneva 138/69-kV transformer	
3	Okee, Lodi Industrial Park, Lodi 69-kV bus		95.5% - 95.9% 90.3% - 91.5%	Intact System Dane - Lodi Tap 69-kV line	No project needed at this time

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Lake Delton, Kirkwood 138-kV bus		88.3% - 91.7%	Trienda - Lake Delton 138-kV line Lake Delton - Kirkwood 138-kV line Trienda - Lewiston ACEC 138-kV line Lewiston ACEC – Kilbourn 138-kV line	
3	Mackford Prairie, Markesan 69-kV bus		87.9% - 91.8%	North Randolph - Markesan Tap 69-kV line Markesan Tap - Mackford Prairie 69-kV line Metomen - Ripon 69-kV line	
3	Eagle View 69-kV bus		90.5%	Eagle View - Dam Height 69-kV line	No project needed at this time
3	Kilbourn, Loch Mirror, Birchwood, Dell Creek, Zobel, Nishan, Artesian, Rock Springs 138-kV bus		87.6% - 91.9%	Lake Delton - Trienda 138-kV line Trienda - Lewiston ACEC 138-kV line Lewiston ACEC - Kilbourn 138-kV line Kilbourn - Loch Mirror 138-kV line	Lake Delton – Birchwood 138-kV line
3	Lewiston 138-kV bus		87.6%	Trienda - Lewiston ACEC 138-kV line	
3	Artesian - Rock Springs - Kirkwood 138-kV line	95.9% - 115.2%		Trienda - Lewiston ACEC 138-kV line Trienda - Kilbourn 138-kV line Kilbourn - Lewiston ACEC 138-kV line Loch Mirror - Kilbourn 138-kV line	Lake Delton – Birchwood 138-kV line
3	Columbia 345/138-kV transformer T21	95.7%		Columbia 345/138-kV transformer T22	No project needed at this time
3	Columbia 345/138-kV transformer T23	95.7%		Columbia 345/138-kV transformer T22	No project needed at this time
3	Kilbourn - Lewiston 138-kV line	101.4%		Lake Delton - Trienda 138-kV line	
3	Kilbourn 138/69-kV transformer T32	96.3%		Kilbourn 139/69 kV transformer T31	No project needed at this time
3	Portage - Columbia 138-kV line	102.3%		Portage - Columbia 1 138-kV line Portage - Columbia 2 138-kV line	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
3	Portage - Columbia 69-kV line	95.7%		Portage 138/69-kV transformer	No project needed at this time
3	Portage - Trienda 1 138-kV line	96.4%		Portage - Trienda 2 138-kV line	No project needed at this time
3	Portage - Trienda 2 138-kV line	107.8%		Portage - Trienda 1 138-kV line	Upgrade Portage to Trienda 2
3	Trienda - Lewiston 138-kV line	96.0% - 103.4%		Lake Delton - Trienda 138-kV line Rock Springs Tap - Kirkwood 138-kV line Lake Delton - Kirkwood 138-kV line	
3	Academy – Columbus Muni #3 tap 69-kV line	108.4 – 117.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Columbus Muni #3 tap – Columbus 69-kV line	106.5 – 116.1%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Acedemy 138/69-kV transformer	95.8%		N. Randolph – Fox Lake 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Beaver Dam – Center Street 69-kV line	99.3 – 113.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	South Fond du Lac – Koch Oil tap 69-kV line	110.9 – 117.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Koch Oil tap – Waupun 69-kV line	112.1 – 119.9%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard – Horicon Industrial Park 69-kV line	98.1 – 105.6%		N. Randolph – Fox Lake 138-kV line Fox Lake – N Beaver Dam 138-kV line	Horicon – East Beaver Dam 138-kV line project
3	Hubbard and Hustisford 138-kV buses		95.3 – 95.7% 84.2 – 90.6%	Base Case Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Concord 138 kV bus tie 4 – 5	Horicon – East Beaver Dam 138-kV line project
3	Dane - Lodi Tap 69-kV line	95.1% - 113.8%		Island Street - Kirkwood 69-kV line Lake Delton - Trienda 138-kV line Lake Delton - Kirkwood 138-kV line Baraboo Tap - Moore Street Tap 69-kV line Island Street - Moore Street Tap 69-kV line	Rebuild Dane-Dam Heights 69-kV line

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PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
4	Edgewater – Washington Street 69-kV line	95.2%		Edgewater – Nicolet 69-kV line	No project identified. Additional study needed.
4	Canal 138/69-kV transformer #1	97.7%		Canal 138/69-kV Transformer #2	No project identified. Additional study needed.
4	Canal 138/69-kV transformer #2	97.2%		Canal 138/69-kV Transformer #1	No project identified. Additional study needed.
4	Sunset Point 138/69-kV transformer #1	96.7%		Sunset Point 138/69-kV Transformer #2	No project identified. Additional study needed.
4	Bluestone 69-kV bus		91.1%	Finger Road – Bluestone 69-kV line	No project identified. Additional study needed.
4	Sister Bay 69-kV bus		94.8%	Base case	Canal – Dunn Road 138-kV line project
4	Egg Harbor 69-kV bus		95.6%	Base case	Canal – Dunn Road 138-kV line project
4	East Krok and Beardsley 69-kV bus		91.4 – 91.9%	East Krok 138/69-kV Transformer	No project identified. Additional study needed.
4	Holland 138-kV bus		90.0%	Charter–Holland–Cedersauk 138 kV Charter–Holland 138 kV	No project identified. Additional study needed.
5	Bain 345/138-kV transformer #5	159.7%		Splitting Pleasant Prairie 345-kV bus between buses 3 and 4.	Reduce Pleasant Prairie generation
5	Albers – Kenosha 138-kV line	101.3%		Bain – Kenosha 138-kV line	
5	Oak Creek-Elm Road 345/230-kV transformer	95.1%		Split Oak Creek 230-kV bus between 7&8	Reduce generator #8 output
5	Arcadian4- Waukesha1 138-kV line	116.3%		Arcadian 6 – Waukesha3 138-kV line	Arcadian – Waukesha line uprate. Run generation at Concord / Germantown
5	Arcadian Transformer #3	114.0%		Arcadian transformer #1	Replace Arcadian transformers. Run generation at Concord and Germantown
5	Arcadian Transformer #2	102.6%		Arcadian transformer #1	Replace Arcadian transformers. Run generation at Concord and Germantown
5	Branch – Kansas 138-kV line	119.0%		Oak Creek – Pennsylvania 138-kV line	
5	Arcadian6 – Waukesha3 138-kV line	115.3%		Arcadian 4- Waukesha1 138-kV line	Arcadian – Waukesha line uprate. Run generation at Concord / Germantown

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
5	Oak Creek - Pennsylvania 138-kV line	99.0% 100.4% 100.2% 99.5% 98.6% 98.3% 95.4%		Intact System Ok Creek-Nicholson 138-kV line Oak Creek–Ramsey 138-kV line Nicholson-Ramsey 138-kV line Kansas-Ramsey 138-kV line Norwich – Ramsey 138-kV line Bluemound3 – OC6 230-kV line Plus other less severe outages	Upgrade Oak Creek-Pennsylvania 138-kV line
5	Merrill Hills 138-kV bus		95.1%	Intact System	
5	Glacier 138-kV bus		95.9%	Intact System	
5	Fredonia 138-kV bus		91.9%	Cedarsauk-Fredonia 138-kV line	
5	Cooney 138-kV bus		94.9% 90.9% 89.9%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV bus between buses 4 & 5	Install Summit capacitor banks
5	Cottonwood 138-kV bus		94.1% 91.6% 91.0% 90.6%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV bus between buses 4 & 5 Bark River – Cottonwood 138-kV line	Install Summit capacitor banks
5	Summit 138-kV bus		94.6% 91.4% 90.6%	Intact System Concord-Cooney 138-kV line Split Concord 138-kV between bus 4 & the generator bus	Install Summit capacitor banks
5	Tichigan 138-kV bus		87.1% 90.8%	Split Burlington 138-kV bus Burlington-Air Liquide-Paris 138-kV line	
5	Burlington 138-kV bus		87.9% 91.7%	Split Burlington 138-kV bus Burlington-Air Liquide-Paris 138-kV line	
5	Hartford 138-kV bus		95.5% 89.7% 91.0%	Intact System Split Concord 138-kV bus between buses 4 & 5 Split Concord 138-kV bus between bus 4 & 5	Install Summit capacitor banks
5	St. Lawrence 138-kV bus		95.9% 91.6%	Intact System Split Concord 138-kV bus between buses 4 & 5	
5	Arthur Road 138-kV bus		95.8% 91.6%	Intact System Split Concord 138-kV bus between buses 4 & 5	

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2024 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2024 Summer Peak Case without Nelson Dewey		Facility Outage(s)	Project or Mitigation
		% of Facility Rating	% of Nominal bus voltage		
5	Bark River 138-kV bus		94.8%	Intact System	
5	Root River 138-kV bus		91.9%	Oak Creek-Root River 138-kV line	
5	Edgewood 138-kV bus		95.2% 90.1%	Intact System Edgewood – St. Martin 138-kV line	Install Mukwonago capacitor banks
5	Chinook 138-kV bus		95.2% 90.1%	Intact System Edgewood – St. Martin 138-kV line	
5	Mukwonago 138-kV bus		95.0% 91.6%	Intact System Edgewood – St. Martins 138-kV line	Install Mukwonago capacitor banks
5	Pleasant Valley 138-kV bus		91.5%	Pleasant Valley – Saukville 138-kV line	
5	Pennsylvania 138-kV bus		90.6%	Oak Creek – Pennsylvania 138-kV line	

Table ZS-5
ATC Day Ahead Market Most Limiting Elements, 2008

Severity Index	Hours (hits)	Constrained Element	Potential Solution
40.39	1,847	Paddock 345/138 kV Transformer T21	Paddock - Rockdale 345 kV (Planned 2010)
19.48	408	Pleasant Prairie - Zion 345 kV	TBD*
17.41	519	Point Beach - Sheboygan 345 kV	Point Beach - Sheboygan 345 kV line uprate (2010)
8.25	221	Minnesota to Wisconsin Exports Interface (MWEX)	Monroe County-Council Creek 161 kV (Proposed 2012)**
8.04	915	Whitcomb - Caroline 115 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
5.76	205	Ellington - Hintz 138 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
5.18	166	Granville 345/138 kV Transformer T1	Install second 345/138 kV transformer at Oak Creek (Planned, 2009)
4.51	78	Bluemound 230/138 kV Transformer T3	Install second 345/138 kV transformer at Oak Creek (Planned, 2009)
4.11	93	Kelly - Whitcomb 115 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
4.02	204	Hintz - Werner 138 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
3.80	163	Arpin - Sigel 138 kV	Arrowhead - Gardner Park 345 kV (Completed 2008) Monroe County-Council Creek 161 kV (Proposed 2012)**
3.75	351	Dewey (CW8) - Weston 115 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
3.43	47	Rocky Run - Plover 115 kV	Morgan - Highway 22 - Werner West 345 kV line (Planned 2009)
3.18	44	Pleasant Valley - Arthur Road 138 kV	Reconductor Saukville - Pleasant Valley – Arthur Road - St. Lawrence 138 kV (Completed 2008)
3.09	134	Eau Claire - Arpin 345 kV	Arrowhead - Gardner Park 345 kV (Completed 2008) Monroe County-Council Creek 161 kV (Proposed 2012)**
177.13	18,295	Total for all ATC Day Ahead constraints - 2008	

** Additional potential solution being studied as part of 2009 Economic Analysis process: Bain - Zion 345 kV line*

*** Additional potential solutions being studied as part of 2009 Economic Analysis process: N. LaCrosse - Cardinal kV & Salem - Cardinal 345 kV*

Table ZS-6
ATC Real Time Market Most Limiting Elements, 2008

Severity Index	Hours (hits)	Constrained Element	Potential Solution
45.13	376	Paddock 345/138 kV Transformer T21	Paddock - Rockdale 345 kV (Planned 2010)
15.58	133	Point Beach - Sheboygan 345 kV	Point Beach - Sheboygan 345 kV line uprate (Proposed 2010)
13.26	119	Pleasant Prairie - Zion 345 kV	TBD*
11.37	87	Eau Claire - Arpin 345 kV	Arrowhead - Gardner Park 345 kV (Completed 2008) Monroe County-Council Creek 161 kV (Proposed 2012)**
11.06	407	Whitcomb - Caroline 115 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
9.05	71	Ellington - Hintz 138 kV	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
7.30	19	Southeast Wisconsin Interface	TBD*
5.54	30	Stone Lake - Gardner Park 345 kV	Monroe County-Council Creek 161 kV (Proposed 2012)**
4.08	112	Arpin - Sigel 138 kV	Arrowhead - Gardner Park 345 kV (Completed 2008) Monroe County-Council Creek 161 kV (Proposed 2012)**
3.36	26	Rocky Run 345/115 kV Transformer T4	Gardner Park - Highway 22 - Werner West 345 kV (Planned 2009) Monroe County-Council Creek 161 kV (Proposed 2012)
3.36	37	Paddock - Town Line Road 138 kV	Paddock - Rockdale 345 kV (Planned 2010)
3.33	40	Granville - Butler 138 kV	Elm Rd. Phase 1 (Expected 2009)
3.22	131	Badger 138/115 kV Transformer T1	Gardner Park - Highway 22 - Morgan 345 kV (Planned 2009)
3.20	23	Granville 345/138 kV Transformer T1	Install 2nd 345/138 kV transformer at Oak Creek (Planned, 2009)
2.89	11	Minnesota to Wisconsin Exports Interface (MWEX)	Monroe County-Council Creek 161 kV (Proposed 2012)**
179.87	3,101	Total for all ATC Real Time constraints - 2008	

** Additional potential solution being studied as part of 2009 Economic Analysis process: Bain - Zion 345 kV line*

*** Additional potential solutions being studied as part of 2009 Economic Analysis process: N. LaCrosse - Cardinal 345 kV & Salem - Cardinal 345 kV*

Table ZS-7: ATC System Angular Stability Assessment for 2009 10-Year Assessment

	Facility Studied	# Units	Total Capacity (MW)	Last Year 0f Detail Study	Response for Selected NERC Category B2, C3 and C8 Outages (NERC Reliability Criteria)				SPS	Note
					2009	2010~2013	2014	Appropriate for 2015~2019		
	Existing Units									
1	Pleasant Prairie	2	1208.0	2007	Acceptable (1, 2, 3)	Acceptable (6)	Acceptable (6)	Yes	Yes	IPO Breakers
2	Paris	4	400.0	2008	Acceptable (2, 3)	Acceptable (2, 3)	Acceptable (2, 3)	Yes	No	
3	Oak Creak	7	1138.0	2007	Acceptable (1, 2, 3)	Acceptable (6)	Acceptable (6)	Yes	No	
4	Valley	2	280.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (4, 5)
5	Germantown	5	345.0	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
6	Port Washington CC1	6	1080.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	See notes (6, 7)
7	Point Beach	2	512; 514	2005	Acceptable (1, 2,3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	Yes	
8	Kewaunee	1	579.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	IPO Breakers, See note (8)
9	Edgewater	3	773.0	2005	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Yes	Yes	IPO Breakers
10	S. Fond du Lac	4	352.0	2005	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Yes	No	
11	Neevin	2	300.0	2005	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Yes	No	
12	Skygen	1	185.0	2005	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Yes	No	
13	Pulliam	6	459.0	2005	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Acceptable (1, 2,3)	Yes	No	See note (9)
14	West Marinette	4	240.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (10,11)
15	Fox Energy	3	672.3	2008	Acceptable (2, 3)	Acceptable (2, 3)	Acceptable (2, 3)	Yes	No	IPO Breakers
16	Sheboygan Energy	2	343.0	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
17	Cypress	88	145.2	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (12)
18	Forward Energy Center	86	129.0	2008	Acceptable (2, 3)	Acceptable (2, 3)	Acceptable (2, 3)	Yes	No	
19	Columbia	2	1050.0	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	IPO Breakers
20	Christiana	3	544.5	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
21	Riverside	3	659.1	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
22	Rock River	5	262.0	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
23	Nelson Dewey	2	226.0	2005	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Acceptable (1, 2, 3)	Yes	No	
24	University	2	236.0	2008	Acceptable (2, 3)	Acceptable (2, 3)	Acceptable (2, 3)	Yes	No	
25	Concord	4	400.0	2008	Acceptable (2, 3)	Acceptable (2, 3)	Acceptable (2, 3)	Yes	No	
26	West Campus	3	147.2	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (13)
27	Presque Isle	5	431.0	2007	Acceptable (14)	Acceptable (14)	Acceptable (14)	Yes	Yes	See note (15)
28	Weston	5	552.6	2005	Acceptable (16, 3)	Acceptable (16, 3)	Acceptable (16, 3)	Yes	No	IPO Breakers, See Note (17)
	New / Future Units									
29	Elm Road Phase I	1	650.0	2006	Acceptable (18)	Acceptable (18)	Acceptable (18)	Acceptable (18)	No	IPO Breakers
30	Elm Road Phase II	1	650.0	2006		Acceptable (18)	Acceptable (18)	Acceptable (18)	No	IPO Breakers
31	Green Lake (wind)	108	160.0	2006		Acceptable (19)	Acceptable (19)	Acceptable (19)	No	
32	Bowers Road (wind)	70	105.0	2006		Acceptable (20)	Acceptable (20)	Acceptable (20)	No	
33	EcoMet (wind)	67	100.5	2008		Acceptable (21)	Acceptable (21)	Acceptable (21)	No	

These shaded rows represent units at plants in which there have been a significant system topological change near the plant or significant parameter changes or updates to the dynamic models used in stability studies and are to be studied in the 2009 TYA as part the system angular stability analysis

Notes:

(1) "American Transmission Company (ATCLLC) - 2005 Ten Year Assessment" (http://www.atc10yearplan.com) dated September 2005 section "ZONE & STUDY RESULTS > Multiple outage analysis" under the heading "Generator Stability" and "Voltage Stability" stating the results of dynamics studies for category C.

(2) Comparing 2009 TYA models with 2008 TYA models, no significant change has occurred near the generation station, other than the local load growth. Therefore, the stability results from the 2008 TYA are still applicable and are acceptable in the following years.

(3) "American Transmission Company (ATCLLC) - 2008 Ten Year Assessment" (http://www.atc10yearplan.com) dated October 2008 section "ZONE & STUDY RESULTS > Multiple outage analysis" under the heading "Generator Stability" and "Voltage Stability" stating the results of dynamics

(4) Since the TYA2008 cases there has been replacement of the IEEET1 exciter model with ESST4B on Valley units 1 and 2.

(5) Stability simulations meet NERC requirements for phase-ground fault with delayed clearing, but do not meet ATC requirements for three-phase fault with delayed clearing. Action plan is to replace breaker failure relays with SEL-352 relays on lines 301, 302 and 311 and replace the existing three cycle oil breakers with two cycle gas breakers at positions 314, 321, and 324.

(6) Generator Validation Study Port Washington Generator Facility - MISO #G014 (#36365-01), MISO #G093 (#37004-01), MISO #G510 (#38429-02)" dated September 8, 2008. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G-T\G_T Projects\Requests in Service\G510 - Port Washington Extra MW\06_As-Built Information\Generator Validation study.

(7) Since the TYA2008 cases there has been replacement of the GAST2A governor model with GGOV1 governor model as part of RFC model standardization project. In addition the 2009 TYA cases have parameter updates for each of the generators in block 1 (POWCTG11, POWSTG10 and POWCTG12).

(8) Since the TYA2008 cases there has been replacement of the IEESGO governor model with USRMDL USIEG2 governor model.

(9) Pulliam units 3 and 4 were removed from service indefinitely as of December 31 2007 decreasing the total capacity to 459 MW.

(10) Area near plant had significant topological system changes that included the addition of the Menominee 138/69 kV transformer and significant re-configuration of 69 kV network between Pioneer, Pound, Sandstone, Crivitz High Falls and Thunder. Also included addition of Wells St-Ogden 69 kV line.

Notes (Continued):

(11) Stability simulations meet NERC requirements for phase-ground fault with delayed clearing, but do not meet ATC requirements for three-phase fault with delayed clearing. System improvements to meet ATC requirements would require replace of circuit breakers and breaker relaying as well as a possible substation reconfiguration that will be factored in with any other system improvements needed in the area. Existing phase-ground fault duty has to nearly double under present clearing times before the NERC requirements are exceeded, which provides an adequate margin in order to planning and implement system improvements needed to meet ATC requirements.

(12) Change in generator model parameters for BlueSky and Greenfield because of change in number of machines from 41 to 44 and in manufacturer plus the addition of a fast response reactive compensation device. Area near plant had significant topological system changes that include addition of the Werner West-Highway 22, Highway 22-Gardner Park, and Highway 22-Morgan 345 kV lines; second Kewaunee transformer; connection of two wind farms totaling 198 MW to the 138 kV system in the area

(13) Area near plant had significant topological system changes that included the conversion of the two Blount-Ruskin 69 kV lines to a single 138 kV, as well as re-configuration of other the 69 kV lines involving the Mendota Substation. In addition, the installation of the North Madison-Huiskamp 138 kV line and loop-in of North Madison-Yahara River 138 kV line into new Vienna.

(14) "Presque Isle Special Protection System “Remedial Action Tripping Scheme” (RATS)" Version 3.0 dated December 17, 2007. http://oasis.midwestiso.org/documents/ATC/PresqueIsleSPS-v3.pdf

(15) Presque Isle units 1 and 2 were retired from service as of January 1 2007. Presque Isle units G3 and G4 are retired as of 12/31/2012. These retirements result in a decreasing the total capacity to 431.

(16) "Generator Interconnection Facility Study Report for G144 - Addendum IV, MISO #G144 (#37187-02)" dated June 16, 2005. \\atc.llc\atcdata\ Knowledge Share\Planning and Service\Generator Requests\G_T Projects\G144 - Weston G4\Study Reports\GIC044_Facility_Study_Report.pdf.

(17) "Weston Unit 4 Special Protection System Review Final Draft" Report, dated February 9, 2009. \\atc.llc\atcdata\PSSE\Special_Studies\SPS Studies PSSE2\ Weston4 SPS\W4 SPS with HWY22 interim\Report.

(18) "Final Facility Study Update – Revision 2 Phase I, II & III Milwaukee County, Wisconsin MISO #G051 (#36760-01)" dated January 15, 2007. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G_T Projects\G051 - Elm Road\04_Faciliies Study\Study Reports G051_Facility_Study_p1-3_revision_2_Final-Jan07.doc

(19) "Interconnection System Impact Study Report - Addendum II - MISO #G376 (#37935-03)" dated May 31, 2008. \\atc.llc\atcdata\ Knowledge Share\Planning and Service\Generator Requests\G-T\G_T Projects\G376 - Green Lake Wind\03_System Impact Study\Study Reports\ G376_Impact_Study.pdf.

(20) "G546 Interconnection System Impact Study Report Revision 2 - MISO #G546 (#38605-01)" dated December 13, 2006. \\atc.llc\atcdata\ Knowledge Share\Planning and Service\Generator Requests\G-T\G_T Projects\G546 - Sugar Creek Wind\03_System Impact Study\Study Reports\G546_ Impact_Study.pdf.

(21) "Interconnection System Impact Study Report" - MISO #G611 (#38791-01)" dated October 24, 2008. \\atc.llc\atcdata\ Knowledge Share\Planning and Service\Generator Requests\G-T\G_T Projects\G611 - EcoMet\03_System Impact Study\Study Reports\G611_Impact_Study.pdf.

Table ZS-8
Zone 1 Load and Generation

Zone 1	2010	2014	2019	2024
Peak Forecast (megawatts)	1685.2	1823	1979.4	2126.7
Average Peak Load Growth	N/A	1.98%	1.66%	1.45%
Existing Generation Capacity (megawatts)	1333.9	1333.9	1333.9	1333.9
Existing Capacity Less Load	-351.3	-489.1	-645.5	-792.8
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	1493.9	1493.9	1493.9	1493.9
Modeled Capacity Less Load (megawatts)	-191.3	-329.1	-485.5	-632.8

Table ZS-9
Zone 2 Load and Generation

Zone 2	2010	2014	2019	2024
Peak Forecast (megawatts)	841.4	862.3	888.9	914.7
Average Peak Load Growth	N/A	0.62%	0.61%	0.57%
Existing Generation Capacity (megawatts)	992.4	992.4	992.4	992.4
Existing Capacity Less Load	151	130.1	103.5	77.7
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	992.4	992.4	992.4	992.4
Modeled Capacity Less Load (megawatts)	151	130.1	103.5	77.7

Table ZS-10
Zone 3 Load and Generation

Zone 3	2010	2014	2019	2024
Peak Forecast (megawatts)	3179.2	3501.5	3936.5	4375.7
Average Peak Load Growth	N/A	2.44%	2.37%	2.14%
Existing Generation Capacity (megawatts)	3933.6	3933.6	3933.6	3933.6
Existing Capacity Less Load	754.4	432.1	-2.9	-442.1
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	4267.6	4366.6	4366.6	4366.6
Modeled Capacity Less Load (megawatts)	1088.4	865.1	430.1	-9.1

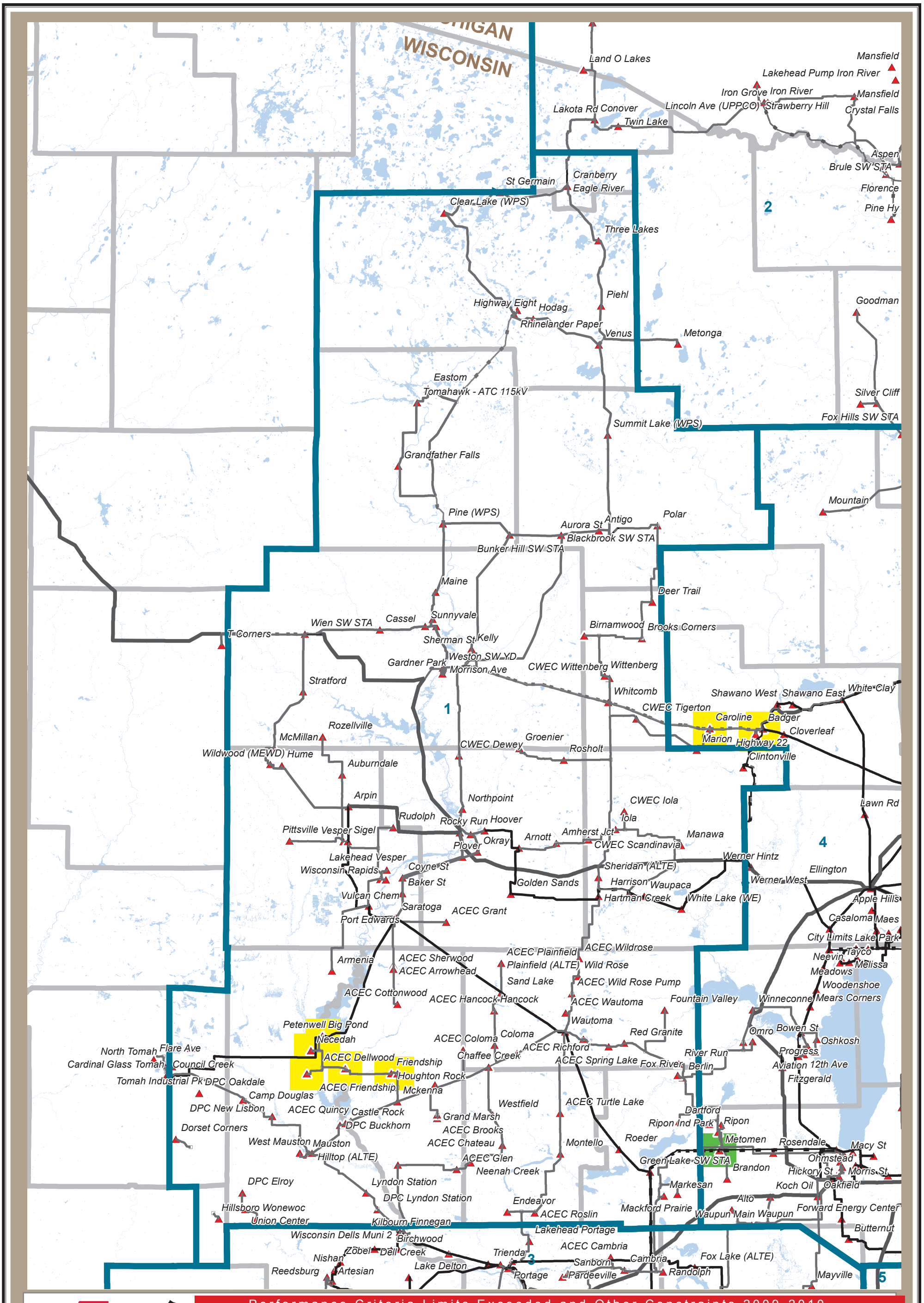
Table ZS-11
Zone 4 Load and Generation

Zone 4	2010	2014	2019	2024
Peak Forecast (megawatts)	3172.4	3372.5	3638.1	3907.4
Average Peak Load Growth	N/A	1.54%	1.53%	1.44%
Existing Generation Capacity (megawatts)	5475.9	5475.9	5475.9	5475.9
Existing Capacity Less Load	2303.5	2103.4	1837.8	1568.5
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5770.6	5871.1	5871.1	5871.1
Modeled Capacity Less Load (megawatts)	2598.2	2498.6	2233	1963.7

Table ZS-12
Zone 5 Load and Generation

Zone 5	2010	2014	2019	2024
Peak Forecast (megawatts)	4715.9	5039.8	5483.7	5936.6
Average Peak Load Growth	N/A	1.67%	1.70%	1.60%
Existing Generation Capacity (megawatts)	4468	4468	4468	4468
Existing Capacity Less Load	-247.9	-571.8	-1015.7	-1468.6
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5100	5750	5750	5750
Modeled Capacity Less Load (megawatts)	384.1	710.2	266.3	-186.6

Figure ZS-1



Performance Criteria Limits Exceeded and Other Constraints 2009-2010

PLANNING ZONE 1

AMERICAN TRANSMISSION COMPANY

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
* Approximately 9350 miles of transmission lines
* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Updated July 9, 2009

AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2011-2014

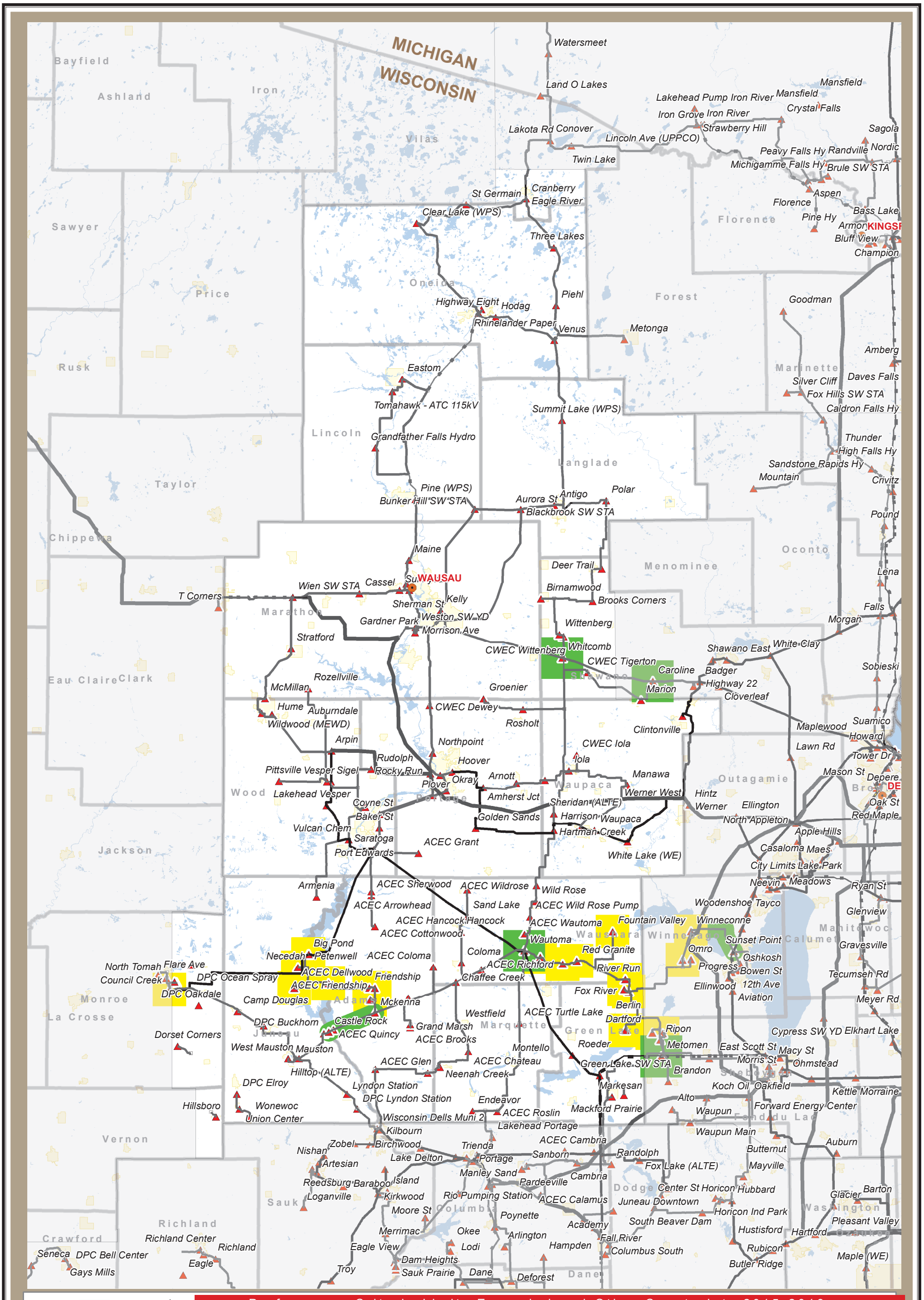
PLANNING ZONE 1

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
* Approximately 9350 miles of transmission lines
* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

Low/High Voltages
Overloaded Facility

Transmission Related Facilities
- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

Updated July 9, 2009



Performance Criteria Limits Exceeded and Other Constraints 2015-2019

PLANNING ZONE 1

AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
* Approximately 9350 miles of transmission lines
* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

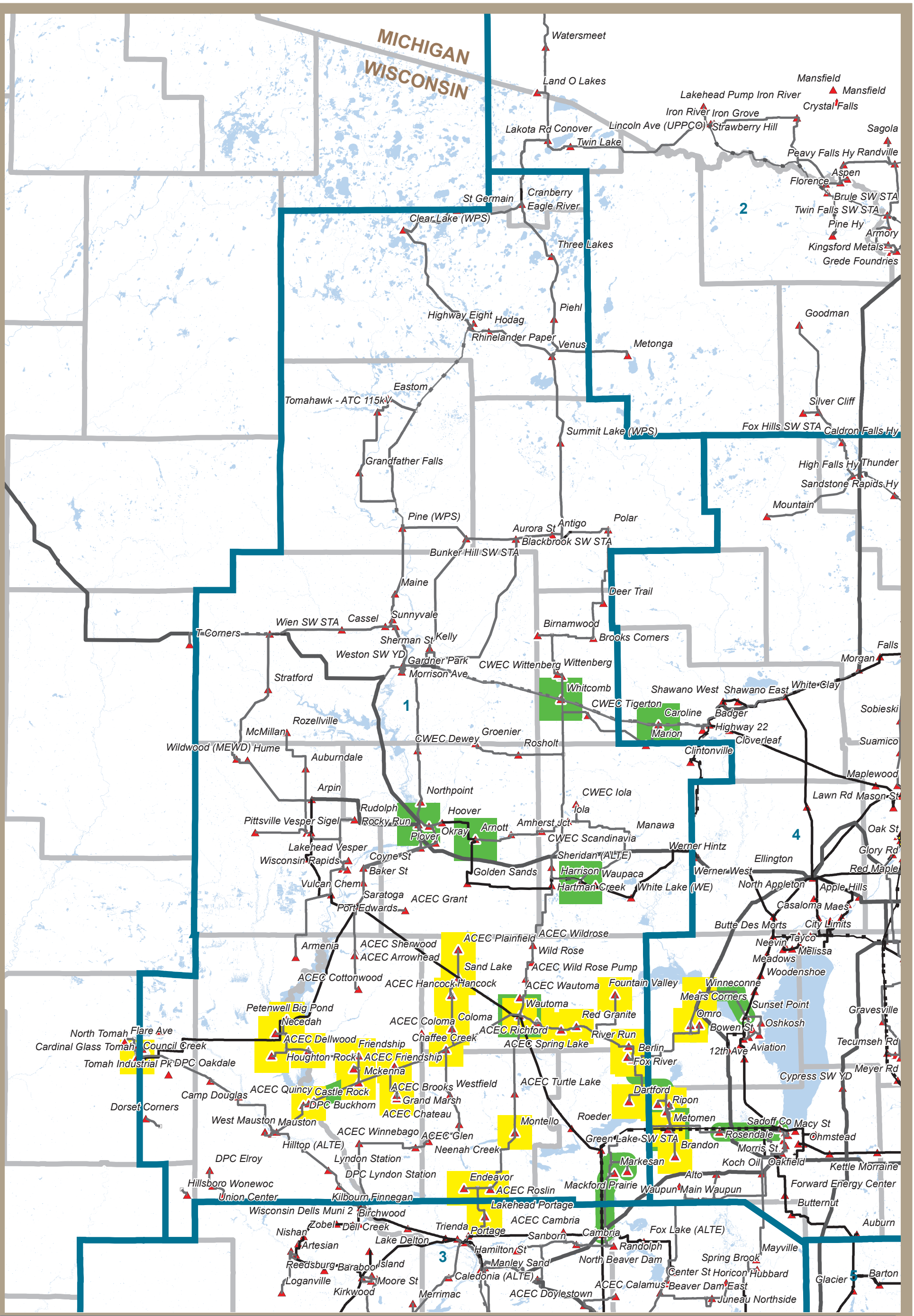
Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Updated March 27, 2009

Figure ZS-4



Performance Criteria Limits Exceeded and Other Constraints 2020-2024

PLANNING ZONE 1

AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
* Approximately 9350 miles of transmission lines
* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

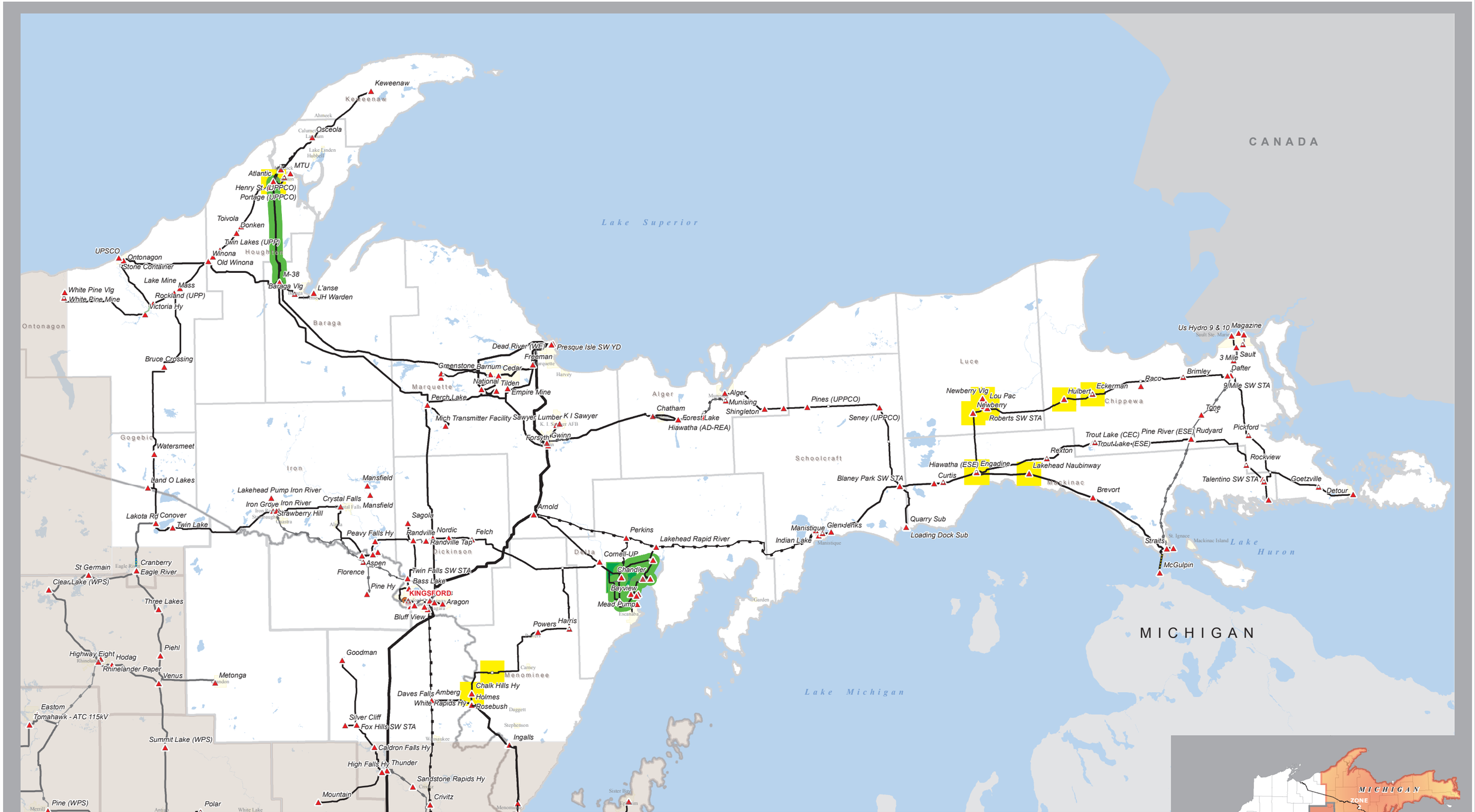
Low/High Voltages
Overloaded Facility

Transmission Related Facilities
Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Updated July 9, 2009

Figure ZS-5



AMERICAN TRANSMISSION COMPANY ®

Performance Criteria Limits Exceeded and Other Constraints 2009-2010

PLANNING ZONE 2

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:

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* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

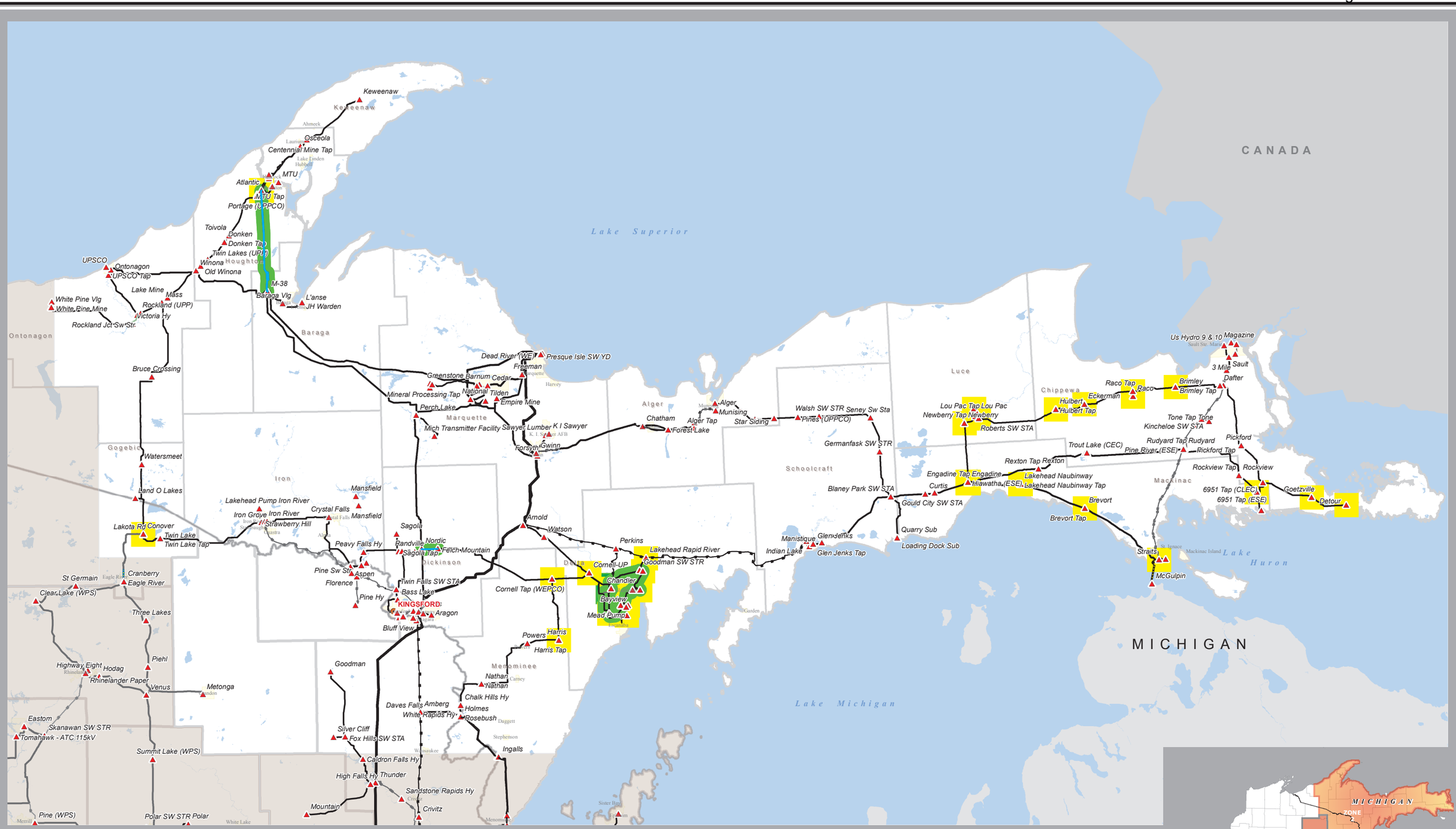
Low/High Voltages
Overloaded Facility
Transmission Service Limiter

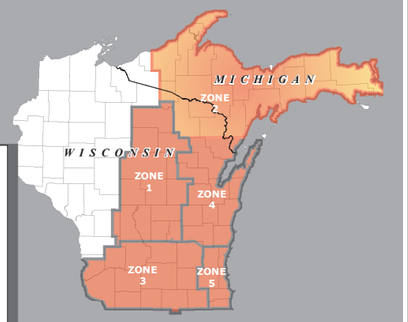
Transmission Related Facilities

Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 11, 2009





AMERICAN TRANSMISSION COMPANY ®

Performance Criteria Limits Exceeded and Other Constraints 2010-2014

PLANNING ZONE 2

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
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* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

Low/High Voltages
Overloaded Facility
Transmission Service Limiter

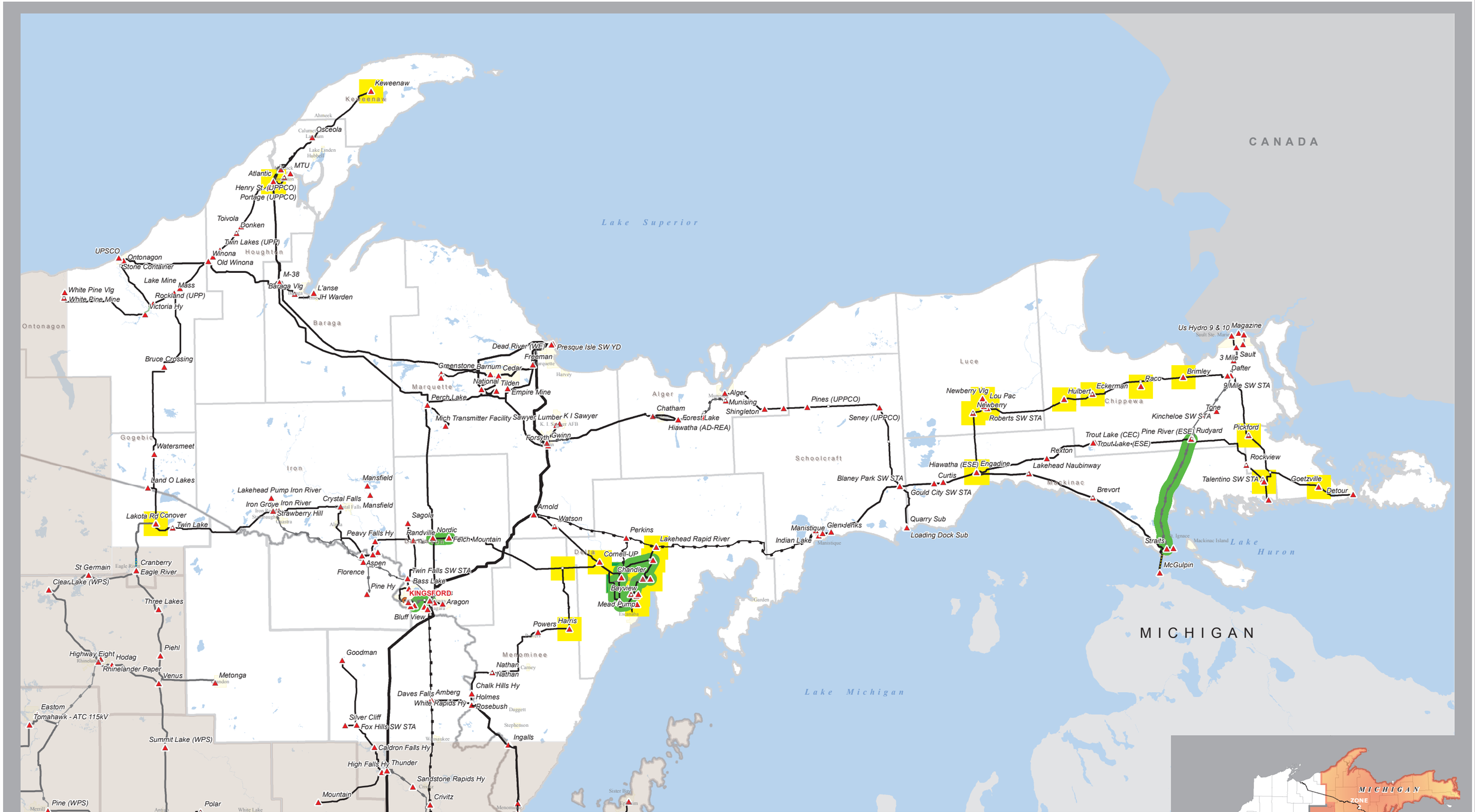
Transmission Related Facilities

Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 23, 2009

Figure ZS-7



AMERICAN TRANSMISSION COMPANY ®

Performance Criteria Limits Exceeded and Other Constraints 2015-2019

PLANNING ZONE 2

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:

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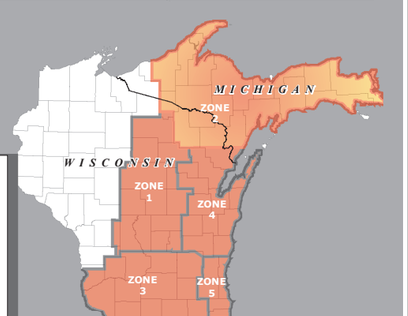
Low/High Voltages
Overloaded Facility
Transmission Service Limiter

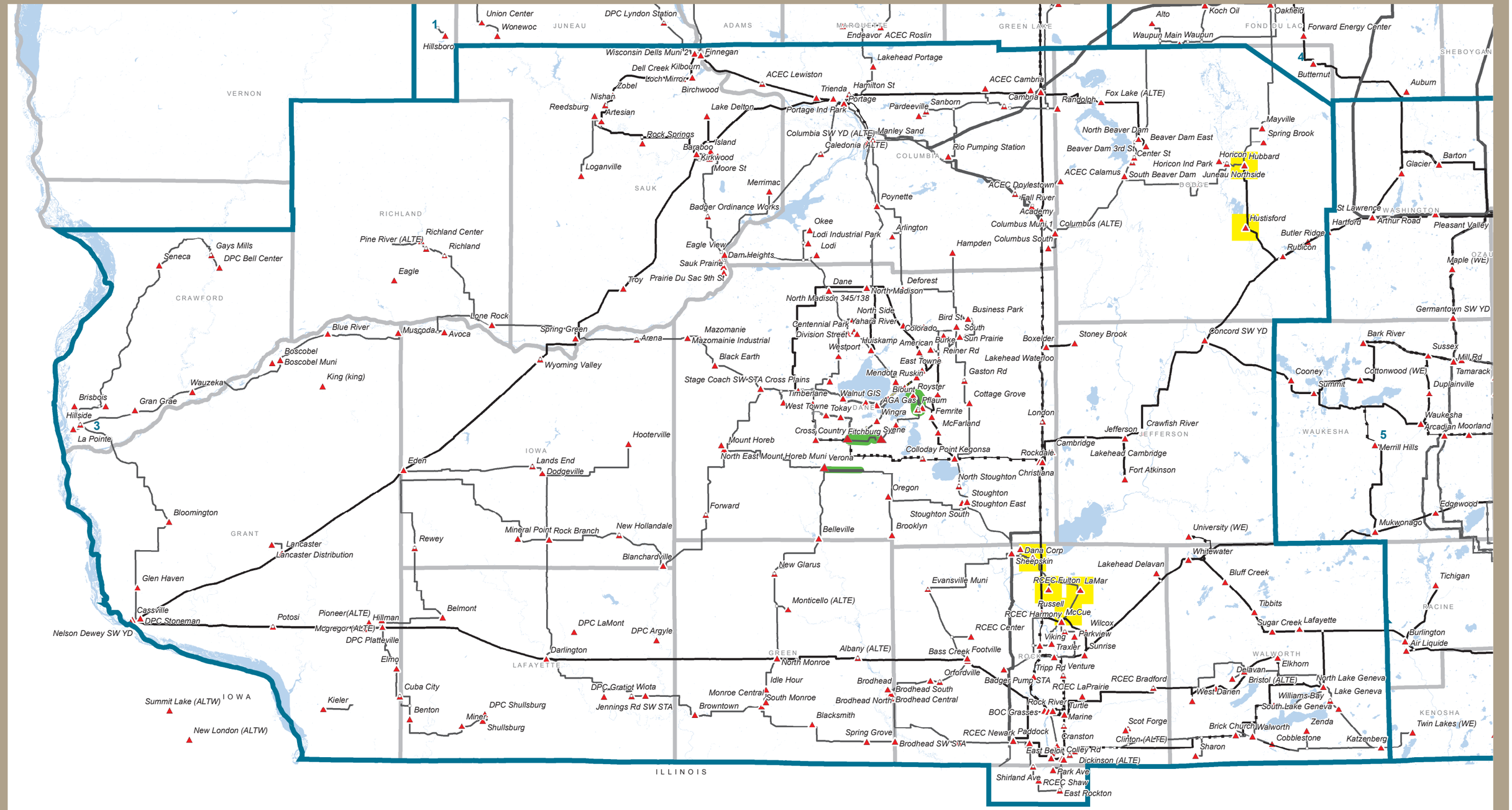
Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility



The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 27, 2009



Performance Criteria Exceeded and Other Constraints 2009-2010

PLANNING ZONE 3

AMERICAN TRANSMISSION COMPANY

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:

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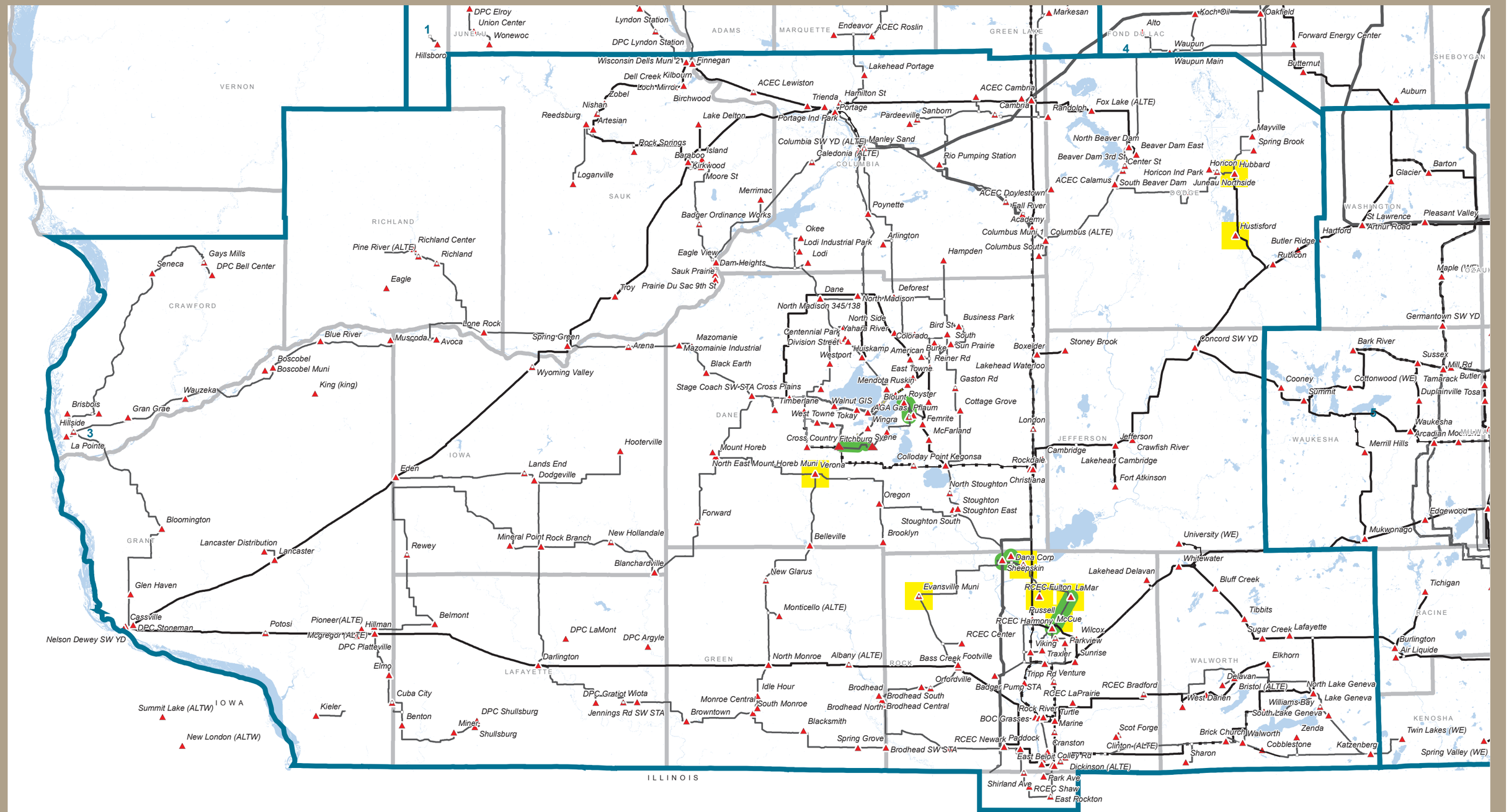
Low/High Voltages
Overloaded Facility

Transmission Related Facilities

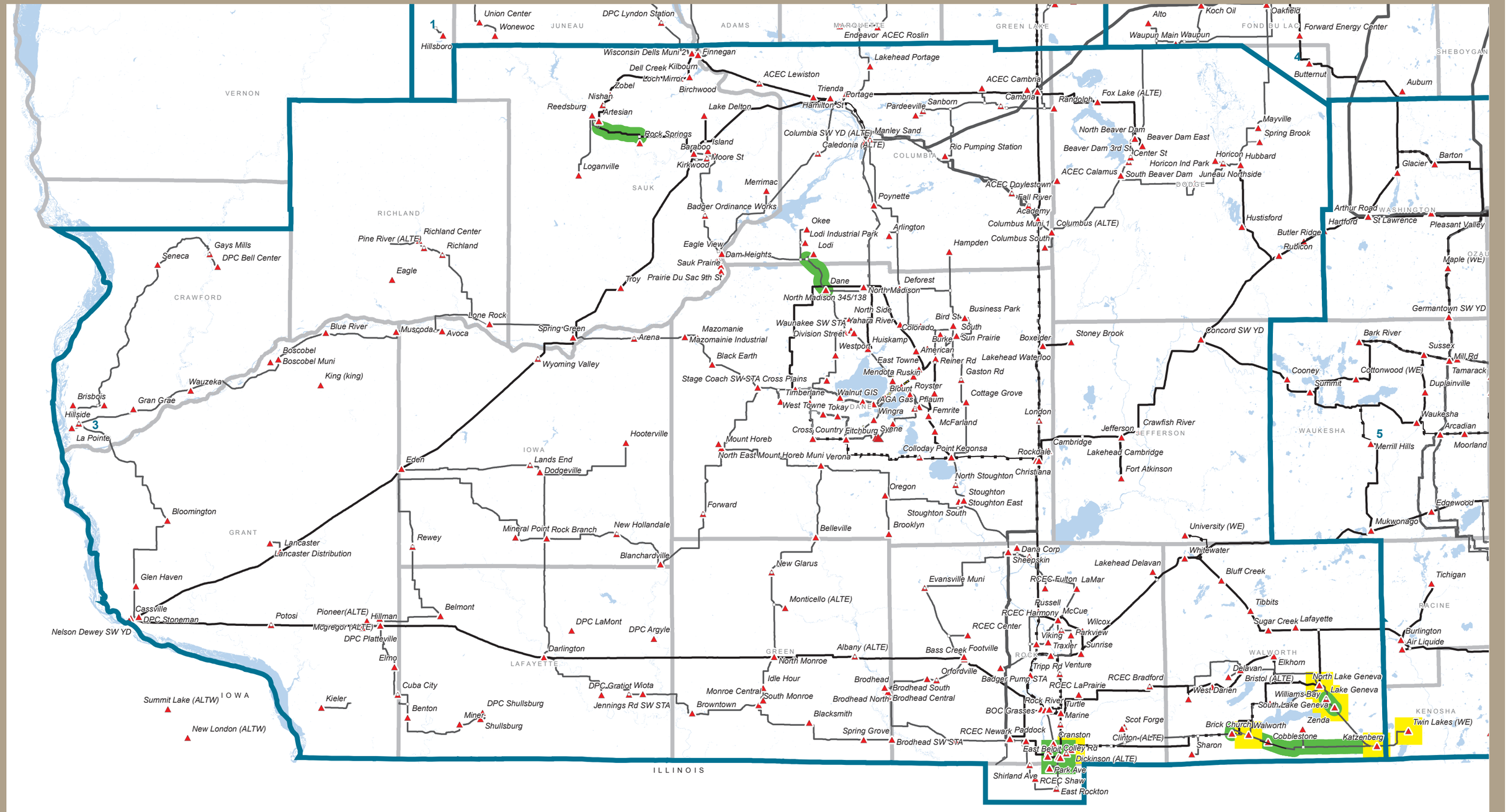
Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

Modified: July 10, 2009



Modified: July 10, 2009

Figure ZS-11



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints 2015-2019

PLANNING ZONE 3

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:

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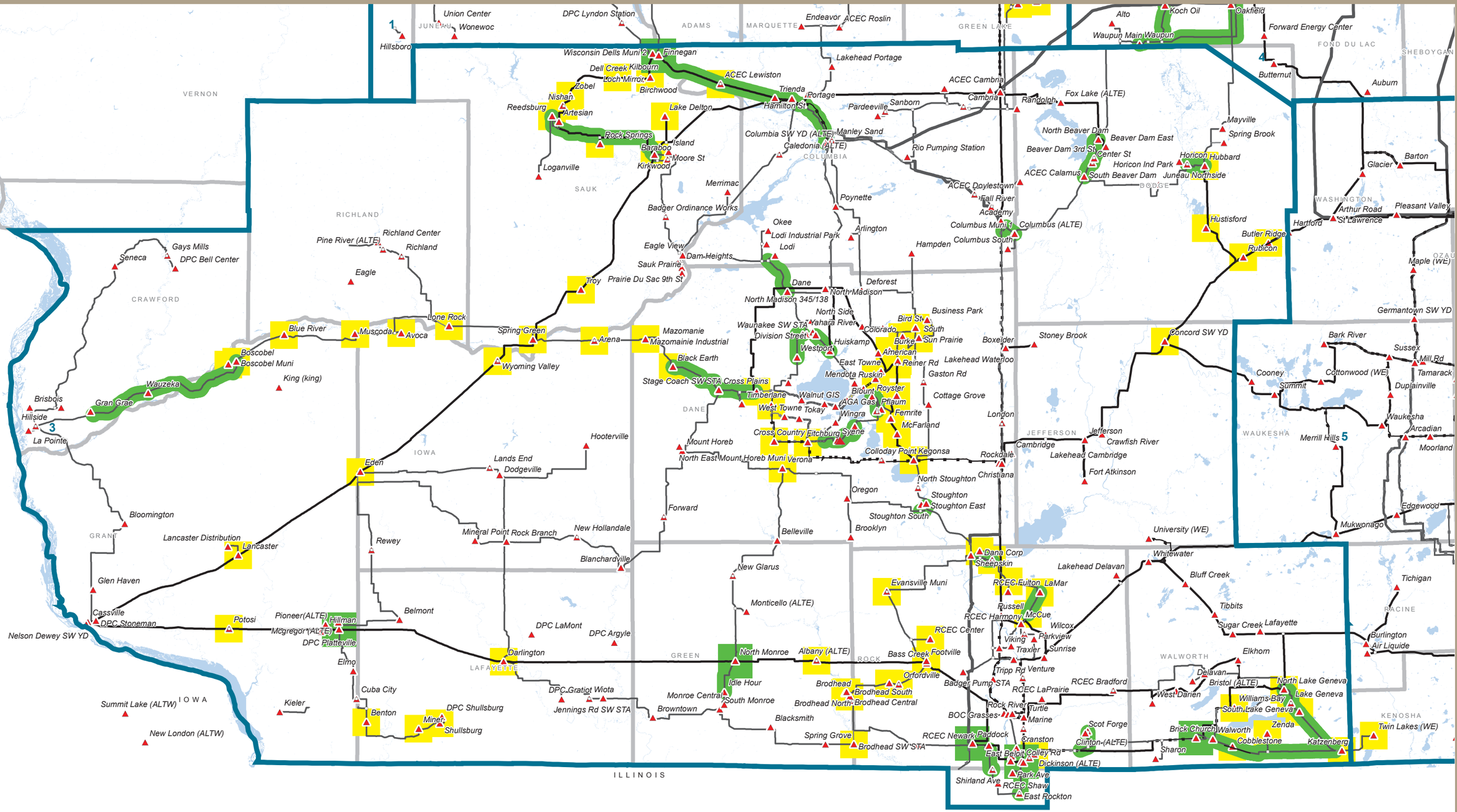
Low/High Voltages
Overloaded Facility

Transmission Related Facilities

Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

Modified: July 10, 2009

Figure ZS-12



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints 2020-2024

PLANNING ZONE 3

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:

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* 410 jointly owned substations
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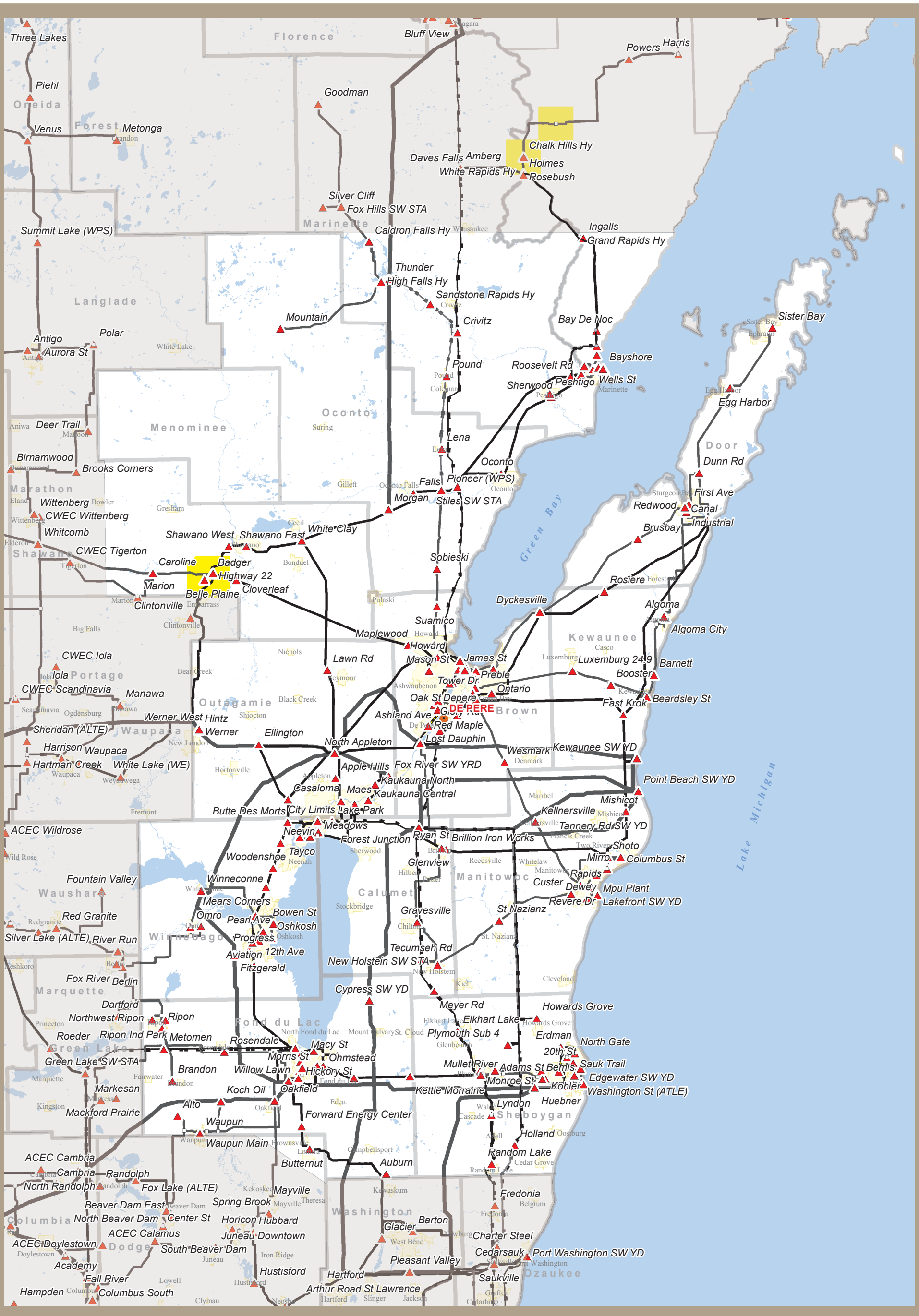
Low/High Voltages
Overloaded Facility

Transmission Related Facilities

Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

Modified: July 13, 2009



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Performance Criteria Limits Exceeded and Other Constraints 2009-2010

PLANNING ZONE 4

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
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* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified: March 10, 2009

AMERICAN TRANSMISSION COMPANY®

Performance Criteria Limits Exceeded and Other Constraints 2011-2014

PLANNING ZONE 4

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Facilities include:
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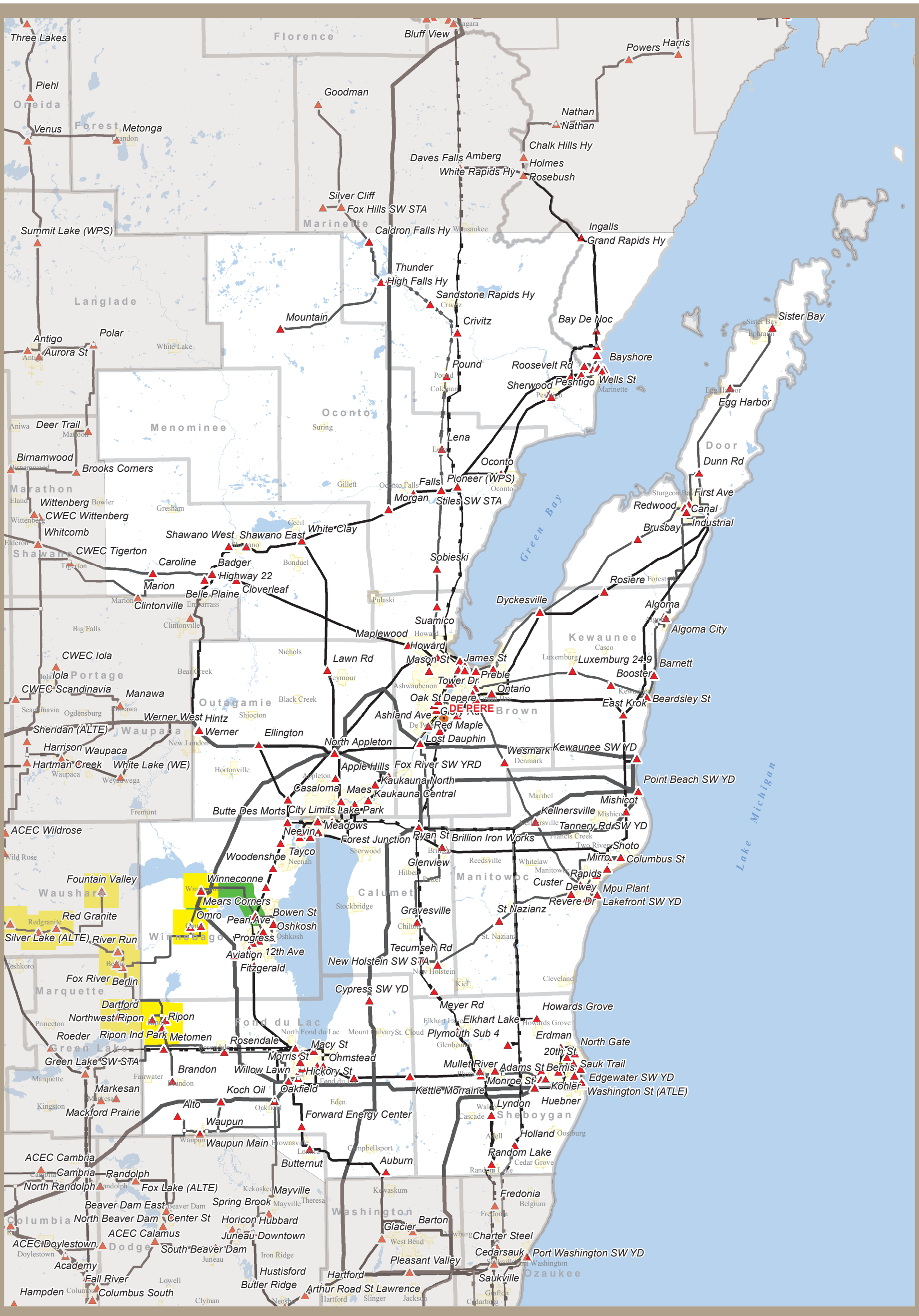
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified: March 23, 2009



AMERICAN TRANSMISSION COMPANY®

Performance Criteria Limits Exceeded and Other Constraints 2015-2019

PLANNING ZONE 4

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Facilities include:
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- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

Modified: March 27, 2009

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Performance Criteria Limits Exceeded and Other Constraints 2020-2024

PLANNING ZONE 4

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Facilities include:
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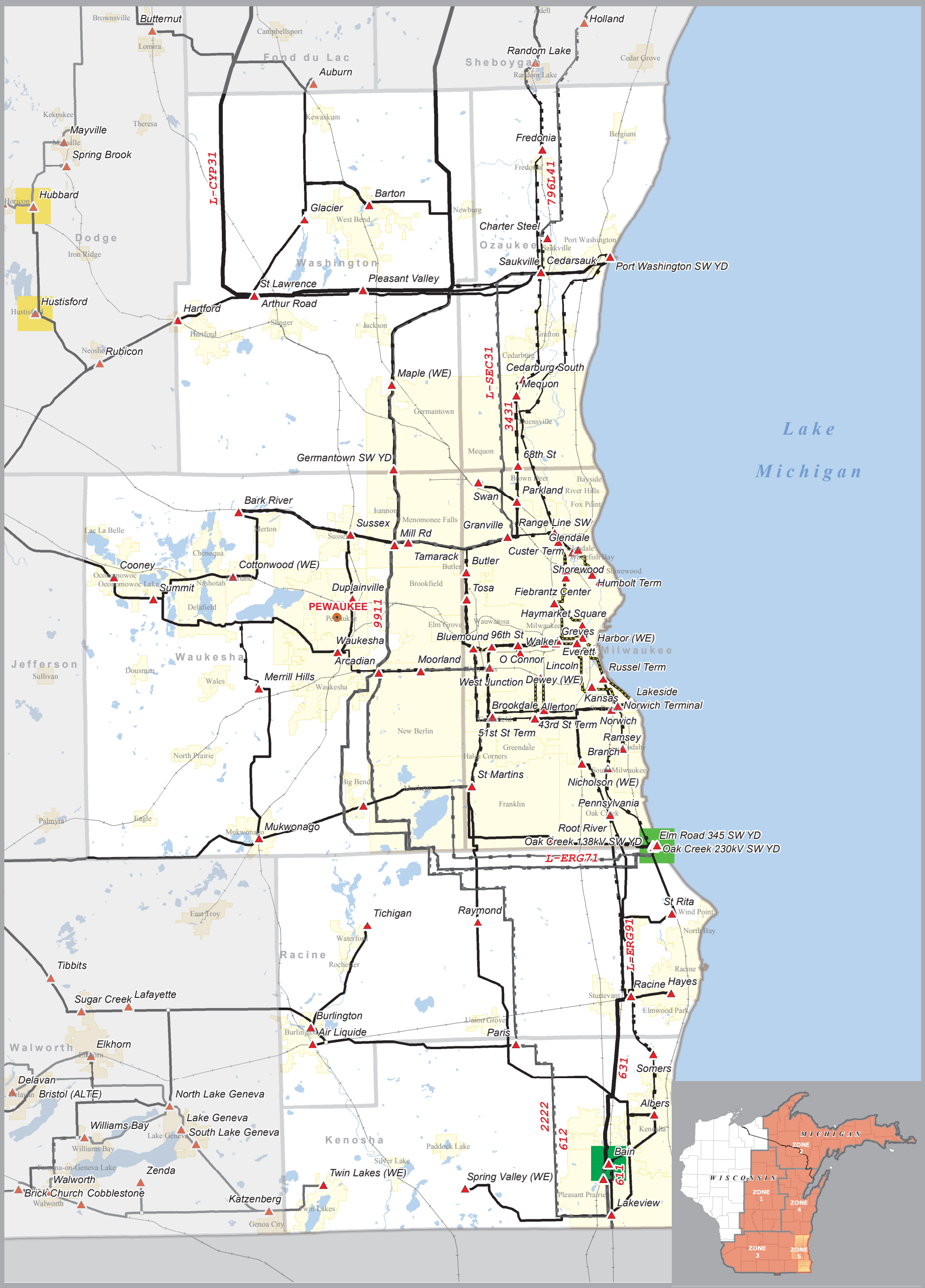
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified: April 24, 2009



AMERICAN TRANSMISSION COMPANY®

Performance Criteria Limits Exceeded and Other Constraints 2009-2010

PLANNING ZONE 5

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
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* 410 jointly owned substations
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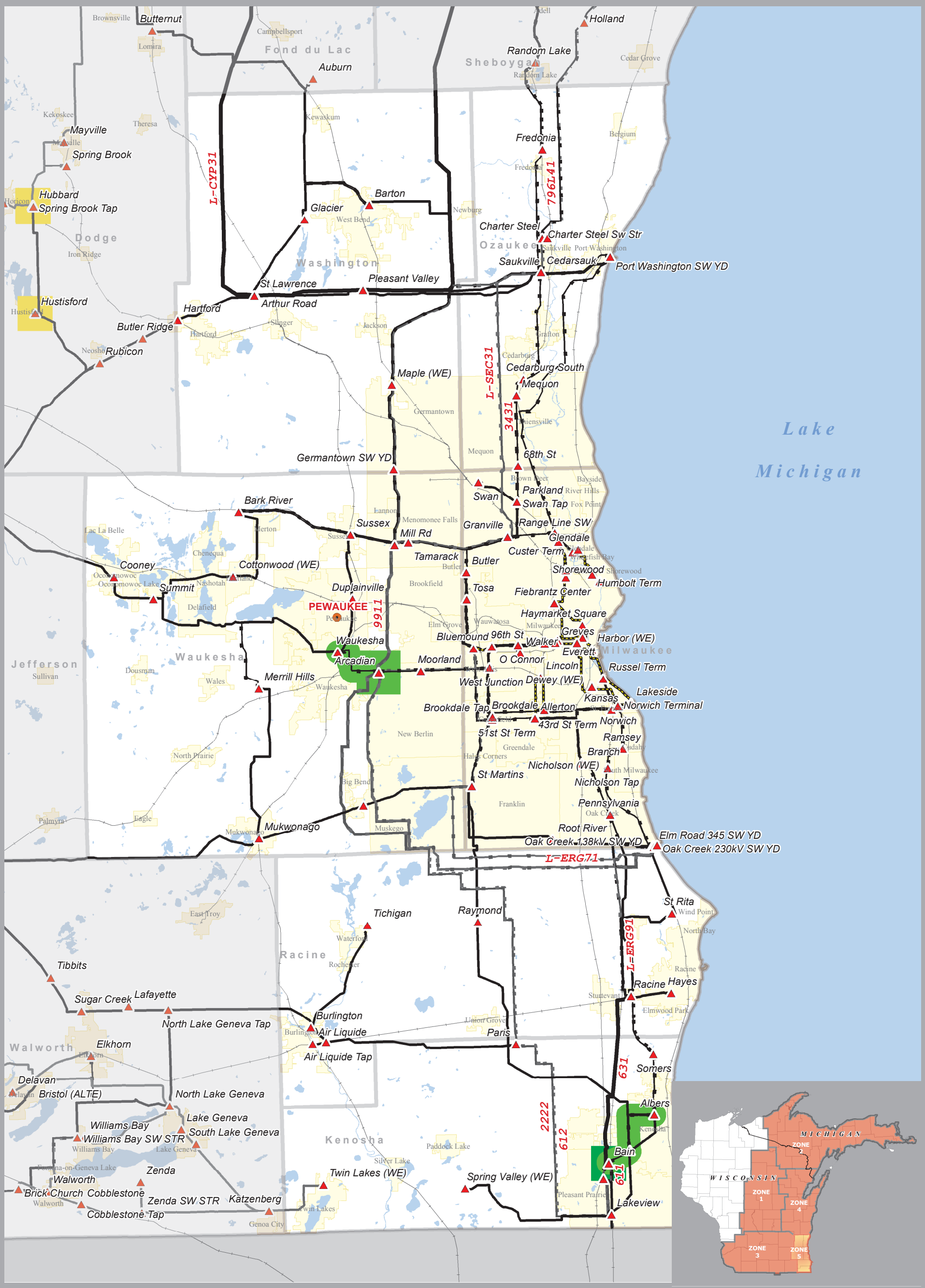
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 10, 2009



AMERICAN TRANSMISSION COMPANY®

Performance Criteria Limits Exceeded and Other Constraints 2011-2014

PLANNING ZONE 5

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* 410 jointly owned substations
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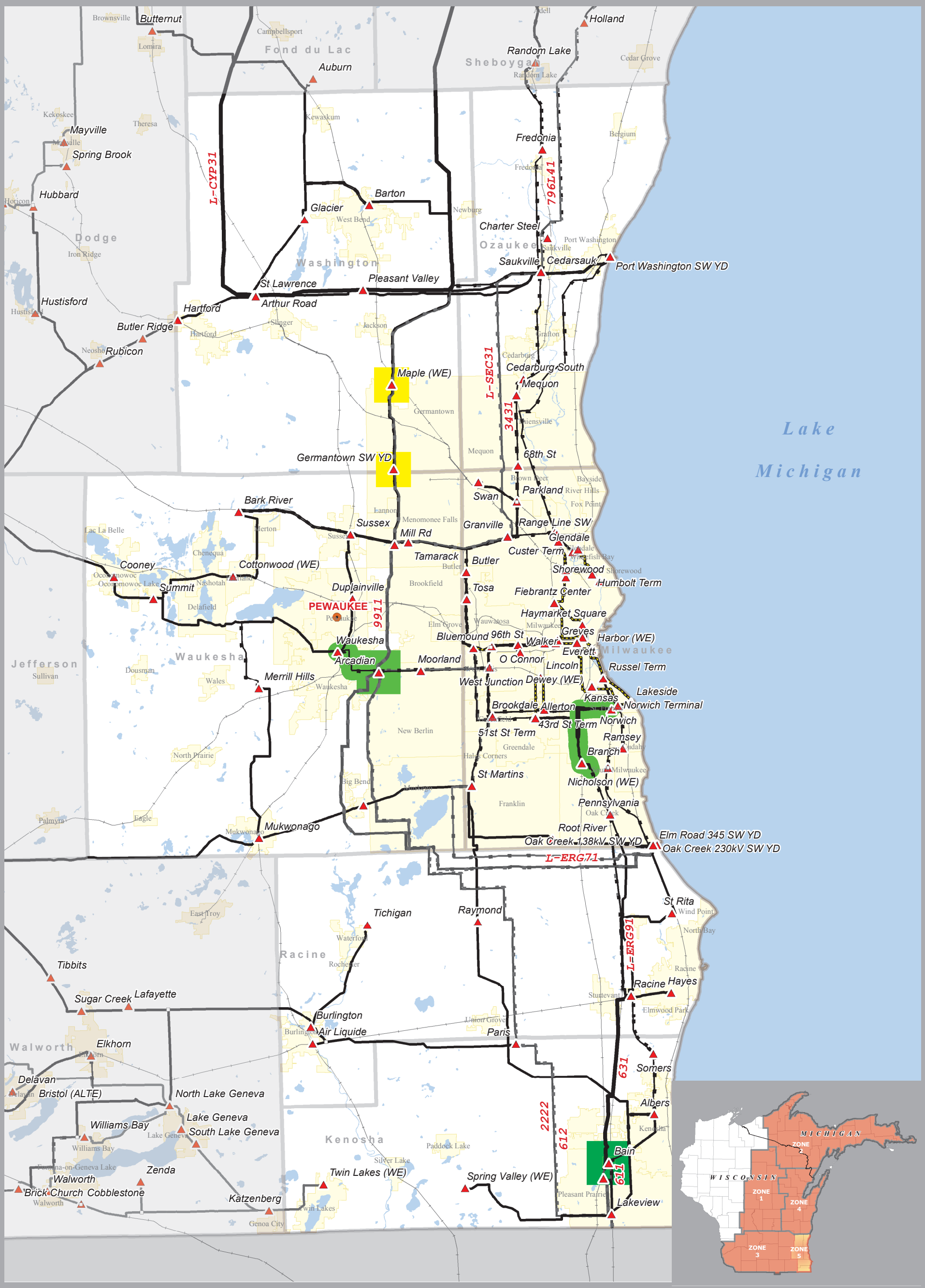
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 23, 2009



AMERICAN TRANSMISSION COMPANY®

Performance Criteria Limits Exceeded and Other Constraints 2015-2019

PLANNING ZONE 5

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
Facilities include:
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* 96 wholly owned substations
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

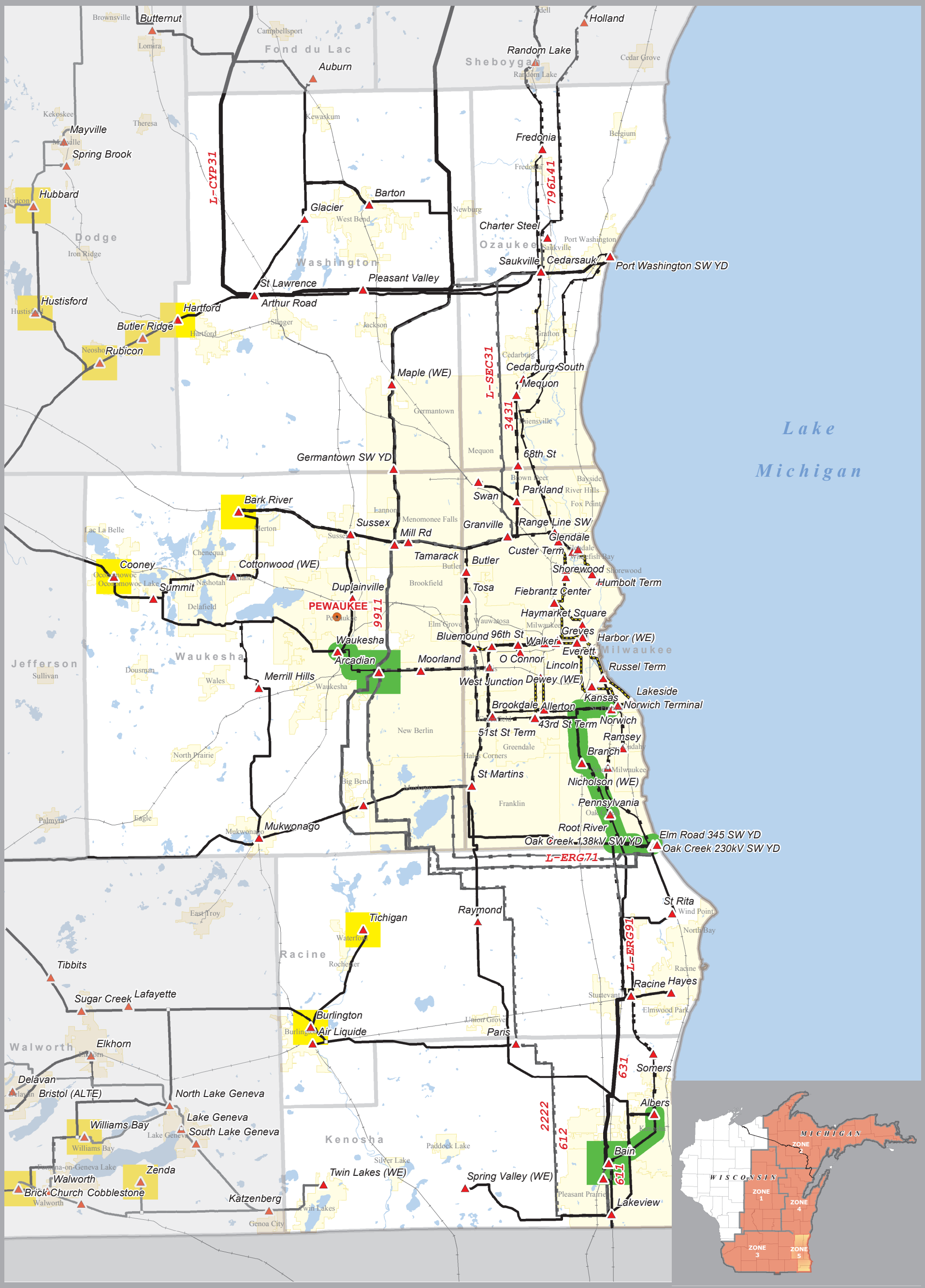
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.

Modified:March 27, 2009



AMERICAN TRANSMISSION COMPANY ®

Performance Criteria Limits Exceeded and Other Constraints 2020-2024

PLANNING ZONE 5

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties.
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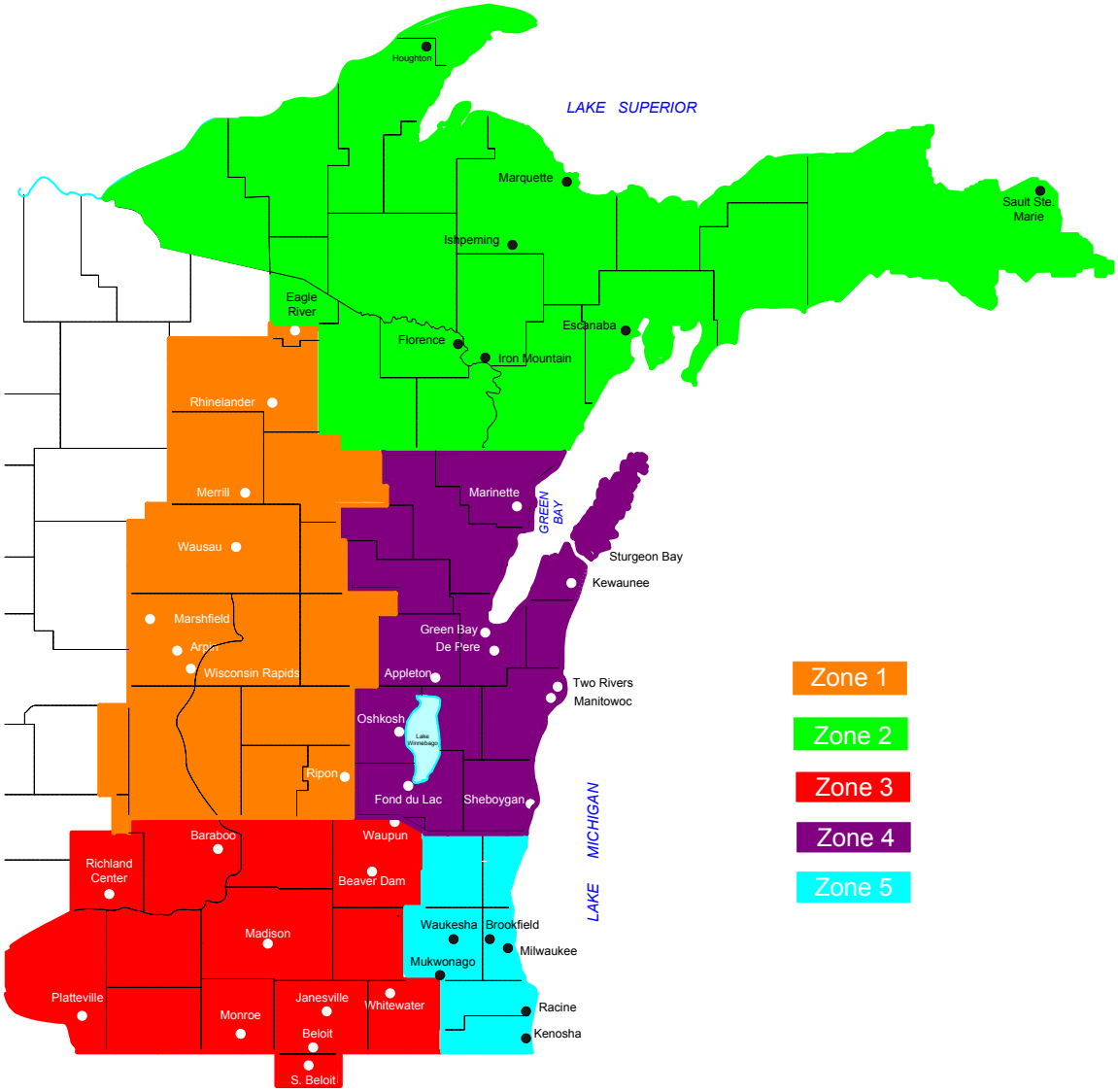
- Low/High Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission Service Limiter

Transmission Related Facilities

- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

Modified:April 24, 2009

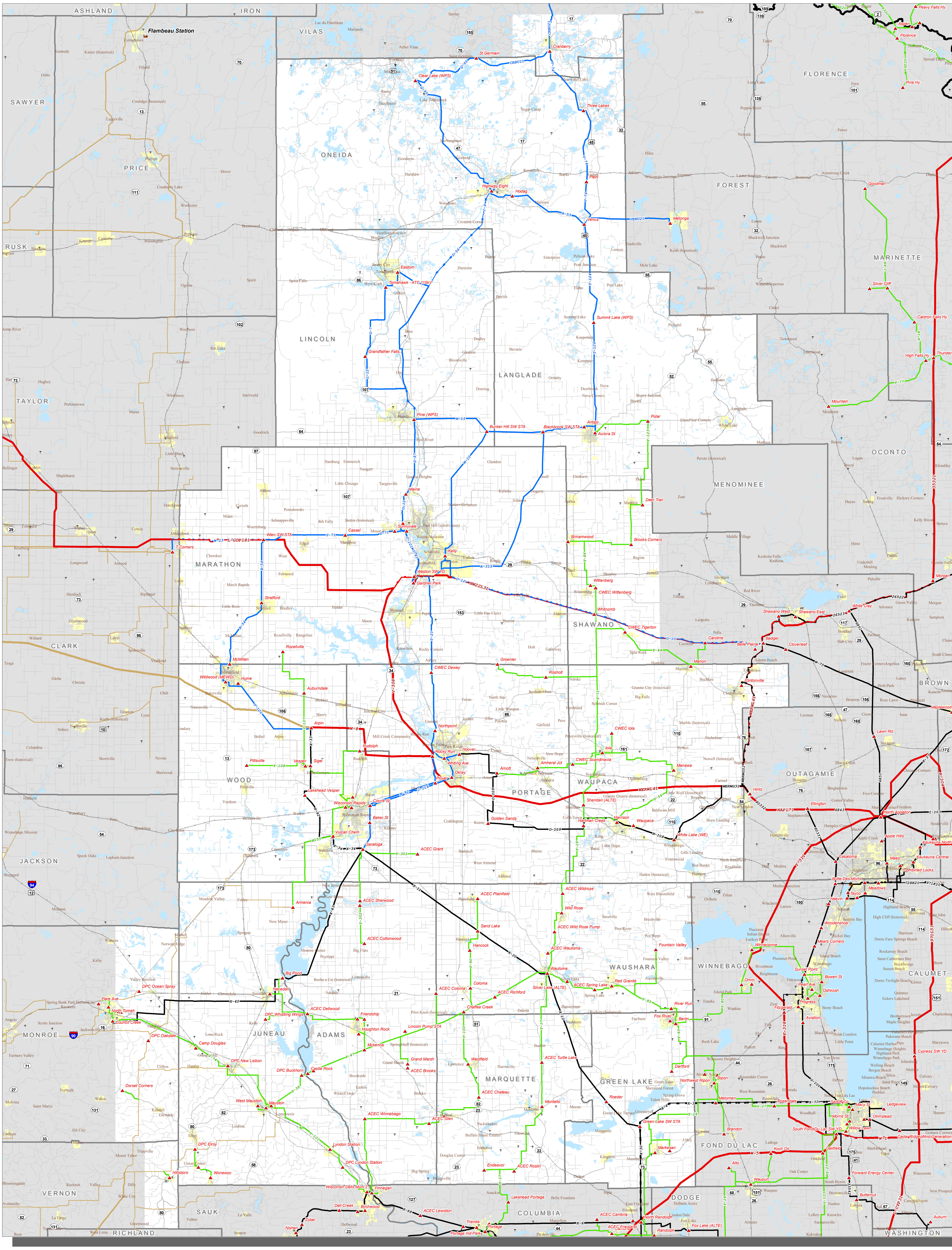
Figure ZS-21


Houghton
LAKE SUPERIOR
Marquette
Sault Ste. Marie
Ishpeming
Eagle River
Florence
Escanaba
Iron Mountain
Rhinelander
Merrill
Marinette
GREEN BAY
Wausau
Sturgeon Bay
Kewaunee
Marshfield
Green Bay
De Pere
Appleton
Wisconsin Rapids
Two Rivers
Manitowoc
Oshkosh
Lake Winnebago
Ripon
Fond du Lac
Sheboygan
LAKE MICHIGAN
Baraboo
Waupun
Richland Center
Beaver Dam
Waukesha
Brookfield
Madison
Milwaukee
Mukwonago
Platteville
Janesville
Whitewater
Racine
Monroe
Beloit
Kenosha
S. Beloit
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5

AMERICAN TRANSMISSION COMPANY®

Transmission Network and Substations

PLANNING ZONE 1



Electric Transmission and Related Facilities

Substation or Switchyard

Generation

ATC Office Location

Airport, Airfield or Helicopter Landing Site

69 kV
115 kV
138 kV
230 kV
345 kV

69 kV Double Circuit
115 kV Double Circuit
138 kV Double Circuit
230 kV Double Circuit
345 kV Double Circuit
Mixed voltage multiple circuit lines drawn with each line color corresponding to the appropriate voltage.

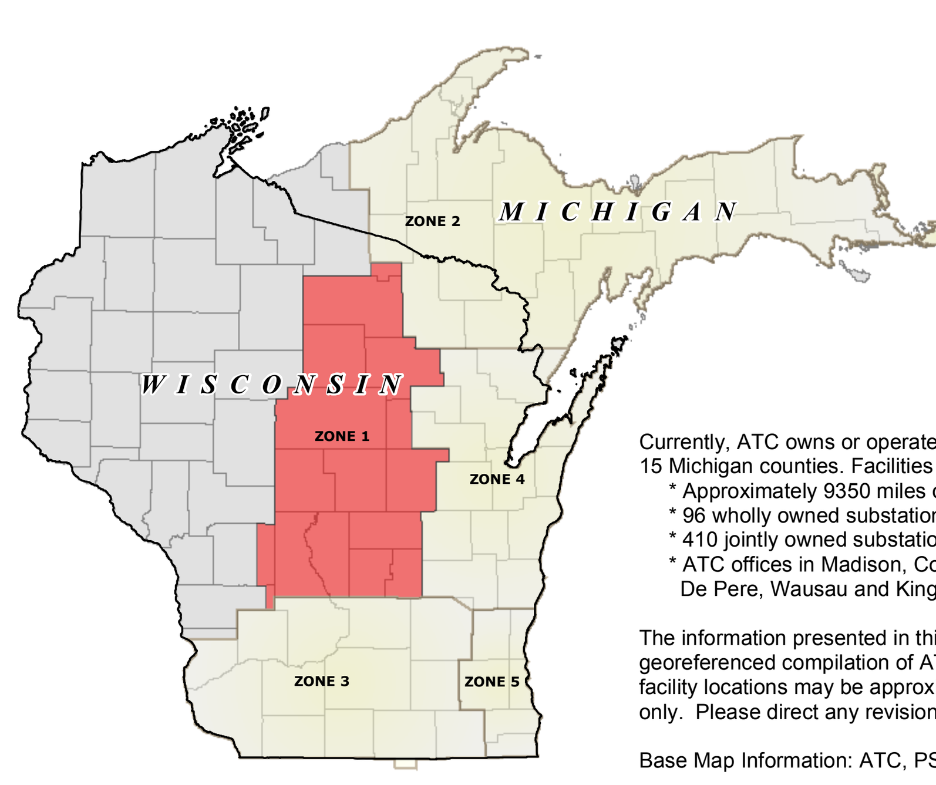
69 kV Underground
115 kV Underground
138 kV Underground

Non-ATC

69 kV
88 kV
115 kV
161 kV
345 kV

Miles

10 0 10 20



N
W E
S

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

* Approximately 9350 miles of transmission lines
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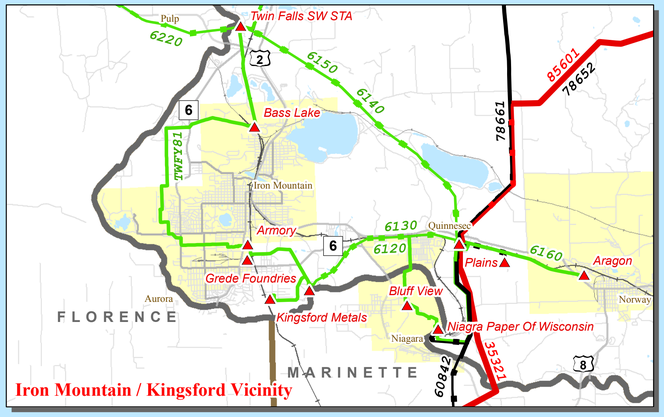
* 410 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

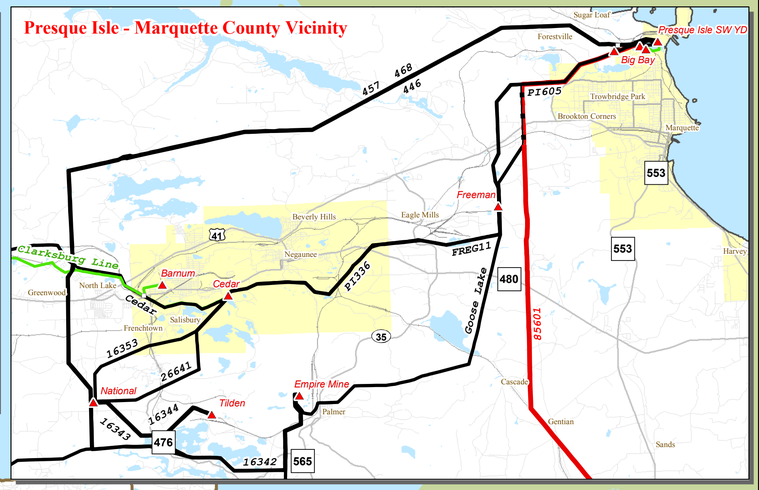
The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities available - some facility locations may be approximate. This map is advisory and intended for reference purposes only. Please direct any revisions or corrections to ATC Asset Applications and GIS Group.

Base Map Information: ATC, PSCW, MiDNR, WDNR

Revised: June 2009

G:\WORKSPACE\ArcMap Templates\Zone Maps\Zone1.mxd Modified: Jun 16, 2009





Electrical Transmission and Related Facilities

Transmission Facilities

- Substation or Switchyard
- Tap or Switching Structure
- Generation
- **ATC Office Location**

Transmission Line Voltage and Type

69 kV	69 kV Double Circuit	69 kV Underground
115 kV	115 kV Double Circuit	115 kV Underground
138 kV	138 kV Double Circuit	138 kV Underground
345 kV	345 kV Double Circuit	

Mixed voltage double circuit lines drawn using line colors representative of voltage. Actual line configuration may be obscured due to map scale. Please notify ATC Real Estate/GIS of any errors or omissions found.

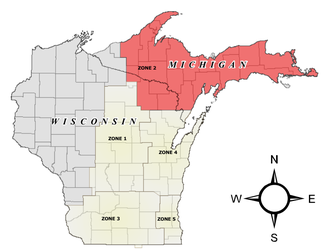
- MI Paved Airport or Airfield
- MI Unpaved Airport or Airfield
- WI Airport or Airfield

Transmission Network and Substations

PLANNING ZONE 2

Miles

10 0 10 20 30 40



AMERICAN TRANSMISSION COMPANY ®

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:

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- *410 jointly owned substations*
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Base Map Information: ATC, PSCW, MIDNR, WDNR

Revised June 2009

G:\WORKSPACE\ArcMap Templates\Zone Maps\Zone2.mxd Modified: June 16, 2009

Electric Transmission and Related Facilities

Transmission Facilities

- Substation or Switching Yard
- Generation
- ATC Office Location
- Airport, Airfield or Helicopter Landing Area

Transmission Line Voltage and Type

69 kV	69 kV Double Circuit	69 kV Underground
115 kV	115 kV Double Circuit	
138 kV	138 kV Double Circuit	138 kV Underground
161 kV	161 kV Double Circuit	
230 kV	230 kV Double Circuit	
345 kV	345 kV Double Circuit	

Mixed voltage double circuit lines drawn with each line color corresponding to the appropriate voltage.

Non-ATC

- < 50 kV
- 69 kV
- 88 kV
- 115 kV
- 161 kV
- 345 kV

Facility (Design or Construction)

G:\WORKSPACE\ArcMap Templates\Zone Maps\Zone3.mxd Modified: June 23,2008

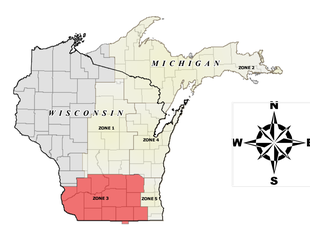
Transmission Network and Substations

PLANNING ZONE 3

Miles

5 0 5 10 15 20

Revised June 2009



AMERICAN TRANSMISSION COMPANY®

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:
- ** Approximately 9350 miles of transmission lines*
- ** 96 wholly owned substations*
- ** 410 jointly owned substations*
- ** ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

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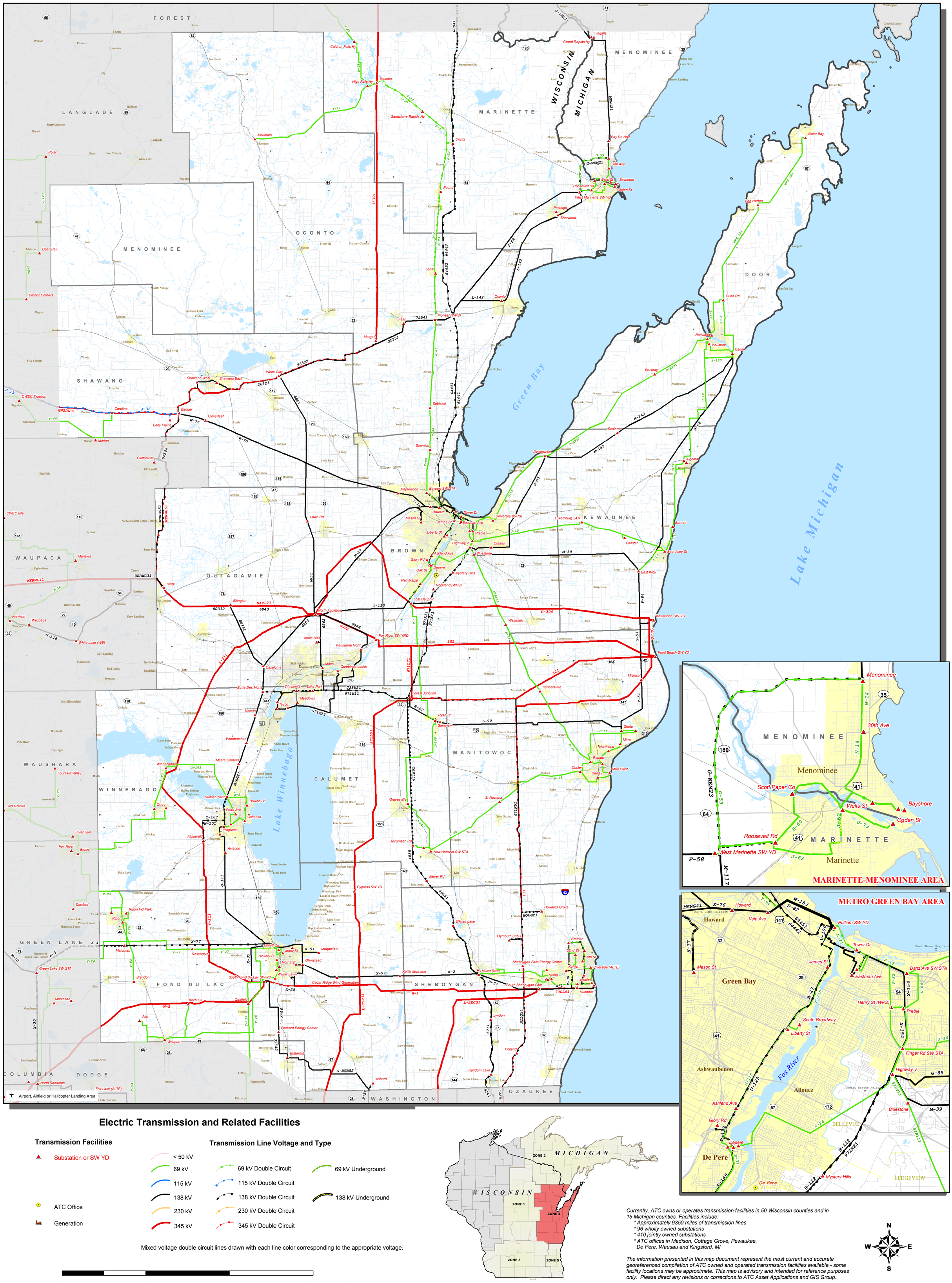
Base Map Information: ATC, PSCW, MIDNR, WDNR

Transmission Network and Substations

AMERICAN TRANSMISSION COMPANY ®

PLANNING ZONE 4



Electric Transmission and Related Facilities

Transmission Facilities

- Substation or SW YD
- ATC Office
- Generation

Transmission Line Voltage and Type

< 50 kV		
69 kV	69 kV Double Circuit	69 kV Underground
115 kV	115 kV Double Circuit	
138 kV	138 kV Double Circuit	138 kV Underground
230 kV	230 kV Double Circuit	
345 kV	345 kV Double Circuit	

Mixed voltage double circuit lines drawn with each line color corresponding to the appropriate voltage.

10 0 10 20 Miles

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- *410 jointly owned substations*
- *ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities available - some facility locations may be approximate. This map is advisory and intended for reference purposes only. Please direct any revisions or corrections to ATC Asset Applications and GIS Group.

Base Map Information: ATC, PSCW, MiDNR, WDNR

N W E S

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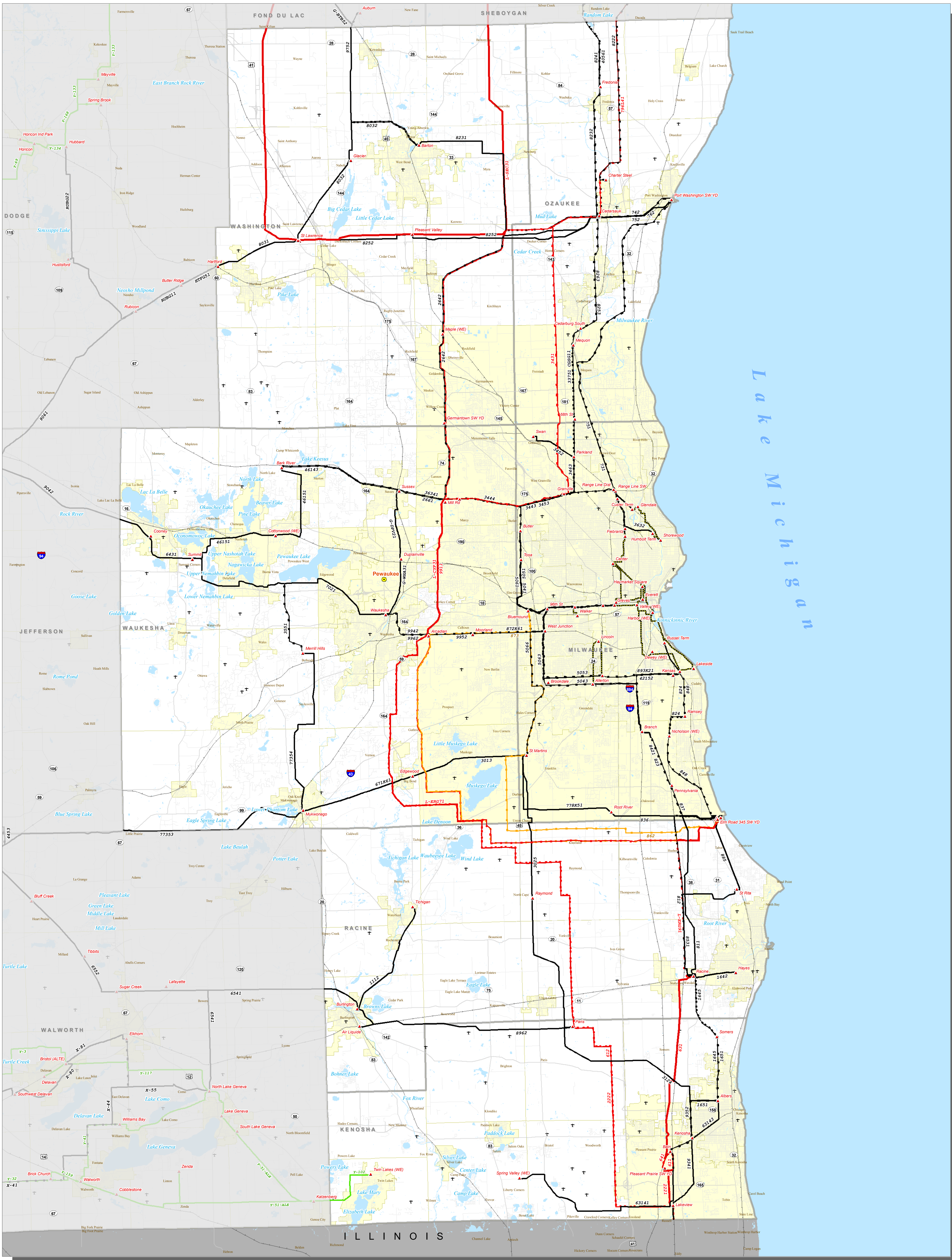
Figure ZS-26

AMERICAN TRANSMISSION COMPANY ®

Transmission Network and Substations

PLANNING ZONE 5



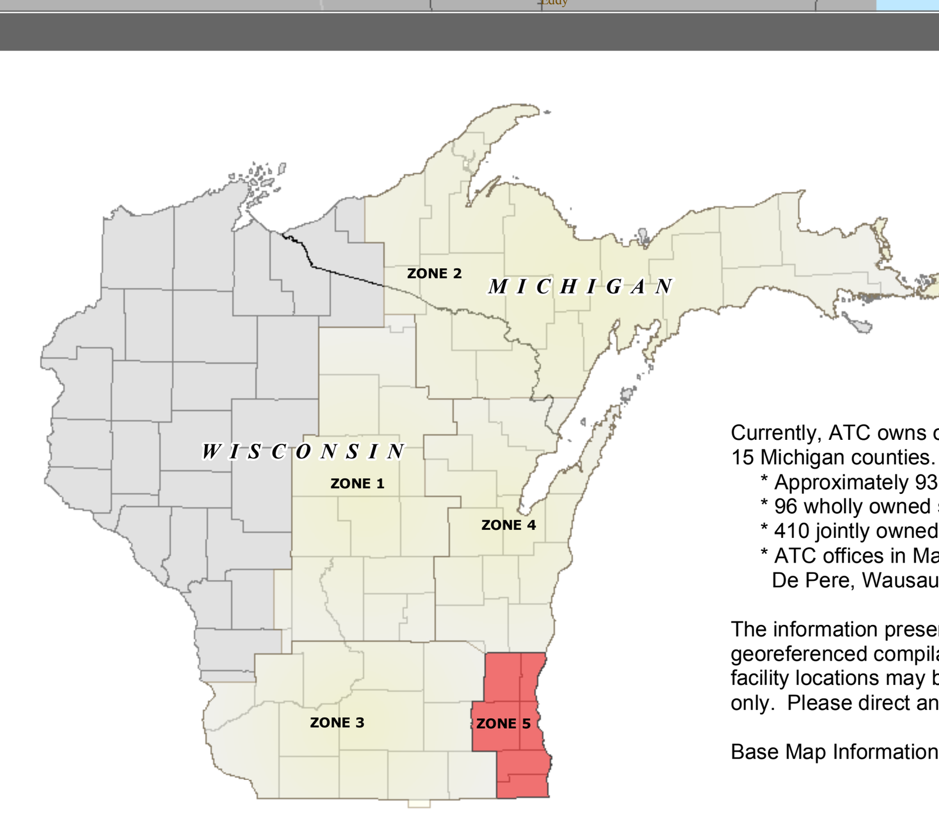
Electric Transmission and Related Facilities

- Substation or Switchyard
- 69 kV
- 69 kV Double Circuit
- 69 kV Underground
- 115 kV
- 115 kV Double Circuit
- 138 kV
- 138 kV Double Circuit
- 138 kV Underground
- Generation
- 230 kV
- 230 kV Double Circuit
- ATC Office Location
- 345 kV
- 345 kV Double Circuit
- Mixed voltage multiple circuit lines drawn with each line color corresponding to the appropriate voltage.
- Airport, Airfield or Helicopter Landing Site

Miles

10 0 10

Revised June 2009



N W E S

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:
- * Approximately 9350 miles of transmission lines
- * 96 wholly owned substations
- * 410 jointly owned substations
- * ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

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Base Map Information: ATC, PSCW, MiDNR, WDNR

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