September 2008 10-Year Assessment
www.atc10yearplan.com

Zones & Study Results section

Introduction

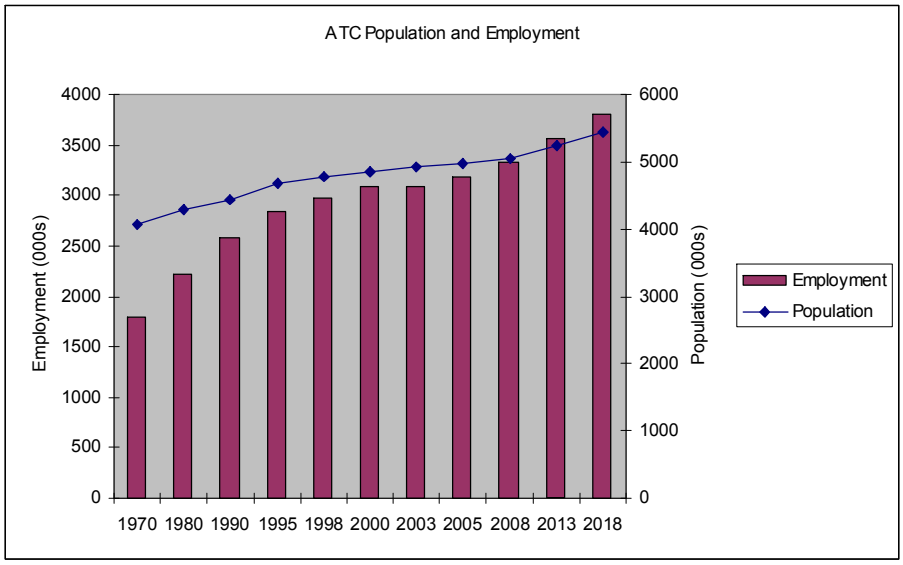
For system planning purposes, we have defined five planning zones representing distinct geographic areas within our overall service territory. Within each zone, we compile and assess the transmission system needs. This zone-level planning is one of four levels at which transmission system needs are assessed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

For each zone, we have compiled recent information on:

- ❑ demographics,
- ❑ future population and employment projections,
- ❑ environmental considerations,
- ❑ electricity demand and generation,
- ❑ transmission system issues,
- ❑ 2007 study results,
- ❑ 2011 study results and
- ❑ 2015 study results.

Demographics

Population and employment for the American Transmission Company service area has grew steadily as the graph below illustrates. From 1970 to 2008, population has grown 0.6% a year, while employment in the service area has grown even faster at 1.6% per year.



For the 10-year period from 1998 to 2008, the population of the service area grew at an annual rate of 0.6%, while the United States increased 1.0% over that same period. The annual employment growth rate for the same period was 1.1%, while again the United States grew faster at 1.4%

Within the ATC service area over the same 10-year period, the highest growth rate for both population and employment occurred in Zone 3 (South Central/Southwest Wisconsin and North Central Illinois.)

Population in the ATC service area is projected to grow at 0.7% annually between 2008 and 2018, while the United States is growing 1.0%. Employment in the ATC service area for the same period is projected to grow at 1.4% annually, which very close to growth in the United States (1.5%).

Within the ATC service area over the same period, the highest growth rate for both population and employment again occurred in Zone 3.

Employment Growth Rates				
	1998-2008	2008-2013	2013-2018	2008-2018
Zone 1	1.07	1.09	1.04	1.07
Zone 2	0.76	1.52	1.41	1.47
Zone 3	1.68	1.70	1.59	1.64
Zone 4	1.31	1.32	1.25	1.29
Zone 5	0.71	1.30	1.21	1.26
ATC Total	**1.12**	**1.40**	**1.31**	**1.35**
Rest of MI	0.48	1.24	1.17	1.20
Rest of WI	1.49	1.27	1.20	1.24
Michigan	0.49	1.24	1.17	1.21
Wisconsin	1.19	1.38	1.29	1.34
United States	1.44	1.55	1.44	1.49

Population Growth Rates				
	1998-2008	2008-2013	2013-2018	2008-2018
Zone 1	0.31	0.58	0.63	0.60
Zone 2	-0.13	0.29	0.35	0.32
Zone 3	0.96	0.96	0.97	0.96
Zone 4	0.63	0.87	0.89	0.88
Zone 5	0.47	0.57	0.61	0.59
ATC Total	**0.56**	**0.71**	**0.74**	**0.73**
Rest of MI	0.27	0.37	0.43	0.40
Rest of WI	0.77	0.86	0.88	0.87
Michigan	0.26	0.37	0.43	0.40
Wisconsin	0.64	0.76	0.79	0.77
United States	0.99	0.96	0.97	0.97

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 2009, 2013, 2018 and 2023 analyses. The same information is shown graphically in Figures ZS-1 through ZS-20.

Note: The results for each zone in many cases are similar to the results presented in our Update of the 2007 10-Year Assessment issued in November 2007. 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 MW) 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 2009 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 2013, such solutions are included in the 2013 model. For criteria limits exceeded in the

2009 analysis where the preferred or potential solutions require further verification or more analysis, such solutions are not included in the 2013 model, but the need is further investigated in the 2013 analysis. In instances where the need is further verified by the 2013 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 2018 and 2023, with planned and several proposed projects being included in the 2018 and 2023 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 by 6,000 people over the period.

During the same period, the annual employment growth rate was 1.1 percent. The highest growth rate occurred in Adams County, while the largest increase in employment occurred in Marathon County.

Future Population and Employment Projections

Population in Zone 1 is projected to grow at 0.6 percent annually for both the 2008 and 2013 and 2013 through 2018 periods. From 2008 to 2013, Marathon County is projected to realize the largest increase in population, while Adams County is projected to have the highest growth rate.

Employment in Zone 1 is projected to grow at 1.1 percent annually between 2008 and 2013 and at 1.0 percent from 2013 through 2018. From 2008 to 2013, Marathon County is

projected to realize the largest increase in employment, while Adams County is projected to have the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 1	1.07	1.09	1.04	33,294	18,398	18,540
Adams County	3.50	2.45	2.38			
Marathon County				14,806	5,222	5,108
Population						
Zone 1	0.31	0.58	0.63	15,959	15,294	16,933
Adams County	1.52	2.03	1.87			
Marathon County				5,972	3,220	3,645

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://www.dnr.state.wi.us/org/land/er/publications/cw/Ecological_landscapes.asp

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 2009, 2013, 2018 and 2023 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 1.3 percent annually from 2009 through 2018. 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 of the 115-kV loop in northern Zone 1 (Rhinelander Loop), including voltage stability,
- the load serving capability of the 138-kV and 69-kV network in southern Zone 1,
- Operating guides for loss of either the 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 tripping for loss of the Eau Claire-Arpin 345-kV line 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. With the Arrowhead-Stone Lake-Gardner Park 345-kV line in service and the commercial operation of Weston 4 generation during 2008, the potential overloads on 115-kV facilities monitored by the Wien SPS are mitigated (and the SPS is slated for retirement). However, the tripping of above mentioned lower voltage facilities strains the load serving capability of the network in Zone 1.
- A fourth large generator was added 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 are currently being implemented.

Zone 1 - 2009 study results

Refer to Table ZS-1 and Figure ZS-1

- 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.
- In order to accommodate the proposed generation in the Wausau area, an additional 345-kV line will be required. The difference between the in-service dates of the proposed generation and the 345-kV line needed for the generation will require that lower-voltage upgrades take place before the generation is placed in service with operating restrictions until the 345-kV line is energized.
- Low voltages at and near the Council Creek substation in the Tomah area will require that a combination of reinforcements be implemented to reliably serve load in the future.

In addition to the recently completed Arrowhead-Gardner Park 345-kV facility additions at the Weston Power Plant site, a new 550-MW generator also was constructed at this site in 2008. ATC has conducted generator interconnection studies and transmission service studies to ensure the generator can be operated without stability limitations and the output

of the generator can be delivered reliably. The analyses showed that the addition of the generator will cause overloads and system instability if the transmission system in this area is not reinforced. The analysis indicates that a new 345-kV line from the Gardner Park Substation is needed to maintain stability and to deliver the generator output, in addition to the Arrowhead-Gardner Park 345-kV line.

Based on the results of the Weston generator studies, ATC is planning the following transmission project. Appropriate applications to the Public Service Commission of Wisconsin were approved in July 2006.

- ❑ Construct a new 345-kV line from the Gardner Park Substation to a new substation, currently called Highway 22, located near the midpoint of the proposed Morgan-Werner West 345-kV line (near Shawano). We are proposing to license, permit, construct and place this line in-service by December 2009.

The Weston 550-MW generator was placed in-service in June 2008, and the projected in-service date for the Gardner Park-Central Wisconsin 345-kV line is December 2009. Based on the 18-month in-service date difference between the generator and 345-kV line project, additional studies were performed to determine if any feasible projects exist for delivery of all or a portion of the generator capacity prior to the in-service date of the Gardner Park-Central Wisconsin 345-kV line project. The interim transmission service and generator interconnection studies identified the following recently completed projects that will allow the generator to operate during this interim period. Full generator operation, without the associated interim Weston 4 Special Protection System, will not be allowed until all required 345-kV lines are placed in service. The recently completed projects are:

- ❑ reconductor Weston-Northpoint 115-kV line,
- ❑ uprate Weston-Kelly 115-kV line,
- ❑ rebuild Weston-Sherman St. and Sherman St.-Hilltop 115-kV lines as double circuits with the second circuit on each section being the new Gardner Park-Hilltop 115-kV circuit, and
- ❑ uprate Kelly-Whitcomb 115-kV line.

We are working 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 of the Monroe County-Council Creek transmission corridor. The proposed solution is 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 2012.

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.

Due to the severity of the problems, it was necessary to address the needs of the Rhinelander Loop in stages. The short-term solution, that is, projects that were implemented prior to 2005 to address the immediate needs of the loop, included the conversion of WPS's 46-kV system between Pine-Grandfather-Tomahawk-Eastom to 115 kV and constructing a new 115-kV line between Skanawan and Highway 8 substations. The conversion was completed in early May 2004 and the new 115-kV line was completed in June 2005.

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 is scheduled to be completed by June 2008 with the remainder of the project 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, capacitor bank upgrades are needed at the Berlin Substation in 2008. To address facility overloads, the existing 47 MVA Metomen 138/69-kV transformer will be replaced with a 100 MVA transformer in 2013. Overloads on the Arpin 345/138-kV transformer and Arpin-Sigel 138-kV line are being addressed by the Arpin Operating Guide. 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 Creek 69-kV line. In 2012, a new 115-kV transmission line is needed from Clear Lake to the new Arnett Road distribution interconnection. The Fairwater distribution interconnection in the greater Ripon

area will require a new 69-kV transmission line. The proposed Fairwater Substation will require a new radial 69-kV line be extended from the Brandon 69-kV Substation in 2010.

A new proposed project is the rebuilding of the Arpin–Rocky Run 345-kV circuit. This maintenance-driven project will improve the circuit's reliability, and ensure safety and our compliance with current code requirements. 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. Thus, ATC is in the process of preparing an application to be submitted to the WPSC in 2008 with an anticipated completion date for the rebuild in 2010.

Projects whose "Need date" precedes the "In-service date"
None

Zone 1 - 2013 study results

Refer to Table ZS-2 and Figure ZS-2

Summary of key findings

- 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.
- 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.

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. These reinforcements include a phase-shifting transformer, series reactor, capacitor banks, operating guides, or a combination. To address the near-term pre- and post- contingency issues, capacitor banks were installed on the Council Creek 138-kV bus in 2006 in conjunction with the continued use of the Council Creek operation guide. We are

currently working 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 2012.

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. Thus, one recently announced large industrial plant closure in this general area will help defer the need to implement a system reinforcement to address looming system limitations.

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. Additionally, redispatch of local generation may help alleviate these issues.

To address low voltages and overloads elsewhere within Zone 1, additional capacitor banks will be needed at the Ripon Substation in 2016 and an additional transformer will be installed at the Wautoma Substation in 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.

Zone 1 - 2018 study results

Refer to Table ZS-3 and Figure ZS-3

- 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 facilities overloads in Zone 1, the Castle Rock-Mckenna 69-kV line will need to be upgraded to achieve a higher thermal rating. 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.

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.

Zone 1 - 2023 study results

Refer to Table ZS-4 and Figure ZS-4

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

Following are the results of the 2023 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 1. 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.

An outage of the Rocky Run 345/115-kV transformer #2 or the Arpin-Sigel 138-kV line results in the Rocky Run 345/115-kV transformer #3 exceeding its summer emergency rating. Transformer #3 is the largest of the three 345/115-kV transformers at Rocky Run, but the overload of this unit occurs first because this unit is the only one of the three transformers at Rocky Run that is not capable of carrying additional load for short durations. Thus, the summer normal and emergency ratings are the same.

The Plover–Coyne 115-kV circuit is approaching its summer emergency rating for an outage of the Arpin–Sigel 138-kV circuit.

The Chaffee Creek–Coloma Tap 69-kV circuit exceeds its summer emergency ratings for an outage of the Necedah Tap – Big Pond 69-kV circuit.

The Harrison 138/69-kV transformer will load to 97% of its summer normal rating under intact system conditions. The loading of the transformer is not yet a concern under first contingency system conditions.

Low voltages are being shown on the 69-kV circuit between Portage and Montello for the Portage-Lakehead Portage or Lakehead Portage–Endeavor Tap 69-kV circuit outages.

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 2009-2013, and for the 2014-2018 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 0.9 percent per year and the largest increase in population of 1,800 occurred in Vilas County.

During the same period, the annual employment growth rate was 0.8%. The highest growth rate and the highest increase in employment occurred in Marquette County (Michigan).

Future Population and Employment Projections

Population in Zone 2 is projected to grow on an annual basis slightly between 2008 and 2013 and only 0.4 percent from 2013 through 2018. From 2008 to 2013, Chippewa County (Michigan) is projected to realize the largest increase in population and Florence County has the highest growth rate.

Employment in Zone 2 is projected to grow at 1.5 percent annually between 2008 and 2013 and at 1.4 percent from 2013 through 2018. From 2008 to 2013, Marquette County (Michigan) is projected to realize the largest increase in employment, while Vilas County is projected to have the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 2	0.76	1.52	1.41	13,245	14,170	14,171
Marquette County (MI)	1.76			6,077	3,176	3,174
Vilas County		2.29	2.04			
Population						
Zone 2	-0.13	0.29	0.35	-4,265	4,798	5,897
Vilas County	0.86			1,834		
Florence County		1.15	1.13			
Chippewa County (MI)					1,415	1,533

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 2009, 2013, 2018 and 2023 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 0.2 percent annually from 2009 through 2018. 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.

Key system performance issues in Zone 2 include:

- 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 have resulted in 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 recent load increases.**

Zone 2 - 2009 study results

Refer to Table ZS-1 and Figure ZS-5

Summary of key findings

- Low voltages for many critical outages in Zone 2 may be adequately addressed with capacitor bank installations or distribution power factor correction, and the addition of the Cranberry-Conover-Plains line project in 2010.
- Potential load additions in Delta County may necessitate the need for several thermal upgrades.

First contingency overloads of one Atlantic-Osceola 69-kV line, for the loss of the parallel Atlantic-Osceola 69-kV line, were observed in the 2009 study. One of the lines was rebuilt in 2008 to address existing condition issues. Clearances are also being increased on the Mass-Winona-Atlantic and M38-Atlantic 69-kV lines in the 2008-2009 timeframe.

Various first-contingency outages are expected to result in voltages less than 90 percent of nominal at the Munising, Roberts, Osceola and L'Anse 69-kV buses. To address first-contingency low voltages elsewhere in Zone 2, 138-kV capacitor bank additions are needed at the M38, Hiawatha and Perkins Substations in the 2009-2010 timeframe. The M38 capacitor bank is new to this Assessment due to higher load forecasts in the western U.P.

An approved Transmission Service Request for 35 MW from the White Pine Mine in 2008 was modeled in the 2009 study case, including the uprates of numerous 69-kV lines in that area to accommodate that service. The studies showed that the addition of this generation in the northwestern portion of the U.P. provided an additional voltage profile benefit due to the reduced level of import to this portion of the system.

Two transmission lines were identified to be limiting elements under specific shoulder peak conditions by 2009. As a result, uprates of the Empire-Forsyth 138-kV and Chandler-Cornell 69-kV lines will be completed in the 2008-2009 timeframe.

Due to age and condition issues associated with the existing facilities, the Cedar Substation is currently being rebuilt and relocated. The new Cedar Substation, renamed North Lake, will also address reliability issues in the north central Upper Peninsula.

The construction of a ring bus at Pine River and associated capacitor bank upgrades in 2009 will bolster the voltage in the Eastern Upper Peninsula under normal and single

contingency conditions to acceptable levels until additional reinforcements can be implemented in the area.

In response to customer requests for new distribution interconnections, the Atlantic and M38 138/69-kV transformers will be uprated in 2009.

Projects whose "Need date" doesn't match the "In-service date"

- ❑ Uprate the Delta-North Bluff 69-kV line summer normal and emergency ratings from 120 to 167 degrees F
- ❑ Uprate the North Bluff-Gladstone 69-kV line summer normal and emergency ratings from 120 to 167 degrees F
- ❑ Uprate the Masonville-Gladstone 69-kV line summer normal and emergency ratings from 120 to 167 degrees F
- ❑ Uprate the Chandler-Masonville 69-kV line summer normal and emergency ratings from 120 to 167 degrees F
- ❑ Uprate the Chandler-Delta #1 69-kV line summer emergency rating from 120 to 167 degrees F
- ❑ Uprate the Chandler-Delta #2 69-kV line summer emergency rating to from 120 to 167 degrees F

New to this Assessment and as a result of a potential load increase in Delta County, potential thermal overloads were discovered on the above six lines under single-contingency conditions. LIDAR surveys and ratings reviews on these lines will be done to determine the scope of these projects. ATC Planning will work with Project Management to determine the ultimate in-service dates of these line uprates. This will also depend upon whether there will be additional load that requires transmission service. Until transmission service is needed and can be provided, generation redispatch will be used to avert overloads.

- ❑ Uprate the Straits-Pine River ESE_6904 69-kV line ratings to 35/50 MVA summer normal/summer emergency
- ❑ Uprate the Straits-Pine River 6905 69-kV line ratings to 35/50 MVA summer normal/summer emergency

New in this Assessment, thermal overloads were discovered on the above two lines under single-contingency conditions. LIDAR surveys and ratings reviews on these lines will be done to determine the scope of these projects. ATC Planning will work with Project Management to determine the ultimate in-service dates of these line uprates.
These overloads were observed in the 2008 Assessment due to projected low hydroelectric generation in the eastern U.P. which was modeled in the study cases. Dispatching local diesel generation or a return to normal hydro levels would mitigate these potential overloads.

Projects whose "Need" and "In-service" dates are to be determined

- ❑ Convert Indian Lake-Hiawatha 69-kV line to double-circuit 138-kV operation, construct new Hiawatha 138-kV Substation
- ❑ Uprate overhead portions of Straits-McGulpin 138-kV circuits #1 & #3 to 230 F degree summer emergency ratings

All four of the above projects require further study to determine when and if the project(s) should be implemented.

Zone 2 - 2013 study results

Refer to Table ZS-2 and Figure ZS-6

Summary of key findings

- ❑ The completion of the Morgan-Werner West and Northern Umbrella Plan projects will result in dramatic increases in Wisconsin-Michigan transfer capability, likely reducing the locational marginal price of energy. In addition, substantial reliability benefits will be realized with these sets of projects.
- ❑ Low voltages were observed in the Eastern U.P. which will be addressed as part of the review performed for this portion of the ATC system.
- ❑ The poor condition of the line and system reliability considerations will require developing a plan to replace the Blaney Park-Munising 69-kV line.

A complete review of ATC's needs in the Eastern Upper Peninsula (U.P.) is underway. Earlier 10-Year Assessments specified various projects in the Eastern U.P., including the creation of a double-circuit 138-kV conduit from Indian Lake to Hiawatha. This review will assess if all or some of those projects should still be constructed in the near-term, constructed in a phased manner, or perhaps a different set of projects proposed.

A collaborative planning effort is underway in Zone 2 to assess the needs of the Upper Peninsula of Michigan. The ATC Energy Collaborative – Michigan will include participation from ATC stakeholders and customers, as well as other regional utilities and entities which have an impact on ATC's northern system performance and needs. This collaborative is scheduled to be completed by late 2008/early 2009 and will result in a plan to address the immediate and long-term energy needs in the Upper Peninsula.

Conversion of the Conover to Plains 69-kV corridor to 138 kV, along with the addition of 138/69-kV transformations at Iron Grove (formerly Iron River Substation) and Aspen

(formerly Brule Substation) will greatly improve the reliability and voltage profile on the western U.P. 69-kV system.

The 2010 addition of the North Bluff 69-kV and Indian Lake 138-kV capacitor banks will address remaining voltage violations in the Upper Peninsula.

Portions of the Blaney Park-Munising 69-kV line will need to be rebuilt due to poor physical condition. Reliability of service to customers served by this line is also a concern because this relatively long line is currently operated radially from Munising (open at Blaney Park). The condition and rating of the line prevents us from closing both ends at the same time. This provisional project has been deferred from 2013 to at least 2014 to allow time to establish an appropriate long-term plan for the area that considers whether the line should be rebuilt at 138 kV or at 69 kV.

Zone 2 - 2018 study results

Refer to Table ZS-3 and Figure ZS-7

Summary of key findings

- ❑ Uprating the Forsyth 138/69-kV transformer will be required because future load increases will exceed the maximum capability of the existing transformer.

The summer emergency rating of the Forsyth 138/69-kV transformer will need to be increased to 57 MVA to accommodate increased loading in the Gwinn and Munising areas. It is anticipated at this time that this work will include an uprate of existing equipment within the transformer, and not require a transformer replacement.

Zone 2 - 2023 study results

Refer to Table ZS-4 and Figure ZS-8

Summary of key findings

- ❑ None

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 63,000 occurred in Dane County.

During the same period, the annual employment growth rate was 1.7 percent. The highest growth rate occurred in Sauk County, while the largest increase in employment occurred in Dane County.

Future Population and Employment Projections

Population in Zone 3 is projected to grow at 1.0 percent annually for both the 2008 and 2013 and 2013 through 2018 periods. From 2008 to 2013, Dane County is projected to realize the largest increase in population, while Walworth County is projected to have the highest growth rate.

Employment in Zone 3 is projected to grow at 1.7 percent annually between 2008 and 2013 and at 1.6 percent from 2013 through 2018. From 2008 to 2013, Dane County is projected to realize the largest increase in population and Sauk County the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 3	1.68	1.70	1.59	129,332	74,027	74,930
Dane County				75,379	39,158	39,836
Sauk County	2.11	2.22	2.18			
Population						
Zone 3	0.96	0.96	0.97	108,441	57,932	61,418
Walworth County		1.61	1.54			
Dane County	1.40			62,893	31,851	33,041

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 2009, 2013, 2018 and 2023 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 2.7 percent annually from 2009 through 2018. 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 - 2009 study results

Refer to Table ZS-1 and Figure ZS-9

Summary of key findings

- Low voltages throughout Zone 3 require a total of 253 MVAR of capacitor banks be installed by 2009.
- A significant number of lines and transformers 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.

In response to low voltages throughout Zone 3, a total of 253 MVAR of capacitor banks distributed at the Sheepskin, Brick Church, Richland Center, Brewer, Beaver Dam, Kilbourn, Artesian, Lamar, Union Townline, Dickinson, Boxelder and South Lake Geneva substations were deemed to be the most feasible solutions in the 2008-2010 timeframe.

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 2009 analysis. Many projects are either planned or proposed to address these near-term thermal problems by 2009. As a result, we propose to uprate four 69-kV lines, five 138-kV lines and one 138/69-kV transformer. In addition, the Stoughton bus and line terminals will be uprated in order to address thermal overloads under contingency.

Dodge County is experiencing considerable load growth. The Rubicon-Horicon 138-kV line project was completed in 2008 to relieve several low 69- and 138-kV bus voltages during a number of key contingencies. The Academy 138/69-kV transformer that supplies power into Beaver Dam Substation and several 69-kV lines feeding the county will be susceptible to overloads under contingency. The recently completed Rubicon-Horicon project will eliminate those potential overloads as well.

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 (2009).

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 is planned 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.

Projects whose "Need date" precedes the "In-service date"
Install 2-8.16 MVAR 69-kV capacitor banks at South Lake Geneva
The need year for this project is 2007, however the in-service date is 2008. The mitigation before the summer of 2008 is to adjust local 138/69-kV transformer tap settings manually to boost the 69-kV system pre-contingency. Potential distribution load shifting may be required as well.

North Madison-Huiskamp 138-kV line
As a result of the in-service date delay of the North-Madison-Huiskamp project, a study was performed to determine what mitigation measures are necessary during the summer of 2008. The study concluded that a temporary operating guide involving an automatic protection scheme needs to be installed on both Blount-Ruskin lines.

Uprate McCue-Lamar 69-kV line
Due to an enhanced generation dispatch scenario utilized in the 2008 TYA[1], potential single-contingency low voltage problems in the Lamar area and an overload of the McCue-Lamar 69-kV line were observed in the 2008 summer peak model. Considering reasonable project lead times, the 2009 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 can be one option to address these issues. In addition, potential distribution load bridging and distribution capacitor bank installation are being investigated.

Jefferson-Lake Mills-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.

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

Install 3-16.33 MVAR 138-kV capacitor banks at North Beaver Dam Substation
The need year for this project is 2005, however the in-service date is 2009. The mitigation before the summer of 2009 is to adjust the local 138/69-kV transformer tap settings manually to boost the 69-kV system pre-contingency. Potential generation redispatch at South Fond Du Lac may also be needed.

Install 1-12.45 MVAR 69-kV temporary capacitor bank at Brick Church Substation
Due to unexpected load addition near Dickinson Substation, potential contingency low voltage problems were observed in this area. The need year for this project is 2008; however, the In-service date is 2009. The mitigation for the summer of 2008 is to install a total of 6.3 MVAR distribution capacitor banks at Dickinson Substation.

Zone 3 - 2013 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 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.
- ❑ Upon the completion of the Rock River-Elkhorn 138-kV conversion project, it is feasible to uprate/rebuild the existing Colley Road-Bristol 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.
- ❑ Load growth on the Gran Grae-Boscobel-Lone Rock-Spring Green-Stage Coach 69-kV line necessitates the need for a second 138/69-kV transformer at the Spring Green Substation.
- ❑ 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.

- 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.

In response to low voltages throughout Zone 3, a total of 273 MVAR of capacitor banks distributed at the Spring Green, Concord, Brick Church and Boscobel substations in the 2010-2013 timeframe were proposed as preliminary solutions. Of this 273 MVAR, 4-49 MVAR (196 MVAR) is proposed to be installed at the Concord 138-kV Substation to address low voltages under system intact and single-contingency conditions in the near term. Economic benefit analysis may be performed to evaluate whether these capacitors or more robust transmission projects can be justified.

There were a number of facility overloads and several facilities near their emergency ratings in Zone 3 based on the 2013 analysis. Several projects are either planned or proposed to address these near-term thermal problems by 2013. As a result, we propose to uprate two 69-kV lines (Sheepskin-Dana line Y-61 McCue-Milton Lawns Y-79) and install a second 138/69-kV transformer at Spring Green. 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 2009 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 service by 2013. Demand in Dane County is projected to grow at an above-average rate for the ATC system. High 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 retire units 3, 4 and 5, thus reducing the capacity of this power plant by 90 MW. 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 reconductor in 2013 will address these problems and provide one additional 138-kV source into Green 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.

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.

ATC submitted a Certificate of Public Convenience and Necessity (CPCN) application for Paddock-Rockdale on April 16, 2007 with a projected 2010 in-service date. Following a year-long regulatory review, the Public Service Commission of Wisconsin (PSCW) gave ATC its verbal approval on May 30, 2008 to move forward with the project. The new line, which is currently under construction, will extend an existing connection to Illinois and allow local electric distribution companies access to lower-cost power produced in the region. The savings will be passed on to end-use electricity customers under PSCW regulations.

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. To address these issues, looping the Nine Springs to Pflaum 69-kV line in and out of the Femrite Substation is proposed as the preliminary preferred project.

ATC and the city of Madison have proposed to bury part of the two Blount-Ruskin 69-kV overhead lines underground. A study is currently underway to determine the detailed scope of this project.

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.

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 rebuild Town Line Road-Bass Creek 138-kV line X-12
The need year is listed as 2009. 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).

Loop 6947 Nine-Springs-Pflaum 69-kV line into Femrite
The need year is listed as 2006. The in-service year is 2013. Post-contingency distribution load bridging will be utilized as an interim mitigation measure to alleviate potential single-contingency thermal and voltage problems.

Zone 3 - 2018 study results

Refer to Table ZS-3 and Figure ZS-11

Summary of key findings

- ❑ Additional reactive support is needed throughout the Zone 3.
- ❑ Load growth in Lake Geneva area causes several single-contingency thermal overloads and low voltages.
- ❑ Numerous low voltages and line overloads in Dodge County signal the need for a new 138-kV source.
- ❑ Potential single-contingency thermal overloads on the Gran Grae-Boscobel 69-kV line, 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 of the Dairyland Power system.
- ❑ Maintaining reliability of service to load in and around the Madison area requires additional system reinforcements in the 2017 timeframe.

In response to low voltages throughout Zone 3, a total of 253 MVAR of capacitor banks distributed at the Eden, Femrite, Mazomanie, Verona, Sun Prairie, Dam Heights and North Monroe substations in the 2014-2018 timeframe were deemed to be the preliminary solutions.

The provisional project of constructing a Horicon-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 2018 analysis. Six line uprate projects (two 138-kV uprates

and four 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 are planned to be 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 2013 will not only interconnect a new T-D substation, but also address impending low voltages and overloads identified on the transmission system.

The West Middleton 138/69-kV transformers and West Middleton-Blackhawk 69-kV line will potentially overload under single-contingency conditions in the 2017 timeframe. To address these thermal overloads, a West Middleton to Blount 138-kV line project is being considered. In conjunction with the Rockdale-West Middleton 345-kV line project (2013), the West Middleton-Blount 138-kV line can eliminate the thermal overload issues in the long term and provide additional transfer capability to into downtown Madison. The status of this project is 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.

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

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 an emerging Bass Creek-Footville thermal overload 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.

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

Zone 3 - 2023 study results

Refer to Table ZS-3 and Figure ZS-12

Summary of key findings

- ❑ Under single contingency, all three Columbia 345/138-kV transformers are approaching to their maximum summer emergency ratings.
- ❑ Load growth in the Green and Rock County areas will drive the need for additional 138/69-kV transformer capacity.
- ❑ Several 69-kV lines in the West Middleton area are approaching their summer emergency ratings under single contingency conditions.
- ❑ 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.

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 in 2018. 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.

In response to single-contingency voltage issues that occur for the loss of North Randoph-Randolph 69-kV line, 2-16.33 MVAR capacitor banks are projected to be installed at the Rio Substation.

The 2023 results suggest that further study of Zone 3, particularly around Dane County, is needed to identify an appropriate long-term solution for this area that may be required beyond the year 2018.

Projects whose "Need" and "In-service" dates are to be determined

- ❑ Construct Evansville-Brooklyn 69-kV line

- ❑ Construct West Middleton-North Madison 345-kV line
- ❑ Replace two overhead Blount-Ruskin 69-kV lines with one underground 69-kV line
- ❑ Construct DPC La Crosse-Hilltop-Spring Green-West Middleton 345-kV line
- ❑ Construct Verona-North Monroe 138-kV line

All five of the above projects require further study to determine when and if the project(s) should be implemented.

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 2009-2013, and for the 2014-2018 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 Green Bay and Appleton 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 by 23,600 people.

During the same period, the annual employment growth rate was 1.3 percent. The highest growth rate occurred in Calumet County, while the largest increase in employment occurred in Brown County, which increased by 29,400 people.

Future Population and Employment Projections

Population in Zone 4 is projected to grow annually at 0.9 percent for both the 2008 through 2013 and 2013 through 2018 periods. From 2008 to 2013, Brown County is projected to realize the largest increase in population and the highest growth rate.

Employment in Zone 4 is projected to grow at 1.3 percent annually for both the 2008 and 2013 and 2013 through 2018 periods. From 2008 to 2013, Brown County is projected to realize the largest increase in employment, while Door County is projected to have the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 4	1.31	1.32	1.25	90,971	50,676	50,931
Calumet County	3.58					
Door County		1.74	1.60			
Brown County				29,363	16,806	16,813
Population						
Zone 4	0.63	0.87	0.89	67,101	48,829	52,124
Calumet County	1.25					
Brown County		1.16	1.15	23,634	14,584	15,271

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 2009, 2013, 2018 and 2023 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 1.6 percent annually from 2009 through 2018. 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 Rocky Run-North Appleton 345-kV line,
- 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,
- heavily loaded 69-kV facilities in the Upper Peshtigo area,
- 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,
- insufficient 138/69-kV transformer capability in the Marinette area,
- heavily loaded 138- and 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 - 2009 study results

Refer to Table ZS-1 and Figure ZS-13

Summary of key findings

- ❑ By 2010, construction of a 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 losses.
- ❑ Load growth in Marinette and Menominee areas will drive the need for additional 138/69-kV transformer capacity.
- ❑ Load growth and generation patterns in the Upper Peshtigo area will drive the need for transmission reinforcements.

Several potential line overloads were confirmed and new low voltage issues were identified in Zone 4 based on the 2009 model.

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 short-term 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),
- constructing a 345/138-kV Substation at Werner West (2006), and
- rebuilding the Hiawatha-Indian Lake 69-kV line (2006).

As discussed in the 2007 10-Year Assessment Update, the following projects have been planned in Zone 4 as long-term solutions to these issues:

- construct a new 345/138-kV substation at Werner West (in service),
- construct a Cranberry-Conover 115-kV line (in service),

- rebuild and convert the Conover-Plains 69-kV line to 138-kV (2010), and
- construct a new Morgan-Werner West 345-kV line (Dec 2009).

The Morgan-Werner West 345-kV line in 2009 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 Clintonville-Werner West 138-kV line will be strung primarily on Morgan-Werner West 345-kV line structures. The planned 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.

Two-1.2 MVAR distribution capacitor banks will be in service at the Sister Bay 69/24.9-kV Substation in 2008. The addition of these capacitor banks will boost the voltages in the area under normal and single-contingency conditions until longer term solutions are in place. The long-term solution may include constructing a Canal-Dunn Road 138-kV line (2012) and a Dunn Road-Egg Harbor 69-kV line (2016) which were delayed due to the planned installation of these capacitor banks. The 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 and 69-kV lines in the area under single-contingency conditions (See Zone 4-2013 study results).

Rebuilding the Crivitz-High Falls double-circuit 69-kV lines is planned for 2009 in order to address the potential overloads on the Pioneer-Sandstone 69-kV line or the Crivitz-High Falls 69-kV line and to provide voltage support in the area under normal and single contingency conditions. The 2009 in-service date is possible because of the interim load-shifting measure from the Sandstone 69-kV to the Crivitz 138-kV Substation in 2008. Due to the non-coincident nature of the load for this area and the hydro generation patterns in the area, the potential overloads and low voltage issues may also occur during off-peak periods.

A new 138/69-kV transformer at the existing Menominee 69-kV (2008) is under construction to address West Marinette and Roosevelt Road 138/69-kV transformer overloads under single-contingency conditions. The placement of a 138/69-kV transformer

at Menominee, rather than replacing the transformers at West Marinette or Roosevelt Road will provide greater geographical diversity, while adding the needed capacity. In addition, it will provide operational and maintenance flexibility during the double-circuit outages of the West Marinette-Menominee 138- and 69-kV lines.

As discussed in earlier Assessments, the rebuild of the Sunset Point-Pearl Avenue 69-kV line would address the potential overload of the line under single-contingency conditions. The project is planned for 2009.

A new 138-kV substation at Cedar Ridge (2008) is currently under construction to accommodate the 98-MW Wind generation interconnection in Fond du Lac County. The existing Ohmstead-Kettle Moraine 138-kV line will be looped into the new substation.

The Mishicot Substation will be relocated in 2009 to accommodate a 99-MW wind generation addition in Kewaunee County.

In the summer of 2008, the North Appleton-Mason Street and North Appleton-Lost Dauphin 138-kV lines were uprated to accommodate the transmission service request associated with the Fox Energy Center wind generation.

An uprate of the North Appleton-Fox River 345-kV line was recently completed. Significant clearance violations on the line were identified in recent LiDar clearance studies. As a result, uneconomic generation redispatch was needed to relieve the loading on the line in anticipation of a North Appleton-Kewaunee 345-kV line outage. The situation became aggravated when the ATC system experienced heavy east-to-west biases in system flow. The project provides additional capacity to the line and addresses the loading issue.

New to this Assessment, installing a second 138-kV reserve auxiliary transformer at Kewaunee and removing the existing tertiary auxiliary transformer (TAT) load from the 345/138-kV transformer T10 is proposed for 2009. Implementing the project will increase the offsite power reliability and provide better operations and maintenance flexibility. With the existing Kewaunee TAT connection on T10, a T10 failure will result in the reduction of the number of offsite power sources to one independent source. This will result in the Kewaunee nuclear unit entering a 7-day Limiting Condition for Operation (LCO). If T10 cannot be replaced or repaired within those 7 days, the unit would be required to shut down. In general, the repair/replacement for a faulted transformer takes more than 7 days. Furthermore, the existing TAT connection makes T10 unavailable for maintenance outside of a refueling outage.

Also, new to this Assessment, significant new loads forecasted at the Sobieski 69-kV Substation would result in unexpected low voltages at Suamico and Sobieski 69-kV substations under normal and single-contingency conditions and heavy flow on the

Pioneer-Sobieski 69-kV line under single-contingency condition. However, recent information from Wisconsin Public Service Corporation indicates that the new load will not be interconnected, and the load forecast at the substation will be revised in future Assessments.

Zone 4 - 2013 study results

Refer to Table ZS-2 and Figure ZS-14

Summary of key findings

- ❑ Additional reinforcements will be required in Northern Door County to facilitate maintenance outages, improve voltages and provide a second source to the area.
- ❑ 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 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.

New to this Assessment, 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 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 metering current transformer at the North Mullet River 69-kV Substation is scheduled for 2011 to address a potential overload of the North

Mullet River-Mullet River 69-kV line under single-contingency conditions. In order to obtain an accurate analysis, the ratings of the line are under investigation. Depending on the ratings of the line, the in-service date of the project may need to be adjusted.

Zone 4 – 2018 study results

Refer to Table ZS-3 and Figure ZS-15

Summary of key findings

- ❑ Load growth in the northern Brown County will drive the need for system reinforcements.
- ❑ Additional reinforcements are needed due to load growth in the Oshkosh, Manitowoc and eastern Calumet County areas.

A provisional project to rebuild and convert the Bayport-Pioneer 69-kV line to 138-kV operation is tentatively scheduled for 2016. This project would provide network service to the currently radially-served Bayport, Suamico and Sobieski and address potential low voltages and thermal overloads under single-contingency conditions.

Several capacitor bank projects have been deferred and are now scheduled for the 2015-2018 timeframe. Additional adjustment of the in-service dates may be needed upon further analysis. Those projects are:

- Install 2-16.3 MVAR capacitor banks at the Mears Corners 138-kV Substation (2015) - This provisional project is to address the potential low voltage issues in the Woodenshoe, Mears Corners, and Sunset Point areas under single contingency conditions until additional reinforcements are implemented in the area. The provisional project has been deferred from 2011 to 2015 primarily due to an updated load model in the area.
- Install 2-16.3 MVAR capacitor banks at the Rosiere 138-kV Substation (2015) - This provisional project is to address the potential low voltage issue in the Ontario, Dyckesville, and Rosiere areas under single contingency conditions until additional reinforcements are implemented in the area. Due to the uncertainty of load demand in the area, a detailed study needs to be done for an accurate in-service date. The provisional project has been deferred from 2011 to 2015 primarily due to an updated load model in the area.
- Install 1-28.8 MVAR capacitor bank at the Butternut 138-kV Substation (2016) –This provisional project is to address potential low voltages at the Butternut, Forward Energy Center and Hickory 138-kV substations under single contingency conditions. The project has been deferred from 2015 to 2016 due to an updated load model in the area.
- Install 2-16.3 MVAR capacitor banks at the Aviation 138-kV Substation (2018) – This provisional project is to address the potential low voltage issues at the Progress and

Ellinwood Substations under single contingency conditions. The project has been deferred from 2015 to 2018 due to updated load model in the area.

A new 138-kV line project is proposed to 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 2014 to 2016 based upon updated generator information, In addition, the in-service date may need to be adjusted after a more detailed study is completed (such as economic benefit analysis).

A provisional project for replacing the two existing Glenview 138/69-kV transformers is scheduled for 2014. It would address the potential overload of the transformers under single contingency conditions. The transformer overloads are primarily due to higher load demand at Brillion Iron Works (BIW). This project may be able to be deferred several years by swapping the loads on the Glenview 69-kV and 138-kV buses.

In the 2018 summer peak timeframe, the two 138/69-kV transformers at the Sunset Point Substation would be overloaded under single contingency conditions. To address these overload issues, replacing the two existing transformers with larger transformers is proposed for 2018. The project has been deferred from 2015 to 2018 due to an updated load model in the area. In addition, the in-service date may need to be adjusted further depending on the analysis performed in the 2009 10-Year Assessment.

Replacing the 1200A breaker at the Edgewater T22 345/138-kV transformer is proposed for 2018 to address potential transformer overloads under single contingency conditions. The project has been deferred from 2014 to 2018 due to an updated load model in the area. The in-service date may need to be adjusted further depending on the analysis performed in the 2009 10-Year Assessment.

Uprating the Melissa-Tayco 138-kV line (0.16 miles) is scheduled for 2016 to address the line overload under single contingency conditions and certain generation patterns. The project has been deferred from 2014 to 2016 based on updated generation dispatch information. The in-service date may need to be adjusted further depending on the results of an economic benefit analysis and system studies performed in the 2009 10-Year Assessment.

Due to generation retirements and/or updated load forecast information, several projects have been cancelled. Those projects are:

- replacing the existing 138/69-kV transformer at South Sheboygan Falls with a 100 MVA transformer,
- reconductoring Pulliam-Danz-Henry Street and Pulliam-Van Buren 69-kV lines, and

- constructing the Northside-City Limits 138-kV line.

Zone 4 – 2023 study results

Refer to Table ZS-4 and Figure ZS-17

Summary of key findings

- ❑ Load growth in the Sheboygan and northern Ozaukee Counties may drive the need for system reinforcements.
- ❑ Additional reinforcements may be needed due to the load growth in the Appleton area.
- ❑ Additional reinforcements may be needed due to load growth in central Kewaunee County.

Transmission reinforcements appear to be needed in the Sheboygan, Kewaunee, and Green Bay areas. The reinforcements listed below are based upon our preliminary analysis to address system problems under single-contingency conditions. Further adjustments will be made to reflect needs as well as in-service dates in the upcoming 2009 10-year Assessment.

- Between 2019 and 2023, 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.
- Heavy flows on the 138-kV lines around the City Limits 138-kV Substation may occur under single-contingency conditions. The City Limits-Maes 138-kV line ratings are currently under review. A detailed study will be performed with the updated/validated line ratings during the 2009 10-Year Assessment to identify the need year of this project. Constructing a second North Appleton-Apple Hills 138-kV line could be one of alternatives studied to address the heavy flow issues.
- Uprating the Edgewater-Washington 69-kV line may be needed in the 2022 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 at the 69-kV substations along line J-10 under single-contingency conditions.
- Additional transmission reinforcements such as rebuilding the existing Oak Street-Ashland 69-kV line may be needed in the 2023 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 such as uprating the Kewaunee-East Krok 138-kV line will be required.

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 2009-2013, and for the 2014-2018 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 by approximately 32,000 people over the period.

During the same period, the annual employment growth rate was 0.7 percent. The highest growth rate was in Kenosha County and the highest increase in employment occurred in Waukesha County.

Future Population and Employment Projections

Population in Zone 5 is projected to grow at 0.6 percent annually for both the 2008 and 2013 and 2013 through 2018 periods. From 2008 to 2013, Waukesha County is projected to realize the largest increase in population, while Washington County is projected to have the highest growth rate.

Employment in Zone 5 is projected to grow at 1.3 percent annually between 2008 and 2013 and at 1.2 percent from 2013 through 2018. From 2008 to 2013, Waukesha County is projected to realize the largest increase in employment and to have the highest growth rate.

	1998-2008	2008-2013	2013-2018	1998-2008	2008-2013	2013-2018
Employment	Annual Growth Rate			Increase		
Zone 5	0.71	1.30	1.21	83,309	81,802	81,304
Kenosha County	2.17					
Waukesha County		2.75	2.35	49,714	44,709	43,347
Population						
Zone 5	0.47	0.57	0.61	88,002	55,090	61,051
Washington County	1.35	1.87	1.76			
Waukesha County				32,235	30,025	31,217

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 2009, 2013, 2018 and 2023 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 1.8 percent annually from 2009 through 2018. 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 are being planned 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,
- sagging voltage profile in portions of Washington, Waukesha and Jefferson counties and
- stability of existing and proposed generation in the southeast portion of Zone 5.

In addition, the Wisconsin Department of Transportation is reconstructing the Marquette Interchange in downtown Milwaukee and portions of the interstate system near the Marquette Interchange. This project affects one ATC transmission line and a We Energies power plant connected to the 138-kV transmission system.

- A portion of Everett - 28th Street underground 138-kV circuit was relocated in 2004. No other ATC facilities were affected by the project.
- The 138-kV switchyard at the Valley Power Plant will require various equipment modifications and a more extensive maintenance program.
- 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.

Zone 5 – 2009 study results

Refer to Table ZS-1 and Figure ZS-17

Summary of key findings

- ❑ Many 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.

Nine 138-kV buses in Waukesha and Washington Counties experience low bus voltages under NERC Category A or TPL-001-0 conditions (intact system) in 2009. The nine buses are Concord (93.5%), Bark River (94.2%), Cooney (92.8%), Cottonwood (93.1%), Germantown (93.6%), Hartford (94.9%), Merrill Hills (94.7%), Maple (94.1%), and Summit (92.9%). These low intact system bus voltages occurred because Concord and Germantown generation was modeled out of service in 2009 as a result of new generation at Oak Creek. A new 650-MW generator is scheduled to be placed in service prior to the summer of 2009. In addition, 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 var support to improve area voltage.

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

An outage of the Jefferson–Crawfish River–Concord 138-kV line will cause the bus voltages at Concord (87.8%), Cooney (89.0%), and Summit (89.7%) to drop below 90%. Running Concord generation will alleviate this situation.

An outage of the Bark River–Cottonwood 138-kV line will cause bus voltages at Cooney (89.3%), Cottonwood (87.7%), and Summit (89.1%) to drop below 90%. Running Concord generation will alleviate this situation.

An outage of the Bark River–Sussex 138-kV line will cause bus voltages at Cooney (89.6%), Cottonwood (88.0%), Bark River (88.0%), Germantown (89.4%), and Summit (0.894) to drop below 90%. Running Concord and Germantown generation alleviate this situation.

An outage of the Maple–Saukville 138-kV line will cause bus voltages at Cooney (90.0%), Cottonwood (89.2%), Bark River (89.6%), Germantown (84.1%), Maple (83.8%) and

Summit (89.9%) to decrease drop below 90%. Running Germantown generation will alleviate this situation.

An outage of Hartford–St. Lawrence 138-kV line will cause low bus voltage at Hartford (86.8%). Running Concord generation will improve the bus voltage at Hartford.

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%. Bus outages are low probability events. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 MW.

An outage of the Bain–Kenosha 138-kV line will cause the Bain–Albers 138-kV line to load to 97.6% 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 106.0% of its summer emergency rating and Arcadian transformers #2 to load to 96.0% of its summer emergency rating. Project development is underway to replace the Arcadian transformers #2 and #3 with a single 500 MVA transformer. 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.

Splitting the Oak Creek 230-kV bus between bus sections 6 and 7 will cause Oak Creek transformer T884 to load to 97.5% of its summer emergency rating. Bus outages are considered low probability events.

Oak Creek generation: We Energies received PSCW approval to build two 650-MW coal powered generators at the Oak Creek Power Plant. The units are scheduled to go into service in 2009 and 2010. The following projects will be constructed as a result of this new generation.

2009 - Oak Creek generation Phase 1

- ❑ build a new Oak Creek 345-kV switchyard to interconnect one new 650-MW 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

- ❑ expand Oak Creek 138-kV switchyard to connect the 345/138-kV, 500 MVA transformer

2010 - Oak Creek generation Phase 2

- ❑ expand 345-kV switchyard at Oak Creek Power Plant to interconnect a second new 650-MW 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
- ❑ Increase line rating of the Kansas – Ramsey 138-kV line

In response to customer requests for new distribution interconnections, new 138-kV bus sections will be constructed at the Pleasant Valley, Shorewood and Brookdale Substations in 2009.

Zone 5 – 2013 study results

Refer to Table ZS-2 and Figure ZS-18

Summary of key findings

- ❑ Additional var 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

Sixteen 138-kV buses in Waukesha and Washington County experience low bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2013. The buses are Concord (90.6%), Allerton (94.7%), Bark River (91.8%), Edgewood (94.4%), Cooney (90.0%), Cottonwood (90.5%), Germantown (91.7%), Hartford (92.6%), Merrill Hills (92.7%), Mukwonago (93.8%), Maple (92.3%), St. Lawrence (94.0%), Summit (90.2%), Sussex (94.9%), Arthur Road (94.0%), and Glacier (94.5%). These low intact system bus voltages occurred because Concord and Germantown generation was modeled out of service in 2013 as a result of new generation at Oak Creek. The new generation is scheduled to be placed in service prior to the summer of 2010.

Two-32.4 Mvar capacitor banks are scheduled to be placed in service at Summit by June 2010 to improve area bus voltages. In the interim, dispatching Concord and/or Germantown will provide var support to improve area voltage.

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 2010.

Following are the results of the 2013 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 (KK9962 and KK9942) results in the other Arcadian–Waukesha 138-kV line overloading by 14-15 percent. The limiting element is the line conductor with clearances set for operation at 200 degrees. The line conductor clearances will be increased in 2010 to permit higher flows under contingency conditions.

An outage of the Arcadian 345/138-kV transformer T1 causes the Arcadian 345/138-kV transformer T3 to overload by 10 percent. As a result, a provisional project to install 1-345/138-kV 500 MVA transformer to replace these two existing transformers is being considered in the 2011 timeframe.

Projects New in this Assessment
The Albers-Bain 138-kV line loads to 96 percent of its summer emergency limit for an outage of the Bain-Kenosha 138-kV line. The limiting elements are bus jumpers at Bain Substation and the line conductor clearances. This line will be upgraded in 2010.

A project to install a second Shorewood-Humboldt underground cable in 2012 is under consideration to accommodate additional distribution load (2009) at the Shorewood Substation under contingency conditions. Under the Cornell-Shorewood 138-kV underground contingency, there is very little load bridging capability. A parallel Shorewood-Humboldt underground line will eliminate a potential load shedding situation.

A provisional project to uprate the Bain-Kenosha 138-kV line is being considered to resolve potential thermal overloads under single-contingency conditions in 2013.

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 2014 in-service date. Please refer to Zone 3 – 2013 study results for details about this project.

Zone 5 – 2018 study results

Refer to Table ZS-3 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

Fifteen 138-kV buses in Waukesha and Washington County experience low bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2018. The fifteen buses are Allerton (93.9%), Bark River (93.7%), Cooney (92.8%), Brookdale East (94.6%), Edgewood (94.5%), Chinook (94.4%), Cooney (93.8%), Cottonwood (92.9%), Germantown (94.4%), Hartford (94.7%), Merrill Hills (94.0%), Mukwonago (94.3%), Maple (94.6%), Summit (93.6%), and Country Aire (94.4%). In addition, another fourteen 138-kV buses have marginal bus voltages between 95-96%. It should be pointed out that provisional capacitor banks scheduled for Bluemound in 2010 as well as Mukwonago in 2014 were not modeled in service in the 2018 base case. In addition, only two Concord generators and one Germantown generator are online at time of peak. Modeling the Bluemound and Mukwonago capacitors in service as well as running additional generation at Concord and Germantown would improve the voltage in Waukesha and Washington counties.

Following are the results of the 2018 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on zone 5.

The Oak Creek–Pennsylvania 138-kV line will load to 100.7% of its summer normal rating under intact system conditions. Under a number of contingencies, the line can exceed it summer emergency rating by up to 2.3%. The line conductor is the limiting element.

Splitting the Pleasant Prairie 345-kV bus between bus sections 3 and 4 will cause the Bain transformer #5 to exceed its summer emergency rating by 59.7%. Bus outages are low probability events. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 MW.

The Bain 345/138-kV transformer #4 will exceed its summer emergency rating by 3.7% for an outage of Bain transformer #5. Reducing Pleasant Prairie generation will provide loading relief.

An outage of the Bain–Albers 138-kV line will result in the Bain–Kenosha 138-kV line loading to 98.7% of its summer emergency rating.

An outage of either one of the Arcadian–Waukesha 138-kV lines (KK9962 or KK9942) will result in the other Arcadian–Waukesha 138-kV line loading to 100% of its summer emergency rating. The limiting element is the line conductor with clearances set for operation at 200 degrees. The line conductor clearances will be increased in 2010 to permit higher flows under contingency conditions.

An outage of the Bark River–Cottonwood 138-kV line or Bark River–Sussex 138-kV line will cause bus voltages at Cottonwood to drop to 89.0%. Increasing the amount of Concord generation online will improve voltages in the area.

An outage of the Bark River–Sussex 138-kV line will cause bus voltages at Bark River to drop to 89.5%. Increasing the amount of Concord generation online will improve area bus voltages.

An outage of the Maple–Saukville 138-kV line will cause bus voltages at Germantown (89.3%), Maple (88.9%) and Country Aire (89.3%) to drop below 900=.0%. Dispatching Germantown generation will improve bus voltages.

An outage of the Bain–Kenosha 138-kV line will cause the Bain–Albers 138-kV line to load to 121.3% of its summer emergency rating. The line conductor clearance is the limiting element.

An outage of Oak Creek 345/138-kV transformer #1 will cause Oak Creek 345/138-kV transformer #2 to load to 99% of its summer emergency rating.

An outage of the Oak Creek–Pennsylvania 138-kV line will cause the Branch–Kansas 138-kV line (108.2%), Nicholson–Ramsey 138-kV line (96.3%), and Oak Creek–Ramsey 138-kV line (96.1%) to approach or exceed their summer emergency ratings. Increasing line conductor clearances on the Branch–Kansas 138-kV line will provide relief.

An outage of the Arcadian 345/138-kV transformer #1 causes the Arcadian transformer #3 to load to 120.1% of its summer emergency rating and Arcadian transformer #2 to load to 101.0% of its summer emergency rating.

Splitting the Burlington 138-kV bus will result in low 138-kV bus voltages at Tichigan (87.7%) and Burlington (88.6%).

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 2014 timeframe in order to address remaining voltage and thermal issues.

Zone 5 – 2023 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.

Eleven 138-kV buses in Waukesha and Washington County experience marginal bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2023. The fifteen buses are Allerton (95.8%), Bark River (95.6%), Barton (95.8%), Cooney (95.5%),

Cottonwood (95.2%), Hartford (95.1%), Merrill Hills (95.6%), St. Lawrence (95.6%), Summit (95.4%), Arthur Road (95.6%), and Glacier (955%).

Following are the results of the 2023 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

The Oak Creek–Pennsylvania 138-kV line will load to 106.3% of its summer normal rating under intact system conditions. Under a number of contingencies, the line can exceed it summer emergency rating by up to 7.8%.

Splitting the Concord 138-kV bus will result in low or marginal 138-kV bus voltage at Hartford (88.7%), St. Lawrence, Arthur Road (90.8%), and Cooney (90.3%).

An outage of the Saukville–Fredonia 138-kV line will cause the bus voltage at Fredonia to drop to 89.2%.

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 59.7%. Bus outages are low probability events. Relief can be provided by reducing the output of Pleasant Prairie generator #2 to about 350 MW.

An outage of the Bain–Kenosha 138-kV line will cause the Albers–Kenosha 138-kV line to exceed its summer emergency rating by 4.0%.

An outage of the Oak Creek–Pennsylvania 138-kV line will cause the Branch–Kansas 138-kV line (119.9%), Nicholson – Ramsey 138-kV line (99.4%), and Oak Creek – Ramsey 138-kV line (99.2%) to approach or exceed their summer emergency ratings.

Splitting the Burlington 138-kV bus will result in low 138-kV bus voltage at Tichigan (0.831) and Burlington (0.842).

An outage of the Arcadian 345/138-kV transformer #1 causes Arcadian transformer #3 to load to 118.9% of its summer emergency rating and Arcadian transformers #2 to load to 97.5% of its summer emergency rating.

In the previous 2018 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 2018, 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 2018 and 2023, 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.

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 2009-2013, and for the 2014-2018 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 2008 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

Steady-state analysis

ATC's steady-state multiple outage assessment started with Commonwealth Associates (CAI) performing more extensive analysis of our transmission system in 2004 to identify NERC Category C type contingencies that potentially could lead to cascading. Since then, ATC has taken this initial screening and enhanced our review in succeeding years.

NERC Category C contingencies are specific sets of multiple outages including lines, transformers and generators. ATC revisited Category C event analysis in 2005, 2006 and 2008. In 2006, we evaluated additional Category C events by screening Zone 3 100-kV and above facilities and ATC 345-kV transmission facilities in addition to the critical contingencies selected in 2005.

For the 2008 work, ATC used the 2009 summer peak model including all projects identified in the 10-Year Assessment for additional steady state multiple outage analysis. Physical Operational Margin (POM)-Optimal Mitigation Measure (OPM) software was used to determine the amount of load that needed to be shed to avoid cascading. Based on the 2006 work, a set of critical outages consisting of 145 multiple contingencies and 4 breaker failure contingencies were selected for restudy in 2008. As part of ATC's efforts to continue to be aware of multiple outage impacts on our system, in 2008, we have performed additional Category C analysis and assessments by screening Zone 5 (100-kV and above) facilities and the combination of ATC 345-kV facility (including ATC 345/138-kV transformers) and generator (100 MW and above). The total number of events tested in this initial study of the 2009 model was 30842 which included:

- 98 multiple outages selected and tested in 2005 and 2006
- 28 multiple outages associated with Zone 3, which were identified as critical in 2006
- 23 multiple outages associated with ATC 345-kV transmission facilities, which were identified as critical in 2006
- 26429 multiple outages associated with Zone 5, which has one of the major ATC load centers such as Metro Milwaukee area, relatively large number of underground cables, and higher voltage transmission facilities:
  - Transmission lines above 100 kV
  - Transformers with 100 kV above (both high and low sides).
  - Generation with 100 MW and above
  - N-2 rules:
    - Transmission line + Transmission line
    - Transmission line + Transformer
    - Transformer + Transformer
    - Transmission line + Generator
    - Transformer + Generator
- 4264 multiple outages associated with ATC 345-kV facility and generator:
  - N-2 rules:
    - ATC 345 kV Transmission line + ATC Generation (100 MW and above)
    - ATC 345/138 kV Transformer + ATC Generation (100 MW and above)

Of the 30,842 events analyzed, 851 resulted in potential voltage problems or thermal overloads in 2009. The most severe 317 events among 851 were reviewed in more detail to determine if cascading was likely. Among the events of Zone 5 and ATC 345-kV facility/generation, if an event results in more than 100 MW of load curtailment, it is considered as severe events and included in the 317 events. As a result of further review,

36 events would require load shedding, 199 events would require other remedial actions such as generation redispatch and operating guide, and 82 turned out to be invalid outages. As in 2006, we found through the use of specific load shedding and generation redispatch that cascading could be ruled out for Category C contingencies on our 2009 system. Three breaker failure events involving Columbia and a single breaker failure event involving Rocky Run were also tested by POM-OPM using the 2009 model. No system problems were identified for the breaker failures. Ranked based on the amount of load shedding, the top 5 Category C events for the 2009 system are

- ❑ North Appleton T1 and T2 transformers
- ❑ North Appleton T1 and T3 transformers
- ❑ North Appleton T2 and T3 transformers
- ❑ Portage Columbia 138-kV line #1 and #2
- ❑ Arcadian 345/138-kV #1 and #2 transformers

To reassess the long-term planning horizon, the 36 Category C events resulting in load shedding to mitigate potential voltage or overloads in 2009 were repeated using the 2013 summer peak model including all projects identified for this 10-Year Assessment.

Of the 36 events analyzed, 10 Category C events had no system problems and 26 Category C events had potential thermal overloads or low voltages in 2013. 11 of the 26 events resulted in overloads or low voltage problems that were more severe in 2013 than in 2009.

Following are the 13 Category C contingencies that became worse in 2013 and the additional load that needed to be shed compared to 2009:

Category C contingencies	*MW load shed in 2009*	*MW load shed in 2013*	*Difference in MW*
Arcadian T1 and T2 345/138-kV transformers	297.4	359	61.6
Arcadian T1 and T3 345/138-kV transformers	260.6	290.2	29.6
Cedarsauk 138 kV bus tie 2-3 and Cedarsauk-Saukville 138-kV bus tie 2-6	140.6	147.7	7.1
Arcadian T1 345/138-kV transformer and Granville-Tamarack 138-kV line	137.6	249.2	111.6
Woodenshoe-Neevin 138-kV line and Fitzgerald 345/138-kV transformer	134.6	177.4	42.8
Kegonsa-Christiana 138-kV line #1 and #2	110.8	231.2	120.4
Arcadian T1 345/138-kV transformer and Sussex-Tamarack 138-kV line	104.2	179.7	75.5
Columbia T1, T2 and T3 345/138-kV transformers	46.3	66	19.7
Werner-White Lake 138-kV line and Whiting Ave-Rocky Run 115-kV line	27.6	35.6	8
Arpin-Sigel 138-kV line and Sandlake-Wautoma 138-kV line	17.3	21.8	4.5
Waupaca-White Lake 138-kV line and Whiting Ave-Rocky Run 115-kV line	13.6	18.2	4.6

Although it is estimated that cascading could be ruled out for Category C contingencies on our 2009 and 2013 systems through the use of specific load shedding and generation redispatch, the 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 screened or 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 B, C and selected D outages. A MRO/RFC joint on-site review completed in December 2007 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 2008 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 MW and associated transmission lines operating above 100 kV are generally selected to assess system angular stabilities.

The methodology used in screening or 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. In addition, the methodology 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. This methodology also includes a review of the date the last time a stability study was conducted for a major generator station 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 6 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 5-year sequence.

If these criteria are confirmed, the generator stability results from the 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 the generator stability is screened or restudied.

In the 2008 10-Year Assessment the power flow models were compared with the 2006 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 2006 TYA studies. The review identified seven (7) 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 5-year elapsed time criteria or d) a combination of the criteria.

The seven (7) generator stations identified are: Paris, Port Washington Combined Cycle Block 1 (CC1) and Combined Cycle Block 2 (CC2), Fox Energy, Forward Energy, University, Concord and Presque Isle. These stations are shown high-lighted in Table ZS-7.

Concord and Paris generator stations had parameter changes for the each of the exciter models. Fox Energy had changes to the type of governor model for the two combustion turbine units as well as parameter changes for the generator, exciter and power system stabilizer models of one of the combustion turbine units. University involved a correction in the representation of the generator step-up transformer from a single three-winding transformer to two two-winding transformers and parameter changes for steam turbine generator model. Forward Energy had a change in number of units installed at the wind farm from 104 to 86 units and was within one year of the 5-year elapsed time criteria for the system angular stability analysis. It also involved the change from the using a simple induction generator model to the new WT3 generic wind model for use in representing the unit in system dynamic simulations. All these major generator stations were re-studied as part of the system angular stability analysis of the 2008 Ten-Year Assessment with the ATC criteria applied.

The Port Washington Generator Station CC1 (in service date 2008) and CC2 (in service 2005) were last studied in 2005 just after CC2 was placed in service. The study used the “as built data” for CC2 units and original data for CC1 units from the 2003 study to evaluate the impact of an additional capacity increase primarily available in winter operating conditions. The "as built data" for the CC1 units recently became available and needs to be studied to verify the results from the previous studies and include any update for the stability models or their associated parameters. A separate unit verification study was conducted in 2008 and satisfies the requirement for a re-study of these stations as part of the system angular stability analysis of the 2008 Ten-Year Assessment. Both studies are noted in the Table ZS-7.

The Presque Isle generator station involves changes to parameter values of each of the generator models; plus updates to the exciter and power system stabilizer models on 5 of the 7 units, as well as, the addition of a power system stabilizer on one unit. In 2007 a separate study was conducted addressing the special protection system at Presque Isle

and satisfies the requirement for a re-study of this station as part of the system angular stability analysis of the 2008 10-Year Assessment and study is noted in the Table ZS-7.

As shown in Table ZS-7, all assessed generators in the ATC area meet the applicable NERC Category B2, C3, C4 and D2 criteria.

Voltage Stability
ATC is still developing a rigorous process for assessing voltage stability across the system. Currently we monitor single and multiple contingency voltages 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.

It was decided that a new detailed voltage stability analysis be performed in the Rhinelander area of Zone 1 for 2008 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. The work on this study is progressing and we will report on these results in either an update of this Assessment or in a future Assessment.

The MRO/RFC joint on-site review completed in December 2007 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.

Planned system reinforcement analysis

The zone analyses discussions presented in this Assessment provide 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?

This year we have taken another step to more adequately address the first two questions. We have built year 2011 and year 2015 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. 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.

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 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.

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 2009, 2013 and 2018 study

years. These models are more appropriate for internal planning studies performed throughout the year. As part of the 10-Year Assessment, the zone planners perform a contingency analysis 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 the 2006 Assessment, this year we have tried to address the first two questions. We have built year 2013 and year 2018 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 2009, 2013 and 2018 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 2013 and 2018 models. The system issues remaining in the 2013 and 2018 "All Projects" models are:

- ❑ The Petenwell transformer is overloaded in the 2013 model under system intact conditions. The transformer is not overloaded in the 2018 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 2013 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 2013 and 2018 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 2018 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 2009, 2013 and 2018 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 2009, 2013 and 2018 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 2009, 2013 and 2018 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 2009, 2013 and 2018. The system issues remaining in the 2009, 2013 and 2018 all project models are:

- ❑ The Verona-Oregon 69-kV line overloads and low voltages for the loss of Stoughton-Aaker Road 69-kV line. (2009)
    - 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 McCue-Lamar 69-kV line overloads for the loss of Kegonsa-North Stoughton 69-kV line or Kegonsa 138/69-kV transformer; the North Stoughton-Stoughton 69-kV line overloads and low voltages on Y61 McCue-Lamar line for the loss any section of the McCue-Harmony-Lamar-Fulton 69-kV line (2009)
    - These violations will be addressed by uprating the McCue-Lamar 69-kV line, rebuilding the Stoughton bus and installing 2-12.45 Mvar capacitor banks at Lamar in 2009.
- ❑ Low bus voltage issues under both system intact and single contingency conditions near Jefferson area (2009)
    - A 2011 provisional project is created to install 4-49 Mvar 138-kV capacitor banks at Concord substation to address these voltage problems. Before this provisional project gets developed, the interim mitigation measure is to run Concord generation.
- ❑ Low 69-kV voltages on the Bass Creek-Brodhead 69-kV line for the loss of Brodhead-Brodhead South line (2009).

- The long term plan to support the voltage in this area is to install a 138/69-kV transformer at Bass Creek substation in 2013. In the near term, a 2009 distribution cap bank project is developed at the new Union Townline substation and the existing Sheepskin cap bank will also be upgraded.

- ❑ The Academy-Columbus 69-kV line overloads for the loss of North Randolph-Fox Lake 138-kV line. (2013)
  - Possible operating procedure to avoid this overload is dispatching South Fond du Lac generation. It is still under investigation. The proxy transmission solution for this problem is to construct a Horicon-East Beaver Dam 138-kV line in 2014.
- ❑ Dane County intact system voltage violations. (2013)
  - Possible operating procedure is to adjust local 138/69-kV transformer LTC tap setting. It is still under investigation. The proxy transmission solution for this problem is to install 2-16.33 MVAR 69-kV capacitor banks and 2-24.5 MVAR 138-kV capacitor banks at Femrite substation in 2014.
- ❑ Low 138-kV voltages at Hubbard and Hustisford for the loss of Rubicon-Hustisford. (2013)
  - Possible operating procedure is adjusting the 138/69-kV Hubbard transformer LTC tap setting to boost the 138-kV bus voltage. The proxy transmission solution for this problem is to construct a Horicon-East Beaver Dam 138-kV line in 2014.
- ❑ The Rio-Pardeeville Tap 69-kV line overloads under single contingency condition. (2013 and 2018)
  - The overload is based on a 42 MVA summer emergency in the planning model which should be increased to 69 MVA to match the SELD rating and current EMS rating. The line is not overloaded based on the 69 MVA rating.
- ❑ The Shaw-Shirland 69-kV line overloads under single contingency conditions.(2018)
  - The overload is based on an 84 MVA summer emergency in the planning model which will be increased to 100 MVA based on the new ATC jumper rating criteria. The line is not overloaded based on the 100 MVA rating.

Zone 4

In the 2009, 2013 and 2018 summer peak “All Projects” models, most of the system overloads or low voltages in Zone 4 are addressed although a few issues still exist under single contingency conditions in our models. Currently, those issues are under further investigation which includes validating line ratings as well as communicating with our customers to confirm the local area load and to determine the Best Value Plan (BVP) in each situation. The system issues remaining in the 2009, 2013 and 2018 “All Projects” models are:

- ❑ Low voltages near Bluestone and Wesmark 69-kV Substations (2009, 2013, and 2018) and Finger Road-Bluestone 69-kV line overload (2018) under single contingency conditions.

- This is primarily due to the temporary load interconnection at the Bluestone 69-kV Substation requested by customer. A detailed study needs to be performed by the customer and ATC to determine a Best Value Plan which will accommodate the new load interconnection while minimizing other concerns such as system impact, construction costs, and public and environmental impact. Constructing a new 138-kV substation along the Highway V-East Krok 138-kV line in the 2011 timeframe is being considered as one of the alternatives. Installing an additional distribution transformer at the existing Mystery Hills 138-kV Substation is also being considered. Until a permanent solution is in place, the existing Bluestone 69-kV Substation will serve the load under normal operating conditions.

- The City Limits-Combined Locks Tap 138-kV line overloads under single contingency conditions in 2018.
  - The ratings of the trap at the City Limits 138-kV Substation facing toward Combined Tap are currently under investigation by the ATC SELD group.

Zone 5
A contingency analysis was performed on the 2009, 2013, and 2018 "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 substation is improving the situation. Running generation at Concord and Germantown 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[2], 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 2008 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 2008 Assessment, ATC has 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[3] peak hour loads in the power flow models representing the year 2013. 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% 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. For the outage of either the Hiawatha-Engadine 69-kV line or the Engadine-Newberry 69-kV line, it is projected that the Eastern U.P. will experience voltage collapse under the 90/10 scenario. ATC has commenced an Energy Collaborative discussion in Zone 2 to identify reasonable futures and drivers that should be considered in developing appropriate plans for Zone 2. As part of this effort, we expect to define what transmission reinforcements will be appropriate to address these potential issues. Table ZS-2 compares the results of the 50/50 and proxy 90/10 analyses for 2013 for Zones 1-5.

[2] 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

[3] Scalable means that these loads follow some predictable load cycle pattern throughout the year that may or may be sensitive to extreme weather conditions.

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),
- Loop Nine Springs-Pflaum 69-kV line into Femrite (2013), and
- Horicon (Hubbard)-East Beaver Dam 138-kV line (2014).

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

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TABLE ZS-1 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Verona-Sun Valley-Oregon 69-kV line	121.3%	–	–	–	105.9%	–	Stoughton-Aaker 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line
3	McCue-Harmony-Lamar 69-kV line	111.6% - 95.2%	–	–	–	99.6% - 97.2%	–	Kegonsa 138/69-kV transformer Kegonsa-North Stoughton 69-kV line North-Stoughton-Stoughton E 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69-kV capacitor banks at Lamar Substation
3	Fitchburg-Syene 69-kV line	101.1%	–	–	–	–	–	Royster-Pflaum Tap 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Stage Coach-Black Earth 69-kV line	98.3%	–	–	–	97.7%	–	Spring Green 138/69-kV transformer	Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Royster-Pflaum Tap 69-kV line	97.8%	–	–	–		–	Fitchburg-Syene 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Enzyme Bio Systems-RC3 69-kV line	97.7%	–	–	–	98.1% - 95.5%	–	Colley Road – Dickinson 138-kV line	Operating guide
3	McCue-Harmony 69-kV line	95.2%	–	–	–		–	Brodhead Switching Station-Brodhead South 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69-kV capacitor banks at Lamar Substation
3	Concord, Rubicon, Hustisford, Hubbard and Butler Ridge 138-kV buses	–	93.4% - 94.7%	–	–	–	94.1% -94.8%	Base Case	Dispatch local generation
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Corp, Sheepskin and Evansville 69-kV buses	–	83.6% - 91.8%	–	90.5% - 91.5%	–	86.8% - 91.5%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69-kV capacitor banks at Lamar Substation
3	Lakehead Cambridge Tap, Fort Atkinson, Jefferson, Crawfish, Concord ,Hubbard, Hustisford, Rubicon and Butler Ridge 138-kV buses	–	86.4% - 91.5%	–	–	–	88.3% - 91.8%	Rockdale to Lakehead Cambridge Tap 138-kV line Lakehead Cambridge Tap-Jefferson4 138-kV line Jefferson4-Jefferson 5 Bus outage Jefferson5-Crawfish 138-kV line Crawfish-Concord4 138-kV line Plus other less severe outages	Dispatch local generation

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages	–	88.2% - 91.7%	–	–	–	90.7% - 92%	Brodhead Switching Station-Brodhead Muni 3 69-kV line Brodhead Muni 2 – Brodhead Muni 3 69-kV line Brodhead Muni 2-Brodhead 69-kV line	Upgrade Sheepskin capacitor bank from 10.8 MVAR to 16.2 MVAR and Install 5.7 MVAR distribution capacitor bank at Union Townline 69-kV Substation
3	Aaker, Oregon and Brooklyn 69-kV buses	–	88.2% - 89.5%	–	–	–		Stoughton-Aaker 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line
3	Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	–	88.5% - 91.4%	–	–	–	90.5% - 91.7%	Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation
3	Hubbard and Hustisford 138-kV buses	–	89.1% - 89.7%	–	88.5% -89.3%	–		Rubicon-Hustisford 138-kV line Hubbard-Hustisford 138-kV line	Adjust load tap changer at Hubbard
3	Dickinson, Global Renewable Energy, William Bay and Brick Church 138-kV buses	–	90.0% - 91.2%	–	89% - 91.5%	–	89.1% - 91.7%	Colley Road – Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Global Renewable Energy-Brick Church 138-kV line	Install a total of 6.3 MVAR distribution capacitor banks at Dickinson Substation and Install one temporary 12.45 MVAR 69-kV mobile capacitor bank at Brick Church Substation
3	Eden and Lancaster 138-kV buses	–	90.4% - 91.7%	–	–	–	–	Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation
3	N Stoughton, Stoughton E, Stoughton and Aaker 69-kV buses	–	91.2% - 91.5%	–	–	–	–	N Stoughton-Kegonsa 69-kV line	Rebuild the Y-119 Verona to Oregon 69-kV line and Construct new Oak Ridge-Verona 138-kV line and install a 138/69-kV transformer at Verona with a 100 MVA summer normal rating
3	Muscoda and Avoca 69-kV buses	–	91.3% - 91.7%	–	–	–	91.9%	Spring Green-Lone Rock 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	Paddock 345/138 kV transformer	–	–	107.7%	–	–	–	Base case	Dispatch local generation
3	Paddock-Townline 138-kV line	–	–	103.1%	–	–	–	Base case	Dispatch local generation
3	Paddock-Townline 138-kV line	–	–	123.3% - 113.8%	–	–	–	Paddock-NW Beloit 138-kV line NW Beloit-Blackhawk 138-kV line Blackhawk-Colley Road 138-kV line	Dispatch local generation
3	Paddock-NW Beloit-Blackhawk-Colley Road 138-kV line	–	–	116.8% - 105.5%	–	–	–	Paddock-Townline 138-kV line	Dispatch local generation

TABLE ZS-1 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
3	Huiskamp-Mendota-Ruskin 69-kV line	–	–	106.5% - 98.9%	–	–	–	North Madison-Vienna 138-kV line Vienna-Yahara River 138-kV line Yahara River-American Center 138-kV line American Center-Sycamore 138-kV line	Dispatch local generation
3	N Stoughton-Stoughton E-Stoughton 69-kV line	–	–	113.9% - 104.4%	–	–	–	Paddock 345/138 kV transformer Paddock-Wempletown 345-kV lines	Dispatch local generation
3	North Monroe-Darlington 138-kV line	–	–	100.8%	–	–	–	Paddock 345/138 kV transformer Paddock-Wempletown 345-kV lines	Dispatch local generation
3	Brick Church 138-kV bus	–	–	–	94.9%			Base case	Dispatch local generation
3	Brick Church. Global Renewable Energy, North lake Geneva, William Bay, Elkhorn, Bristol, Sugar Creek and Bluff Creek 138-kV buses	–	–	–	90.8% - 91.8%	–	–	Burlington 138-kV Bus tie outage	Dispatch local generation
3	Potosi, Hillman, Lafayette wind, Darlington, Albany and North Monroe 138-kV buses	–	–	–	87.3% - 91.8%	–	–	Nelson Dewey-Potosi 138-kV line Potosi-Hillman 138-kV line Hillman-Lafayette Wind 138-kV line	Dispatch local generation
3	Entire Rock County and Walworth County 138-kV bus voltages	–	–	–	86.8% - 91%	–	–	Paddock 345/138 kV transformer Byron-Wempletown 345 kV line Paddock-Wempletown 345-kV line	Dispatch local generation
3	McCue-Harmony 69-kV line	96.5%	--	--	--	--	--	Columbia generator unit 1 or 2	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation
4	West Marinette 138/69-kV transformer #1	96.6-95.1%	–	–	–	–	–	Wells St-Roosevelt 69-kV line Roosevelt 138/69-kV transformer	- Expand the Menominee 69-kV Substation and install 138-kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the Substation - Install 138/69-kV transformer at the expanded Menominee Substation
4	Sunset Point-Pearl Ave 69-kV line	104.8%	–	–	–	–	–	Ellinwood-Twelfth Ave 69-kV line	- Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR
4	Pioneer-Sobieski 69-kV line	99.6%	–	–	–	–	–	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Sobieski 69-kV bus	–	93.9%	–	–	–	94.8%	Base Case	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV

TABLE ZS-1 (continued)
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
4	Suamico 69-kV bus	–	91.6%	–	–	–	–	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Bluestone, Wesmark 69-kV buses	–	89.3-91.5%	–	–	–	–	Finger Rd-Bluestone 69-kV line outage	Construct a new 138-kV substation and loop Highway V-East Krok 138-kV line into the substation
5	Concord 138 kV bus Bark River 138 kV bus Cooney 138 kV bus Cottonwood 138 kV bus Germantown 138 kV bus Hartford 138 kV bus Merrill Hills 138 kV Maple 138 kV bus Summit 138kV bus	–	93.5 % 94.2 % 92.8 % 93.1 % 93.6 % 94.9 % 94.7 % 94.1 % 92.9 %	–	–	–	–	Intact System	Dispatch local generation
5	Concord, Cooney, Cottonwood, Summit, Bark River 138-kV bus voltages	–	90.6 – 91.8% 87.8 – 90.6 % 87.7 – 91.0 % 88.0 – 91.4 % 89.1 - 91.0 %	–	– – – – –	–	91.8 -- 91.9% 89.5 -- 91.9% 88.9 – 90.4 % 89.5 – 90.7 % 91.1 – 91.7 %	Jefferson–Lakehead – Rockdale 138-kV line Jefferson-Crawfish River – Concord 138-kV line Bark River – Cottonwood 138-kV line Bark River – Sussex 138-kV line Maple – Saukville 138kV line Plus other less severe outages	Dispatch local generation
5	Germantown and Maple 138-kV bus voltages	–	88.7% 83.8 – 84.1% 89.4 – 90.4%	–	–	–	91.1 % 87.3 – 87.6 % 91.1 – 91.9%	Germantown – Maple 138kV line Maple - Saukville 138kV line Bark River – Sussex 138kV line	Dispatch local generation
5	Hartford 138-kV bus voltage	–	86.8%	-	–	–	88.6 %	Hartford – St. Lawrence 138kV line	Load shifting
5	Bain 345/138-kV transformer	159.0%	–	130.7%	–	159.1%	–	Pleasant Prairie bus split between buses 3 and 4	Dispatch local generation
5	Albers – Bain 138-kV line	97.6%	–	–	–	102.7%	–	Bain – Kenosha 138-kV line	Dispatch local generation
5	Oak Creek 345/230-kV transformer (T884)	97.5%	–	–	–	–	–	Oak Creek 230-kV bus split between buses 6 & 7	Dispatch local generation
5	Arcadian4 – Waukesha1 138-kV line	–	–	–	–	98.2%	–	Arcadian6 – Waukesha3 138-kV line	Dispatch local generation
5	Arcadian6 – Waukesha3 138-kV line	–	–	–	–	97.4%	–	Arcadian4 – Waukesha1 138-kV line	Dispatch local generation
5	Albers – Paris 138-kV line	–	–	100.7%	–	–	–	Paddock 345/138-kV transformer	Dispatch local generation
5	Harbor – Kansas 138-kV line	–	–	92.6% 93.2% 93.6% 94.6%	–	–	–	Montana – Dewey 138-kV line Dewey 138-kV bus tie outage Dewey – Norwich 138-kV line Kansas – Norwich 138-kV line	Dispatch local generation
5	Tichigan and Burlington 138-kV buses	–	–		89.3-89.6%	–	91.6%	Burlington 138-kV bus split	Load shift
5	Albers- Kenosha 138-kV line	–	–	111.3%	–	113.3%	–	Albers – Bain 138-kV line	Dispatch local generation
5	Root River – Oak Creek 138-kV line	–	–	–	–	101.2%	–	Albers – Paris 138-kV line	Dispatch local generation
5	Tichigan, Burlington and Air Liquide 138-kV buses	–	–	–	91.3-92.0%	–	–	Paddock 345/138-kV transformer	Load shift

TABLE ZS-1 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2009 Summer Peak, 70% High Transfer and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2009 Summer Peak Case		2009 High Transfer Case		2009 90% E-W Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage	% of Facility Rating	% of Nominal bus voltage		
5	Arcadian 345/138-kV transformer #3	- 106.0%	–	108.0% 94.1%	–	100.2% 106.4%	-	Arcadian 345-kV bus and Arcadian transformer #2 Arcadian transformer #1	Dispatch local generation (temporary) Arcadian transformer (provisional permanent solution)
5	Arcadian 345/138-kV transformer #2	96.0 %	--	--	--	97.5%	-	Arcadian transformer #1	Generation redispatch (temporary) Arcadian transformer (provisional permanent solution

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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	Ontonagon-UPPSCO Tap 69-kV line Line, Ontonagon 138/69-kV transformer	-	-	-	-	-	-	97-100%	-	Mass-Rockland 69-kV line Rockland-Rockland Junction 2 69-kV line Rockland Junction 2-Victoria 69-kV line	Dispatch local generation
2	Indian Lake 138/69-kV transformers 1, 2	-	-	-	-	-	-	102%	-	Indian Lake 138/69-kV transformer 1, 2	Operating guide
2	Lakota Road 115-kV bus voltage Engadine, Straits, Hiawatha 69-kV bus voltages	-	105.0-105.2%	-	105.0%	-	-	-	-	Base Case	Operating guide
2	Lakota Road 115-kV bus voltage Indian Lake, Perkins, Atlantic 138-kV bus voltages, Munising, Alger 69-kV bus voltages	-	-	-	-	-	105.1-106.0%	-	-	Base Case	Operating guide
2	Lakota Road 115-kV bus voltage	-	-	-	-	-	-	-	105.1%	Base Case	Operating guide
2	Delta, West Side, Escanaba, Masonville, Mead, Gladstone, Bay View, North Bluff, Harris 69-kV bus voltages	-	91.7%-92.0%	-	90.4-92.0%	-	90.9-91.8%	-	-	Chandler 138/69-kV transformer	North Bluff 69-kV capacitor bank, or dispatch local generation
2	Atlantic 138-kV bus voltage	-	88.4%	-	86.8%	-	115.1%	-	-	Atlantic-M-38 138-kV line	M38 138-kV capacitor bank
2	Engadine, Newberry Village, Lou Pac, Newberry, Newberry Hospital, Newberry Hospital Tap, Roberts, Hulbert, Eckerman, Raco 69-kV bus voltages	-	-	-	Eastern U.P. Votlage Collapse	-	-	-	-	Hiawatha-Engadine 69-kV line Engadine-Newberry 69-kV line	9 Mile/Roberts 69-kV capacitor banks, and/or dispatch local generation
2	Engadine, Newberry Village, Lou Pac, Newberry, Newberry Hospital, Newberry Hospital Tap, Roberts, Hulbert, Eckerman, Raco 69-kV bus voltages	-	-	-	-	-	-	-	Eastern U.P. Votlage Collapse	Hiawatha-Engadine 69-kV line	9 Mile/Roberts 69-kV capacitor banks, and/or dispatch local generation
2	Engadine, Newberry Village, Lou Pac, Newberry, Newberry Hospital, Newberry Hospital Tap, Roberts, Hulbert, Eckerman, Raco 69-kV bus voltages	-	-	-	-	-	-	-	86.4-91.0%	Engadine-Newberry 69-kV line	9 Mile/Roberts 69-kV capacitor banks, and/or dispatch local generation
2	L'Anse 69-kV bus voltage	-	-	-	91.6%	-	-	-	-	M38 138/69-kV transformer	L'Anse 69-kV capacitor bank
3	North Stoughton-Stoughton East– Stoughton 69-kV line	131.9%-110.7%	-	143.3%-98.3%	-	-	-	115.7%-97.6%	-	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Rebuild Stoughton Substation bus
3	Sheepskin-Dana Tap 69-kV line	110.2%-105%	-	120.5%-114.4%	-	-	-	-	-	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Sheepskin Substation protection project
3	Enzyme Bio Systems-RC3 69-kV line	109.6%-96.1%	-	114.1%-96.6%	-	-	-	109.4%-95.7%	-	Colley Road-Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Brick Church 138/69-kV transformer Global Renewable Energy-Brick Church 138-kV line	Rebuild Y-32 Colley Road-Brick Church 69-kV line
3	Stoughton-Sheepskin 69-kV line	107.4%-102.8%	-	118.1%-112.6%	-	-	-		-	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	North Lake Geneva-Lake Geneva 69-kV line	105.7%	-	111.1%-96.6%	-	-	-		-	Brick Church-Cobble Stone 69-kV line	Uprate Y-152 North Lake Geneva-Lake Geneva 69-kV line to achieve a 115 MVA summer emergency rating
3	Fitchburg-Syene 69-kV line	105.5%	-	110.9%	-	-	-	95.7%	-	Royster-Pflaum Tap 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Academy-Columbus Muni 2 Tap 69-kV line and Columbus Muni 2 Tap- Columbus 69-kV line	103.2%-98%	-	105-100.8%	-	-	-	100.6%-97.1%	-	N Randolph-Fox Lake 138-kV line Fox Lake-N Beaver Dam 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	McCue-Harmony-Lamar 69-kV line	102.5%-96.8%	-	108%-95.2%	-	-	-	-	-	Kegonsa 138/69-kV transformer Kegonsa-N Stoughton 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation
3	Royster-Pflaum Tap 69-kV line	102.4%	-	107.4%	-	-	-	-	-	Fitchburg-Syene 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Colley Road-Marine 138-kV line	98.6%	-	101.3%-95.5%	-	-	-	-	-	Paddock-NW Beloit 138-kV line	Colley Road protection project in 2010
3	McCue-Milton Lawn 69-kV line	97.7%	-	102.6%	-	-	-	-	-	Janesville 138/69-kV transformer	Uprate terminal limitations at McCue for the Y-79 McCue-Milton Lawns 69-kV line
3	N Monroe-Idle Hour 69-kV line	97.6%-95.3%	-	102.1%-95.4%	-	-	-	-	-	Darlington-Gratiot 69-kV line Gratiot-Wiota 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line and Rebuild Y-33 Brodhead to South Monroe 69-kV line

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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	Walworth-Schofield 69-kV line	97.1%	-	101.5%	-	-	-	-	-	N Lake Geneva-138/69-kV transformer	Uprate Y-41 Walworth- North Lake Geneva 69-kV to achieve a 69 MVA summer emergency rating
3	Gran Grae-Wauzeka-Boscobel 69-kV line	97.1%-96.8%	-	100.9%-96%	-	-	-	-	-	Spring Green 138/69-kV transformer Nelson Dewey-Lancaster 138-kV line 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	Rock Springs Tap – Artesian 138-kV line	96.7%-95.8%	-	98.2%-95.7%	-	-	-	-	-	Trienda-Lewiston 138-kV line East Dells-Lewiston 138-kV line	Construct a Lake Delton-Birchwood 138-kV line
3	Colley Road 138/69-kV transformer	96.4%	-	100.1%	-	-	-	-	-	Paddock 138/69-kV transformer	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Dane-Lodi Tap 69-kV line	95.7%	-	99.9%	-	-	-	-	-	Kirkwood-Island 69-kV line	Rebuild part of the Y-8 Dane-Dam Heights 69-kV line
3	Shaw-Shirland Ave 69-kV line	95.2%	-	98.8%	-	-	-	-	-	Colley Road 138/69-kV transformer	Rating increase after SELD validation
3	Jefferson, Lake Mills, Fort Atkinson, Crawfish, Concord, Rubicon, Hustisford, Hubbard and Butler Ridge 138-kV buses	-	91.4%-95.8%	-	90.8%-95.1%	-	-	-	93.1%-95.9%	Base Case	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Brick Church 138-kV bus	-	95.6%	-		-	-	-		Base Case	Install 2-24.5 Mvar 138-kV capacitor banks and 1-18 Mvar 69-kV capacitor bank at Brick Church substation
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Corp, Sheepskin and Evansville 69-kV buses	-	78.7%-91.8%	-	75.3%-92%	-	88.8%-91.8%	-	83.9%-91.9%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69-kV capacitor banks at Lamar Substation and Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Lakehead Cambridge Tap, Fort Atkinson, Jefferson, Crawfish, Concord ,Hubbard, Hustisford, Rubicon and Butler Ridge 138-kV buses	-	83.6%-91.3%	-	87.1%-91.9%	-	91.4%-91.8%	-	86.4%-91.8%	Rockdale to Lakehead Cambridge Tap 138-kV line Lakehead Cambridge Tap-Jefferson4 138-kV line Jefferson4-Jefferson 5 Bus outage Jefferson5-Crawfish 138-kV line Crawfish-Concord4 138-kV line Plus other less severe outages	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	-	85.9%-91.4%	-	84.5%-91.8%	-	-	-	89.1%-91.8%	Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages	-	86%-92%	-	84.2%-91.3%	-	-	-	89.2%-91.5%	Brodhead Switching Sta-Brodhead Muni 3 69-kV line Brodhead Muni 2 -Brodhead Muni 3 69-kV line Brodhead Muni 2-Brodhead 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Dickinson, Global Renewable Energy, William Bay and Brick Church 138-kV buses	-	87.1%-91.5%	-	86.1%-91.8%	-	87.1%-91.7%	-	86.6%-91.9%	Colley Road – Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Global Renewable Energy-Brick Church 138-kV line	Install 2-24.5 Mvar 138-kV capacitor bank and 1-18 Mvar 69-kV capacitor bank at Brick Church Substation
3	Hubbard and Hustisford 138-kV buses	-	88.5%-89.1%	-	88.1%-88.8%	-	88.3%-88.6%	-	88.3%-88.8%	Rubicon-Hustisford 138-kV line Hubbard-Hustisford 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	Evansville 69-kV bus	-	90.6%	-	89.5%-91.9%	-	-	-	-	Evansville-Sheepskin 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Lake Geneva and Twin Lake 69-kV buses	-	91.9%-92%	-	89.6%-90.6%	-	-	-	-	N Lake Geneva-Lake Geneva 69-kV line	Construct new 138-kV line from North Lake Geneva to South Lake Geneva Substation and construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation
3	Eden, Wyoming Valley and Lancaster 138-kV buses	-	89.7%-91.6%	-	89%-91.8%	-	-	-	91.2%-91.9%	Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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	Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	-	89.7%-91.9%	-	88.7%-91%	-	-	-	91.9%	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	Cobblestone and Zenda 69-kV buses	-	90.5%-91.7%	-	90.2%-91.6%	-	-	-	-	Brick Church-Cobblestone 69-kV line	North Lake Geneva-South Lake Geneva 138-kV line project in 2014. The need year is determined by Cobblestone voltage problem.
3	Idle Hour, Monroe and S Monroe 69-kV buses		91.6%-92%	-	90.3%-90.7%	-	-	-	-	N Monroe-Idle Hour 69-kV line	Rebuild Y-33 Brodhead to South Monroe 69-kV line
3	Avoca, Muscoda 69-kV buses		91.9%	-	90.2-91.4%	-	-	-	-	Lone Rock-Avoca 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	Troy 138-kV bus	-	92%	-	91.2%-91.9%	-	-	-	-	Kirkwood-Troy 138-kV line Troy-Spring Green 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Burke and Reiner 69-kV buses	-	-	-	90.9%-91.6%	--	92%			Reiner Road 138/69-kV transformer	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	West Middleton-Black Hawk 69-kV line	-	-	-	-	101.6%	-	-	-	Base Case	Dispatch local generation
3	Nelson Dewey 161/138-kV transformer	-	-	-	-	115.3%	-	-	-	Base Case	2nd Nelson Dewey 161/138 kV transformer
3	Paddock 345/138-kV transformer	-	-	-	-	97.1%	-	-	-	Base Case	Dispatch local generation
3	Benton-Miner 69-kV line	-	-	-	-	109%	-	-	-	Nelson Dewey 161/138-kV transformer	2nd Nelson Dewey 161/138 kV transformer
3	Paddock-NW Beloit-Blackhawk 138-kV line	-	-	-	-	100.7%-98%	-	-	-	Paddock-Townline 138-kV line	Dispatch local generation
3	North Stoughton-Stoughton East-Stoughton 69-kV line	-	-	-	-	118.5%-107.4%	-	-	-	Paddock 345/138 kV transformer and Paddock-Wempletown 345-kV lines	Dispatch local generation
3	West Middleton-Black Hawk 69-kV line	-	-	-	-	108.4%-95%	-	-	-	North Madison-Vienna 138-kV line Vienna-Yahara 138-kV line Yahara-American Center 138-kV line Kegonsa-McFarland 138-kV line McFarland-Femrite 138-kV line Plus other less severe outages	Dispatch local generation
3	Nelson Dewey 161/138-kV transformer	-	-	-	-	100.6%-96.5%	-	-	-	Paddock 345/138-kV transformer Paddock-Wempletown 345-kV line Rockdale-Wempletown 345-kV line Byron-Wempletown 345-kV line	2nd Nelson Dewey 161/138-kV transformer
3	North Monroe-Darlington 138-kV line	-	-	-	-	103.7%	-	-	-	Paddock 345/138 kV transformer	Dispatch local generation
3	Paddock-Townline 138-kV line	-	-	-	-	105.2%-96.1%	-	-	-	Paddock-NW Beloit 138-kV line NW Beloit-Blackhawk 138-kV line Blackhawk-Colley Road 138-kV line	Dispatch local generation
3	Entire Rock County and Walworth County 138-kV bus voltages	-	-	-	-	-	92.5%-96%	-	-	Base Case	Dispatch local generation
3	Fitchburg, Oakridge 138-kV buses	-	-	-	95.5%	-	95.8%-95.9%	-	-	Base Case	Dispatch local generation
3	Concord 138-kV buses	-	-	-	-	-	95.4%	-	-	Base Case	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Entire Rock County and Walworth County 138-kV bus voltages	-	-	-	-	-	82.7%-92%	-	-	Paddock 345/138 kV transformer Paddock-Wempletown 345-kV line Rockdale-Wempletown 345-kV line Byron-Wempletown 345-kV line	Dispatch local generation
3	Entire Rock County and Walworth County 138-kV bus voltages	-	-	-	-	-	87.7%-92%	-	-	Burlington 138-kV bus 1-2 outage Burlington-Air Liquide 138-kV line Air Llquide-Paris 138-kV line	Dispatch local generation
3	Williams Bay 138-kV bus	-	-	-	-	-	90.7%	-	-	Elkhorn-Williams Bay 138-kV line	Dispatch local generation
3	La Prairie, Bradford, West Darien, SW Delavan and North Shore 138-kV buses	-	-	-	91.7%-91.9%	-	91.8%	-	-	Rock River-La Prairie 138-kV line La Prairie-Bradford 138-kV line Bradford-West Darien 138-kV line	Dispatch local generation
3	Sugar Creek 138-kV bus	-	-	-	-	-	91.9%	-	-	Burlington-N Lake Geneva Tap 138-kV line	Dispatch local generation
3	Brick Church, Williams Bay, Elkhorn and North Lake Geneva 138-kV buses	-	-	-	-	-	90.8%-91.8%	-	-	North Lake Geneva Tap-North Lake Geneva 138-kV line	Dispatch local generation
3	North Lake Geneva Tap 138-kV bus voltage	-	-	-	-	-	-	-	92%	Burlington 138-kV bus 1-2 outage	Dispatch local generation
3	Whitewater 138-kV bus	-	-	-	-	-	-	-	91.7%	Whitewater 138-kV bus 4-5 outage Whitewater-Lakehead Tap 138-kV line	Dispatch local generation
3	Whitewater, Lakehead, University and Bluff Creek 138-kV buses	-	-	-	-	-	-	-	90.7%-91.9%	Sunrise-Lakehead Tap 138-kV line	Dispatch local generation

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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	Spring Green and Wyoming Valley 138-kV buses	-	-	-	95.9%	-	-	-	-	Base Case	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Cobblestone- Zenda 69-kV line	-	-	95.5%	-	-	-	-	-	North Lake Geneva-Lake Geneva 69-kV line	Construct new 138-kV line from North Lake Geneva to South Lake Geneva Substation and construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation
3	Spring Green 138/69-kV transformer	-	-	99.5%-97.4%	-	-	-	-	-	Gran Grae-Wauzeka 69-kV line Wauzeka-Boscobel 69-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Stage Coach-Black Earth 69-kV line	-	-	97%	-	-	-	-	-	Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Nine Springs-Syene 69-kV line	-	-	97%	-	-	-	-	-	Royster-Pflaum 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	South Fond Du Lac-Waupun 69-kV line	-	-	103.6%-102.5%	-	-	-	-	-	North Randolph-Fox Lake 138-kV line Fox Lake-N Beaver Dam 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	Bluff Creek and Sugar Creek 138-kV buses	-	-	91.3%-91.7%	-	-	-	-	-	University-Bluff Creek 138-kV line	Dispatch local generation
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages	-	-	91.1%-92%	-	-	-	-	-	Paddock-Newark 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Rockdale-Lakehead Cambridge 138-kV line	95.2%	--	--	--	--	--	--	--	Oak Creek generation unit 1 or 2	Construct new 138-kV line from North Lake Geneva to South Lake Geneva Substation and construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation Construct Spring Valley-Twin Lakes-South Lake Geneva 138-kV line
4	Pulliam-Suamico 69-kV line	100.8%	-	105.6%	-	-	-	-	-	Base case	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	West Marinette 138/69-kV transformer #1	97.8-96.3%	-	100-101.9%	-	-	-	-	-	Wells St-Roosevelt 69-kV line Roosevelt 138/69-kV transformer	Expand the Menominee 69-kV Substation and install 138 kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the Substation Install 138/69-kV transformer at the expanded Menominee Substation
4	Pioneer-Sobieski 69-kV line	110.3%	-	116.5%	-	-	-	99.4%	-	Pulliam-Suamico 69-kV line followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Sunset Point-Pearl Ave 69-kV line	104.4%	-	109.5%	-	-	-	-	-	Ellinwood-Twelfth Avenue 69-kV line	Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR
4	Melissa-Tayco 138-kV line	103.8%	-	-	-	-	-	-	-	Butte Des Morts 138-kV bus tie 1-2 outage	Uprate the Melissa-Tayco to 229 MVA (300F)
4	North Appleton-Fox River 345-kV line	-	-	-	-	-	-	95.6%		North Appleton-Kewaunee 345-kV line	Uprate North Appleton-Fox River 345-kV line
4	Sobieski, Suamico 69-kV bus voltages	-	94.2-92.2%	-	94.3-92.2%	-	-	-	95.7-93.9%	Base case	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Sobieski 69-kV bus voltage	-	91.8%	-		-	-	-	-	Morgan-Highway 22 345-kV line	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Bluestone, Wesmark 69-kV bus voltages	-	90.1-87.6%	-	86.4-88.9%	-	-	-	90.3%	Finger Rd-Bluestone 69-kV line	Construct a new 138-kV substation and loop Highway V-East Krok 138-kV line into the substation
4	East Krok, Beardsley St 69-kV bus voltages	-	91.9-91.5%	-	90.8-91.2%	-	-	-	-	East Krok 138/69-kV transformer	No provisional project Additional study is being conducted.
4	Hickory, Forward Energy Center, Butternut 4, and Butternut 5 138-kV bus voltages	-	91.9%	-	91%	-	-	-	-	Hickory-South Fond du Lac 138-kV line	Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation
4	Holland 138-kV bus voltage	-	91.8%	-	91.4%	-	-	-	-	Charter Steel Industry-Holland 138-kV line	No provisional project. Additional study is being conducted.
4	Suamico 69-kV bus	-	90.7%	-	89.8%	-	-	-	91.5	Pulliam-Suamico 69-kV line followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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		
4	Edgewater-Washington Ave 69-kV line	-	-	95.6%		-	-	-	-	Edgewater-Nicolet 69-kV line	No provisional project. Additional study is being conducted.
4	City Limits-Combined Locks Tap 138-kV line	-	-	98.1%		-	-	-	-	North Appleton-Apple Hills 138-kV line	No provisional project. Additional study is being conducted.
4	Barnett 69-kV bus voltage	-	-	-	91.8%	-	-	-	-	East Krok 138/69-kV transformer	No provisional project. Additional study is being conducted.
4	Auburn 138-kV bus voltage	-	-	-	91.7%	-	-	-	-	Hickory-South Fond du Lac 138-kV line	Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation
4	Forward Energy Center, Butternut 4, and Butternut 5 138-kV bus voltages	-	-	-	91.6%	-	-	-	-	Hickory-Forward Energy Center 138-kV line	Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation
4	Butternut 4, Butternut 5 138-kV bus voltages	-	-	-	91.8%	-	-	-	-	Butternut 5-Forward Energy Center 138-kV line	Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation
4	Holland 138-kV bus voltage	-	-	-	91.9%	-	-	-	-	Charter Steel Industry 138-kV bus plus Charter Steel-Cedarsauk 138-kV line	No provisional project. Additional study is being conducted.
5	Concord 138-kV bus voltage Allerton 138-kV bus voltage Bark River 138-kV bus voltage Brookdale (East) 138-kV bus voltage Edgewood 138-kV bus voltage Cooney 138-kV bus voltage Cottonwood 138-kV bus voltage Germantown 138-kV bus voltage Hartford 138-kV bus voltage Merrill Hills 138-kV bus voltage Mukwonago 138-kV bus voltage Maple 138-kV bus voltage Pleasant Valley 138-kV bus voltage St. Lawrence 138-kV bus voltage Summit 138-kV bus voltage Sussex 138-kV bus voltage Arthur Road 138-kV bus voltage Glacier 138-kV bus voltage Albers – Paris 138-kV line	--	90.6% 94.7% 91.8% > 96.0% 94.4% 90.0% 90.5% 91.7% 92.6% 92.7% 93.8% 92.3% > 95.0% 94.0% 90.2% 94.9% 94.0% 94.5% 97.7%		89.9% 93.9% 91.9% 94.6% 93.7% 89.4% 90.3% 93.6% 92.0% 92.1% 93.2% 93.9% 94.6% 93.5% 89.7% 94.6% 93.5% 94.2% 95.6%	--	--	94.1% --- 94.9% --- --- 93.4% 93.9% 94.7% --- 94.9% --- --- --- --- 93.5% --- --- --- --	Intact System (No Concord or Germantown generation is on line in the summer peak model. One Germantown unit is on line in the high load growth model. Voltages are based on 90% machine Q. Contingencies based on 95% Q) * Two 32 MVar capacitors were placed in service at Summit prior to 2013 summer peak contingency analysis and high load growth contingency analysis. Intact system voltages are prior to capacitor installation.	Dispatch local generation
5	Concord, Cooney, Cottonwood, Summit, Bark River 138-kV bus voltages	--	86.6 – 89.8% 87.2 – 89.7% 86.8 – 89.6% 87.4 – 89.4% 88.7 – 89.9% --	--	85.6 – 89.4% 84.7 – 87.9% 87.5 – 89.2% 86.1 – 89.5 % 87.2 – 88.6% --	--	--	--	89.8 % -- -- -- -- --	Jefferson-Crawfish River - Concord 138-kV line Bark River – Cottonwood 138-kV line Bark River – Sussex 138-kV line Hartford – St. Lawrence 138-kV line Cooney – Summit 138-kV line Plus other less severe outages	Summit, Mukwonago caps & Dispatch local generation
5	Germantown and Maple 138-kV bus voltages	--	88.1 – 89.2% 87.3% 82.2 – 82.5%	--	-- -- 88.8 – 89.2 %	--	--	--	-- -- 87.6 87.9%	Bark River – Sussex 138-kV line Germantown – Maple 138-kV line Maple – Saukville 138-kV line	Dispatch local generation
5	Hartford 138-kV bus voltage	--	83.9% 89.3%	--	82.3 % 88.3 %	--	--	--	89.1 % --	Hartford – St. Lawrence 138-kV line Pleasant Valley – Saukville 138-kV line	Load shifting
5	St. Lawrence, Arthur Road 138-kV bus voltage	--	--	--	89.1%	--	--	--	--	Pleasant Valley – Saukville 138-kV line	No Project Yet Load shifting
5	Pleasant Valley 138-kV bus voltage	--	89.4%	--	--	--	--	--	--	Pleasant Valley – Saukville 138-kV line	Load Shifting
5	Bain 345/138-kV transformer T5	159.9% 99.6% 100.4%	--	160.3% 98.8% 103.9%	--	139.2% -- --	--	159.1% -- 97.0%	--	Pleasant Prairie bus split between 3 and 4 Pleasant Prairie bus split between 2 and 3 Pleasant Prairie - Bain transformer T4	Dispatch local generation
5	Bain 345/138-kV transformer T4	99.6%	--	103.1%	--	--	--	96.2%	--	Pleasant Prairie - Bain transformer T5	Dispatch local generation
5	Albers – Bain 138-kV line	118.2%	--	121.6%	--	101.8%	--	117.5%	--	Bain – Kenosha 138-kV line	Uprate Albers – Bain 138-kV line Dispatch local generation
5	Edgewood – St. Martins 138-kV line	--	--	--	--	98.7% 103.6 % 107.3% 106.0% 101.2%	--	--- --- --- 96.5% ---	--	Split Burlington 138-kV bus Burlington – Air Liquide – Paris Paddock 345/138-kV transformer Merrill Hills – Waukesha 138-kV line Wempletown – Paddock 345-kV line	No project yet Dispatch local generation
5	Bain – Kenosha 138-kV line	95.6%	--	98.8	--	--	--	--	--	Albers – Bain 138-kV line	No project yet – Dispatch local generation

TABLE ZS-2 (continued)

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2013 Summer Peak, High Growth, 3000 MW Import and 90% East-to-West Bias Cases

Planning Zone	Criteria Exceeded/Need	2013 Summer Peak Case		2013 High Load Growth		2013-70% - 3000 MW Import Case		2013-90% - E-W Bias Case		Facility Outage(s)	Project
		% 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		
5	Arcadian6 – Waukesha3 138-kV line	100.0%	--	101.7%	--	95.4%	--	107.7%	--	Arcadian4 – Waukesha1 138-kV line	Uprate Arcadian – Waukesha 138-kV line Dispatch local generation
5	Arcadian4 – Waukesha1 138-kV line	100.8%	--	102.5%	--	96.1%	--	108.5%	--	Arcadian6 – Waukesha3 138kV line	Uprate Arcadian – Waukesha 138-kV line Dispatch local generation
5	Maple – Saukville 138-kV line	100.3%	--	--	--	--	--	--	--	Bark River – Sussex 138-kV line	Dispatch local generation
5	Oak Creek – Pennsylvania 138-kV line	_ 95.3 % _ _ 95.2% _	_ _ _ _ _ _	98.1% 99.4% 98.7% 97.3% 99.2% --	-- -- -- -- -- --	_ _ _ _ _ _	_ _ _ _ _ _	95.1% 95.9% 95.4% _ 95.9% _	_ _ _ _ _ _	Kansas – Ramsey 138-kV line Oak Creek – Nicholson 138-kV line Nicholson – Ramsey 138-kV line Norwich – Ramsey 138-kV line Oak Creek – Ramsey 138-kV line Plus other less severe outages	No Project yet Load Shifting
5	Oak Creek 345/138-kV transformer #2	--	--	97.4%	--	--	--	96.7%	--	Oak Creek 345/138-kV transformer #1	No project yet – Dispatch local generation
5	Branch – Kansas 138-kV line	--	--	97.8%	--	--	--	--	--	Oak Creek – Pennsylvania 138-kV line	No project yet - Load shifting
5	Nicholson – Ramsey 138-kV line	--	--	--	--	--	--	97.9%	--	Oak Creek – Pennsylvania 138-kV line	No project yet - Load shifting
5	Oak Creek – Ramsey 138-kV line	--	--	--	--	--	--	97.1%	--	Oak Creek – Pennsylvania 138-kV line	No project yet - Load Shifting
5	Bark River – Sussex 138-kV line	98.8%	--	--	--	--	--	--	--	Maple – Saukville 138-kV line	No project yet – Dispatch local generation
5	Harbor – Kansas 138-kV line	--	--	--	--	102.1% 98.7% 102.9% 103.2% 100.1%	--	--	--	Montana – Dewey 138-kV line Valley – Montana 138-kV line Split Dewey 138-kV bus Dewey – Norwich 138-kV line Kansas – Norwich 138-kV line Plus less severe outages	No project yet – Dispatch local generation
5	Tichigan , Burlington1 138-kV bus voltages	--	--	--	--	--	86.1-86.6%	--	89.3-90.0%	Split Burlington 138-kV bus	No project yet - Load Shifting
5	Paris – Albers 138-kV line	--	--	--	--	99.7%	--	--	--	Paddock 345/138-kV transformer	No project yet – Dispatch local generation
5	Tichigan, Burlington, Walworth, Air Liquide 138-kV buses	--	--	--	--	--	88.2-89.1%	--	--	Paddock 345/138-kV transformer	No project yet - Load shift
5	Albers-Kenosha 138-kV line	--	--	--	--	120.2%	--	--	109.0%	Albers – Bain 138-kV line	No project yet – Dispatch local generation
5	Granville 345/138-kV transformer #1	--	--	--	--	--	--	100.0% 98.5%	--	Granville-Cedarsauk 345-kV line Granville 345/138-kV T2 Granville 345-kV bus split between 2 and 3	No project yet – Dispatch local generation
5	Arcadian 345/138-kV transformer #2	94.9%	--	--		99.7%		98.2%		Arcadian 345/138-kV transformer #1	No project yet - Replace Arcadian transformer
5	Arcadian 345/138-kV transformer #3	111.8% --	--	101.0% 102.0%	--	117.4% --	--	113.2% 105.5% 101.3%		Arcadian 345/138-kV transformer #1 Arcadian 345-kV bus split between 1 and 2 Arcadian xfmr #2 and 345-kV bus outage	Replace Arcadian transformer

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
2	Chandler – Delta 69-kV #1 line	114%	-	Chandler-Delta 69-kV #2 line	Uprate Chandler-Delta 69 kV line #1, or dispatch local generation
2	Chandler – Delta 69-kV #2 line	108%	-	Chandler-Delta 69-kV #1 line	Uprate Chandler-Delta 69 kV line #2, or dispatch local generation
2	Chandler 138/69-kV transformer	97-107%	-	Nordic-Mountain 69-kV line Mountain-Harris Tap 69-kV line Forsyth 138/69-kV transformer	Increased existing SE rating from SELD
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	123-162%	-	Delta-Mead 69-kV line	Uprate Chandler-Masonville, Masonville-Gladstone, Gladstone-North Bluff, Delta-Mead-North Bluff 69 kV lines; or dispatch local generation
2	Forsyth 138/69-kV transformer	102%	-	Chandler 138/69-kV transformer	Uprate the Forsyth 138/69 kV transformer
2	Atlantic-Henry St. Tap 69-kV line	97%	-	Base Case	
2	Atlantic-M38 69-kV line	101%	-	Atlantic-M38 138-kV line Atlantic 138/69-kV transformer	Uprate Atlantic-M38 69 kV line
2	Atlantic 138/69-kV transformer	100%	-	M38 138/69-kV transformer	Uprate Atlantic 138/69 kV transformer
2	Delta, West Side, Escanaba, Masonville, Mead, Gladstone, Bay View, North Bluff, Harris 69-kV bus voltages	-	90.4-92.0%	Chandler 138/69-kV transformer	North Bluff 69 kV capacitor bank, or dispatch local generation
2	Atlantic, Elevation St., Henry St., MTU, Osceola, Portage, Keweenaw 69 kV bus voltages	-	82.0-91.1%	Atlantic-M38 138-kV line Atlantic 138/69-kV transformer	M38/Osceola capacitor banks, or dispatch local generation
2	L'Anse, Baraga 69 kV-bus voltages	-	90.7-91.3%	M38 138/69-kV transformer	L'Anse capacitor bank
2	Winona, Atlantic, M38 138-kV bus voltages M38, L'Anse, Baraga 69-kV bus voltages	-	89.0-92.0%	M38-Perch Lake 138-kV line	M38/Osceola capacitor banks, or dispatch local generation
3	Fitchburg-Syene-Nine Springs 69-kV line	119.4%-102%		Royster-Pflaum Tap 69-kV line Pflaum-Pflaum Tap 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	Enzyme Bio Systems-RC3-Clinton-Sharon 69-kV line	118%-96.3%		Colley Road-Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Brick Church 138/69-kV transformer Global Renewable Energy-Brick Church 138-kV line	Rebuild Y-32 Colley Road-Brick Church 69-kV line
3	Royster-Pflaum Tap-Pflaum 69-kV line	115.9%-99.2%		Fitchburg-Syene 69-kV line Nine Springs-Syene 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	North Stoughton-Stoughton E – Stoughton 69-kV line	114.7%-112.2%		McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Rebuild Stoughton Substation bus
3	Sheepskin-Dana Tap 69-kV line	113.8%-109%		McCue-Harmony 69-kV line Harmony-Lamar 69-kV line	Sheepskin substation protection project in 2010

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Stage Coach-Black Earth-Mazomanie 69-kV line	113.2%-102.1%		Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Dane-Lodi Tap 69-kV line	110.1%-96.4%		Kirkwood-Island 69-kV line Island-Moore St 69-kV line Moore St-Baraboo 69-kV line	Rebuild part of the Y-8 Dane-Dam Heights 69-kV line
3	South Lake Geneva-Lake Geneva 69-kV line	109.7%		Brick Church-Cobble Stone 69-kV line	Construct new 138-kV line from North Lake Geneva to South Lake Geneva substation and Construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation
3	West Middleton-Timberland 69-kV line	107.7%		Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Academy-Columbus Muni 2 Tap 69-kV line and Columbus Muni 2 Tap- Columbus 69-kV line	107.5%-97.6%		North Randolph-Fox Lake 138-kV line Fox Lake-N Beaver Dam 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	South Fond Du Lac-Waupun 69-kV line	107.4%-102.2%		North Randolph-Fox Lake 138-kV line Fox Lake-N Beaver Dam 138-kV line	Hubbard-North Beaver Dam project in 2014.
3	Colley Road 138/69-kV transformer	106.8%-96.4%		Paddock 138/69-kV transformer Paddock-Shirland Ave 69-kV line Shaw-Shirland 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line and Rebuild Y-33 Brodhead to South Monroe 69-kV line
3	Shaw-Shirland 69-kV line	106.6%		Colley Road 138/69-kV transformer	Rating increase after SELD validation
3	Cobblestone-Zenda Tap 69-kV line	106.5%		North Lake Geneva-Lake Geneva 69-kV line	Construct new 138-kV line from North Lake Geneva to South Lake Geneva substation and Construct new 138-kV bus and install a 138/69-kV 100 MVA transformer at South Lake Geneva Substation
3	N Monroe-Idle Hour 69-kV line	106.2%-98.7%		Darlington-Gratiot 69-kV line Gratiot-Wiota 69-kV line Wiota-Jennings Rd 69-kV line Darlington 138/69-kV transformer Paddock-Newark 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line and Rebuild Y-33 Brodhead to South Monroe 69-kV line

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Gran Grae-Wauzeka-Boscobel 69-kV line	105.4%-97.6%		Spring Green 138/69-kV transformer Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line Eden-Wyoming Valley 138-kV line 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	Kirkwood-Rock Springs Tap – Artesian 138-kV line	103.2%-97.9%		Trienda-Lewiston 138-kV line East Dells-Kilbourn 138-kV line East Dells-Lewiston 138-kV line	Construct a Lake Delton-Birchwood 138-kV line
3	Spring Green 138/69-kV transformer	102.3%-101%		Gran Grae-Wauzeka 69-kV line Wauzeka-Boscobel 69-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Hillman 138/69-kV transformer	99.4%-96.9%		DPC Galena-Pilot 69-kV line Pilot-Terr TP 69-kV line	Replace the existing 46 MVA Hillman 138/69-kV transformer with a 100 MVA transformer
3	Paddock-Shirland Ave 69-kV line	98.6%		Colley Road 138/69-kV transformer	No project so far
3	McCue-Milton Lawn 69-kV line	96.7%		Janesville 138/69-kV transformer	Uprate terminal limitations at McCue for the Y-79 McCue-Milton Lawns 69-kV line
3	Eden 138/69-kV transformer	96.4%		Eden-Wyoming Valley 138-kV line	No project so far
3	McCue-Harmony 69-kV line	96.4%-95.6%		Kegonsa 138/69-kV transformer Kegonsa-N Stoughton 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation
3	West Middleton 138/69 kV transformer	96.4%		West Middleton 138/69-kV transformer	Construct West Middleton-Blount 138-kV line
3	Colley Road-Dickinson 138-kV line	96%-95.1%		Rock River-La Prairie 138-kV line La Prairie-Bradford 138-kV line Bradford-West Darien 138-kV line	Colley Road protection project in 2010
3	Eden, Spring Green, Wyoming Valley and Troy 138-kV buses		92.9%-94.2%	Base Case	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Oakridge, Hawk, Pleasant View, McFarland, Sprecher, Kegonsa, Colloday Point, Reiner Road, Cross County, Fitchburg, Sycamore, Femrite and Blount 138-kV buses		93.7%-95.7%	Base Case	Install 2-16.33 MVAR 69-kV capacitor banks and 2-24.5 MVAR capacitor banks at Femrite substation
3	Hustisford, Hubbard, Concord, Rockvale, Fort Atkinson, Crawfish and Rubicon 138-kV buses		94.5%-95.8%	Base Case	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Boscobel, Muscoda and Blue River 69-kV buses		95.3%-95.6%	Base case	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, Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Lodi and Okee 69-kV buses		95.4%-95.9%	Base case	Install 2-16.33 Mvar 69-kV capacitor banks at Dam Heights
3	Gaston Road, Cottage Grove and Bird Street 69-kV buses		95.7%-96%	Base case	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		78.9%-90.1%	Spring Green 138/69-kV transformer	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Corp, Sheepskin and Evansville 69-kV buses		84.4%-91.7%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation and construct double-circuit line between McCue and Lamar substations
3	Wauzeka, Spring Green, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages, Spring Green and Wyoming Valley 138-kV bus voltages		85.9%-91.6%	Gran Grae-Wauzeka 69-kV line Wauzeka-Boscobel 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	Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		85.9%-88.5%	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, Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Hubbard and Hustisford 138-kV bus voltages		86.1%-86.8%	Rubicon-Hustisford 138-kV line Hubbard-Hustisford 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Eden, Wyoming Valley, Spring Green, Troy and Lancaster 138-kV bus voltages, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		86.2%-91.9%	Nelson Dewey-Lancaster 138-kV line Lancaster-Wyoming Valley 138-kV line Lancaster-Eden 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Dickinson, Global Renewable Energy, William Bay and Brick Church 138-kV buses		86.9%-91.6%	Colley Road – Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Global Renewable Energy-Brick Church 138-kV line	Install 2-24.5 Mvar 138-kV capacitor bank and 1-18 Mvar 69-kV capacitor bank at Brick Church substation
3	Idle Hour, Monroe, Black Smith, New Glarus, Monticello, Brown town and S Monroe 69-kV buses		87.4%-91.3%	North Monroe-Idle Hour 69-kV line North Monroe 138/69-kV transformer outage	Rebuild Y-33 Brodhead to South Monroe 69-kV line and Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Concord ,Hubbard, Hustisford, Rubicon, Rockvale and Butler Ridge 138-kV bus voltages		87.7%-91.8%	Concord4-5 138-kV bus outage Hartford-St Lawrence 138-kV line	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Avoca, Muscoda, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		87.8%-91.6%	Lone Rock-Avoca 69-kV line Avoca-Muscoda 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	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages		87.8%-91.9%	Brodhead Switching Station-Brodhead Muni 3 69-kV line Brodhead Muni 2 -Brodhead Muni 3 69-kV line Brodhead Muni 2-Brodhead 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Eden, Wyoming Valley, Spring Green, Troy, City view, Lake Delton and Lancaster 138-kV bus voltages,		88.2%-91.8%	Trienda-Lewiston 138-kV line Lake Delton-City View 138-kV line City View-Kirkwood 138-kV line Trienda-Lake Delton 138-kV line plus other less severe outages	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Cobblestone, Lake Shore, Twin Lakes, Richmond and Zenda 69-kV buses		88.4%-91.6%	Brick Church-Cobblestone 69-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Lake Geneva, S Lake Geneva, Richmond, Katzenberg and Twin Lake 69-kV buses		88.4%-89.3%	North Lake Geneva-Lake Geneva 69-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating
3	Burke, Sun Prairie, Token Creek, South, Colorado, Bird St, Gaston RD and Reiner 69-kV buses		88.6%-91.9%	Reiner Road 138/69-kV transformer outage, Burke-Colorado 69-kV line and Reiner Road-Burke 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	Evansville, Footville, Center and Bass Creek 69-kV bus voltages		88.7%-91.1%	Evansville-Sheepskin 69-kV line	Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	Arena, Mazomanie and Black Earth 69-kV bus voltages		88.7%-91.9%	Spring Green-Arena 69-kV line	Install 2-12.25 MVAR 69-kV capacitor banks at Mazomanie Substation
3	Eden, Wyoming Valley, Spring Green, Troy and Lancaster 138-kV bus voltages,		89%-91.8%	Spring Green-Troy 138-kV line Troy-Kirkwood 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Island, Moore St, Baraboo, Dam Heights, Tower St , Eagle View and Prairie Du Sac 69-kV bus voltages		89.3%-91.3%	Island-Kirkwood 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Dam Heights
3	Rockvale 138-kV bus voltage		90%	Concord-Rockvale 138-kV line	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Potosi, Hillman, Darlington and Lafayette Wind 138-kV bus voltages		90.1%-90.9%	Nelson Dewey-Potosi 138-kV line Potosi-Hillman 138-kV line	Install 2-16.33 Mvar 69-kV cap banks at North Monroe
3	Albany and N Monroe 138-kV bus voltages		90.5%-90.6%	Townline-Albany 138-kV line	Install 2-16.33 Mvar 69-kV cap banks at North Monroe
3	Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages		90.7%-91.9%%	Spring Green-Wyoming Valley 138-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, Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Oakridge, Cross County, Fitchburg 138-kV buses		91.4%-91.9%	Rockdale-West Middleton 345-kV line West Middleton 345/138-kV transformer outage Pleasant View-West Middleton 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks and 2-24.5 MVAR capacitor banks at Femrite Substation
3	Fox Lake, N Beaver Dam and E Beaver Dam 138-kV bus voltages		90.2%-90.3%	North Randolph-Fox Lake 138-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	Bluff Creek and Sugar Creek 138-kV bus voltage		91%-91.3%	University-Bluff Creek 138-kV line	No project so far
3	Sun Valley 69-kV bus voltage		91.8%	Sun Valley-Verona 69-kV line	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation, Install a 138/69-kV transformer at Bass Creek Substation and rebuild/reconductor X-12 Town Line Road-Bass Creek 138-kV line
3	La Prairie, Bradford, West Darien, SW Delavan and North Shore 138-kV buses		91.5%-91.9%	Rock River-La Prairie 138-kV line La Prairie-Bradford 138-kV line Bradford-West Darien 138-kV line	Install 2-24.5 Mvar 138-kV capacitor bank and 1-18 Mvar 69-kV capacitor bank at Brick Church Substation
3	Black Earth 69-kV bus voltage		92%	Stage Coach-Black Earth 69-kV line	Install 2-12.25 MVAR 69-kV capacitor banks at Mazomanie Substation
3	Cottage Grove and Gaston RD 69-kV bus voltage		90.5%-91.2%	Kegonsa-Cottage Grove 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	McFarland, Femrite and Sprecher 138-kV bus voltages		90.8%-91.9%	Kegonsa-McFarland 138-kV line McFarland-Femrite 138-kV line	Install 2-16.33 MVAR 69-kV capacitor banks and 2-24.5 MVAR capacitor banks at Femrite Substation
3	Deforest, Burke, Sun Prairie, Token Creek, South, Colorado, Bird St, Gaston RD and Reiner 69-kV buses		91.2%-92%	Deforest-North Madison 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Sun Prairie
3	Lodi, Okee 69-kV bus voltages		90.6%-92%	Dane-Lodi Tap 69-kV line	Install 2-16.33 Mvar 69-kV capacitor banks at Dam Heights
3	Eagle View 69-kV bus voltage		92%	Eagle View-Dam Heights 69-kV line	No project so far
3	Randolph, Didion and Cambria 69-kV bus voltages		90.9%-91.8%	North Randolph-Randolph Tap 69-kV line Didion-Randolph Tap 69-kV line	Install 2-16.33 Mvar 69-kV cap banks at Rio
3	Boscobel 69-kV bus voltage		91.3%	Gran Grae 138/69-kV transformer	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	Yahara, Vienna and American Center 138-kV bus voltages		91.3%-91.6%	North Madison-Yahara 138-kV line	No project so far
3	Miner and Shullsburg 69-kV bus voltages		91.8%-91.9%	DPC Galena-Pilot 69-kV line	No project so far

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
3	Fort Atkinson 138-kV bus voltage		91.6%-91.8%	Jefferson-Lakehead Cambridge 138-kV line Rockdale- Lakehead Cambridge 138-kV line	Install 4-49 MVAR 138-kV capacitor banks at Concord Substation
3	Horicon and Horicon Industry 69-kV bus voltage		91.2%-91.5%	Hubbard-Horicon 69-kV line	Construct a Horicon-East Beaver Dam 138-kV line
3	LCI and Pflaum 69-kV bus voltage		91.4%	Royster-Pflaum 69-kV line	Loop 6947 Nine Springs-Pflaum 69-kV line into Femrite Substation
3	N Lake Geneva Tap 138-kV bus voltage		91.9%	Burlington 138-kV bus 1-2	No project so far
3	Spring Green and Wyoming Valley 138-kV bus voltages		90.9%-91%	Columbia generation Unit 1 or Unit 2	Install 2-16.33 MVAR 69-kV capacitor banks at Spring Green Substation and Install a second 138/69-kV transformer at Spring Green with a 100 MVA summer normal rating and Install 2-16.33 MVAR 69-kV capacitor banks at Eden Substation
3	Wauzeka-Boscobel 69-kV line	99.2%		Columbia generation Unit 1 or Unit 2	Y-40 rebuild
3	North Monroe 138/69 kV transformer	95.3%		Columbia generation Unit 1 or Unit 2	Construct Verona-North Monroe 138-kV line
3	McCue-Harmony-Lamar 69-kV line	100.1%-97.2%		Sheepskin generation Unit 1	Uprate Y-61 McCue-Lamar 69-kV line to achieve 300 deg F line ratings and install 2-12.45 Mvar 69 kV capacitor banks at Lamar Substation
3	West Middleton-Black Hawk 69-kV line	95.7%		West Campus generation ST	Construct West Middleton-Blount 138-kV line
3	Nelson Dewey-Gran Grae 161-kV line	96.1%		DPC Genoa generation Unit 3	No project so far
4	Pulliam-Suamico 69-kV line	117%	-	Base case	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	West Marinette 138/69-kV transformer #1	99.8-98%	-	Wells St-Roosevelt 69-kV line outage Roosevelt 138/69-kV transformer outage	- Expand the Menominee 69-kV Substation and install 138 kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the Substation - Install 138/69-kV transformer at the expanded Menominee Substation
4	Pioneer-Sobieski 69-kV line	128%	-	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Sunset Point-Pearl Ave 69-kV line	106.1%	-	Ellinwood-Twelfth Avenue 69-kV line outage	Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
4	Canal 138/69-kV transformer #1	95.1%	-	Canal 138/69-kV transformer #2 outage	- Construct Canal-Dunn Road 138-kV line - Install 60 MVA 138/69-kV transformer at Dunn Road
4	Glenview 138/69-kV transformer #1	96.1%	-	Glenview 138/69-kV transformer #2 outage	Replace two existing 138/69-kV transformers at Glenview Substation with 100 MVA transformers
4	Glenview 138/69-kV transformer #2	95.6%	-	Glenview 138/69-kV transformer #1 outage	Replace two existing 138/69-kV transformers at Glenview Substation with 100 MVA transformers
4	Finger Rd-Bluestone 69-kV line	96.5-113%	-	Wesmark-Kellnersville 69-kV line outage Kellnersville-Manrap 69-kV line outage Mishicot-Shoto 138-kV line outage Lakefront G9 outage	Construct a new 138-kV substation and loop Highway V-East Krok 138-kV line into the substation
4	Northeast-Mirro 69-kV line	95.9%	-	Lakefront G9 outage	Construct Shoto to Custer 138-kV line
4	City Limits 138-kV bus tie 1-2 City Limits-Combined Locks Tap 138-kV line	100.8-107.5%	-	North Appleton-Apple Hills 138-kV line outage	No provisional project. Additional study is being conducted.
4	Sobieski, Suamico 69-kV bus voltages	-	91-87.5%	Base case Pulliam G5 or G7 outage	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Bluestone, Wesmark 69-kV bus voltages	-	Diverged	Finger Rd-Bluestone 69-kV line outage	Construct a new 138-kV substation and loop Highway V-East Krok 138-kV line into the substation
4	East Krok, Beardsley St, Barnett, Booster 69-kV bus voltages	-	90.3-91.5%	East Krok 138/69-kV transformer outage	No provisional project. Additional study is being conducted.
4	Hickory, Forward Energy Center, Butternut 4, Butternut 5 138-kV bus voltages	-	91.3-91.5%	Hickory-South Fond du Lac 138-kV line outage	Install 28.8 MVAR capacitor bank at Butternut 138-kV Substation
4	Holland, Plymouth #4 138-kV bus voltage	-	90.1-91.8%	Charter Steel Industry-Holland 138-kV line outage	No provisional project. Additional study is being conducted.
4	Suamico, Sobieski 69-kV bus voltages	-	88.5-91.2%	Pulliam-Suamico 69-kV line outage followed by Sobieski-Pioneer 69-kV line close	Rebuild/Convert Bayport-Suamico-Sobieski-Pioneer 69-kV line to 138 kV
4	Holland 138-kV bus voltages	-	90.6%	Charter Steel 138-kV bus plus Charter Steel-Cedarsauk 138-kV line outage	No provisional project. Additional study is being conducted.

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
5	Bluemound 230-kV bus Concord 138-kV bus Walworth 138-kV bus Allerton 138-kV bus Bark River 138-kV bus Barton 138-kV bus Brookdale E 138-kV bus Brookdale W 138-kV bus Edgewood 138-kV bus Chinook 138-kV bus Cooney 138-kV bus Cottonwood 138-kV bus Germantown 138-kV bus Hartford 138-kV bus Merrill Hills 138-kV bus Mukwonago 138-kV bus Maple 138-kV bus Pleasant Valley 138-kV bus Duplainville 138-kV bus St. Lawrence 138-kV bus St. Martins 138-kV bus Summit 138-kV bus Sussex 138-kV bus 28th St 138-kV bus Tamarack 138-kV bus Arthur Road 138-kV bus Westridge 138-kV bus Country Aire 138-kV bus Glacier 138-kV bus	--	95.3% 95.6% 95.8% 93.8% 93.7% 95.9% 94.6% 95.4% 94.4% 94.3% 93.7% 92.9% 94.3% 94.7% 94.0% 94.2% 94.5% 95.8% 95.9% 95.3% 95.8% 93.6% 95.5% 95.8% 95.7% 95.3% 95.0% 94.3% 95.4%	Intact system	Generation redispatch
5	Oak Creek – Pennsylvania 138-kV line	100.7 % 101.0% 102.3% 101.6% 102.1%	--	Intact system Kansas – Ramsey 138-kV line Nicholson – Oak Creek 138-kV line Nicholson – Ramsey 138-kV line Oak Creek – Ramsey 138-kV line Plus other less severe outages	Load shift
5	Cottonwood 138-kV bus voltage	--	88.9% 89.5%	Bark River – Cottonwood 138-kV line Bark River – Sussex 138-kV line	Generation redispatch
5	Bark River 138-kV bus voltage	--	89.5%	Bark River – Sussex 138-kV line	Generation redispatch
5	Germantown, Country Aire, Maple 138-kV buses	--	88.9 – 89.3%	Maple – Saukville 138-kV line	Generation redispatch
5	Bain 345/138-kV transformer T5	95.1% 159.7% 104.5%	--	Pleasant Prairie bus split between 2 and 3 Pleasant Prairie bus split between 3 and 4 Bain transformer #1	Generation redispatch

TABLE ZS-3
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2018 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2018 Summer Peak Case		Facility Outage(s)	Project
		% of Facility Rating	% of Nominal bus voltage		
5	Bain 345/138-kV transformer T4	103.7%	--	Bain transformer T5	Generation redispatch
5	Albers – Bain 138-kV line	121.3%	--	Bain – Kenosha 138-kV line	Generation redispatch
5	Bain – Kenosha 138-kV line	98.7%	--	Albers – Bain 138-kV line	Generation redispatch
5	Arcadian6 – Waukesha3 138-kV line	99.3%	--	Arcadian4 – Waukesha1 138-kV line	Generation redispatch
5	Oak Creek 345/138-kV transformer #2	99.0%	--	Oak Creek 345/138-kV transformer #1	Generation redispatch
5	Branch – Kansas 138-kV line	108.2%	--	Oak Creek – Pennsylvania 138-kV line	Load shift
5	Nicholson – Ramsey 138-kV line	96.3%	--	Oak Creek – Pennsylvania 138-kV line	Load shift
5	Oak Creek – Ramsey 138-kV line	96.1%	--	Oak Creek – Pennsylvania 138-kV line	Load shift
5	Arcadian4 – Waukesha1 138-kV line	100.1%	--	Arcadian6 – Waukesha1 138-kV line	Generation redispatch
5	Tichigan , Burlington1 138-kV bus voltages	--	87.7-88.6%	Split Burlington 138-kV bus	Load shift
5	Arcadian 345/138-kV transformer #2	101.0%		Arcadian 345/138-kV transformer #1	Generation redispatch (temporary) Arcadian transformer (provisional permanent solution)
5	Arcadian 345/138-kV transformer #3	120.1%		Arcadian 345/138-kV transformer #1	Generation redispatch (temporary) Arcadian transformer (provisional permanent solution)

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
1	Ripon, Ripon Industrial Park, NW Ripon, Dartford and SW Ripon 69-kV bus voltages	--	88.1 – 91.7%	Metomen-Ripon 69-kV line NW Ripon-Ripon 69-kV line Winneconne-Sunset Point 69-kV line Silver Lake-Wautoma 69-kV line Silver Lake-Spring Lake 69-kV line
1	Winneconne, Omro and Omro Industrial 69-kV bus voltages	--	83.5 – 91.8%	Winneconne-Sunset Point 69-kV line Omro-Winneconne 69-kV line Silver Lake-Wautoma 69-kV line
1	Silver Lake, Fountain Valley, Spring Lake, Red Granite and River Run 69-kV bus voltages	--	85.7 – 92.0%	Wautoma-Silver Lake 69-kV line Silver Lake-Spring Lake 69-kV line Spring Lake-Red Granite 69-kV line Fountain Valley-Red Granite 69-kV line Plus other less severe outages
1	Quincy (ACEC), Lincoln Pumping Station, Brooks (ACEC) and Grand Marsh 69-kV bus voltages	--	90.1 – 91.9%	Big Pond-Necedah tap 69-kV line
1	Fairwater 69-kV bus voltage	--	91.9%	Metomen 138/69-kV transformer
1	Sand Lake and Wautoma 138-kV bus voltage	--	95.0 – 95.3% 88.5 – 91.2%	Base Case Arpin-Sigel 138-kV line Sigel-Lakehead Vesper 138-kV line
1	Roeder and Green Lake 138-kV bus voltage	--	95.2 – 96.0%	Base Case
1	Metomen 138-kV bus voltage	--	94.7% 90.8%	Base Case Rosendale-North Fond du Lac 69-kV line
1	Hillsboro, Dorset Corners, Wonewoc, and Union Center 69-kV bus voltages	--	91.1 – 91.5%	Hillsboro 161/69-kV transformer
2	Delta – Mead 69-kV line	100-161%	-	Base Case 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	116%	-	Chandler-Delta 69 kV #2 line
2	Chandler – Delta 69 kV #2 line	111%	-	Chandler-Delta 69 kV #1 line
2	Chandler 138/69-kV transformer	96-109%	-	Nordic-Mountain 69-kV line Mountain-Harris Tap 69-kV line Forsyth 138/69-kV transformer
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	126-165%	-	Delta-Mead 69-kV line
2	Forsyth 138/69-kV transformer	105%	-	Chandler 138/69-kV transformer
2	Atlantic-Henry St. Tap 69-kV line	99%	-	Base Case
2	Atlantic-M38 69-kV line	107%	-	Atlantic-M38 138-kV line Atlantic 138/69-kV transformer
2	Atlantic 138/69-kV transformer	106%	-	M38 138/69-kV transformer
2	Indian Lake 138/69-kV transformer 1, 2	97%	-	Indian Lake 138/69-kV transformer 1, 2
2	Valley, Indian Lake, Glen Jenks, Manistique, Blaney Park, Curtis, Gould City, Straits, Engadine, Hiawatha 69-kV bus voltages	-	105.1-105.8%	Base Case

TABLE ZS-4

PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
2	Delta, West Side, Escanaba, Masonville, Mead, Gladstone, Bay View, North Bluff, Harris 69-kV bus voltages	-	86.0-88.1 %	Chandler 138/69-kV transformer
2	Atlantic, Elevation St., Henry St., MTU, Osceola, Portage, Keweenaw 69 kV bus voltages	-	77.8-86.3%	Atlantic 138/69-kV transformer
3	North Monroe 138/69-kV transformer	106%	--	Base Case
3	Colley Road 138/69-kV transformer	99%	--	Base Case
3	Paddock 138/69-kV transformer	98.1%	--	Base Case
3	Wauzeka-Boscobel 69-kV line	96.8%	--	Base Case
3	Concord 4-Concord generation bus	99.4%	--	Base Case
3	North Stoughton-Stoughton East–Stoughton 69-kV line	142.4%-98.8%	--	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Fulton-Lamar 69-kV line Oak Ridge-Verona 138-kV line Verona 138/69-kV transformer
3	Sheepskin-Dana Tap 69-kV line	132%-126.1%	--	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line
3	Fitchburg-Syene-Ninesprings 69-kV line	129%-110.4%	--	Royster-Pflaum Tap 69-kV line Pflaum-Pflaum Tap 69-kV line
3	Stage Coach-Black Earth-Mazomanie 69-kV line	126%-96.7%	--	Spring Green 138/69-kV transformer
3	Dane-Lodi Tap 69-kV line	126%-97.2%	--	Kirkwood-Island 69-kV line Island-Moore St 69-kV line Moore St-Baraboo 69-kV line Trienda-Lake Delton 138-kV line Lake Delton-City View 138-kV line City View-Kirkwood 138-kV line
3	Cobblestone-Zenda Tap 69-kV line	124.5%-96.6%	--	North Lake Geneva-Lake Geneva 69-kV line Lake Geneva-S Lake Geneva 69-kV line
3	Royster-Pflaum Tap-Pflaum 69-kV line	124.1%-104.2%	--	Fitchburg-Syene 69-kV line Nine Springs-Syene 69-kV line
3	Lake Geneva-S Lake Geneva-Katzenberg 69-kV line	123.1%-105.6%	--	Brick Church-Cobble Stone 69-kV line
3	West Middleton-Timberland-Stage Coach 69-kV line	119.1%-96%	--	Spring Green 138/69-kV transformer Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line
3	Colley Road 138/69-kV transformer	117.1%-96.2%	--	Paddock 138/69-kV transformer Paddock-Shirland Ave 69-kV line Shaw-Shirland 69-kV line Brick Church 138/69-kV transformer Colley Road-Dickinson 138-kV line
3	Enzyme Bio Systems-RC3-Clinton-Sharon 69-kV line	114.7%-97%	--	Colley Road-Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Brick Church 138/69-kV transformer Global Renewable Energy-Brick Church 138-kV line
3	North Monroe-Idle Hour 69-kV line	114.2%-95.7%	--	Darlington-Gratiot 69-kV line Gratiot-Wiota 69-kV line Wiota-Jennings Road 69-kV line Darlington 138/69-kV transformer Paddock-Newark 69-kV line Whistling Wind-Black Smith 69-kV line
3	South Fond Du Lac-Koch Oil-Waupun 69-kV line	114.1%-107.8%	--	North Randolph-Fox Lake 138-kV line Fox Lake-North Beaver Dam 138-kV line

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
3	Kirkwood-Rock Springs Tap – Artesian 138-kV line	113.5%-106.8%	--	Trienda-Lewiston 138-kV line East Dells-Kilbourn 138-kV line East Dells-Lewiston 138-kV line
3	Gran Grae-Wauzeka-Boscobel-Blue River 69-kV line	113%-96.1%	--	Spring Green 138/69-kV transformer Nelson Dewey-Lancaster 138-kV line Lancaster-Eden 138-kV line Eden-Wyoming Valley 138-kV line Spring Green-Lone Rock 69-kV line King-Eau Claire-Arpin 345-kV line
3	East Rockton-Shaw-Shirland 69-kV line	112.7%-103.2%	--	Colley Road 138/69-kV transformer Paddock 138/69-kV transformer
3	McCue-Harmony-Lamar 69-kV line	112%-95.6%	--	Kegonsa 138/69-kV transformer Kegonsa-North Stoughton 69-kV line North Stoughton-Stoughton 69-kV line Brodhead Switching-Brodhead South 69-kV line Sheepskin generation outage
3	Academy-Columbus Muni 2 Tap 69-kV line and Columbus Muni 2 Tap- Columbus 69-kV line	111.9%-100.4%	--	North Randolph-Fox Lake 138-kV line Fox Lake-North Beaver Dam 138-kV line
3	Brick Church-Cobblestone 69-kV line	107.9%	--	North Lake Geneva-Lake Geneva 69-kV line
3	McCue-Milton Lawn 69-kV line	107.1%	--	Janesville 138/69-kV transformer
3	Stoughton-Aaker Road 69-kV line	106.9%	--	Oak Ridge-Verona 138-kV line Verona 138/69-kV transformer
3	Hillman 138/69-kV transformer	106.3%-97.6%	--	DPC Galena-Pilot 69-kV line Pilot-Terr Tap 69-kV line
3	North Monroe 138/69-kV transformer	104.6%-95.4%	--	Darlington 138/69-kV transformer Darlington-Gratiot 69-kV line Gratiot-Wiota 69-kV line Wiota-Jennings Road 69-kV line Darlington 138/69-kV transformer Paddock-Newark 69-kV line
3	Paddock-Shirland Ave 69-kV line	104.5%	--	Colley Road 138/69-kV transformer
3	Spring Green 138/69-kV transformer	104.1%-97.3%	--	Gran Grae-Wauzeka 69-kV line Wauzeka-Boscobel 69-kV line Black Earth-Stage Coach 69-kV line
3	Eden 138/69-kV transformer	103.9%-96.1%	--	Eden-Wyoming Valley 138-kV line Spring Green-Wyoming Valley 138-kV line Nelson Dewey-Potosi 138-kV line Potosi-Hillman 138-kV line
3	Hubbard-Horicon 69-kV line	103.9%-99.6%	--	North Randolph-Fox Lake 138-kV line Fox Lake-N Beaver Dam 138-kV line
3	Brownstown-South Monroe 69-kV line	103.7%	--	North Monroe 138/69-kV transformer North Monroe-Idle Hour 69-kV line
3	Zenda-Katzenberg 69-kV line	102.6%	--	North Lake Geneva-Lake Geneva 69-kV line
3	North Lake Geneva-Lake Geneva 69-kV line	101.9%	--	Brick Church-Cobble Stone 69-kV line
3	Concord 4-Concord Generation Bus	101.8%-99.4%	--	Saukville-Pleasant Valley 138-kV line Rockdale-Lake Cambridge 138-kV line Lake Cambridge-Jefferson 138-kV line
3	Portage-Columbia 138-kV line	100.7%	--	Second Portage-Columbia 138-kV line
3	Paddock 138/69-kV transformer	100.4%	--	Colley Road 138/69-kV transformer
3	Bloomington-La Pointe 69-kV line	100.1%	--	Gran Grae 161/69-kV transformer
3	Colley Road-Park Ave 69-kV line	98.6%	--	Paddock 138/69-kV transformer
3	Center Street-South Beaver Dam 69-kV line	98.6%	--	North Randolph-Fox Lake 138-kV line

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
3	Academy 138/69-kV transformer	95.7%	--	North Randolph-Fox Lake 138-kV line
3	West Middleton 138/69-kV transformer	97.1%	--	West Middleton 138/69-kV transformer
3	West Middleton-West Town 69-kV line	95.3%	--	West Middleton-Pleasant View 138-kV line
3	Whistling Wind-Black Smith 69-kV line	98.6%	--	North Monroe-Idle Hour 69-kV line
3	Gratiot-Wiota 69-kV line	97%-95.9%	--	North Monroe 138/69-kV transformer North Monroe-Idle Hour 69-kV line
3	Brick Church 138/69-kV transformer	98.5%	--	North Lake Geneva 138/69-kV transformer
3	Waunakee Switching-Waunakee Muni 2 69-kV line	96.7%	--	West Middleton-Pheasant Branch 69-kV line
3	Huiskamp-Waunakee Industrial 69-kV line	99.5%	--	North Madison 138/69-kV transformer
3	Femrite-Royster 69-kV line	96.1%	--	Fitchburg-Syene 69-kV line
3	Portage-Trienda 138-kV line	98.3%	--	Second Portage-Trienda 138-kV line
3	West Middleton-Pleasant View 138-kV line	95.4%	--	Kegonsa-Christiana 138-kV line
3	Columbia T22 345/138-kV transformer	96.1%	--	Columbia T21 and T23 345/138-kV transformer
3	Columbia T21 and T23 345/138-kV transformer	95.4%	--	Columbia T22 345/138-kV transformer
3	Eden, Spring Green, Wyoming Valley, Lancaster and Troy 138-kV buses	--	90.7%-95.7%	Base Case
3	Oakridge, Hawk, Pleasant View, McFarland, Sprecher, Kegonsa, Colloday Point, Reiner Road, Cross County, Fitchburg, Sycamore, Femrite and Blount 138-kV buses	--	92.8%-95.4%	Base Case
3	Boscobel, Muscoda, Avoca and Blue River 69-kV buses	--	93.1%-94.1%	Base Case
3	East Beaver Dam, North Beaver Dam, Fox Lake, North Randolph, Fountain Prairie, Friesland and Academy 138-kV buses	--	94.6%-94.7%	Base Case
3	Okee and Lodi 69-kV buses	--	94.6%-95.2%	Base Case
3	Kirkwood, Lake Delton, City View, Rock Springs, Artesian and Nishan 138-kV buses and Reedsburg, Artesian 69-kV buses	--	94.8%-95.9%	Base Case
3	Mazomanie, Black Earth and Arena 69-kV buses	--	94.9%-95.6%	Base Case
3	Hustisford, Hubbard, Butler Ridge, Concord, Rockvale, Fort Atkinson, Crawfish, Lake Mills, Stoney Brook, Boxelder, Jefferson and Rubicon 138-kV buses	--	95.1%-95.9%	Base Case
3	Gaston Road and Cottage Grove 69-kV buses	--	95.7%	Base Case
3	Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	--	75.9%-90.8%	Spring Green 138/69-kV transformer
3	Harmony, Lamar, Fulton, Saunders Creek, Dana Corp, Sheepskin Footville, RCEC Center, Bass Creek, Orfordville and Evansville 69-kV buses	--	80%-91.8%	McCue-Harmony 69-kV line Harmony-Lamar 69-kV line Lamar-Fulton 69-kV line
3	Wauzeka, Spring Green, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni ,69-kV bus voltages, Spring Green, Eden and Wyoming Valley 138-kV bus voltages	--	79.5%-91.4%	Gran Grae-Wauzeka 69-kV line Wauzeka-Boscobel 69-kV line
3	Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni , Pine River, Brewer and Richland Center 69-kV bus voltages	--	82.9%-91.2%	Lone Rock-Spring Green 69-kV line
3	Hubbard, Hustisford, North Beaver Dam and Beaver Dam East 138-kV bus voltages	--	85%-85.8%	Rubicon-Hustisford 138-kV line Hubbard-Hustisford 138-kV line
3	Eden, Wyoming Valley, Spring Green, Troy and Lancaster 138-kV bus voltages, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	--	83.8%-92%	Nelson Dewey-Lancaster 138-kV line Eden-Wyoming Valley 138-kV line Lancaster-Eden 138-kV line

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
3	Dickinson, Global Renewable Energy, William Bay N Lake Geneva, Como, Elkhorn and Brick Church 138-kV buses	--	87%-91.8%	Colley Road – Dickinson 138-kV line Dickinson-Global Renewable Energy 138-kV line Global Renewable Energy-Brick Church 138-kV line
3	Idle Hour, Monroe, Black Smith, New Glarus, Monticello, Brown town, Monticello, New Glarus, Whistling Wind and S Monroe 69-kV buses	--	83.7%-92%	North Monroe-Idle Hour 69-kV line North Monroe 138/69-kV transformer Monroe-Idle Hour 69-kV line
3	Concord ,Hubbard, Hustisford, Rubicon, Rockvale, Crawfish, Jefferson, Fort Atkinson and Butler Ridge 138-kV bus voltages	--	85.6%-91.9%	Concord4-5 138-kV bus Hartford-St. Lawrence 138-kV line
3	Avoca, Muscoda, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	--	88.2%-91.3%	Lone Rock-Avoca 69-kV line Avoca-Muscoda 69-kV line
3	Brodhead Muni 3, Brodhead Muni 2, Brodhead, Brodhead Muni 1, RCEC Orfordville, Orfordville, Bass Creek, Footville, RCEC Center, Evansville 69-kV bus voltages	--	84.8%-91.9%	Brodhead Switching Station-Brodhead Muni 3 69-kV line Brodhead Muni 2 -Brodhead Muni 3 69-kV line Brodhead Muni 2-Brodhead 69-kV line
3	Cobblestone, Lake Shore, Twin Lakes, Richmond and Zenda 69-kV buses	--	86.5%-91.1%	Brick Church-Cobblestone 69-kV line
3	Lake Geneva, South Lake Geneva, Richmond, Katzenberg and Twin Lake 69-kV buses	--	83.1%-92%	North Lake Geneva-Lake Geneva 69-kV line Lake Geneva-South Lake Geneva 69-kV line South Lake Geneva-Katzenberg 69-kV line
3	Burke, Sun Prairie, Token Creek, South, Colorado, Bird St, Gaston Road and Reiner 69-kV buses	--	88.1%-91.9%	Reiner Road 138/69-kV transformer Burke-Colorado 69-kV line Reiner Road-Burke 69-kV line
3	Evansville, Footville, Center and Bass Creek 69-kV bus voltages	--	87.2%-91.4%	Evansville-Sheepskin 69-kV line
3	Arena, Mazomanie and Black Earth 69-kV bus voltages	--	88.2%-91.7%	Spring Green-Arena 69-kV line
3	Eden, Wyoming Valley, Spring Green, Troy and Lancaster 138-kV bus voltages,	--	85.9%-90.1%	Spring Green-Troy 138-kV line Troy-Kirkwood 138-kV line
3	Island, Moore St, Baraboo, Dam Heights, Tower St , Eagle View, Lodi, Okee and Prairie Du Sac 69-kV bus voltages	--	86.2%-92%	Island-Kirkwood 69-kV line Island-Moore St 69-kV line
3	Rockvale 138-kV bus voltage	--	92%	Concord-Rockvale 138-kV line
3	Potosi, Hillman, Darlington, North Monroe and Lafayette Wind 138-kV bus voltages	--	87%-91.6%	Nelson Dewey-Potosi 138-kV line Potosi-Hillman 138-kV line Hillman-Lafayette Wind 138-kV line Lafayette Wind-Darlington 138-kV line
3	Albany, North Monroe, Darlington, Lafayette Wind 138-kV bus voltages	--	86.5%-91.6%	Townline-Albany 138-kV line Albany-North Monroe 138-kV line
3	Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages, Troy 138-kV bus voltage	--	88.4%-91.8%	Spring Green-Wyoming Valley 138-kV line
3	Pleasant View, Hawk, West Middleton, NE Cross Plains, Oakridge, Cross County, Fitchburg 138-kV buses	--	89.4%-91.9%	Rockdale-West Middleton 345-kV line West Middleton 345/138-kV transformer West Middleton 138/69-kV transformer Pleasant View-West Middleton 138-kV line
3	North Beaver Dam and East Beaver Dam 138-kV bus voltages, Koch Oil 69-kV bus voltage	--	91.5%-92%	South Fond Du Lac-Koch Oil 69-kV line Koch Oil-Waupun 69-kV line
3	Bluff Creek and Sugar Creek 138-kV bus voltage	--	91.6%-91.9%	University-Bluff Creek 138-kV line
3	Cottage Grove 69-kV bus voltage	--	91.4%	Kegonsa-Cottage Grove 69-kV line
3	McFarland, Femrite and Sprecher 138-kV bus voltages	--	90.3%-91.1%	Kegonsa-McFarland 138-kV line McFarland-Femrite 138-kV line
3	Lodi, Okee 69-kV bus voltages	--	88.8%-91.7%	Dane-Lodi Tap 69-kV line Lodi-Okee Tap 69-kV line

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
3	Eagle View 69-kV bus voltage	--	91%	Eagle View-Dam Heights 69-kV line
3	Randolph, Didion and Cambria 69-kV bus voltages	--	89.4%-91.7%	North Randolph-Randolph Tap 69-kV line Didion- Randolph Tap 69-kV line
3	Boscobel, Blue River, Wauzeka, Gran Grae, La Pointe, Muscoda, Avoca 69-kV bus voltage	--	88.3%-91.9%	Gran Grae 138/69-kV transformer
3	Yahara, Vienna, Reiner Road, Sprecher, Femrite and American Center 138-kV bus voltages	--	91.2%-92%	North Madison-Yahara 138-kV line Vienna-Yahara 138-kV line
3	Horicon, Juneau and Horicon Industry 69-kV bus voltages, North Beaver Dam, Fox Lake and Beaver Dam East 138-kV bus voltages	--	89%-91.8%	Hubbard-Horicon Industrial 69-kV line Horicon-Horicon Industrial 69-kV line
3	LCI, Ninesprings and Pflaum 69-kV bus voltage	--	89.6-91.6%	Royster-Pflaum 69-kV line
3	Lewiston, East Dells, Kilbourn, Loch Mirror, Birchwood, Zobel, Nishan, Artesian, Rock Springs, Kirkwood, City View , Kirkwood, Lake Delton and Troy 138-kV bus voltages, Reedsburg and Artesian 69-kV bus voltages	--	87.4%-91.8%%	City View-Kirkwood 138-kV line Kirkwood-Lake Delton 138-kV line Trienda-Lewiston 138-kV line Lewiston-East Dells 138-kV line East Dells-Kilbourn 138-kV line Trienda-Lake Delton 138-kV line Loch Mirror-Kilbourn 138-kV line Loch Mirror-Birchwood 138-kV line
3	Academy 138-kV bus voltage	--	91.9%	Boxelder-Academy 138-kV line
3	Aaker Road 69-kV bus voltage	--	91.1%	Stoughton-Aaker Road 69-kV line
3	Timberline, Stage Coach, Cross Plains, Black Earth, Spring Green, Arena, Mazomanie, Mazomanie Industrial, Lone Rock, Muscoda, Avoca, Blue River, Boscobel, Boscobel Muni 69-kV bus voltages	--	88.8%-92%	West Middleton-Timberline 69-kV line Black Earth-Mazomanie 69-kV line Stage Coach-Black Earth 69-kV line
3	West Darien, Southwest Delavan and North Shore 138-kV bus voltages	--	91.6%-91.8%	Bradford-West Darien 138-kV line
3	La Prairie, Bradford, West Darien, SW Delavan and N Shore 138-kV bus voltages	--	91.6%-91.7%	Rock River-La Prairie 138-kV line
3	Newark, Brodhead Switching, Brodhead South, Brodhead, Brodhead North, Orfordville, Bass Creek, Spring Grove and Footville 69-kV bus voltages	--	90.6%-92%	Paddock-Newark 69-kV line Newark-Brodhead Switching Station 69-kV line
3	Lone Rock, Muscoda, Avoca, Blue River, Pine River, Richland Center, Brewer and Seneca 69-kV bus voltages	--	89.9%-91.6%	Seneca-Bell Center 161-kV line
3	Lone Rock, Muscoda, Avoca, Pine River, Richland Center, Brewer 69-kV bus voltages	--	90.7%-91.9%	Hillsboro 161/69-kV transformer
3	Lone Rock, Muscoda, Avoca, Pine River, Richland Center, Brewer and Boscobel 69-kV bus voltages	--	89.3%-91.7%	Richland Center-T RC 69-kV line T RC-Dayton 69-kV line
3	Miner, Shullsburg 69-kV bus voltages	--	90.5%-92%	DPC Galena-Pilot 69-kV line Pilot-Terr Tap 69-kV line
3	Verona, Sun Valley, Montrose 69-kV bus voltages	--	90.3%-91.1%	Oak Ridge-Verona 138-kV line Verona 138/69-kV transformer
3	North Lake Geneva, Sugar Creek, Williams Bay, Como, Elkhorn and Brick Church 138-kV bus voltages	--	88.4%-92%	Burlington 138-kV Bus 1-2 outage Paris-Air Liquide 138-kV line Burlington-Air Liquide 138-kV line
3	Fox Lake, Beaver Dam East and North Beaver Dam 138-kV bus voltages	--	88.3%-89.7%	North Randolph-Fox Lake 138-kV line Fox Lake-North Beaver Dam 138-kV line
3	Reiner Road 138-kV bus voltage	--	91.7%	Reiner Road-Sycamore 138-kV line
3	Hamilton, North Beaver Dam and Beaver Dam East 138-kV bus voltages	--	91.8-91.9%	Portage-Hamilton 138-kV line
3	Cambridge, London 138-kV bus voltages	--	91.8%-92%	Rockdale-Cambridge Tap 138-kV line
3	N Monroe 138/69-kV transformer	108.6%	--	Columbia generator 1 or 2 outage

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
3	McCue-Harmony-Lamar 69-kV line	98.9%-95.8%	--	Columbia generator 1 or 2 outage
3	Wauzeka-Boscobel 69-kV line	107.1%	--	Columbia generator 1 or 2 outage
3	Troy, Eden, Kirkwood, City View, Lake Delton 138-kV bus voltages, Muscoda, Blue River, Boscobel, Avoca an Reedsburg 69-kV bus voltages	--	88.9%-91.8%	Columbia generator 1 or 2 outage
3	Nelson Dewey 161/138-kV transformer	102.1%-100.7%	--	Nelson Dewey generator 1 or 2 outage
3	McCue-Harmony-Lamar 69-kV line	111.8%-108.6%	--	Sheepskin generation outage
3	McCue 138/69-kV transformer	97.6%	--	Sheepskin generation outage
3	North Stoughton-Stoughton 69-kV line	105.5%	--	Sheepskin generation outage
3	Nelson Dewey-Gran Grae 161-kV line	98.3%	--	DPC Genoa generation outage
4	Pulliam-Suamico 69-kV line	134%	--	Base case
4	Edgewater 138/69-kV transformer #1 Edgewater 138/69-kV transformer #2	100-101%	--	Base case
4	Edgewater 138/69-kV transformer #1	96.4%	--	Edgewater 138/69-kV transformer #2
4	Edgewater-Washington St 69-kV line	104.4%	--	Edgewater-Nicolet 69-kV line
4	Pulliam-James St 138-kV line	96.2%	--	Green Bay South West-De Pere 138-kV line
4	Pioneer-Sobieski 69-kV line Pioneer 138/69-kV transformer	128-96.6%	--	Pulliam-Suamico 69-kV line followed by Sobieski-Pioneer 69-kV line close
4	Canal 138/69-kV transformer #1	99%	--	Canal 138/69-kV transformer #2
4	Canal 138/69-kV transformer #2	98.6%	--	Canal 138/69-kV transformer #1
4	Glenview 138/69-kV transformer #1	115.1%	--	Glenview 138/69-kV transformer #2
4	Glenview 138/69-kV transformer #2	114.6%	--	Glenview 138/69-kV transformer #1
4	Finger Road-Bluestone 69-kV line	96.3-126.2%	--	Wesmark-Kellnersville 69-kV line Kellnersville-Manrap 69-kV line Mishicot-Shoto 138-kV line
4	City Limits 138-kV bus tie 1-2 City Limit-Butte Des Morts 138-kV line City Limits-Combined Locks Tap 138-kV line	100-118.9%	--	North Appleton-Apple Hills 138-kV line
4	Manrap-Custer 69-kV line	95.4%	--	Revere-Lakefront 69-kV line
4	Sunset Point 138/69-kV transformer #1	100.3%	--	Sunset Point 138/69-kV transformer #2
4	Oak St-Ashland Ave 69-kV line	103.1%	--	Pulliam-South Broadway Tap 69-kV line
4	East Krok 138/69-kV transformer	96.9%	--	Canal-East Krok 138-kV line
4	Sobieski, Suamico 69-kV bus voltages	--	87.2-89.6%	Base case
4	Ashland 69-kV bus voltage	--	95.6%	Base case
4	Bluestone, Wesmark 69-kV bus voltages	--	Diverged	Finger Road-Bluestone 69-kV line
4	East Krok, Beardsley St, Barnett, Booster, Luxemburg 69-kV bus voltages	--	89.2-91.1%	East Krok 138/69-kV transformer
4	Combined Lock Taps, Maes, Apple Hills 138-kV bus voltages	--	90.7-91.9%	North Appleton-Apple Hills 138-kV line
4	Hickory, Forward Energy Center, Butternut 4, Butternut 5 138-kV bus voltages	--	91%	Hickory-South Fond du Lac 138-kV line
4	Forward Energy Center, Butternut 4, Butternut 5 138-kV bus voltages	--	91.8%	Hickory-Forward Energy Center 138-kV line
4	Butternut 4, Butternut 5 138-kV bus voltages	--	91.9%	Butternut-Forward Energy Center 138-kV line
4	Holland, Plymouth #4, Howards Grove, Meeme 138-kV bus voltages	--	87.1-91.6%	Charter Steel Industry-Holland 138-kV line Charter Steel Industry 138-kV bus plus Charter Steel-Cedarsauk 138-kV line
4	Lyndon 138-kV bus voltage	--	90.8%	Cedarsauk-Fredonia 138-kV line
4	Suamico, Sobieski 69-kV bus voltages	--	87-90.2%	Pulliam-Suamico 69-kV line followed by Sobieski-Pioneer 69-kV line close

TABLE ZS-4
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2023 Summer Peak Case

Planning Zone	Criteria Exceeded/Need	2023 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal bus voltage	
5	Allerton9 138-kV bus voltage Bark River 138-kV bus voltage Barton 138-kV bus voltage Cooney 138-kV bus voltage Cottonwood 138-kV bus voltage Hartford 138-kV bus voltage Merrill Hills 138-kV bus voltage St. Lawrence 138-kV bus voltage Summit 138-kV bus voltage Arthur Road 138-kV bus voltage Glacier 138-kV bus voltage	--	95.8% 95.5% 95.8% 95.4% 95.2% 95.1% 95.6% 95.6% 95.4% 95.5% 95.5%	Intact System
5	Oak Creek – Pennsylvania 138-kV line	106.3% 107.8% 107.6% 107.0% 106.4%	--	Intact System Nicholson – Oak Creek 138-kV line Oak Creek – Ramsey 138-kV line Nicholson – Ramsey 138-kV line Kansas – Ramsey 138-kV line Plus other less severe outages
5	Hartford 138-kV bus voltage	--	88.7%	Concord 138-kV bus split between 4 and 5
5	St. Lawrence and Arthur Road 138-kV buses	--	90.8%	Concord 138-kV bus split between 4 and 5
5	Glacier 138-kV bus voltage	--	91.8%	Concord 138-kV bus split between 4 and 5
5	Cooney, Cottonwood, Hartford, Summit 138-kV buses	--	90.2-91.9%	Concord 138-kV bus split between G and 4
5	Brookdale W – Kansas 138-kV line	95.5%	--	Bluemound – Brookdale W 138-kV line
5	Fredonia 138-kV bus voltage	--	89.2%	Cedarsauk – Fredonia 138-kV line
5	Swan 138-kV bus voltage	--	91.5%	Granville – Swan Tap 138-kV line
5	Bain 345/138-kV transformer T5	159.7%	--	Pleasant Prairie bus split between 3 and 4
5	Albers – Kenosha 138-kV line	104.0%	--	Bain – Kenosha 138-kV line
5	Pleasant Valley 138-kV bus	--	91.1%	Pleasant Valley – Saukville 138-kV line
5	Branch – Kansas 138-kV line	119.9%	--	Oak Creek – Pennsylvania 138-kV line
5	Nicholson – Ramsey 138-kV line	99.4%	--	Oak Creek – Pennsylvania 138-kV line
5	Oak Creek – Ramsey 138-kV line	99.2%	--	Oak Creek – Pennsylvania 138-kV line
5	Tichigan , Burlington1 138-kV bus voltages	--	83.1-84.2% 88.1–89.1%	Split Burlington 138-kV bus Burlington – Air Liquide – Paris 138-kV line
5	Arcadian 345/138-kV transformer #2	97.5 %		Arcadian 345/138-kV transformer #1
5	Arcadian 345/138-kV transformer #3	118.9%		Arcadian 345/138-kV transformer #1

Table ZS-5

ATC Day Ahead Market Constraints (January 1, 2007 through December 31, 2007)

Shadow Price*	Hours Rank**	Constraint (Common Name)	Potential Solution
$67,996	1	Paddock 345/138 kV Transformer T21	Paddock – Rockdale 345 kV (Planned, 2010)
$55,278	2	Eau Claire – Arpin 345 kV	Arrowhead – Gardner Park 345 kV (Completed, 2008)
$46,541	5	Hintz – Werner 138 kV	Substation upgrades (Completed, August 2007) Morgan – Highway 22 – Gardner Park (Planned, 2009)
$43,654	8	Ellington – Hintz 138 kV	Increased line clearance (Completed, August 2007) Morgan – Highway 22 – Gardner Park (Planned, 2009)
$43,250	13	Pleasant Valley – Arthur Road 138 kV	Reconductor of circuit (Planned, 2008)
$22,782	4	Highway V – Preble 138 kV	Morgan – Highway 22 – Werner West 345 kV (Planned, 2009)
$21,255	6	North Appleton – Werner West – Rocky Run 345 kV	No solution identified
$19,625	3	Stiles – Pulliam 138 kV (Line 64451)	Morgan – Highway 22 – Werner West 345 kV (Planned, 2009)
$14,466	7	Stiles – Pulliam 138 kV (Line 64441)	Morgan – Highway 22 – Werner West 345 kV (Planned, 2009)
$9,118	19	Badger - Belle Plaine - Caroline - Whitcomb 115 kV	Morgan – Highway 22 – Gardner Park (Planned, 2009)
$7,900	21	Lakeview – Zion 138 kV	No solution identified
$6,575	20	McGulpin – Straits 138 kV	ATC Michigan Energy Collaborative will investigate potential solutions (2008).
$5,365	22	Pleasant Prairie – Racine 345 kV	No solution identified
$4,858	34	Morrison Avenue – Sherman Street 115 kV	New Gardner Park – Hilltop 115 kV line (Completed, May 2007) Weston - Sherman St. - Hilltop 115 kV rebuild (Competed, May 2007)
$4,512	14	Flow South Stability Flowgate	Morgan – Highway 22 – Werner West 345 kV line (Planned, 2009) Construct Cranberry – Conover 115 kV line (Completed, 2008) Convert Conover – Plains to 138 kV (Planned, 2010)
$460,072			**Total for all ATC Day Ahead constraints, 1/1/07 - 12/31/07**

NOTE: Four constraints have been omitted from this list because they are caused by virtual market transactions in the Day Ahead Market.

** Sum of shadow prices throughout year – i.e. the amount of money to be saved if this constraint is relieved by one MW.*

*** Hours rank is based on the constraints that occur most often on the system, regardless of severity (shadow price).*

Table ZS-7: ATC System Angular Stability Assessment for 2008 10-Year Assessment

	Major Generator Stations	# Units	Total Capacity (MW)	Last Year 0f Detail Study	Response for Selected NERC Category C Outages (NERC Reliability Criteria)				SPS	Note
					2009	2010~2012	2013	Appropriate for 2014~2018		
	Existing Units									
1	Pleasant Prairie	2	1200.0	2006	Acceptable (1, 2)	Acceptable (6)	Acceptable (6)	Yes	Yes	IPO Breakers
2	Paris	4	400.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (7)
3	Oak Creak	7	1135.0	2006	Acceptable (1, 2)	Acceptable (6)	Acceptable (6)	Yes	No	New G8 Exciter
4	Valley	2	267.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
5	Germantown	5	342.8	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
6	Port Washington CC1	3	540.0	2005	Acceptable (3,16)	Acceptable (3,16)	Acceptable (3,16)	Yes	No	See note (15)
7	Port Washington CC2	3	540.0	2005	Acceptable (3,16)	Acceptable (3,16)	Acceptable (3,16)	Yes	No	See note (15)
8	Point Beach	2	557; 559	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	Yes	
9	Kewaunee	1	579.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	Yes	
10	Edgewater	3	773.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	Yes	IPO Breakers
11	S. Fond du Lac	4	352.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
12	Neevin	2	300.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
13	Skygen	1	185.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
14	Pulliam	5	404.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	See note (18)
15	West Marinette	4	240.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
16	Fox Energy	3	672.3	2005	Acceptable	Acceptable	Acceptable	Yes	No	IPO Breakers, See note (11)
17	Sheboygan Energy	2	343.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
18	Cypress	88	145.2	2007	Acceptable (9)	Acceptable (9)	Acceptable (9)	Yes	No	
19	Forward Energy Center	86	129.0	2004	Acceptable	Acceptable	Acceptable	Yes	No	See note (17)
20	Columbia	2	1050.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	IPO Breakers
21	Christiana	3	544.5	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
22	Riverside	3	659.1	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
23	Rock River	5	262.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
24	Nelson Dewey	2	226.0	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
25	University	2	236.0	2005	Acceptable	Acceptable	Acceptable	Yes	No	See note (12)
26	Concord	4	400.0	2006	Acceptable (8)	Acceptable (8)	Acceptable (8)	Yes	No	See note (7)
27	West Campus	3	147.2	2005	Acceptable (1, 2)	Acceptable (1, 2)	Acceptable (1, 2)	Yes	No	
28	Presque Isle	9	617.0	2005	Acceptable (14)	Acceptable (14)	Acceptable (14)	Yes	Yes	See notes (13, 19)
29	Weston	5	552.6	2005	Acceptable (4)	Acceptable (4)	Acceptable (4)	Yes	No	IPO Breakers
	New / Future Units									
30	Weston 4	1	550.0	2005	Acceptable (4)	Acceptable (4)	Acceptable (4)	Acceptable (4)	Yes(5)	IPO Breakers
31	Elm Road Phase I	1	650.0	2006	Acceptable (6)	Acceptable (6)	Acceptable (6)	Acceptable (6)	No	IPO Breakers
32	Elm Road Phase II	1	650.0	2006		Acceptable (6)	Acceptable (6)	Acceptable (6)	No	IPO Breakers
33	Nelson Dewey 3	1	280.0	2006				Acceptable (9)	No	IPO Breakers

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 2008 TYA as part the system angular stability analysis

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 update to the dynamic models used in stability studies and would have been studied in the 2008 TYA system angular stability analysis. However, these changes or updates have already been addressed in other angular stability studies (as noted) recently completed satisfying the need for inclusion in the 2008 TYA anaylsis.

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 catergory C.

(2) Comparing 2008 TYA models with 2005 TYA models, no significant change has occurred near the generation station, other than the local load growth. Therefore, the stabilityresults from the 2005 TYA are still applicable and are acceptable in the following years.

(3) "Generator Interconnection Combined Feasibility and System Impact Study Report for G510 - Revision #1, MISO #G510 (#38429-02)" dated February 14, 2006. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G-T Projects\G510 - Port Washington Extra MW \02_Feasibility Study\Study Data\G510_Impact_Study.pdf. Study included "as built data" for CC2 and original data for CC1 from 2003 study. "Generator Interconnection Facility Study Report for G093 - Revision #3, MISO #G093 (#37004-01)" dated May 13, 2003. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G-T Projects\G093 - IC027 - Port Washington Extra MW\ Study Data\IC027 reports\GIC027_Facilities_Study_Report.pdf.

(4) "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.

(5) A temporary special protection system to trip Weston 4 and a temporary generation restriction on Weston 31 and 32 from June 1, 2008 to December 1 2009 will be implemented to maintain angular stability until the completion of the following facilities: a) 345-kV Arrowhead-Stone Lake lin (expected in service date is June 1, 2008), b) 345-kV Morgan-Central Wisconsin-Werner West line (December 1, 2009), and c) 345-kV Gardner Park-Central Wisconsion line (December 1, 2009).

(6) "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

Notes (Continued):

(7) An update of the parameters for all four exciter models of the Combustion Turbines (C1-C4) were studied as part ogf the 2008 TYA. These parameter changes were not included as part of the recent studies done to assess the 24 MW capacity increase at Concord (8) and Paris plants (TYA2005).

(8) "G550 Interconnection Combined Feasibility/System Impact Study Report 24 MW Simple Cycle Gas Generation Revision 1, MISO (#36512-02)" dated December 16, 2006. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G-T Projects \G550_Concord CT Uprate\ Study Reports\G550 FeS_SIS Report Final Revision 1.doc.

(9) "Interconnection System Impact Study Report 280 MW Coal Generation MISO Queue #38512-01" dated Novenber 27, 2006. \\atc.llc\atcdata\ Knowledge Share\Planning and Service\Generator Requests\G-T Projects\\G527 - Nelson Dewey Unit 3\03_System Impact Study\Study Reports\ G527 ISIS Report-Rev2.doc.

(10) "258 MW Wind Generation Optional Study 2 MISO #G353/354/427 (#37825-01, 37825-02, 38121-03), dated February 26, 2007. \\atc.llc\atcdata\Knowledge Share\Planning and Service\Generator Requests\G-T Projects\G353_G354 - Blue Sky_Green Field\ 04a_Optional Studies\Optional Study 2\G353_354_427_Optional_Study_2.pdf.

(11) Both combustion turbines (C1 and C2) had the "non-standard (USER) governor model replaced with the standard model developed to represent the non-standard model. Combustion turbine C2 was replaced with new parameters for generator, exciter and power system stabilizer.

(12) The University Generator Step-up originally modeled as a three-winding transformer to connect both CT and ST units, but 2 two-winding transformers were installed to connect CT and ST generators separately. Generator parameters for ST unit changed slightly.

(13) Since TYA2005 cases, there has been an update to the generator model parameters for G3 and G4; an update of the exciter and power system stabilizer models on units 5 and 6; updates to generator model parameters for units G7, G8 and G9; plus an update of exciter and power system stabilizer models on units 7 and 8; plus a model update for the exciter and the addition of a power system stabilizer on unit G9. The study described in note 14 includes the identified model changes in that study and satisfies the need for re-study these units as part of the 2008 TYA.

(14) "Presque Isle Special Protection System “Remedial Action Tripping Scheme” (RATS)" Version 3.0 dated December 17, 2007. \\atc.llc\atcdata\PSSE\Special_Studies\SPS Studies\Presque Isle SPS\Final report\PresqueIsleSPS-v3.pdf.

(15) The "as built data" for the CC1 units recently became available and needs to be studied to verify the results from the previous studies and include any update of the stbility models or their associated parameters. The study described in note 16 satisfies the requirement for re-study of these units as part of the 2008 TYA.

(16) Unit Verification study conducted dated May 8, 2008. \\atc.llc\atcdata\PSSE\Special_Studies\SPS Studies\Unit Verification Studies\Port Washington Validation Study Block #1\Generator Validation Study.doc

(17) In the TYA2005 cases and previous studies a simple induction generator model (CIMTR3) was used to model the GE 1.5 MW units comprising this wind farm and current dynamic representation uses the new WT3 generic wind models to represent the GE 1.5 MW units at this wind farm. In addition, the installed capacity represented changed from 104 to 86 units and was within one year of the 5-year sequence for the system angular stability analysis.

(18) Pulliam units 3 and 4 were removed from service indefinitely as of December 31 2007.

(19) Presque Isle units 1 and 1 were retired from service as of January 1 2007.

Table ZS-8
Zone 1 – Peak Load and Generation

Zone 1	2009	2013	2018	2023
Peak Forecast (megawatts)	1778.4	1871.4	2002.4	2133.9
Average Peak Load Growth	N/A	1.28%	1.36%	1.28%
Existing Generation Capacity (megawatts)	1333.9	1333.9	1333.9	1333.9
Existing Capacity Less Load	-444.5	-537.5	-668.5	-800
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	1493.9	1493.9	1493.9	1493.9
Modeled Capacity Less Load (megawatts)	-284.5	-377.5	-508.5	-640

Table ZS-9
Zone 2 – Peak Load and Generation

Zone 2	2009	2013	2018	2023
Peak Forecast (megawatts)	807.4	731.3	759.5	780.2
Average Peak Load Growth	N/A	-2.44%	0.76%	0.54%
Existing Generation Capacity (megawatts)	992.9	992.9	992.9	992.9
Existing Capacity Less Load	185.5	261.6	233.4	212.7
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	992.9	992.9	992.9	992.9
Modeled Capacity Less Load (megawatts)	185.5	261.6	233.4	212.7

Table ZS-10
Zone 3 – Peak Load and Generation

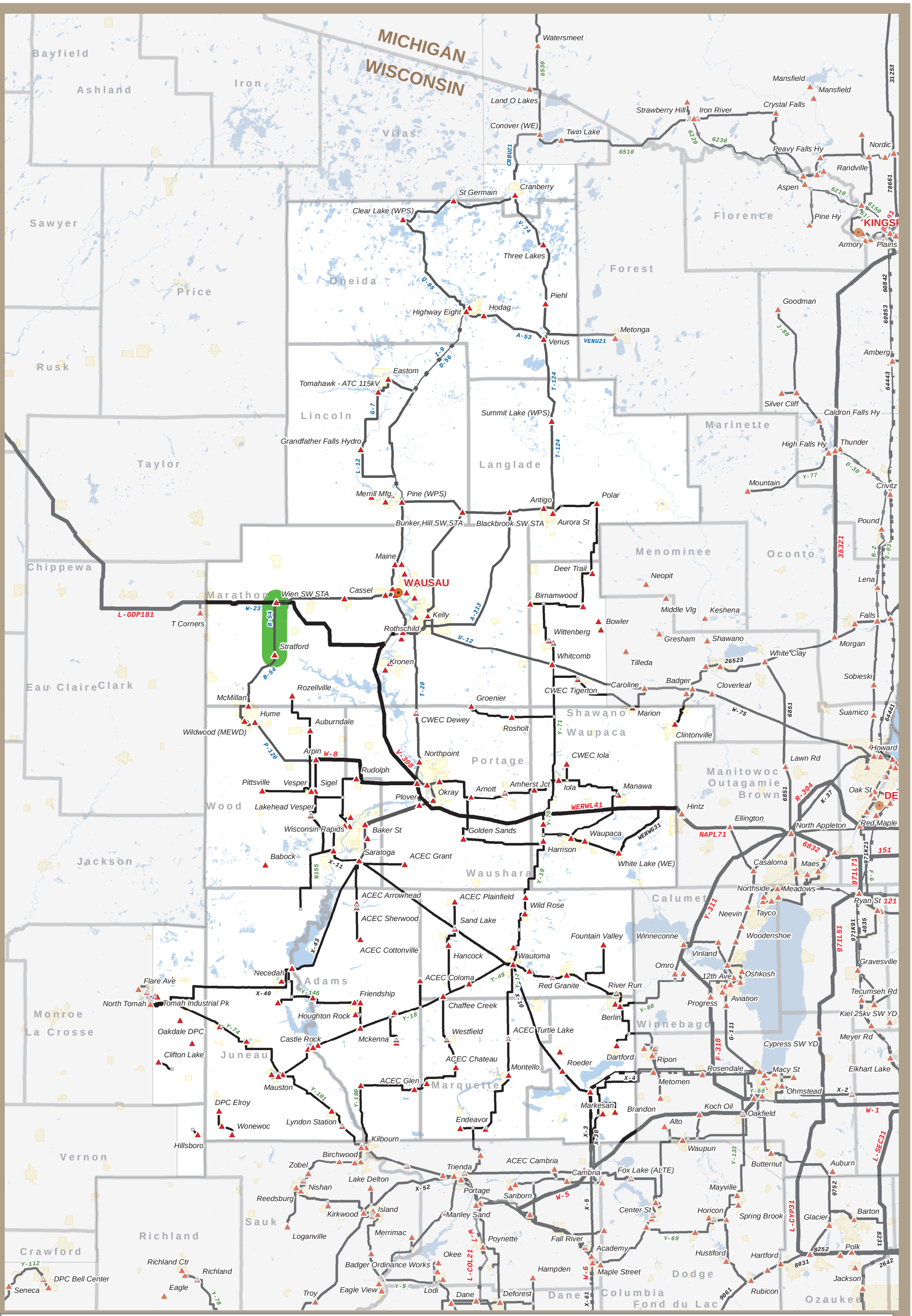
Zone 3	2009	2013	2018	2023
Peak Forecast (megawatts)	3210.1	3632.1	4066.8	4534.4
Average Peak Load Growth	N/A	3.14%	2.29%	2.20%
Existing Generation Capacity (megawatts)	3867.1	3867.1	3867.1	3867.1
Existing Capacity Less Load	657	235	-199.7	-667.3
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	4162.6	4426.1	4426.1	4426.1
Modeled Capacity Less Load (megawatts)	952.5	794	359.3	-108.3

Table ZS-11
Zone 4 – Peak Load and Generation

Zone 4	2009	2013	2018	2023
Peak Forecast (megawatts)	3453.4	3699.9	3973.4	4274.7
Average Peak Load Growth	N/A	1.74%	1.44%	1.47%
Existing Generation Capacity (megawatts)	5648.1	5648.1	5648.1	5648.1
Existing Capacity Less Load	2194.7	1948.2	1674.7	1373.4
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5849	5849	5849	5849
Modeled Capacity Less Load (megawatts)	2395.6	2149.1	1875.6	1574.3

Table ZS-12
Zone 5 – Peak Load and Generation

Zone 5	2009	2013	2018	2023
Peak Forecast (megawatts)	4709.4	5075.1	5550.9	6069
Average Peak Load Growth	N/A	1.89%	1.81%	1.80%
Existing Generation Capacity (megawatts)	4468	4468	4468	4468
Existing Capacity Less Load	-241.4	-607.1	-1082.9	-1601
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5118	5768	5768	5768
Modeled Capacity Less Load (megawatts)	408.6	692.9	217.1	-301



Performance Criteria Limits Exceeded and Other Constraints 2008-2009

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 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

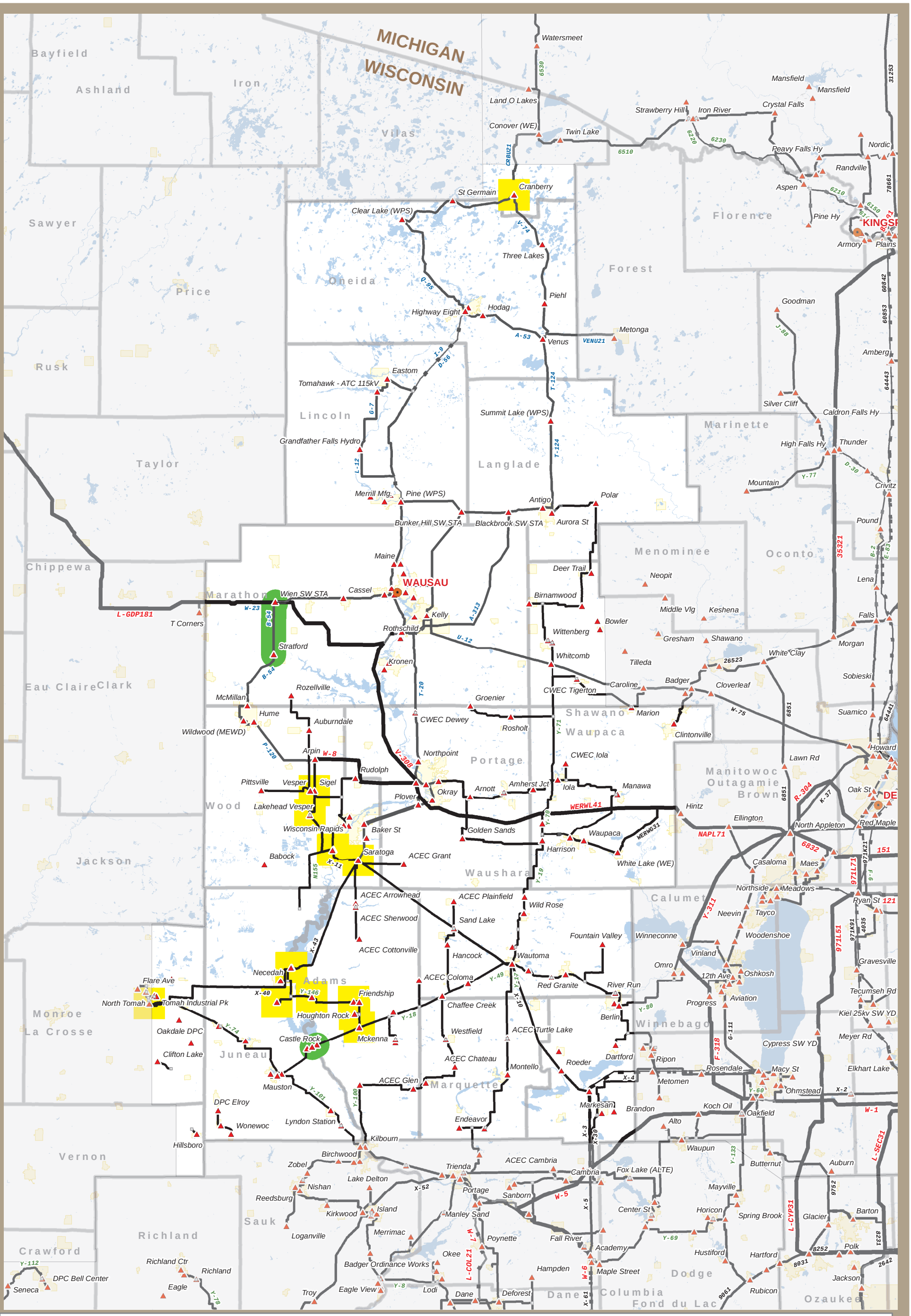
Low Voltages
Overloaded Facility
New Generation/Stability
Transmission Needed for Load Growth

Transmission Related Facilities

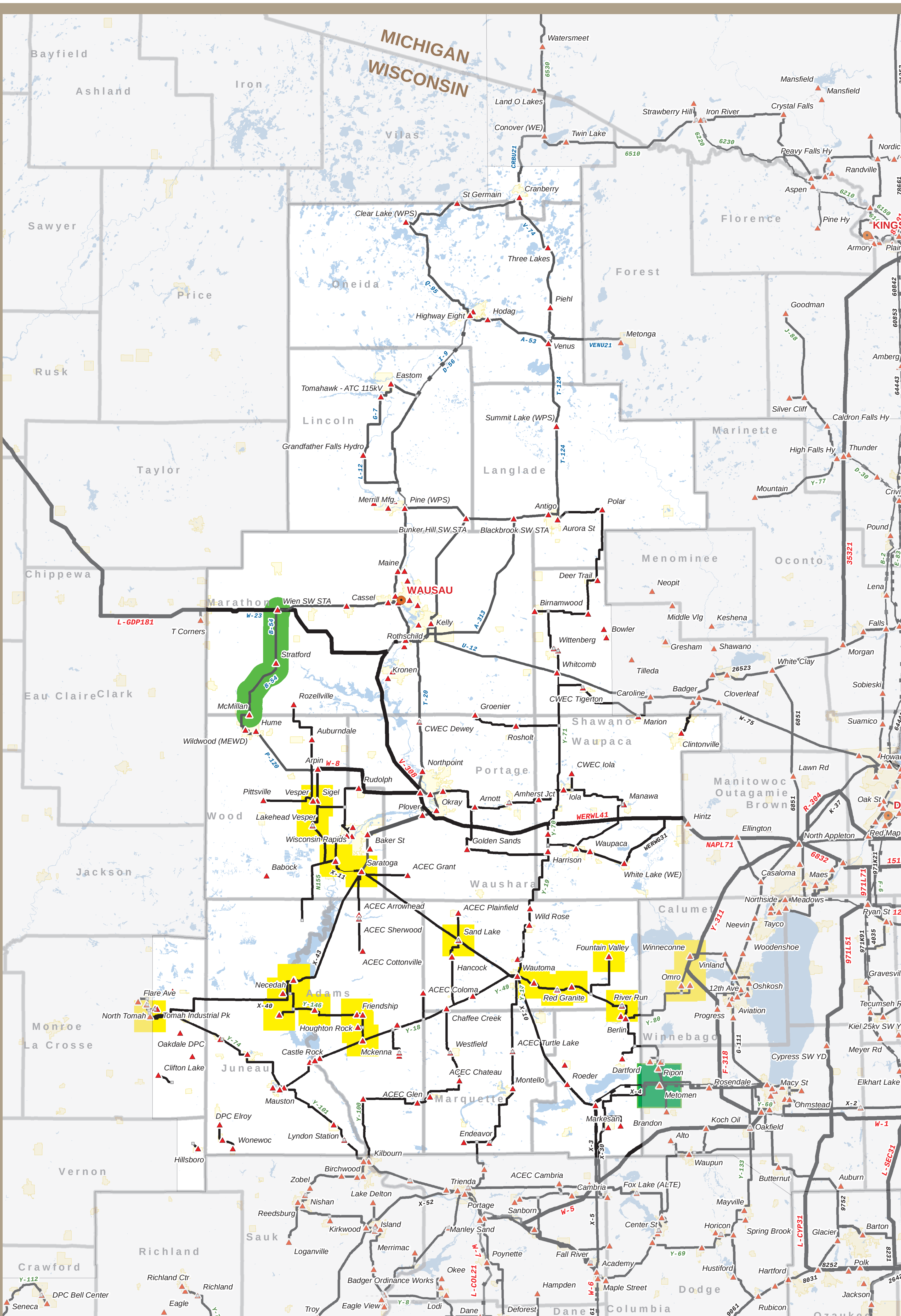
- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

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 June 16, 2008



Updated June 16, 2008



Performance Criteria Limits Exceeded and Other Constraints 2014-2018

PLANNING ZONE 1

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

* Approximately 8900 miles of transmission lines
* 98 wholly owned substations
* 358 jointly owned substations
* Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI

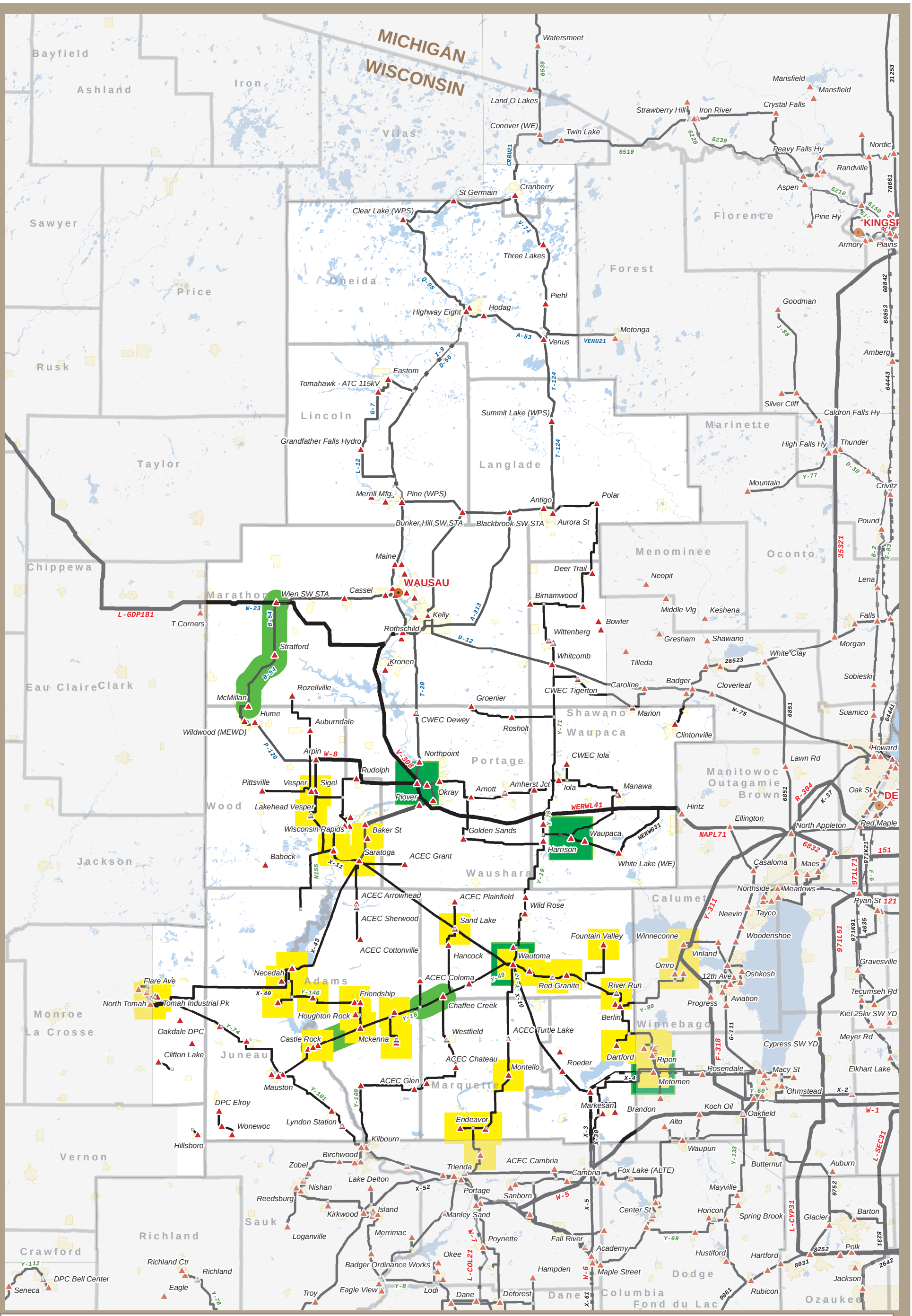
Low Voltages
Overloaded Facility
New Generation/Stability
Transmission Needed for Load Growth

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 June 16, 2008



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2019-2023

PLANNING ZONE 1

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

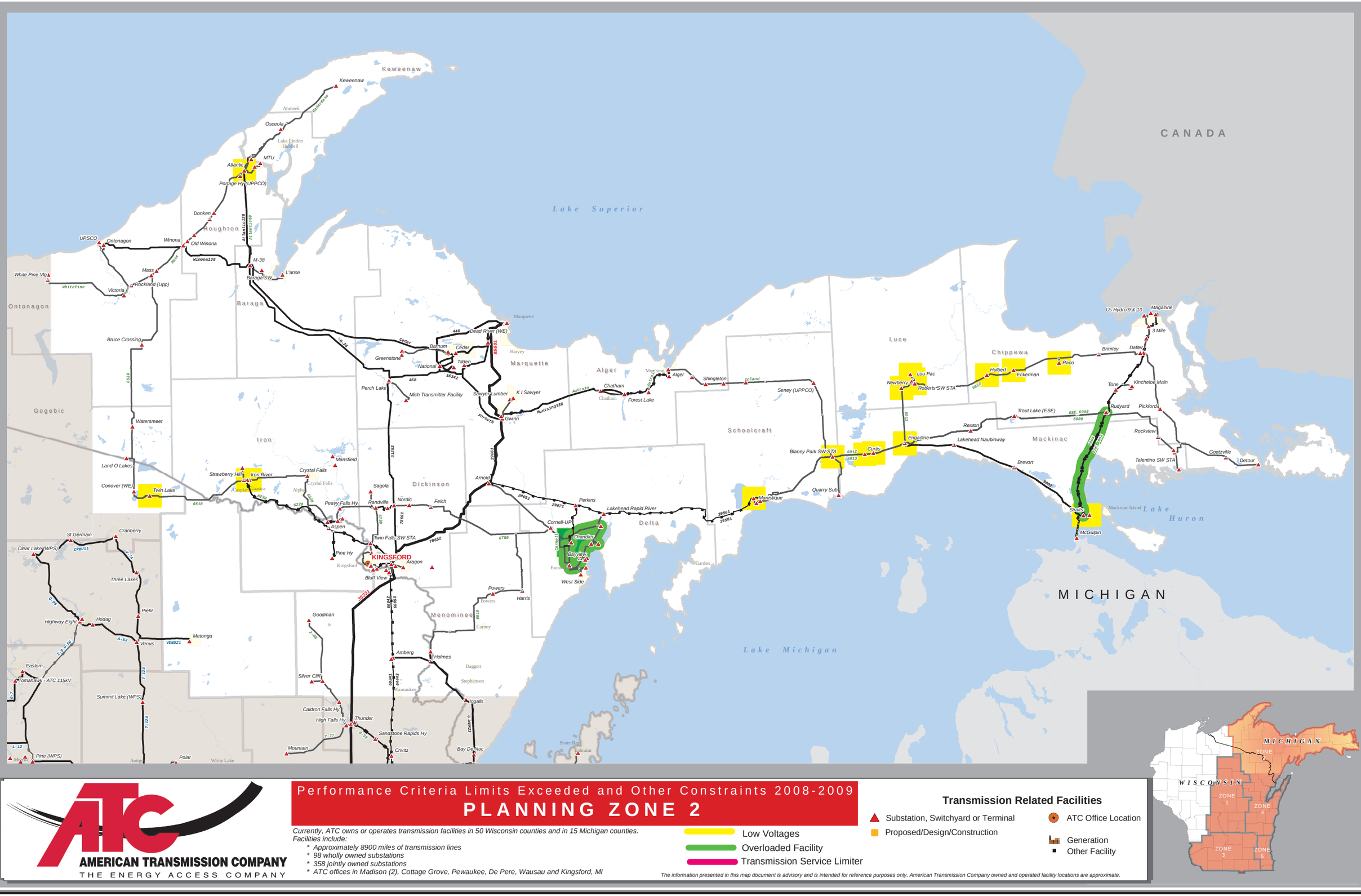
Low Voltages
Overloaded Facility
New Generation/Stability
Transmission Needed for Load Growth

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 June 16, 2008



Modified: January 23, 2008

AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2010-2013

PLANNING ZONE 2

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

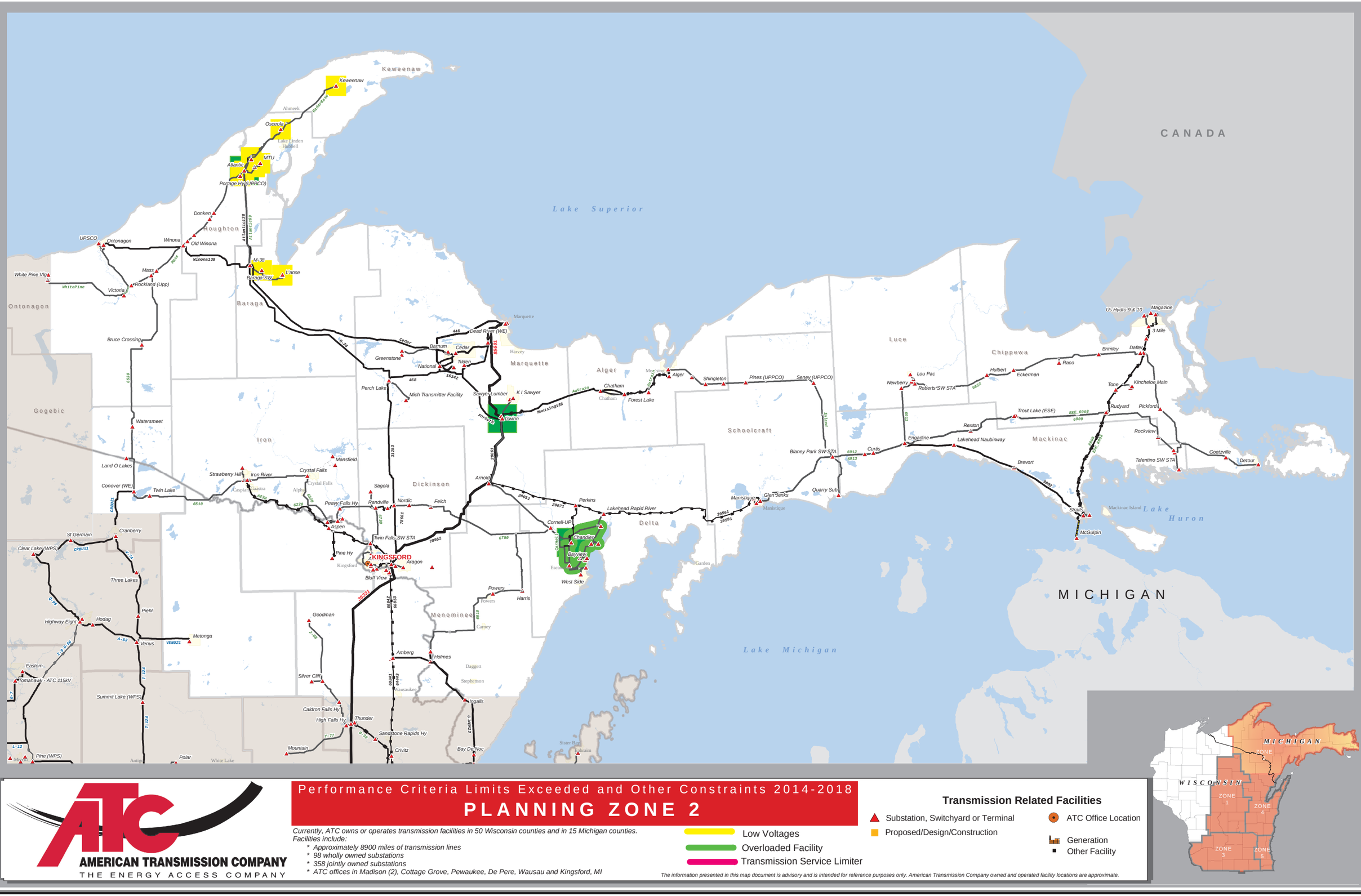
Low Voltages
Overloaded Facility
Transmission Service Limiter

Transmission Related Facilities

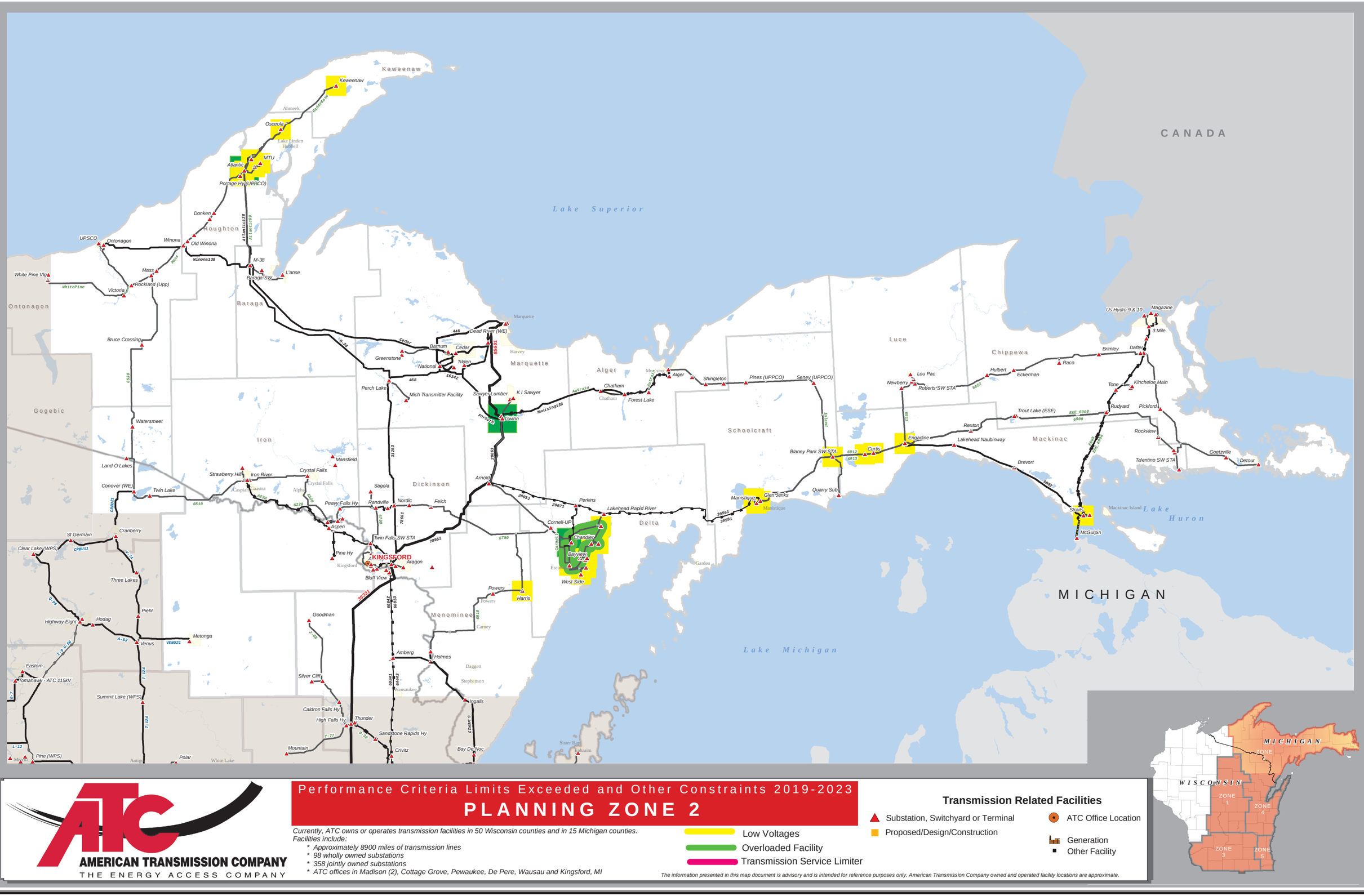
Substation, Switchyard or Terminal
Proposed/Design/Construction
ATC Office Location
Generation
Other Facility

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: January 23, 2008



Modified: June 30, 2008



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2019-2023

PLANNING ZONE 2

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

Low Voltages
Overloaded Facility
Transmission Service Limiter

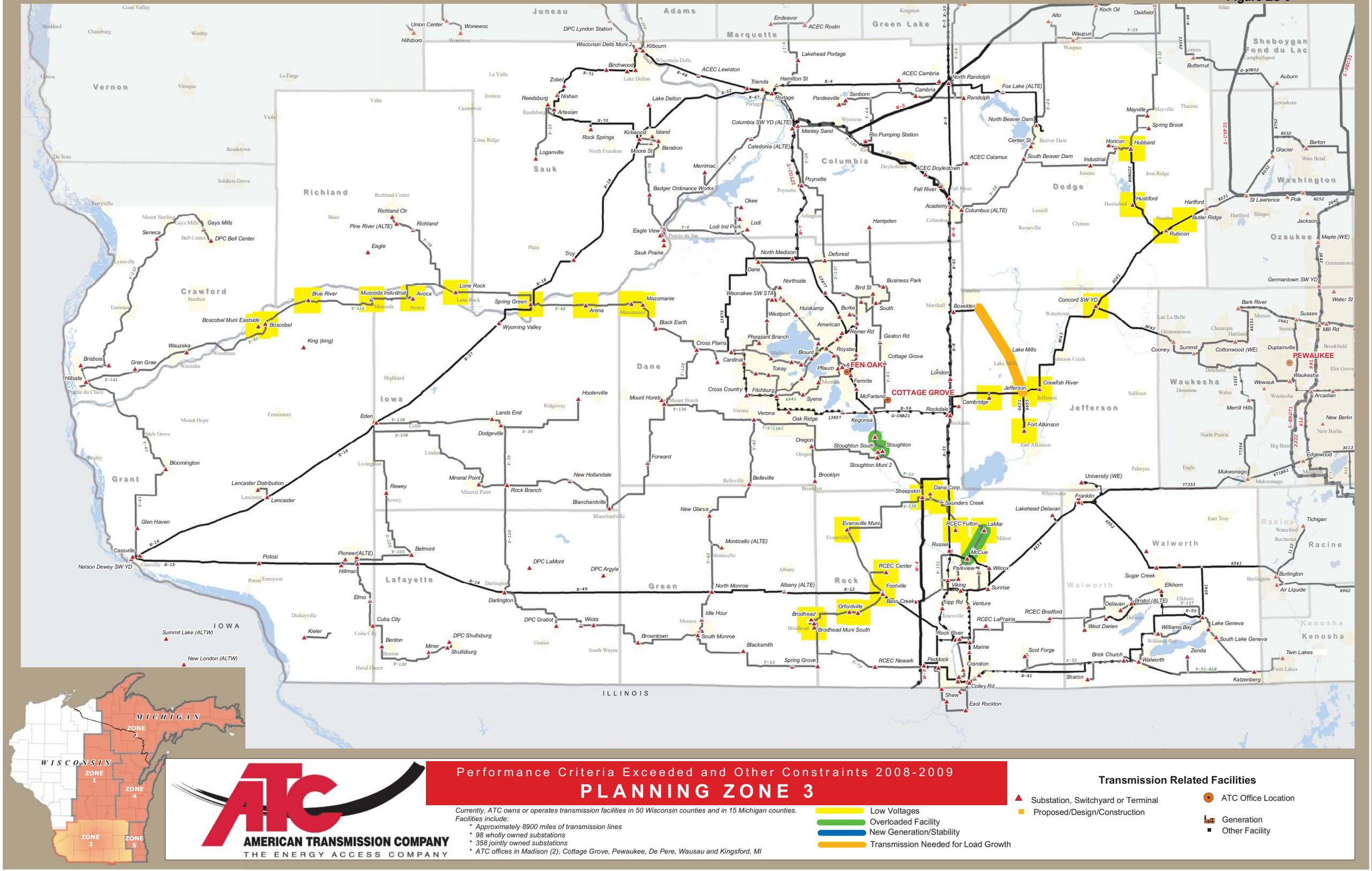
Transmission Related Facilities

- 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: June 30, 2008

Figure ZS-9



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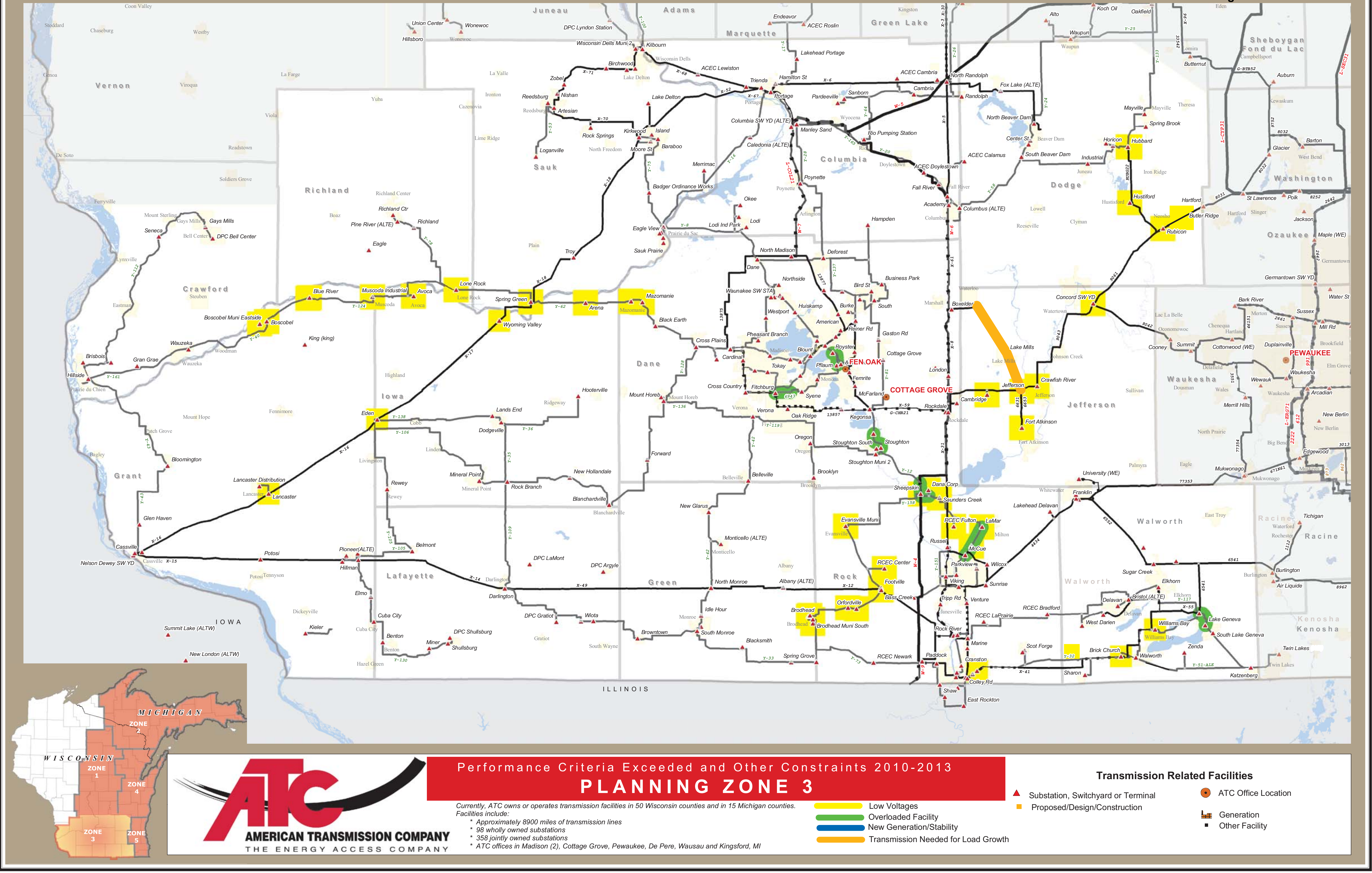

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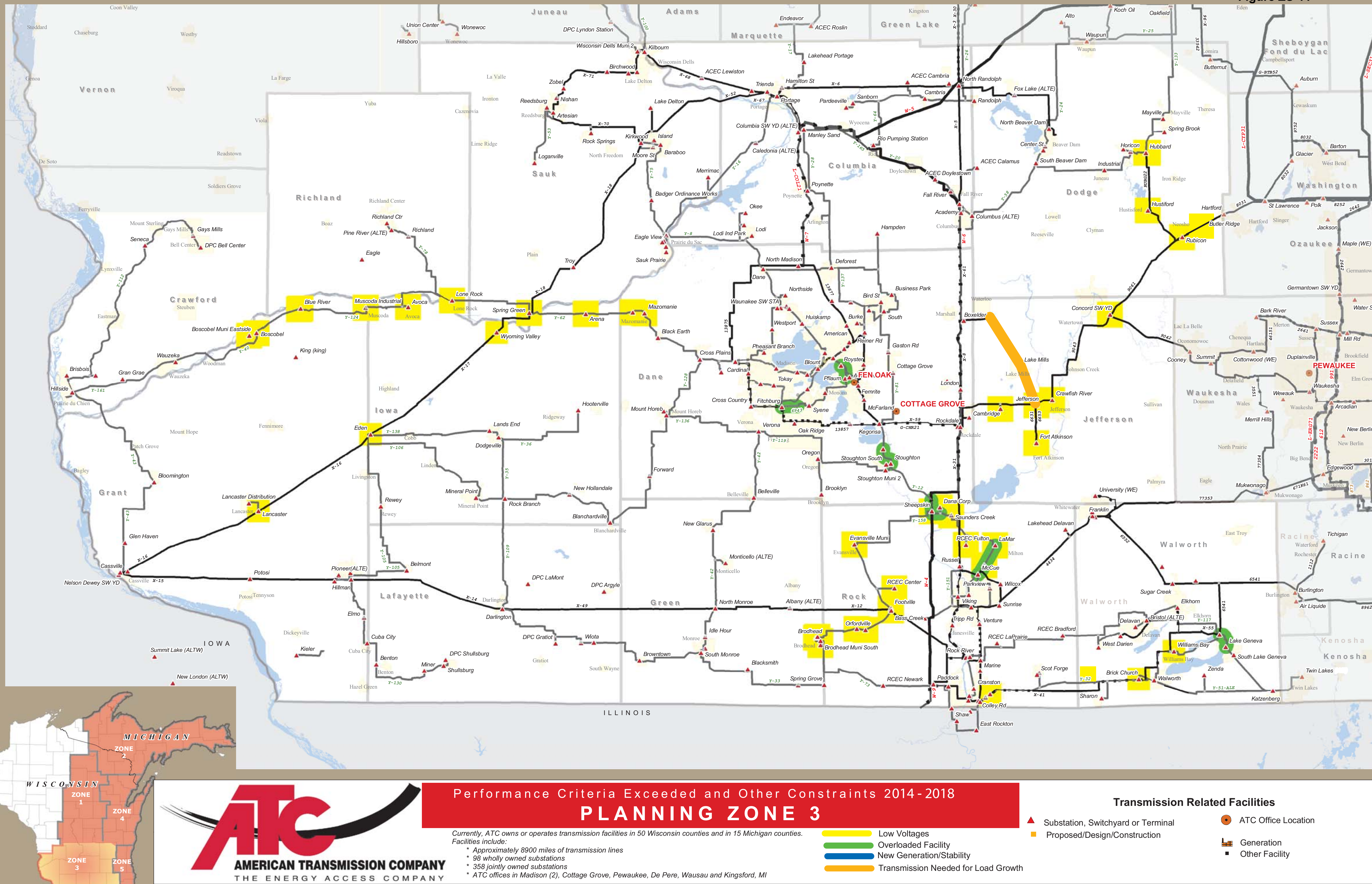

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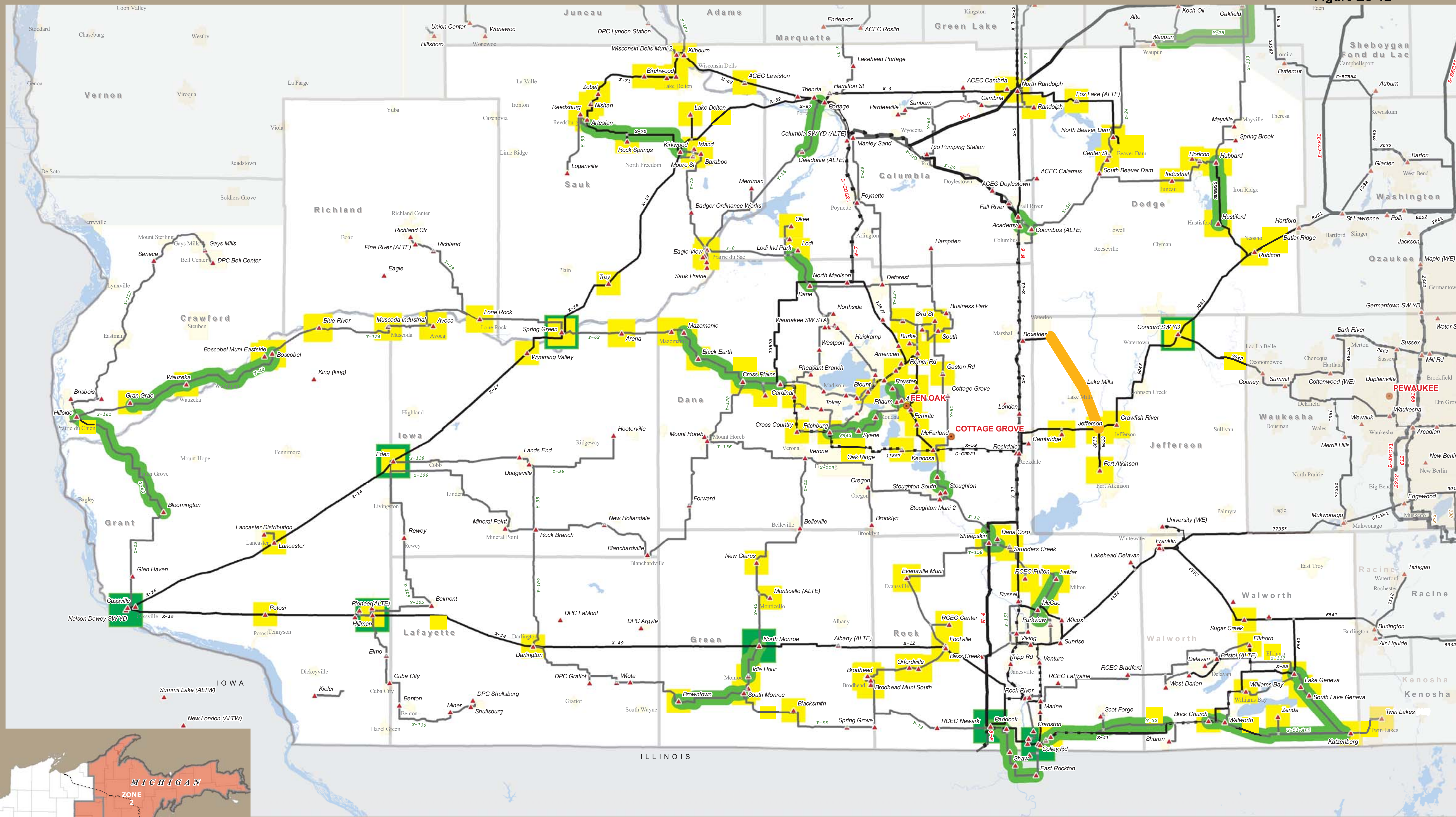
Figure ZS-12



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Exceeded and Other Constraints 2019-2023

PLANNING ZONE 3

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *ATC offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI*

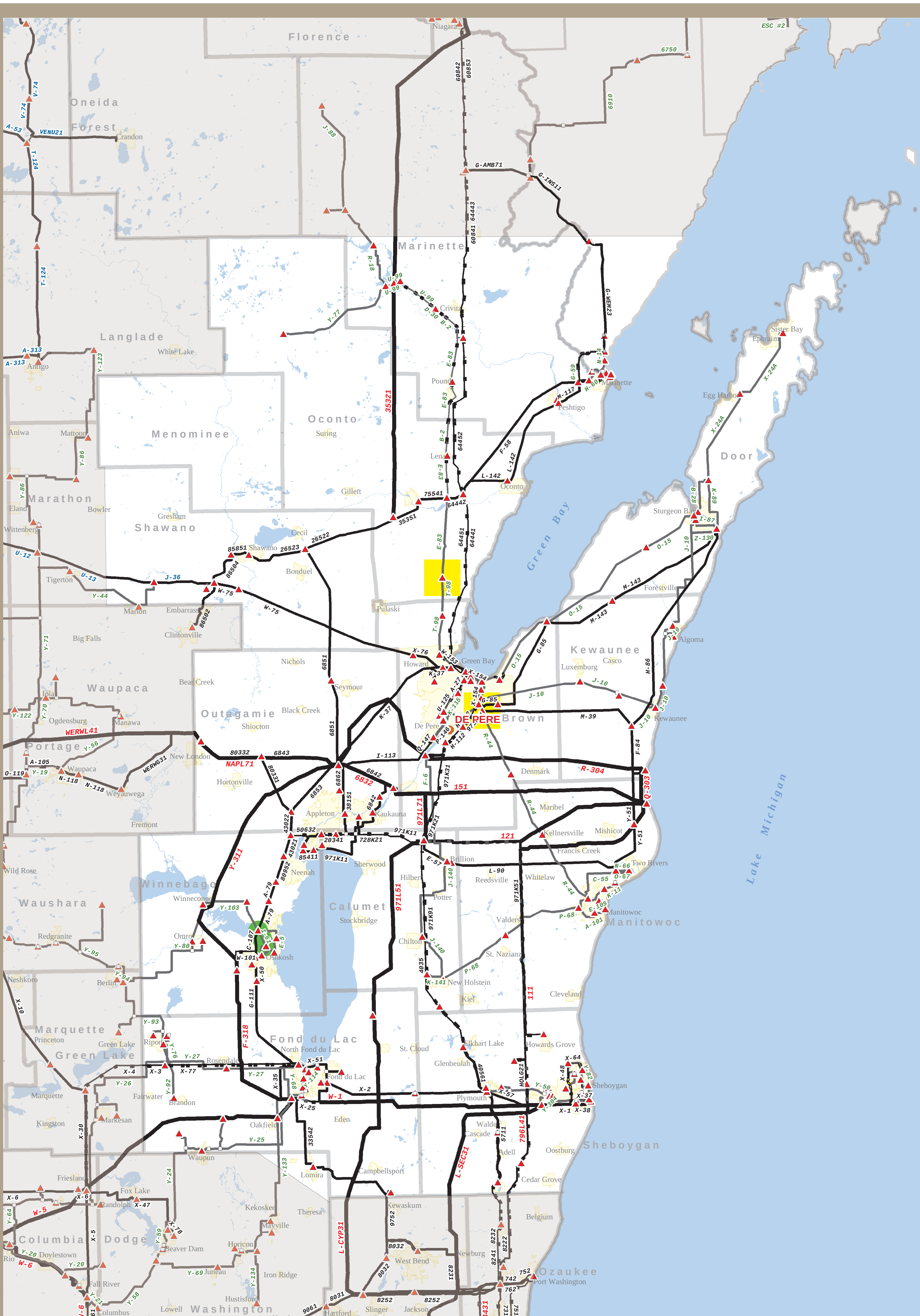
Low Voltages
Overloaded Facility
New Generation/Stability
Transmission Needed for Load Growth

Transmission Related Facilities

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

Modified: June 17, 2008

Figure ZS-13



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2008-2009

PLANNING ZONE 4

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

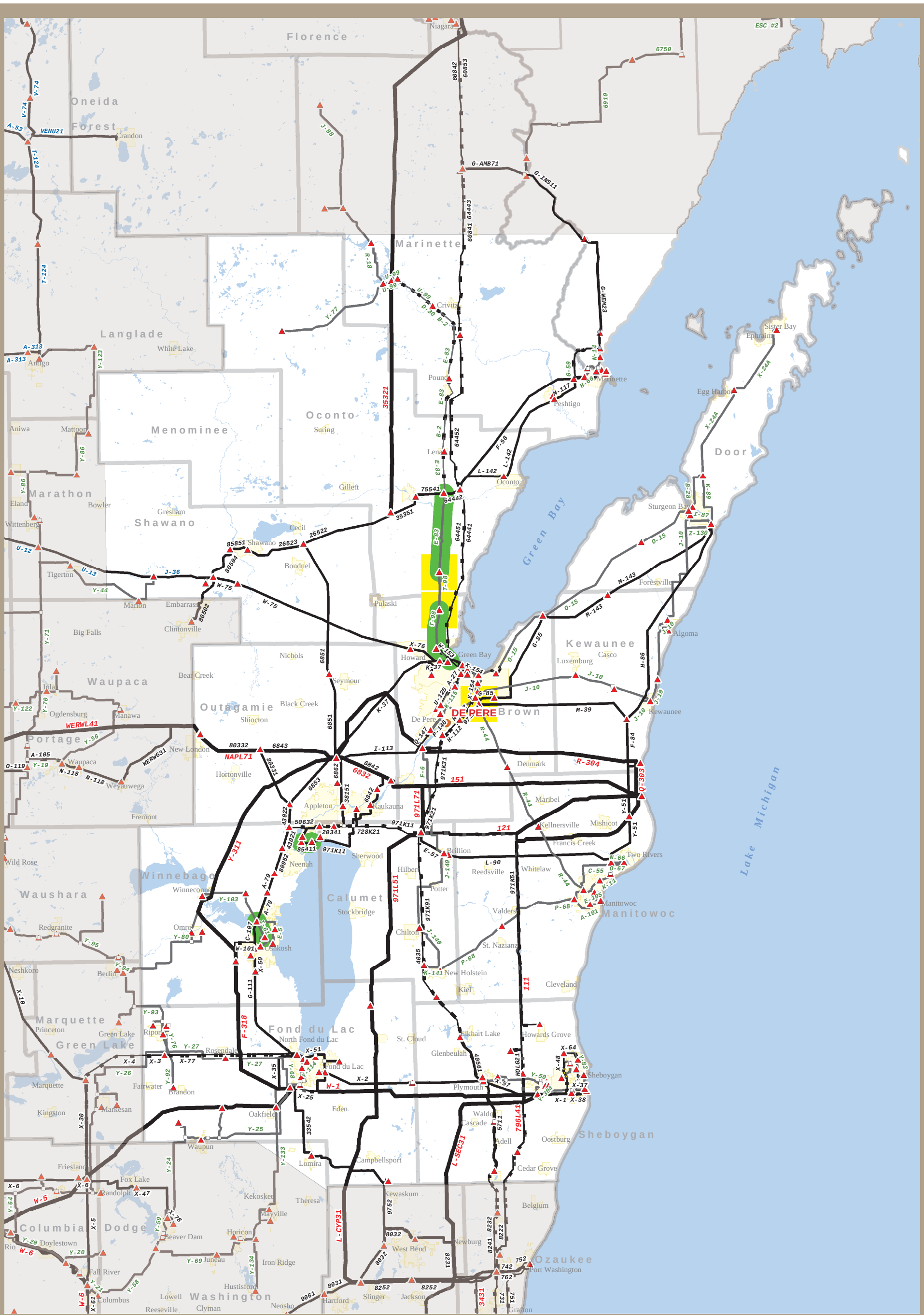
Low Voltages
Overloaded Facility
New Generation/Stability
Transmission Needed for Load Growth

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: February 20, 2008



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2010-2013

PLANNING ZONE 4

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

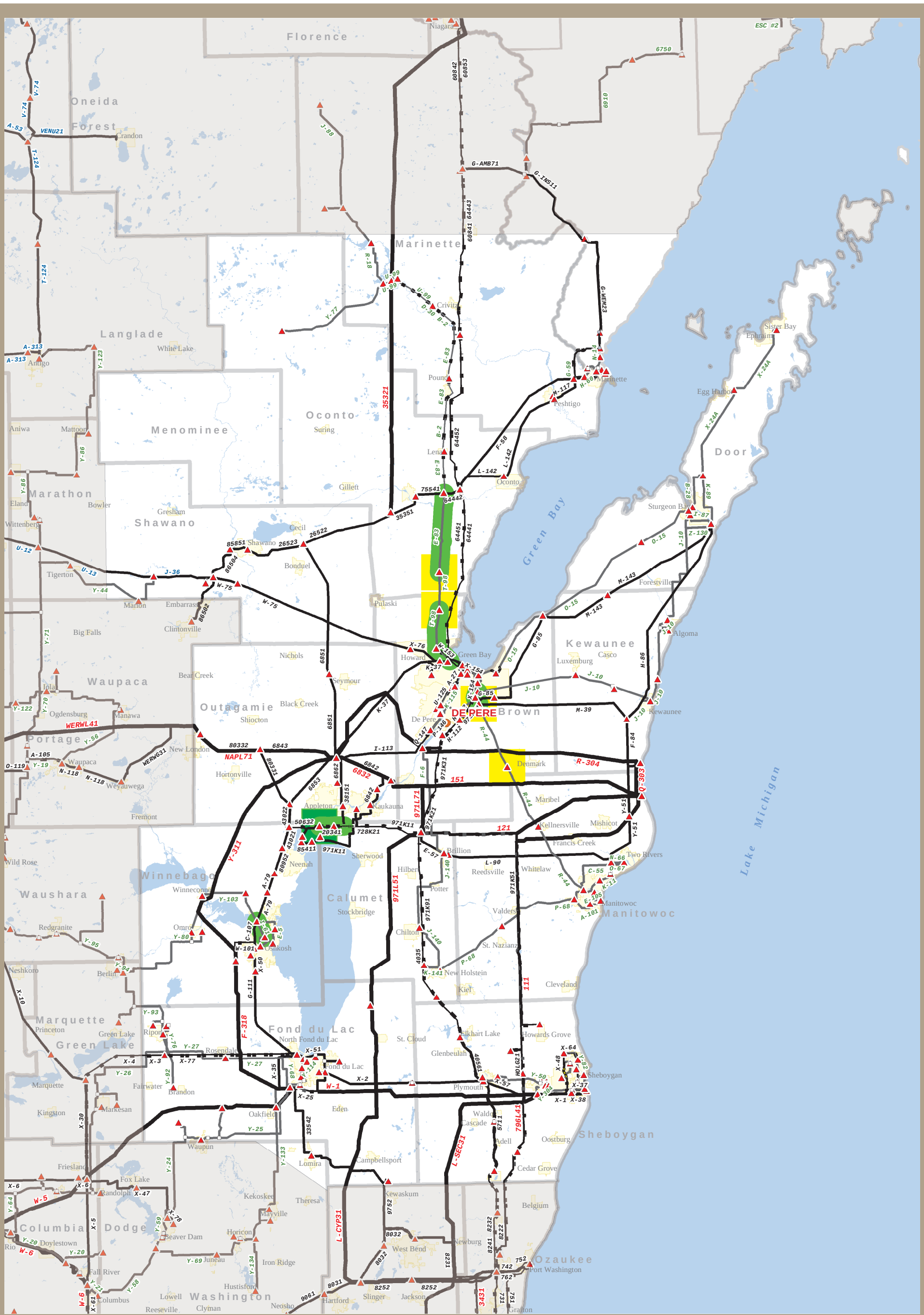
- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

Low 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: February 20, 2008



Performance Criteria Limits Exceeded and Other Constraints 2014-2018

PLANNING ZONE 4

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 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

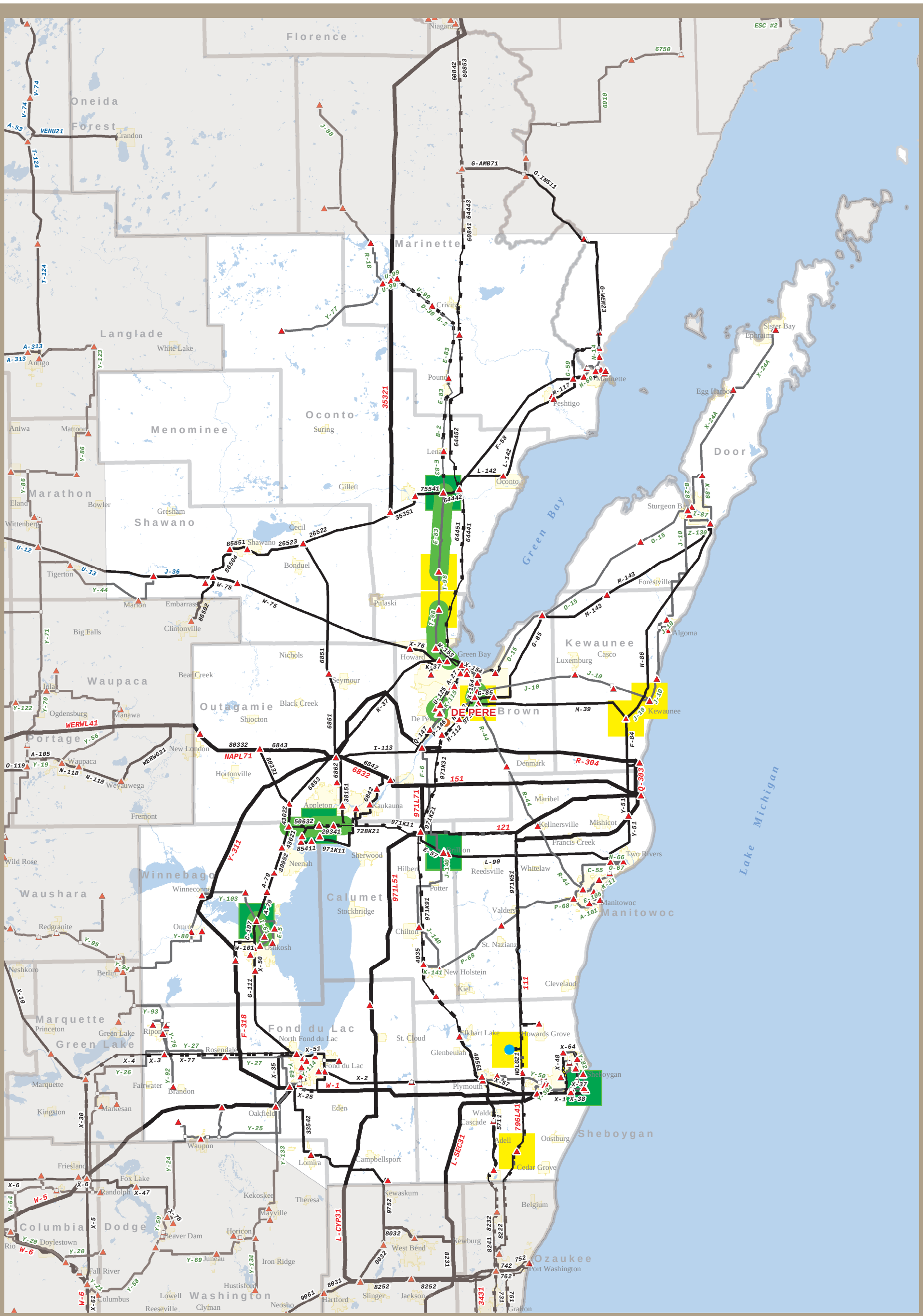
- Low Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth

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: February 20, 2008



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2019-2023

PLANNING ZONE 4

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

- Low 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

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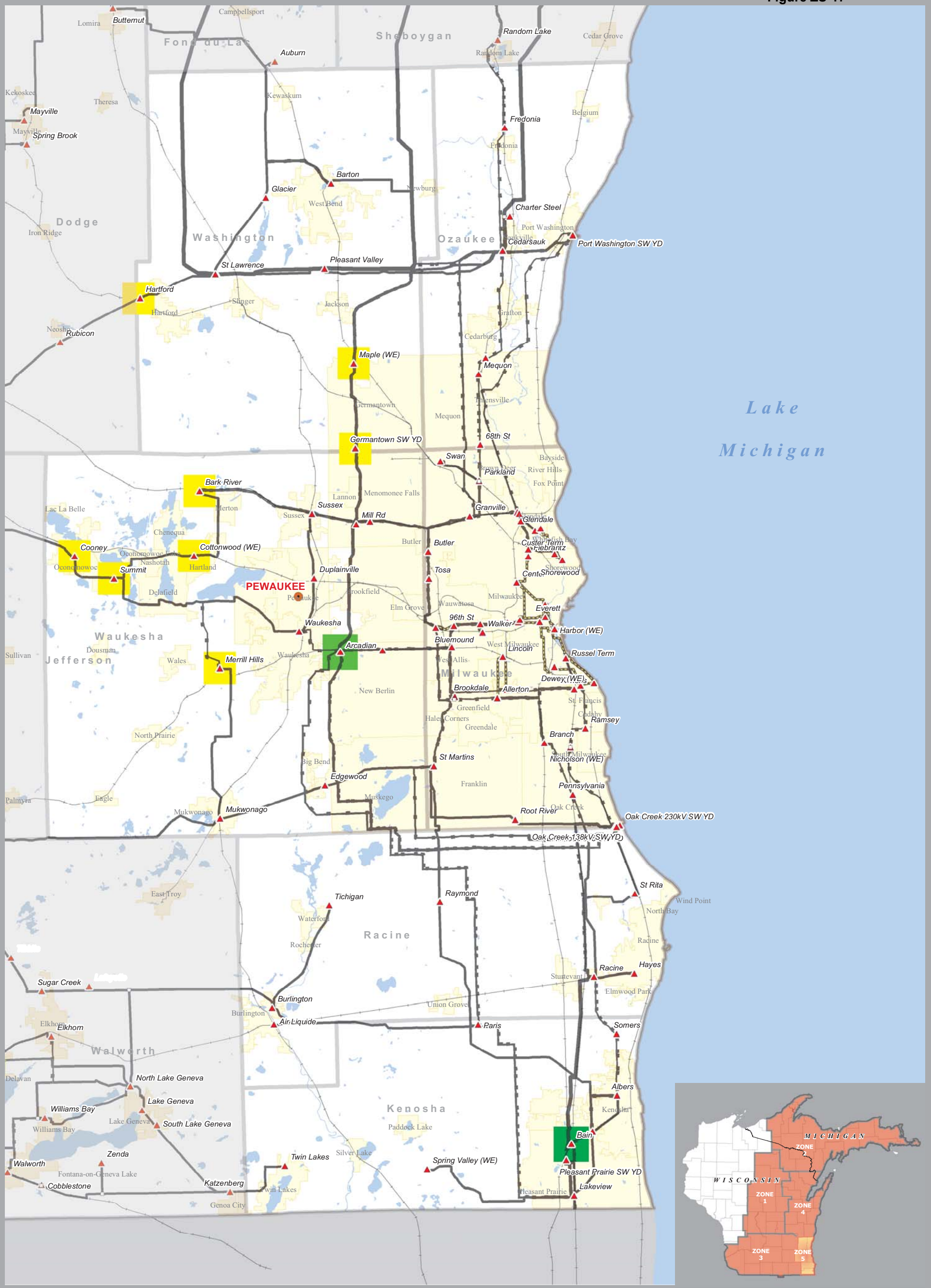
Modified: February 20, 2008

Figure ZS-17



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2008-2009

PLANNING ZONE 5

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

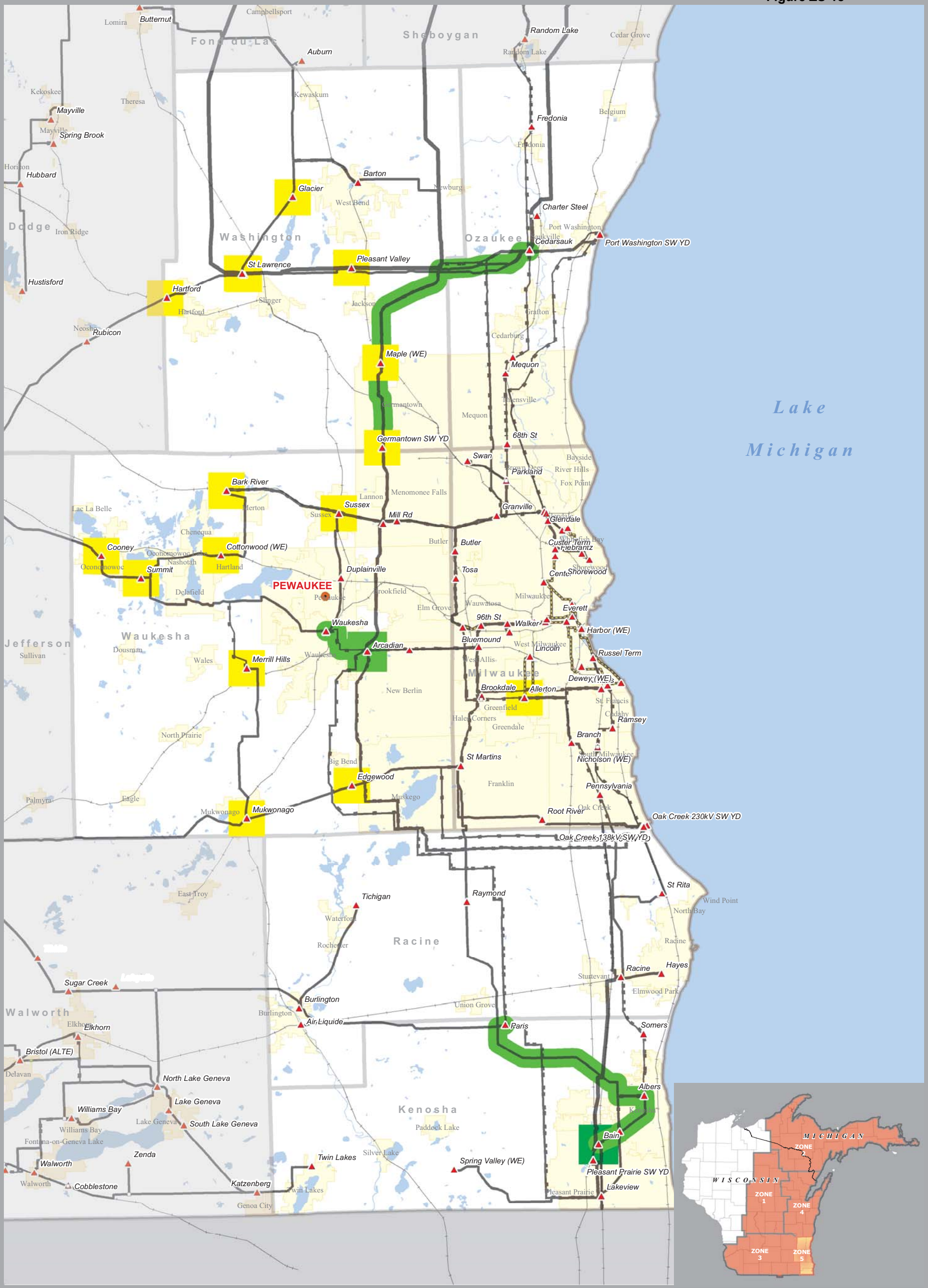
Transmission Related Facilities

- 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: June 17, 2008

Figure ZS-18



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2010-2013

PLANNING ZONE 5

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

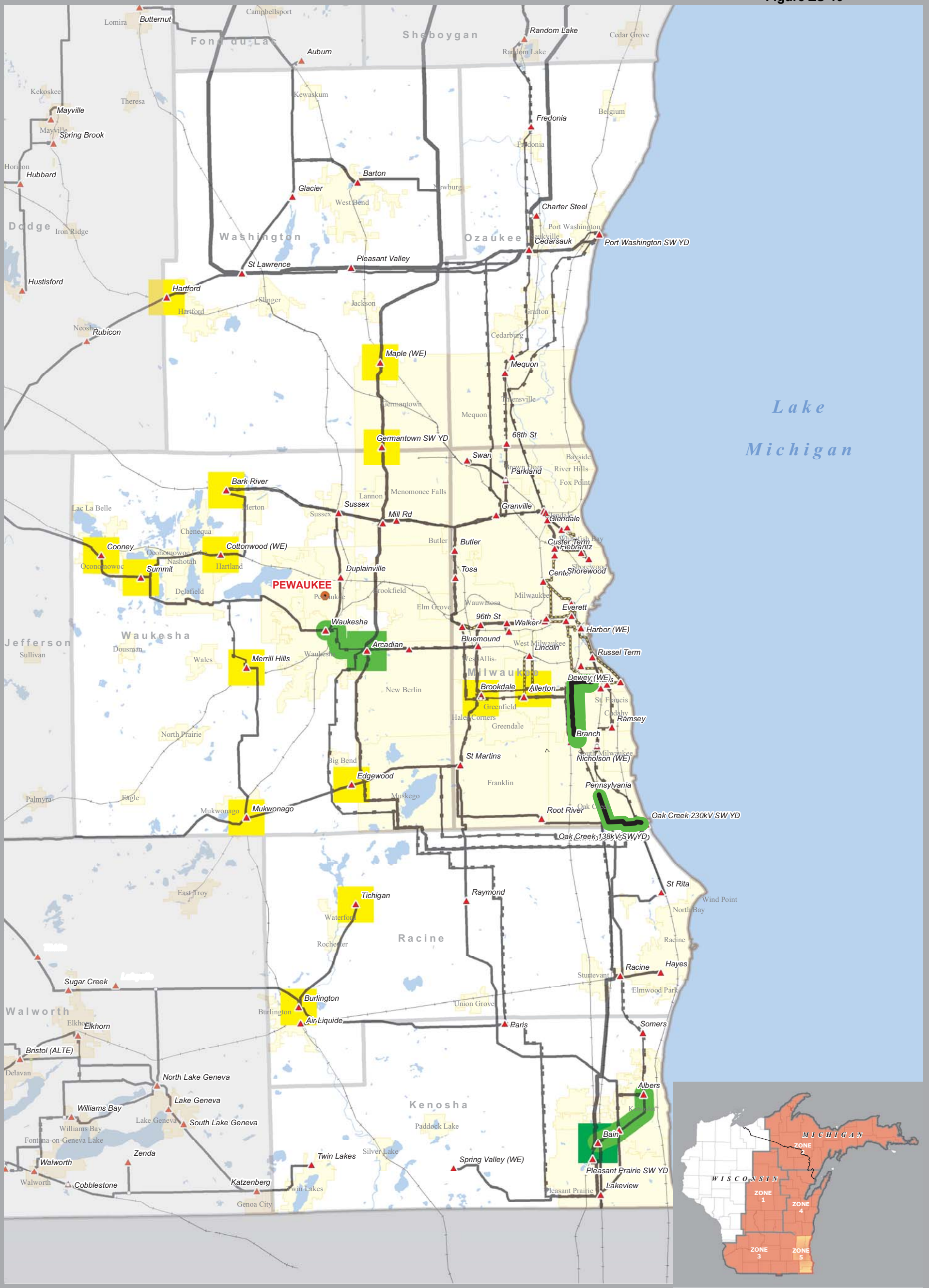
Transmission Related Facilities

- 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: June 20, 2008

Figure ZS-19



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2014-2018

PLANNING ZONE 5

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

- Low 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

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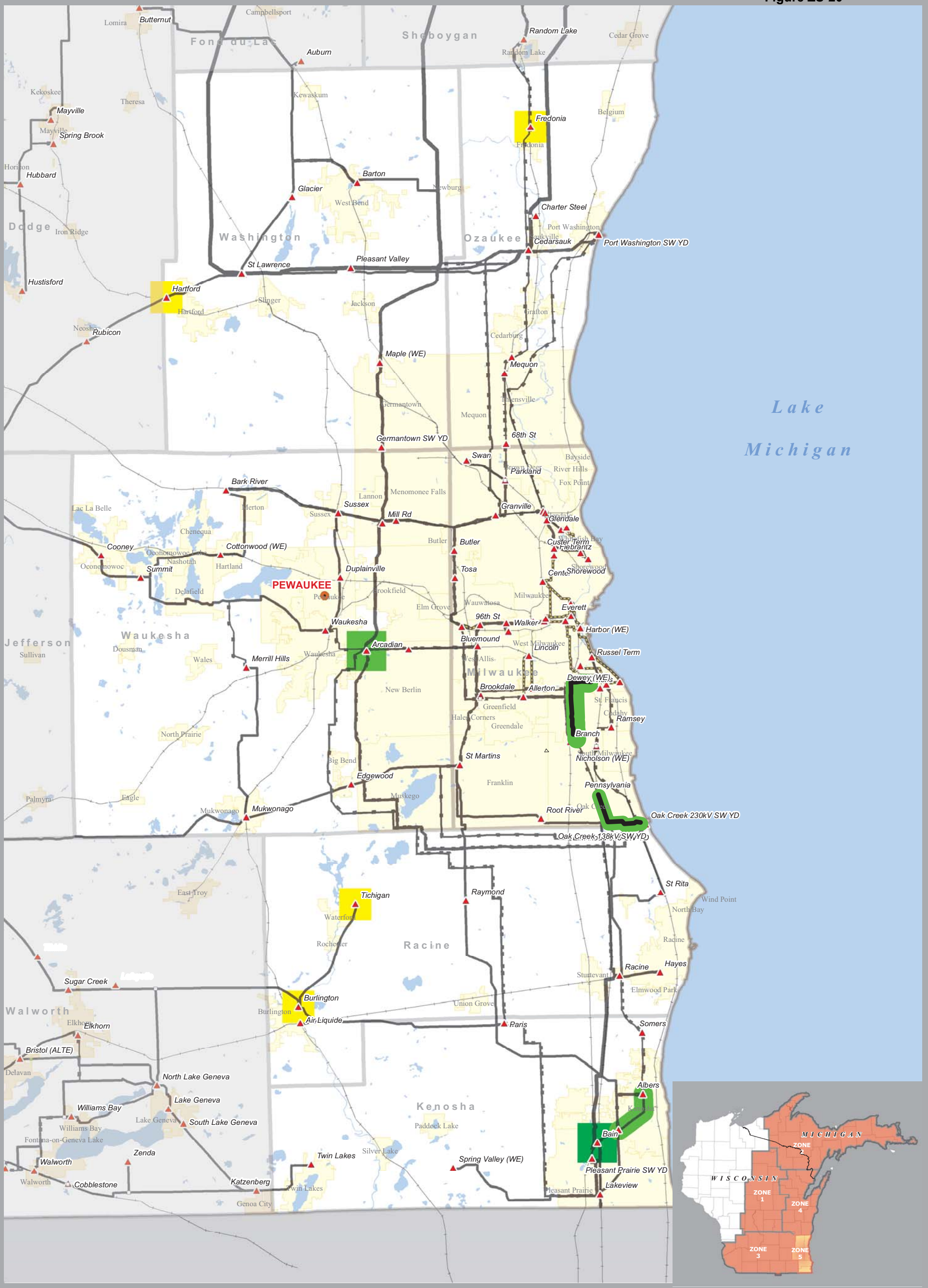
Modified: June 20, 2008

Figure ZS-20



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Performance Criteria Limits Exceeded and Other Constraints 2019-2023

PLANNING ZONE 5

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

- *Approximately 8900 miles of transmission lines*
- *98 wholly owned substations*
- *358 jointly owned substations*
- *Offices in Madison (2), Cottage Grove, Pewaukee, De Pere Wausau and Kingsford, MI*

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

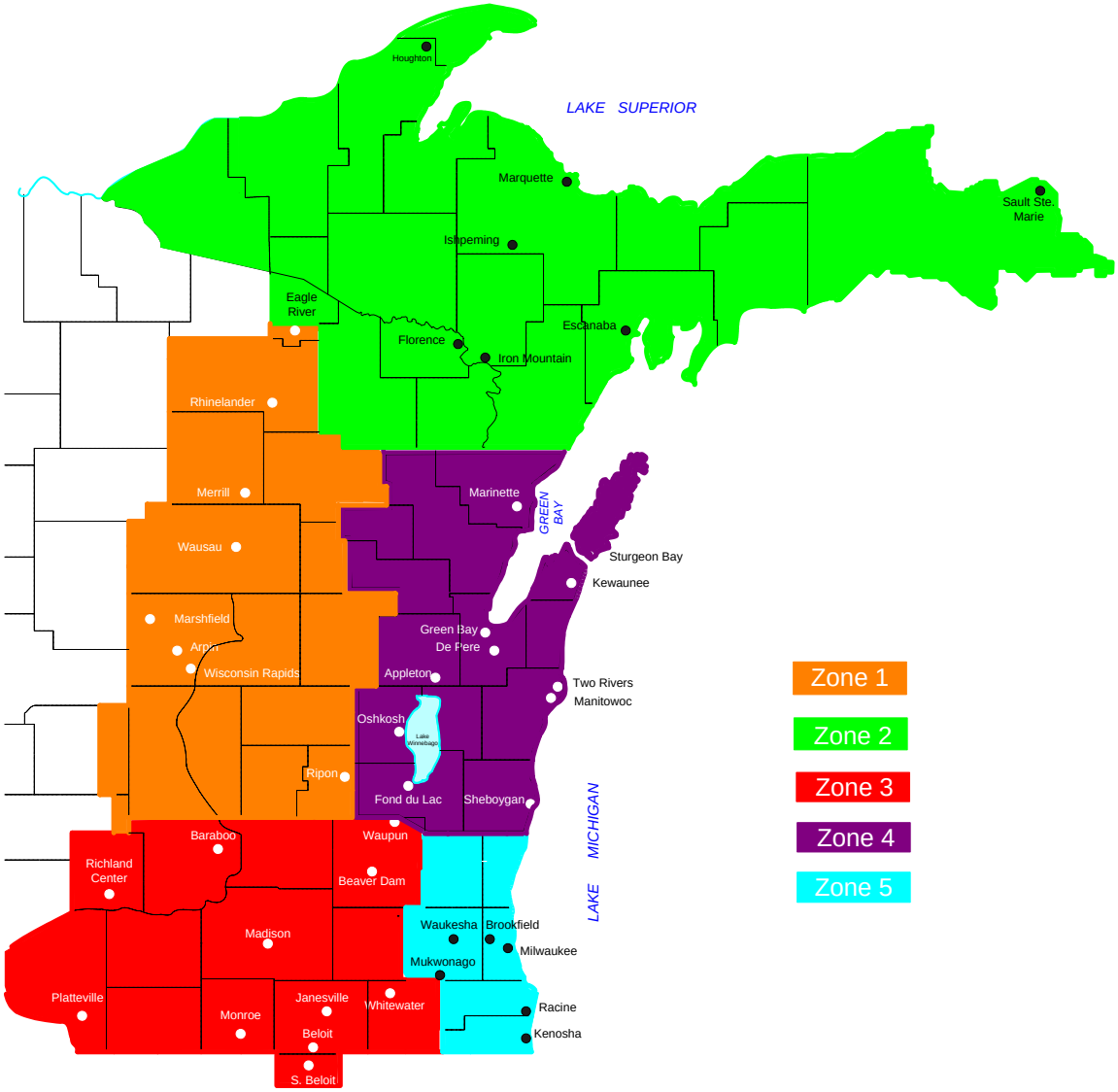
Transmission Related Facilities

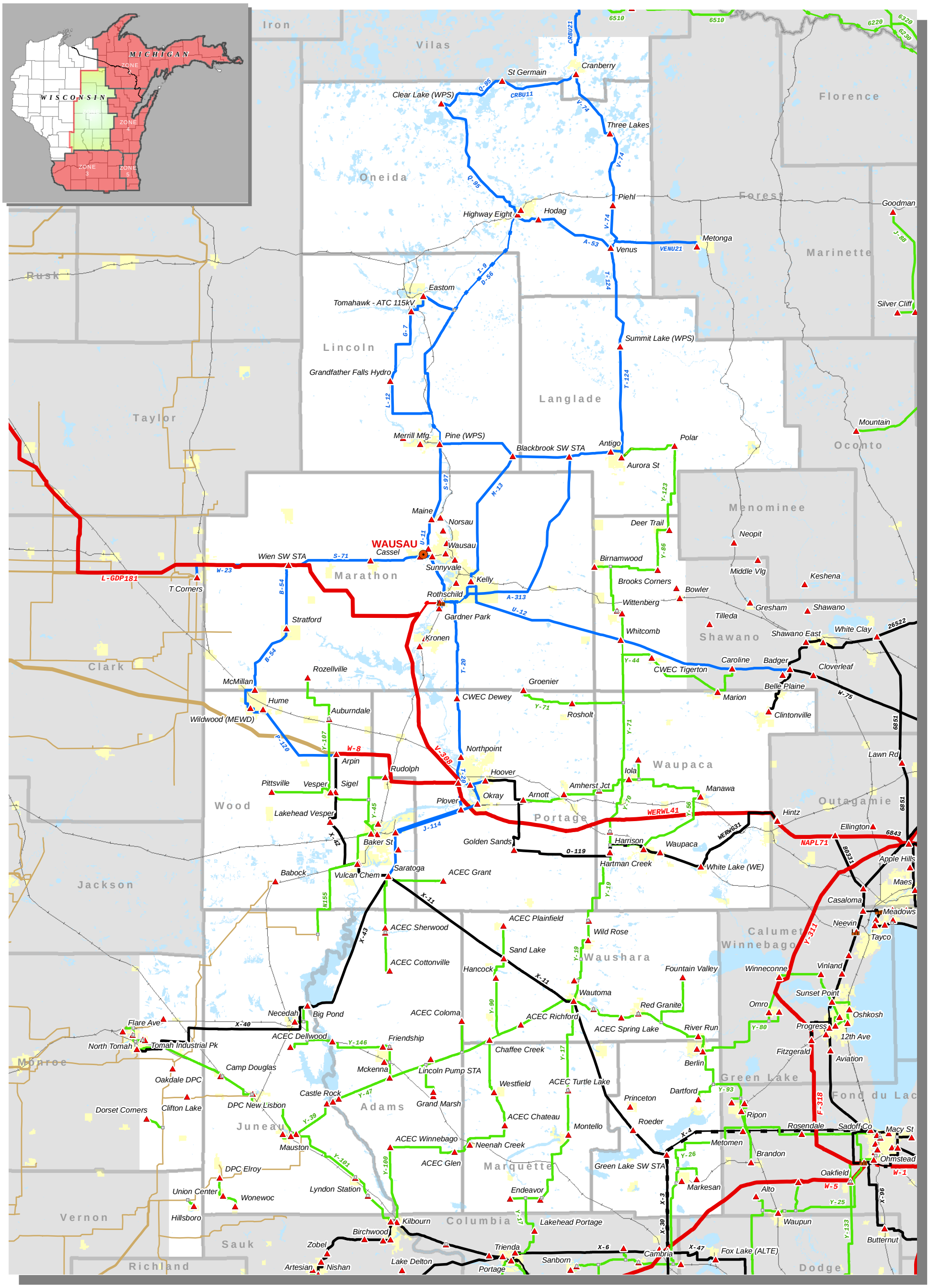
- Substation, Switchyard or Terminal
- Proposed/Design/Construction
- ATC Office Location
- Generation
- Other Facility

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: June 20, 2008

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
Two Rivers
Manitowoc
Wisconsin Rapids
Oshkosh
Lake Winnebago
Ripon
Fond du Lac
Sheboygan
LAKE MICHIGAN
Baraboo
Waupun
Richland Center
Beaver Dam
Waukesha
Brookfield
Milwaukee
Madison
Mukwonago
Platteville
Janesville
Whitewater
Racine
Monroe
Beloit
Kenosha
S. Beloit
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5



AMERICAN TRANSMISSION COMPANY

Electric Transmission Network & Substations

PLANNING ZONE 1

0 5 10 20 Miles

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*

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities. Please direct any revisions or corrections to ATC Real Estate/GIS Services.

Base Map Information: ATC, PSCW, MiDNR, WDNR

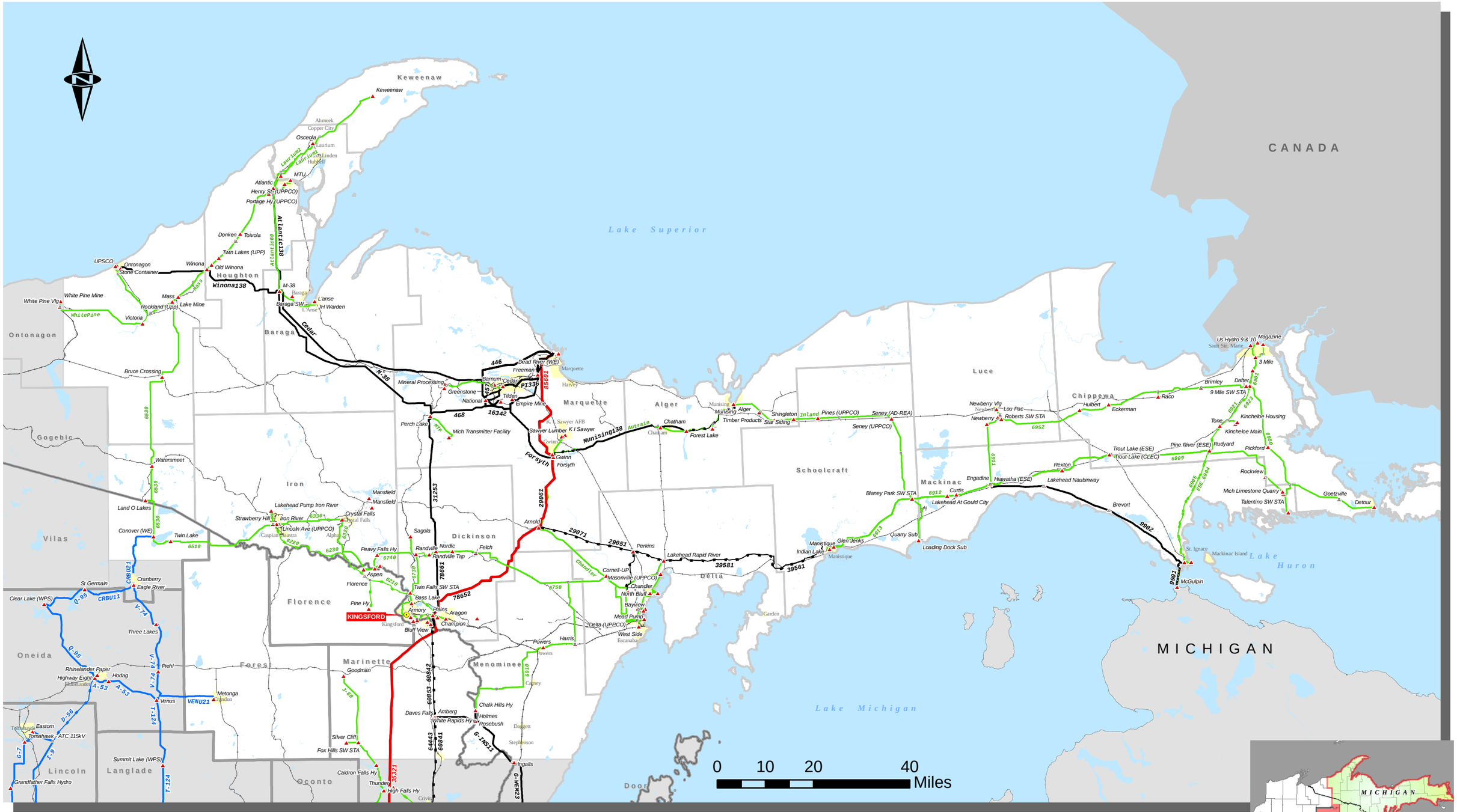
G:\WORKSPACE\ArcMap Templates\Zone Maps\Zone1 11x17.mxd Modified: June 23, 2008

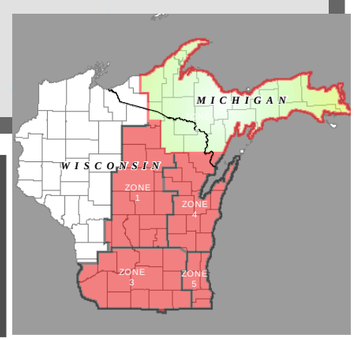
Transmission Line Voltage

- 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
- 69 kV Underground
- 138 kV Underground
- Non-ATC Line

Transmission Related Facilities

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





AMERICAN TRANSMISSION COMPANY ®

Electric Transmission Network & Substations

PLANNING ZONE 2

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*

Transmission Line Voltage

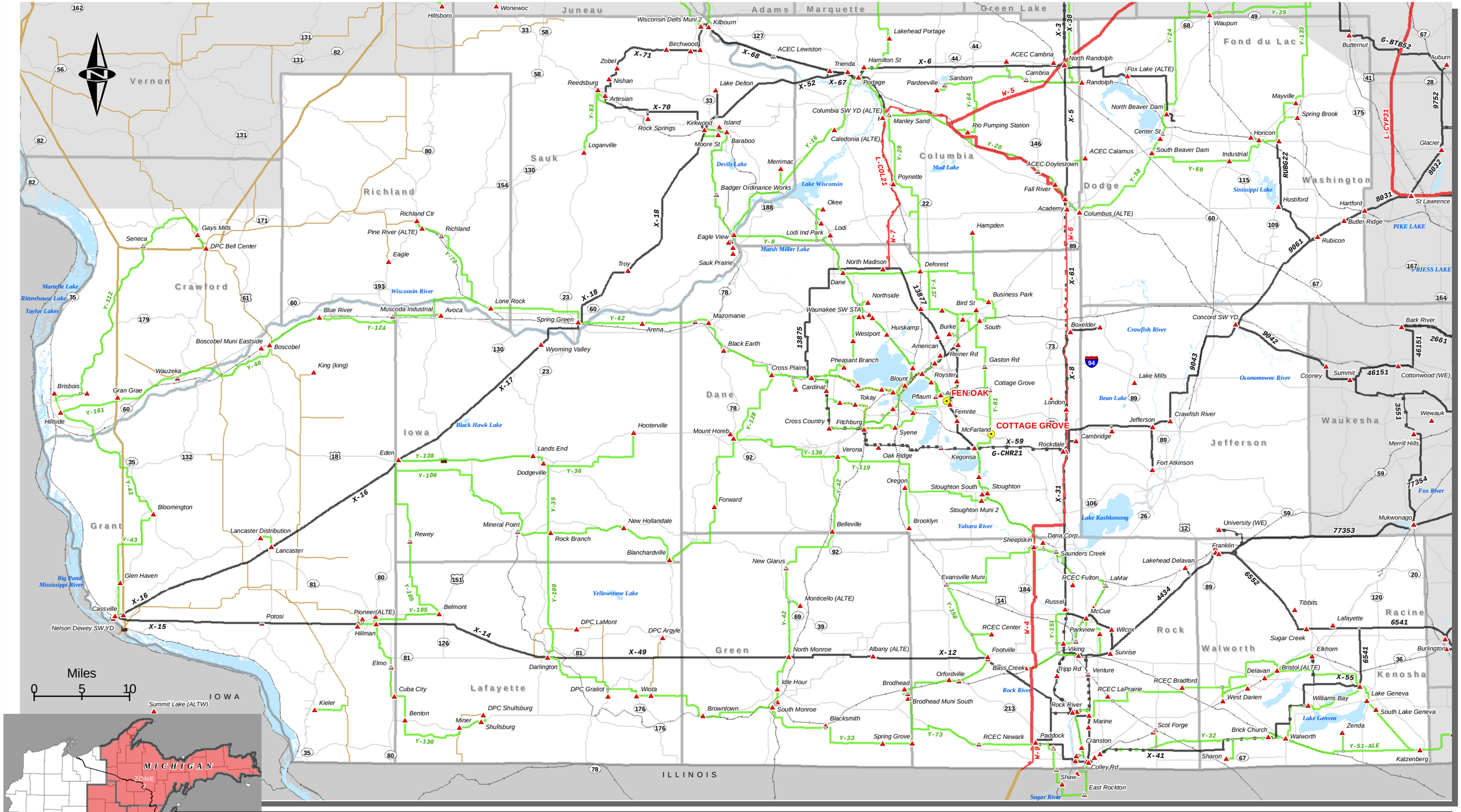
- 69 kV
- 115 kV
- 138 kV
- 230 kV
- 345 kV
- 69 kV Double Circuit
- 115 kV Double Circuit
- 138 kV Double Circuit
- 230 kV Double Circuit
- 345 kV Double Circuit
- 69 kV Underground
- 138 kV Underground
- Non-ATC Line

Transmission Related Facilities

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

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities. Please direct any revisions or corrections to ATC Real Estate/GIS Services.
Base Map Information: ATC, PSCW, MiDNR, WDNR

G:\GISDATA\WORKSPACE\ArcMap Templates\Zone Maps\Zone2 11x17.mxd Modified: June 23, 2008



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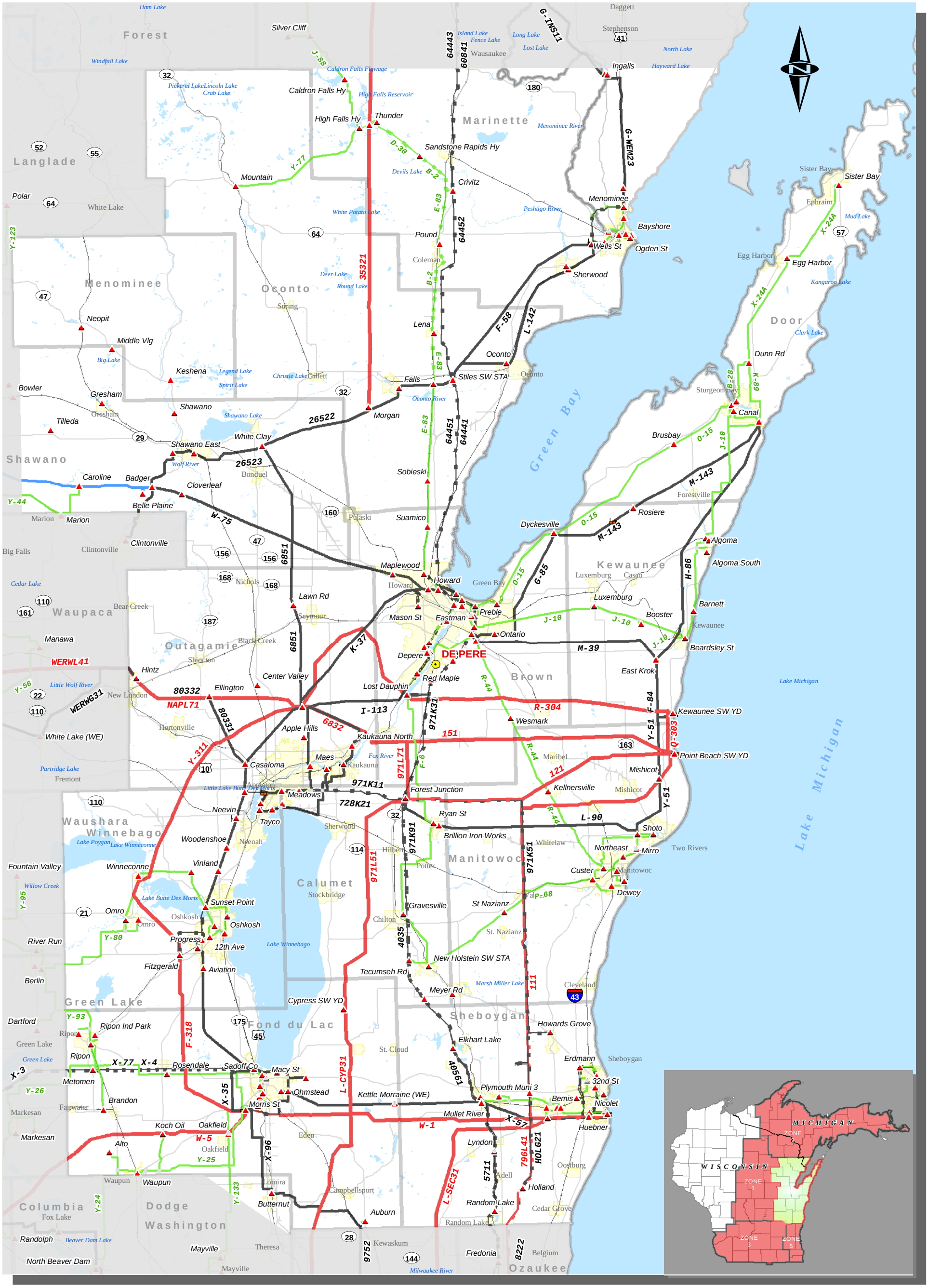


AMERICAN TRANSMISSION COMPANY®

Electric Transmission Network & Substations
PLANNING ZONE 4

0 5 10 20 Miles

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*

Transmission Line Voltage

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
69 kV Underground
138 kV Underground
Non-ATC Line

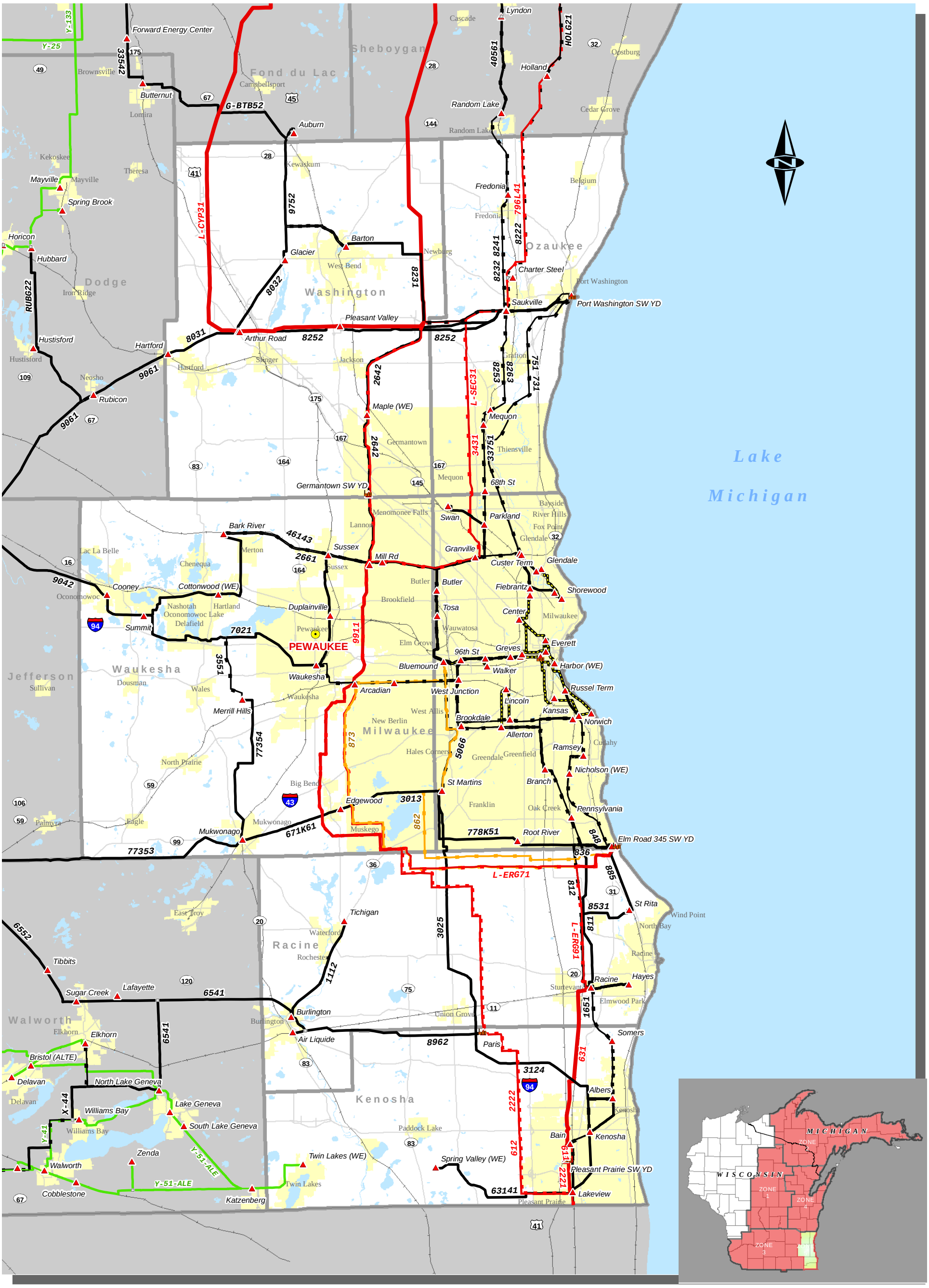
Transmission Related Facilities

Substation or Switchyard
Tap or Switching Structure
ATC Office Location
Generation

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities. Please direct any revisions or corrections to ATC Real Estate/GIS Services.

Base Map Information: ATC, PSCW, MiDNR, WDNR

G:\GISDATA\WORKSPACE\ArcMap Templates\Zone Maps\Zone4 11x17.mxd Modified: June 23, 2008



AMERICAN TRANSMISSION COMPANY
THE ENERGY ACCESS COMPANY

Electric Transmission Network and Substations

PLANNING ZONE 5

0 5 10 Miles

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in15 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*

Transmission Line Voltage

69 kV	69 kV Double Circuit	69 kV Underground
115 kV	115 kV Double Circuit	138 kV Underground
138 kV	138 kV Double Circuit	Non-ATC Line
230 kV	230 kV Double Circuit	
345 kV	345 kV Double Circuit	

Transmission Related Facilities

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

The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities. Please direct any revisions or corrections to ATC Real Estate/GIS Services.

Base Map Information: ATC, PSCW, MiDNR, WDNR

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