Zones & Study Results

Introduction

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

As part of FERC Order 890-A, FERC requires a coordinated, open, and transparent transmission planning process on both a local and regional level. To comply with these requirements, ATC submitted a compliance filing on Order 890-A that provides a summary of our network planning process to ensure that the economic planning process is both coordinated and open. The solutions ultimately selected to address the identified needs and limitations 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.

For each zone, we compiled recent information on:

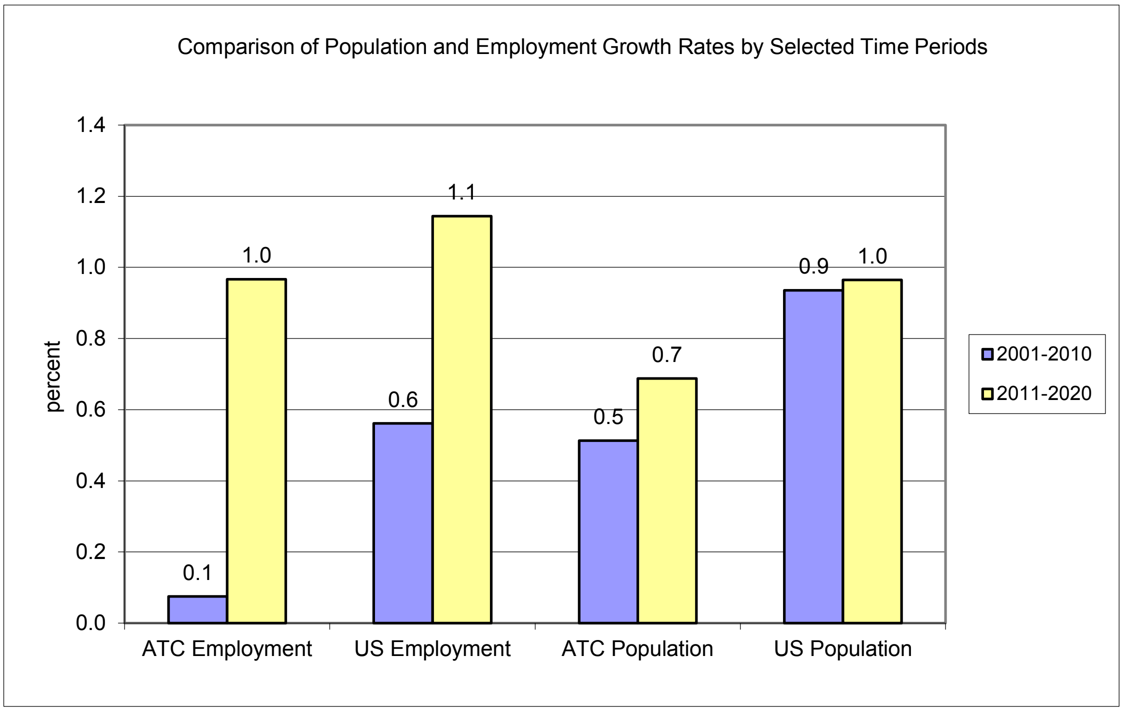
- Demographics
- Future population and employment projections
- Environmental considerations
- Electricity demand and generation
- Transmission system issues
- 2012 study results including minimum load sensitivity
- 2016 study results including various system bias scenarios
- 2021 study results including various system bias scenarios
- 2026 study results

Demographics – Long-term overview

For the ten-year period 2001 to 2010, population and employment for the American Transmission Company (ATC) service area, which owns approximately 80 percent of the transmission lines in the state of Wisconsin, has experienced significantly slower growth in both employment and population when compared to growth in employment and population for the United States.

The population of the service area grew at an annual rate of 0.5%, while the United States increased 0.9% over that same period; however, employment growth in the ATC service area has been impacted due to the current economic slowdown. The annual employment growth rate has slowed to just 0.1%, while again the United States grew significantly faster at 0.6%.

Population in the ATC service area is projected to grow at 0.7% annually between 2011 and 2020, while the United States is projected to grow 1.0%. Employment in the ATC service area for the same period is projected to grow at 1.0% annually, while the growth in employment for the United States is projected to increase slightly faster (1.1%).



Within the ATC service area over the historical period, the highest annual growth rate for both population (0.9%) and employment (0.6%) occurred in the ATC Zone 3, which is defined as South Central/Southwest Wisconsin and North Central Illinois and includes the Wisconsin counties of:

- Columbia
- Crawford (southern portion)
- Dane
- Dodge
- Grant
- Green
- Iowa
- Lafayette

- Jefferson
- Richland
- Rock
- Sauk
- Walworth and
- Winnebago, Illinois (northern portion)

In addition, the Zone 3 historical annual growth rates for population and employment are similar to both the Rest-of-Wisconsin and the United States growth rates.

For the 2011-to-2020 period, Zone 3 again is projected to grow faster than any other ATC zone, and the projected growth rates for population and employment are slightly greater than the Rest-of-Wisconsin and the United States.

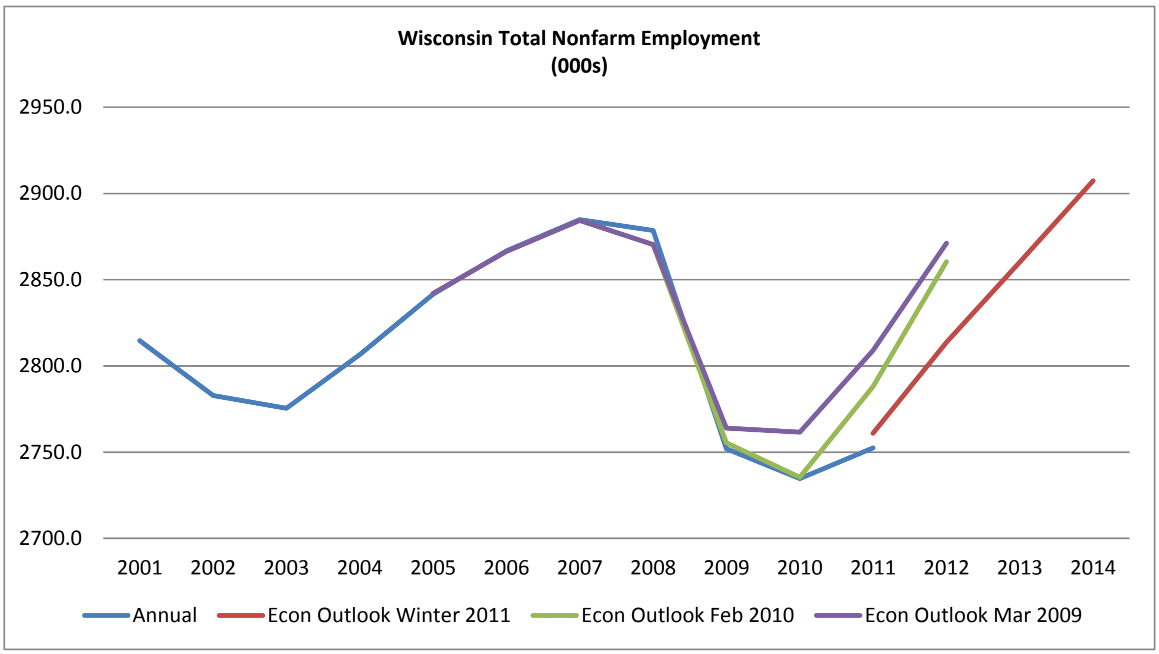
	Annual Growth Rates			
	Employment		Population	
	2001-2010	2011-2020	2001-2010	2011-2020
Zone 1	0.1	0.9	0.2	0.6
Zone 2	-0.4	0.8	-0.3	0.2
Zone 3	0.6	1.2	0.9	1.2
Zone 4	0.2	0.9	0.5	0.7
Zone 5	-0.3	0.8	0.5	0.5
ATC Total	**0.1**	**1.0**	**0.5**	**0.7**
Rest of MI	-1.2	0.8	0.0	0.3
Rest of WI	0.6	1.0	0.7	1.0
Michigan	-1.2	0.8	0.0	0.3
Wisconsin	0.2	1.0	0.6	0.8
United States	0.6	1.1	0.9	1.0

Historically, the growth in ATC service area population and employment has been slower than both the Rest of Wisconsin and the United States. The historical trend, however, is not being projected to continue for employment. The annual employment growth rate for the ATC service area is in line with the projected growth rates for both the Rest of Wisconsin and the United States. The slower historical population growth relative to the Rest of Wisconsin and the United States is projected to continue.

Demographics – Short-term overview

As verified by the National Bureau of Economic Research, the national economy was in recession from December 2007 to June 2009. "Wisconsin employment declined 4.5% in 2009 and 0.8% in 2010. Wisconsin started to modestly add jobs in January 2010, but the gains were not enough to lift total annual employment above 2009. Wisconsin employment will grow between 1% and 2% per year between 2011 and 2014."[1]

As illustrated in the graph below, employment peaked in 2007, declined slightly in 2008, fell dramatically in 2009, and again fell in 2010; however, year-to-date 2011 state employment is increasing slightly over 2010 employment levels.



Source: Actual - Bureau of Labor Statistics, State and Metro Area Employment, Hours, & Earnings databases (2011 actual is the average of January through March 2011 data)
Econ Outlook Mar 2009 - Wisconsin Economic Outlook March 2009, Appendix 1
Econ Outlook Feb 2010 - Wisconsin Economic Outlook February 2010, Appendix 1

1 Wisconsin Economic Outlook, Winter 2011, page 1.

Econ Outlook Winter 2011 - Wisconsin Economic Outlook Winter 2011, Appendix 1

The current economic outlook projects that the decline in state employment will stop in 2011 and projects state employment to grow 1.3% in 2011 and 1.9% in 2012[1]; however, given the larger-than-expected decline in the actual state employment from 2008 through 2010, "getting back" to the long-term trend will require several years of strong economic growth; as a result, the estimates of future growth in both employment and population, as illustrated by the tables below, should be viewed as "upper bound" estimates.

Population (000s)				
	2001	2011	2015	2020
Zone 1	509.9	522.1	534.9	551.6
Zone 2	334.9	327.6	330.0	333.5
Zone 3	1,093.8	1,204.8	1,262.5	1,336.6
Zone 4	1,059.0	1,114.8	1,144.1	1,182.6
Zone 5	1,853.3	1,943.9	1,982.6	2,034.1
ATC Total	**4,850.8**	**5,113.3**	**5,254.2**	**5,438.4**
Rest of MI	9,707.6	9,735.1	9,858.6	10,028.4
Rest of WI	856.4	917.7	953.6	1,000.0
Michigan	10,006.1	10,026.7	10,151.8	10,324.0
Wisconsin	5,408.8	5,739.3	5,914.6	6,142.8
United States	285,081.6	313,009.6	325,343.4	341,251.7

Employment (000s)				
	2001	2011	2015	2020
Zone 1	301.4	311.1	322.7	337.6
Zone 2	167.4	165.5	171.1	178.3
Zone 3	730.2	793.0	832.5	884.4
Zone 4	681.2	708.2	735.4	770.8
Zone 5	1,151.7	1,149.5	1,188.5	1,239.1
ATC Total	**3,031.9**	**3,127.3**	**3,250.3**	**3,410.2**
Rest of MI	5,339.2	4,915.4	5,083.6	5,299.0
Rest of WI	506.0	547.1	569.9	599.4
Michigan	5,489.8	5,064.3	5,237.6	5,459.6
Wisconsin	3,387.3	3,525.5	3,666.2	3,849.0
United States	165,510.2	178,646.4	186,999.8	197,896.7

About the study results

For each zone, Planning Criteria limits that are exceeded (overloads, low voltages, etc.) are identified from the results of each base model and associated sensitivity models along with their causes. 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 Planning Criteria limits are exceeded that were identified in the 2012, 2016, 2021 and 2026 analyses. The same information is shown graphically for the summer peak studies in Figures ZS-1 through ZS-20.

Note: The results for each zone in some cases are similar to the results presented in the 2010 10-Year Assessment issued in September 2010. Where new results or changes have been found, the new information is identified as such. A summary of changes for the 2011 10-Year Assessment can be found in Table PR-23.

ATC continues 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 the 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.

The multiple outage analysis section contains a status summary of the steady state multiple outage studies that have been conducted. The system stability section includes a summary of multiple outage stability analyses reviewed or recently completed, providing general 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.

The major population center in the area is Wausau

Demographics

Historical and Projected Population

The population of the counties in Zone 1 grew at an annual rate of 0.2% from 2001 to 2010. The highest growth rate occurred in Juneau County, which grew at 1.0, while the highest increase in population occurred in Marathon County, which increased 6,200 people over the period.

Population in Zone 1 is projected to grow at 0.6% annually for the 2011 to 2020 period. Marathon County will realize the largest increase in population (6,900), while Adams County will have the highest growth rate of about 1.8%.

Historical and Projected Employment

During the historical period of 2001 to 2010, the annual employment growth rate was 0.1%. The highest growth rate occurred in Adams County (1.9%), while the largest increase in employment occurred in Portage County of over 3,100.

Employment in Zone 1 is projected to grow at 0.9% annually between 2011 and 2020. From 2011 to 2020, Marathon County is projected to realize the largest increase in employment of about 7,100, while Adams County is projected to have the highest growth rate (1.5%).

Employment			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 1	0.1	Zone 1	0.9
Adams, WI	1.9	Adams, WI	1.5
Total Increase			
	2001-2010		2011-2020
Zone 1	2,675	Zone 1	26,496
Portage, WI	3,134	Marathon, WI	7,127

Population			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 1	0.2	Zone 1	0.6
Juneau,WI	1.0	Adams, WI	1.8
Total Increase			
	2001-2010		2011-2020
Zone 1	9,164	Zone 1	29,471
Marathon, WI	6,187	Marathon, WI	6,852

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

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

Zone 1 electricity demand and generation
The coincident peak load forecasts for Zone 1 for 2012, 2016, 2021 and 2026 are shown in Table ZS-11. The table also shows existing generation, proposed generation based on projected in-service year, and resultant capacity margins (with and without the proposed generation).

The table shows that load in Zone 1 is projected to grow at roughly 0.66 percent annually from 2012 through 2021. Comparing load with generation (at maximum output) within the zone indicates that Zone 1 is a net importer of power during peak load periods.

Key Zone 1 transmission facilities
Key transmission facilities in Zone 1 include:

- East-west 345-kV line from Arpin Substation through Stevens Point extending to the Appleton area,
- 345-kV line extending from Wausau to northeastern Minnesota,
- 345-kV line extending from Wausau to Stevens Point to eastern Outagamie County (Highway 22),
- 115-kV network in the northern portion of the zone, and
- 138-kV and 69-kV network in the southern portion of the zone.

Key system performance issues in Zone 1 include:

- Sensitivity of the 69-kV transmission corridor in the central part of Monroe County to a west-to-east system bias

- Metomen 138/69-kV transformer has the potential to overload with an intact system and under contingency
- Thermal overloads under contingency in the central Juneau and southeast Woods County areas
- Voltage issues in the Ripon, Berlin, Omro, and Winneconne areas under contingency.
- Several projects in past 10-Year Assessments found low voltage and thermal overload issues which did not appear in the 2011 TYA. The in-service dates of these projects were retained for now until it can be determined in future assessments that these voltage and thermal issues no longer exist.

Zone 1 - 2012 Study Results

Refer to Table ZS-1 and Figure ZS-1

Summary of key findings

- Sensitivity of the 69-kV transmission corridor in the central part of Monroe County to a west-to-east system bias, and
- Thermal overloads under contingency along the Petenwell to Saratoga line with a west-to-east bias.

The 138-kV bus voltages at the Petenwell, Council Creek and ACEC Badger West substations fall below ATC Planning Criteria under certain contingencies during high loads. The low voltages can be addressed by manually adjusting LTCs on local 138/69-kV transformers. This issue does not occur in the off-peak sensitivity models.

The planned distribution interconnection (Woodmin Substation) in the Minocqua area will require a new 115-kV transmission line to be installed by June 2012. The Public Service Commission of Wisconsin (PSCW) granted a certificate of public convenience and necessity in October of 2010, authorizing ATC to construct the facilities described in our application.

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

- None

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

- None

Zone 1 - 2016 study results

Refer to Table ZS-2 and Figure ZS-2

Summary of key findings

- The 69-kV transmission corridor in the central part of Monroe County and the 138-kV facilities in central Juneau County and southeast Wood County are sensitive to west-to-east system biases,
- Petenwell 138/69-kV transformer overloads under system intact and single contingency conditions, and
- Maintenance and voltage issues exist in the greater Berlin and Ripon areas that need to be addressed.

Low voltages and overloads on the transmission facilities can occur 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 to be implemented to reliably serve load in the future. Several potential reinforcements have been evaluated to address the low voltage and thermal overload issues in the Tomah area. Furthermore, there is a need for periodic separation of the ATC and Dairyland Power Cooperative facilities at the Council Creek Substation to prevent overloads. ATC worked in cooperation with Dairyland Power Cooperative and Xcel Energy to develop a more comprehensive long term solution to address reliability issues in the Tomah area as well as the limitations along the Monroe County to 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 2014. This solution addresses Planning Criteria driven needs, reduces system losses and provides economic benefits to customers.

The loading on the Petenwell 138/69-kV transformer exceeds its summer normal rating under system intact conditions and exceeds its summer emergency rating under single contingency conditions. A proposed project to upgrade this transformer is currently scheduled for 2015. To improve operating flexibility, this project also includes the reconfiguration of the Petenwell 138-kV bus. Dispatching generation and distribution load bridging will be utilized as an interim mitigation measure to alleviate potential loading issues. This issue does not occur in the off-peak sensitivity models.

Low voltages around the greater Berlin area will necessitate additional capacitors to be installed at Ripon Substation. This issue does not occur in the off-peak sensitivity models.

No performance limits were exceeded for Category A conditions for all 2016 analysis except the high voltage at Council Creek 138-kV bus in the 2016 minimum load model. The

Council Creek high voltage issue can be addressed by adjusting the Council Creek 138/69-kV transformer LTC settings.

The lead times necessary to implement the corrective plans that are scheduled for 2012 through 2016 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the near term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- Upgrade and install capacitor banks at Ripon 69-kV substation

Zone 1 - 2021 study results

Refer to Table ZS-3 and Figure ZS-3

Summary of key findings

- Two transformers serving the 69-kV system are overloaded under single contingency and/or under an intact system,
- Additional reinforcement on the 69-kV line system in central Juneau County is needed due to overloads under contingency, and
- Potential voltage issues in the Ripon-Berlin and Omro –Winneconne areas begin to appear under contingency.

The Metomen 138/69-kV transformer loading is approaching its summer emergency rating under contingency conditions. The Metomen transformer 69-kV breaker was replaced in 2009 and the existing 47 MVA Metomen 138/69-kV transformer will be replaced with a 100 MVA transformer in 2017.

As discussed in the 2016 study results, the Petenwell 138/69-kV transformer loading exceeds its summer normal rating under system intact conditions and exceeds its summer emergency rating under single contingency conditions. The transformer needs to be replaced in 2015. Dispatching generation and distribution load bridging will be utilized as an interim mitigation measure to alleviate potential thermal problems.

Maintenance and voltage issues exist in the greater Berlin and Ripon areas that need to be addressed. To address these 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.

No performance limits were exceeded for Category A conditions for all 2021 analysis except the high voltage at Council Creek 138-kV bus in the 2021 minimum load model and overload of the Petenwell 138/69-kV transformer in the 2021 summer peak model. The Council Creek high voltage issue can be addressed by adjusting the Council Creek 138/69-kV transformer LTC settings. The Petenwell transformer overloading issue is addressed by replacing the transformer in 2015.

The lead times necessary to implement the corrective plans that are scheduled for 2017 through 2021 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the longer term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- None

Zone 1 - 2026 study results

Refer to Table ZS-4 and Figure ZS-4

Summary of key findings

- Voltage and thermal issues remain in Zone 1 under contingency conditions. The results of the 2026 contingency analysis (NERC Category B or TPL-002 conditions) performed on Zone 1 can be found in Table ZS-4. Please note that because this is a 15-year projected scenario, new projects were not necessarily added to the Assessment based upon these results. However, we will continue to monitor these situations in future scenarios to determine which project(s) may solve these potential issues.

Assessment of Steady State Compliance with NERC Standards

The mitigation plans comprised of planned, proposed, and provisional project as well as appropriate system adjustments identified for Zone 1 in this Assessment will allow the ATC system in Zone 1 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2012-2016, and for the 2017-2021 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

Historical and Projected Population

The population of the counties in Zone 2 experienced slightly negative growth from 2001 to 2010. The highest growth rate of 0.2% per year and the largest increase in population of 1,100 occurred in Marquette County.

Population in Zone 2 is projected to grow on an annual basis of 0.2% between 2011 and 2020. For the same period, Vilas County is projected to realize the largest increase in population of about 1,300, as well as the highest growth rate (0.6%).

Historical and Projected Employment

During the same period, the annual employment also had a slightly negative growth rate was -0.4%. The highest growth rate and the highest increase in employment were in Marquette County (Michigan).

Employment in Zone 2 is projected to grow at 0.8% annually between 2011 and 2020. During this time period, Marquette County (Michigan) is projected to realize the largest increase in employment of over 3,800, while Luce County (Michigan) is projected to have the highest growth rate of 1.8%.

Employment			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 2	-0.4	Zone 2	0.8
Marquette, MI	0.6	Luce, MI	1.8
Total Increase			
	2001-2010		2011-2020
Zone 2	-5,511	Zone 2	12,724
Marquette, MI	1,899	Marquette, MI	3,812

Population			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 2	-0.3	Zone 2	0.2
Marquette, MI	0.2	Vilas, WI	0.6
Total Increase			
	2001-2010		2011-2020
Zone 2	-7,722	Zone 2	5,903
Marquette, MI	1,152	Vilas, WI	1,305

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 2012, 2016, 2021 and 2026 are shown in Table ZS-11. The table also shows existing generation, proposed generation based on projected in-service year, and resultant capacity margins (with and without the proposed generation).

This table shows that load in Zone 2 is projected to grow at roughly 0.59 percent annually from 2012 through 2021. 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:

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

Transmission study drivers

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

Please note that more information on the need drivers and preliminary solution development is presented fully in the ATC Energy Collaborative - Michigan section. This section presents a strategic flexibility approach to the multiple factors emerging across the U.P. and the status of current studies. The solution development process utilized in the ATC Energy Collaborative – Michigan, in addition to our ongoing studies, identified the area solutions to address various limitations based upon ATC's Planning criteria.

Key system performance issues in Zone 2 include:

- Connecting possible renewable generation sources,
- Serving possible point load increases,
- Anticipating possible generation retirements,
- Limited import and export capability,
- Aging 69-kV and 138-kV infrastructure throughout the Upper Peninsula,
- Generator stability in the central portion of Upper Peninsula,
- Parallel path flow around Lake Michigan that contributes to heavy loading on the 138-kV and 69-kV systems, and results in the need for transmission loading relief incidents and reconfiguration of the system,
- Record low Lake Superior water levels in previous years result in reduced available hydro generation
  output in the eastern U.P., magnifying reliability concerns in this area,
- High voltage concerns at lighter load periods for central and eastern Upper Peninsula,
- Low voltages, most pronounced in the western and eastern Upper Peninsula,
- Potential low voltages and overloads in the northwestern U.P. due to recent load increases, and
- Potential marginal voltages and overloads in the central U.P. due to potential load increases and generation reductions.
- Several provisional projects in past 10-Year Assessments found low voltage and thermal overload issues which did not appear in the 2011 TYA. The provisional project in-service dates were retained for now until it can be determined in future assessments that these voltage and thermal issues no longer exist.

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

Zone 2 - 2012 study results

Refer to Table ZS-1 and Figure ZS-5

Summary of key findings

- Low voltages throughout the Newberry area under contingency necessitate a project to transfer load off of the Hiawatha-Roberts 69 kV line 6911 around 2012,
- Maintaining reliability of service to load in and around the greater Escanaba area requires that system reinforcements be implemented in the near term, and
- Power flows particularly through the eastern U.P. necessitate the need for system reinforcements in the near term.

There were facility overloads and several facilities near their emergency ratings in Zone 2 based on the 2012 analysis. Many projects are either planned or proposed to address these near-term thermal issues by 2014. Details regarding these projects are described in this section and in the Zone 2 – 2016 study results section.

Eastern U.P.

High voltages have been experienced on an intact system in real time in the eastern U.P. The high voltages usually occur at lighter load levels. The primary sources are the Straits-McGulpin 138-kV submarine cables, which are significant reactive power sources (13 MVAR each) and act like capacitor banks which raise system voltages.

To mitigate this operating limitation in the near term, two 13.8-kV reactors (total 25 MVAR) were installed at the Straits Substation in 2010.

Escanaba area

As part of the ATC Energy Collaborative – Michigan, several projects were identified to address system issues in the Escanaba area by 2012.

- Install a second Chandler 138/69-kV transformer (2012),
- Install Delta 69-kV bus tie breaker (2012), and
- Replace five 69-kV breakers at Delta Substation (2012).

These Escanaba area projects were identified as a result of the analyses of several potential futures, which indicated low voltages and overloaded facilities throughout the 69-kV system in central Delta County. These projects also address many System Operations and Asset Renewal limitations. There are numerous System Operations needs associated with the Escanaba area driven by outage coordination issues that make maintenance work very difficult and/or expensive to perform. In addition, there are local issues associated with the lack of generation availability and/or possible network transmission service additions. Additional projects to be installed by 2016 are identified in the 2016 Results section.

Munising/Newberry area
To address Munising area limitations, the following project has been proposed in the 2012 timeframe:

- Engadine load move project
    - A facility outage of the Hiawatha-Engadine 69-kV line situates the Engadine load at the end of a long radial feed and causes the voltage criteria on the Newberry area 69-kV buses to be exceeded, and
    - This project will address these low voltages under low generation and single contingency conditions.

Western area
No western area reinforcements are needed through 2012.

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

- Large power flows through the eastern U.P. of Michigan result in inadequate loading performances and voltage, increased system losses, and high Locational Marginal Prices (LMPs) for local power purchases. Current measures taken to address the high flows include splitting the U.P. system almost all of the time to eliminate the flows through the U.P. and expensive generation redispatch to try to accommodate urgent maintenance outages in both the U.P. and northern lower peninsula. Please refer to the Zone 2 - 2016 Study results for further information and the solution to these issues

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

- None

Zone 2 - 2016 study results

Refer to Table ZS-2 and Figure ZS-6

Summary of key findings

- Maintaining reliability of service to load in and around the greater Escanaba area requires that system reinforcements be implemented in the near term, and
- Projects driven solely by the potential for the Kinross load addition in the eastern U.P. have been removed from the project list.

Escanaba area
As part of the ATC Energy Collaborative – Michigan, several projects were identified to address system issues in the Escanaba area by 2016.

- Construct Chander-18th Road double-circuit 138-kV lines (2014), and
- Install Arnold 345/138-kV transformer (2015)

These Escanaba area projects were identified as a result of the analyses of several potential futures, which indicated low voltages and overloaded facilities throughout the 69-kV system in central Delta County. These projects also address many System Operations and Asset Renewal limitations. There are numerous System Operations needs associated with the Escanaba area driven by outage coordination issues that make maintenance work very difficult and/or expensive to perform. In addition, there are local issues associated with the lack of generation availability and/or possible network transmission service additions.

Eastern U.P.

A new transmission-distribution interconnection, referred to as the Kinross load, was proposed as a load addition in Chippewa County south of Sault Ste. Marie. This load originally represented a significant addition to the existing load in the Sault Ste. Marie area, and created a sudden change in the load, generation, and transmission balance in the eastern U.P. Since the 2010 Assessment the net load proposed for this project has been greatly reduced to the point of not needing projects driven solely by the original load addition. The following projects are now needed without the large Kinross load.

- Rebuild Straits-Pine River lines 6904/5 for 138 kV and operate at 69 kV (2014), and
- Uprate Pine River-Nine Mile 69-kV line 6923 to 167 degrees F and minimum asset renewal (2016).

These projects will be required to improve the voltage profile and eliminate thermal limitations in the eastern U.P. during this timeframe.

In order to eliminate power flow limitations in the eastern U.P., ATC is proposing the addition of flow control technology in the area. The project chosen to address these issues is the installation of a back-to-back HVDC device with voltage source converter technology (VSC). The VSC will be connected in series with the Straits-McGulpin 138-kV lines (9901/9903) for installation as soon as possible around the year 2014.

Power flow control in the eastern U.P. will adjust flows to more manageable levels to preserve system reliability during maintenance and construction activities in the Upper and Lower Peninsula systems through a large variety of system conditions, as well as providing improved local area power quality. It could also reduce system losses and allow more economic dispatch of market generation if used to eliminate congestion while maintaining local area reliability. Further study is required to determine the appropriate operational protocol using this new device.

In conjunction with the eastern U.P. power flow control, ATC expects to permanently energize a Hiawatha-Indian Lake line at 138 kV as soon as the VSC flow control is in service. The Hiawatha-Indian Lake 138-kV project will increase the effectiveness of the flow control project. It will enhance reliability by relieving voltage limitations and providing more reliable maintenance outage opportunities.

Munising/Newberry area
As part of the ATC Energy Collaborative – Michigan, an uprate of the Munising-Blaney Park 69-kV line was identified to address network system, asset renewal, and System Operations issues in 2014.

Western area
Project development following the ATC Energy Collaborative – Michigan, determined that a rebuild of the Atlantic69 line should be scheduled for completion in the 2013 timeframe. This project will address low voltages, overloaded facilities and facility condition throughout the Western area.

Several other projects were identified as near term solutions for the U.P. The solutions for the eastern U.P., Munising/Newberry and Escanaba areas for the years 2012-2016 are outlined in the Zone 2 – 2012 study results section.

No performance limits were exceeded for Category A conditions for all 2016 analysis except the high voltage at Munising, Alger, and Alger-Delta 138-kV buses and the Lakota Road 115-kV bus in the 2016 70% load model. The high voltage issues can be addressed by adjusting generation in the area.

The lead times necessary to implement the corrective plans that are scheduled for 2012 through 2016 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the near term planning horizon have an “In-service date” that matches the “Need date”, except the following projects:

Projects whose “Need date” precedes the “In-service date”
- None

Projects whose “In-service date” precedes the “Need date”
- None

Zone 2 – 2021 study results

Refer to Table ZS-3 and Figure ZS-7

Summary of key findings

- All longer term area needs were described and addressed in the Zone 2 – 2012 study results and Zone 2 – 2016 study results sections.

There was one thermal limitation and three area bus voltage limitations that appeared in Table ZS-3. All of these limitations are addressed by generation adjustments and/or the projects outlined in Zone 2 – 2012 study results and Zone 2 – 2016 study results. In addition, further explanation can be found in the ATC Energy Collaborative – Michigan section.

No performance limits were exceeded for Category A conditions for all 2021 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2017 through 2021 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the longer term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- None

Zone 2 - 2026 study results

Refer to Table ZS-4 and Figure ZS-8

Summary of key findings

- Limitations identified will be addressed in projects outlined in the 2012 and 2016 sections.

There are three thermal limitations and several voltage limitations listed in Table ZS-4. The voltage and thermal limitations occur in the Munising/Newberry, eastern U.P. and

Escanaba areas and will be mitigated by projects described in the 2012 and 2016 study results.

Please refer to the ATC Energy Collaborative – Michigan for further information.

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

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

Assessment of Steady State Compliance with NERC Standards
The mitigation plans comprised of planned, proposed and provisional projects identified for Zone 2 in this Assessment will allow the ATC system in Zone 2 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2012-2016, and for the 2017-2021 planning horizon.

Zone 3 overview

Zone 3 includes the Wisconsin counties of:

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

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

Land use in Zone 3 is a mix of rural, urban and agricultural.

The major population centers are the Madison metropolitan area and the Janesville/Beloit area.

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

Demographics

Historical and Projected Population

The population of the counties in Zone 3 grew at an annual rate of .9% from 2001 to 2010. The highest growth rate of 1.5% per year and the largest increase in population of 64,400 occurred in Dane County.

Population in Zone 3 is projected to grow at 1.2% annually for the 2011 to 2020 period. From 2011 to 2020, Dane County is projected to realize the largest increase in population (82,900) and is projected to have the highest growth rate of 1.7%.

Historical and Projected Employment

During the same period, the annual employment growth rate was 0.6%. The highest growth rate (1.2%) and the largest increase in employment (37,800) occurred in Dane County.

Employment in Zone 3 is projected to grow at 1.2% annually between 2011 and 2020. Dane County is projected to realize the largest increase in employment of over 54,000 and the highest growth rate of 1.4%.

Employment			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 3	0.6	Zone 3	1.2
Dane, WI	1.2	Dane, WI	1.4
Total Increase			
	2001-2010		2011-2020
Zone 3	42,276	Zone 3	91,406
Dane, WI	37,870	Dane, WI	54,008

Population			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 3	0.9	Zone 3	1.2
Dane, WI	1.5	Dane, WI	1.7
Total Increase			
	2001-2010		2011-2020
Zone 3	96,894	Zone 3	131,829
Dane, WI	64,473	Dane, WI	82,972

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 driftless 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 2012, 2016, 2021 and 2026 are shown in Table ZS-11. The table also shows existing generation, proposed generation based on projected in-service year, and resultant capacity margins (with and without the proposed generation).

The table shows that load in Zone 3 is projected to grow at roughly 1.37 percent annually from 2012 through 2021. 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:

- Columbia-North Madison 345-kV lines,
- Columbia-Rockdale 345-kV line,
- Paddock-Rockdale 345-kV line,
- Paddock-Wempletown 345-kV line,
- Rockdale – Wempletown 345-kV line, and
- 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:

- Existing contingency thermal overloads on the Fitchburg-Royster 69-kV line,
- Low voltages for two separate double circuit tower outages in Dane County transmission system calls for reactive support in 2011
- 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 the Rock and Green Counties, along with the mismatch of load to generation in the area, could 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 69-kV source into the area. Adding the Bass Creek 138/69-kV transformation will address a number of potential low voltage issues and transformer overloads.
- Several provisional projects in past 10-Year Assessments found low voltage and thermal overload issues which did not appear in the 2011 Assessment. The provisional project in-service dates were retained for now until it can be determined in future assessments that these voltage and thermal issues no longer exist.

Zone 3 - 2012 study results

Refer to Table ZS-1 and Figure ZS-9

Summary of key findings

- Short term operation procedures are required to address the Fitchburg-Royster 69-kV line overload problems before a permanent transmission solution can be implemented,
- Maintaining reliability of service to load in and around the Madison area requires that system reactive 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 the Rock and Green Counties, along with the mismatch of load to generation in the area, could 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 69-kV source into the area. Adding the Bass Creek 138/69-kV transformation addresses a number of potential low voltage issues and transformer overloads.

In response to some single contingency low voltage problems in Zone 3, a total of 98 MVAR of capacitor banks distributed among the Femrite, Kegonsa and Spring Green substations was deemed to be the most feasible solutions in the 2011-2012 timeframe.

Studies have shown the potential for severe low voltage problems in Dane County area for the loss of certain double circuit tower outages. To address these issues in the near term, one-32.66 MVAR 138-kV Femrite capacitor bank and one-32.66 MVAR 138-kV Kegonsa capacitor bank have been installed. Also in Dane County, the Fitchburg, Cross County, Oak Ridge and Pleasant View 138-kV buses have marginal system intact voltages under certain conditions. The Femrite and Kegonsa capacitor bank projects will also improve potential system intact low voltage limitations.

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 certain single contingencies. A package of projects was proposed to address these issues. It includes uprating the Fitchburg-Nine Springs 69-kV and Royster-Pflaum 69-kV lines, moving the AGA load to the Royster-Femrite 69-kV line and installing two 16.33 MVAR, 69-kV capacitor banks at the Nine Springs Substation in 2013. Prior to the implementation of these projects, a short-term operation procedure including potential load bridging is available. The short-term operation procedure will be evaluated each year until the transmission projects are implemented.

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

Load growth in the Rock and Green Counties, along with the mismatch of load to generation in the area, will result in unacceptably low voltages in the Monroe area. Under several single contingency conditions, thermal overloads also arise on the Y-33 69-kV line sections Brodhead-Spring Grove-Blacksmith-South Monroe. The planned 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. A138/69-kV transformer at Bass Creek and the Townline Road–Bass Creek 138-kV line uprate have been put in service in 2011 to address these problems and provide an additional 69-kV source into Green and Rock Counties. These projects will also allow the delay of a new Brooklyn to Evansville 69-kV line project outside of ATC's 10-year planning horizon.

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.

No performance limits were exceeded for Category A conditions for all 2012 analysis except the high voltage at Darlington 138-kV bus in the 2012 minimum load model. The Darlington high voltage issue can be addressed by adjusting the North Monroe 138/69-kV transformer LTC settings.

Zone 3 - 2016 study results

Refer to Table ZS-2 and Figure ZS-10

Summary of key findings

- 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,
- Low voltage problems were observed in the Boscobel area under single contingency conditions with the Gran Grae 161/69-kV transformer prior outage.
- Due to 69-kV system load growth in Verona and Spring Green areas, the West Middleton-Stage Coach 69-kV line requires higher capacity.

In 2009, ATC received the regulatory CPCN approval for the Rockdale-West Middleton (Cardinal) 345-kV line project. This project will address line overloads and low voltage issues in Dane County and is planned to be in-service in 2013.

ATC Asset Management has determined that currently ATC has no spares for a 161/69-kV transformer installed in the system and the spare equipment lead-time is in excess of 1 year. The provisional project of installing one 8.16 Mvar capacitor bank at Boscobel 69-kV substation and upgrading the existing 5.4 Mvar bank with an 8.16 MVAR bank is advanced from 2019 to 2015. The advance is mainly due to single contingency low voltage constraints near Boscobel area observed in the 2011 10-Year Assessment with the prior outage of the existing 161/69 kV transformer.

Uprating the West Middleton-Stage Coach 69-kV line is needed by 2015. It will address potential line overload problems under single contingency conditions. In addition, under the certain transformer prior outage condition, the West Middleton-Stage Coach 69-kV line can be overloaded after another transformer outage.

Past 10-Year Assessments found thermal and voltage issues involving the 69-kV loop between North Lake Geneva and Brick Church under contingency conditions. A new 138kV line between North Lake Geneva – South Lake Geneva was proposed for 2016 to resolve these issues. However, recent load forecast reduction has resulted in ATC delaying the North Lake Geneva – South Lake Geneva project in-service date from 2016 to

2018. This area continues to be under review to determine when the next system additions are warranted.

No performance limits were exceeded for Category A conditions for all 2016 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2012 through 2016 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the near term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- Uprate Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, move AGA to the Femrite-Royster 69-kV line and install Nine Springs capacitor bank. The need year is listed as 2008. The in-service year is 2013. Post-contingency generation dispatch or distribution load bridging will be utilized as an interim mitigation measure to alleviate potential single-contingency thermal and voltage issues.

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

- None

Zone 3 - 2021 study results

Refer to Table ZS-3 and Figure ZS-11

Summary of key findings

- Additional reactive power is needed throughout the Zone 3,
- The estimated need date for the West Middleton (Cardinal) - Blount 138-kV project is 2020; the primary need driver is certain double circuit tower outages,
- Due to 69-kV system load growth in the Southeast Madison area, the Sycamore-Royster 69-kV line requires higher capacity,
- Several projects were delayed due to lower load forecast in certain local area

In response to low voltages throughout Zone 3, a significant amount of capacitor banks distributed at the Eden, Mazomanie, Concord, Brick Church, Sun Prairie, Dam Heights, and North Monroe substations in the 2017-2023 timeframe were deemed to be the preliminary solutions. The in-service dates for some of these capacitor bank projects are delayed mainly due to load forecast reduction in local areas. The new in-service dates are chosen considering both the latest 2011 10-Year Assessment need date and previous 10-Year Assessments identified need dates.

The Royster-Sycamore 69-kV line is overloaded under single contingency conditions in the 2021 summer peak model analysis. The existing provisional Royster-Sycamore line uprate project is advanced to 2018 based on the new results. A potential project alternative to the line uprate is to add a second Femrite transformer.

Past 10-Year Assessments found thermal overload issues under single contingency conditions for the existing Spring Green 138/69-kV transformer, the existing Hillman 138/69-kV transformer and the North Monroe-South Monroe 69-kV line. Those issues did not appear in the 2011 10-Year Assessment. The past solutions were to install a second transformer at Spring Green, a second transformer at Hillman and uprate the Y87 line in 2018. These provisional projects were retained for now until it can be determined in future 10-Year Assessments that these thermal issues truly no longer exist.

Due to higher validated line ratings and load forecast reduction in Alliant area, the reliability need date for the Y119 Sun Valley tap-Oregon 69-kV line rebuild project is beyond 2026 in the 2011 TYA analysis. A new in-service date of 2020 is chosen mainly based on the preliminary Asset Management need date for rebuilding this line.

Past 10-Year Assessments found voltage and thermal issues in the Reedsburg loop. Those issues did not appear in the 2011 10-Year Assessment. The past solution was to construct a 138kV line between Lake Delton and Birchwood in 2020. This provisional project was retained for now until it can be determined in future 10-Year Assessments that the line is not needed.

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

In 2013, the existing West Middleton substation will be divided into two separate adjacent substations behind the same fence as follows:

- West Middleton will remain as 69 kV, and
- Cardinal Substation will encompass 138 and 345-kV portions of the substation.

Since the 2008 Assessment, the West Middleton (Cardinal) 138/69-kV transformer ratings have been validated with higher ratings. In addition, with the new load forecasts utilized in the 2009, 2010 and 2011 10-Year Assessments, the original needs for the Cardinal-Blount 138-kV project are sliding out of 10-year planning horizon. However, considering the potential severe low voltage problem under certain double circuit tower outage conditions (especially during a major 345-kV line maintenance outage), as a potential long term solution, it was decided to keep the project in the project table as a provisional 2020 project. It is provisional because the justification of the project needs to be confirmed and a project scope needs to be developed.

Past 10-Year Assessments have identified the emerging McCue-Lamar and Bass Creek-Footville thermal overloads and voltage issues at the Lamar Substation under single-contingency conditions. Those issues did not appear in the 2011 10-Year Assessment. A second 69-kV line from McCue to Lamar in 2017 was being considered as a placeholder to resolve the issues in this area. It was decided to delay this provisional project to 2019 for now until it can be determined in future 10-Year Assessments that the project is not needed.

In the past, Y-32 (Colley Road-Brick Church 69-kV line) saw thermal overloads under contingency conditions as well as age and condition issues. The thermal issues were not seen in the 2011 10-Year Assessment. The age and condition issues remain and will likely result in a line rebuild in the next 10-15 years. The project In-Service date was retained at 2018 until future 10-Year Assessments assure the need to rebuild for thermal reasons no longer exists.

Past 10-Year Assessments determined the Brick Church 138-kV bus could experience low voltages under various contingencies. The provisional project of 2-24.5 MVAR 138-kV capacitor banks and 1-18 MVAR 69-kV capacitor bank at Brick Church would address these issues. While voltage issues were not seen in the Brick Church area, the 2017 In-Service date was retained until we can be assured the voltage issues won't return in the next few 10-Year Assessments.

Past 10-Year Assessments found thermal and voltage issues in the Lake Geneva area. A provisional project to construct a 138kV line between Spring Valley, in eastern Kenosha County to the Lake Geneva area is still being considered. It is expected the new 138kV line would connect to the proposed North Lake Geneva – South Lake Geneva 138kV line. One or two 138/69kV transformers could be installed along the provisional Spring Valley – North Lake Geneva line to strengthen the area. Past 10-Year Assessment had the provisional Spring Valley – Lake Geneva line being placed in service in 2018. The project has been delayed to 2019 due to lower load forecasts.

For detailed discussions on the Badger-Coulee 345-kV line project and the Dubuque-Spring Green-Cardinal 345-kV line project, please refer to Regional Planning section.

No performance limits were exceeded for Category A conditions for all 2021 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2017 through 2021 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the longer term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- None

Zone 3 - 2026 study results

Refer to Table ZS-4 and Figure ZS-12

Summary of key findings

- 69-kV lines between West Middleton and Waunakee substations are exceeding their summer emergency ratings under single contingency conditions,
- Waunakee Industrial Park-Huiskamp 69-kV line is approaching its summer emergency rating under single contingency condition.

The 2026 results suggest that further study of Zone 3, particularly around Dane County area, is needed to identify an appropriate long-term solution for this area that may be required beyond the year 2020.

Thermal overloads were observed on the Y-131 Waunakee - West Port 69-kV line and the 6963 West Middleton-Pheasant Branch 69-kV lines under single contingency conditions. Rebuilding West Middleton-Pheasant Branch 69-kV line with double circuits in 2022 could be a potential long term solution to address these two potential constraints.

Past 10-Year Assessments determined the Portage – Trienda 138-kV line could experience thermal issues under various contingencies. The provisional project was to uprate the line by 2022. While thermal issues were not seen with the Portage – Trienda line in the 2011

10-Year Assessment analysis, the 2022 In-Service date was retained until we can be assured the thermal issues won't return in the next few 10-Year Assessments.

Past 10-Year Assessments determined that 345/138kV transformation was needed in the North Randolph area to support the area. The provisional project was to construct a 345kV bus at North Randolph and loop the Columbia – South Fond du Lac 345kV line into North Randolph. The need for the transformer was not seen in the 2011 10-Year Assessment. While need drivers did not appear in this 10-Year Assessment, the 2025 In-Service date was retained until we can be assured the area needs won't return in the next few 10-Year Assessments.

The provisional project of constructing a Hubbard-East Beaver Dam 138-kV line will address not only several 69-kV thermal overloads, but also the low voltages in the Beaver Dam area for an outage of the North Randolph-North Beaver Dam 138-kV line. While the 2011 10-Year Assessment didn't show a need this year, the 2020 In-Service date was retained until future 10-Year Assessments indicate the need is no longer there.

No performance limits were exceeded for Category A conditions for all 2026 analysis.

Assessment of Steady State Compliance with NERC Standards

The mitigation plans comprised of planned, proposed and provisional projects identified for Zone 3 in this Assessment will allow the ATC system in Zone 3 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2012-2016, and for the 2017-2021 planning horizon.

Zone 4 overview

Zone 4 includes the counties of:

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

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

Demographics

Historical and Projected Population

The population of the counties in Zone 4 grew at an annual rate of 0.5% from 2001 to 2010. The highest growth rate occurred in Calumet County (1.0%), while the largest increase in population over the period occurred in Brown County, which increased about 19,500 people.

Population in Zone 4 is projected to grow annually at 0.7% for the 2011 through 2020 period. Outagamie County is projected to realize the largest increase in population (17,800), while Calumet County the highest growth rate of 1.3%.

Historical and Projected Employment

During the same period, the annual employment growth rate was 0.2%. The highest growth rate occurred in Calumet County (0.7%). In addition, the largest increase in employment also occurred in Brown County, which increased about 5,500 employees.

Employment in Zone 4 is projected to grow at 0.9% annually for the 2011 to 2020 period. Brown County is projected to realize the largest increase in employment of over 16,500, while Calumet County is projected to have the highest growth rate (1.4%).

Employment			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 4	0.2	Zone 4	0.9
Calumet, WI	0.7	Calumet, WI	1.4
Total Increase			
	2001-2010		2011-2020
Zone 4	10,677	Zone 4	62,653
Brown, WI	5,537	Brown, WI	16,495

Population			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 4	0.5	Zone 4	0.7
Calument, WI	1.0	Calumet, WI	1.3
Total Increase			
	2001-2010		2011-2020
Zone 4	48,794	Zone 4	67,765
Brown, WI	19,520	Outagamie, WI	17,832

Zone 4 Environment 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 2012, 2016, 2021 and 2026 are shown in Table ZS-11. The table also shows existing generation, proposed generation based on projected in-service year, and resultant capacity margins (with and without the proposed generation).This table shows that load in Zone 4 is projected to grow at roughly 0.67 percent annually from 2012 through 2021. 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,
- Four 345-kV lines connecting the Gardner Park, Werner West, Morgan, and Plains Substations,
- Two 345-kV lines from North Appleton to Werner West and Fitzgerald, and
- Three 345-kV lines connecting South Fond du Lac Substation to the Columbia, Edgewater and Fitzgerald Substations.

Key system performance issues in Zone 4 include:

- Asset renewal concerns for the 138 and 69-kV facilities in the Green Bay area, north of Green Bay, southern Door County, areas north and west of Manitowoc and the Fox River Valley area,
- Heavily loaded 138-kV lines west of Green Bay and Appleton, and
- Heavily loaded 69-kV facilities in the Oshkosh area
- Several provisional projects in past 10-Year Assessments found low voltage and thermal overload issues which did not appear in the 2011 Assessment. The provisional project in-service dates were retained for now until it can be determined in future assessments that these voltage and thermal issues no longer exist.

Zone 4 – 2012 study results

Refer to Table ZS-1 and Figure ZS-13

Summary of key findings

- The Oshkosh area 69-kV facilities continue to overload under single contingency conditions.
- Low voltages and heavily loaded 138/69-kV transformers exist in the northern portion of Door County.

As discussed in previous Assessments, the rebuild of the Sunset Point – Pearl Avenue 69-kV line will address the overload of the circuit under single-contingency conditions. To see the impact of this overload and to verify the overload is getting progressively worse over time, the rebuild project planned to reinforce this circuit was not included in the base case models analyzed for this assessment. Hence, the reason the overload appears in models past its anticipated in-service date. The current in-service date for this reinforcement project is April 2012. Once complete, the limitation will be addressed.

The completion of the Kewaunee switchyard reconfiguration along with the addition of a second 345/138-kV transformer in 2011 provides increased offsite power reliability for the nuclear power plant, helps facilitate switchyard maintenance on transmission facilities, provides the ability to deliver generation into our transmission network under transmission outages and brings more economical base load generation to the marketplace.

Similar to previous Assessments, the potential for low voltages under normal and single contingency conditions and the potential for overloads under single contingency conditions in northern Door County necessitates a combination of reinforcement projects be implemented. This area is unique because of the local area's peak load usually does not occur during ATC's typical system peak. The Sister Bay capacitor bank and the Canal – Dunn Road projects described below were included in all models evaluated for this assessment, thus the overloads and voltage issues noted in the summary of key findings above will not appear in any of the results.

To address the immediate needs of this area, two additional 1.2 MVAR distribution capacitor banks were installed at the Sister Bay Substation in 2008. The addition of these capacitor banks on the distribution system supports the voltages in the area under normal and single-contingency conditions until the longer term reinforcements noted below are in place.

The proposed long-term solutions for northern Door County include implementing reinforcements in two phases. The in-service dates for both phases were able to be deferred to their current in-service dates as a result of installing the distribution capacitor banks at Sister Bay. The two phases consist of:

- Rebuild the existing Canal – Dunn Road 69-kV line as a new Canal – Dunn Road 138/69-kV double-circuit line and install a new 138/69-kV transformer at the Dunn Road Substation by June 2012, and
- Constructing a second Dunn Road – Egg Harbor 69-kV line by June 2021.

The proposed Canal – Dunn Road 138/69-kV double-circuit line and Dunn Road transformer will not only address the low voltages in the area under normal and single-contingency conditions, but also addresses the overloads of the 138/69-kV transformers at Canal and various 69-kV lines in the area under single-contingency conditions. The installation of the 138/69-kV transformer at the Dunn Road Substation introduces a third such transformer to this area and will provide geographic diversity from the existing transformation at the Canal Substation. ATC received approval in August 2010 for its CPCN application from the Public Service Commission of Wisconsin to construct the first phase of this project.

The second 69-kV line between Dunn Road and Egg Harbor Substations will provide a second source to the northern Door County area and facilitate maintenance outages of the existing Dunn Road – Egg Harbor 69-kV line. See Zone 4 – 2021 study results section for additional details.

No performance limits were exceeded for Category A conditions for all 2012 analysis.

Zone 4 – 2016 study results

Refer to Table ZS-2 and Figure ZS-14

Summary of key findings

- Zone 4 is an active study area for potential wind generation additions,
- Zone 4 is an active area for asset renewal type projects, and
- For the 2016 study model, the remainder of zone 4 is free of system limitations largely due to the reduced load forecast.

The Sunset Point – Pearl Avenue 69-kV line continues to overload and the magnitude of the overload continues to increase in the 2016 summer peak models. To see the impact of this overload and to verify the overload is getting progressively worse over time, the rebuild project planned to reinforce this circuit was not included in the base case models analyzed for this assessment. Hence, the reason the overload appears in models past its anticipated in-service date. The current in-service date for this reinforcement project is April 2012. Once complete, the limitation will be addressed. See Zone 4 – 2012 study results section for additional details.

To improve reliability, ensure safety and comply with current code requirements, an Asset Management driven rebuild of the Dyckesville – Sawyer 69-kV circuit is proposed for 2016. ATC is currently performing a detailed study of structure integrity and conductor-to-ground clearances of this 69-kV circuit.

For a variety of reasons, we will be considering the installation of a second 345/138 kV transformer at the Fitzgerald Substation. Because this project is in the very early stages of project development, it is currently not listed in the project tables.

No performance limits were exceeded for Category A conditions for all 2016 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2012 through 2016 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the near term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- None

Zone 4 – 2021 study results

Refer to Table ZS-3 and Figure ZS-15

Summary of key findings

- Zone 4 is an active study area for potential wind generation additions,
- The updated load forecasts have resulted in the deferral of several projects identified in prior 10-Year Assessments,
- Additional reinforcements may be needed in the Manitowoc and eastern Calumet County areas, and
- Additional reinforcements may be needed in Northern Door County to facilitate maintenance outages and improve system intact as well as voltages under contingency conditions.

- The load forecasts have resulted in the deferral or absence of system performance issues identified in prior 10-Year Assessments.

The Sunset Point – Pearl Avenue 69-kV line continues to overload and the magnitude of the overload continues to increase in the 2021 summer peak models. The current in-service date for this reinforcement project is April 2012. Once complete, the limitation will be addressed. See Zone 4 – 2012 study results section for additional details.

A new limitation appeared in the 2021 analysis, the Glenview – Gravesville 69-kV circuit overloads for various contingencies. The ratings of this circuit were reduced in 2010 as a result of a Line Rating Study conducted by ATC. The result of this study was to develop a small Asset Renewal project to increase the conductor clearances to restore circuit ratings to an acceptable level. This project was completed in April 2011, thus the limitation can now be considered addressed.

There is an impending overload of the Manrap – Custer 69-kV circuit under single contingency conditions. A current project to address off-peak periods with certain generation patterns is currently proposed for a 2022 in-service date. This project may also address the Manrap – Custer loading issue. See Zone 4 – 2026 study results section for additional details of this project. Additional study of this impending overload will be needed to determine what mitigation measures are available or what potential reinforcements may be needed.

The proposed long-term solutions for northern Door County include implementing reinforcements in two phases. The first phase included implementing the Canal – Dunn Road 138 kV project with a planned in-service date of June 2012. The first phase is assumed complete in the base case model. The second phase includes adding a second 69-kV line between the Dunn Road and Egg Harbor substations. This is a provisional project pending the Best Value Planning process to determine how best to support maintenance outages, voltages and radial loads served by the Egg Harbor and Sister Bay substations.

Point Beach generation upgrades
NextEra has submitted requests to the MISO to increase the output of both of their generation units at the Point Beach Nuclear Plant (MISO queue positions G833, G834, J022 & J023). ATC completed the reliability assessment of the proposed changes in October 2009. This assessment is performed to ensure that the generators can be operated without stability limitations and the output of the generators can be delivered to the MISO market reliably. This assessment showed that the additional output from these generating units will result in overloads and system instability if the transmission system in this area is not reinforced.

The proposed reinforcements identified by the reliability assessment include the following transmission projects:

- Construct a new 345-kV switching station (tentatively named Birch River) near the northern intersection of the Point Beach – Sheboygan Energy Center 345-kV circuit and the Forest Junction – Howards Grove 138-kV circuit,
- Construct a new 345/138-kV substation (tentatively named Barnhart) near the intersection of the Edgewater – South Fond du Lac 345-kV circuit and the Howards Grove – Holland 138-kV circuit,
- Convert the existing double circuit line (345-kV and 138-kV) between Forest Junction and the new Birch River Switching Station and between the new Birch River and Barnhart substations to double circuit 345-kV lines, and
- To keep the existing Plymouth and Howards Grove substations networked, a new 138-kV line is proposed between the new Barnhart and Erdman substations, including looping into the Plymouth and Howards Grove substations.

The scope of work described above is subject to approval by the Public Service Commission of Wisconsin and ATC is currently targeting a CPCN application submittal date of October 2012 for this project.

The scheduled in-service dates for the generator changes are spring 2011 for unit 2 and fall 2011 for unit 1 with a projected in-service date for the new 345-kV facilities described above of June 2018. Based on the in-service date difference between the proposed generator changes and the proposed 345-kV transmission line and substations, 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 345-kV projects. The interim generator interconnection studies identified the following projects that will allow the generator to operate during this interim period under certain operating limitations and restrictions. These interim projects have all been completed and put in-service. Full generator operation, without restrictions, will not be allowed until all required 345-kV facilities are placed in service:

- Replacement of 345-kV terminal equipment at the North Appleton Substation,
- Replacement of system protection equipment on various 345-kV transmission lines at the Point Beach Substation,
- Improvements to the line conductor rating for two 345-kV transmission circuits, and
- Reconfiguration of the Kewaunee 345/138-kV Substation.(complete)

No performance limits were exceeded for Category A conditions for all 2021 analysis except the high voltage at the Kewaunee 138-kV bus in the 2021 minimum load model. The Kewaunee high voltage issue can be addressed by adjusting generation in the area.

The lead times necessary to implement the corrective plans that are scheduled for 2017 through 2021 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the longer term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- New Dunn Road – Egg Harbor 69-kV line: Past 10-Year Assessments have found reliability issues in northern Door County. These issues did not appear in the 2011 10-Year Assessment. This proposed project was retained for now until it can be determined in future 10-Year Assessments that these issues truly no longer exist.

Zone 4 – 2026 study results

Refer to Table ZS-4 and Figure ZS-17

Summary of key findings

- Zone 4 is an active study area for potential wind generation additions,
- Additional reinforcements may be needed in the Kewaunee, Manitowoc and eastern Calumet County areas due to potential increases in generation, and
- The load forecasts have resulted in the deferral or absence of system performance issues identified in prior 10-Year Assessments.

A project for replacing the two existing Glenview 138/69-kV transformers in past Assessments has been delayed from 2020 and is now scheduled for 2025. It would address the potential overload of the transformers under single contingency conditions. The transformer overloads are primarily due to the potential for higher load demand of a local industrial customer. This project may be able to be deferred several additional years by transferring load from the Glenview 69-kV bus to the 138-kV buses, depending upon the customer's load cycle.

A provisional project to address the potential overload of the two existing Sunset Point 138/69-kV transformers has a current in-service date of 2024. The prior in-service date was driven by potential economic benefits to replacing the transformers, but updated economic benefits screening has shown that the project cost is now likely to exceed the projects economic benefits.

The Manrap – Custer 69-kV circuit continues to overload and the magnitude of the overload continues to increase in the 2026 summer peak models. A provisional project for a new Shoto – Custer 138-kV line could help address this overload as well as the potential heavy flows on the Shoto – Mirro – Northeast – Revere 69-kV line or the Shoto 138/69-kV transformer. These loading issues occur under single contingency conditions during non-peak periods with certain generation patterns. The project includes constructing a new Shoto – Custer 138-kV line and installing a new 138/69-kV transformer at Custer Substation. This project is currently scheduled for a 2022 in-service date based upon updated load and generation assumptions utilized in the studies. The in-service date as well as the scope of the project may need to be adjusted once a more detailed study is completed.

A new limitation to the 2026 analysis is the Glenview – Gravesville 69-kV circuit overloads for various contingencies. The ratings of this circuit were reduced in 2010 as a result of a Line Rating Study conducted by ATC. The result of this study was to develop a small Asset Renewal project to increase the conductor clearances to restore circuit ratings to an acceptable level. This project was completed in April 2011, thus the limitation can now be considered addressed.

No performance limits were exceeded for Category A conditions for all 2026 analysis.

Prior assessments have shown the need for potential transmission reinforcements in the Sheboygan, Kewaunee, and Green Bay areas. Although system needs in the 2026 timeframe have diminished with the load forecasts used in the 2011 10-Year Assessment, it is desirable to keep the discussion below in mind in case the system needs re-emerge in the next Assessment. The reinforcements listed below are based upon preliminary analysis to address system issues under single-contingency conditions. Further adjustments will be made to reflect system needs as well as in-service dates in future 10-Year Assessments.

Potential future reinforcements are:

- Uprating the Edgewater – Washington Ave. 69-kV line may be needed in the timeframe just beyond 2026 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 timeframe beyond the current planning horizon to boost voltages along the East Krok – Beardsley Street – Barnett 69-kV line under single-contingency conditions, and
- Depending on the load forecasted in downtown Green Bay, additional transmission reinforcements such as rebuilding the older sections of the existing Oak Street –

Ashland 69-kV line may be needed in the timeframe beyond the current planning horizon to address line overloads under single-contingency conditions.

- Increasing the rating of the Kewaunee – East Krok 138-kV line may be needed to address line overloads under certain transmission outages and generation patterns,

Assessment of Steady State Compliance with NERC Standards

The mitigation plans comprised of planned, proposed and provisional projects identified for Zone 4 in this Assessment will allow the ATC system in Zone 4 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2011-2015, and for the 2016-2020 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

Historical and Projected Population

The population of the counties in Zone 5 grew at an annual rate of 0.5% from 2001 to 2010. The highest growth rate occurred in Washington County (1.2%), while the largest increase in population occurred in Waukesha County, which increased about 22,900 people over the period.

Population in Zone 5 is projected to grow at 0.5% annually for the 2011 through 2020 period. Waukesha County is projected to realize the largest increase in population of 43,500, while Washington County is projected to have the highest growth rate (1.5%).

Historical and Projected Employment

During the same period, the annual employment growth rate declined slightly. The highest growth rate was in Washington County of 0.5% and the highest increase in employment of 3,000.

Employment in Zone 5 is projected to grow at 0.8% annually between 2011 and 2020. Waukesha County is projected to realize the largest increase in employment of 30,400, while Washington County the highest growth rate (1.2%).

Employment			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 5	-0.3	Zone 5	0.8
Washington, WI	0.5	Washington, WI	1.2
Total Increase			
	2001-2010		2011-2020
Zone 5	-29,618	Zone 5	89,609
Washington, WI	3,043	Waukesha, WI	30,458

Population			
Annual Growth Rate			
	2001-2010		2011-2020
Zone 5	0.5	Zone 5	0.5
Washington, WI	1.2	Washington, WI	1.5
Total Increase			
	2001-2010		2011-2020
Zone 5	81,496	Zone 5	90,138
Waukesha, WI	22,973	Waukesha, WI	43,549

Zone 5 environmental considerations

Zone 5 encompasses the southeastern portion of the state and is the most densely populated planning zone. 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 2012, 2016, 2021 and 2026 are shown in Table ZS-11. The table also shows existing generation, proposed generation based on projected in-service year, and resultant capacity margins (with and without the proposed generation).

The table shows that load in Zone 5 is projected to grow at roughly 1.25 percent annually from 2012 through 2021. Comparing load with generation (at maximum output) within the zone indicates that Zone 5 has more 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,
- A significant 138-kV network in the Milwaukee area, a portion of which is underground,
- Heavy flows on aging facilities, and
- Heavy market flows from and to the south, resulting in high 345-kV and 138-kV line loadings and the need to monitor potential multiple contingency conditions.
- Several provisional projects in past 10-Year Assessments found low voltage and thermal overload issues which did not appear in the 2011 Assessment. The provisional project in-service dates were retained for now until it can be determined in future assessments that these voltage and thermal issues no longer exist.

Apart from the analysis performed in this Assessment, there is one major area event that could impact transmission plans in Zone 5. The proposed road rebuild of the Zoo interchange is moving forward with the following in-service dates:

- Expand/update Watertown Plank area (2013),
- Expand/update Highway 100/Highway 45 area (2014), and
- Expand/update remainder of freeway (2015-2018).

The analyses of this road relocation project will likely result in new projects to reconfigure the transmission system around Bluemound and 96th Street substations. Further projects may develop depending on the Department of Transportation's plans to rebuild the interchange. Studies are ongoing and plans will be finalized in the 2011-2012 timeframe.

Zone 5 – 2012 study results

Refer to Table ZS-1 and Figure ZS-17

Summary of key findings

- Some of the line loading and low voltage issues in Zone 5 occur as a result of opening substation bus tie breakers; the remedy is to adjust local generation within applicable timeframes.
- Outages of one of the Arcadian – Waukesha 138-kV lines can cause high flows on the other line.

Circuit breaker outages at Pleasant Prairie and Oak Creek can cause transformers at Bain and Oak Creek to exceed their summer emergency ratings. Loading relief can be achieved by backing down local area generation, keeping facilities within applicable ratings.

An outage of either one of the Arcadian–Waukesha 138-kV lines (KK9962 and KK9942) results in the other Arcadian–Waukesha 138-kV line approaching their summer emergency ratings. Re-dispatching local area generation will provide interim relief.

Two 138-kV buses in southeastern Wisconsin indicate marginal bus voltage under single contingency conditions during the summer peak period. The 138-kV buses experiencing marginal bus voltages are Maple and Germantown Substations. Neither bus drops below 90 percent under contingency. ATC Planning Criteria calls for maintaining bus voltages at 90 percent or higher under intact system conditions.

No performance limits were exceeded for Category A conditions for all 2012 analysis except the high voltage on the 138-kV buses found in the Racine, Kenosha and Oak Creek area in the 2012 minimum load model. This issue can be addressed by re-dispatching area generation.

Zone 5 – 2016 study results

Refer to Table ZS-2 and Figure ZS-18

Summary of key findings

- Potential thermal limitations indicate the need for facility upgrades in the Waukesha area,
- Distribution load serving issues will be addressed by the construction of the Milwaukee County interconnection project,
- There are likely to be impacts related to the road interchange reconstruction project near the Milwaukee County Zoo that will generate transmission system projects in the next few years, and
- Load serving issues in Kenosha County and along the ATC/Commonwealth Edison interface will be resolved with a 345-kV line between Pleasant Prairie and Zion Energy Center.

In response to a customer request for a new distribution interconnection, two radial 138-kV transmission lines will be placed in service in 2015 to serve the new Milwaukee County Substation.

Studies are ongoing to determine potential transmission system impacts related to the expansion of the road interchange near the Milwaukee County Zoo. ATC is meeting with the Department of Transportation and We Energies to determine impacts and coordination issues related to those impacts. The current plan for expansion of the interchange area is as follows:

- Expand/update Watertown Plank area (2013),
- Expand/update Highway 100/Highway 45 area (2014), and
- Expand/update remainder of freeway (2015-2018).

Preliminary results indicate that as a result of this road relocation project, the transmission system around the Zoo Interchange could require reconfiguration in the 2013 timeframe. If there are additional transmission impacts as a result of this road expansion, projects will be developed as needed and reported in future Assessments.

Following are the results of the 2016 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Circuit breaker outages at Pleasant Prairie continue to cause the transformer at Bain to exceed its summer emergency rating. Temporary load relief can be achieved by backing down local generation. The proposed 345-kV bus reconfiguration at Pleasant Prairie in 2013 will resolve the issue at that substation.

Circuit breaker outages at Oak Creek continue to cause the transformer at Oak Creek to exceed its summer emergency rating. In the 2016 90% E-W bias case, a Granville 345-kV bus outage causes thermal overloads on the 345/138-kV transformer. Thermal relief in these areas can be achieved by backing down local generation.

As was discussed in the 2012 results discussion, an outage of either Arcadian – Waukesha 138-kV line continues to create thermal overload issues in the area. A project to rebuild the Arcadian – Waukesha 138-kV lines will address these issues and is proposed for 2016.

An outage of the Arcadian 345/138-kV transformer #1 causes the other area transformer to approach its summer emergency rating. Project development is underway to replace the existing Arcadian transformers with one or two 500 MVA transformers. Other alternatives are also being considered. Re-dispatching local generation will provide interim relief.

Past 10-Year Assessment found low voltages issues under contingency conditions in the Oak Creek/Bluemound area. Those issues did not appear in the 2011 10-Year Assessment. The previous solution was to install three 75 MVAR capacitor banks at the Bluemound Substation in 2014. This provisional project was retained and delayed one year to 2015 until it can be determined in future 10-Year Assessments that these voltage issues truly no longer exist.

The Bain – Kenosha, Kenosha – Lakeview, and Lakeview – Zion 138-kV lines exceed their summer emergency ratings for certain outages. In addition, the Pleasant Prairie – Zion 345-kV line approaches its summer emergency rating for certain outages. A project to construct a six mile, 345-kV line between Pleasant Prairie and the Zion Energy Center scheduled for 2014 will address these issues. For more information, please refer to Economics.

The Albers – Kenosha 138-kV line exceeds its summer emergency rating for certain outages. Further study is needed to determine the best solution to this issue. Temporary loading relief can be achieved by re-dispatching area generation.

The Harbor – Kansas and Oak Creek – Ramsey 138-kV lines overload under contingency in off-peak scenarios. Further study is needed to determine the best solution to these issues. Temporary loading relief can be achieved by backing down local generation.

No performance limits were exceeded for Category A conditions for all 2016 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2012 through 2016 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the near term planning horizon have an “In-service date” that matches the “Need date”, except the following projects:

Projects whose “Need date” precedes the “In-service date”

- None

Projects whose “In-service date” precedes the “Need date”

- Bluemound capacitor banks as described above.

Zone 5 – 2021 study results

Refer to Table ZS-3 and Figure ZS-19

Summary of key findings

- Load growth in Waukesha and Washington counties will require voltage and thermal reinforcements. Local generation adjustment is an interim solution, and
- Voltage and thermal issues remain in Zone 5 under contingency conditions.

Following are the results of the 2021 contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Low probability circuit breaker outages at Oak Creek continue to be a chronic issue. Relief can be provided by reducing the output of area generation.

Certain outages will result in the Albers–Kenosha 138-kV line loading to exceed its summer emergency rating. Re-dispatching local generation will provide relief.

Two 138-kV buses in southeastern Wisconsin indicate low bus voltages under single contingency conditions during off peak periods. The 138-kV buses experiencing marginal bus voltages are Maple and Germantown Substations. Re-dispatching area generation will provide relief.

Loading issues on the Arcadian – Waukesha 138-kV lines and Arcadian transformers under contingency conditions worsen when compared to 2016. Rebuilding the lines with higher capacity conductors and replacing the two smaller transformers at Arcadian are potential solutions. Running local generation provides additional relief.

Loading on the Pleasant Prairie – Zion 345-kV line exceeds its summer emergency rating under contingency conditions. The Kenosha – Lakeview, Lakeview – Zion and Arcadian – Zion 138-kV lines exceed their summer emergency ratings under certain outage conditions. The new Pleasant Prairie – Zion Energy Center (2014) 345-kV line as described in the Zone 5 - 2016 analysis and our Economics section will resolve these issues.

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 could be considered. Such a line would improve the voltage profile in Jefferson, Waukesha and Washington counties, reduce loading on parallel 138-kV circuits, reduce system losses, and 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.

As part of our 2021 analyses, we performed a screen to determine the potential impact upon the transmission system given the long lead-time outage of Oak Creek 345/230-kV transformer T884. The results of this screen indicate a potential overload of the Oak Creek – Bluemound 230-kV line under this scenario plus the next contingency. Further study is needed, but a provisional project to uprate the Oak Creek – Bluemound 230-kV line 873 could address this issue.

A provisional project to uprate the Oak Creek-Pennsylvania 138-kV line is being considered in the 2021 timeframe in order to address remaining voltage and thermal issues.

No performance limits were exceeded for Category A conditions for all 2021 analysis.

The lead times necessary to implement the corrective plans that are scheduled for 2017 through 2021 were considered and taken into account prior to assigning an in-service date for each associated project. All of the projects scheduled for the longer term planning horizon have an "In-service date" that matches the "Need date", except the following projects:

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

- None

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

- Replace two existing 345/138-kV transformers at Arcadian Substation with 1-500 MVA transformer.

Zone 5 – 2026 study results

Refer to Table ZS-4 and Figure ZS-20

Summary of key findings

- Heavy load growth in Waukesha and Washington 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,
- The Oak Creek-Pennsylvania 138-kV line uprate in-service date was determined considering not only the need date identified in the 2011 10-Year Assessment, but also the need dates identified in both the 2010 and 2009 Assessments. Therefore, the 2011 in-service date precedes the 2011 Assessment need date as described below, and
- Voltage and thermal issues remain in Zone 5 under contingency conditions.

The Brookdale East 138-kV bus, Allerton 138-kV bus and Bluemound 230-kV buses experience marginal bus voltage under NERC Category A or TPL-001-0 conditions (intact system) in 2026.

Following are the results of the 2026 steady state contingency analysis (NERC Category B or TPL-002-0 conditions) performed on Zone 5.

Contingency results were similar to those seen in 2021. The only new finding is the marginal voltage at Pennsylvania in for the outage of Oak Creek – Pennsylvania 138-kV line. The Pennsylvania 138-kV bus does not drop below 90 percent under contingency, so no mitigation is needed in this timeframe. ATC Planning Criteria calls for maintaining bus voltages at 90 percent or higher under intact system conditions.

Past 10-Year Assessments found thermal overload issues under single contingency conditions for the existing Oak Creek – Pennsylvania 138-kV line. This issue did not appear in the 2011 10-Year Assessment. The past solution was to uprate the Oak Creek – Pennsylvania 138-kV line in 2021. This provisional project in-service date was retained for now until it can be determined in future Assessments that these thermal issues truly no longer exist.

In the 2021 results section, a potential Rockdale–Mill Road 345-kV line was discussed as a way to improve bus voltages in Waukesha, Washington, and Jefferson Counties. Through 2019, our planning models indicate there is generation available that could provide support to the three county region. At some point between 2019 and 2024, all of the available generation will be dispatched. Dispatching local generation 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.

A Rockdale – Mill Road 345-kV line could consist of the following components:

- 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.

No performance limits were exceeded for Category A conditions for all 2026 analysis.

Assessment of Steady State Compliance with NERC Standards

The mitigation plans comprised of planned, proposed and provisional projects identified for Zone 5 in this Assessment will allow the ATC system in Zone 5 to meet the steady state portions of NERC standards TPL-001 and TPL-002 in each of the five years 2012-2016, and for the 2016-2021 planning horizon.

Reactive power analysis
Appropriate availability of reactive power is necessary to keep a transmission system operating robustly. Much of the reactive power on our system is provided by generators that are interconnected with ATC. Our computer load flow models list a minimum and maximum reactive power 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 reactive power 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 2011 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 Multiple Outage Analysis

This section only discusses the steady state multiple outage analysis. The dynamic analysis of multiple outage contingencies is covered in the Stability Analysis Section.

On a five year rolling schedule, ATC performs a comprehensive evaluation of each appropriate NERC Category C and D outage types. The comprehensive review of the each outage type is spread out over the five year schedule to levelize the resources needed for the analysis. For each outage type in the remaining four years, ATC carries forward the list of outages defined as severe. NERC has defined Category C as selected multiple element outages that the system should not have wide spread cascading or go unstable. NERC has defined Category D as several types of more severe outage combinations. The following subsections summarize ATC's Category C and D multiple outage process and results.

NERC Category C

There are 9 Category C outage types. In 2010 ATC reviewed its process for analyzing Category C outage types and enhanced it for 2011. See Figure MO-1 for 2011 and succeeding 4 years schedule ATC expects to follow to analyze appropriate Category C outages.

For years prior to 2011, ATC Category C process is identified below.

As part of ATC's continuing effort to comply with NERC standards for multiple outage impacts on ATC's transmission system, an initial system wide screening was performed by Commonwealth Associates (CAI) in 2004. ATC enhanced its Category C contingency Analysis in succeeding years. For succeeding years,the Category C analysis includes the assessment of the selected potentially severe multiple outages identified from previous multiple outage studies. In addition, ATC performs a comprehensive multiple outage analysis for at least one of our five planning zones with an objective of revisiting each zone at least once every five years. Also for each of these prior years ATC performed a comprehensive Category C screening of the entire ATC 345-kV system plus all 100-kV and above tie lines to the neighboring transmission networks. More details about recent past years of analysis are provided below.

In 2008, we analyzed the potentially severe multiple outage lists from prior study years. Additional Category C events were evaluated by a comprehensive screening of Zone 5 facilities(100-kV and above) and a combination of all ATC 345-kV facilities (including ATC 345/138-kV transformers) and generators (100 MW and above).

In 2009, we analyzed the potentially severe multiple outage lists from prior study years. Additional Category C events were evaluated by a comprehensive screening of Zone 1 facilities that included all 100-kV and above branches within Zone 1 and all 100-kV and above ties to Zone 1. This analysis also included a comprehensive screening of the entire ATC 345-kV system (including transformers with a 345 kV high-side), all 100-kV and above connected generators within the ATC transmission system and all 100-kV and above tie lines to our neighboring transmission networks. In addition, a comprehensive screening of NERC Category C.1 (bus section) and C.2 (breaker failure) events across the entire ATC transmission system were evaluated for all facilities 100-kV and above.

In 2010, we analyzed the potentially severe multiple outage lists from prior study years. Additional Category C events were evaluated by a comprehensive screening of Zone 2 and Zone 4 facilities that included all 100-kV and above branches within Zone 2 and Zone 4, all 100-kV and above ties to Zone 2 and Zone 4 and all 100-kV and above connected generators within Zone 2 and Zone 4. This analysis also included a comprehensive screening of the entire ATC 345-kV system (including transformers with a 345 kV high-side), all 100-kV and above connected generators within the ATC transmission system and all 100-kV and above tie lines to our neighboring transmission networks. In last half of 2010, we performed a comprehensive C.9 analysis.

For 2011, we analyzed the potentially severe multiple outage lists from prior study years. Additional Category C events were evaluated by a comprehensive screening of Zone 3 facilities that included all 100-kV and above branches within Zone 3, all 100-kV and above ties to Zone 3 and all 100-kV and above connected generators within Zone 3. This analysis also included a comprehensive screening of the entire ATC 345-kV system (including transformers with a 345 kV high-side), all 100-kV and above connected generators within the ATC transmission system and all 100-kV and above tie lines to our neighboring transmission networks.

In the 2011 analysis, ATC used the 2016 and 2021 all projects summer peak (100% of peak load) and off peak (70% of peak load) models with all ATC generators reactive power capability reduced to 95% of the maximum capability. Models with generators at 95% reactive power were used because of the ATC multiple outage planning criteria which states that the post contingency voltage thresholds should be met with the net generator reactive power limited to 95% of the applicable reactive power capability. Physical Operational Margin (POM) – Optimal Mitigation Measures (OPM) software was used to identify potential, large load shed or generation re-dispatch requirements. Table 1-1 below contains a summary of the NERC Category C types of outages that were performed for the 2011 TYA.

Table 1-1: Summary of the NERC Category C Outages Types

<table>
<tr><th rowspan="2">ATC System Studies</th><th colspan="4">2016 & 2021 Summer Peak</th><th colspan="4">2016 & 2021 70% Summer Peak</th></tr>
<tr><th>C1 & C2</th><th>C3</th><th>C5</th><th>C6 - C9</th><th>C1 & C2</th><th>C3</th><th>C5</th><th>C6 - C9</th></tr>
<tr><td>Zone 1</td><td rowspan="6">Severe List</td><td rowspan="2">Severe List</td><td rowspan="2">Severe List</td><td rowspan="6">See Notes 1 & 2</td><td rowspan="6">Severe List</td><td rowspan="2">Severe List</td><td rowspan="6">Not Analyzed (See note 3)</td><td rowspan="6">See Notes 1 & 2</td></tr>
<tr><td>Zone 2</td></tr>
<tr><td>Zone 3</td><td>All</td><td>All</td><td>All</td></tr>
<tr><td>Zone 4</td><td rowspan="2">Severe List</td><td rowspan="2">Severe List</td><td rowspan="2">Severe List</td></tr>
<tr><td>Zone 5</td></tr>
<tr><td>ATC 230-kV and above</td><td>All</td><td>All</td><td>All</td></tr>
<tr><td colspan="9">Note 1: For the ATC transmission system - C6 covered by B1, C1 & C2. C7 covered by C1, C2 & C3 without manual system adjustments. C8 covered by C1 and C2.

Note 2: For the ATC transmission system – C9 stuck breaker covered by C2. For the C9 with protection system failure not covered by C1 and C2, they were simulated using 2010 Assessment summer peak models for 2015 and 2020 only.

Note 3: C5 outages were not analyzed for off peak models because off peak models studies were intended to identify constraints under system maintenance conditions (N-1-1). Additionally, the impacts produced by C5 outages at peak load would be more severe than the impacts produced at off peak period.</td></tr>
</table>

ATC enhanced multiple outage screening in 2011 TYA by analyzing all ATC 230-kV and above system elements as compared to 345-kV and above system elements in the previous analyses.

The following contingencies were analyzed for this assessment:

- For the 2016 and 2021 analyses, from the 2010 study, the set of 84 selected severe Category C contingencies.
- All 230-kV branches (including 345/138-kV transformers) and generators connected to ATC Bulk Electric System, including all 100-kV and above ties to the 230-kV and above system.
- ATC's planning Zone 3 100-kV and above, including all 100-kV and above ties to Zone 3 and Zone 3 generators connected to the bulk electric system.

In 2016 summer peak, out of the 133 valid contingencies that caused system constraints, 16 contingencies required 100 MW or greater of load shedding to mitigate in addition to other remedial actions. In 2021 summer peak, out of the 167 valid contingencies that caused system constraints, seven contingencies required 100 MW or greater of load-shedding to mitigate in addition to other remedial actions. For the summer peak studies, ATC estimates that cascading could be ruled out on our modeled 2016 and 2021 summer peak systems through the use of specific load shedding and/or generation redispatch.

Further review will be done by System Planning and System Operations to develop or confirm appropriate and more specific mitigation solutions.

The 2016 and 2021 summer off peak study results show that there are potentially no Category C severe multiple outages in 2016 and 2021 summer off peak periods since none of the outages potentially require 100 MW or greater of load shedding to mitigate.

Considering the summer off peak studies as maintenance outage scenarios (Category B outages under system maintenance), the screening results show that in 2016, out of a total of 62 valid outages that caused system constraints, 11 outages could potentially require load shedding to mitigate. The 2021 off peak model studies show that out of the 43 outages that caused system constraints, 13 outages could potentially require load shedding to mitigate. These outages will be investigated further to confirm the needs and the appropriate mitigation measures. In general, the maintenance outage situation seems to be degrading as time passes. ATC's future studies will identify whether additional mitigation, beyond the 2011 TYA projects, is needed to maintain appropriate maintenance outage conditions.

NERC Category D

ATC assessed its transmission system for the conditions of Category D in Table 1 of the NERC TPL-004-0 Reliability Standard in 2011 for the near-term (2012 to 2016) horizon. ATC has performed Category D assessments annually since its inception in 2001 using a variety of current year and past year studies and simulations to address Category D outage types in Table 1. The most recent steady state studies and simulations are no more than five years old. On a rolling five year cycle, the Category D studies and simulations covers some aspect of every year in the near-term planning horizon. To meet the requirements regarding Critical Energy Infrastructure Information (CEII) the detailed results of these analyses are only available to signatories of CEII agreements.

We performed steady state Category D analyses for a range of conditions and study years. Over the past 5 years, we performed multiple generation interconnection studies using various models for the planned in-service years for Category D1 through D5 contingencies. Also in the past, MISO has performed studies for shoulder model conditions for selected Category D2, D3, and D4 contingencies [MTEP08, MTEP09, & MTEP10] using the five year future model. In 2010, we performed analyses that used the summer peak, all-project models for the study years of 2015 and 2020 for Category D6 through D10 contingencies.

For Category D11, ATC understands "a large load or major load center" to be either a single 100 kV and above end-use customer interconnected at one substation with 300 MW or more load (i.e. "a large load") or a 100 kV and above interconnected distribution substation serving 300 MW or more of load (i.e. "major load center"), which is consistent with the load at risk threshold of CIP-002 requirement 1.2.5. ATC does not have any single end-use customers or interconnected distribution substations that meet these thresholds. Therefore, no Category D11 analysis is required.

For SPS studies (Category D12 and D13) in accordance with the MRO and RFC procedures for implementing PRC-012 and PRC-014, ATC performs an assessment of each Special Protection System for review by the applicable Regional Entity. These reviews include an assessment of the BES performance without the Special Protection System installed, which replicates a D12 contingency. These reviews also include an assessment of the BES performance for the inadvertent operation of the Special Protection System, which replicates a D13 contingency.

For Category D14, both MRO and RFC have performed analysis of severe power system disturbances for actual system events (e.g., August 2003 initiating event in RFC and September 2008 initiating event in MRO). These analyses have not identified a significant impact on the ATC system under these severe disturbances. Therefore, severe power swings or oscillations in another Regional Entity beyond the MRO and RFC will have an even less significant impact on the ATC system.

The Category D analyses are performed using system models that were drawn from the latest MMWG series of power system models that are available in the year prior to the year that the analyses were performed. Each of the MMWG models has all of the projected firm transfers for the applicable years described in the Methodology and Assumptions Section.

The Category D analyses were performed using the latest all-projects models, which include all of the existing and planned projects for the applicable power system model year as described in the All Projects Model Analysis Section.

The Category D analyses included Reactive Power resources to ensure that adequate reactive resources are available to meet system performance. We considered the static and dynamic reactive resources that were expected to be available in the years that were studied. In general, some margin of reactive resource capability was considered by modeling generator var output at reduced levels. We screened for voltage stability in the Category D contingencies, as noted in the Voltage Stability Section.

We included the effects of existing and planned protection systems in the Category D analyses by simulating event based outages. The Methodology and Assumptions Section discusses the inclusion of all existing and planned protection systems that would be applicable to the assessments. Previous year assessments can also be viewed to see that these assumptions were used to build models that have been used in ATC Category D analysis. Dynamic studies in particular simulate protection scheme operating times, associated breaker clearing times, and back up device tripping functionality.

We included all existing and planned transmission control devices in our current and past studies and simulations. As in prior 10-Year Assessments, the Methodology and Assumptions Section explains the inclusion of all control devices that would be applicable to this assessment. These control devices included, but are not limited to: transformer automatic tap changers, phase shifters, automatic reactive compensation devices, and DVAR units.

We considered any planned facility outages in our current and past studies and simulations. A planned facility outage is a scheduled facility outage that ATC knows of soon enough to include in its planning horizon models. ATC was not aware of any specific facility outages scheduled for the planning horizon at the demand levels that were studied. As the future unfolds and facility outages are scheduled, they are scheduled for conditions that provide acceptable reliability. For short term (next 6 months) outage planning, ATC performs planned outage analysis for the appropriate demand levels.

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 ATC's criteria for assessing system stability.

Reviewing compliance with NERC Standards and ATC stability criteria is a continuous process with ATC adding to its library of studies each year. There are three components to consider in assessing system stability; Angular stability of the system (often referred to as generator stability), Voltage stability and Small signal stability. Our approach to assessing all of the system stability components is described below.

Generator Stability

For each 10-Year Assessment, generator stability is assessed at selected major generator stations connected to the ATC system based on generator, exciter, power system stabilizer and governor equipment changes plus any associated system topology changes. Numerous generator interconnection studies add to our knowledge of the ATC system stability response to select NERC Category B, C, and D contingencies.

In the 2011 10-Year Assessment, we have reviewed 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 usually above 100 kV are selected to assess system angular stability.

The methodology used in assessing the major generator stations includes:

1. A review to determine that no significant system topological changes have occurred near the generator stations other than local load growth.
2. A review of the parameter values and the model types used in representing the dynamic response of units at the generator stations in system angular stability simulations to determine that no significant changes have occurred.
3. A review of the date of the last stability study conducted for each of the major generator stations to determine that the elapsed time does not exceed 5 years.

Considering the number of existing major generator stations shown in Table ZS-7 - ATC System Angular Stability Assessment, this requires that at least 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 rotation.

If any portion of these criteria is confirmed, the generator stability results of existing studies are reviewed and a determination is made if past studies are still applicable. If any of these criteria are not met then generator stability is reviewed and/or restudied.

In the 2011 10-Year Assessment the power flow models were compared to the 2010 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 2010 TYA studies. For the 2011 10-Year Assessment, the review identified six (6) generator stations that did not meet the aforementioned criteria and required an evaluation of the generator's stability performance.

The six (6) generator stations identified are: Neevin, Pulliam, Weston, Columbia, Christiana and Sheboygan Energy Center. These stations are shown high-lighted in Table ZS-7 - ATC System Angular Stability Assessment.

The Neevin, Pulliam, Weston, Columbia, Christiana and Sheboygan Energy Center plant selection was based primarily on the fact that they were approaching the 5-year time criteria. Sheboygan Energy Center is the only facility in the list that has had recent study work done in the local area which is used to determine what additional supporting analysis is needed to ensure full compliance with reliability standards. Minor changes in governor dynamics data was identified for Pulliam, Columbia and Weston that has no impact on performance. No major topology changes were identified for the ATC system that will impact the evaluation of the BES generation.

These six major generator stations were evaluated as part of the system angular stability analysis with the ATC stability criteria applied. Table ZS-15 provides a summary of the NERC category contingency types assessed for this generator stability analysis.

In summary, Neevin, Pulliam, Weston, Sheboygan Energy Center, Christiana and Columbia generating facilities were able to meet all of applicable NERC TPL-001 through TPL-003 reliability standards for the Bulk Electric System (BES) and the ATC Planning Criteria for the ATC Transmission System.

Stability issues associated with NERC category D4 contingencies were identified for Neevin, Pulliam and Christiana facilities and issues associated with NERC Category D2, and/or D3 were identified for Christiana and Columbia facilities. These issues are summarized in the following paragraphs with inclusion of potential mitigation options discussed for those instances where the ATC stability criteria were not met.

Table ZS-15:
Summary NERC Category Contingency Assessment for Angular Stability Analysis

NERC Contingency Category	Generator Stations Studied [i, ii]					
	Neevin	Pulliam	Weston	Sheboygan Energy Center	Christiana	Columbia
A	(1), a	(1), a	(1), a	(1), a	(1), a	(1), a
B1	b	b	b	b,g	b	b
B2	(2)	(2)	c	g	(2)	(3)
B3	d	d	c	g	(1)	(1)
B4	e	e	e	e	e	e
C1	c	c	c	g	c	c
C2	c	(3)	c	g	c	c
C3	(2)	c	(4)	g	(4)	(4)
C4	e	e	e	e	e	e
C5	(1)	(2)	(4)	g	(1)	(2)
C6	b	b	b	b,g	b	b
C7	d	d	(2)	g	(1)	(2)
C8	(6)	(15)	(9)	g	(8)	(5)
C9	(2)	(4)	(2)	(1)	c	(2)
D1	b	b	b	b,g	b	b
D2	(4)	(11)	(9)	g	(9)	(5)
D3	d	d	(2)	g	(3)	(2)
D4	(2)	(3)	c	g	(2)	c
D5	c	c	c	g	c	c
D6	f	f	f	f	f	f
D7	f	f	f	f	f	f
D8	f	f	f	f	f	f
D9	f	f	f	f	f	f
D10	f	f	f	f	f	f
D11	f	f	f	f	f	f
D12	f	f	f	f	f	f
D13	f	f	f	f	f	f
D14	f	f	f	f	f	f

Notes:

i. Number enclosed within parenthesis indicates number of contingencies studied for each NERC category.

ii. Lower case letters provide the following explanations/comments regarding consideration of applicability of the NERC category contingency:
   a. Intact system 20 second simulation.
   b. Loss of generation will result in a more stable system and is less severe than other contingencies considered.
   c. Contingency not as severe as other contingency types in category.
   d. No contingencies were evaluated because no bulk electric system transformers are located in the study area.
   e. Not applicable since there are no DC lines in ATC system under study.
   f. Not applicable for generator stations under study.

Both the Neevin facility and the Pulliam facility met all applicable NERC and ATC performance requirements. For each generating facility, a single NERC TPL-004 contingency caused these units to lose synchronism with the transmission system. However, this contingency type is beyond ATC's performance criteria and TPL-004 does not require a system improvement for this condition.

Christiana facility met all applicable NERC performance requirements and did not meet ATC's performance requirements for twelve (12) TPL-004 contingencies. TPL-004 does not require a system improvement for these conditions but ATC's Planning Criteria will require system improvements. ATC's Planning Criteria recognizes that portions of ATC's footprint were not originally designed to meet the more stringent criteria adopted at ATC's formation. For these particular contingencies, new relay settings will be issued, which will result in the Christiana facility meeting ATC's performance requirements. For this generating facility, two (2) other NERC TPL-004 contingencies caused these units to lose synchronism with the transmission system. However, these contingency types are beyond ATC's performance criteria and TPL-004 does not require a system improvement for this condition.

Columbia facility met all applicable NERC performance requirements and did not ATC's performance requirements for two (2) TPL-004 contingencies. TPL-004 does not require a system improvement for these conditions but ATC's Planning Criteria will require system improvements. ATC's Planning Criteria recognizes that portions of ATC's footprint were not originally designed to meet the more stringent criteria adopted at ATC's formation. For these particular contingencies, new relay settings will be issued, which will result in the Columbia facility meeting ATC's performance requirements.

Both the Sheboygan Energy Center facility and the Weston facility met all applicable NERC and ATC performance requirements.

As shown in <u>Table ZS-7 - ATC System Angular Stability Assessment</u>, all assessed generators in the ATC area meet the applicable NERC TPL-001 through TPL-003 criteria and will meet ATC's Planning Criteria through proposed improvements that will be implemented by ATC.

Voltage Stability

ATC uses steady-state analysis to assess voltage stability throughout the ATC system. Low voltages or non-convergent simulations during single and multiple contingency events under both near and longer term horizons indicate where there may be voltage stability concerns. Additionally, each angular stability study performed by ATC screens the system for voltage stability issues through the application of the ATC voltage recovery criteria described in ATC's Planning Criteria. If steady state or dynamic analyses identifies areas of weakness indicative of voltage instability, further examination of system characteristics and, possibly, more detailed analysis will be performed. This more detailed analysis may include replacement of lumped load modeling with more specific modeling of the distribution system and its loads.

The Rhinelander area of Zone 1 (the 115-kV network between the southern substations of Pine and Aurora Street and the northern substation of Cranberry) was studied in 2010 and 2011 through a detailed dynamic analysis to evaluate the continued need for the superconducting D-SMES units in the area after recent system improvements. These improvements included adding a Cranberry-Lakota Road 115 kV line, rebuilding the Lakota Road-Plains 69 kV path to 138 kV, and adding 138/115 kV and 138/69 kV transformers at Lakota Road. After examining voltage stability for more than 150 events under NERC Categories A, B, C and D for system peak load conditions it was determined that system performance requirements were met with only the dynamic reactive power capability of the D-SMES in operation. This allowed ATC to de-energize the superconducting magnetic energy storage component of the D-SMES units and reconfigure them as D-VAR units which only provide reactive compensation for voltage support.

ATC is performing additional dynamic simulations in 2011 to determine if D-VAR units can be eliminated in conjunction with ATC's planned implementation of under voltage load shedding relays (UVLS), replicating existing distribution level, customer owned under voltage relaying. The UVLS program under evaluation would be installed at a single location in the western part of the Rhinelander area. This location currently serves a single end-use customer who is already using their own under-voltage load shedding relaying to separate their facilities from the network to preserve their internal load and generation. From a transmission standpoint, this action looks like the loss of approximately 24 MW of load although the actual amount will vary based on the electrical output of internal plant generation. The installation of the ATC-owned under-voltage shedding relay would replicate the end-use customer's relay settings and improve system performance for specific maintenance outage conditions combined with certain severe (i.e. TPL-003) contingencies.

Small Signal Stability

In the 2011 10-Year Assessment, ATC performed a small signal stability assessment for ATC transmission system in accordance with the now-retired Midwest Reliability Organization (MRO) standard PRC-502-MRO-01. The main objective of the small signal stability assessment is to ensure that power system stabilizers on generating units are designed, installed and tuned as required to dampen power system oscillations that might occur on the electrical system.

ATC's small signal stability assessment examined local, inter-plant and inter-area modes to ensure that no poorly damped oscillations are observed. The local and inter-plant modes of oscillation are studied as part of ATC's annual 10-Year Assessment and for each generator interconnection study for a proposed generating facility. The resulting performance of the interconnected generation is compared to the rotor angle damping criteria defined in ATC's Planning Criteria, which ensures acceptable system performance.

For the 2011 10-Year Assessment of inter-area modes of oscillations, system simulations were performed for 2011 and 2015 system conditions including light load, shoulder load and peak load levels. Because the ATC system is significantly impacted by the transfer of power from Minnesota to Wisconsin, the analysis included simulation of heavy power flows from the west. In total, 262 NERC TPL-001, 002 and 003 contingencies categories were evaluated for each system scenario.

ATC's small signal stability assessment demonstrated that all local, inter-plant and inter-area modes of oscillation involving generation located within the ATC footprint met PRC-502-MRO-01 and ATC Planning Criteria requirements.

Conclusion

Based on these assessments and numerous other studies, the ATC network meets NERC System Stability Standards.

Fault Duty Evaluation

Every new generator interconnection that either involves the addition of a generator that provides a fault current contribution to the system, or results in system topology changes, is evaluated within the System Impact phase of the interconnection process. This evaluation determines if the addition of the new generator and related facilities will negatively impact the fault current interrupting capabilities of the existing system breakers. If the fault current is at or near the breaker's capability as the result of the new generator interconnection, projects are identified within the System Impact Study to replace these breakers prior to interconnecting the new generator to the transmission system.

Additionally, every year, ATC evaluates the fault duty capabilities at substations in the existing system topology to determine if breakers located at these facilities are at or near the fault current capability. The results of this fault analysis are compared against a database of equipment ratings to help categorize which breakers at ATC facilities will be replaced. For breakers identified as exceeding their fault current capability, projects are initiated in the near term to replace these breakers. Breakers that are within 3% of their fault duty rating are continuously monitored to determine if changes to the ATC system will require replacement in the near term.

For this analysis, a worst case current interruption exposure for each circuit breaker is evaluated with all generation assumed to be on line and the sub transient reactance or equivalent modeled for all generators. Three-phase and phase-to-ground faults are evaluated with zero fault impedance and all network buses and branches in their normal configuration. Fault currents are calculated in accordance with IEEE/ANSI Standard C37.010-1999 using the X/R multiplying factors for each of the facilities. Currents through a breaker are calculated assuming the worst case fault current through a breaker with a disconnect switch on one side of the breaker open and the fault located between the breaker and disconnect switch. For each circuit breaker, the interrupting capability of the circuit breaker must be greater than the worst case fault current interrupting exposure of the circuit breaker. ATC considers a circuit breaker over duty when it reaches a negative margin. Circuit breakers are derated for reclosing duty per the applicable IEEE/ANSI standard.

Previous fault duty analysis revealed four 69 kV breakers at South Fond du Lac substation, and one 138 kV breaker at Tower Drive substation is at their fault interrupting capacity and have been scheduled for replacement by 2011. Additionally, one breaker at Lost Dauphin substation and one breaker at Sherman Street substation are at their fault interrupting capacity and are scheduled for replacement by 2012.

For 2011, a 138 kV breaker at Cornell substation and a second 138 kV breaker at Sherman Street substation are at their fault interrupting capacity and will need to be scheduled for replacement. As new projects are placed in-service analysis is performed to determine if additional breakers are nearing their fault current interrupting capabilities.

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, all project-deficient models are updated to include all planned, proposed and most provisional projects. These new models are called “All Projects” models and are meant to test the combined effect of all solutions during the 10-Year Horizon, specifically in the 2012, 2016 and 2021 study years. As part of the 10-Year Assessment, zone planners perform system intact and required Reliability Standard contingency analyses on each of the “All Projects” models. The contingency analysis includes systematically removing each line, generator, transformer, shunt devices and modeled bus ties individually to determine the effect on the transmission system. The analysis will verify whether the included 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 performed in previous Assessments, this year an attempt was made to address the first two questions. All project models were built for years 2012, 2016 and 2021 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 the 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 2012, 2016 and 2021 summer peak All Projects models, all system overloads and low voltages in Zone 1 have been addressed by planned, proposed, and provisional projects as well as appropriate system adjustments.

Zone 2

With all projects in the 2012, 2016 and 2021 summer peak models, most of the system overloads and low voltages in Zone 2 are addressed, although a few system limitations still exist under single contingency conditions in all three study years. The system issues remaining in the 2012, 2016 and 2021 "All Projects" models are:

- Low voltages at the Mead, Gladstone, North Bluff, and Bay View 69-kV buses are observed under certain contingency conditions in 2012.
  - These limitations will be eliminated once the Chandler 138/69-kV transformer is in service in late 2011. Dispatching local generation will be required to mitigate the constraints until then.
- Thermal overloads exist at the Chandler-Masonville 69-kV line under certain contingency conditions in 2012.
  - These limitations will be eliminated once the Chandler – 18th Road line project is in service in 2014. Dispatching local generation will be required to mitigate the constraints until then.
- Low voltages at the Newberry, Lou Pac, Newberry Hospital, Newberry Village and Roberts 69-kV buses are observed under certain contingency conditions in 2021.
  - Dispatching local generation can mitigate these voltage issues until approximately 2025. Additional analyses will be run to determine any future projects that could address these limitations in the future.

Zone 3

With all projects in the 2012, 2016 and 2021 summer peak and various sensitivity models, most of the system overloads and low voltages in Zone 3 are addressed, although several system problems still exist under system intact or single contingency conditions in 2012, 2016 and 2021. The system issues remaining in the 2012, 2016 and 2021 "All Projects" models are:

- The Pflaum-Royster 69-kV line overloads under certain contingency conditions in the 2012 summer peak model.
  - This limitation will be addressed by a short-term operation procedure including potential load bridging. The transmission solution is to uprate the Fitchburg-Nine Springs and Royster-Pflaum 69-kV lines, move AGA to Femrite-Royster line and install Nine Springs capacitor bank in 2013.
- The Huiskamp 138-kV bus voltage can be lower than 90 percent under certain contingency conditions in both the 2012 summer peak model and the 2016 increased load model.
  - This limitation will be addressed by adjusting the Huiskamp138/69-kV transformer tap settings.

- The Albany, North Monroe, Darlington and Hillman 138-kV bus voltages can be higher than 105 percent under system intact condition in the 2012 minimum load model.
  - This limitation will be addressed by adjusting the North Monroe and Darlington138/69-kV transformer tap settings and turning off South Monroe 69-kV cap banks.
- The Verona, Huiskamp, Albany, North Monroe and Bass Creek 138-kV bus voltages can be higher than 110 percent under certain contingency conditions in the 2012 minimum load model.
  - This limitation will be addressed by adjusting the Verona, Huiskamp, Bass Creek, North Monroe and Darlington138/69-kV transformer tap settings and turning off South Monroe 69-kV cap banks.
- The Verona 138-kV bus voltage can be lower than 90 percent under certain contingency conditions in both the 2016 summer peak model and the 2016 increased load model.
  - Possible mitigation plan is to adjust the Verona 138/69-kV transformer to boost the 138-kV bus as necessary.
- The Huiskamp 138-kV bus voltage can be higher than 110 percent under certain contingency conditions in the 2016 light load model and 2021 minimum load model.
  - This limitation will be addressed by adjusting the Huiskamp138/69-kV transformer tap settings.
- The Royster-Sycamore 69-kV line overloads under certain contingency conditions in the 2016 increased load model.
  - Potential mitigation plan is to uprate the Royster-Sycamore 69-kV line.
- The Verona 138-kV bus voltage can be higher than 110 percent under certain contingency conditions in the 2021 70% shoulder load / 3000 MW import model and the 2021 65% load/West-East bias model.
  - This limitation will be addressed by adjusting the Verona 138/69-kV transformer tap settings.
- East Campus-Walnut 69-kV line overloads under certain contingency conditions in the 2021 90% load/East-West Bias model.
  - The limitation will be addressed by reducing West Campus generation and increasing Blount and Sycamore generation.
- Low 138-kV voltages at Hubbard and Hustisford under certain contingency conditions.
  - These low voltages are mitigated by adjusting the Hubbard 138/69-kV transformer load tap changer setting to boost the 138-kV bus voltage. The proxy transmission solution to this issue is to construct the Hubbard-East Beaver Dam 138-kV line which currently has a 2022 in-service date.

Zone 4
With all appropriate projects included in the 2012, 2016 and 2021 summer peak models, nearly all of the overloads and low voltages within Zone 4 are addressed. System problems still exist under single contingency conditions in the 2021 study year. The system issues remaining in the All Projects models are noted below:

- The Glenview – Gravesville 69-kV circuit overloads under certain contingency conditions.
    - As described in the Zone 4 – 2021 study results section, a project to address this limitation has already been issued and it was completed in April 2011. Thus this limitation can now be considered addressed.
- Additional limitations showed up in the All Projects 2016 and 2021 off peak sensitivity models. The expectation for these modeling scenarios is that the limitations can be addressed by re-dispatching generation since they did not show up in the summer peak All Project results.

Zone 5
With all appropriate projects included in the 2012, 2016 and 2021 summer peak models, the majority of the system overloads and low voltages in Zone 5 are addressed, although system issues still exist under single contingency conditions in all three study years. The system issues remaining in the 2012, 2016 and 2021 All Projects models are:

- The Bain 345/138 and Oak Creek 345/230-kV transformers overload under certain contingency conditions.
    - As described in the Zone 5 – 2012 study results write-up, circuit breaker outages are low probability events that we do not plan reinforcements for unless the consequences are extremely severe. Loading relief can be achieved by backing down local generation. In addition, the Bain transformer outage will be resolved once the Pleasant Prairie bus is reconfigured in 2013.

Sensitivity analyses

This section considers two aspects of load sensitivity:

- Increased Load, load exceeding a particular summer peak hour forecast
- Minimum Load, the lowest hourly load level expected to be seen in the Planning Horizon.

Load sensitivity analysis – Increased load (2016)

The analysis that is performed 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 projects in the project list 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 projections for the load forecasts we use in our analysis. As these are usually a 50/50 forecast, we do not have a 90/10 forecast available for the risk assessment in the 2011 Assessment. However, research on weather-normalization and benchmarking analysis by Clearspring Energy Advisors has found that a 5.1 percent increase in certain peak loads may be a reasonable assumption for a 90/10 versus a 50/50 forecast. Therefore, for the 2011 Assessment, ATC has used a 5.1 percent increase in certain peak loads as a proxy for the higher 90/10 forecast.

ATC applied a 5.1 percent increase to scalable[3] summer peak loads in the power flow models representing the year 2016 summer peak while holding non-scalable loads

[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 not be sensitive to extreme weather conditions.

constant. Table ZS-2 compares the results of the summer peak and the increased load analyses for 2016 for Zones 1-5.

In Zones 1 and 5, ATC found that the increased load did not have a significant impact on the need date for projects.

In Zone 2, the in-service date of the M38-Atlantic 69 kV line rebuild becomes more critical if loads are higher than expected.

In Zone 3, the in-service date of the Royster-Sycamore 69 kV line uprate becomes more critical if loads are higher than expected

In Zone 4, the Manrap-Custer 69 kV line can become overloaded under certain contingency conditions if loads are higher than expected. This can potentially be mitigated by generation adjustments.

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

Load sensitivity analysis – Minimum load[4] (2012 model and 2021 model)
ATC created a 2012 minimum load case and 2021 minimum load case in an attempt to simulate real world minimum load conditions in each year. To model this scenario, ATC applied a 60 percent decrease to scalable loads in the power flow models representing the year 2012 and 2021 summer peaks while holding the non-scalable loads smaller than or equal to 5 MW constant and applying light load ratios[5] to the non-scalable loads greater than 5 MW.

Line overloads and low voltages improved in all five zones. High bus voltages appeared in all zones, but it should be noted that these issues can be mitigated by generation adjustments, turning off area capacitor banks and/or adjusting transformer tap changers. Table ZS-1 and ZS-3 compares the results of the summer peak and minimum load analyses for 2012 and 2021 for Zones 1-5.

In Zones 1-5, ATC found that the decreased load did not have a significant impact on the need date for projects.

[4] For assumptions for the Minimum load models, please refer to the model building section under Methodology.
[5] To enhance the modeling of shoulder and light load conditions for the ATC Planning analysis, during the load forecast process, ATC requested local distribution companies to provide shoulder-to-peak ratios and light- to-peak ratios for the non-scalable loads greater than 5 MW.

For Zone 2, in the 2012 minimum load case, the Mead and Bay View 69-kV bus voltages are marginal under certain contingency conditions. This might be mitigated by generation adjustments.

At this time, ATC is not proposing to delay or advance project timing because of the minimum load scenario. However, we will continue to evaluate these conditions in future Assessments and in continued development of each project.

Table ZS-1

2012 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2012 Summer Peak Case		2012 Minimum Load Case		Facility Outage(s)
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	
1	Base case loading criteria exceeded	FALSE	--	FALSE	--	System Intact
1	Base case voltage criteria exceeded	--	FALSE	--	FALSE	System Intact
1	Council Creek 138-kV bus	--	89.1% - 89.2%	--	--	Council Creek - Petenwell 138-kV line ACEC Badger West - Saratoga 138 KV line ACEC Badger West - Petenwell 138 KV line Saratoga - Petenwell 138-KV line
1	Badger West 138-kV bus	--	89.3%	--	--	ACEC Badger West - Saratoga 138 KV line
1	Petenwell 138-kV bus	--	89.3%	--	--	ACEC Badger West - Saratoga 138 KV line ACEC Badger West - Petenwell 138 KV line Saratoga - Petenwell 138-KV line
2	Base case loading criteria exceeded	FALSE	--	FALSE	--	System Intact
2	Base case voltage criteria exceeded	--	FALSE	--	TRUE	System Intact
2	M38 – Atlantic 69-kV line	94.6%	--	--	--	M38 – Atlantic 138-kV line M38 – Atlantic 138-kV line[5]
2	Chandler – Lakehead Tap 69-kV line Masonville – Lakehead Tap 69-kV line Gladstone – North Bluff 69-kV line Madonville – Gladstone 69-kV line	108.5% 104.3% 97.3% 97.2%	--	--	--	Delta – Mead 69-kV line
2	Delta – Mead 69-kV line	97.3%	--	--	--	Chandler – Lakehead 69-kV line
2	Engadine, Newberry, LouPac, Newberry Hospital, Newberry Village, Roberts 69-kV buses	--	90.9 - 91.3%	--	--	Hiawatha – Engadine 69-kV line
2	North Bluff, Bay View, Mead, Gladstone, Masonville and Lakehead 69-kV buses	--	84.2 - 89.1%	--	--	Delta – Mead 69-kV line
2	Mead and Bay View 69-kV buses	--	--	--	90.4-91.0%	Delta – Mead 69-kV line
2	Alger Delta, Munising, Alger 69-kV buses	--	--	--	105.4-105.5%	System Intact
2	Atlantic 138-kV bus	--	--	--	113.7%	Atlantic – M38 138-kV line
3	Base Case Loading Criteria Exceeded	FALSE	--	FALSE	--	System Intact
3	Base Case Voltage Criteria Exceeded	--	FALSE	--	TRUE	System Intact
3	Royster – AGA Gas Tap 69-kV line	109.0%	--	--	--	Fitchburg – Syene 69-kV line
3	Royster – Sycamore 69-kV line	95.5%	--	--	--	Femrite 138/69-kV transformer
3	Darlington 138-kV bus	--	--	--	105.2%	System Intact
3	Huiskamp 138-kV bus	--	90.5%	--	114.8%	Huiskamp – North Madison 138-kV line
3	Verona 138-kV bus	--	90.9%	--	114.6%	Verona – Oak Ridge 138-kV line

Table ZS-1
2012 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2012 Summer Peak Case		2012 Minimum Load Case		Facility Outage(s)
		% of Facility Rating	% of Nominal Bus Voltage	% of Facility Rating	% of Nominal Bus Voltage	
3	Hubbard and Hustisford 138-kV buses	--	87.5% 88.1% 88.1%	--	90.1% 90.2% 90.2%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line
4	Base case loading criteria exceeded	FALSE	--	FALSE	--	System Intact
4	Base case voltage criteria exceeded	--	FALSE	--	FALSE	System Intact
4	Sunset Point – Pearl Avenue 69-kV line	106.7% 106.4%	--	--	--	Ellinwood – 12th Avenue 69-kV line Ellinwood 138/69-kV transformer[3]
5	Base Case Loading Criteria Exceeded	FALSE	--	FALSE	--	System Intact
5	Base Case Voltage Criteria Exceeded	--	FALSE	--	TRUE	System Intact
5	Albers, Allerton, Hayes, Kenosha, Nicholson, Oak Creek, Pennsylvania, Racine, Ramsey, St. Rita, and Somers 138-kV buses	--	--	--	105-106.1%	System Intact
5	Maple and Germantown 138-kV buses	--	91.7% 91.2%	--	--	Maple – Saukville 138-kV line
5	Bain 345/138-kV transformer #5	108.3% 158.2%	--	--	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23
5	Oak Creek 345/230-kV transformer T895	104% 100.1%	--	--	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67
5	Arcadian4 – Waukesha1 138-kV line	98.8%	--	--	--	Arcadian6 – Waukesha3 138-kV line
5	Arcadian6 – Waukesha3 138-kV line	95.7%	--	--	--	Arcadian4 – Waukesha1 138-kV line Split Waukesha 138-kV bus 12
5	Harbor – Kansas 138-kV line	94.8%	--	--	--	Kansas – Norwich 138-kV line

Table ZS-2
2016 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2016 Summer Peak Case		2016 70% Load Case		2016 90% Load Case		2016 105% Load Case		2016 65% High W-E Case		Facility Outage(s)
		% 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	% of Facility Rating	% of Nominal Bus Voltage	
1	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
1	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	TRUE	--	FALSE	--	TRUE	System Intact
1	Council Creek 138-kV bus	--	104.9%	--	--	--	105.3%	--	--	--	105.4%	System Intact
1	Dartford 69-kV bus	--	91.2 - 91.4%	--	--	--	--	--	--	--	--	Ripon - Northwest Ripon Tap 69-KV line Metomen - Ripon 69-KV line
1	Petenwell 138/69 KV transformer	98.0 - 95.2%	--	--	--	--	--	98.1%	--	115.5%	--	Castle Rock - Quincy ACEC 69-KV line Hilltop - Buckhorn Tap 69-KV line Castle Rock - McKenna 69-kV line[1] McKenna - Quincy ACEC 69-KV line
1	ACEC Badger West - Saratoga 138-kV line	--	--	95.2 - 96.8%	--	--	--	--	--	95.8 - 100.9%	--	Arpin - Eau Claire 345-kV line King - Eau Claire - Arpin 345-kV line[5]
1	ACEC Badger West - Petenwell 138-kV line	--	--	98.2 - 99.8%	--	--	--	--	--	95.8 - 103.9%	--	Arpin - Eau Claire 345-kV line King - Eau Claire - Arpin 345-kV line[5]
2	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
2	Base case voltage criteria exceeded	--	FALSE	--	TRUE	--	FALSE	--	FALSE	--	FALSE	System Intact
2	Mead and Chandler 69-kV buses	--	--	--	--	--	--	--	--	--	95.1 - 95.9%	System Intact
2	Munising, Alger, Alger-Delta 69-kV buses	--	--	--	105-105.5%	--	--	--	--	--	--	System Intact
2	Lakota Road 115-kV bus	--	--	--	105.30%	--	--	--	--	--	--	System Intact
2	Indian Lake 69-kV bus	--	--	--	--	--	--	--	--	--	92.0% 91.1% 91.6% 91.7%	Pleasant Prairie – Zion 345-kV line Pleasant Prairie – Zion 345-kV line[27] Indian Lake 69-kV capacitor bank Perkins 138-kV capacitor bank
2	Indian Lake 138/69-kV transformer #1 Indian Lake 138/69-kV transformer #2	--	--	--	--	--	--	--	--	97.2-98.2%	--	Indian Lake 138/69-kV transformer #2 Indian Lake 138/69-kV transformer #1
2	Delta – Mead 69-kV line	102.3% 97.4% 97.1%	--	--	--	--	--	101.7% 96.8% 96.7%	--	--	--	Chandler – Lakehead Tap 69-kV line Masonville – Lakehead Tap 69-kV line Chandler - Lakehead - Masonville 69-kV line[26]
2	Chandler – Lakehead Tap 69-kV line Masonville – Gladstone 69-kV line Masonville – Lakehead Tap 69-kV line	112.8% 96.9% 108.5%	--	101.8% 90.7% 98.8%	--	108.6% 94.3% 104.7%	--	114.8% 97.9% 110.2%	--	103.9% 93.4% 101.1%	--	Delta – Mead 69-kV line
2	M38 – Atlantic 69-kV line	--	--	--	--	--	--	96.3% 96.5% 100%	--	--	--	M38 – Atlantic 138-kV line Atlantic 138/69-kV transformer M38 – Atlantic 69-kV line[23]
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village, Hulbert and Eckerman 69-kV buses	--	90.3-90.7%	--	--	--	91.5-91.9%	--	91.3-91.7%	--	--	Hiawatha – Engadine 69-kV line
2	North Bluff, Bay View, Mead, Gladstone, Lakehead, Masonville 69-kV buses	--	84.7-91.8%	--	85.5-90.1%	--	84.9-89.6%	--	83.7-91.6%	--	82.3-90.5%	Delta – Mead 69-kV line
2	Empire - Presque Isle 138-kV line	--	--	--	--	--	--	--	--	100.6%	--	Split Empire 138-kV bus #23
2	Escanaba and West 69-kV buses	--	91.4-91.9%	--	--	--	--	--	--	--	--	Delta - West Tap 69-kV line
2	Nordic – Mountain 69-kV line	--	--	--	--	--	--	--	--	102.0% 110.5%	--	Empire – Forsyth 138-kV line Plains – Arnold 138-kV line

Table ZS-2
2016 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2016 Summer Peak Case		2016 70% Load Case		2016 90% Load Case		2016 105% Load Case		2016 65% High W-E Case		Facility Outage(s)
		% 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	% of Facility Rating	% of Nominal Bus Voltage	
3	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
3	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact
	Royster – Sycamore 69-kV line	98.2%	--	--	--	--	--	--	104.5%	--	--	Femrite 138/69-kV transformer
3	Verona 138-kV bus	--	89.4%	--	--	--	89.9%	--	88.8%	--	--	Verona – Oak Ridge 138-kV line
3	Huiskamp 138-kV bus	--	89.9%	--	91.7%	--	90.4%	--	89.9%	--	91.7%	Huiskamp – North Madison 138-kV line
3	Darlington – North Monroe 138-kV line	--	--	--	--	--	--	--	--	102.0 – 95%	--	Paddock 345/138-kV transformer Darlington 138/69-kV transformer Darlington – DPC Gratiot 69-kV line
3	Eden – Mineral Point 69-kV line	--	--	--	--	--	--	--	--	95.3%	--	Darlington – Lafayette Wind 138-kV line
3	South Monroe – Browntown 69-kV line	--	--	--	--	--	--	--	--	97.0%	--	Darlington – North Monroe 138-kV line
3	Concord 138-kV bus	--	--	--	--	--	--	--	96.0%	--	--	System Intact
3	Hubbard and Hustisford 138-kV buses	--	87.5% 88.2% 88.2%	--	87.1% 87.4% 87.4%	--	87.2% 86.5% 86.5%	--	--	--	87.2% 87.9% 87.9%	Rubicon – Hustisford 138-kV line Hustisford - Hubbard 138kV line Rubicon - Hustisford - Hubbard 138kV line
4	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
4	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact
4	Manrap – Custer 69-kV line	--	--	--	--	--	--	95.4%	--	--	--	Dewey – Lakefront 69-kV line
4	Lau Road – Elkhart Lake 138-kV line	--	--	--	--	--	--	--	--	95.6% 95.6% 95.6%	--	Sheboygan Energy Center – Grandville 345-kV line Point Beach – Sheboygan Energy Center 345-kV line Point Beach 345-kV bus tie 1 - 2
4	Elkhart Lake – Saukville 138-kV line	--	--	--	--	--	--	--	--	106.7% 106.7% 106.6% 103.4% 102.9% 101.9 – 95.0%	--	Point Beach 345-kV bus tie 1 - 2 Point Beach – Sheboygan Energy Center 345-kV line Sheboygan Energy Center – Granville 345-kV line Cypress – Arcadian 345-kV line Edgewater – Cedarsauk 345-kV line Plus other less severe contingencies
4	Gravesville - Glenview 138-kV line	96.7% 96.7% 96.6% -- --	--	--	--	--	--	102.9% 102.9% 102.9% 96.0% 96.0%	--	--	--	Tecumseh Road 138/69 kV Transformer* Tecumseh Road 138/69 kV Transformer Tecumseh Road - Ford Drive tap 69-kV line Ford Drive tap - New Holstein 69-kV line Tecumseh Road - New Holstein 69-kV line*
4	Sunset Point – Pearl Avenue 69-kV line	107.9% 107.9%	--	--	--	97.0% 96.9%	--	113.6% 113.4%	--	--	--	Ellinwood – 12th Avenue 69-kV line Ellinwood 138/69-kV transformer*
5	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
5	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact
5	Bain 345/138-kV transformer #5	158.6% 111.4%	--	142.5% --	--	158.8% --	--	158.3% 106.4%	--	142.6% 127.1%	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23
5	Oak Creek 345/230-kV transformer T895	104.2% 101.5%	--	--	--	104.4% --	--	104.3% 101.9%	--	--	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67
5	Arcadian4 – Waukesha1 138-kV line	97.9%	--	114.1%	--	130.4%	--	98.5%	--	--	--	Arcadian6 – Waukesha3 138-kV line
5	Arcadian6 – Waukesha3 138-kV line	94.7% --	--	110.5% 100.4%	--	126.3% 112.7%	--	95.4% --	--	--	--	Arcadian4 – Waukesha1 138-kV line Split Waukesha 138-kV bus 12

Table ZS-2
2016 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2016 Summer Peak Case		2016 70% Load Case		2016 90% Load Case		2016 105% Load Case		2016 65% High W-E Case		Facility Outage(s)
		% 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	% of Facility Rating	% of Nominal Bus Voltage	
5	Arcadian 345/138-kV transformer #3	--	--	--	--	96.2% 99.6% 94.9%	--	--	--	--	--	Split Arcadian 345-kV bus 12 Arcadian 345-kV bus outage Arcadian 345/138-kV transformer #1
5	Bain – Kenosha 138-kV line	--	--	--	--	--	--	--	--	100.3%	--	Pleasant Prairie – Zion 345-kV line
5	Pleasant Prairie – Zion 345-kV line	--	--	--	--	--	--	--	--	96.8%	--	Zion – Arcadian 345-kV line[27]
5	Granville 345/138-kV transformer #1	--	--	--	--	108.2%	--	--	--	--	--	Split Granville 345-kV bus 23
5	Harbor – Kansas 138-kV line	--	--	110.4% 105.3% 102.5% 101.7%	--	100.0% -- -- --	--	--	--	--	--	Kansas – Norwich 138-kV line Dewey – Norwich 138-kV line Split Dewey 138-kV bus Dewey – Montana 138-kV line Plus Other Less Severe Outages
5	Albers – Kenosha 138-kV line	--	--	107.2%	--	105.6%	--	--	--	--	--	Albers – Bain 138-kV line
5	Edgewood – St. Martins 138-kV line	--	--	98.1%	--	--	--	--	--	--	--	Merrill Hills – Waukesha 138-kV line
5	Oak Creek – Ramsey 138-kV line Kansas – Ramsey 138-kV line Nicholson – Ramsey 138-kV line	--	--	--	--	101.0% 96.1% 95.1%	--	--	--	--	--	Oak Creek – Pennsylvania 138-kV line
5	Waukesha 138-kV bus 12	--	--	--	--	99.7%	--	--	--	--	--	Arcadian6 – Waukesha3 138-kV line
5	Kenosha – Lakeview 138-kV line	--	--	--	--	--	--	96.2%	--	126.9%	--	Pleasant Prairie – Zion 345-kV line
5	Lakeview – Zion 138-kV line	--	--	--	--	--	--	--	--	129.9%	--	Pleasant Prairie – Zion 345-kV line

Table ZS-3
2021 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2021 Summer Peak Case		2021 Minimum Load Case		2021 70% Shoulder Case		2021 90% E-W Bias Case		2021 65% High W-E Bias Case		Facility Outage(s)
		% 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	% of Facility Rating	% of Nominal Bus Voltage	
1	Base case loading criteria exceeded	TRUE	--	FALSE	--	FALSE	--	FALSE	--	TRUE	--	System Intact
1	Base case voltage criteria exceeded	--	FALSE	--	TRUE	--	FALSE	--	FALSE	--	FALSE	System Intact
1	Dartford,Ripon Industrial Park, Northwest Ripon and Ripon 69-kV buses	--	90.5 - 91.9% 90.6 - 91.9% 91.6%	--	--	--	--	--	--	--	--	Ripon - NW Ripon Tap 69-KV line Metomen - Ripon 69-KV line NW Ripon Tap - Dartford Tap 69-KV line
1	Winneconne, Omro and Omro Industrial Park 69-kV buses	--	90.8 - 91.4%	--	--	--	--	--	--	--	--	Winneconne - Sunset Point 69-kV line
1	Council Creek 161-kV bus	--	91.2%	--	--	--	--	--	--	--	--	Monroe County - La Crosse 161-kV line
1	Council Creek 138-kV bus	--	--	--	105.5%	--	--	--	--	--	--	System Intact
1	Metomen 138/69 KV transformer	95.6%	--	--	--	--	--	--	--	--	--	System Intact
1	Petenwell 138/69 KV transformer	101.7% 106.2% 104.1% 103.5% 101.4 - 103.3%	--	--	--	95.6 - 104.2%	--	--	--	119.2%	--	System Intact Castle Rock - Quincy ACEC 69-KV line Hilltop - Buckhorn Tap 69-KV line Castle Rock - McKenna 69-kV line[14] Plus other less severe contingencies
1	Castle Rock - ACEC Quincy 69-KV line	98.8% 98.8% 98.7%	--	--	--	--	--	--	--	--	--	Petenwell - Big Pond 69-KV line Petenwell 138/69-kV Transformer Necedah Tap - Big Pond 69-KV line
1	ACEC Badger West - Petenwell 138-kV line	--	--	--	--	96.9 - 135.9%	--	--	--	96.1 - 103.8%	--	Arpin - Eau Claire 345-kV line King - Eau Claire 345-kV line Arpin 345/138-kV transformer Arrowhead - Stone Lake 345-kV line Plus other less severe contingencies
1	ACEC Badger West - Saratoga 138-kV line	--	--	--	--	97.1 - 132.7%	--	--	--	100.5%	--	Arpin - Eau Claire 345-kV line King - Eau Claire 345-kV line Arpin 345/138-kV transformer Arrowhead - Stone Lake 345-kV line Plus other less severe contingencies
2	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
2	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact
2	Engadine, Newberry, Newberry Hospital, Roberts, LouPac, Newberry Village, Hulbert, Eckerman 69-kV buses	--	84.4-90.4% --	--	--	--	--	--	88.5-89.0% 89.5-89.8%			Hiawatha-Engadine 69-kV line Engadine-Newberry 69-kV line
3	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
3	Base case voltage criteria exceeded	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	System Intact
3	Darlington – North Monroe 138-kV line	--	--	--	--	--	--	--	--	118.8 – 98.8%	--	Paddock 345/138-kV transformer Darlington 138/69-kV transformer Darlington – DPC Gratiot 69-kV line Eden – Wyoming Valley 138-kV line Eden – Wyoming Valley – Spring Green 138-kV line plus other less severe contingencies
3	Eden – Mineral Point 69-kV line	--	--	--	--	--	--	--	--	111.3 – 98.5%	--	Darlington – Lafayette Wind 138-kV line
3	South Monroe – Browntown – Jennings Road – Wiote 69-kV line	--	--	--	--	--	--	--	--	110.8 – 101.2%	--	Darlington – North Monroe 138-kV line
3	Nelson Dewey 161/138-kV transformer	--	--	--	--	96.0%	--	--	--	--	--	System Intact
3	Nelson Dewey 161/138-kV transformer	--	--	--	--	103.1 – 99.4%	--	--	--	--	--	Nelson Dewey Unit 2 Pleasant Praire Unit 1 Pleasant Praire Unit 2 Edgewater Unit 5 plus other less severe contingencies
3	Royster – Sycamore 69-kV line	106.3%	--	--	--	--	--	96.3%	--	--	--	Femrite 138/69-kV transformer

Table ZS-3
2021 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2021 Summer Peak Case		2021 Minimum Load Case		2021 70% Shoulder Case		2021 90% E-W Bias Case		2021 65% High W-E Bias Case		Facility Outage(s)
		% 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	% of Facility Rating	% of Nominal Bus Voltage	
3	Westport – Wanakee Muni#2 69-kV line	98.1%	--	--	--	--	--	--	--	--	--	West Middleton – Pheasant Branch 69-kV line
3	Verona 138-kV bus	--	87.9%	--	--	--	90.8%	--	88.8%	--	91.4%	Verona – Oak Ridge 138-kV line Verona 138/69-kV transformer
3	Huiskamp 138-kV bus	--	89.4%	--	114.8%	--	90.1%	--	90.4%	--	91.4%	Huiskamp – North Madison 138-kV line
3	Hubbard and Hustisford 138-kV bus	--	87.5% 88.1% 88.1%	--	87.5% 87.6% 87.6%	--	86.9% 87.3% 87.3%	--	88.1% 88.1% 88.1%	--	87.2% 87.2% 87.1%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line
3	Paddock – Townline 138kV line	--	--	--	--	102.8% 101.8% 101.1%	--	--	--	--	--	NW Neloit – Paddock 138-kV line Paddock – NW Beloit – Blackhawk 138-kV line NW Beloit – Blackhawk 138-kV line
3	NW Beloit – Paddock 138kV line	--	--	--	--	96.9%	--	--	--	--	--	Paddock – Townline 138-kV line
4	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
4	Base case voltage criteria exceeded	--	FALSE	--	TRUE	--	FALSE	--	FALSE	--	FALSE	System Intact
4	Manrap – Custer 69-kV line	99.3%	--	--	--	--	--	--	--	--	--	Dewey – Lakefront 69-kV line
4	Glenview – Gravesville 69-kV line	103.7% 103.7% 103.7% 97.0% 97.0%	--	--	--	--	--	--	--	--	--	Tecumseh Road 138/69 kV Transformer* Tecumseh Road 138/69 kV Transformer Tecumseh Road - Ford Drive tap 69-kV line Ford Drive tap - New Holstein 69-kV line Tecumseh Road - New Holstein 69-kV line*
4	Sunset Point – Pearl Avenue 69-kV line	110.5% 110.4%	--	--	--	--	--	98.9% 98.9%	--	--	--	Ellinwood 138/69-kV transformer* Ellinwood – 12th Avenue 69-kV line
4	Morgan – Falls 138-kV line	--	--	--	--	101.8%	--	--	--	--	--	Morgan – Plains 345-kV line
4	Elkhart Lake – Saukville 138-kV line	--	--	--	--	--	--	--	--	97.9%	--	Barnhart – Cedarsauk 345-kV line
4	Kewaunee 138-kV bus	--	--	--	103.6%	--	--	--	--	--	--	System Intact
5	Base case loading criteria exceeded	FALSE	--	FALSE	--	FALSE	--	FALSE	--	FALSE	--	System Intact
5	Base case voltage criteria exceeded	--	FALSE	--	TRUE	--	FALSE	--	FALSE	--	FALSE	System Intact
5	Oak Creek 345/230-kV transformer T895	104.3% 102.5%	--	--	--	--	--	104.4% 102.5%	--	102.7% 99.8%	--	Split Oak Creek 230-kV bus 78 Split Oak Creek 230-kV bus 67
5	Bain 345/138-kV transformer #5	158.4% 104.6%	--	--	--	--	--	--	--	--	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23
5	Arcadian4 – Waukesha1 138-kV line	98.4%	--	--	--	110.2%	--	120.4%	--	--	--	Arcadian6 – Waukesha3 138-kV line
5	Arcadian6 – Waukesha3 138-kV line	95.3% --	--	--	--	106.8% 95.8%	--	116.6% 102.0%	--	--	--	Arcadian4 – Waukesha1 138-kV line Split Waukesha 1-2 bus
5	Arcadian 345/138-kV transformer #3	--	--	--	--	--	--	95.9%	--	--	--	Arcadian 345/138-kV transformer #1
5	Pleasant Prairie – Zion 345-kV line	--	--	--	--	--	--	--	--	108.2% 101.1% 98.8%	--	Zion – Arcadian 345-kV line Zion - Arcadian 345-kV line[14] System Intact
5	Lakeview – Zion 138-kV line Arcadian – Zion 345-kV line Kenosha - Lakeview 138-kV line	96.8% -- 99.6%	--	--	--	--	--	--	--	144% 108.1% 141.9%	--	Pleasant Prairie – Zion 345-kV line
5	Bain – Kenosha 138-kV line	--	--	--	--	--	--	--	--	107.8%	--	Pleasant Prairie – Zion 345-kV line
5	Albers – Kenosha 138-kV line	--	--	--	--	100.4%	--			--	--	Albers – Bain 138-kV line
5	Maple and Germantown 138-kV buses	--	--	--	--	--	--	--	89.7-90.3%	--	--	Saukville – Maple 138-kV line

Table ZS-4
2026 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2026 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal Bus Voltage	
1	Base case loading criteria exceeded	TRUE	--	System Intact
1	Base case voltage criteria exceeded	--	TRUE	System Intact
1	Silver Lake, ACEC Spring Lake, Redgranite, Fountain Valley, River Run, Berlin and Fox River 69-kV buses	--	90.0 - 91.7% 91.0 - 91.2% 91.2 - 91.4% 91.8 - 91.9%	Wautoma – Silver Lake Tap 69-kV line Ripon - Northwest Ripon Tap 69-KV line Metomen – Ripon 69-kV line Silver Lake – ACEC Spring Lake 69-kV line
1	Dartford,Ripon Industrial Park, Northwest Ripon and Ripon 69-kV buses	--	96.4% 88.3 - 89.8% 88.5 - 89.9% 90.4 - 91.8%	System Intact Ripon - Northwest Ripon Tap 69-KV line Metomen – Ripon 69-kV line Northwest Ripon Tap - Dartford Tap 69-KV line
1	Winneconne, Omro and Omro Industrial Park 69-kV buses	--	89.4 - 90.0%	Winneconne – Sunset Point 69-kV line
1	Castle Rock – ACEC Quincy 69-kV line	101.1%	--	Necedah Tap – Big Pond 69-kV line Petenwell – Big Pond 69-kV line Petenwell 138/69-kV transformer
1	Metomen 138/69 KV transformer	100.5% 101.4% 100.0%	--	System Intact North Fond du Lac 138/69-kV transformer North Fond du Lac – Rosendale Tap 69-kV line
1	Petenwell 138/69-kV transformer	106.2% 110.2% 107.9% 107.5% 107.3% 98.6 - 106.2%	--	System Intact Castle Rock – Quincy ACEC 69-kV line McKenna – Quincy ACEC 69-kV line Hilltop – Buckhorn Tap 69-kV line Castle Rock - McKenna 69-kV line[25] Plus other less severe contingencies
1	Wautoma - ACEC Wautoma Tap 69-kV line	96.9%	--	Harrison North - Harrison 69-kV line
2	Base case loading criteria exceeded	FALSE	--	System Intact
2	Base case voltage criteria exceeded	--	FALSE	System Intact
2	Hulbert, Eckermann, Lou-Pac, Newberry Village, Roberts, Talantino 69-kV buses	--	83.5 - 89.4% 88.1 - 91.5% 86.4 - 90.8% 86.7 - 91.2%	Engadine – Newberry 69-kV line Newberry – Newberry Hospital 69-kV line Newberry Hospital – Roberts 69-kV line Hiawatha – Roberts 69-kV line 6911[24]
3	Base case loading criteria exceeded	FALSE	--	System Intact
3	Base case voltage criteria exceeded	--	FALSE	System Intact
3	Timberlane Tap – West Middleton 69-kV line	95.6%	--	Spring Green 138/69-kV transformer
3	West Middleton – Pheasant Branch 69-kV line	107.8 – 96.5%	--	Waunakee Switching – Waunakee Municipal 2 69-kV line Westport – Waunakee Municipal 2 69-kV line
3	West Middleton 138/69-kV transformer		--	West Middleton 138/69-kV transformer
3	Westport – Waunakee Muni2 69-kV line	114.7%	--	West Middleton – Pheasant Branch 69-kV line
3	Waunakee Industrial Park – Huiskamp 69-kV line	95.7%	--	West Middleton – Pheasant Branch 69-kV line
3	Royster – Sycamore 69-kV line	115.0%	--	Femrite 138/69-kV transformer
3	Huiskamp 138-kV bus	--	88.7%	Huiskamp – North Madison 138-kV line
3	Verona 138-kV bus	--	86.0%	Verona – Oak Ridge 138-kV line
3	Hubbard and Hustisford 138-kV bus	--	87.0% 87.7% 87.7%	Rubicon – Hustisford 138-kV line Hustisford – Hubbard 138-kV line Rubicon – Hustisford – Hubbard 138-kV line
3	Alto 69-kV bus	--	96.8%	System Intact
4	Base case loading criteria exceeded	FALSE	--	System Intact
4	Base case voltage criteria exceeded	--	FALSE	System Intact
4	Manrap – Custer 69-kV line	106.2%	--	Dewey – Lakefront 69-kV line

Table ZS-4
2026 Limitations and Performance Criteria Exceeded

Planning Zone	Criteria Exceeded/Need	2026 Summer Peak Case		Facility Outage(s)
		% of Facility Rating	% of Nominal Bus Voltage	
4	Glenview – Gravesville 69-kV line	101.5% 101.5% 101.5%	--	Tecumseh Road 138/69-kV transformer[24] Tecumseh Road 138/69-kV transformer Tecumseh Road – Ford Drive 69-kV
4	Sunset Point – Pearl Avenue 69-kV line	113.2% 112.9%	--	Ellinwood – 12th Avenue 69-kV line Ellinwood 138/69-kV transformer[20]
5	Base Case Loading Criteria Exceeded	FALSE	--	System Intact
5	Base Case Voltage Criteria Exceeded	--	FALSE	System Intact
5	Bluemound 230-kV buses #1, #2 and #3	--	95.8%	System Intact
5	Brookdale East, Allerton 138-kV buses	--	95.5 - 95.9%	System Intact
5	Bain 345/138-kV transformer #5	158.9% 99.5%	--	Split Pleasant Prairie 345-kV bus 34 Split Pleasant Prairie 345-kV bus 23
5	Oak Creek 345/230-kV transformer T895	102.4% 104.7%	--	Split Oak Creek 230-kV bus 67 Split Oak Creek 230-kV bus 78
5	Kenosha – Lakeview 138-kV line	103.0%	--	Pleasant Prairie – Zion 345-kV line
5	Lakeview – Zion 138-kV line	99.3%	--	Pleasant Prairie – Zion 345-kV line
5	Pennsylvania 138-kV bus	--	91.6%	Oak Creek – Pennsylvania 138-kV line
5	Arcadian – Waukesha 138-kV line	--	96.8%	Arcadian – Waukesha 138-kV line

Table ZS-5
ATC Day Ahead Market Most Limiting Elements, 2010

Severity Index	Hours	Constraint Element	Potential Solution
37.58	2,975	Pleasant Prairie - Zion 345-kV	Upgrade equipment at Zion Substation in ComEd system (In-Service March 2011) Pleasant Prairie - Zion Energy Center 345-kV line (Proposed 2014)
12.56	512	Minnesota to Wisconsin Exports Interface (MWEX)	Monroe County - Council Creek 161-kV line (Proposed 2014) Badger Coulee 345-kV line (Proposed 2018)
7.93	3,473	Nordic - Felch Tap 69-kV	Chandler 138/69-kV T2 (Proposed 2012) Flow Control Device (Proposed 2014) Arnold 345/138-kV Transformer (Proposed 2015)
7.52	415	Granville - Butler 138-kV	Upgrade equipment at Butler Substation (Planned 2012)
5.34	794	Oak Creek 345/230-kV Transformer T884	Area transmission outages may have contributed to this constraint
5.09	123	Rocky Run 345/115-kV Transformer T1	Monroe County - Council Creek 161-kV line (Proposed 2014)
4.56	313	Spring Green - Arena 69-kV	Rockdale - West Middleton 345-kV (Planned 2013)
3.69	977	Indian Lake 138/69-kV Transformer T2	Flow Control Device (Proposed 2014)
3.04	1,441	Flow South PTDF	Flow Control Device (Proposed 2014)
2.57	1,420	Chandler - Delta 69-kV CKT 1	Chandler - Delta 69-kV Ckt 1 and Ckt 2 Line Uprate (In-Service 2010)
2.56	1,403	Chandler - Delta 69-kV CKT 2	Chandler - Delta 69-kV Ckt 1 and Ckt 2 Line Uprate (In-Service 2010)
1.71	61	Arcadian 345/138-kV Transformer T2	Replace Arcadian Transformers T2 and T3 (Provisional 2020)
1.53	144	Saukville - Edgewater 345-kV	ATC is investigating a future 345-kV N-S path in the Fox Valley corridor
1.34	292	McCue - REC Harmony Tap 69-kV	Construct 69-kV double-circuit line between McCue and Lamar (Provisional 2019)
1.16	109	Arpin - Sigel 138-kV	Monroe County - Council Creek 161-kV line (Proposed 2014) Badger Coulee 345-kV line (Proposed 2018)
109.19	**18,403**	**Total for All ATC Day Ahead Constraints - 2010**	

Table ZS-6
ATC Real Time Market Most Limiting Elements, 2010

Severity Index	Hours	Constraint Element	Potential Solution
36.99	529	Pleasant Prairie - Zion 345-kV	Upgrade equipment at Zion Substation in ComEd system (In-Service March 2011) Pleasant Prairie - Zion Energy Center 345-kV line (Proposed 2014)
10.42	1,035	Nordic - Felch Tap 69-kV	Arnold 345/138-kV Transformer (Proposed 2015) Flow Control Device (Proposed 2014) Chandler 138/69-kV T2 (Proposed 2012)
8.59	96	Granville - Butler 138-kV	Upgrade equipment at Butler Substation (Planned 2012)
6.87	44	Rocky Run 345/115-kV Transformer T1	Monroe County - Council Creek 161-kV line (Proposed 2014)
6.63	87	Indian Lake 138/69-kV Transformer T2	Flow Control Device (Proposed 2014)
6.27	7	Minnesota to Wisconsin Exports Interface (MWEX)	Monroe County - Council Creek 161-kV line (Proposed 2014) Badger Coulee 345-kV line (Proposed 2018)
4.43	95	Spring Green - Arena 69-kV	Rockdale - West Middleton 345-kV (Planned 2013)
3.66	308	Oak Creek 345/230-kV Transformer T884	Area transmission outages may have contributed to this constraint
2.95	273	Chandler - Delta 69-kV CKT 2	Chandler - Delta 69-kV Ckt 1 and Ckt 2 Line Uprate (In-Service 2010)
2.62	13	Rocky Run 345/115-kV Transformer T4	Monroe County - Council Creek 161-kV line (Proposed 2014)
2.00	42	Kenosha - Lakeview 138-kV	Pleasant Prairie - Zion Energy Center 345-kV line (Proposed 2014)
1.70	24	Elkhart Lake - Forest Junction 138-kV	Upgrades associated with G611 (Planned 2010) ATC is investigating a future 345-kV N-S path in the Fox Valley corridor
1.49	33	Albers - Kenosha 138-kV	Pleasant Prairie - Zion Energy Center 345-kV line (Proposed 2014) Economic Analysis 2011
1.38	24	Arpin - Sigel 138-kV	Monroe County - Council Creek 161-kV line (Proposed 2014) Badger Coulee 345-kV line (Proposed 2018)
1.34	4	Paddock 345/138-kV Transformer T21	Paddock - Rockdale 345-kV (In-Service March 2010)
111.68	**3,141**	**Total for All ATC Real Time Constraints - 2010**	

Table ZS-7: ATC System Angular Stability Assessment for 2011 10-Year Assessment (as of July 1, 2011)

	Facility Studied	# Units	Total Capacity (MW)	Last Year 0f Detail Study	Response to Selected NERC Category B, C and D Contingencies (NERC Reliability Criteria)				SPS	Note
					2011	2012~2015	2016	Appropriate for 2017~2021		
	Existing Units									
1	Pleasant Prairie	2	1208.0	2007	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	See notes (4,5)
2	Paris	4	400.0	2008	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	2008 TYA
3	Oak Creak	7	1138.0	2007	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	See note (5)
4	Valley	2	280.0	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA, See note (6)
5	Germantown	5	345.0	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	No	2010 TYA, See note (7)
6	Port Washington	6	1080.0	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA, See note (8)
7	Point Beach	2	512; 514	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	Yes	See note (9)
8	Kewaunee	1	579.0	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA
9	Edgewater	3	773.0	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	Yes	2010 TYA, See note (10)
10	S. Fond du Lac	4	352.0	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	No	2010 TYA
11	Neevin	2	300.0	2005	Acceptable (20)	Acceptable (20)	Acceptable (20)	Yes	No	2011 TYA
12	De Pere	1	185.0	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	No	2010 TYA, See note (11)
13	Pulliam	6	459.0	2005	Acceptable (20)	Acceptable (20)	Acceptable (20)	Yes	No	2011 TYA
14	West Marinette	4	240.0	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA
15	Fox Energy	3	672.3	2008	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	2008 TYA, See note (9)
16	Sheboygan Energy	2	343.0	2005	Acceptable (20)	Acceptable (20)	Acceptable (20)	Yes	No	2011 TYA, See note (9)
17	Cypress	88	145.2	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA
18	Forward Energy Center	86	129.0	2008	Acceptable (1,2,3)	Acceptable (1,2, 3)	Acceptable (1,2,3)	Yes	No	2008 TYA
19	Columbia	2	1050.0	2005	Acceptable (18)	Acceptable (18)	Acceptable (18)	Yes	No	2011 TYA
20	Christiana	3	544.5	2005	Acceptable (19)	Acceptable (19)	Acceptable (19)	Yes	No	2011 TYA
21	Riverside	3	659.1	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	No	2010 TYA
22	Rock River	5	132.0	2010	Acceptable (3)	Acceptable (3)	Acceptable (3)	Yes	No	2010 TYA
23	Nelson Dewey	2	226.0	2010	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	See note (12)
24	University	2	236.0	2008	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	2008 TYA
25	Concord	4	400.0	2008	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	2008 TYA
26	West Campus	3	147.2	2009	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	No	2009 TYA
27	Presque Isle	5	431.0	2007	Acceptable (2,3)	Acceptable (2,3)	Acceptable (2,3)	Yes	Yes	See note (13)
28	Weston	5	552.6	2005	Acceptable (20)	Acceptable (20)	Acceptable (20)	Yes	No	2011 TYA
26	Elm Road	1	1230.0	2007	Acceptable (1,2,3)	Acceptable (1,2,3)	Acceptable (1,2,3)	Yes	No	See note (5)
	New / Future Units with Signed Interconnection Agreement									
27	EcoMet (wind)	67	100.5	2008	See note (17)	See note (17)	See note (17)	See note (17)	No	See note (14)
22	Glacier Hills (wind)	138	249.0	2009	See note (15)	See note (15)	See note (15)	See note (15)	No	See note (15)
23	Lake Breeze	49	98.0	2004	See note (17)	See note (17)	See note (17)	See note (17)	No	See note (16)

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 2011 TYA as part the system angular stability analysis

Notes:

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

(2) Comparing 2010 TYA models with 2009 TYA models, no significant change has occurred near the generation station, other than the local load growth. Therefore, the stability results from the 2009 TYA are still applicable and are acceptable in the following years.

(3) Comparing 2011 TYA models with 2010 TYA models, no significant change has occurred near the generation station, other than the local load growth. Therefore, the stability results from the 2010 TYA are still applicable and are acceptable in the following years.

(4) Since 2009 TYA Pleasant Prairie Special Protection System (SPS) study was completed on May 27, 2009 and concluded the SPS was no longer required and could be retired.

(5) "Final Facility Study Update – Revision 2 Phase I, II & III Milwaukee County, Wisconsin MISO #G051 (#36760-01)" dated January 15, 2007.

(6) Replacment of breaker failure relays and breakers required per 2009 TYA.

(7) Addition of redundant bus differential relays and reduction of delayed clearing times required per 2010 TYA.

(8) 2009 TYA Evaluation, Generator Validation Study dated September 8, 2008. River Bend D-T Study Dated December 2010 covers any changes in the local area.

(9) "Final ISIS Report Point Beach Generators Manitowoc County, Wisconsin MISO #G833/J022 (#39297-01), G834/J023 (#39297-02)" dated October 2, 2009. A single NERC Category C9 was evaluated to ensure full compliance with applicable NERC standards.

(10) Addition of redundant bus differential relays required per 2010 TYA.

(11) Addition of redundant bus differential relays and reduction of delayed clearing times required per 2010 TYA.

(12) "Interconnection System Impact Study Report 50 MW Wind Generation Grant County, Wisconsin J084" dated June 24, 2010

(13) "Presque Isle Special Protection System “Remedial Action Tripping Scheme” (RATS)" Version 3.0 dated December 17, 2007. Presque Isle will be re-studied as part of the next SPS review.

Notes (Continued):

(14) "Interconnection System Impact Study Report 99 MW Wind Generation Revision 4; Calumet County, Wisconsin" - MISO #G611 (#38791-01)" dated October 24, 2008.
"Interconnection System Impact Study Report 1.5 MW Wind Generation; Calumet County, Wisconsin" - MISO #G927 (#39423-01)" dated May 16, 2008.

(15) "Interconnection System Impact Study Report 99 MW Wind Generation Revision 3; Columbia County, Wisconsin" - MISO #G706 (#39041-01)" dated September 4, 2008.
"Interconnection System Impact Study Report 150 MW Wind Generation Revision 2; Columbia County, Wisconsin" - MISO #H012 (#39567-01)" dated July 13, 2009.
Glacier Hills will be commercial by the end of 2011 and will be put into the rotation of studied generators beginning with the 2012 TYA study.

(16) "Interconnection Evaluation Study Report 98 MW Wind Generation; Fond du Lac County, Wisconsin" - MISO #G427 (#38121-01)" dated December 22, 2004.

(17) Until a generator declares commercial operation, an assessment of this facility will not be completed as part of the current Ten Year Assessment.

(18) Two NERC Category D3 contingencies resulted in un-acceptable performance for ATC post-contingency voltage recovery criteria. Re-setting breaker failure relays for these contingencies result in meeting applicable ATC planning criteria. No angular instability was identified for these contingencies. All applicable NERC planning criteria was met for these contingencies.

(19) Nine NERC Category D2 and three NERC Category D3 contingencies resulted in un-acceptable performance for ATC stability and post-contingency voltage recovery criteria. Re-setting breaker failure relays for the category D2 and D3 contingencies result in meeting applicable ATC criteria. All applicable NERC planning criteria was met for these contingencies.

(20) No angular or voltage stability concerns were identified for this generator for the 2011 TYA.

Table ZS-8
Zone 1 Load and Generation

Zone 1	2012	2016	2021	2026
Peak Forecast (megawatts)	1657	1692.1	1758	1819.8
Average Peak Load Growth	N/A	0.53%	0.77%	0.69%
Existing Generation Capacity (megawatts)	1284.5	1284.5	1284.5	1284.5
Existing Capacity Less Load (megawatts)	-372.5	-407.6	-473.5	-535.3
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	1284.5	1284.5	1284.5	1284.5
Modeled Capacity Less Load (megawatts)	-372.5	-407.6	-473.5	-535.3

Table ZS-9
Zone 2 Load and Generation

Zone 2	2012	2016	2021	2026
Peak Forecast (megawatts)	844.3	867.6	890.5	913.7
Average Peak Load Growth	N/A	0.68%	0.52%	0.52%
Existing Generation Capacity (megawatts)	867.2	867.2	867.2	867.2
Existing Capacity Less Load (megawatts)	22.9	-0.4	-23.3	-46.5
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	867.2	867.2	867.2	867.2
Modeled Capacity Less Load (megawatts)	22.9	-0.4	-23.3	-46.5

Table ZS-10
Zone 3 Load and Generation

Zone 3	2012	2016	2021	2026
Peak Forecast (megawatts)	2975.9	3124.5	3363.2	3600.4
Average Peak Load Growth	N/A	1.23%	1.48%	1.37%
Existing Generation Capacity (megawatts)	1203.2	1203.2	1203.2	1203.2
Existing Capacity Less Load (megawatts)	-1772.7	-1921.3	-2160	-2397.2
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	1203.2	1351.9	1351.9	1351.9
Modeled Capacity Less Load (megawatts)	-1772.7	-1772.6	-2011.3	-2248.5

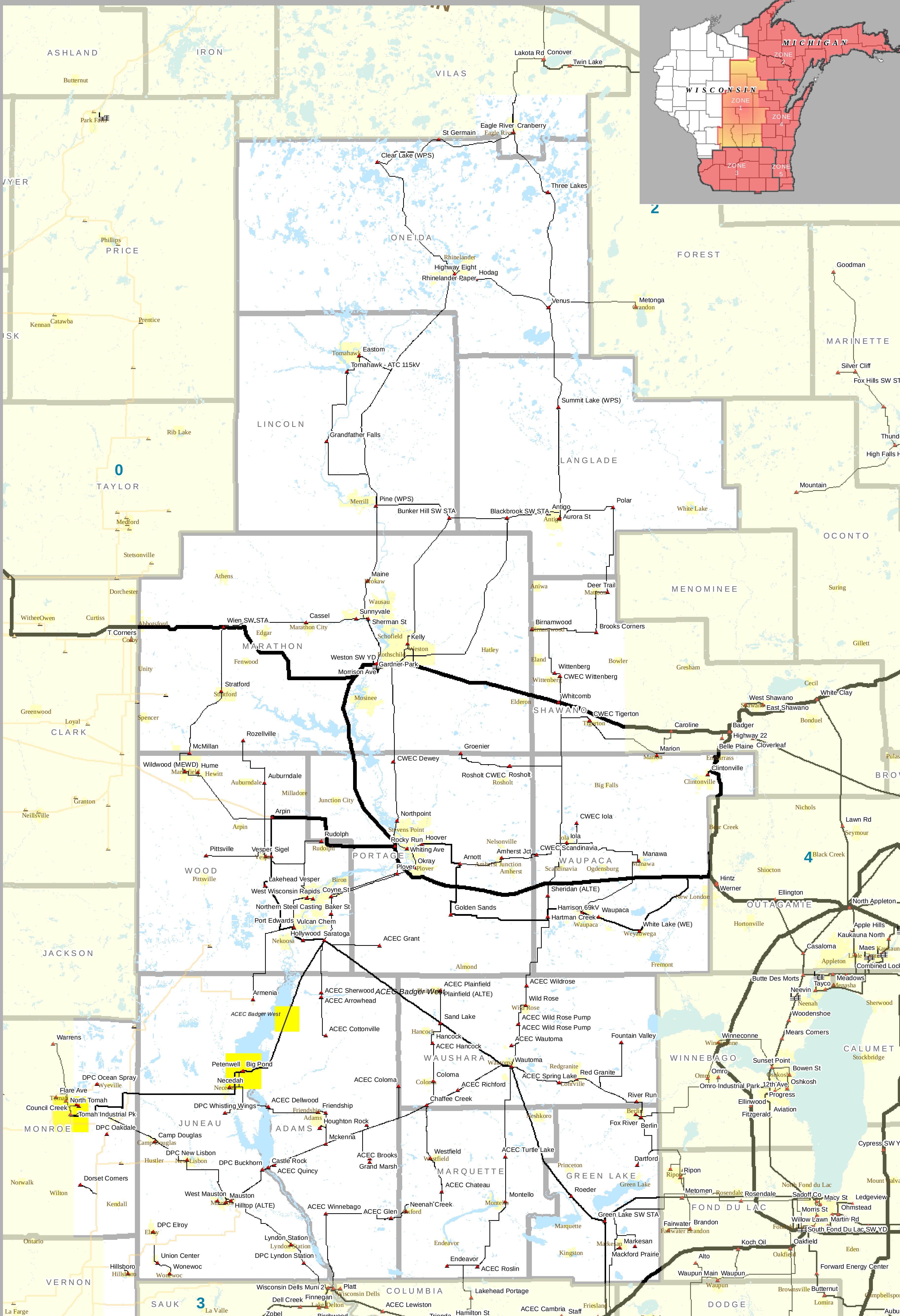
Table ZS-11
Zone 4 Load and Generation

Zone 4	2012	2016	2021	2026
Peak Forecast (megawatts)	3226.9	3296.6	3427.1	3548.3
Average Peak Load Growth	N/A	0.54%	0.78%	0.70%
Existing Generation Capacity (megawatts)	5310.6	5310.6	5310.6	5310.6
Existing Capacity Less Load (megawatts)	2083.7	2014	1883.5	1762.3
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5645.7	5994.2	5994.2	5994.2
Modeled Capacity Less Load (megawatts)	2418.8	2697.6	2567.1	2445.9

Table ZS-12
Zone 5 Load and Generation

Zone 5	2012	2016	2021	2026
Peak Forecast (megawatts)	4553.1	4784.4	5093.1	5408.9
Average Peak Load Growth	N/A	1.25%	1.26%	1.21%
Existing Generation Capacity (megawatts)	5535	5535	5535	5535
Existing Capacity Less Load (megawatts)	981.9	750.6	441.9	126.1
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5535	5535	5535	5535
Modeled Capacity Less Load (megawatts)	981.9	750.6	441.9	126.1

Figure ZS-1



Performance Criteria Exceeded and Other Constraints (2011-2012)

PLANNING ZONE 1

Currently, ATC owns or operates transmission facilities in Wisconsin, Illinois, Minnesota, and the Upper Peninsula of Michigan. Facilities include:

- * Approximately 9440 miles of transmission lines
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- * 419 jointly owned substations
- * ATC offices in Madison, Cottage Grove, Pewaukee, DePere, and Kingsford, MI

High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Non-ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)
- Non-ATC Transmission Line

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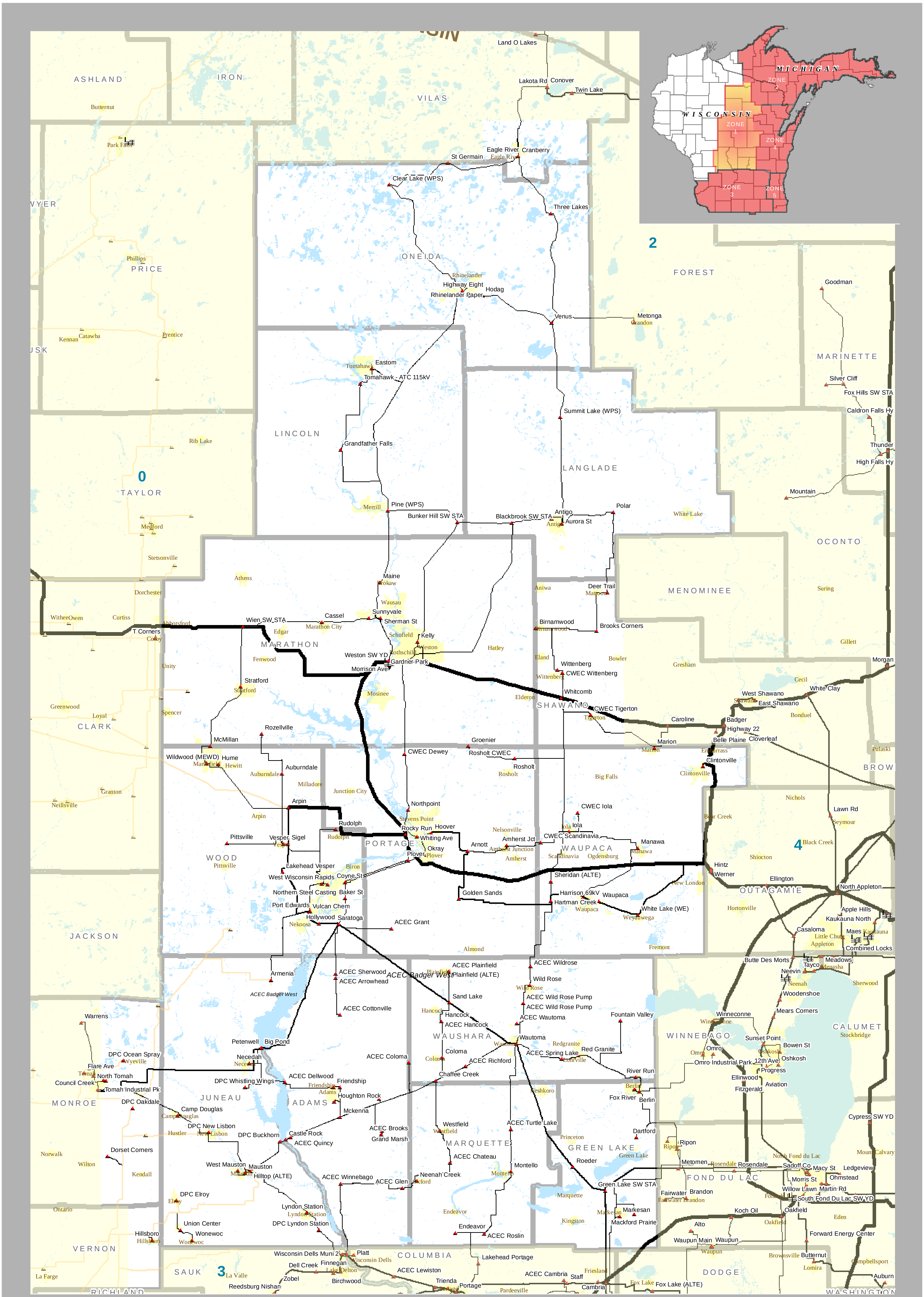
Updated June 20, 2011

Figure ZS-2



Performance Criteria Exceeded and Other Constraints (2013-2016)

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High or Low Bus Voltage

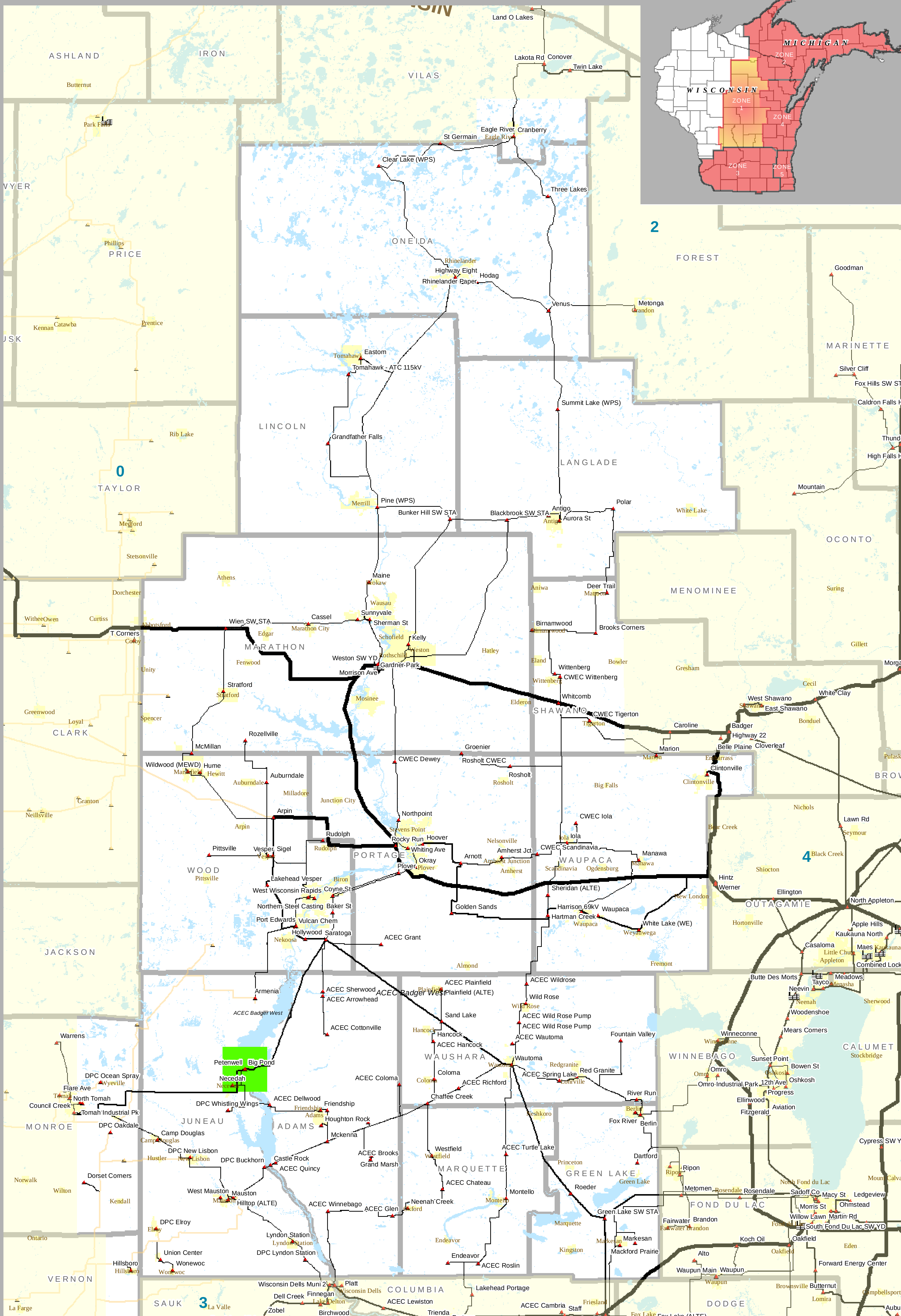
Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Non-ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)
- Non-ATC Transmission Line

Updated June 20, 2011

Figure ZS-3



PLANNING ZONE 1

Performance Criteria Exceeded and Other Constraints (2017-2021)

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

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- Generation
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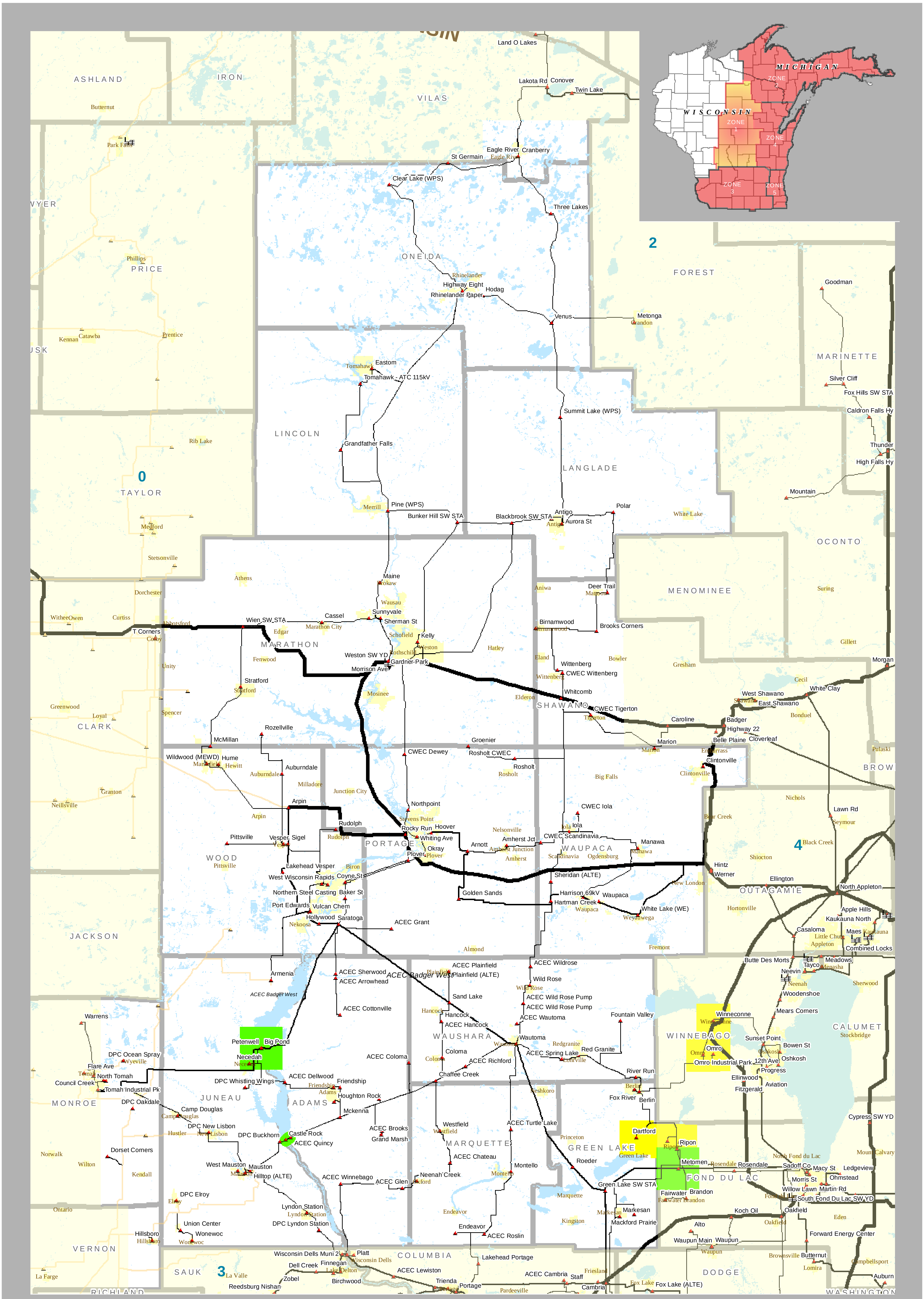
Updated June 20, 2011

Figure ZS-4



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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
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- Non-ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)
- Non-ATC Transmission Line

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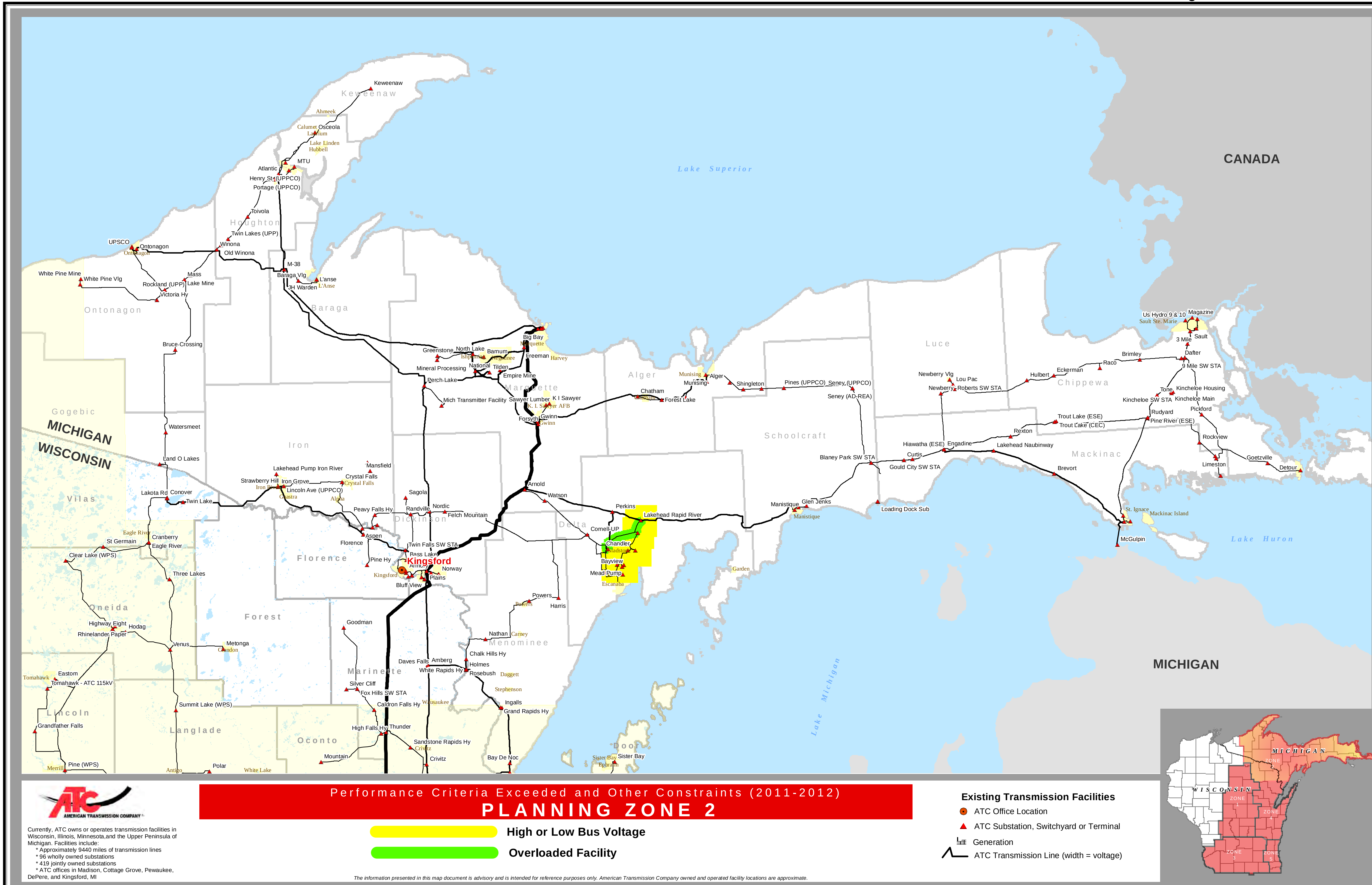
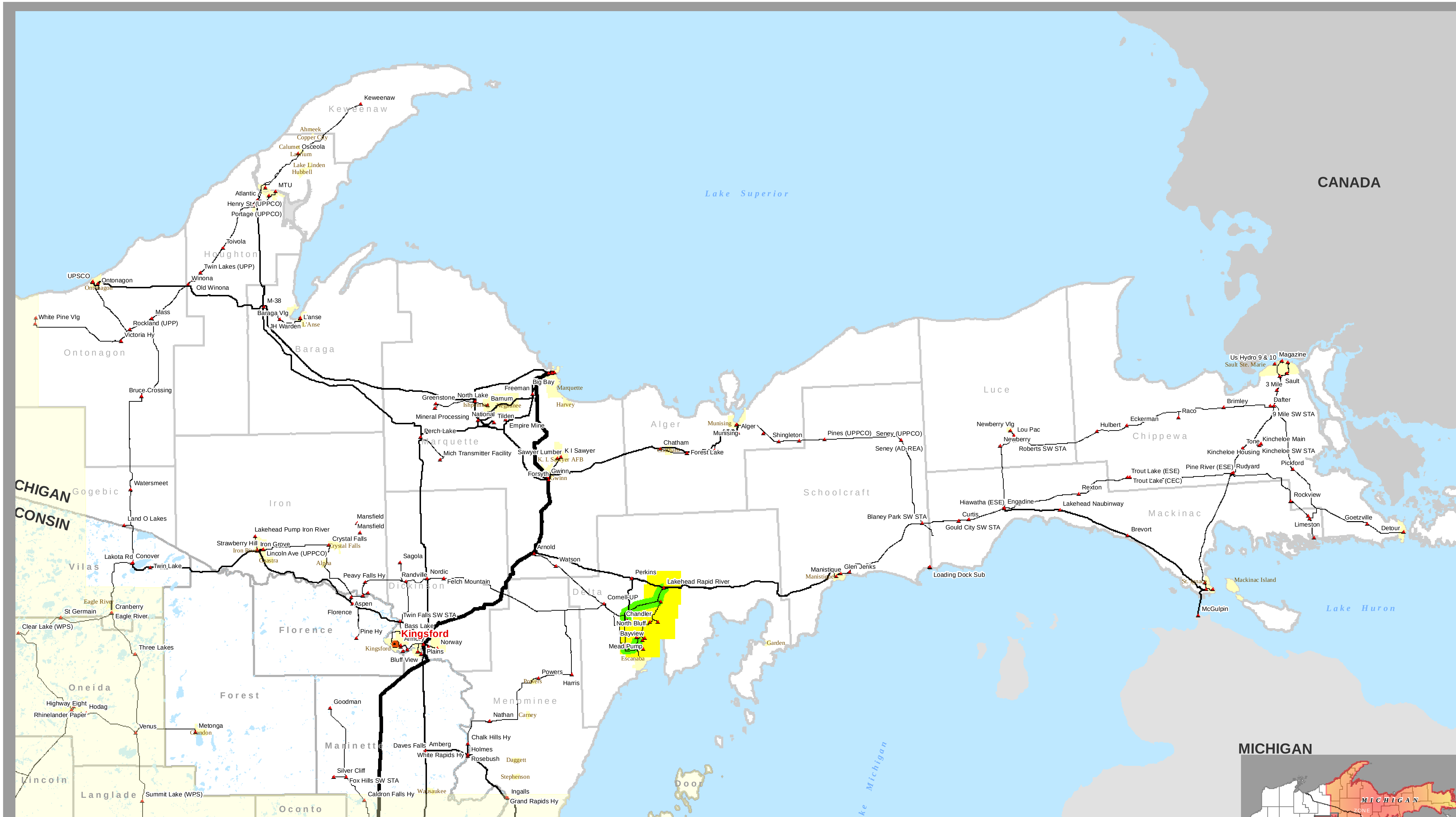
Updated June 20, 2011

Figure ZS-5



Modified: June 20, 2011

Figure ZS-6



AMERICAN TRANSMISSION COMPANY

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Performance Criteria Exceeded and Other Constraints (2013-2016)

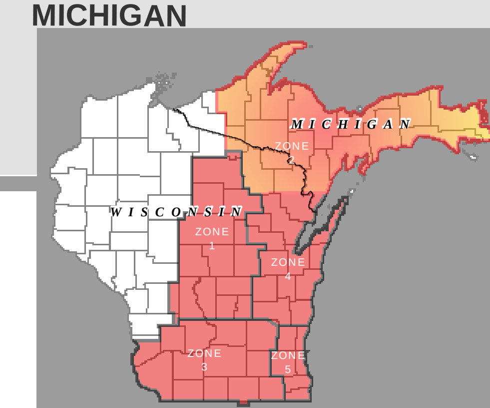
PLANNING ZONE 2

High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)



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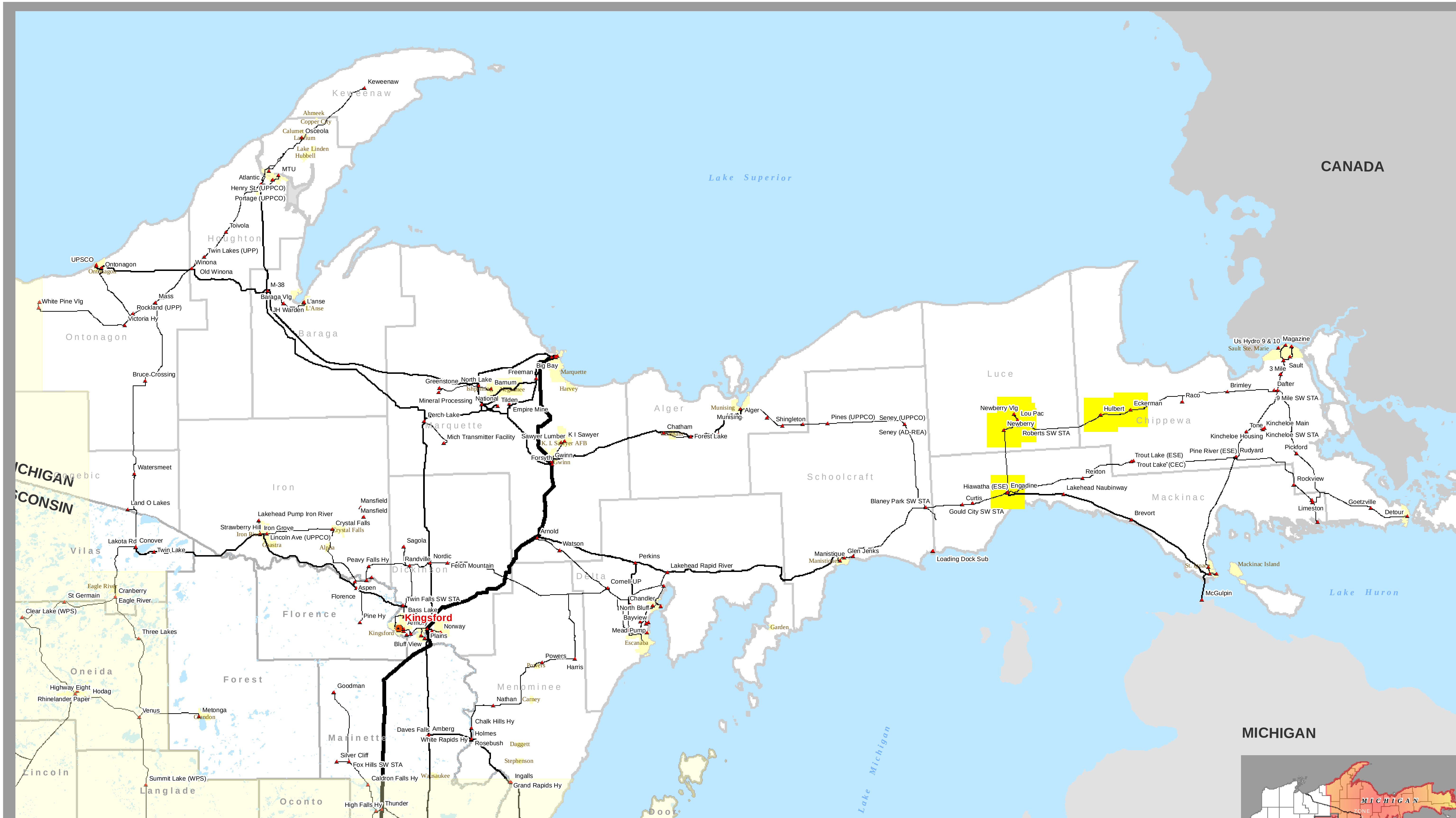
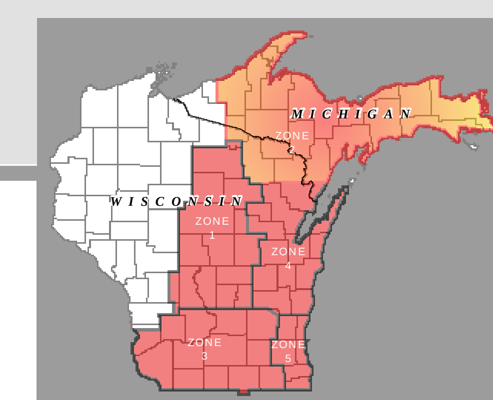
Updated June 20, 2011

Figure ZS-7





AMERICAN TRANSMISSION COMPANY

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Performance Criteria Exceeded and Other Constraints (2017-2021)
PLANNING ZONE 2

High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities
- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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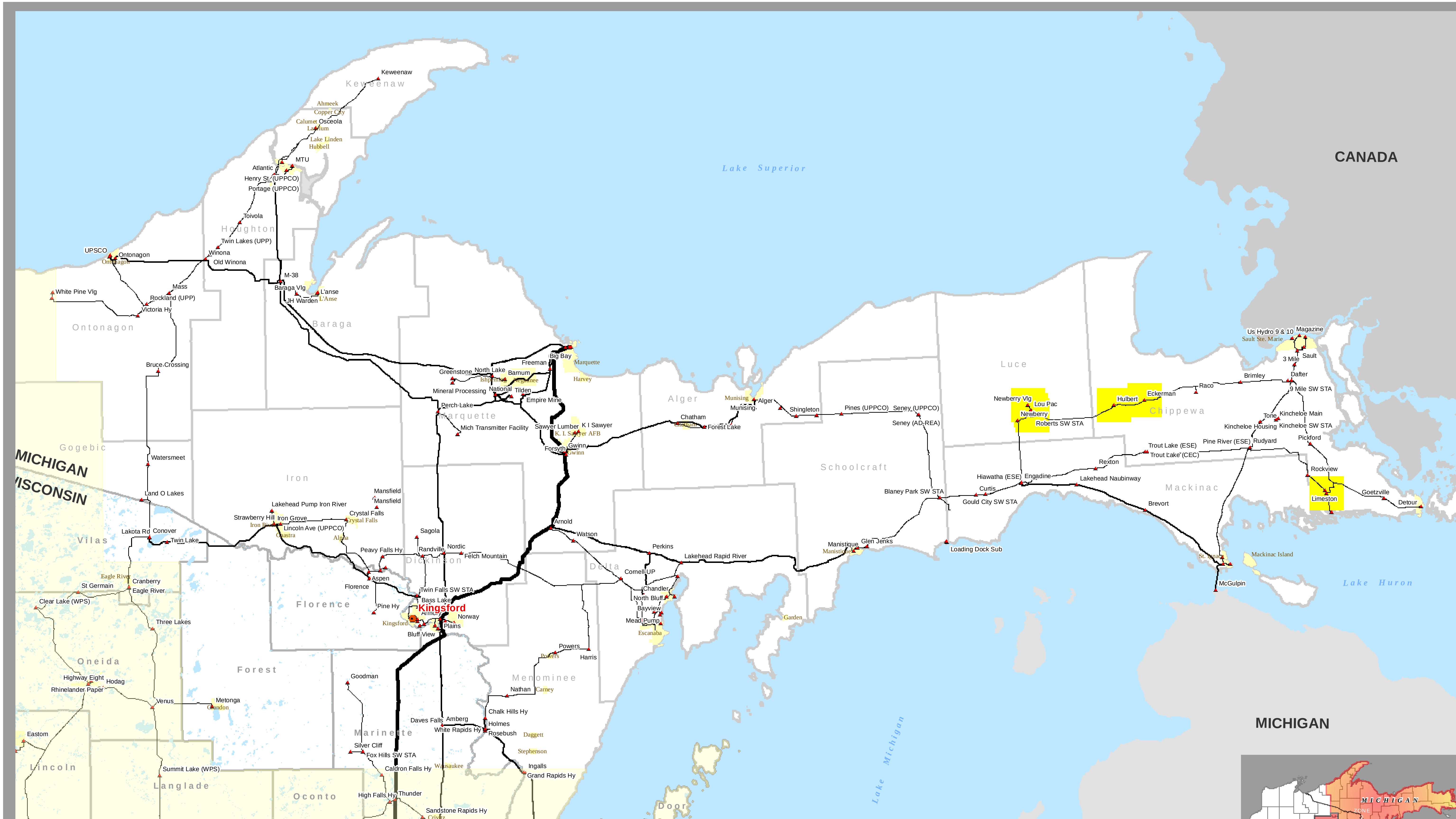
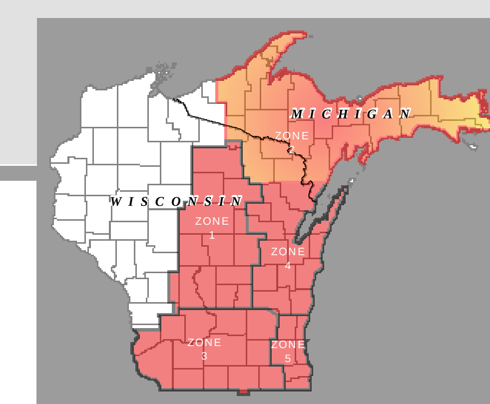
Updated June 20, 2011





ATC AMERICAN TRANSMISSION COMPANY

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Performance Criteria Exceeded and Other Constraints (2012-2026)

PLANNING ZONE 2

High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities
- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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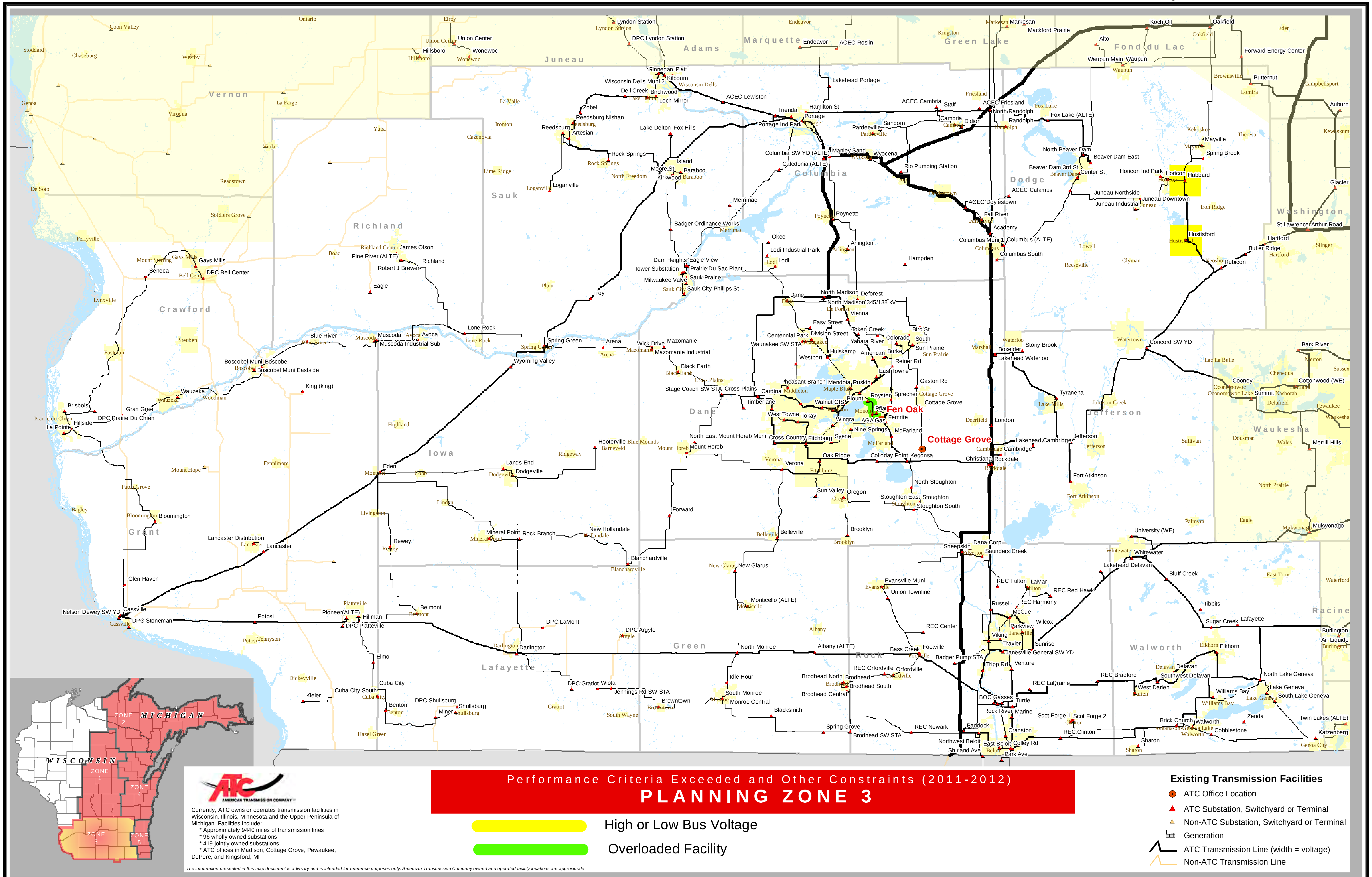
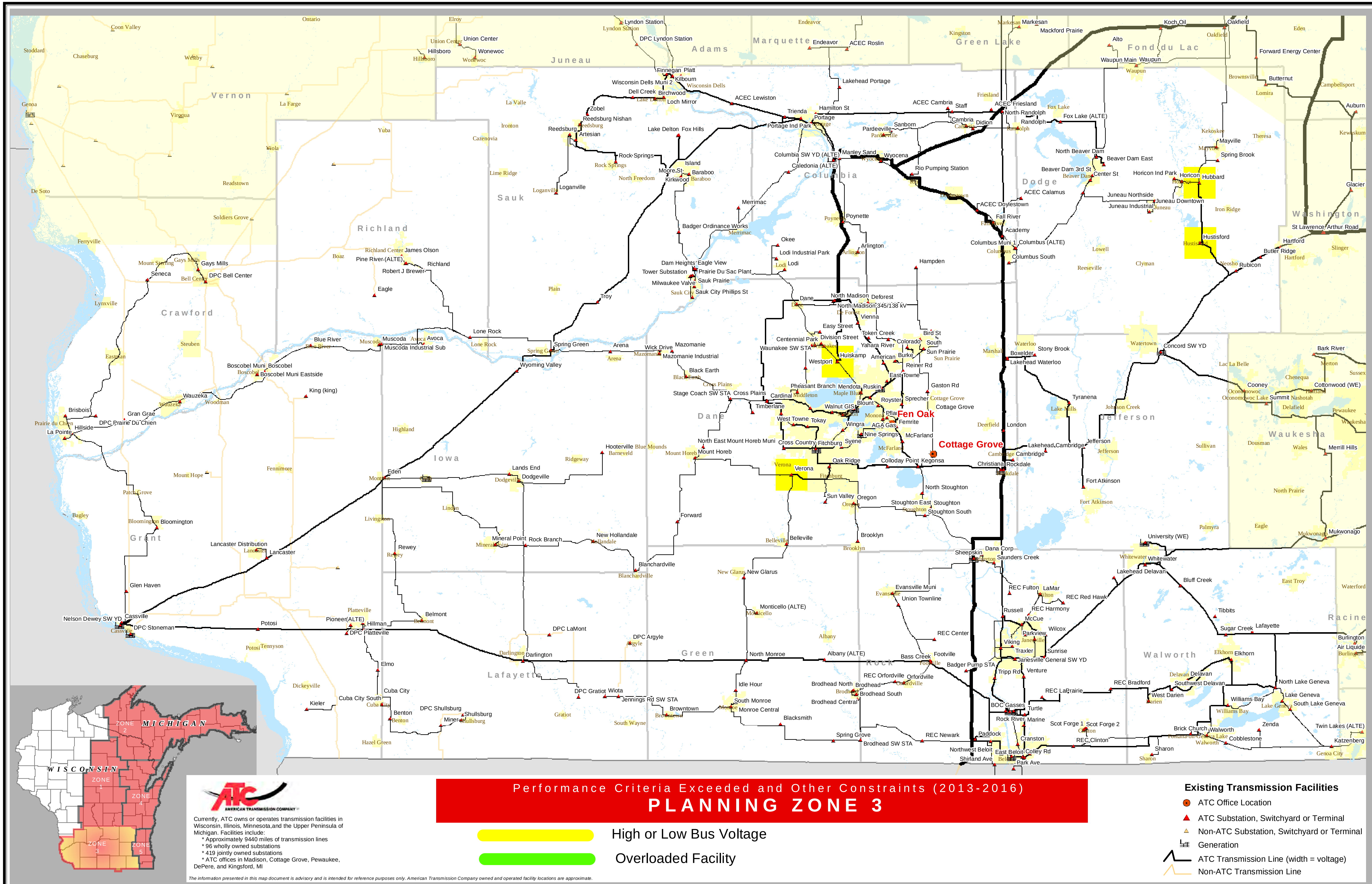
Updated June 20, 2011

Figure ZS-9



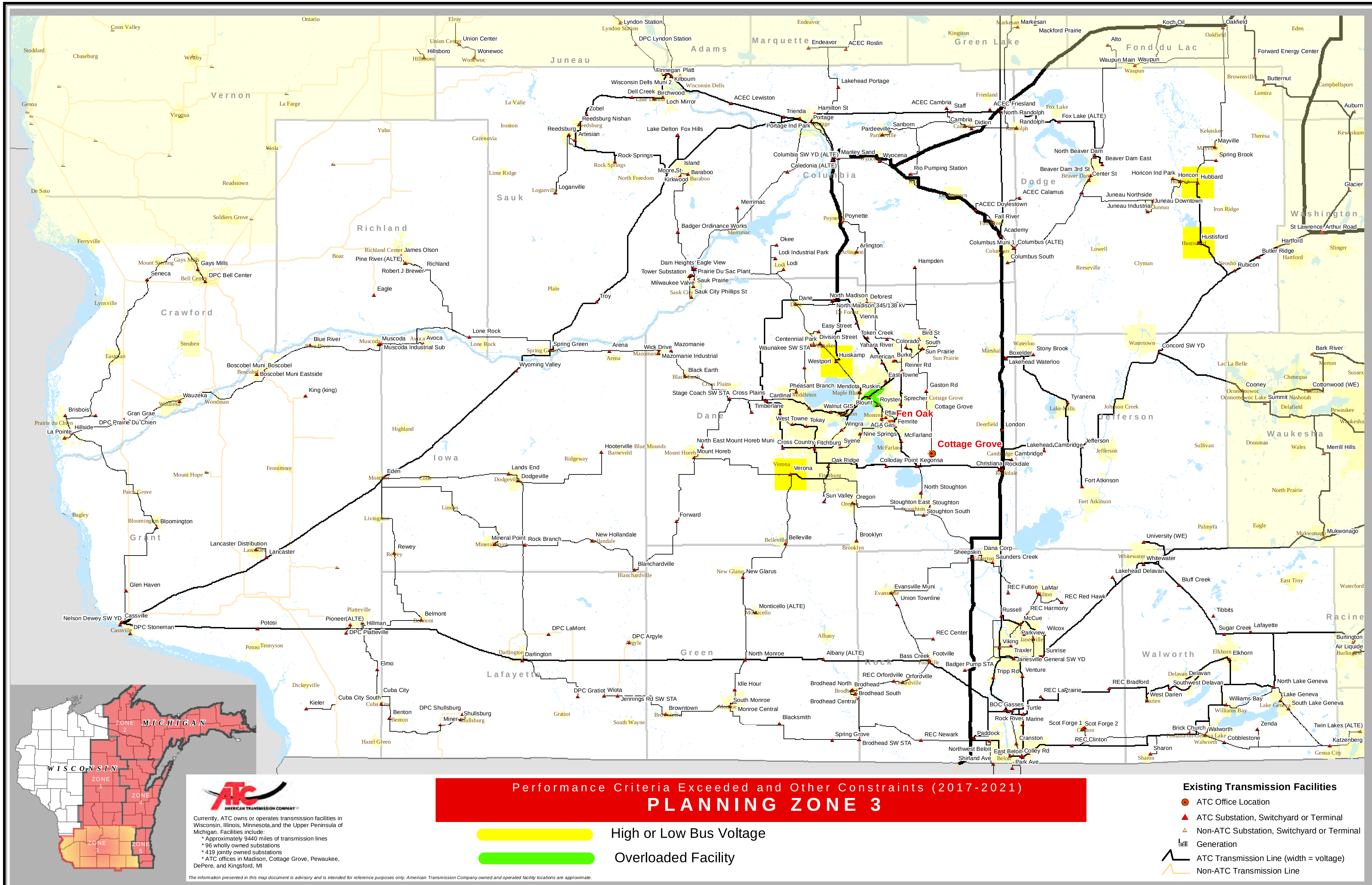
Modified: June 20, 2011

Figure ZS-10



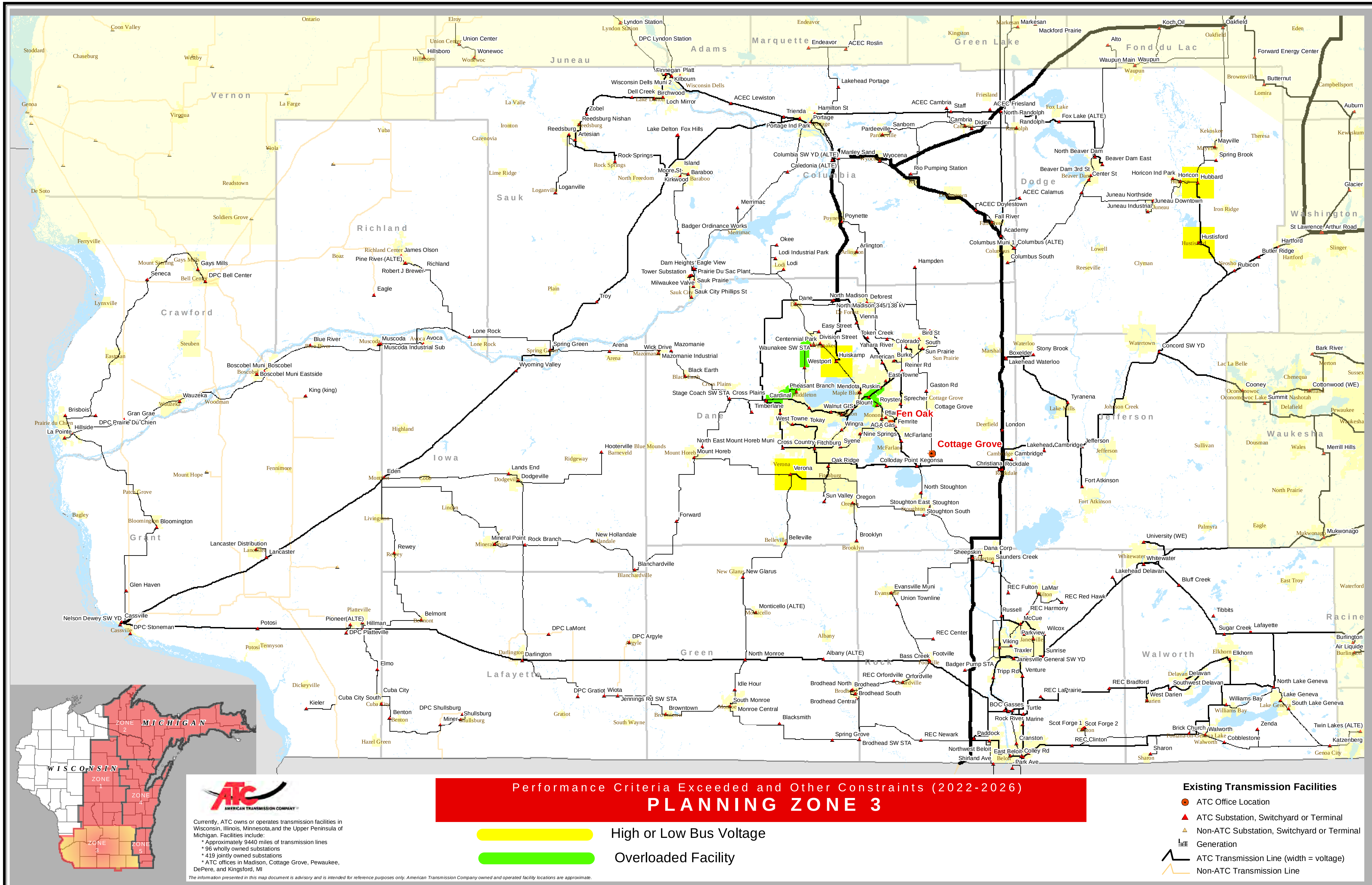
Updated June 20, 2011

Figure ZS-11



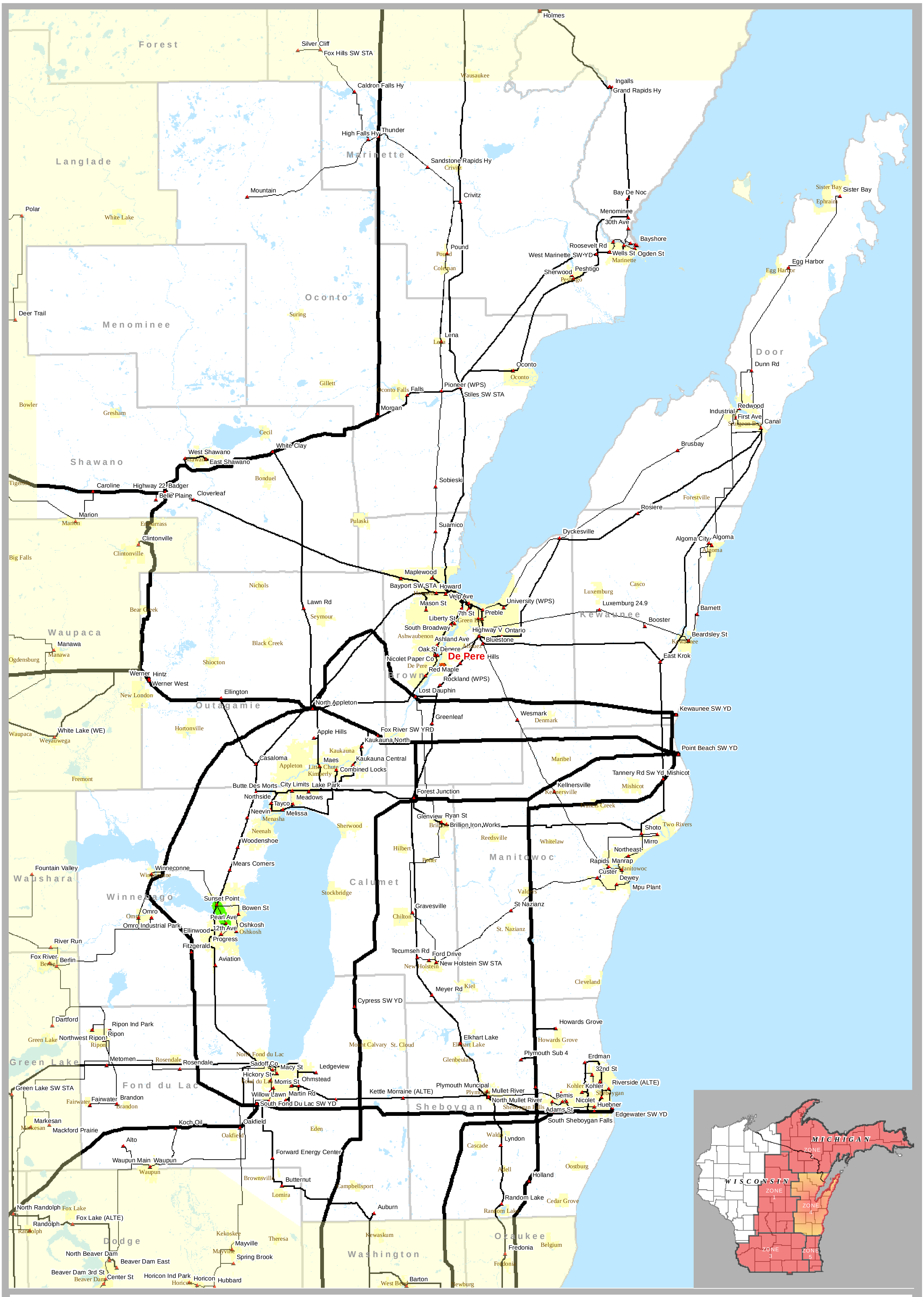
Updated June 20, 2011

Figure ZS-12



Updated June 20, 2011

Figure ZS-13



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints (2011-2012)

PLANNING ZONE 4

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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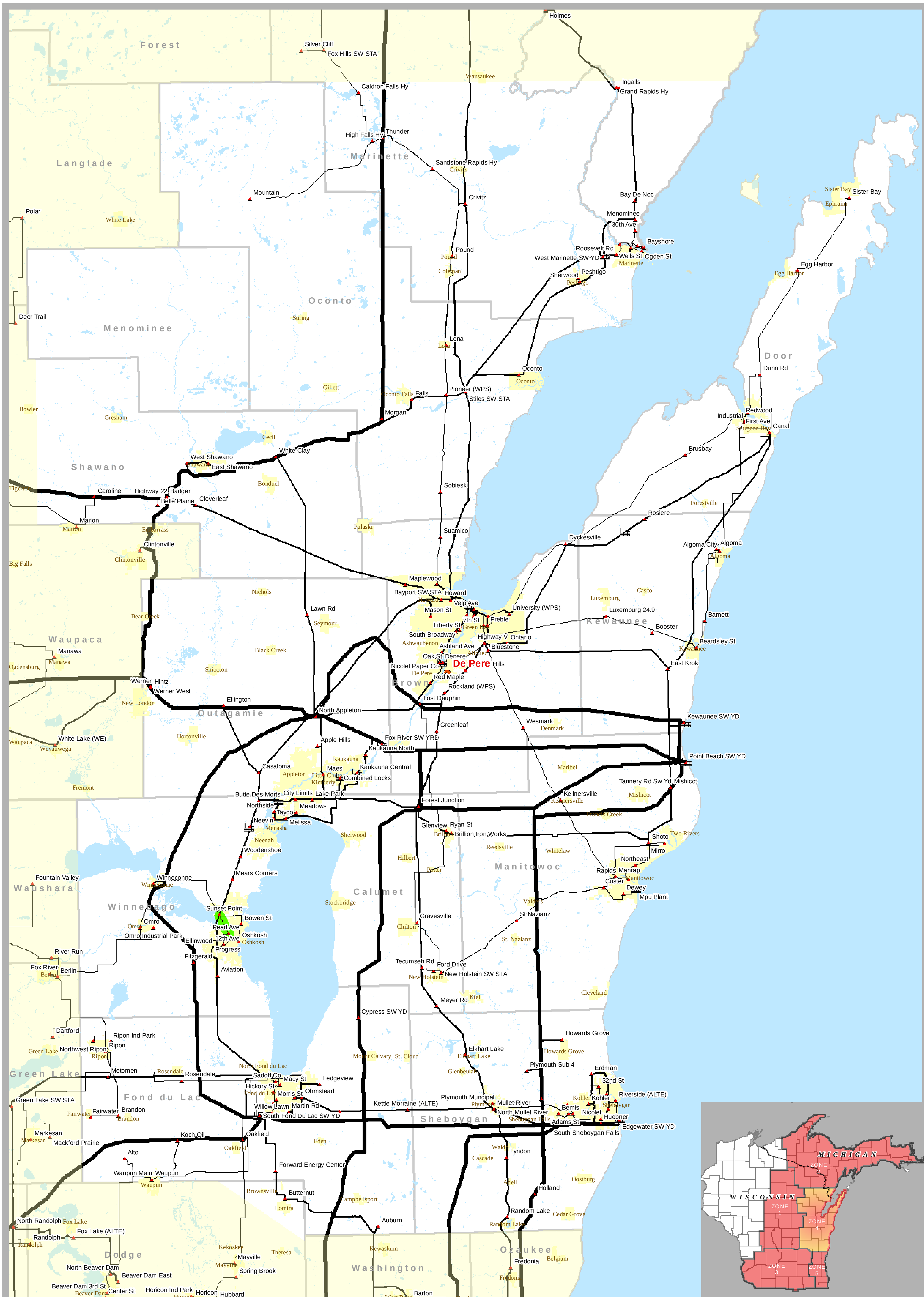
Updated June 20, 2011

Figure ZS-14



ATC AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints (2013-2016)

PLANNING ZONE 4

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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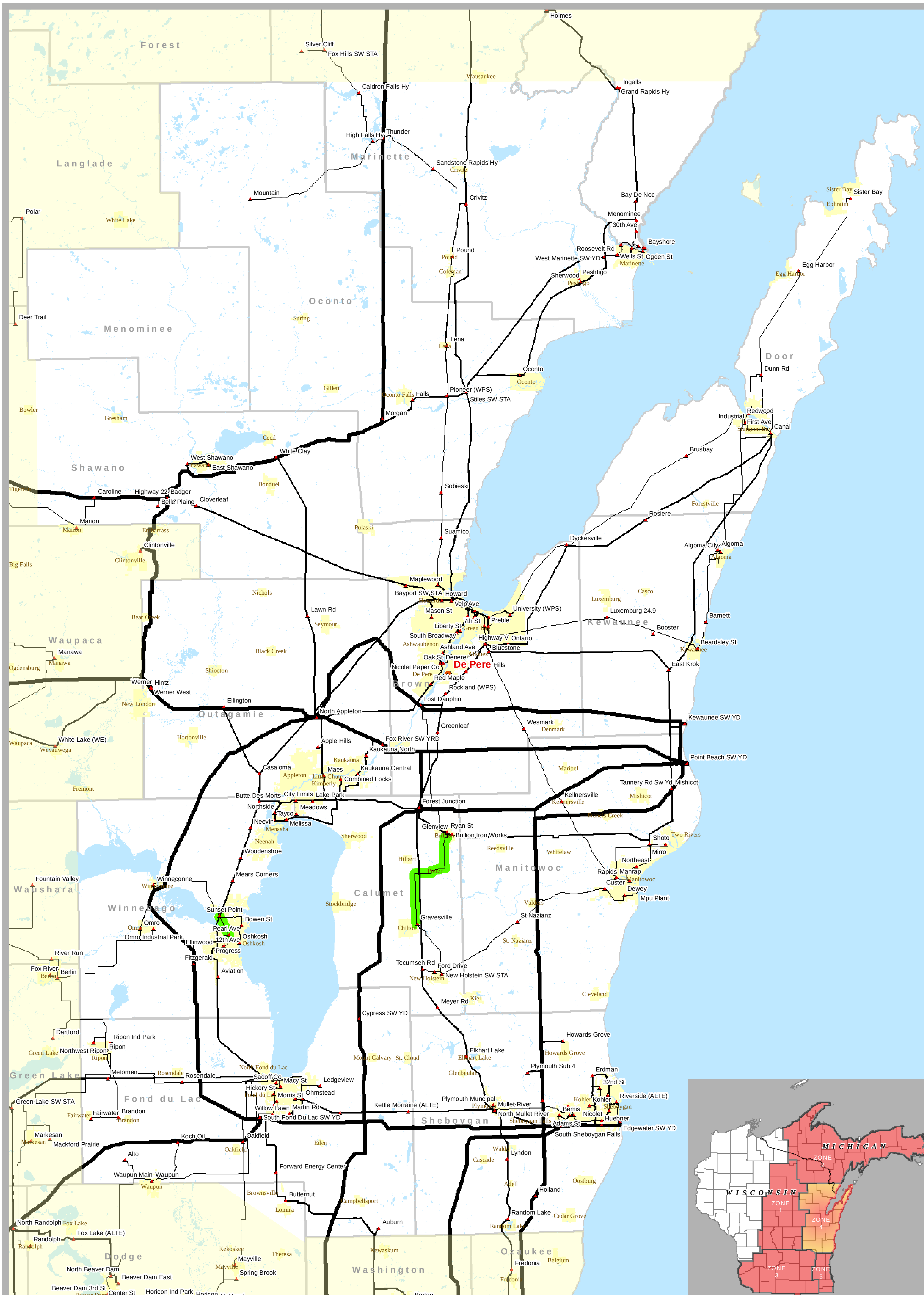
Updated June 20, 2011



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints (2017-2021)

PLANNING ZONE 4

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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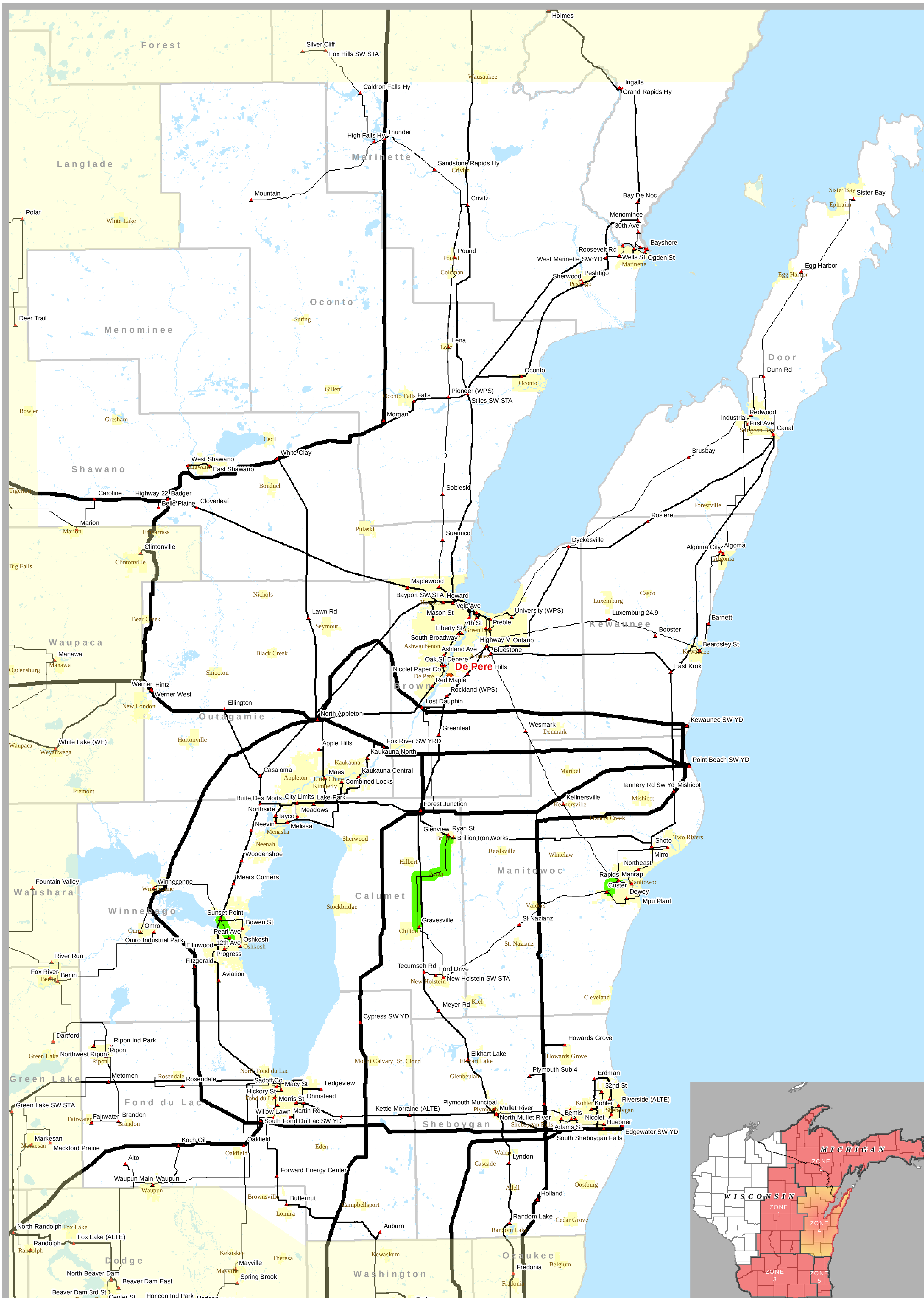
Updated June 20, 2011



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceeded and Other Constraints (2022-2026)

PLANNING ZONE 4

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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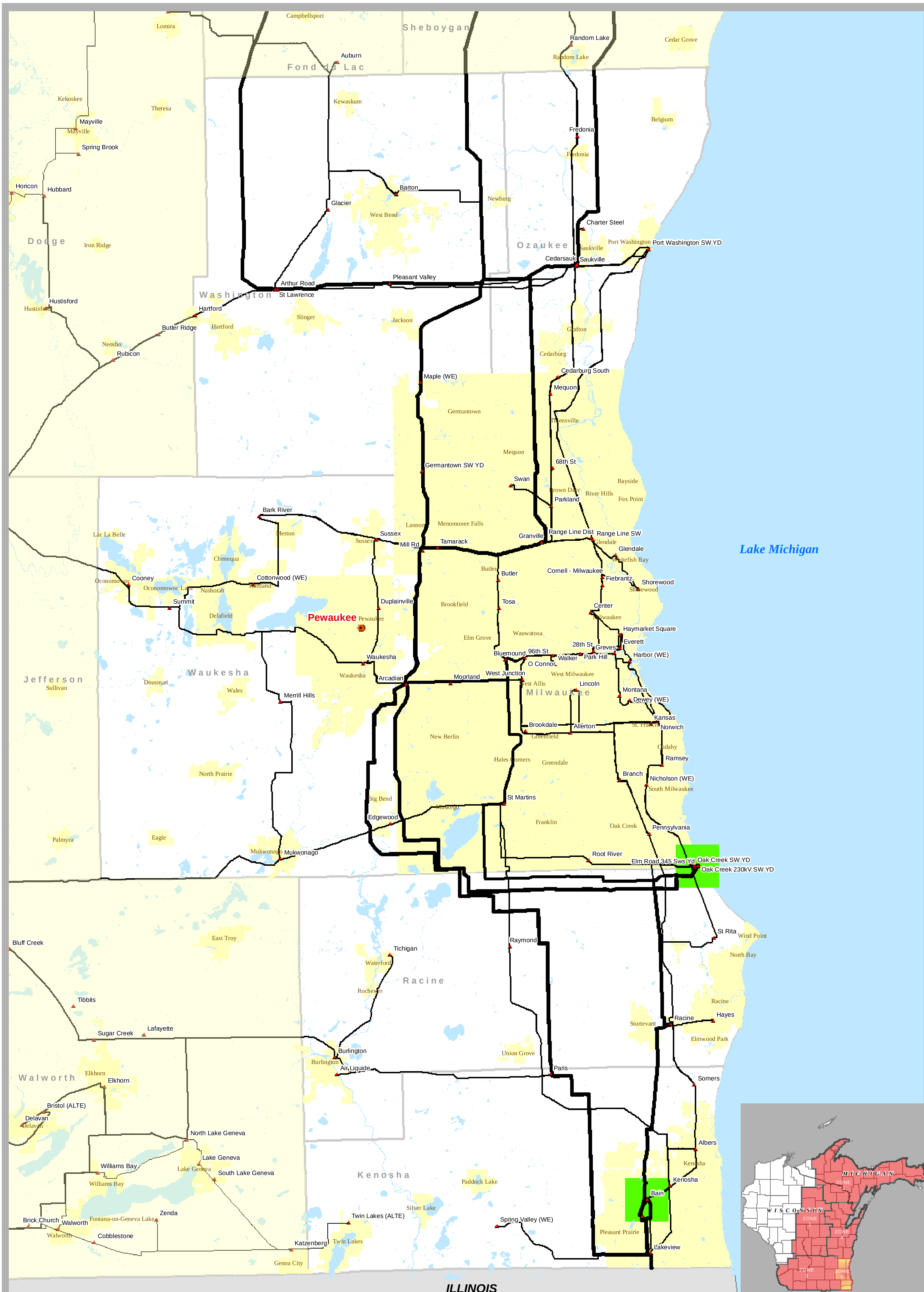
Updated June 20, 2011

Figure ZS-17



Performance Criteria Exceed and Other Constraints (2011-2012)

PLANNING ZONE 5

AMERICAN TRANSMISSION COMPANY

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High or Low Bus Voltage

Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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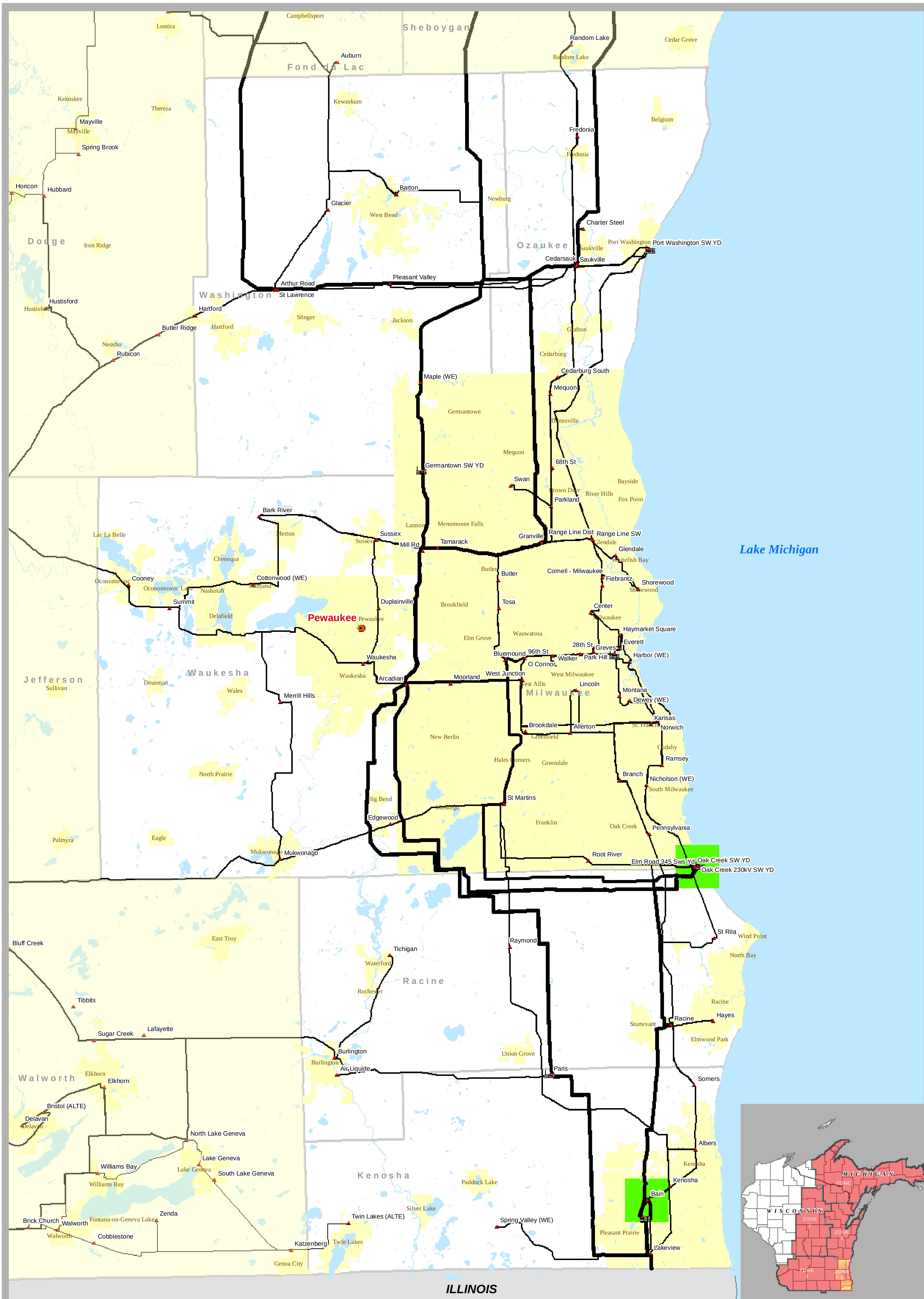
Updated June 20, 2011

Figure ZS-18



Performance Criteria Exceed and Other Constraints (2013-2016)

PLANNING ZONE 5

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High or Low Bus Voltage

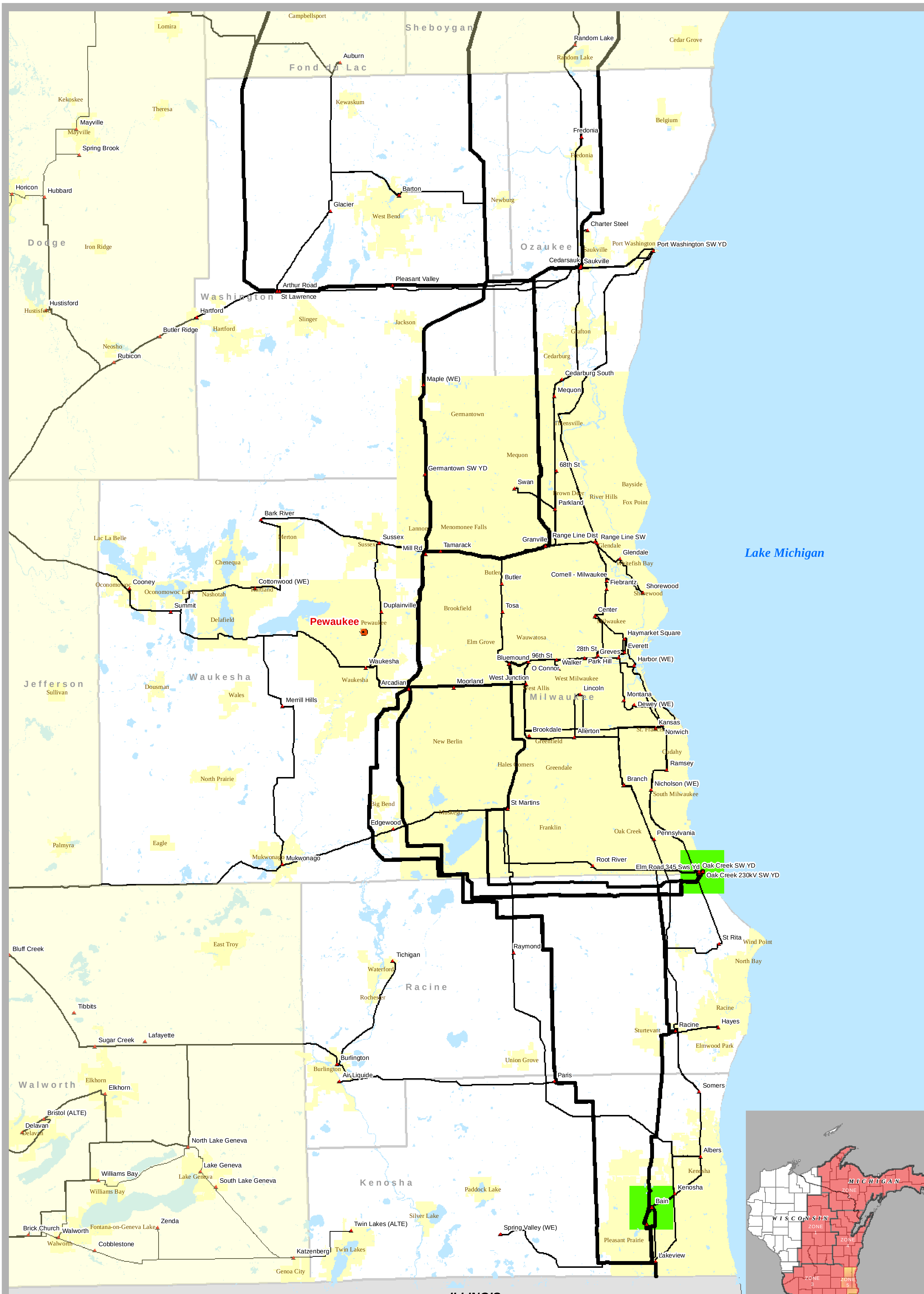
Overloaded Facility

Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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 20, 2011



Performance Criteria Exceed and Other Constraints (2017-2021)

PLANNING ZONE 5

Currently, ATC owns or operates transmission facilities in Wisconsin, Illinois, Minnesota, and the Upper Peninsula of Michigan. Facilities include:

* Approximately 9440 miles of transmission lines
* 96 wholly owned substations
* 419 jointly owned substations
* ATC offices in Madison, Cottage Grove, Pewaukee, DePere, and Kingsford, MI

High or Low Bus Voltage

Overloaded Facility

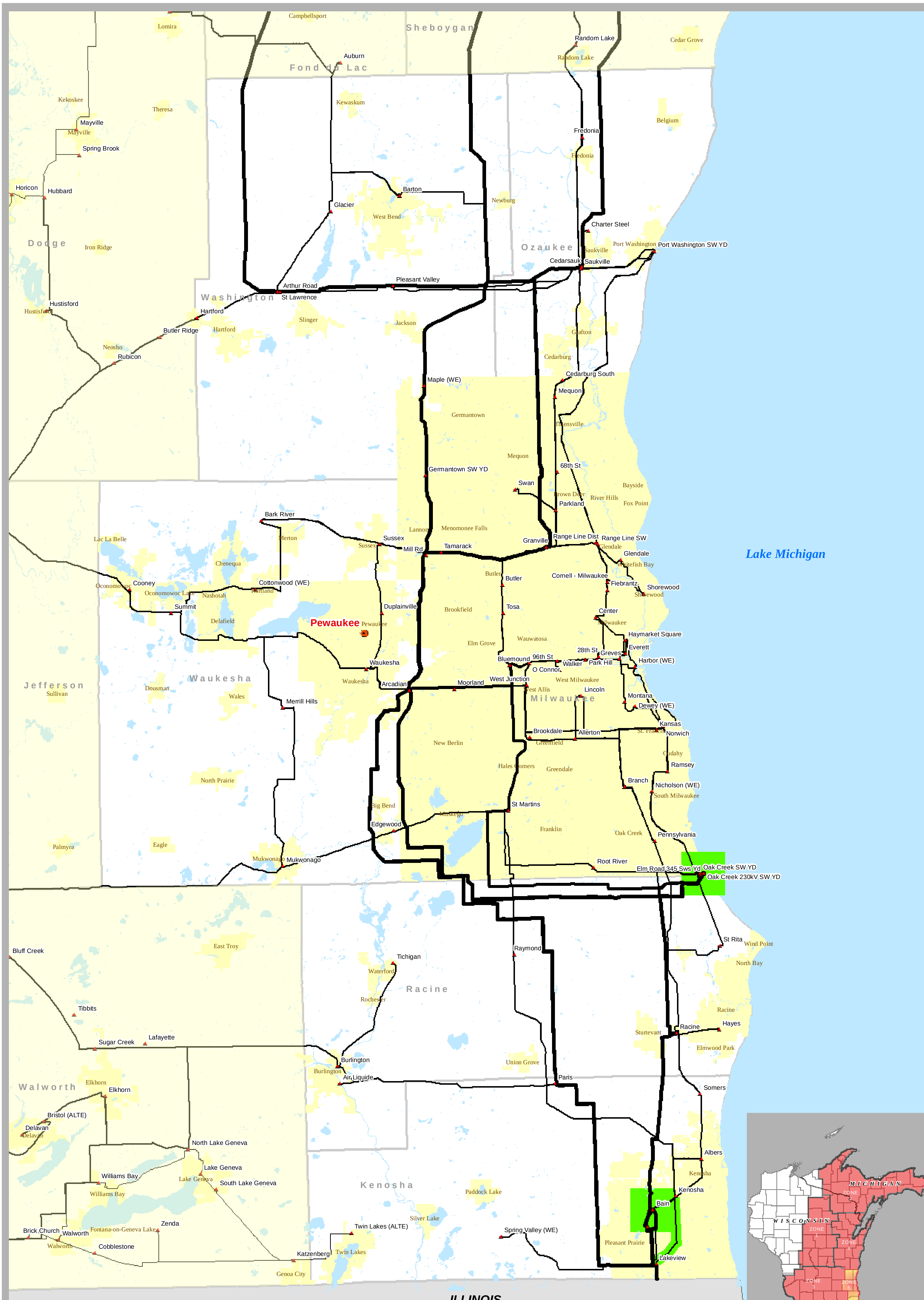
Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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 20, 2011

Figure ZS-20



AMERICAN TRANSMISSION COMPANY

Performance Criteria Exceed and Other Constraints (2022-2026)

PLANNING ZONE 5

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High or Low Bus Voltage

Overloaded Facility

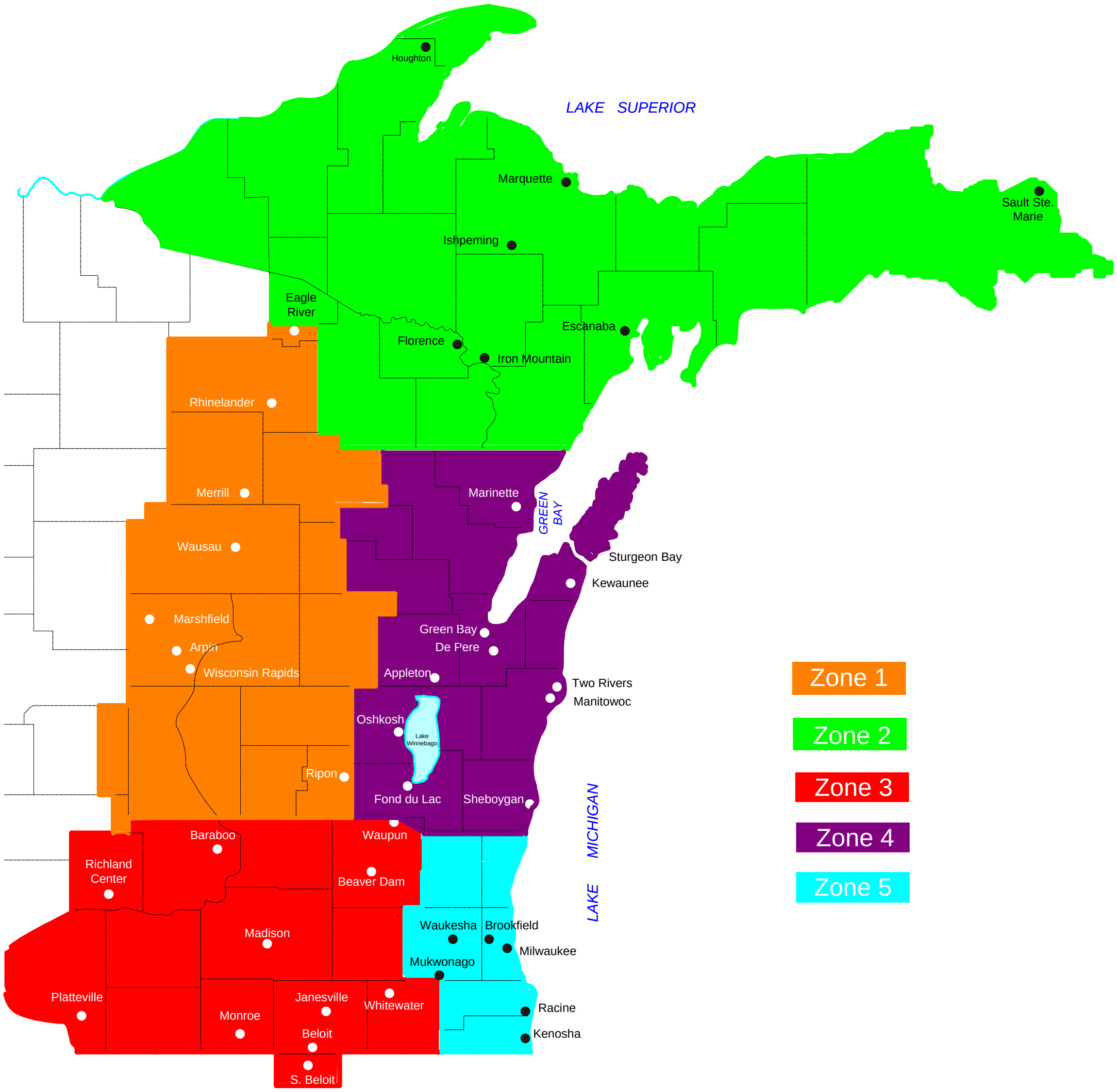
Existing Transmission Facilities

- ATC Office Location
- ATC Substation, Switchyard or Terminal
- Generation
- ATC Transmission Line (width = voltage)

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 20, 2011

Figure ZS-21



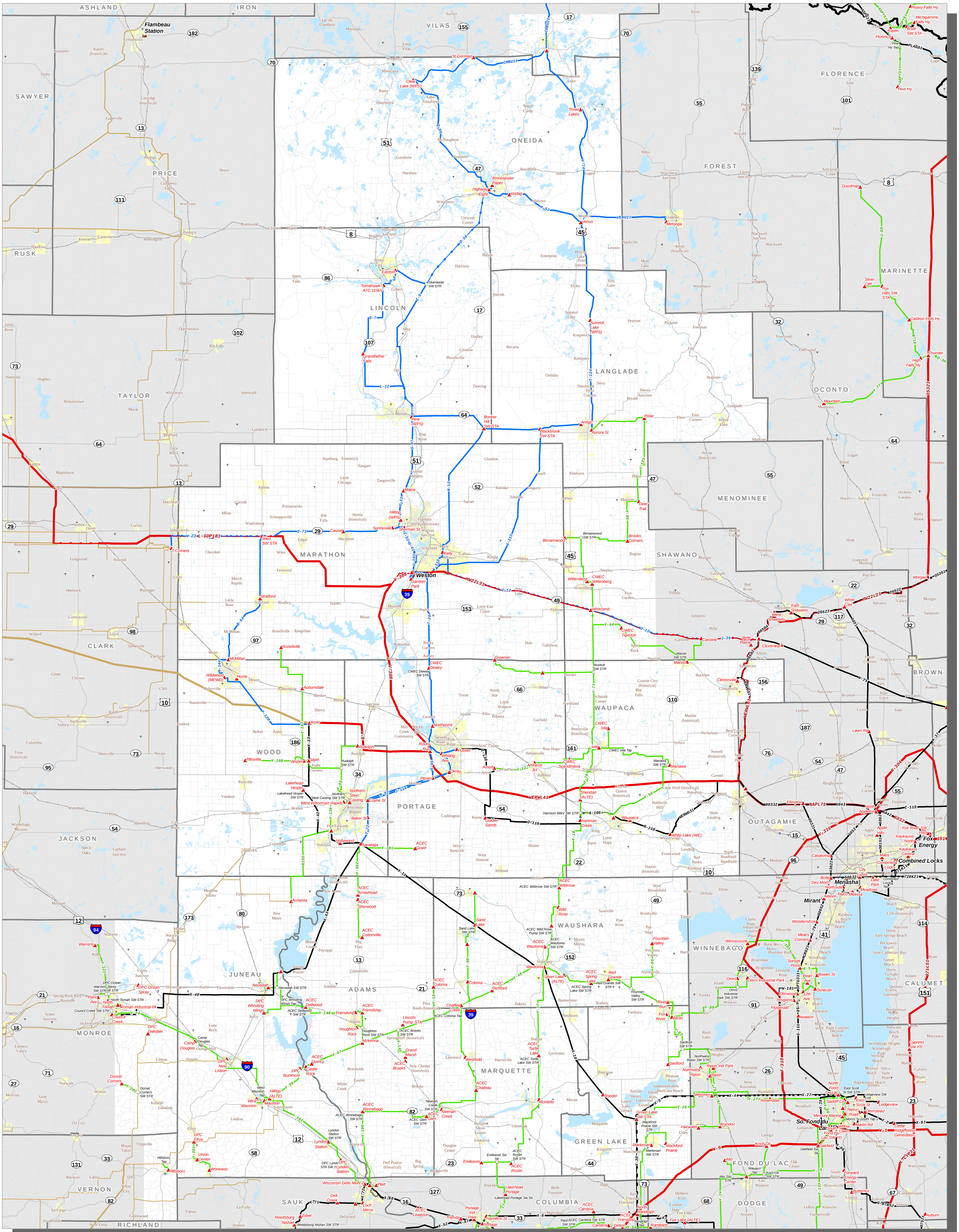
Houghton
LAKE SUPERIOR
Marquette
Sault Ste. Marie
Ishpeming
Eagle River
Escanaba
Florence
Iron Mountain
Rhinelander
Merrill
Marinette
GREEN BAY
Wausau
Sturgeon Bay
Kewaunee
Marshfield
Arpin
Wisconsin Rapids
Green Bay
De Pere
Appleton
Two Rivers
Manitowoc
Oshkosh
Lake Winnebago
Ripon
Fond du Lac
Sheboygan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

Figure ZS-22

AMERICAN TRANSMISSION COMPANY ®

Transmission Network and Substations

PLANNING ZONE 1



Electric Transmission and Related Facilities

Substation or Switchyard

Tap or Switching Structure

Generation

ATC Office Location

Airport, Airfield or Helicopter Landing Site

69 kV | 69 kV Double Circuit | 69 kV Underground

115 kV | 115 kV Double Circuit | 115 kV Underground

138 kV | 138 kV Double Circuit | 138 kV Underground

230 kV | 230 kV Double Circuit

345 kV | 345 kV Double Circuit

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

Non-ATC

69 kV

88 kV

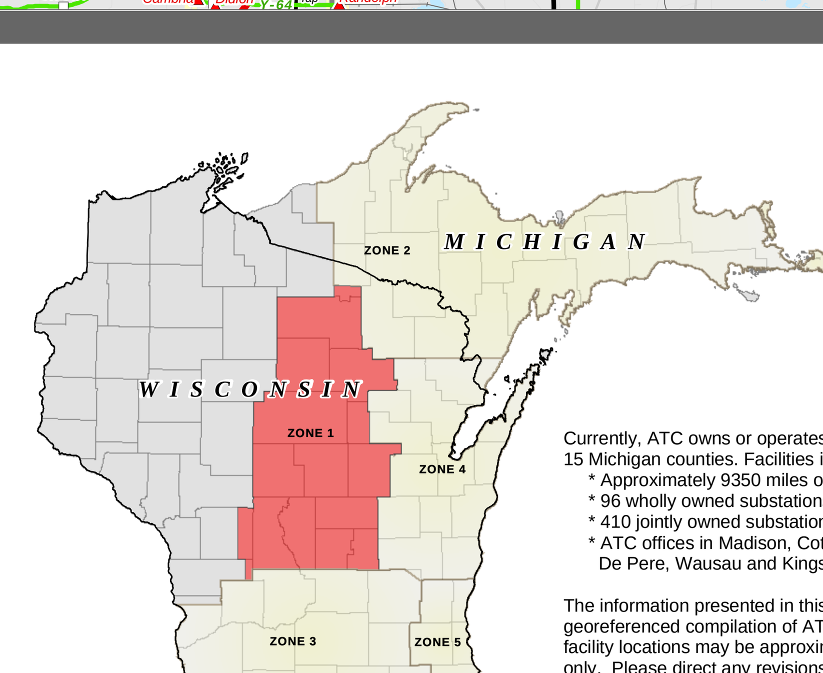
115 kV

161 kV

345 kV

Miles

10 0 10 20



N W E S

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

* Approximately 9350 miles of transmission lines
* 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 available - some facility locations may be approximate. This map is advisory and intended for reference purposes only. Please direct any revisions or corrections to ATC Asset Applications and GIS Group.

Base Map Information: ATC, PSCW, MiDNR, WDNR

Revised: Feb 2011

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Electrical Transmission and Related Facilities

Transmission Facilities

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

Transmission Line Voltage and Type

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

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

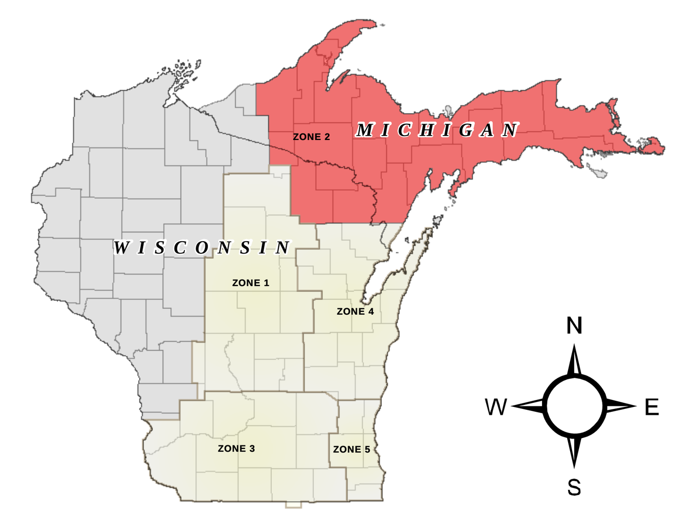
- MI Paved Airport or Airfield
- MI Unpaved Airport or Airfield
- WI Airport or Airfield

Transmission Network and Substations

PLANNING ZONE 2

Miles

10 0 10 20 30 40



N
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AMERICAN TRANSMISSION COMPANY ®

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Base Map Information: ATC, PSCW, MiDNR, WDNR

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Revised February 2011

Figure ZS-24

Electric Transmission and Related Facilities

Transmission Facilities

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

Transmission Line Voltage and Type

- 69 kV
- 115 kV
- 138 kV
- 161 kV
- 230 kV
- 345 kV
- 69 kV Double Circuit
- 115 kV Double Circuit
- 138 kV Double Circuit
- 161 kV Double Circuit
- 230 kV Double Circuit
- 345 kV Double Circuit
- 69 kV Underground
- 138 kV Underground
- Non-Op Underground

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

Non-ATC

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

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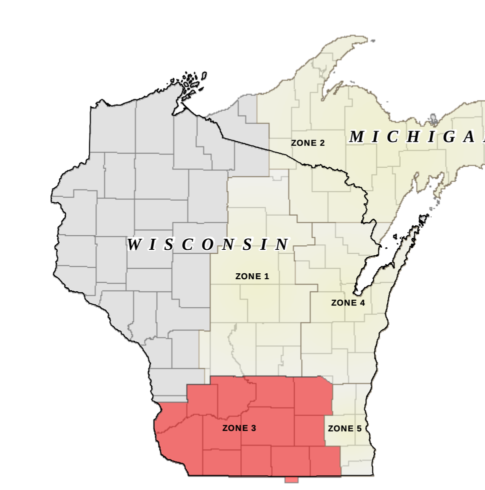
Transmission Network and Substations

PLANNING ZONE 3

Miles

5 0 5 10 15 20

Revised February 2011



N E S W

AMERICAN TRANSMISSION COMPANY®

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

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

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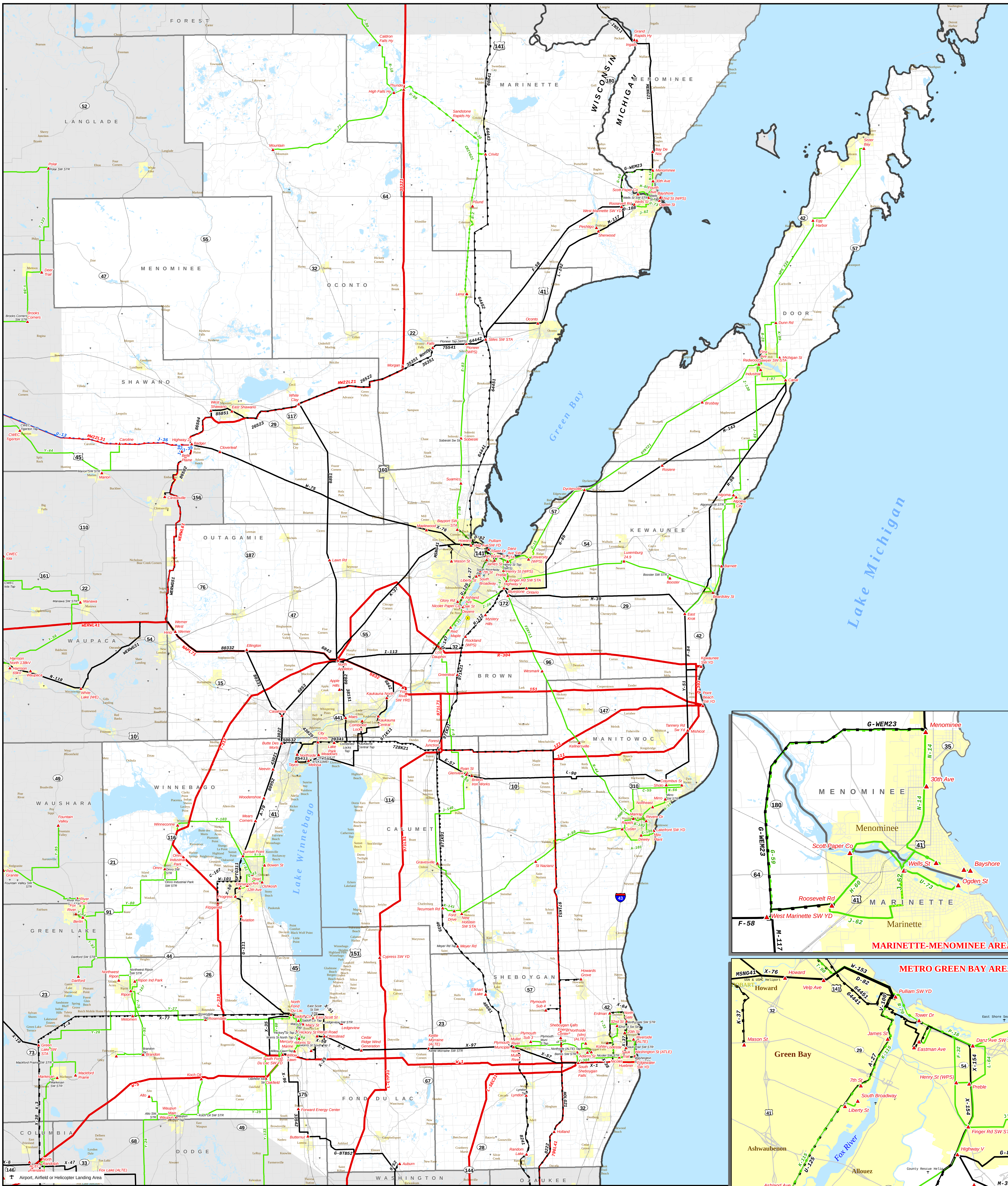
Base Map Information: ATC, PSCW, MiDNR, WDNR

AMERICAN TRANSMISSION COMPANY ®

Transmission Network and Substations

PLANNING ZONE 4



Electric Transmission and Related Facilities

Transmission Facilities

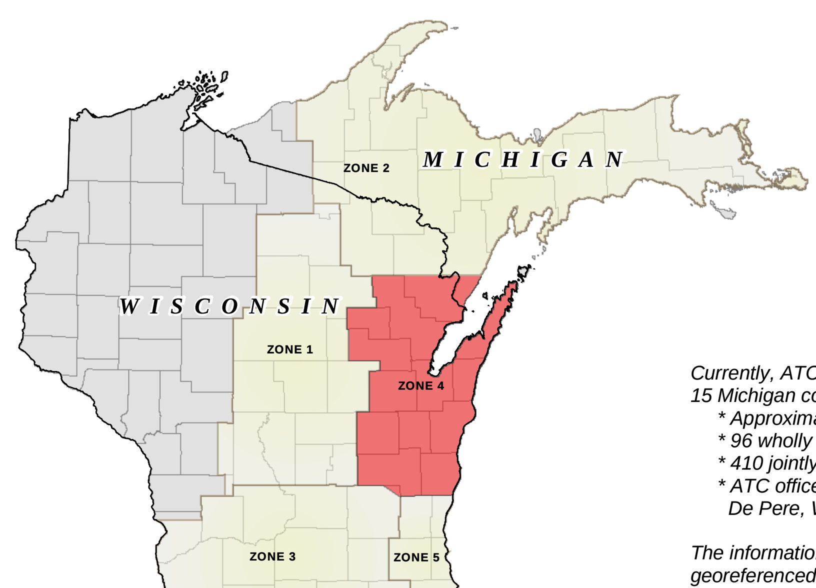
- Substation or SW YD
- Tap or Switching Structure
- ATC Office
- Generation

Transmission Line Voltage and Type

- < 50 kV
- 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

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

10 0 10 20 Miles



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Base Map Information: ATC, PSCW, MiDNR, WDNR

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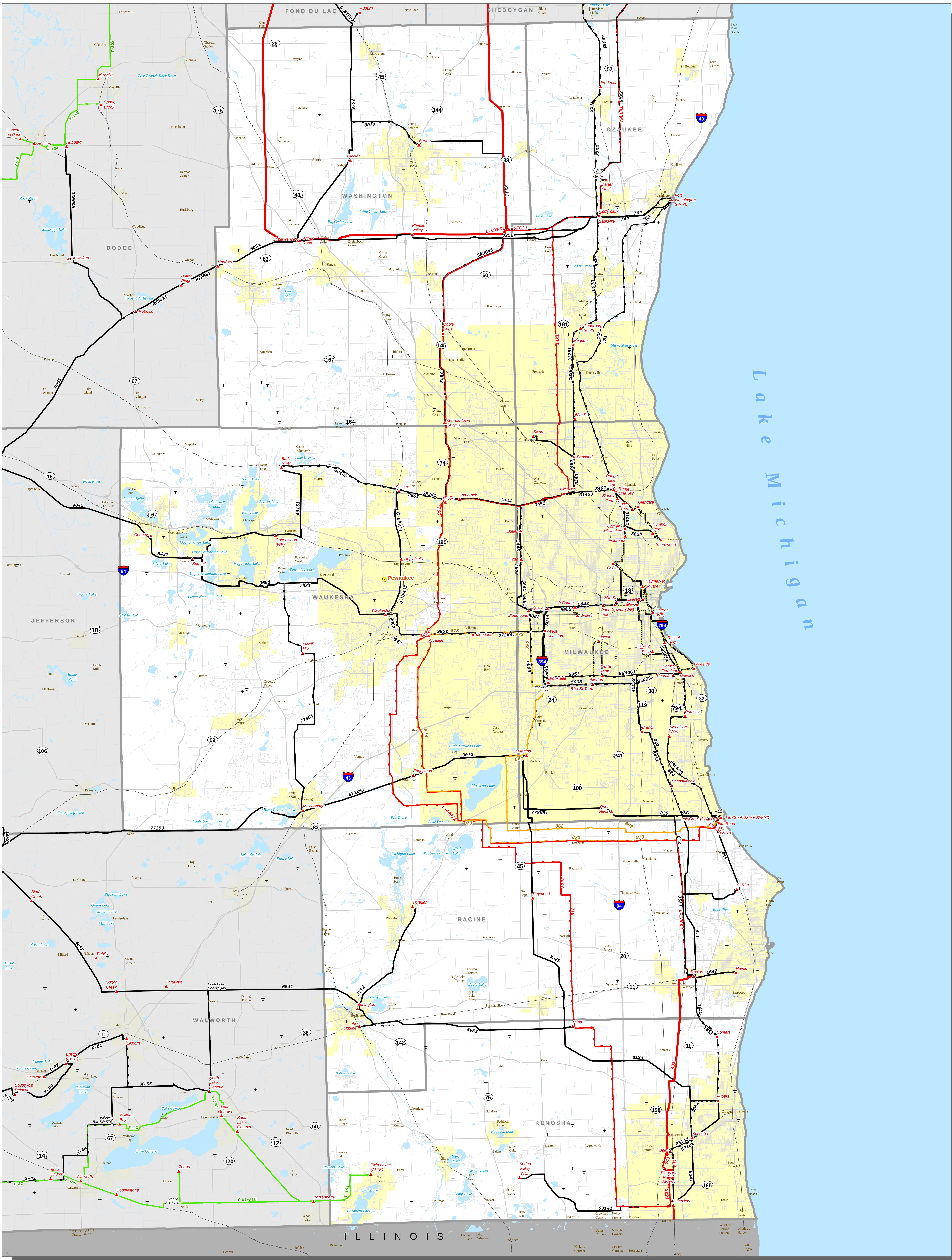
Figure ZS-26

AMERICAN TRANSMISSION COMPANY ®

Transmission Network and Substations

PLANNING ZONE 5



Electric Transmission and Related Facilities

Substation or Switchyard

Tap or Switching Structure

Generation

ATC Office Location

Airport, Airfield or Helicopter Landing Site

69 kV

115 kV

138 kV

230 kV

345 kV

69 kV Double Circuit

115 kV Double Circuit

138 kV Double Circuit

230 kV Double Circuit

345 kV Double Circuit

69 kV Underground

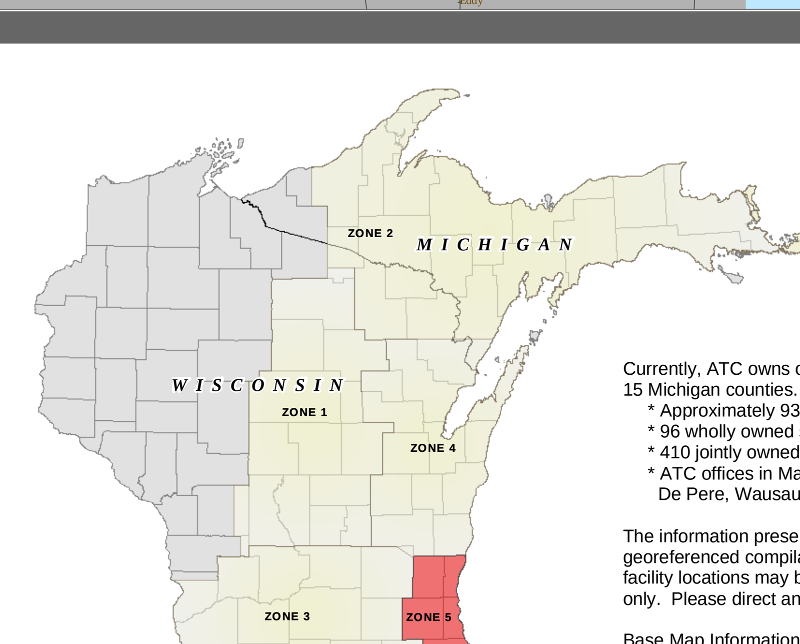
138 kV Underground

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

Miles

10 0 10

Revised February 2011



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Base Map Information: ATC, PSCW, MiDNR, WDNR

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Figure ZS-27
ATC Day Ahead Market Most Limiting Elements, 2010

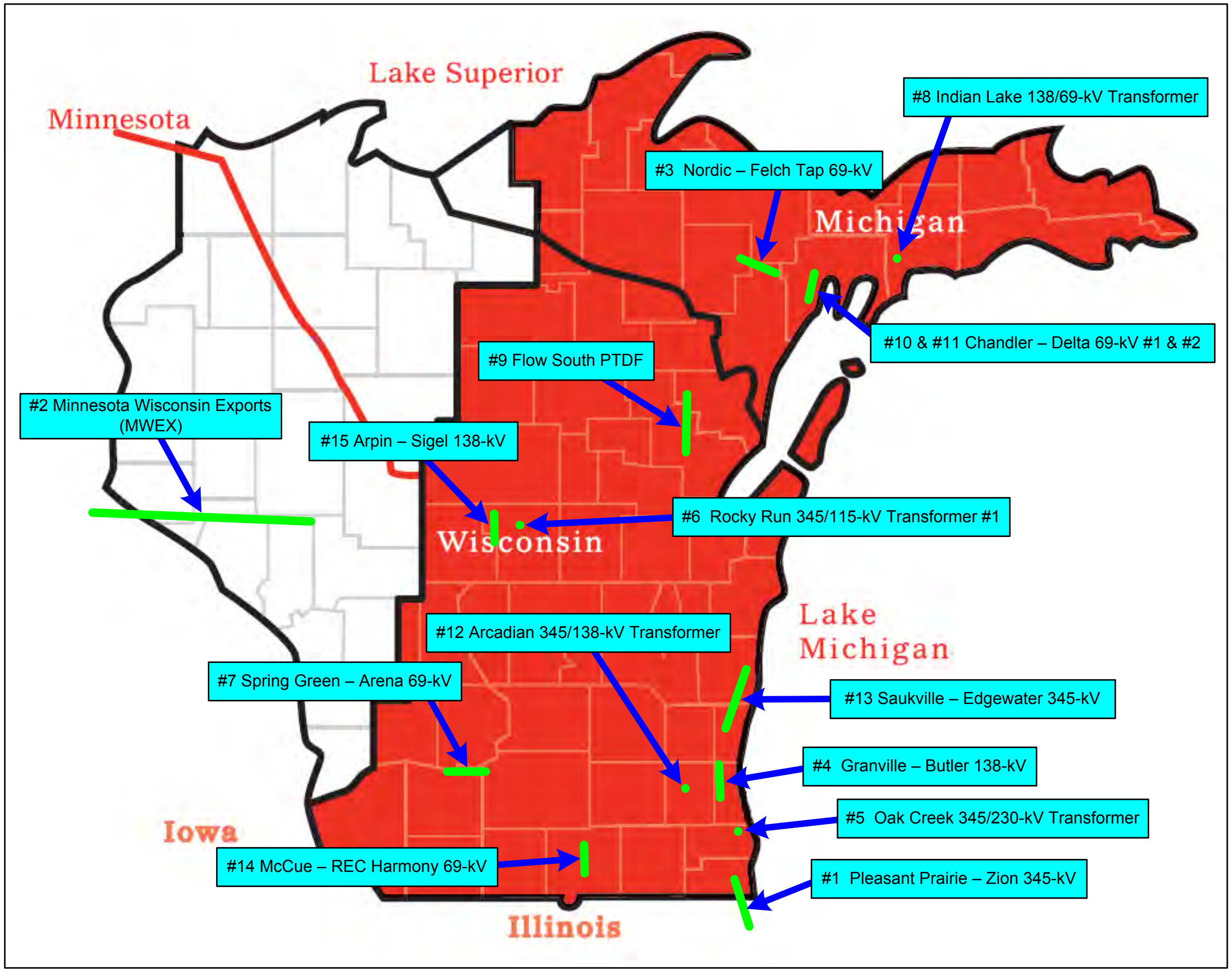

Figure ZS-28
ATC Real Time Market Most Limiting Elements, 2010