

## ZONE & STUDY RESULTS > Zone 1 overview

Zone 1 includes the Wisconsin counties of:

- Adams
- Green Lake
- Juneau
- Langlade
- Lincoln
- Marathon
- Marquette
- Monroe (eastern portion)
- Oneida
- Portage
- Shawano (western portion)
- Vernon (eastern portion)
- Waupaca
- Waushara
- Wood

The physical boundaries of Zone 1 and transmission facilities located in Zone 1 are shown in [Figure ZS-18](#).

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.

### Zone 1 demographics

The population of the counties in Zone 1 grew at an annual rate of 0.8 percent from 1994 to 2004. The highest growth rate occurred in Waushara County, which grew more than 2 percent, while the highest increase in population occurred in Marathon County, which added more than 9,000 people.

During the same period, the employment growth rate was 1.4 percent. The highest employment growth rate occurred in Adams County, while the largest increase in employment occurred in Marathon County.

### Zone 1 future population and employment projections

Population in Zone 1 is projected to grow at 0.6 percent annually between 2000 and 2005 and at 0.6 percent from 2005 through 2010. Marathon County is projected to realize the largest increase in population, while Juneau County is projected to have the highest growth rate.

Employment in Zone 1 is projected to grow at 0.7 percent annually between 2000 and 2005 and at 1.2 percent from 2005 through 2010. Marathon County is projected to realize the largest increase in employment, while Adams County is projected to have the highest growth rate.

### **Zone 1 environmental considerations**

Zone 1 covers the central and north-central portions of Wisconsin and spans a wide range of ecological landscapes varying from the Northern Highland and North Central Forest regions in the northern part of the zone through the Forest Transition, Central Sand Plains and Central Sand Hills regions to the Western Coulee and Ridges region in the southern portions of the zone. Descriptions of the characteristics of each of these ecological landscapes may be found on the Wisconsin Department of Natural Resources Web site: [http://www.dnr.state.wi.us/org/land/er/publications/cw/Ecological\\_landscapes.asp](http://www.dnr.state.wi.us/org/land/er/publications/cw/Ecological_landscapes.asp)

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

### **Zone 1 electricity demand and generation**

The coincident peak load forecasts for Zone 1 for 2006, 2010 and 2014 are shown in Table ZS-10. Existing generation, along with proposed generation based on projected in-service year, also is shown. The resultant difference between load and generation, with or without the proposed generation, is shown as well.

The table shows that load is projected to grow at roughly 2 percent annually from 2006 through 2014. Comparing load with generation (at maximum output) within the zone indicates that Zone 1 is a net importer of power during peak load periods.

### **Zone 1 transmission system issues**

Key system performance issues in Zone 1 include:

- ❑ the load serving capability of the 115-kV loop in northern Zone 1 (Rhineland Loop), including voltage stability,
- ❑ the load serving capability of the 138-kV and 69-kV network in southern Zone 1,
- ❑ reclosure angle on the Eau Claire-Arpin 345-kV line. This issue can limit the allowable flow on this line. Stability issues can arise if the reclosure angle is too large after a trip of this line.
- ❑ operating guides for lower voltage facilities for loss of either the Eau Claire-Arpin or Arpin-Rocky Run 345-kV lines. In particular, the Monroe County-Council Creek 69-kV line and the T Corners-Wien 115-kV line are susceptible to tripping for loss of the Eau Claire-Arpin 345-kV line. For the loss of the Arpin-Rocky Run 345-kV line, the 138-kV



system south of Arpin and the 115-kV system north of Arpin are susceptible to overloads. These conditions strain the load serving capability of the network in Zone 1.

- The outage of the Weston Unit 3 generator can result in potential voltage collapse and system instability in the area and can aggravate the Eau Claire-Arpin flow limit issues.
- Generator interconnection studies were performed for the addition of a large generator in the Wausau area. In order to accommodate the proposed generation, additional 345-kV lines will be required along with upgrades to existing lower voltage facilities.

**Table PR-13**  
**Transmission System Additions for Zone 1**

<b>System additions</b>	<b>System need year</b>	<b>Projected in-service year</b>	<b>Planning zone</b>	<b>Need category</b>	<b>Planned, Proposed or Provisional</b>
Construct new Eagle River Muni distribution Substation directly adjacent to the existing Cranberry 115-kV Substation	2005	2005	1	T-D interconnection	Planned
Install 2-8.16 MVAR capacitor banks at Council Creek 138 kV	2005	2006	1	reliability	Planned
Reconductor Wien-McMillan 115-kV line (ATC,MEWD)	2006	2006	1	reliability	Planned
Reconductor Weston-Northpoint 115-kV line	2005	2006	1	achieve transfer capability associated with Arrowhead-Gardner Park, reliability, new generation	Planned
Construct new Gardner Park 345/115-kV Substation	2006	2006	1	service limitation, reliability, import capability & Weston stability	Planned
Replace 345/115-kV 200 MVA transformer at Weston with two 500 MVA units at the Gardner Park Substation	2005	2006	1	service limitation, reliability, import capability & Weston stability	Planned
Construct Gardner Park-Stone Lake 345-kV line	1997	2006	1	service limitation, reliability, import capability & Weston stability	Planned
Install 3-50 MVAR capacitor banks at Gardner Park 115 kV	2006	2006	1	achieve transfer capability associated with Arrowhead-Gardner Park	Planned
Install a 345/161-kV transformer at Stone Lake (temporary installation for construction outages)	2006	2006	1	reliability	Planned
Upgrade Weston-Kelly 115-kV line conductor clearances to 300F	2006	2006	1	new generation, reliability	Planned

**Table PR-13**  
**Transmission System Additions for Zone 1 (continued)**

<b>System additions</b>	<b>System need year</b>	<b>Projected in-service year</b>	<b>Planning zone</b>	<b>Need category</b>	<b>Planned, Proposed or Provisional</b>
Increase size of existing Summit Lake 115-kV capacitor bank from 11.3 to 16.9 MVAR	2006	2006	1	reliability	Planned
Uprate Metomen-North Fond du Lac 69-kV line terminal equipment	2006	2007	1	reliability	Planned
Install 2-16.3 MVAR capacitor banks at Wautoma 138 kV	2007	2007	1	reliability	Proposed
Construct Venus-Metonga 115-kV line	2007	2007	1	T-D interconnection	Planned
Rebuild Weston-Sherman St. and Sherman St-Hilltop 115-kV lines as double-circuits with a new Gardner Park-Hilltop 115-kV line	2007	2007	1	new generation, reliability	Proposed
Construct Brandon-Fairwater 69-kV line	2007	2007	1	T-D interconnection	Provisional
Construct a 69-kV line from SW Ripon to the Ripon-Metomen 69-kV line	2008	2008	1	T-D interconnection	Provisional
Upgrade Kelly-Whitcomb 115-kV line conductor clearances to 300F	2008	2008	1	achieve transfer capability associated with Arrowhead-Gardner Park	Planned
Construct Stone Lake-Arrowhead 345-kV line	1997	2008	1	service limitation, reliability, import capability & Weston stability	Planned
Install 2-75 MVAR capacitor banks at Arrowhead 345 kV	2008	2008	1	achieve transfer capability associated with Arrowhead-Gardner Park	Planned
Install 1-75 MVAR capacitor bank and 1-45 MVAR inductor at Stone Lake 345 kV	2008	2008	1	achieve transfer capability associated with Arrowhead-Gardner Park	Planned
Install 1-50 MVAR capacitor bank at Arpin	2008	2008	1	achieve transfer capability associated with Arrowhead-Gardner Park	Planned

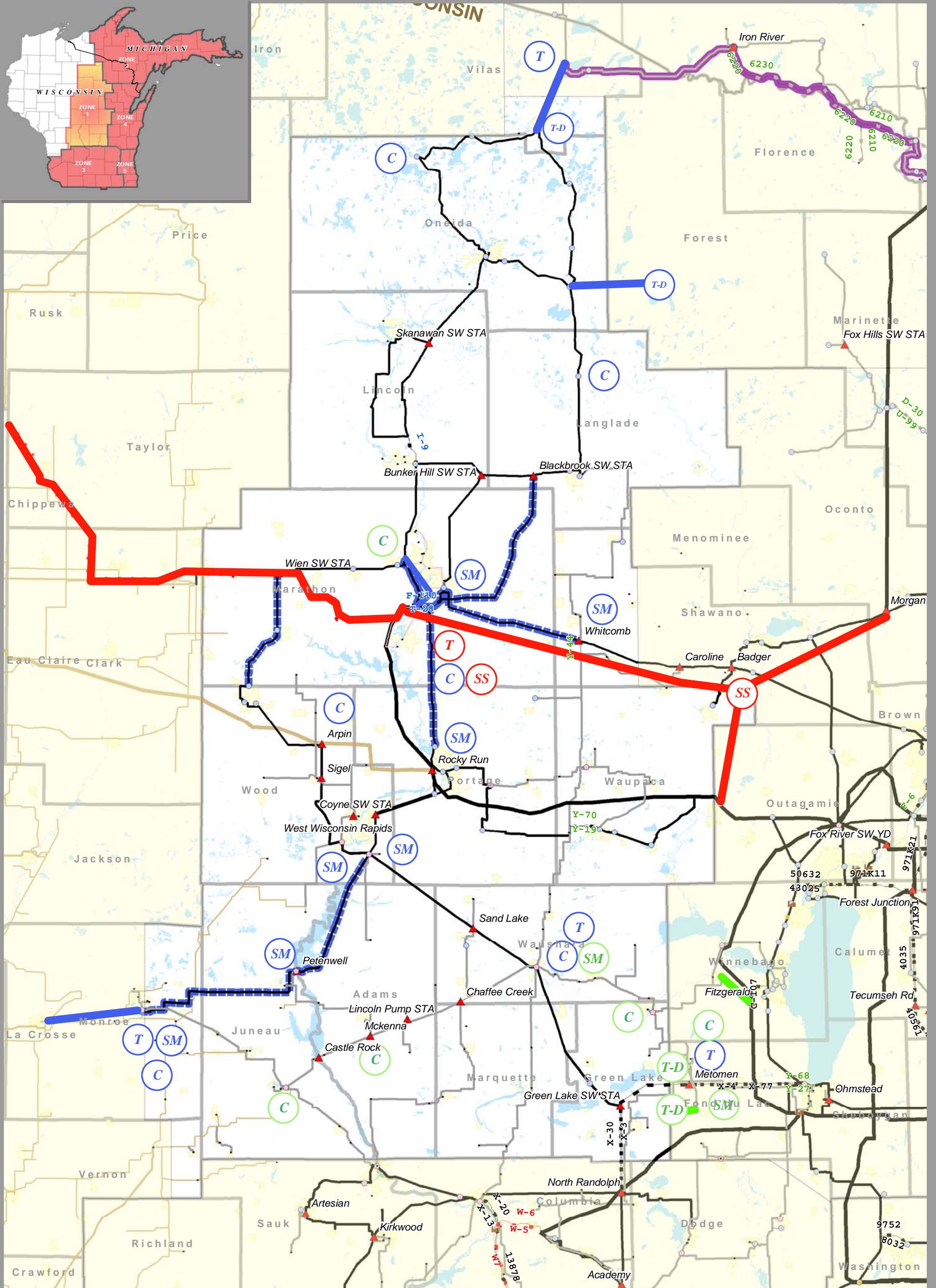
**Table PR-13**  
**Transmission System Additions for Zone 1 (continued)**

<b>System additions</b>	<b>System need year</b>	<b>Projected in-service year</b>	<b>Planning zone</b>	<b>Need category</b>	<b>Planned, Proposed or Provisional</b>
Construct the new permanent Stone Lake 345/161-kV Substation	2008	2008	1	reliability, import capability & Weston stability	Planned
Upgrade 4.1 MVAR capacitor bank to 8.2 MVAR and install a new 8.2 MVAR capacitor bank at Berlin 69 kV	2008	2008	1	Reliability	Proposed
Construct Cranberry-Conover 115-kV line	2008	2008	1 & 2	reliability, transfer capability	Proposed
Rebuild/convert Conover-Plains 69-kV line to 138 kV	2008	2008	1 & 2	reliability, transfer capability	Proposed
Construct 138-kV bus and install 138/115-kV 150 MVA and 138/69-kV 60 MVA transformers at Conover	2008	2008	1 & 2	reliability, transfer capability	Proposed
Construct 138-kV bus and install a 138/69-kV, 60 MVA transformer at Iron Grove	2008	2008	1 & 2	reliability, transfer capability	Proposed
Construct 138-kV bus and install 138/69-kV, 60 MVA transformer at Aspen	2008	2008	1 & 2	reliability	Proposed
Relocate Iron River Substation (Iron Grove)	2008	2008	1 & 2	reliability	Proposed
Uprate Rocky Run-Plover 115-kV line terminal equipment	2009	2009	1	new generation	Proposed
Construct Gardner Park-Central Wisconsin 345-kV line	2009	2009	1	service limitation, reliability, import capability and Weston stability	Planned
Construct new Central Wisconsin 345-kV Substation	2009	2009	1	service limitation, reliability, import capability and Weston stability	Planned
Uprate Wautoma-Berlin 69-kV line terminal equipment at Wautoma	2010	2010	1	reliability	Provisional
Replace 138/69-kV transformer at Metomen	2010	2010	1	reliability	Provisional

*Table PR-13  
Transmission System Additions for Zone 1 (continued)*

<b>System additions</b>	<b>System need year</b>	<b>Projected in-service year</b>	<b>Planning zone</b>	<b>Need category</b>	<b>Planned, Proposed or Provisional</b>
Construct Monroe County-Council Creek 161-kV line	2010	2010	1	access initiative, reliability	Provisional
Install a 161/138-kV transformer at Council Creek	2010	2010	1	access initiative, reliability	Provisional
Uprate Council Creek-Petenwell 138-kV line	2010	2010	1	access initiative, reliability	Provisional
Rebuild/reconductor Petenwell-Saratoga 138-kV line	2010	2010	1	access initiative, reliability	Provisional
Upgrade 4.1 MVAR capacitor bank to 8.2 MVAR and install a new 8.2 MVAR capacitor bank at Ripon 69 kV	2011	2011	1	reliability	Provisional
Uprate Gardner Park-Black Brook 115-kV line - scope TBD	2012	2012	1	reliability	Provisional
Install a 12.2 MVAR capacitor bank at Hilltop 69 kV	2012	2012	1	reliability	Provisional
Uprate Port Edwards-Saratoga 138-kV line - Scope TBD	2013	2013	1	reliability	Provisional
Increase McKenna 69-kV capacitor bank from 6.3 to 10.8 MVAR	2014	2014	1	reliability	Provisional
Uprate Metomen-Ripon 69-kV line - scope TBD	2014	2014	1	reliability	Provisional
Replace 138/69-kV transformer at Wautoma	2015	2015	1	reliability	Provisional
Construct Fitzgerald-Omro Industrial 69-kV line	2015	2015	1	reliability	Provisional
Install additional 13.6 MVAR capacitor bank at Clear Lake 115 kV	2015	2015	1	reliability	Provisional





Transmission System Additions (May be Planned, Proposed or Provisional)  
**PLANNING ZONE 1**

- (SS) New Substation
- (SM) Substation Modifications
- (T) Transformer
- (C) Capacitor Bank
- (T-D) New T-D Interconnection

- 345 kV Transmission Line
- 115 or 138 kV Transmission Line
- Rebuilt 115 or 138 kV Transmission Line
- Transmission Line Voltage Conversion
- 69 kV Transmission Line

- Transmission Related Facilities**
- ▲ ATC Owned Substation
  - Joint Owned Substation - Assets Conveyed
  - Joint Owned Substation - Assets Retained
  - Proposed/Design/Construction
  - ATC Office Location
  - Generation
  - Other Facility

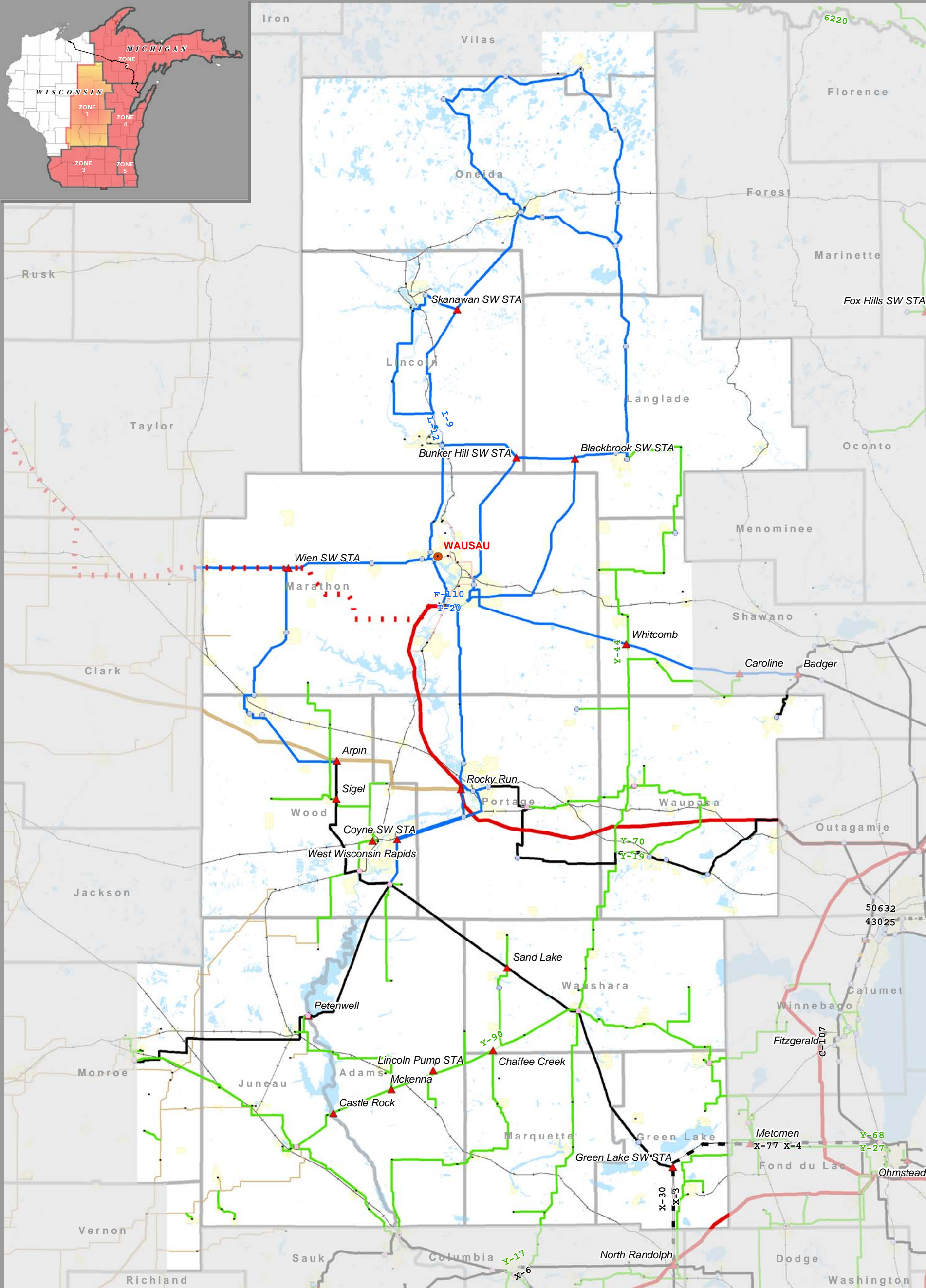
The information presented in this map document is advisory and is intended for reference purposes only. American Transmission Company owned and operated facility locations are approximate.



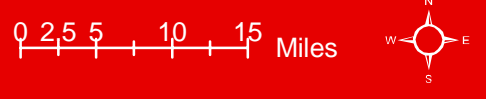
*Table ZS-10  
Forecast of Peak Load and Generation in Zone 1*

	2006	2010	2014
Peak Forecast (megawatts)	1788.6	1926.5	2148.8
Average Peak Load Growth	N/A	1.87%	2.77%
Existing Generation Capacity (megawatts)	747.3	747.3	747.3
Existing Capacity Less Load	-1041.3	-1179.2	-1401.5
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	747.3	1301.3	1301.3
Modeled Capacity Less Load (megawatts)	-1041.3	-625.2	-847.5

*Modeled generating capacity additions in the table above reflect those proposed capacity additions that were included in the 2005 Assessment analyses models, as listed in the **Projects** section.*



Electric Transmission Network & Substations  
**PLANNING ZONE 1**



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

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

- | Transmission Line Voltage |              |  | Transmission Related Facilities |  |  |
|---------------------------|--------------|--|---------------------------------|--|--|
|                           | 69 kV        |  | 69 kV Double Circuit            |  | 69 kV Underground                        |
|                           | 115 kV       |  | 115 kV Double Circuit           |  | 138 kV Underground                       |
|                           | 138 kV       |  | 138 kV Double Circuit           |  | ATC Owned Substation                     |
|                           | 230 kV       |  | 230 kV Double Circuit           |  | Joint Owned Substation - Assets Conveyed |
|                           | 345 kV       |  | 345 kV Double Circuit           |  | Joint Owned Substation - Assets Retained |
|                           | Non-ATC Line |  | Proposed/Design/Construction    |  | ATC Office Location                      |
|                           | Generation   |  | Other Facility                  |  |  |

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## ZONE & STUDY RESULTS > Zone 1 – 2006 study results

Refer to [Table ZS-1](#) and [Figure ZS-1](#)

### Summary of key findings

- The Rhinelander Loop will require additional interconnections to other portions of the system in order to reliably serve load in the future.
- The Arrowhead-Gardner Park 345-kV line will significantly reduce or potentially preclude the need for certain operating guides currently in use, will improve system stability and, in concert with other lower-voltage projects, will improve import capability.
- In order to accommodate the proposed generation in the Wausau area, an additional 345-kV line will be required. The difference between the in-service dates of the proposed generation and the 345-kV line needed for the generation will require that lower-voltage upgrades take place before the generation is placed in service with operating restrictions until the 345-kV line is energized.
- Low voltages at and near the Council Creek Substation in the Tomah area will require that a combination of reinforcements be implemented to reliably serve load in the future.

In Zone 1, there were a number of facility overloads, several facilities near their emergency ratings, low voltages in the Rhinelander Loop and impending low voltages under contingency throughout the zone. In addition, the need exists to address potentially heavy flows due in part to parallel path flows on certain ATC facilities during non-peak periods and to keep the system intact during outages of the Eau Claire-Arpin and Arpin-Rocky Run 345-kV lines.

We anticipate that the parallel path flow and import issues will be addressed in large part by the planned Arrowhead-Gardner Park 345-kV transmission line project and other lower-voltage projects. However, the projected in-service date for the Arrowhead-Gardner Park project is the end of June 2008, so interim mitigation measures will be necessary to ensure continued reliable transmission service. We expect that modifications to existing operating guides dealing with parallel path flow and imports will be utilized prior to the completion of the Arrowhead-Gardner Park project.

For Arrowhead-Gardner Park, the current plan is to construct the 345-kV line project in phases. In the first phase, new 345- and 115-kV switchyards (Gardner Park Substation) will be constructed on the Weston Power Plant site along with the southern portion of the Arrowhead-Gardner Park line, from Gardner Park to Stone Lake. The first phase is scheduled to be completed in late 2006.

After an extensive evaluation of the existing facilities at the existing Weston Substation, we have determined that a new 345/115-kV substation on the Weston Power Plant site is the most feasible course of action. To avoid future confusion between the two substations, the new substation will be called Gardner Park and will be the southern terminus of the new 345-kV line to the Arrowhead Substation. The new Gardner Park Substation will be tied to



the existing 115-kV Weston Substation via two new 115-kV circuits entirely on existing Weston Power Plant property. This extensive evaluation also identified several safety, reliability and maintenance issues at the existing Weston 115-kV Substation. Thus we have concluded that the most prudent course of action is to reconfigure the existing Weston Substation to address these critical issues.

The Arrowhead-Gardner Park project initially will require the development of the following 345- and 115-kV facilities at the new Gardner Park Substation:

- a new, four-position, 345-kV ring bus to accommodate the new Arrowhead-Gardner Park 345-kV line,
- the existing Weston-Rocky Run 345-kV line,
- two new 500 MVA, 345/115-kV transformers,
- a new, six-position, 115-kV breaker and one-half bus to accommodate the above two 500 MVA transformers,
- two short 115-kV transmission lines connecting the existing Weston 115-kV Substation to the new Gardner Park Substation and
- relocating two of the existing 115-kV lines currently terminated at the existing 115-kV Weston bus. Power flow studies and routing constraints at Weston have indicated that moving the Weston-Kelly and the Weston-Blackbrook 115-kV lines to the new Gardner Park Substation provide the optimum network benefits.

At Stone Lake, a 345/161-kV transformer is proposed to be installed and connected to the Gardner Park-Stone Lake line. The existing Stone Lake-Stinson 161-kV line will then be taken out of service, and construction on the northern portion of the Arrowhead-Gardner Park line, from Stone Lake to Arrowhead, will begin on the Stone Lake-Stinson right-of-way. The 345/161-kV transformer at Stone Lake is needed to provide support in northwest Wisconsin, while the Stone Lake-Stinson right-of-way is under construction. The portion of the line from Stone Lake to Stinson will be built as a double-circuit line, carrying the Arrowhead-Gardner Park 345-kV circuit and the Stone Lake-Stinson 161-kV circuit.

ATC evaluated several potential options for making the temporary expansion of the Stone Lake Substation permanent. Because of the network benefits this interconnection provides, we have decided to pursue this substation expansion as a permanent facility. As noted above, a 345/161-kV transformer will be installed at Stone Lake during construction of the northern portion of the Arrowhead-Gardner Park line to support the system during the construction-driven outage of the Stone Lake-Stinson 161-kV line. Making this installation permanent will provide long-term support to the northern Wisconsin system and improve the operating characteristics of the Arrowhead-Gardner Park 345-kV line. Other related projects include installation of capacitor banks and an inductor bank for both switching and operating the Arrowhead-Gardner Park line.

Since the release of the 2004 10-Year Assessment, we have reassessed the reactive support requirements for the Arrowhead-Gardner Park 345-kV line in an effort to optimize the capacitor size and location. The completed steady state and voltage stability studies indicated the following capacitor installations as the configurations providing the most system benefits:

- ❑ two 75 MVAR capacitor banks at the Arrowhead 345-kV bus,
- ❑ one 75 MVAR capacitor bank at the Stone Lake 345-kV bus,
- ❑ three 50 MVAR capacitor banks at the Gardner Park 115-kV bus and
- ❑ one new 50 MVAR capacitor bank at the Arpin 138-kV bus.

There are a number of projects associated with the Arrowhead-Gardner Park 345-kV line needed to achieve the level of import capability contemplated in the Wisconsin Reliability Assessment Organization report. ATC's projects include constructing a 345-kV switchyard at Weston, replacing the existing 345/115-kV transformer at Weston, rebuilding the Kelly-Whitcomb and the Weston-Northpoint 115-kV lines and installing capacitor banks at Arpin, Weston, Arrowhead and Rocky Run. The Kelly-Whitcomb and West-Northpoint projects are discussed in more detail below.

In addition to the Arrowhead-Gardner Park facility additions at the Weston Power Plant site, a new 550-MW generator also has been proposed at this site. This proposed generator is projected to be in service in June 2008. We have conducted generator interconnection studies and transmission service studies to ensure the generator can be operated without stability limitations and the output of the generator can be delivered reliably. The analyses showed that the addition of the proposed generator will cause overloads and system instability if the transmission system in this area is not reinforced. The analysis indicates that a new 345-kV line from Weston is needed to maintain stability and to deliver the generator output, in addition to the Arrowhead-Gardner Park 345-kV line.

Based on the results of the Weston generator studies, we are proposing the following transmission project. Appropriate applications to the Public Service Commission of Wisconsin have been developed and were submitted to the PSC in March 2005.

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

The scheduled in-service date for the new Weston 550-MW generator is June 2008, and the projected in-service date for the Gardner Park-Central Wisconsin 345-kV line is December 2009. Based on the 18-month in-service date difference between the generator and 345-kV line project, additional studies were performed to determine if any feasible projects exist for delivery of all or a portion of the generator capacity prior to the in-service date of the Gardner Park-Central Wisconsin 345-kV line project. The interim transmission service and generator interconnection studies identified the following projects that will allow the generator to operate during this interim period under certain operating limitations and



restrictions. Full generator operation, without restrictions, will not be allowed until all required 345-kV lines are placed in service.

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

The Weston-Northpoint 115-kV line project involves replacing the existing conductor and periodic structure replacements to accommodate the larger conductor and achieve the needed clearances. The in-service date for this project has been accelerated to January 2006 to help facilitate construction outages and cutovers associated with the Arrowhead-Gardner Park and the Weston G4 projects. To address overloads and achieve the desired emergency ratings on the Weston-Kelly and Kelly-Whitcomb 115-kV lines, we are recommending that line clearances be increased to 300 degrees F and substation facilities be upgraded at the Kelly Substation. The new 115-kV line between the Gardner Park and Hilltop Substation in the Wausau area is proposed to address the overloads on the two parallel Weston-Sherman Street 115-kV lines. The Weston-Sherman Street (O-41) and Sherman Street-Hilltop single-circuit H-frame lines will be replaced with double-circuit structures. The Weston-Sherman Street and Sherman Street-Hilltop 115-kV lines will retain their original terminations at the Weston, Sherman Street and Hilltop substations. The second circuit on each section will be the proposed new 115-kV circuit and will terminate at the Gardner Park and Hilltop substations. This project is being recommended instead of rebuilding the existing two parallel Weston – Sherman Street 115-kV lines to avoid rebuilding the Sherman Street Substation at a significant investment and to reduce the risk to the Wausau area because of the outage requirements that would be needed to rebuild the Sherman Street Substation. It also addresses one of the more significant outages for the Rhinelander Loop by providing a parallel path to the Sherman Street-Hilltop 115-kV line.

For the heavy flows on and the contingency separation of certain 69-kV and 138-kV facilities on the western edge of our service territory, the primary solution would be the Arrowhead-Gardner Park project. However, as noted above, this project is not expected to be in service until the end of June 2008. Several potential projects have been evaluated to address the separation of the ATC-Dairyland Power Cooperative facilities at the Council Creek Substation. They include a phase-shifting transformer, series reactor, capacitor banks, operating guides, or a combination. To address the near-term pre- and post-contingency issues, we are recommending the installation of a capacitor bank on the Council Creek 138-kV bus in 2006 in combination with the continued use of the Council Creek operation guide. We also are working in cooperation with Dairyland Power Cooperative to develop a more comprehensive long-term solution to address the limitations of the Monroe County-Council Creek transmission corridor.

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

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

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

Alternatives considered as longer-term solutions for the Rhinelander Loop limitations include:

- rebuilding additional portions of the Rhinelander Loop,
- constructing a new 115-kV or 138-kV line from Cranberry north to Conover combined with the conversion of the Conover-Plains or Conover-Winona 69-kV lines to 138 kV,
- constructing a new 115-kV or 138-kV line from Venus east to the Amberg or Plains substations or tie into the Plains-Morgan 345-kV line near Dunbar,
- constructing a new 115-kV line from Clear Lake west to the Park Falls Substation (Xcel Energy),
- constructing a new 115-kV or 345-kV line from Weston north to Venus, or
- a combination of the above.

Based on analyses, our preferred longer-term solution is a specific part of the second bullet above, constructing a Cranberry-Conover 115-kV line and rebuilding the Conover-Iron River-Plains 69-kV line and converting to 138-kV operation. This alternative addresses the longer-term reliability issues of the Rhinelander Loop, provides substantial voltage support to the 69-kV system in the western portion of the Upper Peninsula and addresses potential long-term condition issues due to the age of the existing 69-kV system. The new 115-kV line between Cranberry and Conover is needed by January 2008, specifically to accommodate a transmission service request, with the remainder of the project needed by 2010 to meet reliability standards for serving the Rhinelander Loop. Without the Conover-

Plains portion of this solution, overloads and voltage issues begin to reappear in the Wausau/Rhineland Loop area in this timeframe.

To address low voltages elsewhere in Zone 1, capacitor banks are needed at the Summit Lake and Wautoma substations in 2006 and 2007. To address facility overloads, the Metomen-North Fond du Lac 69-kV line needs to be uprated and the Wien-Stratford-McMillan 115-kV line needs to be reconducted. Minor facility upgrades were implemented to allow for the deferral of the Wien-Stratford-McMillan reconductor project from 2005 to 2006 to better align with available construction resources and outage requirements. Overloads on the Arpin 345/138-kV transformer and Arpin-Sigel 138-kV line are being addressed by the Arpin Operating Guide. The low voltages at the Council Creek 138-kV Substation are being addressed through manual control of load tap changers on the Council Creek 138/69-kV transformer and the installation of a capacitor bank in 2006. Completion of the Arrowhead-Gardner Park 345-kV line should provide additional relief.

In response to customer requests for new distribution interconnections, a new 115-kV transmission line is planned in 2007 from the Venus Substation to a new Metonga Substation to be sited on the southwest side of Crandon. Also, a new substation will be constructed adjacent to the existing Cranberry Substation near Eagle River to accommodate a new distribution transformer in response to customer requests for new transmission interconnections. Two new distribution interconnections in the Ripon area are currently under evaluation that will require new 69-kV transmission lines. South West Ripon will require a new 69-kV line be constructed to intersect with the Ripon-North Randolph 69-kV line and the proposed Fairwater Substation will require a new 69-kV line be extended from the Brandon 69-kV Substation.

**TABLE ZS-1  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2006**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
1	Antigo, Aurora Street and Summit Lake 115-kV bus voltages		89 – 92%	Gardner Park-Blackbrook-Antigo 115-kV line outage	Load Serving
1	Gardner Park-Blackbrook 115-kV line	96%		Hilltop-Sherman Street 115-kV line outage	Load Serving
1	Gardner Park-Kelly 115-kV line	96%		Hilltop-Sherman Street 115-kV line outage	Load Serving
1	Weston-Sherman Street 115-kV line	96 – 104%		Weston-Morrison 115-kV line outage Morrison-Sherman Street 115-kV line outage	Load Serving
1	Weston-Morrison 115-kV line	100%		Weston-Sherman Street 115-kV line outage	Load Serving
1	Morrison-Sherman Street 115-kV line	109%		Weston-Sherman Street 115-kV line outage	Load Serving
1	Wien-Stratford 115-kV line	98 -104%		Arpin 138/115-kV Transformer outage Arpin – Powers Bluff 115-kV line outage Powers Bluff – Hume 115-kV line outage Arpin 345/138-kV transformer outage	Load Serving
1	Stratford-McMillan 115-kV line	95-96%		Arpin 138/115-kV Transformer outage Arpin – Powers Bluff 115-kV line outage	Load Serving
1	McMillan, Wildwood, Hume and Powers Bluff 115-kV bus voltages		91 – 92%	Arpin 138/115-kV Transformer outage Arpin – Powers Bluff 115-kV line outage	Load Serving
1	Sigel, Lakehead Vesper and Port Edwards 138-kV bus voltages		89 – 91%	Arpin 345/138-kV Transformer outage Arpin-Sigel 138-kV line outage Sigel-Lakehead Vesper 138-kV line outage	Load Serving
1	Port Edwards, Hollywood and Saratoga 138-kV bus voltages		91 – 92%	Arpin-Sigel 138-kV line outage	Load Serving
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages		88 – 95%	Base Case Various contingencies	Load Serving
1	Metomen-Ripon 69-kV line	97%		Winneconne-Sunset Point 69-kV line outage	Load Serving
1	Metomen-Rosendale 69-kV line	96 – 120%		Various contingencies	Load Serving
1	North Fond du Lac-Rosendale 69-kV line	106%		Metomen 138/69-kV transformer	Load Serving
1	Ripon-Mackford Prairie 69-kV line	97%		Metomen-Ripon 69-kV line outage	Load Serving
1	Berlin area 69-kV bus voltages		88 – 92%	Various line outages	Load Serving
1	Council Creek and Petenwell 138-kV bus voltages		88 – 95%	Base Case Various contingencies	Load Serving
1	Council Creek 69-kV bus tie	100 – 106%		King-Eau Claire-Arpin 345-kV line outage Eau Claire-Arpin 345-kV line outage Hillsboro-Hillsboro tap 69-kV line outage	Load Serving
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		91 – 92%	Various outages	Load Serving
1	Hilltop, Mauston, Lyndon Station, Wisconsin Dells and Kilbourn 69-kV bus voltages		90-91%	Kilbourn 138/69-kV transformer	Load Serving
1	Neenah Creek, Glen and Winnebago 69-kV bus voltages		90 – 92%	Kilbourn 138/69-kV transformer	Load Serving
1	Whitcomb-Wittenberg 69-kV line	95 – 105%		Gardner Park-Blackbrook-Antigo-Aurora Street 115-kV outage Gardner Park-Blackbrook-Antigo 115-kV outage Blackbrook-Antigo 115-kV outage	Load Serving
1	Deer Trail-Polar tap 69-kV line	98%		Gardner Park-Blackbrook-Antigo 115-kV outage	Load Serving
1	Roslin, Endeavor and Lakehead Portage 69-kV bus voltages		89 – 91%	Portage-Lakehead Portage 69-kV line outage	Load Serving
2	Atlantic-Elevation Tap #1 69-kV	138%		Atlantic-Elevation Tap #2 69-kV line outage	Load Serving
2	Osceola-Elevation Tap #1 69-kV	110%		Atlantic-Elevation Tap #2 69-kV line outage	Load Serving

**TABLE ZS-1 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2006**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
2	Atlantic-Elevation Tap #2 69-kV	106%		Atlantic-Elevation Tap #1 69-kV line outage	Load Serving
2	Atlantic-Elevation Tap #1 69-kV	106%		Osceola-Elevation Tap #2 69-kV line outage	Load Serving
2	Sawyer, Gwinn, Chatham, Forest Lake and Seney Tap 69-kV bus voltages		84-91%	Forsyth-Gwinn 69-kV line outage	Load Serving
2	Bruce Crossing, Watersmeet, Land O Lakes, Conover and Twin Lakes 69-kV bus voltages		84-89%	Mass-Bruce Crossing 69-kV line outage	Load Serving
2	L'Anse and M38 69-kV bus voltages		88-90%	M38 138/69-kV transformer outage	Load Serving
2	Seney Tap, Timber Products and Munising 69-kV bus voltages		87-92%	Forsyth-Munising 138-kV line outage	Load Serving
2	Atlantic, Stone Container, M38, Winona and Ontonagon 138-kV buses, L'Anse 69-kV and M38 69-kV bus voltages		89-90%	M38-Perch Lake 138-kV line outage	Load Serving
2	Seney Tap, Timber Products and Munising 69-kV bus voltages		90-92%	Munising 138/69-kV transformer outage	Load Serving
2	Stone Container, Ontonagon and Winona 138-kV bus voltages		90%	Winona-M38 138-kV line outage	Load Serving
2	Brevort, Hiawatha and Lakehead 138-kV bus voltages		90%	Brevort-Straits 138-kV line outage	Load Serving
2	Hiawatha and Lakehead 138-kV bus voltages		90%	Brevort-Lakehead 138-kV line outage	Load Serving
2	Stone Container and Ontonagon 138-kV bus voltages		91%	Winona-Ontonagon 138-kV line outage	Load Serving
3	North Beaver Dam, Fox Lake, East Beaver Dam 138-kV bus voltages		97%	Base Case due-tap settings at Columbia on the 345/138-kV transformers	Load Serving
3	Hillman 138/69-kV transformer	118%		Pilot Knob – Galena 69-kV line outage	Load Serving
3	North Monroe 138/69-kV transformer	95-108%		Kegonsa-Stoughton 69-kV line segments, Darlington-South Monroe 69-kV line segments, Darlington 138/69-kV transformer, Brodhead-Newark 69-kV line, Stoughton-Aaker Road 69-kV line, Paddock 138/69-kV transformer	Load Serving
3	Brodhead-Blacksmith and Brodhead-Newark 69-kV lines	105-115%		North Monroe 138/69-kV transformer, North Monroe-Idle Hour 69-kV line outage, Town Line Road-Albany 138-kV line	Load Serving
3	Turtle–Rock River 69-kV line	104%		Colley Road-Dickinson 138-kV line outage	Load Serving
3	Columbia 138/69-kV transformer	109%		Portage 138/69-kV transformer	Load Serving
3	Colley Road-Brick Church 69-kV line	115%		Colley Road-Brick Church 138-kV line	Load Serving
3	Rock River 138/69-kV transformer	98-103%		Colley Road-Brick Church 138-kV line, Black hawk 138/69-kV transformer	Load Serving
3	Colley Road 138/69-kV transformer	111-125%		Paddock-Shirland Ave 69-kV line, Paddock 138/69-kV transformer, Colley Road-Brick Church 138-kV line	Load Serving
3	Paddock 138/69-kV transformer	98%		Colley Road 138/69-kV transformer	Load Serving
3	Brick Church 138/69-kV transformer	97%		Brick Church-Williams Bay 138-kV line	Load Serving
3	McCue-Milton Lawns 69-kV line	98%		Janesville 138/69-kV transformer	Load Serving
3	North Stoughton-Kegonsa 69-kV line	98%		McCue-La Mar 69-kV line	Load Serving
3	Verona-Oregon 69-kV line	123%		Stoughton-Aaker Road 69-kV line	Load Serving
3	Blount-Ruskin 69-kV lines (both circuits)	103-128%		North Madison 138/69-kV transformer, Blount-Ruskin 69-kV adjacent line	Load Serving



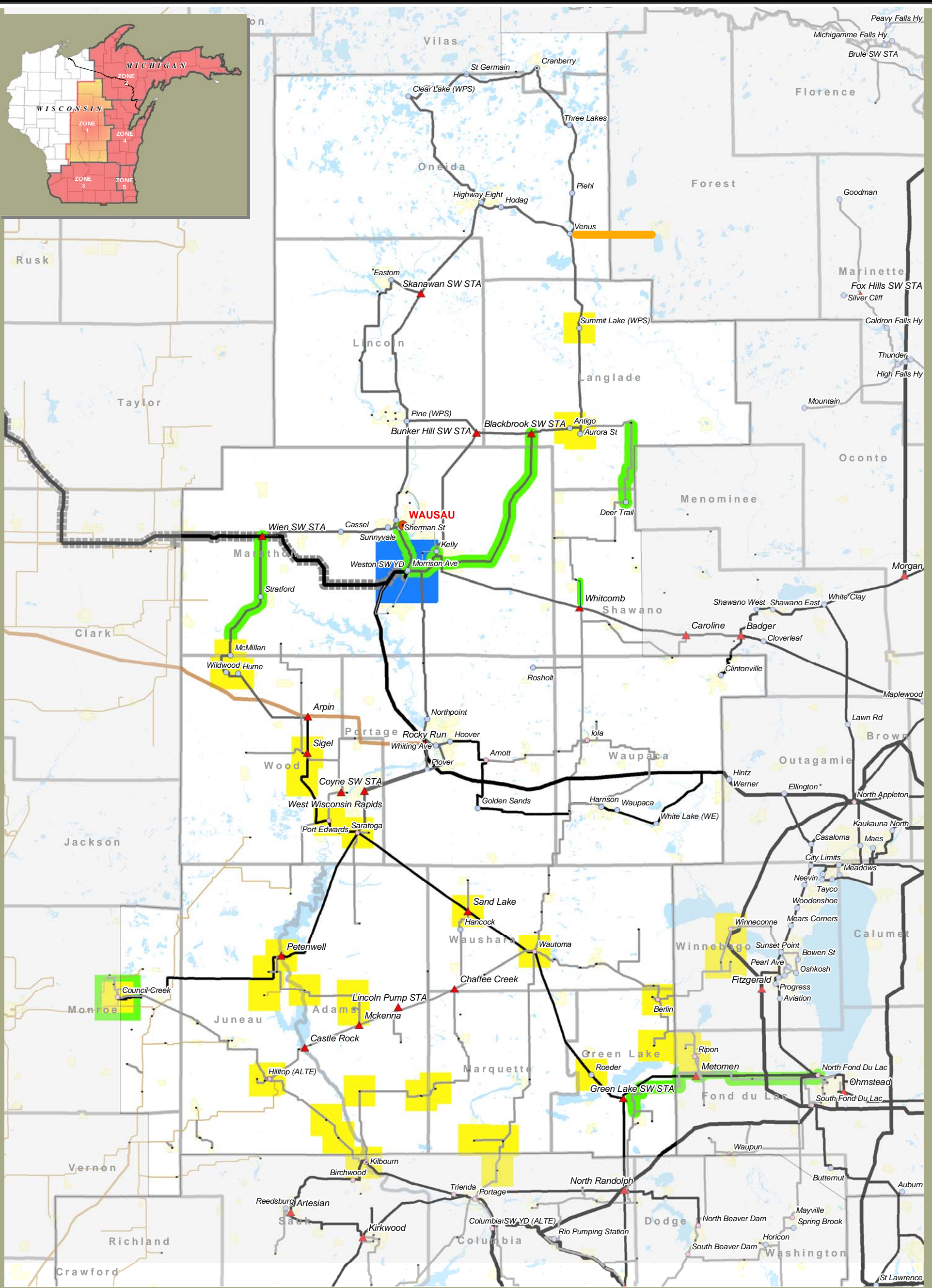
**TABLE ZS-1 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2006**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
3	Royster-Pflaum Tap 69-kV line	103%		Fitchburg-Nine Springs 69-kV line	Load Serving
3	Pheasant Branch-West Port 69-kV line	102%		West Middleton-Pheasant 69-kV line	Load Serving
3	Dane-North Madison 69-kV line	97%		American Center-Sycamore 138-kV line	Load Serving
3	Paddock-Shirland Ave 69-kV line	97-133%		Colley Road-Park Ave 69-kV line, Colley Road 138/69-kV transformer	Load Serving
3	Monticello, New Glarus, Belleville 69-kV buses		87-89%	North Monroe-Monticello 69-kV line	Load Serving
3	Reiner, Burke and Sprecher 69-kV buses		90-91%	Reiner Tap-Sycamore 69-kV line	Load Serving
3	Oregon and Brooklyn 69 buses		89%	Oregon-Aaker Road 69-kV line	Load Serving
3	Monroe, Idle Hour, South Monroe, Black Smith, Browntown, Jennings Road, Argyle (DPC) 69-kV buses		85-92%	North Monroe-Idle Hour Tap 69-kV line	Load Serving
3	Verona, Monroe, Idle Hour, South Monroe, New Glarus, Monticello, Black Smith, Browntown, Jennings Road, Argyle (DPC) 69-kV buses		85-92%	North Monroe 138/69-kV transformer	Load Serving
3	Muscoda, Avoca, Spring Green, Lone Rock, Arena 69-kV bus voltages		92%	Lone Rock-Spring Green 69-kV line	Load Serving
3	Aaker Road (Stoughton), Oregon, Brooklyn and Verona 69-kV buses		82-91%	Stoughton-Aaker Road 69-kV line outage	Load Serving
3	Brodhead Municipal, Orfordville, Footville, Bass Creek 69-kV buses		90-92%	Brodhead SS-Brodhead Muni 69-kV line	Load Serving
3	Concord 138-kV bus 6, Rubicon 138-kV buses		85-87%	Concord Bus 6 – 5 Bus tie outage	Load Serving
3	Eden, Lancaster, Wyoming Valley, 138-kV bus voltages		90-91%	Nelson Dewey-Eden 138-kV line segments	Load Serving
3	Brick Church, Dickinson 138-kV bus voltages		91%	Colley Road-Brick Church 138-kV line outage	Load Serving
3	Cambridge, London, Boxelder, Stonybrook, Friesland, East Beaver Dam, Academy, North Randolph, Fox Lake, North Beaver Dam, Lakehead Pumping 138-kV bus voltages		85-92%	Rockdale-Cambridge Tap 138-kV line outage	Load Serving
3	Kilbourn, Platte, Finnegan 69-kV buses		89%	Kilbourn 138/69-kV transformer	Load Serving
3	Rock Springs, Artesian, Nishan, Zobel, Lewiston, Loch Mirror Birchwood, Dell Creek 138-kV buses / Artesian, Loganville, Reedsburg, Lewiston 69-kV buses		88-92%	Kilbourn-Trienda 138-kV line segments	Load Serving
3	Rock Springs, Artesian, Nishan, Zobel, Troy, Kirkwood, Lake Delton 138-kV buses / Artesian, Loganville and Reedsburg 69-kV buses		90-92%	Trienda-Kirkwood 138-kV line segments	Load Serving
3	North Beaver Dam, Fox Lake and East Beaver Dam 138-kV bus voltages		82-95%	North Randolph – East Beaver Dam 138-kV line segments, Portage-Friesland 138-kV line segments, Rockdale-Boxelder 138-kV line segments	Load Serving
3	Pine River, Richland Center, Richland, Eagle (DPC) 69-kV bus voltages		89%	Lone Rock Phase Shifter, Lone Rock-Richland, Dayton-Richland Center Tap 69-kV line outage	Load Serving
4	Crivitz-High Falls 69-kV line	96%		Pioneer-Sandstone 69-kV line outage	Load Serving
4	Pioneer-Sandstone 69-kV line	101%		Crivitz-High Falls 69-kV line outage	Load Serving
4	Ellinwood 138/69-kV T1 transformer	99%		Fitzgerald-Sunset Point 138-kV line outage	Load Serving

**TABLE ZS-1 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2006**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
4	Goodman 69-kV bus voltage		94%	Base Case	Load Serving
5	Pleasant Prairie-Bain 345-kV line	161%		Splitting Pleasant Prairie 345-kV bus sections 3 and 4	Load Serving
5	Bluemound 230-kV bus voltage		91%	Pleasant Prairie-Racine 345-kV line Outage	Load Serving
5	Pleasant Valley-Saukville 138-kV line	112%		Splitting Concord 5 and 6	Load Serving

Figure ZS-1



Performance Criteria Limits Exceeded and Other Constraints 2005-2006  
**PLANNING ZONE 1**

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:  
 \* Approximately 8900 miles of transmission lines  
 \* 98 wholly owned substations  
 \* 358 jointly owned substations  
 \* Offices in Madison (2), Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, MI

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

- Transmission Related Facilities**
- ▲ ATC Owned Substation
  - Joint Owned Substation - Assets Conveyed
  - Joint Owned Substation - Assets Retained
  - Proposed/Design/Construction
  - Future Arrowhead-Gardner Park 345 kV line
  - ATC Office Location
  - Generation
  - Other Facility

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

## ZONE & STUDY RESULTS > Zone 1 – 2010 study results

Refer to [Table ZS-2](#) and [Figure ZS-2](#)

### Summary of key findings

- ❑ The Rhinelander Loop will require additional reinforcement prior to and sometime after 2008. One alternative, a 115-kV line from Cranberry to Conover combined with the conversion of the Conover-Iron River-Plains 69-kV system to 138 kV, will considerably improve the load serving capability of the Rhinelander Loop transmission system, but it is anticipated that an additional source to the Loop will be needed at some point beyond the current planning horizon.
- ❑ Accommodating the proposed new generation at the Weston Power Plant will play a role in defining many of the larger system reinforcement projects within Zone 1.
- ❑ Overloaded 115-kV facilities in and around the Wausau area will require that a combination of reinforcements be implemented.
- ❑ Low voltages and overloaded 69-kV facilities around the Berlin-Ripon area will necessitate a combination of reinforcement projects.

Similar to the 2006 results, there were a number of facilities overloaded and several others were near their emergency ratings within Zone 1. After the completion of the short-term Rhinelander Loop projects, low voltages begin to reappear in the Rhinelander Loop. Under single contingency conditions, impending low voltages are seen throughout the zone including the northern Wausau area.

As discussed in the 2006 analysis, ATC's preferred alternative to address the low voltages within the Rhinelander Loop is to construct a Cranberry-Conover 115-kV line in combination with the rebuilding of the Conover-Iron River-Plains 69-kV line and converting to 138-kV operation. This alternative not only addresses intermediate and longer-term reliability needs of the Rhinelander Loop, but it also provides immediate support and future reinforcement flexibility to the transmission system in the western portion of the Upper Peninsula. See [Zone 1 - 2006 study results](#) for additional details outlining the alternatives that were evaluated to address this system issue.

In the 2008 - 2010 timeframe, several 115-kV lines in the Wausau area are either overloaded or are approaching their emergency ratings. These system conditions are not only caused by existing network issues, but also are aggravated by the addition of the proposed generation at Weston. The 115-kV lines in question are the two parallel Weston-Sherman Street 115-kV lines and the Weston-Kelly 115-kV line. See [Zone 1 - 2006 study results](#) for details regarding the solutions to these system limitations. Also, two additional 115-kV lines in the Wausau area are near their emergency ratings: Sherman Street-Hilltop-Maine and the Weston-Blackbrook 115-kV lines. The impending overload of the Sherman Street-Hilltop 115-kV line will be addressed by the Weston-Sherman Street 115-kV line solution discussed in the [Zone 1 - 2006 study results](#), while the Weston-Blackbrook 115-kV





line will require the upgrading of terminal equipment along with some conductor replacements.

To address low voltages and overloads elsewhere within Zone 1, an additional capacitor bank will be needed at the Berlin Substation in 2008 and the Ripon Substation in 2011. To address facility overloads, the 138/69-kV transformers at Metomen and Wautoma will need to be upgraded and the Wautoma-Berlin 69-kV and Rocky Run-Plover 115-kV lines need to be updated by replacing select terminal equipment.



**TABLE ZS-2  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
1	Gardner Park-Kelly 115-kV line	96 - 103%		Maine-Hilltop 115-kV line outage Maine-Pine 115-kV line outage	Load Serving
1	Arpin 345/138-kV Transformer	102%		Arpin-Rocky Run 345-kV line outage	Off Peak Load Serving
1	Sigel-Arpin 138-kV line	104%		Arpin-Rocky Run 345-kV line outage	Off Peak Load Serving
1	Young Road-Sigel 138-kV line	109%		Arpin-Rocky Run 345-kV line outage	Off Peak Load Serving
1	Young Road-Lakehead Vesper 138-kV line	108%		Arpin-Rocky Run 345-kV line outage	Off Peak Load Serving
1	Sigel, Lakehead Vesper and Port Edwards 138-kV bus voltages		90 – 91%	Arpin-Sigel 138-kV line outage	Load Serving
1	Port Edwards, Hollywood and Saratoga 138-kV bus voltages		91 – 92%	Arpin-Sigel 138-kV line outage	Load Serving
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages		90 – 95%	Base Case Various contingencies	Load Serving
1	Metomen-Ripon 69-kV line	98%		Winneconne-Sunset Point 69-kV line outage	Load Serving
1	Omro-Winneconne 69-kV line	98%		NW Ripon 69-kV line outage	Load Serving
1	Wautoma-Spring Lake 69-kV line	100 – 103%		NW Ripon 69-kV line outage Winneconne-Sunset Point 69-kV line outage	Load Serving
1	Berlin area 69-kV bus voltages		88 – 92%	Various contingencies	Load Serving
1	Council Creek 69-kV bus tie	95 – 124%		King-Eau Claire-Arpin 345-kV line outage Eau Claire-Arpin 345-kV line outage Hillsboro-Hillsboro tap 69-kV line outage	Network
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		91 – 92%	Petenwell 138/69-kV transformer outage Petenwell-Big Pond 69-kV line outage Big Pond-Necedah tap 69-kV line outage	Load Serving
1	Hilltop, Mauston, Lyndon Station, Wisconsin Dells and Kilbourn 69-kV bus voltages		90 - 91%	Kilbourn-Wisconsin Dells #2 line outage	Load Serving
1	Roslin, Endeavor and Lakehead Portage 69-kV bus voltages		88 – 91%	Portage-Lakehead Portage 69-kV line outage	Load Serving
2	Winona-Twin Lakes 69-kV	97%		Atlantic-M 38 69-kV line outage, Atlantic 138/69-kV transformer outage	Load Serving
2	Atlantic, Stone Container, M38, Winona and Ontonagon 138-kV buses and L'Anse 69-kV bus voltages		90-92%	M38-Perch Lake 138-kV line outage	Load Serving
2	L'Anse 69-kV bus voltage		91%	M38 138/69-kV transformer outage	Load Serving
2	Atlantic, Stone Container, M38, Winona and Ontonagon 138-kV buses and L'Anse 69-kV bus voltages		90-91%	M38-Perch Lake 138-kV line outage	Load Serving
2	L'Anse 69-kV bus voltage		92%	M38 138/69-kV transformer outage	Load Serving
2	Stone Container, Ontonagon and Winona 138-kV bus voltages		91-92%	Winona-M38 138-kV line outage	Load Serving
2	Land O' Lakes and Conover 69-kV bus voltages		91%	Conover 138/69-kV transformer outage	Load Serving
2	Winona-Twin Lakes-Portage Tap-Atlantic 69-kV line	160-98%		Atlantic 138/69-kV transformer outage, M38 138/69-kV transformer outage, Atlantic-M 38 138-kV line outage, M38-Perch Lake 138-kV line outage	Load Serving
2	Atlantic-Henry St Tap 69-kV line	127%		M38-Perch Lake 138-kV line outage	Load Serving

**TABLE ZS-2 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
2	Atlantic 138/69-kV transformer	117-96%		M38 138/69-kV transformer outage, Atlantic-Portage Tap 69-kV line outage, Winona-Twin Lakes 69kV line outage, Winona-M38 138-kV line outage, Twin Lakes-Portage Tap 69-kV line outage, M38-Perch Lake 138-kV line outage	Load Serving
2	M38-Atlantic 69-kV line	115-98%		Atlantic 138/69-kV transformer outage, M38 138/69-kV transformer outage, Atlantic-M 38 138-kV line outage	Load Serving
2	Atlantic-Elevation Tap #2 69-kV line	115%		Atlantic-Elevation Tap #1 69-kV line outage	Load Serving
2	Hiawatha 69-138-kV transformer (reverse flow limitation)	96%		Straits 138/69-kV transformer outage	Load Serving
2	North Lake-M38 138-kV line	98%		M38-Perch Lake 138-kV line outage	Load Serving
2	Atlantic, Stone Container, Ontonagon, Winona, M38 and Indian Lake 138-kV buses and L'Anse and M38 69-kV bus voltages		91-95%	Base Case	Load Serving
2	Atlantic, L'Anse, Keweenaw, Keweenaw Tap, MTU, Osceola, Henry St, Henry St Tap, M38, Elevation #2, 1 Elevation Tap #2, Elevation #1, Elevation Tap #1, Portage, Portage Tap, Ontonagon, Twin Lakes, UPSCO, Winona, Lake Mine, Mass, Rockland Junction, Rockland, Victoria, Bruce Crossing, Toll Free, White Pine Village and White Pine Mine 69-kV buses and Atlantic, Stone Container, Ontonagon, Winona and M38 138-kV bus voltages		74-92%	M38-Perch Lake 138-kV line outage	Load Serving
2	Keweenaw, Keweenaw Tap, MTU, Osceola, Henry St, Henry St Tap, Elevation #2, 1 Elevation Tap #2, Elevation #1, Elevation Tap #1, Portage, Atlantic, Portage Tap, L'Anse, M38 and Twin Lakes 69-kV buses and Stone Container, Ontonagon, Winona and M38 138-kV bus voltages		77-91%	Atlantic-M 38 138-kV line outage	Load Serving
2	Keweenaw, Keweenaw Tap, MTU, Osceola, Henry St, Henry St Tap, Elevation #2, Elevation Tap #2, Elevation #1, Elevation Tap #1, Portage, Atlantic, Portage Tap, L'Anse, M38 and Twin Lakes 69-kV buses and Stone Container, Ontonagon, Winona and M38 138-kV bus voltages		77-92%	Atlantic 138/69-kV transformer outage	Load Serving
2	L'Anse, M38, Keweenaw, Keweenaw Tap, MTU, Osceola, Henry St and Henry St Tap 69-kV buses and Atlantic, Stone Container, Ontonagon, Winona and M38 138-kV bus voltages		80-92%	M38 138/69-kV transformer outage	Load Serving
2	Sawyer, Gwinn, Chatham, Forest Lake, Seney Tap, Timber Products, Alger 69-kV buses and Munising 69 and 138-kV bus voltages		80-92%	Forsyth-Gwinn 69-kV line outage	Load Serving
2	Stone Container and Ontonagon 138-kV bus voltages		87-91%	Ontonagon-UPSCO Tap 138-kV line outage, Victoria-Rockland Junction 69-kV line outage, Rockland Junction-UPSCO Tap 69-kV line outage, Winona-Ontonagon 138-kV line outage	Load Serving
2	Stone Container, Ontonagon and Winona 138-kV buses and Ontonagon 69-kV bus voltages		87-92%	Winona-M38 138-kV line outage	Load Serving
2	Seney Tap, Timber Products, Munising and Alger 69-kV bus voltages		87-91%	Forsyth-Munising 138-kV line outage	Load Serving
2	Newberry Village, Louis Pacific, Newberry, Newberry Hospital, Roberts and Hulbert		89-92%	Engadine-Newberry 69-kV line outage, Hiawatha-Engadine 69-kV line outage	Load Serving

**TABLE ZS-2 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
2	Seney Tap, Timber Products, Alger and Munising 69-kV bus voltages		89-91%	Munising 138/69-kV transformer outage	Load Serving
2	Keweenaw, Keweenaw Tap, Elevation #1, Elevation Tap #1 and Osceola 69-kV bus voltages		90-91%	Atlantic-Elevation Tap #1 69-kV line outage	Load Serving
2	Atlantic, Stone Container, Winona, Ontonagon and M38 138-kV buses and L'Anse and M38 69-kV bus voltages		89-92%	Presque Isle-Perch Lake 138-kV line outage	Load Serving
2	Brevort, Lakehead and Hiawatha 138-kV bus voltages		91%	Straits-Brevort 138-kV line outage	Load Serving
2	L'Anse 69-kV bus voltage		90%	Atlantic-M38 69-kV line outage	Load Serving
2	Newberry Village, Louis Pacific, Newberry Hospital and Roberts 69-kV bus voltages		91-92%	Newberry-Newberry Tap 69-kV line outage	Load Serving
2	Lakehead and Hiawatha 138-kV bus voltages		91%	Brevort-Lakehead 138-kV line outage	Load Serving
2	L'Anse, M38, Keweenaw, Keweenaw Tap, MTU and Osceola 69-kV buses and Atlantic, Stone Container, Ontonagon, Winona and M38 138-kV bus voltages		87-92%	Northlake-M38 138-kV line outage	Load Serving
2	Land O Lakes 69-kV bus voltage		92%	Conover-Land O Lakes 69-kV line outage	Load Serving
3	Richland Center 69-kV bus voltage		94.5%	Base case	Load Serving
3	North Monroe Transformer	97-100%		Darlington-Gratiot 69-kV line outage, Paddock-Brodhead Switching Station 69-kV line outage and Darlington 138/69-kV transformer	Load Serving
3	Brodhead Switching Station-South Monroe 69-kV line	100-105%		North Monroe-South Monroe 69-kV line outage and North Monroe 138/69-kV transformer	Load Serving
3	Paddock-Brodhead Switching Station 69-kV line	100-112%		Albany-Townline Road 138-kV, Rockdale-Wempletown 345-kV, North Monroe-South Monroe 69-kV, McCue-LaMar 69-kV line outages and North Monroe 138/69-kV transformer	Load Serving
3	Monroe, South Monroe, Idle Hour, Browntown and Blacksmith 69-kV bus voltages		88-91%	North Monroe-Idle Hour Tap 69-kV line outage	Load Serving
3	Brodhead Muni 69-kV bus voltages		91%	Brodhead Switching Station-Brodhead Muni 69-kV line outage	Load Serving
3	Evansville, RCEC Center 69-kV bus voltages		91%	Evansville-Sheepskin 69-kV line outage	Load Serving
3	Colley Road-Brick Church 69-kV line	95-116%		Brick Church 138/69-kV transformer outage	Load Serving
3	Colley Road 138/69-kV transformer	101%		Northwest Beloit-Shirland Ave 69-kV line outage	Load Serving
3	Northwest Beloit-Shaw 69-kV line	101-108%		Colley Road 138/69-kV transformer outage	Load Serving
3	Brick Church 138/69-kV transformer	104%		North Lake Geneva 138/69-kV transformer outage	Load Serving
3	McCue 138/69-kV transformer	106%		Janesville 138/69-kV transformer outage	Load Serving
3	McCue-Milton Lawns 69-kV line	97%		Janesville 138/69-kV transformer outage	Load Serving
3	Lancaster 69-kV bus, Eden, Spring Green, Troy, Lancaster, Wyoming Valley 138-kV bus voltages		80-91%	Nelson Dewey-Lancaster 138-kV line outage	Load Serving

**TABLE ZS-2 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010**

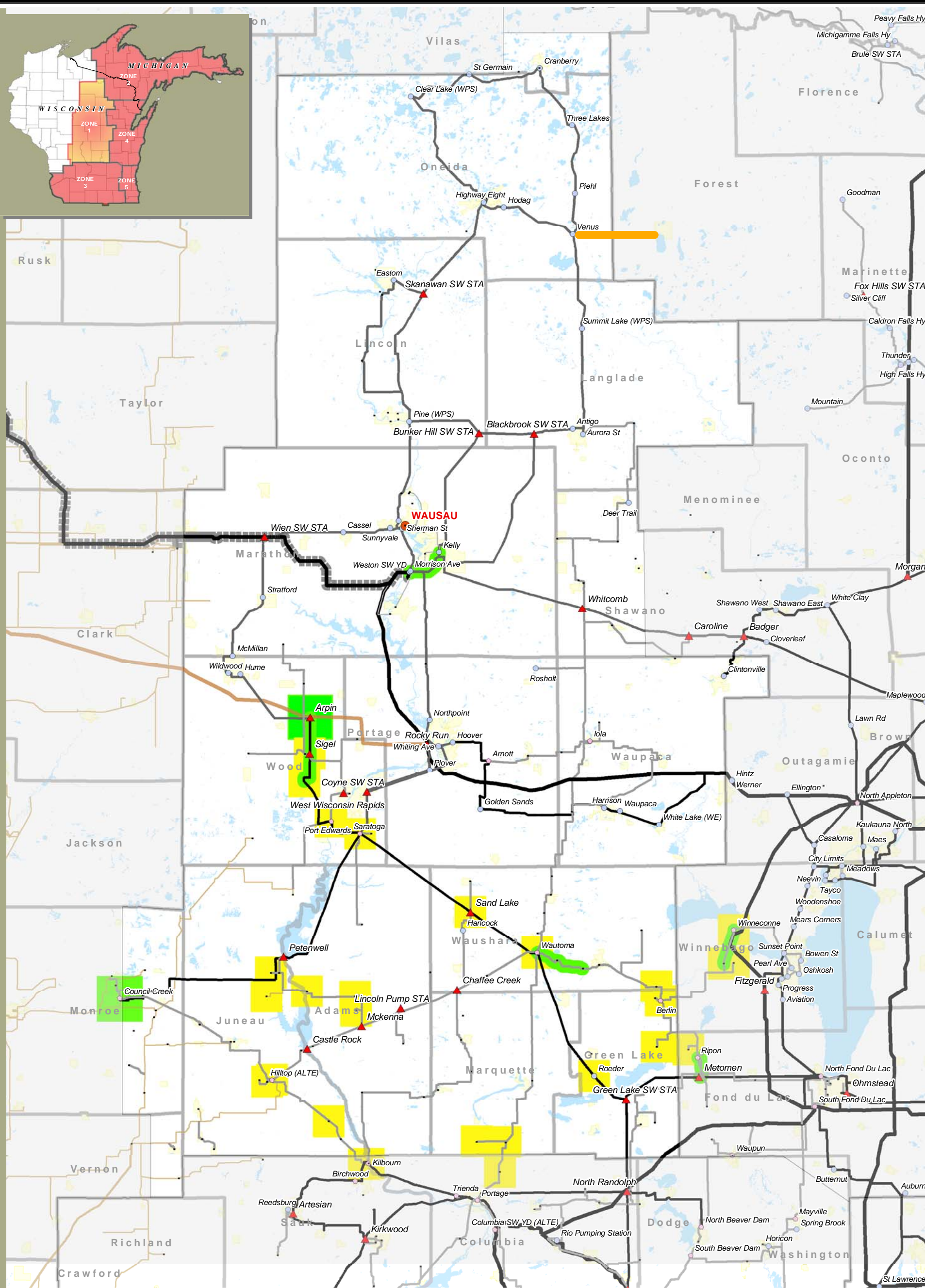
<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
3	Pine River, Richland Center, Lone Rock 69-kV bus voltages		80-92%	Lone Rock-Richland Center 69-kV line segment outages, Lone Rock Phase Shifter, Spring Green-Lone Rock 69-kV line outage	Load Serving
3	Boscobel, Blue River, Muscoda, Avoca 69-kV bus voltages		87-92%	Spring Green 138/69-kV transformer outage, Spring Green-Lone Rock and Lone Rock-Avoca 69-kV line outages	Load Serving
3	Colorado-Sun Prairie South 69-kV line	105%		Reiner Road-Burke Tap 69-kV line outage and Reiner 138/69-kV transformer outage	Load Serving
3	Burke 69-kV bus voltage		90%	Reiner Road-Burke Tap 69-kV line outage and Reiner 138/69-kV transformer outage	Load Serving
3	Columbia 138/69-kV transformer	98-107%		North Madison-De Forest 69-kV line outage, Portage 138/69-kV transformer outage	Load Serving
3	Lodi and Okee 69-kV bus voltages		92%	Dane-Lodi Tap 69-kV line outage	Load Serving
3	Pheasant Branch-Westport, West Port-Waunakee 69-kV lines	96-126%		North Madison-Sycamore 138-kV, North Madison-West Middleton 138-kV, West Middleton-Pheasant Branch 69-kV, Waunakee-Ruskin 69-kV line segment outages	Load Serving
3	Blount-Ruskin 69-kV lines	97%		Waunakee-Waunakee Tap 69-kV line outage	Load Serving
3	Fitchburg-South Nine Springs 69-kV line	108%		Royster-Pflaum Tap 69-kV line outage	Load Serving
3	Nine Springs, LCI, Pflaum 69-kV bus voltages		91%	Royster-Pflaum Tap 69-kV line outage	Load Serving
3	Platte, Finnegan, Reedsburg, Kilbourn, Lewiston and Loganville 69-kV buses; Dell Creek, East Wisconsin Dells, Artesian, Zobel, Nishan, Birchwood, Lewiston and Kilbourn 138-kV bus voltages		89-92%	Kilbourn-Trienda 138-kV line segment outages	Load Serving
3	Hillman-Belmont and Darlington-Rock Branch 69-kV line	102-135%		Nelson Dewey-Eden 138-kV line segment outages	Load Serving
3	Columbia 345/138-kV 200 MVA transformers	107%		Columbia 345/138-kV 200 MVA transformer outage	Load Serving
3	Fox Lake, North Beaver Dam and East Beaver Dam 138-kV buses; Alto, Third Street, North Beaver Dam and North Fox Lake 69-kV bus voltages		90-92%	North Randolph-North Beaver Dam 138-kV line outage	Load Serving
3	North Beaver Dam-Waupun 69-kV line	105-120%		Alto Tap-Koch Tap 69-kV line outage	Load Serving
3	Royster-Sycamore 69-kV line	95%		Femrite 138/69-kV transformer outage	Load Serving
4	Canal 138/69-kV transformer #1	99%		Canal 138/69-kV transformer #2 outage	Load Serving
4	Canal 138/69-kV transformer #2	98%		Canal 138/69-kV transformer #1 outage	Load Serving
4	Crivitz-High Falls 69-kV line	99%		Pioneer-Sandstone 69-kV line outage	Load Serving
4	Pioneer-Sandstone 69-kV line	103%		Crivitz-High Falls 69-kV line outage	Load Serving
4	Sunset Point-Pearl Avenue 69-kV line	106%		Ellinwood-Twelfth Ave 69-kV line outage	Load Serving
4	Melissa-Tayco 138-kV line	102%		Butte Des Mortes bus tie outage	Load Serving
4	Kaukauna Central Tap-Melissa 138-kV line	95%		Butte Des Mortes bus tie outage	Load Serving

**TABLE ZS-2 (continued)**  
**PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2010**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
4	West Marinette 138/69-kV transformer #1	105-108%		Wells St-Roosevelt Rd 69-kV line outage Roosevelt 138/69-kV transformer outage	Load Serving
4	West Marinette 138/69-kV transformer #2	95- 98%		Wells St-Roosevelt Rd 69-kV line outage Roosevelt 138/69-kV transformer outage	Load Serving
4	Roosevelt Road 138/69-kV transformer	95%		W. Marinette 138/69-kV transformer #2 outage	Load Serving
4	Ellinwood 138/69-kV transformer #1	103%		Fitzgerald-Sunset Point 138-kV line outage	Load Serving
4	Northgate-20th Street 138-kV line	97%		Edgewater-Huebner 138-kV line outage	Load Serving
4	Egg Harbor 69-kV bus voltage		95%	Base Case	Load Serving
4	Sister Bay 69-kV bus voltage		90-93%	Base Case Canal-Dunn Rd 69-kV line outage First Ave-Sawyer 69-kV line outage	Load Serving
4	Canal 138-kV bus voltage		91%	Canal-East Krok 138-kV line outage	Load Serving
5	Bain transformer #5	99 – 162%		Splitting Pleasant Prairie 345-kV bus between bus sections 2 and 3 or 3 and 4	Load Serving
5	Bain – Kenosha 138-kV line	107-120%		Various contingencies	Load Serving
5	Albers – Bain 138-kV line	100%		Bain – Kenosha 138-kV line outage	Load Serving
5	Oak Creek 230-kV bus tie 59	94–113%		Various contingencies	Load Serving
5	Oak Creek 230-138-kV transformer	94-121%		Various contingencies	Load Serving
5	Harbor–Ramsey 138-kV line	93–110%		Various contingencies	Load Serving
5	Bluemound–Brookdale 138-kV line	99%		Bluemound – 96 <sup>th</sup> St line outage	Load Serving
5	Racine–Oak Creek 345-kV line	101 %		Arcadian – Oak Creek 345-kV line outage	Load Serving
5	Oak Creek–Pennsylvania 138-kV line	93-101%		Various contingencies	Load Serving
5	Oak Creek–Ramsey 138-kV line	93-109%		Various contingencies	Load Serving
5	Allerton–Oak Creek 138-kV line	95%		Oak Creek – Pennsylvania 138-kV line outage	Load Serving



Figure ZS-2



Performance Criteria Limits Exceeded and Other Constraints 2007-2010

**PLANNING ZONE 1**

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

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

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

- Transmission Related Facilities**
- ▲ ATC Owned Substation
  - Joint Owned Substation - Assets Conveyed
  - Joint Owned Substation - Assets Retained
  - Proposed/Design/Construction
  - ▬ Future Arrowhead-Gardner Park 345 kV line
  - ATC Office Location
  - Generation
  - Other Facility

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

## **ZONE & STUDY RESULTS > Zone 1 – 2014 study results**

Refer to [Table ZS-3](#) and [Figure ZS-3](#)

### **Summary of key findings**

- ❑ The Rhinelander Loop will require additional reinforcements at some time beyond the current planning horizon. Two potential alternatives are a new 138-kV line from Metonga to the Plains or Amberg substations or rebuilding select 115-kV lines supporting this area to the south.
- ❑ Low voltages and line overloads in the greater Berlin/Ripon area will require that a new source be connected to the existing 69-kV network.
- ❑ Proposed Weston 5 or Plover generation requests may impact transmission system plans.

Many alternatives have been evaluated as long-term solutions for the Rhinelander Loop as discussed in the 2006 and 2010 sections. Not included in preceding discussions were potential 345-kV alternatives because the lead-time needed to implement such projects far exceeds the date needed. Of the 345-kV alternatives that have been evaluated, the best performing project consisted of a new Weston-Venus-Plains 345-kV line utilizing the existing 345-kV facilities between Weston and Black Brook. Although this 345-kV alternative meets the needs for the Rhinelander Loop for the foreseeable future, we currently are favoring a lower-voltage and lower-cost solution.

To address Rhinelander Loop voltage and thermal loading issues beyond the planning horizon, potential alternatives, in addition to the 345-kV projects described above, could include the following:

- ❑ a new 138-kV line from Metonga to the Plains or Amberg substations
- ❑ addition of another 115-kV circuit serving the Rhinelander Loop from the south by rebuilding select 115-kV facilities as double-circuit lines

Unless other need drivers appear, the lower-voltage solutions may be the best suited for area needs.

To address low voltages elsewhere within Zone 1, new or additional capacitor banks will be needed at the Hilltop Substation in 2012, McKenna Substation in 2014 and the Clear Lake Substation in 2015. To address facility overloads, the 138/69-kV transformers at Wautoma will need to be upgraded and the Metomen-Ripon 69-kV and the Port Edwards-Saratoga 138-kV lines will need to be updated.

The greater Berlin/Ripon area is in need of a more robust solution for overloads and low voltages. We presently are recommending building a new transmission line between the Omro Industrial and Fitzgerald substations. This line initially would be operated at 69 kV but be constructed with 138-kV clearances with the intent to convert it to 138 kV and



# 10-Year Assessment

An annual report summarizing proposed additions and expansions to the transmission system to ensure electric system reliability.

2005

[www.atc10yearplan.com](http://www.atc10yearplan.com)

extend the 138-kV line to the Berlin Substation. This would address the Berlin area reliability issues for the foreseeable future.

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
1	Bunker Hill-Blackbrook 115-kV line	103%		Gardner Park-Blackbrook 115-kV line outage	Load Serving
1	Antigo and Aurora St. 115-kV bus voltages		90 -92%	Gardner Park-Blackbrook 115-kV line outage Gardner Park-Blackbrook-Antigo 115-kV line outage	Load Serving
1	Gardner Park-Blackbrook 115-kV line	101 - 102%		Maine-Pine 115-kV line outage Maine-Hilltop 115-kV line outage	Load Serving
1	Rocky Run-Plover 115-kV line	99%		Rocky Run-Whiting Ave. 115-kV line outage	Load Serving
1	Hollywood-Port Edwards 138-kV line	98 – 105%		Sigel-Arpin 138-kV line outage Arpin 345/138-kV transformer outage	Load Serving
1	Hollywood-Saratoga 138-kV line	101 - 108%		Sigel-Arpin 138-kV line outage Arpin 345/138-kV transformer outage	Load Serving
1	Sigel, Lakehead Vesper & Port Edwards 138-kV bus voltages		89 – 90%	Arpin-Sigel 138-kV line outage	Load Serving
1	Port Edwards, Hollywood & Saratoga 138-kV bus voltages		90 – 91%	Arpin-Sigel 138-kV line outage	Load Serving
1	Council Creek 138/69-kV transformer	103 – 105%		King-Eau Claire-Arpin 345-kV line outages Eau Claire-Arpin 345-kV line outage	Network
1	Hilltop, Mauston, Lyndon Station, Wisconsin Dells and Kilbourn 69-kV bus voltages		84 – 91%	Kilbourn-Wisconsin Dells #2 69-kV line outage	Load Serving
1	Necedah, Whistling Wings, Dellwood, Friendship, Houghton Rock 69-kV bus voltages		87 – 92%	Big Pond-Necedah tap 69-kV line outage Necedah tap-Whistling Wings tap 69-kV line outage	Load Serving
1	Wautoma, Sand Lake and Roeder 138-kV bus voltages		90 – 95%	Base Case Various contingencies	Load Serving
1	Metomen 138/69-kV transformer	95 – 115%		Various contingencies	Load Serving
1	Metomen-Ripon 69-kV line	95 – 111%		Various contingencies	Load Serving
1	Winneconne-Sunset 69-kV line	99%		Ripon-NW Ripon Tap 69-kV line outage	Load Serving
1	Berlin area 69-kV bus voltages		88 – 92%	Various contingencies	Load Serving
1	Whitcomb 115/69-kV transformer	95 – 96%		Gardner Park-Blackbrook 115-kV line outage Gardner Park-Blackbrook-Antigo 115-kV line outage	Load Serving
1	Coloma and Coloma Tap 69-kV bus voltages		91 – 92%	Chaffee Creek-Coloma 69-kV line outage	Load Serving
2	Atlantic 138/69-kV transformer	134-98%		M38 138/69-kV transformer outage M38-Winona 138-kV line outage Winona-Twin Lakes 69-kV line outage Atlantic-M38 69-kV line outage Atlantic-Portage Tap 69-kV line outage Tap-Twin Lakes 69-kV line outage	Load Serving
2	M38 138/69-kV transformer	108%		Atlantic 138/69-kV transformer outage Atlantic-M38 138-kV line outage	Load Serving
2	Atlantic-Henry Street 69-kV line	95%		Base case	Base Case
2	Hiawatha, Lakehead, Brevort and Straits 138-kV bus voltages		92%	Livingston-Emmit Co 138-kV line outage	Load Serving
2	Atlantic 138-kV bus voltage		91-92%	M38-Perch Lake 138-kV line outage	Load Serving
2	Newberry Village 69-kV bus voltage		92%	Engadine-Newberry 69-kV line outage	Load Serving
2	Seney Tap 69-kV bus voltage		92%	Munising 138/69-kV transformer outage Forsyth- Munising 138-kV line outage	Load Serving
2	Brevort 138-kV bus voltage		92%	Straits-Brevort 138-kV line outage	Load Serving



**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 (continued)**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
3	Oregon-Stoughton 69-kV line	97-107%		Sugar River (Montrose)-Verona 69-kV line outage	Load Serving
3	Stagecoach-Timberlane Tap 69-kV line	97%		Sugar River-Verona 69-kV line and Spring Green 138/69-kV transformer outage	Load Serving
3	North Stoughton-Kegonsa 69-kV line	100-114%		Sugar River-Verona, McCue-Karmony, Stoughton-Sheepskin 69-kV line outages	Load Serving
3	Verona, Aaker Road, Brooklyn, North Stoughton, Oregon 69-kV bus voltages		87-91%	Sugar River-Verona, Stoughton-Aaker Road, Kegonsa-North Stoughton 69-kV line and Sugar River 138/69-kV transformer outages	Load Serving
3	Sugar River-Verona 69-kV line	96-124%		West Middleton-Timberlane Tap and Stoughton-Aaker Road 69-kV line outages	Load Serving
3	North Monroe-Idle Hour 69-kV line	96-109%		Darlington 138/69-kV transformer, Brodhead-South Monroe 69-kV line outages	Load Serving
3	Hooterville 69-kV bus voltage		91%	Eden 138/69-kV transformer outage	Load Serving
3	Darlington-Rock Branch 69-kV line	116%		Eden 138/69-kV transformer outage	Load Serving
3	Brodhead Switching Station-South Monroe 69-kV line	98 - 127%		North Monroe-South Monroe 69-kV line and North Monroe-Albany 138-kV line outages	Load Serving
3	Bird Tap-Sun Prairie 69-kV line	98 - 104%		Reiner Road-Burke Tap 69-kV line and Reiner Road 138/69-kV transformer outages	Load Serving
3	Burke 69-kV bus voltage		89%	Reiner Road 138/69-kV transformer outage	Load Serving
3	Token Creek-Yahara River 69-kV line	126%		Reiner Road 138/69-kV transformer outage	Load Serving
3	Colley Road-Park Street Tap 69-kV line	100%		Northwest Beloit-Shirland Ave 69-kV line outage	Load Serving
3	Kilbourn 47 MVA 138/69-kV transformer	98%		Kilbourn 100 MVA transformer outage	Load Serving
3	Colley Road 138/69-kV transformer	98%		Northwest Beloit-Shirland Ave 69-kV line outage	Load Serving
3	Northwest Beloit-Shaw 69-kV line	101 - 108%		Colley Road 138/69-kV transformer outage	Load Serving
3	Academy-Fall River 69-kV line	101%		Columbia-Manley Sands 69-kV line outage	Load Serving
3	Columbia 138/69-kV transformer	100%		Portage 138/69-kV transformer outage	Load Serving
3	Portage 138/69-kV transformer	102%		Columbia 138/69-kV transformer outage	Load Serving
3	North Beaver Dam-Waupun 69-kV line	96 - 118%		South Fond du Lac-Waupun 69-kV line segment outage	Load Serving
3	Hillman-Potosi 138-kV line	96%		Nelson Dewey-Lancaster 138-kV line outage	Load Serving
3	Stagecoach-Black Earth 69-kV line	102%		Eden-Wyoming Valley 138-kV line outage	Load Serving
3	Portage-Trienda 138-kV circuits	112%		adjacent Portage-Trienda 138-kV circuit outage	Load Serving
3	Columbia-Portage 138-kV circuits	100%		adjacent Columbia-Portage 138-kV circuit outage	Load Serving
3	Columbia 345/138-kV 200 MVA transformers	99%		Columbia 345/138-kV 400 MVA transformer outage	Load Serving
3	North Fox Lake, Alto, Waupun, Koch Oil 69-kV bus voltages		90 - 92%	South Fond Du Lac-North Beaver Dam 69-kV line segment outage	Load Serving

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 (continued)**

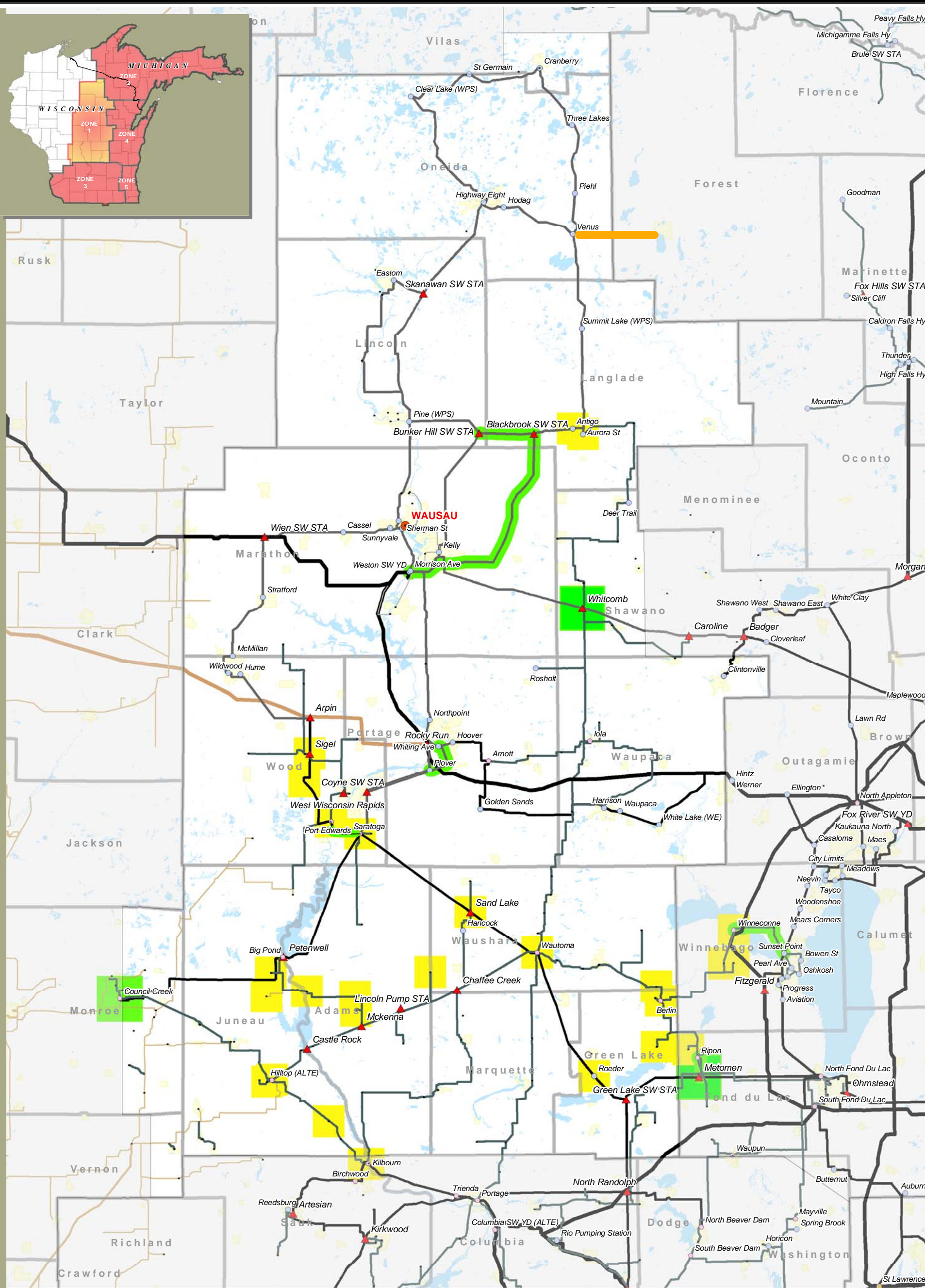
<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
3	Columbia-North Madison 345-kV Circuit #1	102%		adjacent Columbia-North Madison 345-kV circuit outage	Load Serving
3	Lodi and Okee 69-kV bus voltages		91%	Dane-Lodi Tap 69-kV line outage	Load Serving
3	Royster-Sycamore 69-kV line	95%		Femrite 138/69-kV transformer outage	Load Serving
3	Platte, Finnegan, Reedsburg, Kilbourn, Lewiston and Loganville 69-kV buses; Dell Creek, East Wisconsin Dells, Artesian, Zobel, Nishan, Birchwood, Lewiston and Kilbourn 138-kV buses		92%	Kilbourn-Trienda 138-kV line segment outage	Load Serving
3	Pine River, Richland Center, Lone Rock 69-kV buses		87 - 90%	Lone Rock-Richland Center, Richland Center-Dayton, Lone Rock Phase Shifter outage	Load Serving
3	Brick Church-Katzenberg 69-kV line	98 - 122%		North Lake Geneva-South Lake Geneva 69-kV line, North Lake Geneva 138/69-kV transformer outages	Load Serving
3	Brick Church-North Lake Geneva 69-kV line	98 - 110%		North Lake Geneva and Brick Church 138/69-kV transformer outages	Load Serving
3	North Lake Geneva 138/69-kV transformer	105%		Brick Church 138/69-kV transformer outage	Load Serving
3	McCue 138/69-kV transformer	102%		Janesville 138/69-kV transformer outage	Load Serving
3	McCue-Milton Lawns 69-kV line	116%		Janesville 138/69-kV transformer outage	Load Serving
3	Janesville 138/69-kV transformer	97%		McCue 138/69-kV transformer outage	Load Serving
3	Janesville-Park View 69-kV line	103%		McCue 138/69-kV transformer outage	Load Serving
3	Spring Green, Arena, Mazomanie bus voltages		92%	Spring Green-Arena 69-kV line, the Spring Green 138/69-kV transformer outages	Load Serving
3	West Middleton-Black Earth 69-kV line	95 - 105%		Spring Green 138/69-kV transformer outage	Load Serving
4	Egg Harbor 69-kV bus voltage		91 - 93%	Base Case First Avenue-Sawyer 69-kV line outage Canal-Dunn Road 69-kV line outage Canal-East Krok 138-kV line outage	Load Serving
4	Sister Bay 69-kV bus voltage		88 - 91%	Base Case Various contingencies	Load Serving
4	Quarry Run, Woodenshoe 138-kV bus voltages		92%	Quarry Run-Neevin 138-kV line outage	Load Serving
4	Dyckesville, Ontario, Rosiere, Scottwood, 138-kV bus voltages		90 - 92%	Highway V-Ontario 138-kV line outage	Load Serving
4	Canal 138-kV bus voltage		89 - 91%	Highway V-Ontario 138-kV line outage Canal-East Krok 138-kV line outage	Load Serving
4	South Sheboygan Falls 138/69-kV transformer	102%		North Mullet River-Mullet River 69-kV line outage Mullet River 138/69-kV transformer outage	Load Serving
4	North Mullet River- Mullet River 69-kV line	100 - 120%		Northside Tap-Sheboygan Falls 69-kV line outage South Sheboygan Falls-Bemis Tap 69-kV line outage South Sheboygan Falls 138/69-kV transformer outage Monroe-Bemis Tap 69-kV line outage	Load Serving
4	Adams Street-Sheboygan Falls 69-kV line	106%		South Sheboygan Falls-Bemis Tap 69-kV line outage South Sheboygan Falls 138/69-kV transformer outage	Load Serving
4	Sheboygan-Edgewater 69-kV line	99%		South Sheboygan Falls-Edgewater 138-kV line outage	Load Serving

**TABLE ZS-3  
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – 2014 (continued)**

<b>Planning Zone</b>	<b>Criteria Exceeded/Need</b>	<b>% of Facility Rating</b>	<b>% of Nominal Bus Voltage</b>	<b>Cause</b>	<b>Condition</b>
4	Edgewater 345/138-kV transformer #2	98%		Edgewater 345/138-kV #1 outage	Load Serving
4	Edgewater-Huebner 138-kV line	95%		Edgewater-Sauktrail 138-kV line outage	Load Serving
4	Edgewater-Sauktrail 138-kV line	96%		Edgewater-Huebner 138-kV line outage	Load Serving
4	Northgate-20th Street 138-kV line	106 - 119%		Edgewater-Huebner 138-kV line outage Lodestar-Huebner 138-kV line outage	Load Serving
4	Edgewater-Washington Street 69-kV line	109%		Edgewater-Nicolet 69-kV line outage	Load Serving
4	Washington Street-Riverside 69-kV line	109%		Edgewater-Nicolet 69-kV line outage	Load Serving
4	Edgewater-Nicolet 69-kV line	117%		Erdman-32nd St 69-kV line outage	Load Serving
4	Pulliam-Danz 69-kV line	97%		Pulliam-Van Buren 69-kV line outage	Load Serving
4	Canal-Dunn Road 69-kV line	101%		1st Avenue-Sawyer 69-kV line outage	Load Serving
4	1st Avenue-Dunn Road 69-kV line	106%		Canal-Dunn Road 69-kV line outage	Load Serving
4	Canal 138/69-kV transformer #2	111%		Canal 138/69-kV transformer #1 outage	Load Serving
4	Canal 138/69-kV transformer #1	111%		Canal 138/69-kV transformer #2 outage	Load Serving
4	Tecumseh 138/69-kV transformer	98%		Glenview-Gravesville 69-kV line outage	Load Serving
4	Glenview 138/69-kV transformer #1	96%		Glenview 138/69-kV transformer #2 outage	Load Serving
4	Glenview 138/69-kV transformer #2	96%		Glenview 138/69-kV transformer #1 outage	Load Serving
4	Sunset Point-Pearl Ave 69-kV line	108%		Ellinwood-Twelfth Avenue 69-kV line outage	Load Serving
4	Ellinwood 138/69-kV transformer #1	99 - 107%		Fitzgerald-Sunset Point 138-kV line outage Ellinwood 138/69-kV transformer #2 outage	Load Serving
4	Sunset Point 138/69-kV transformer #2	96%		Sunset Point 138/69-kV transformer #1 outage	Load Serving
4	Sunset Point 138/69-kV transformer #1	96%		Sunset Point 138/69-kV transformer #2 outage	Load Serving
4	Melissa-Tayco 138-kV line	100 - 120%		Butte Des Mortes 138-kV bus tie outage North Appleton-High Point 138-kV line outage Butte Des Mortes-High Point 138-kV line outage	Load Serving
4	Kaukauna Central Tap-Melissa 138-kV line	111%		Butte Des Mortes 138-kV bus tie outage	Load Serving
4	Butte Des Mortes 138-kV bus tie	96%		Fitzgerald 345/138-kV transformer outage	Load Serving
5	Albers – Kenosha 138-kV line	100%		Bain – Kenosha 138-kV line outage	Load Serving



Figure ZS-3



Performance Criteria Limits Exceeded and Other Constraints 2011-2014

# PLANNING ZONE 1

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

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

- |                                     |  |                     |
|-------------------------------------|--|---------------------|
| Low Voltages                        | ATC Owned Substation                     | ATC Office Location |
| Overloaded Facility                 | Joint Owned Substation - Assets Conveyed | Generation          |
| New Generation/Stability            | Joint Owned Substation - Assets Retained | Other Facility      |
| Transmission Needed for Load Growth | Proposed/Design/Construction             |                     |

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.