

ZONE & STUDY RESULTS > Zone 4 overview

Zone 4 includes the Wisconsin counties of:

- ❑ Brown
- ❑ Calumet
- ❑ Door
- ❑ Fond du Lac
- ❑ Manitowoc
- ❑ Marinette (southern portion)
- ❑ Menominee
- ❑ Oconto
- ❑ Outagamie
- ❑ Kewaunee
- ❑ Shawano (eastern portion)
- ❑ Sheboygan
- ❑ Winnebago

The physical boundaries of Zone 4 and transmission facilities located in Zone 4 are shown in [Figure ZS-21](#).

Zone 4 land use is a mix of agricultural, forest and urban.

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

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

Zone 4 demographics

The population of the counties in Zone 4 grew at an annual rate of 1.1 percent from 1994 to 2004. The highest growth rate occurred in Calumet County (more than 2 percent), while the largest increase in population occurred in Brown County, which increased by about 31,000 people.

During the same period, the employment growth rate was 1.5 percent. The highest growth rate occurred in Door County, while the largest increase in employment occurred in Brown County.

Zone 4 future population and employment projections

Population in Zone 4 is projected to grow at 0.8 percent annually between 2000 and 2005 and at 0.8 percent from 2005 through 2010. Brown County is projected to realize the largest increase in population, while Calumet County is projected to have the highest growth rate.

Employment in Zone 4 is projected to grow at 0.7 percent annually between 2000 and 2005 and at 1.2 percent from 2005 through 2010. Brown County is projected to realize the largest increase in employment, while Door County is projected to have the highest growth rate.

Zone 4 environmental considerations

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

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

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

Zone 4 electricity demand and generation

The coincident peak load forecasts for Zone 4 for 2006, 2010 and 2014 are shown in [Table ZS-13](#). Existing generation, along with proposed generation based on projected in-service year, are also shown. The resultant capacity margins, with or without the proposed generation, are shown as well.

This table shows that load is projected to grow at roughly 2.5 percent annually from 2006 through 2014. 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 Green Bay area,
- ❑ two 345-kV lines extending from the Edgewater Power Plant,
- ❑ the eastern portion of the Rocky Run-North Appleton 345-kV line,
- ❑ 345-kV lines from South Fond du Lac to Columbia, Edgewater and Fitzgerald and
- ❑ a 345-kV line from Fitzgerald to North Appleton.

Key system performance issues in Zone 4 include:

- ❑ heavily loaded and aging 138- and 69-kV facilities in the Green Bay area, north of Green Bay and the Fox River Valley,
- ❑ heavily loaded 138-kV and 69-kV facilities in the Sheboygan area.
- ❑ low voltages in the northern Door County area,
- ❑ heavily loaded 138-kV lines west of Green Bay and Appleton,
- ❑ insufficient 138/69-kV transformer capability in the West Marinette area,
- ❑ the stability response of the Point Beach nuclear units and
- ❑ the limited import capability of northeast Wisconsin and Michigan's Upper Peninsula, resulting in uneconomic dispatch of generating units.

For a comprehensive list and graphical depiction of projects in Zone 4, please refer to Table PR-16 and Figure PR-4.

*Table PR-16
Transmission System Additions for Zone 4*

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Uprate the North Appleton-Rocky Run 345-kV line	2005	2005	4	reliability	Planned
Construct a 138-kV substation at a new Forward Energy Center; loop existing Butternut-South Fond du Lac line into Forward Energy Center	2005	2005	4	new generation	Planned
Install a 138-kV series reactor at Highway V	2005	2006	4	reliability, service limitation, T-D interconnection	Planned
Upgrade 48 MVA RTU and CT at Mullet River 138/69 kV	2006	2006	4	reliability	Proposed
Construct a 345-kV substation at new Cypress; loop existing Forest Junction-Arcadian line into new Cypress	2006	2006	4	new generation	Planned
Construct a 345/138-kV switchyard at a new Werner West Substation; install a 345/138-kV transformer. Loop existing Rocky Run to North Appleton 345-kV and existing Werner to White Lake 138-kV lines into Werner West	2004	2006	4	reliability, service limitation	Planned
Construct a Martin Road-South Fond du Lac/Ohmstead 138-kV line	2006	2006	4	T-D interconnection	Planned
Construct North Appleton 345-kV double breaker ring bus configuration	2006	2006	4	operations, maintenance and stability	Planned
Rebuild Stiles-Amberg double-circuit 138-kV line	1996	2006	2 & 4	reliability, service limitation, condition	Planned
String a new Ellinwood-Sunset Point 138-kV line on existing structures	2007	2007	4	reliability	Provisional
Install 2-16.3 MVAR capacitor bank at Canal 69 kV	2007	2007	4	reliability	Planned
Replace the 1200 A breaker at Edgewater T22 345/138 kV	2007	2007	4	reliability	Proposed

Table PR-16
Transmission System Additions for Zone 4 (continued)

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Construct double-circuit 138-kV line from Forest Junction/Howards Grove/Charter Steel to Plymouth #4	2007	2007	4	T-D interconnection	Proposed
Uprate North Appleton-Lawn Road-White Clay 138-kV line	2007	2007	4	reliability	Planned
Construct 138-kV line from Canal to Dunn Road	2008	2008	4	reliability	Proposed
Install 60 MVA 138/69-kV transformer at Dunn Road	2008	2008	4	reliability	Proposed
Rebuild/Convert Pulliam-New Suamico 69-kV line to 138 kV	2008	2008	4	reliability, condition, T-D interconnection	Provisional
Uprate North Appleton-Mason Street 138-kV line	2008	2008	4	reliability, service limitation	Proposed
Uprate North Appleton-Lost Dauphin 138-kV line	2008	2008	4	reliability, service limitation	Proposed
Expand the Menominee 69-kV Substation and install 138-kV terminals. Loop the West Marinette-Bay De Noc 138-kV line into the substation	2008	2008	4	reliability	Provisional
Install 138/69-kV transformer at the expanded Menominee Substation	2008	2008	4	reliability	Provisional
Rebuild Crivitz-High Falls 69-kV double-circuit line	2008	2008	4	reliability	Provisional
Rebuild 2.37 miles of 69 kV from Sunset Point to Pearl Ave with 477 ACSR	2009	2009	4	reliability	Proposed
String a new 138-kV line from Clintonville-Werner West primarily on Morgan-Werner West 345-kV line structures	2004	2009	4	reliability, service limitation	Planned
Construct Morgan-Werner West 345-kV line	2004	2009	4	reliability, service limitation	Planned
Retap 48 MVA CT at South Sheboygan Falls 138/69-kV transformer	2010	2010	4	reliability	Proposed

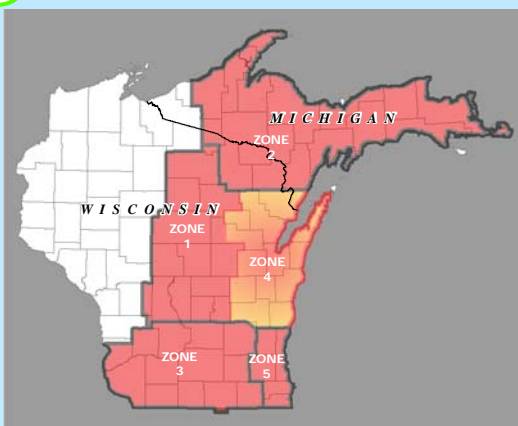
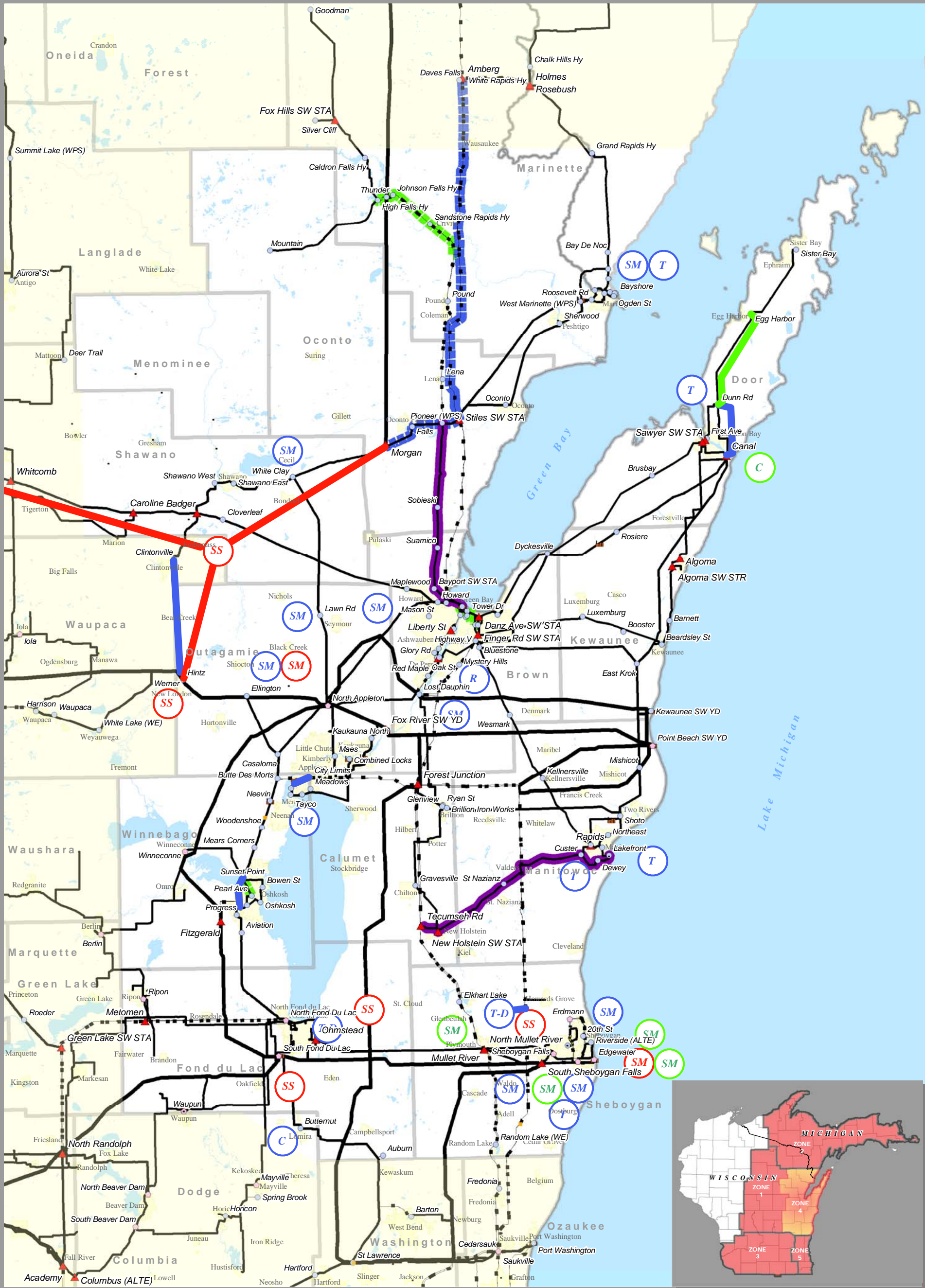
Table PR-16
Transmission System Additions for Zone 4 (continued)

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Rebuild/convert New Holstein-St Nazianz-Custer-Lakefront 69-kV line to 138 kV (1225 Amps minimum)	2010	2010	4	access initiative	Provisional
Rebuild Tecumseh Road-New Holstein to double-circuit 138/69 kV, where 69 kV will serve Gravesville via New Holstein	2010	2010	4	access initiative	Provisional
Install 47 MVA 138/69-kV transformer at Custer	2010	2010	4	access initiative	Provisional
Install 100 MVA 138/69-kV transformer at Lakefront	2010	2010	4	access initiative	Provisional
Construct a second Dunn Road-Egg Harbor 69-kV line	2010	2010	4	reliability	Proposed
Uprate Northgate-20th Street 138-kV line	2011	2011	4	reliability	Provisional
Replace the 400 amp metering CT at North Mullet River 69 kV	2011	2011	4	reliability	Provisional
Retap 400A primary CT at Edgewater to 600A	2012	2012	4	reliability	Provisional
Replace 300 A metering CT at Edgewater 69 kV	2013	2013	4	reliability	Proposed
Rebuild/convert Chalk Hills-Chandler 69 kV to 138 kV operation	2013	2013	2 & 4	reliability	Provisional
Replace 300 A metering CT at Riverside 69 kV	2013	2013	4	reliability	Proposed
Replace the 300A current transformer at Sheboygan Falls 69 kV	2013	2013	4	reliability	Provisional
Replace the existing 46.7 MVA 138/69-kV transformer at South Sheboygan Falls with 100 MVA transformer	2014	2014	4	reliability	Provisional
Uprate the Melissa-Tayco to 229 MVA (300F)	2014	2014	4	reliability	Provisional
Install 28.8 MVAR capacitor bank at Butternut 138 kV	2015	2015	4	reliability	Provisional
Construct a Northside-City Limits 138-kV line	2015	2015	4	reliability	Provisional

*Table PR-16
Transmission System Additions for Zone 4 (continued)*

System additions	System need year	Projected in-service year	Planning zone	Need category	Planned, Proposed or Provisional
Reconductor Pulliam-Danz 69-kV line	2015	2015	4	reliability	Provisional
Reconductor Danz-Henry Street 69-kV line	2015	2015	4	reliability	Provisional
Reconductor Pulliam-Van Buren 69-kV line	2015	2015	4	reliability	Provisional
Rebuild/Convert New Suamico-Pioneer 69-kV line to 138 kV	2015	2015	4	reliability, condition	Provisional

Figure PR-4



Transmission System Additions (May be Planned, Proposed or Provisional)

PLANNING ZONE 4

- SS** New Substation
- SM** Substation Modifications
- T** Transformer
- C** Capacitor Bank
- T-D** New T-D Interconnection
- R** Reactor

- 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
- ▬▬▬ Rebuilt 69 kV Transmission Line

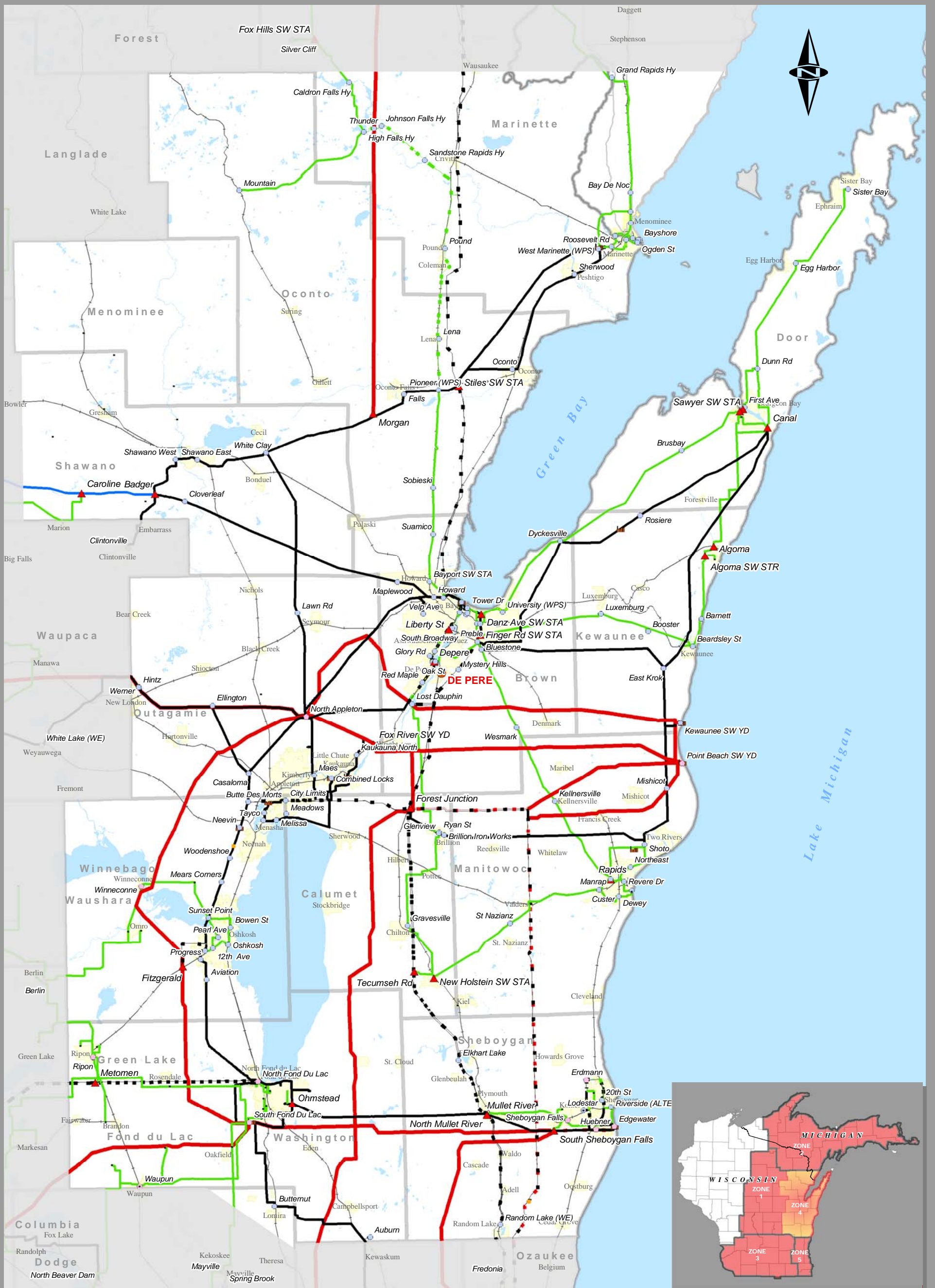
- Transmission Related Facilities**
- ▲ ATC Owned Substation
 - Joint Owned Substation - Assets Conveyed
 - Joint Owned Substation - Assets Retained
 - Proposed/Design/Construction
 - ATC Office Location
 - Generation
 - Other Facility

*Table ZS-13
Forecast of Peak Load and Generation in Zone 4*

	2006	2010	2014
Peak Forecast (megawatts)	3251.4	3556.7	3963.6
Average Peak Load Growth	N/A	2.27%	2.74%
Existing Generation Capacity (megawatts)	5588.6	5588.6	5588.6
Existing Capacity Less Load	2337.2	2031.9	1625.0
Existing Generation Capacity plus Modeled Generating Capacity Additions (megawatts)	5748.6	5828.6	5828.6
Modeled Capacity Less Load (megawatts)	2497.2	2271.9	1865

*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.*

Figure ZS-21



Electric Transmission Network & Substations
PLANNING ZONE 4



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

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

Transmission Line Voltage

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

Transmission Related Facilities

ATC Owned Substation	ATC Office Location
Joint Owned Substation - Assets Conveyed	Generation
Joint Owned Substation - Assets Retained	Other Facility
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.

ZONE & STUDY RESULTS > Zone 4 – 2006 study results

Refer to Table ZS-1 and Figure ZS-10

Summary of key findings

- Construction of a new 345/138-kV substation at a Werner West site will avert overloads and improve 138-kV voltage profiles in the area.
- Load growth in the Oshkosh area will necessitate transmission reinforcements to mitigate overloading the Ellinwood 138/69-kV transformer for single contingency conditions.
- New 345-kV and 138-kV substations will be required in order to accommodate the proposed wind driven generators in Fond du Lac County.

Several potential line and transformer overloads as well as low voltages were revealed in Zone 4 based on the 2006 analysis.

As noted in the Northern Umbrella Plan discussion in the 2004 10-Year Assessment, the most chronic problem plaguing day-to-day operation of our transmission system is the limited transfer capability during non-peak periods between Wisconsin and Michigan's Upper Peninsula. The resulting effects include:

- uneconomic dispatch of generation,
- chronic interruption or curtailment of transmission service,
- frequent reconfiguration of the system (opening the Hiawatha-Indian Lake 69-kV lines in Zone 2),
- operating near system security limits for extended periods of time and
- limited ability to schedule maintenance without invoking redispatch, system reconfiguration or other measures.

Several of the facilities that show up as limitations also are well beyond their design life with the following three having more than 70 years in service:

- Plains-Amberg-Stiles 138-kV double-circuit line (1925)
- Bay de Noc-Grand Rapids 69-kV (line conductor is 1922 vintage; poles were rebuilt in 1931, which is part of West Marinette-Amberg route)

To increase transfer capability between Wisconsin and the Upper Peninsula, minimize the impact on system operation while system reinforcements are being implemented, address facility condition issues to the extent practical, achieve greater reliability to reduce the risk of widespread outages in the Upper Peninsula, and achieve all of these benefits at the lowest reasonable cost, the following projects are going to be in service or under construction in Zone 4 as interim solutions:

- rebuilding Morgan-Falls-Pioneer-Stiles 138-kV line (August 2005),
- rebuilding Plains-Amberg 138-kV line (September 2005),

- rebuilding/converting West Marinette-Amberg 69-kV line to 138 kV (September 2005) and
- rebuilding Amberg-Stiles 138-kV line (October 2006).

As long-term solutions, the following projects have been planned in Zone 4:

- construct a new 345/138-kV substation at Werner West (June 2006) and
- construct a new Morgan-Werner West 345-kV line (December 2009).

The Werner West 345/138-kV transformation also would:

- address the overload on the North Appleton-Ellington 138-kV line under single contingency conditions,
- reduce the line loadings between Werner West and North Appleton, and
- provide voltage support to the area.

As noted in the Update to our 2004 10-Year Assessment, recent review of the rating of the North Appleton-Rocky Run 345-kV line resulted in a significant reduction in its rating (from 679 MVA to 589 MVA, summer emergency). This rating change can cause this line to overload, limiting imports into our system once it is looped into the planned Werner West 345/138-kV Substation in 2006. The project for uprating the North Appleton-Rocky Run 345-kV line is under construction and is anticipated to be in service by the end of 2005.

As noted in the Update to our 2004 10-Year Assessment, the rating of the Highway V-Preble 138-kV line (X-154) currently is limited by the line conductor. X-154 is a chronic limiter to transmission service, both now and in the future. Given the location of this line, rebuilding or reconductoring the line poses complex construction issues. The addition of a series reactor at Highway V will divert transmission flows to parallel circuits, permitting greater utilization of the transmission system without significant investment. The reactor project is scheduled to be in service by 2006.

To accommodate the new load interconnection at Howards Grove, we are constructing a double-circuit 138-kV line to loop the Forest Junction-Charter Steel-Saukville 138-kV line into the proposed Howards Grove Substation. The project is scheduled to be in service by August 2005.

The North Appleton 345-kV double-breaker ring bus configuration is under construction with an in-service year of 2006. The project will modify the existing 345-kV bus into a double-breaker ring bus. The project will address the following issues:

- The interconnection study for the Fox Energy 670 MW generation in conjunction with the 43 MW increase of the Kewaunee Nuclear Plant identified numerous system upgrades (system stability and breaker duty) required for the existing system.

- ❑ The condition of the existing 345-kV high side circuit switchers (switchers 6815 and 6833) for two of the 345/138-kV transformers at North Appleton are older, difficult to maintain and unreliable.
- ❑ Outages for breaker maintenance at North Appleton are very difficult to schedule due to the existing straight bus configuration. Converting the existing 345-kV facilities to the double-breaker ring bus configuration will provide operating and maintenance flexibility.

As an interim solution, a capacitor bank is planned at the Canal 69-kV Substation in 2007 to address low voltages in the Door County area. The addition of this capacitor bank will boost the voltage of the intact system to an acceptable level until the Canal-Dunn Road 138-kV line is in place (See Zone 4 - 2010 study results). The project also would provide beneficial voltage support to the Ontario-Dyckesville-Rosiere-Canal 138-kV lines under single contingency conditions (See Zone 4 - 2014 study results).

To accommodate a new distribution interconnection near Plymouth in 2007, the Forest Junction-Howards Grove-Saukville 138-kV line is to be looped into the proposed Plymouth #4 Substation (approximately 1.25 miles).

As discussed in the Update to our 2004 10-Year Assessment and based on results of additional studies, the project for stringing the Ellinwood-Sunset Point 138-kV line is proposed for 2007 to address potential overloads on the Ellinwood 138/69-kV T1 transformer and Ellinwood-12th Avenue 69-kV line under single contingency conditions.

Several projects related to proposed generation additions have been completed and those are:

- Transmission projects associated with Fox Energy Center:
 - ❑ a new 345-kV switchyard located at the power plant site to connect the two generators and three 345-kV lines,
 - ❑ loop the existing Point Beach-North Appleton 345-kV line into the new switchyard and
 - ❑ a 345-kV line from the power plant site to Forest Junction substation on existing right-of-way.

Transmission projects associated with the Sheboygan Energy Center:

- ❑ a new 345-kV switchyard located at the power plant site to connect the generators and to connect two 345-kV lines and
- ❑ loop the existing Point Beach-Granville 345-kV line into the new switchyard.

As discussed in the Update to our 2004 10-Year Assessment, two wind farms have been proposed in the Fond du Lac County area.

- ❑ Forward Energy Wind Farm (2005)
- ❑ Blue Sky and Green Field Wind Farms, connected at the new Cypress Substation (2006)

Forward Energy Center (200 MW) is scheduled to be in service in 2005. Interconnection studies have been completed for this generation, and transmission service studies for 150 MW of the plant output have been completed. We will construct the following transmission facilities to support this new generation:

- ❑ a new 138-kV switchyard will be located at the wind farm site to connect the generators and to connect two 138-kV lines and
- ❑ we will loop the existing South Fond du Lac-Butternut 138-kV line into the new switchyard.

Cypress (160 MW) is scheduled to be in service in 2006. Interconnection studies have been completed and a transmission service study for 160 MW has been completed; the requested service is approved and accepted. We will construct the following transmission facilities to support this new generation:

- ❑ a new 345-kV switchyard will be located at the wind farm site to connect the generators and two 345-kV lines and
- ❑ we will loop the existing Forest Junction-Arcadian 345-kV line into the new switchyard.

The project for replacing the Edgewater 138/69-kV transformers has been cancelled due to the validation of the transformer ratings yielding a higher available rating than previously modeled.

The project for replacing the Mullet River 138/69-kV transformer has been replaced with a project for upgrading terminal equipment due to the validation of the transformer ratings yielding a higher available rating than previously modeled.

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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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

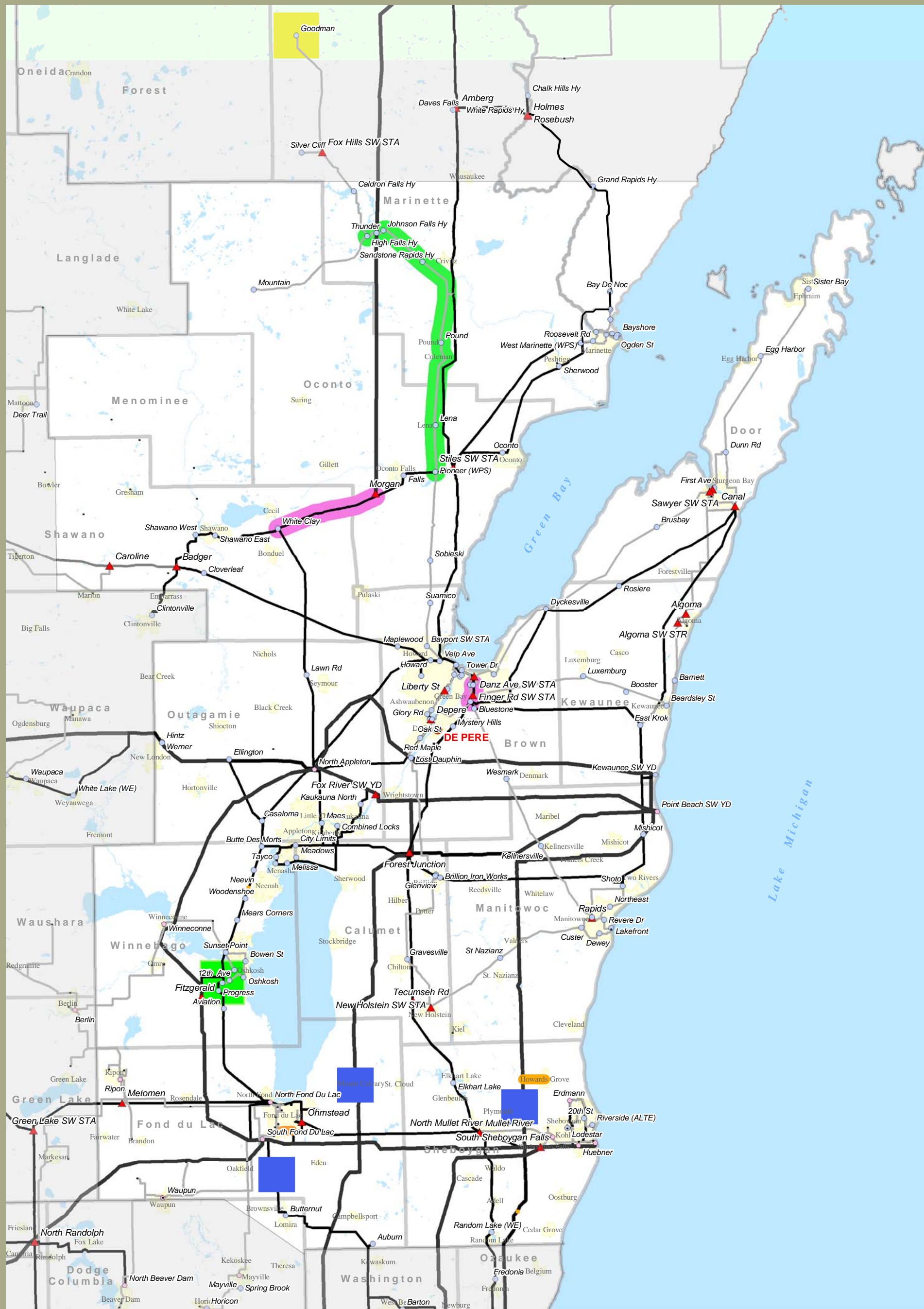
Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
2	Atlantic-Elevation Tap #2 69-kV	106%		Atlantic-Elevation Tap #1 69-kV line outage	Load Serving
2	Atlantic-Elevation Tap #1 69-kV	106%		Osceola-Elevation Tap #2 69-kV line outage	Load Serving
2	Sawyer, 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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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



Performance Criteria Limits Exceeded and Other Constraints 2005-2006

PLANNING ZONE 4

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

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

- Low Voltages
- Overloaded Facility
- New Generation/Stability
- Transmission Needed for Load Growth
- Transmission 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 4 – 2010 study results

Refer to [Table ZS-2](#) and [Figure ZS-11](#)

Summary of key findings

- ❑ Construction of a new 345-kV line from Morgan Substation to Werner West Substation will significantly increase transfer capability between Wisconsin and the Upper Peninsula, avert overloads in and around the Green Bay area, improve 138-kV voltage profiles in the Fox Valley and Green Bay areas, and significantly lower losses.
- ❑ Transmission reinforcements will be needed to address the condition of the 69-kV lines between Suamico and Pioneer substations to accommodate a distribution interconnection at Suamico, and to provide reliable network service to the area.
- ❑ Load growth and generation patterns in the Upper Peshtigo area will necessitate transmission reinforcements to mitigate impending/potential 69-kV line overloads under contingency conditions and to support the voltage in the area.
- ❑ Northern Door County area will require transmission reinforcements to address impending/potential low voltages at Sister Bay and Egg Harbor substations under normal and contingency conditions, impending overloads on the transformers at Canal Substation and 69-kV lines in the area under single contingency conditions.
- ❑ Additional 138/69-kV transformer capacity is needed in the West Marinette area.
- ❑ Poor import capability into the Manitowoc area will necessitate reinforcements.

As discussed in the Update to our 2004 10-Year Assessment, the project for rebuilding the Sunset Point-Pearl Avenue 69-kV line would address the potential Sunset Point-Pearl Avenue 69-kV line overload under single contingency conditions. The project is proposed for 2009.

The northern Door County project is proposed as a two-phased approach to resolve the voltage and thermal loading problem in Door County.

- ❑ Phase I: Construct a 7.7-mile, 138-kV transmission line from the Canal Substation to Dunn Road Substation and install a new 138/69-kV transformer at Dunn Road by June 2008.
- ❑ Phase II: Construct a second 12.7-mile, 69-kV transmission line from Dunn Road Substation to Egg Harbor Substation by June 2010.

The rebuild of the Canal-Dunn Road 69-kV line as a 138/69-kV double-circuit line will provide the necessary additional link to northern Door County. The placement of a third 138/69-kV transformer in Door County at a different substation from the other two will provide geographic diversity for the transformation. The second 69-kV line between Dunn Road and Egg Harbor substations will provide a second source to the area and facilitate maintenance outages of the existing line. All three projects will provide significant voltage support and more capacity to northern Door County.

Rebuilding/converting the Pulliam-Suamico-Sobieski-Pioneer 69-kV line to 138 kV is proposed as a two-phased approach to resolve line condition, distribution interconnection and load serving issues.

- Phase I: Rebuild/convert Bayport-New Suamico 69-kV line to 138 kV by 2008.
- Phase II: Rebuild/convert New Suamico-Pioneer 69-kV line to 138 kV by 2015.

We assumed that the new Suamico Substation would replace the existing Suamico and Sobieski 69-kV substations. Phase I would address the line condition of the Pulliam-Suamico-Sobieski 69-kV line built in 1911 and accommodate the new load interconnection at Suamico Substation. Phase II would provide network service to the new Suamico and the existing Bayport 138-kV substations as well as improve the condition of the 69-kV line between Sobieski and Pioneer substations. Phases I and II also would provide operational/maintenance flexibility during multiple contingency conditions even after the Morgan-Werner West 345-kV line is placed in service.

In the 2008 and 2010 summer peak timeframe, 138/69-kV transformers in the West Marinette and Roosevelt substations will be either overloaded or approaching their emergency ratings under certain generation patterns. To address these overload issues, the West Marinette-Bay de Noc 138-kV line will need to be looped into the existing Menominee Substation and a new 138/69-kV transformer will need to be installed at the Menominee Substation. The preliminary in-service date of the project is 2008.

The project for rebuilding the Crivitz-High Falls double-circuit 69-kV line to 138-kV standards (2008) has been proposed to address impending and potential overloads on the Crivitz-High Falls 69-kV line or Pioneer-Sandstone 69-kV line and to provide voltage support to the Upper Peshtigo area under single contingency conditions.

Upgrading of the North Appleton-Mason Street and North Appleton-Lost Dauphin 138-kV lines is scheduled for 2008. These projects are needed to provide transmission service from Fox Energy to We Energies.

The proposed Morgan-Werner West 345-kV line in 2009 would aid the transmission system by reducing the south to north loading on the 138-kV lines through the Green Bay area, thus deferring or eliminating the need for numerous 138-kV transmission line upgrades/rebuilds in and around Green Bay. The proposed project also would provide the extra transmission capacity needed to fully utilize the upgrades to the Wisconsin-Upper Peninsula transmission corridor which are scheduled to be completed before this project (i.e., Plains-Stiles and Cranberry-Conover).

The proposed Clintonville-Werner West 138-kV line will be strung primarily on Morgan-Werner West 345-kV line structures. The proposed project would provide significant system benefits. Those benefits include reduced loading on the Highway V-Preble-Tower Drive 138-kV line, the North Appleton-Lawn Road-White Clay 138-kV line, the Badger 138/115-kV transformer, the Badger-Caroline 115-kV line and facilitating a future de-energized



rebuild of the Pulliam-Stiles double-circuit 138-kV line, which would not be possible under current system conditions. In addition, the Clintonville-Werner West line will provide a second 138-kV source to the city of Clintonville.

To improve the import capability into the Manitowoc area, several projects are being considered. The projects include rebuilding/converting the New Holstein-Lakefront 69-kV line to 138 kV and rebuilding the Tecumseh Road-New Holstein 69-kV line to double-circuit 138/69 kV. These projects would alleviate the impending transformer overload at Tecumseh Road under single contingency conditions that may appear in the 2014 time frame as a result of continued load growth in the area. One possible solution to address the transformer overload would be upgrading the terminal equipment at Tecumseh Road. These potential projects were identified as part of our Access Initiative in 2004 for the purpose of improving transfer capability into and through our system. This effort is on going in 2005 as ATC refines the Access "package" and attempts to obtain consensus. The specific projects above are provisional projects, which will require additional study and could be replaced by other project alternatives. A preliminary in-service date for the projects, based on our Access Initiative work, is 2010.

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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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

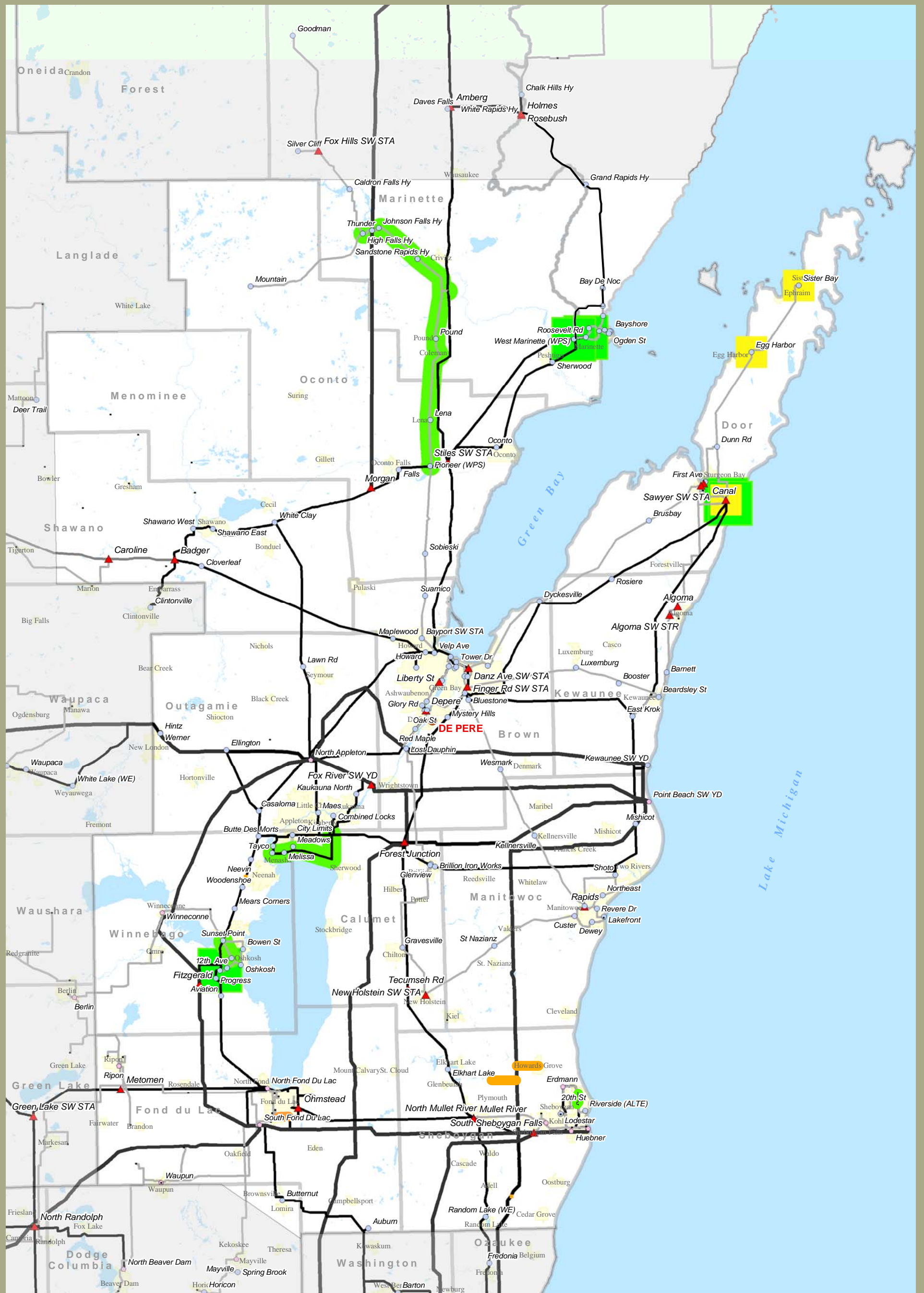
Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
2	Seney Tap, Timber Products, Alger and Munising 69-kV bus voltages		89-91%	Munising 138/69-kV transformer outage	Load Serving
2	Keweenaw, Keweenaw Tap, Elevation #1, Elevation Tap #1 and Osceola 69-kV 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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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 th 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



Performance Criteria Limits Exceeded and Other Constraints 2007-2010

PLANNING ZONE 4

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

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

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

Transmission Related Facilities

- 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 4 – 2014 study results

Refer to [Table ZS-3](#) and [Figure ZS-12](#)

Summary of key findings

- Load growth in Ontario, Dyckesville and Rosiere areas will drive the need for system reinforcements.
- Load growth in the Sheboygan area will require transmission system reinforcements.

In 2014, the voltages on the Ontario-Dyckesville-Rosiere-Canal 138-kV lines would be close to 90 percent under single contingency conditions. The Canal capacitor bank mentioned in the [Zone 4 – 2006 study results](#) discussion will address the impending low voltage issues until additional reinforcements are in place.

Numerous line overloads in the Sheboygan County area were found under contingency conditions that need to be addressed. A 138/69-kV transformer replacement at South Sheboygan Falls will be required to address the transformer overload in the 2014 time frame. The transformer replacement project has been deferred due to validation of the transformer ratings yielding a higher available rating than previously modeled. In addition, an upgrade of terminal equipment in the area is required to address numerous overloads. Specifically, the following projects are required:

- re-tap 48 MVA CT at South Sheboygan Falls 138/69 kV (2010)
- replace 400 A CT at North Mullet River 69 kV (2011)
- uprate the Northgate-20th Street 138-kV line (2011)
- re-tap 400 A primary CT at Edgewater 69 kV (2012)
- replace 300 A metering CT at Edgewater 69 kV (2013)
- replace 300 A metering CT at Riverside 69 kV (2013)
- replace 300 A CT at Sheboygan Falls 69 kV (2013)

Upgrading the Melissa-Tayco 138-kV line (0.16 miles) is scheduled for 2014 to address line overloads under single contingency conditions.

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

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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)**

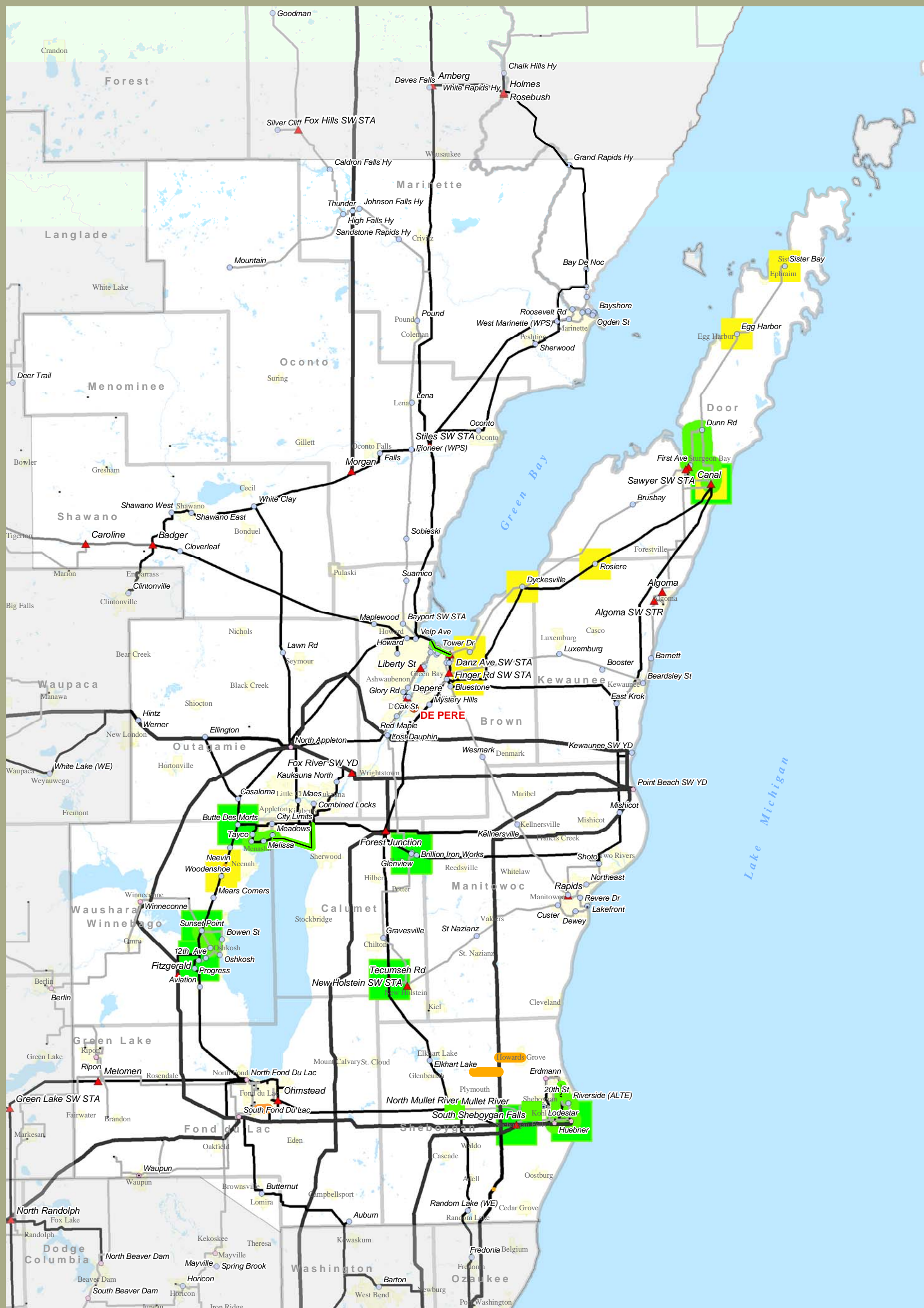
Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
3	Oregon-Stoughton 69-kV line	97-107%		Sugar River (Montrose)-Verona 69-kV line outage	Load Serving
3	Stagecoach-Timberlane Tap 69-kV line	97%		Sugar River-Verona 69-kV line and Spring Green 138/69-kV transformer 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)**

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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)**

Planning Zone	Criteria Exceeded/Need	% of Facility Rating	% of Nominal Bus Voltage	Cause	Condition
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



Performance Criteria Limits Exceeded and Other Constraints 2011-2014
PLANNING ZONE 4

ATC
AMERICAN TRANSMISSION COMPANY
 THE ENERGY ACCESS COMPANY

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 * 358 jointly owned substations
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<ul style="list-style-type: none"> Low Voltages Overloaded Facility New Generation/Stability Transmission Needed for Load Growth 	<p>Transmission Related Facilities</p> <ul style="list-style-type: none"> ▲ 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
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