



## ATC Energy Collaborative - Michigan

This section documents the ATC Energy Collaborative – Michigan (U.P. Collaborative) study results. It summarizes current projects and then elaborates on the Collaborative process including use of the Strategic Flexibility approach to planning, identified needs and core solutions, and remaining work.

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

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

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

### *Strategic Flexibility Planning*

Planning for the Upper Peninsula transmission system has been a unique challenge. For example, small changes in existing or planned load or generation can push the system beyond reasonable limits. Therefore, ATC decided to apply strategic flexibility planning principals to better understand the core and contingent needs and solutions in this specific area of our system. To develop our strategic flexibility assumptions for the intermediate (3-5 year) and long term (10-15 year) periods, during 2008 and 2009 we have engaged Upper Peninsula stakeholders in the Collaborative process to examine the bounds of six plausible futures. Similar to ATC's past economic benefits studies, the futures include: Robust Economy, High Retirements, High Environmental, Slow Growth, DOE 20% Wind, and Fuel & Investment Limitations. These futures were developed from specific Upper Peninsula drivers using stakeholder input. Figures UP-1 and UP-2 illustrate the initial plan for Collaborative activities which has slipped about one to two months from the milestones shown. Table UP-1 delineates the specific studies conducted to establish the operational needs for the study area.

Developing drivers and futures for the geographically vast west-east expanse in the Upper Peninsula required breaking the region into three zones: Western, Central, and Eastern. Figure UP-3 summarizes the load and generation bounds used in the six futures developed in the U.P. Collaborative. Tables UP-2 and UP-3 provide specific details about the futures assumptions.

Using the assumptions for the six U.P. futures we modified the MISO 2018 Joint Coordinated System Plan (JCSP) study model, which was used for the ATC economic benefits studies performed in 2009, to create the 2018 and 2024 PSS/E planning models for each of the six U.P. futures.



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### Needs Analysis and Solutions Development

A cross-functional team was formed at ATC to identify needs and develop solutions. This allowed integration of multiple need drivers into the solution development process, including NERC transmission planning standards, generation and distribution interconnections, asset renewal, and system operating driven needs. To establish NERC transmission planning driven needs, we analyzed the 12 power flow future models, gathered information on ATC asset renewal needs, and reviewed loop flow impacts and operating outage coordination concerns. This allowed us to establish sets of core and contingent transmission system needs across the Upper Peninsula. Core needs occurred in most futures. Contingent needs occurred only in a few futures.

The planning needs from the 12 peak study models for 2018 and 2024 are summarized in overload and low voltage tables for each of the three U.P. study zones. These needs were determined by performing single contingency analysis on the 12 peak study models, and identifying overloaded facilities or low post-contingency voltages. The tables include:

Western U.P. zone	<u>Tables UP-4-W and UP-4A-W</u>
Central U.P. zone	<u>Tables UP-4-C and UP-4A-C</u>
Eastern U.P. zone	<u>Tables UP-4-E and UP-4A-E</u>

These planning needs are also depicted graphically in the following figures:

Western U.P. zone	<u>Figures UP-4-W and UP-4A-W</u>
Central U.P. zone	<u>Figures UP-4-C and UP-4A-C</u>
Eastern U.P. zone	<u>Figures UP-4-E and UP-4A-E</u>

Solution development on each of the 12 peak study models was completed by testing numerous individual solutions and combinations of solutions that would mitigate the overload and voltage violations in each futures case. For each future, two or three solution sets were identified whose solutions addressed the issues in both 2018 and 2024 for that future.

The solution sets developed for each planning future are summarized in the following tables and depicted graphically in the following diagrams:

Future	Solution Sets Table	Solution Sets Diagram
Robust Economy	<u>Table UP-5-RE</u>	<u>Figure UP-5-RE</u>
High Retirements	<u>Table UP-5-HR</u>	<u>Figure UP-5-HR</u>
High Environmental	<u>Table UP-5-HE</u>	<u>Figure UP-5-HE</u>
Slow Growth	<u>Table UP-5-SG</u>	<u>Figure UP-5-SG</u>
DOE 20% Wind	<u>Table UP-5-DW</u>	<u>Figure UP-5-DW</u>
Fuel & Investment Limitations	<u>Table UP-5-FI</u>	<u>Figure UP-5-FI</u>

In addition to the planning needs from the futures study, there are a significant number of asset renewal concerns regarding condition and performance of transmission lines throughout the U.P. The Asset Planning and Engineering department identified twelve U.P. transmission lines that



either exhibit poor reliability performance or are expected to have condition issues (rotting poles, insulator replacement, etc.) in the next 10-15 years. These lines are shown on Figure UP-6.

The System Operations department identified several areas in the U.P. with significant operating issues. These issues can be caused by high bias flows through the U.P. that create reliability concerns, maintenance outages that are very difficult or expensive to perform due to weak transmission or lack of available generation in specific areas, and high steady-state voltages and voltage excursions. Figure UP-7 depicts the most significant operating issues in the U.P. Note that these issues often occur during off-peak and light system loading periods, meaning they can occur a significant number of hours per year.

The solution development process in the U.P. therefore included the future planning needs as well as the asset renewal and system operating needs throughout the U.P. to identify the core solutions required in the U.P.

The needs driving these core solutions are related to potential thermal overloads or potential out of range voltages for serving the more likely load and generation forecasts of the future. These needs are aggravated by loop flows crossing the region from either west-to-east or east-to-west. All of these conditions make it extremely difficult or even impossible to coordinate maintenance outages without affecting service to customers. The next section gives more details about specific need drivers and solution options evaluated in the various U.P. areas.

### *Core U.P. Solutions*

As the system needs analysis and solution development proceeded we found it convenient to identify four critical areas within the three original U.P. study zones due to system performance characteristics unique to those areas. These four areas are.

- Eastern area – located within the eastern U.P. study zone, and consists of the far eastern U.P. (St. Ignace and Sault Ste. Marie areas) and the lower half of the eastern U.P. to Manistique.
- Escanaba area – central Delta County in the southern part of the central U.P. study zone.
- Munising/Newberry area – located in the northern half of the central and eastern U.P. study zones from Forsyth east through Newberry to Brimley.
- Western area – defined as the same as the western U.P. study zone.

### *Eastern Area Core Solutions*

Figures UP-8A-E and UP-8B-E summarize the core needs identified in the eastern U.P. area. The planning futures needs are low voltages and overloaded facilities along the north-to-south transmission corridor between St. Ignace and Sault Ste. Marie. The asset renewal concerns are also located along the St. Ignace-Sault Ste. Marie transmission corridor. There are numerous system operations needs throughout the eastern U.P. due to high west-to-east and east-to-west bias flows, high voltages and voltage excursions, and numerous operating outage coordination issues when maintenance work is very difficult or very expensive to perform.

A new transmission-distribution interconnection, referred here to as Kinross Township Unforecasted Load Addition (Kinross Load), was recently proposed for a 25-megawatt load addition in Chippewa



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county south of Sault Ste. Marie. This load represents a significant addition to the 45 megawatts of existing load in the Sault area, and creates a sudden change in the load, generation, and transmission balance in the eastern U.P. Due to the significance of this proposed load, a seventh eastern U.P. Planning future (Kinross) was created to specifically study the impacts this load would have on the Planning needs and solutions.

The solution development process identified several possible core solutions that could address different levels of the various planning needs as well as the asset renewal and system operations concerns.

Large bias flows through the U.P. in both directions during off-peak system conditions regularly create excessive loadings or low voltages that affect the ability to reliably operate and maintain the eastern U.P. transmission system. The Collaborative effort has identified power flow control in the eastern U.P. at Straits Substation as needed to address the reliability and maintenance concerns. The eastern U.P. core transmission solutions that were considered are shown in [Figure UP-8C-E](#).

The various projects considered exhibited varying degrees of performance benefit. Performance matrices were developed to summarize how each of the considered core solutions addressed the needs in each planning future, including the asset renewal and system operations needs. [Table UP-8A-E](#) shows the performance matrix of the considered core solutions for the six original Planning futures, the Kinross T/D future, and the asset renewal issues. [Table UP-8B-E](#) shows the performance matrix of the solutions for the various system operations issues.

The performance matrices can be best interpreted by the color codes in the cells associated with each future or other need. If a cell was black, this means the project or projects listed in the left half of that row did not perform adequately ("Not Adequate") to address the Planning, Customer Relations/Interconnection Services, or Asset Renewal department need in that column. If a cell was green, the solution(s) was adequate or nearly adequate to address the issues, while a yellow cell indicated the solution(s) was more robust than required to address that need. There were gray cells in the System Operations performance matrix that had varying levels of marginal performance that were identified.

The core projects that ATC identified and are reviewing with stakeholders for input in the eastern U.P. area include:

- Uprate both Straits-McGulpin 138-kV overhead lines (E2)
- Rebuild the Pine River-Straits 69-kV lines as 69 kV double circuit (E4)
- Uprate Pine River-9 Mile 69-kV line 6923 to 167 deg F and minimum asset renewal projects (E6, E-AR2)
- 9 Mile-ESE Hydro Minimum Asset Renewal Projects (E-AR4)
- Power Flow control on the Straits-McGulpin 138-kV Lines (E3 or E31)
- Energize the 2<sup>nd</sup> Indian Lake-Hiawatha line at 138 kV (E8)
- Install flow control at the Straits Substation, such as phase-shifting transformers or back-to-back HVDC (E3)



If the Kinross load is confirmed then projects E4, E6, and E-AR2 will be replaced with project E23, and the core projects will include:

- Uprate both Straits-McGulpin 138-kV overhead lines (E2)
- Rebuild Pine River-Straits 69-kV lines as 138-kV double circuit, rebuild Pine River-9 Mile as 138/69-kV double circuit, add a new 138/69-kV transformer each at Pine River and 9 Mile Substations (E23)
- 9 Mile-ESE Hydro Minimum Asset Renewal Projects (E-AR4)
- Power flow control on the Straits-McGulpin lines (E3 or E31)
- Energize 2<sup>nd</sup> Indian Lake-Hiawatha line at 138 kV (E8)

The customer associated with the Kinross load initially requested that construction of these transmission facilities be completed in 2012. However, various delays have pushed this date out until at least 2013.

### *Escanaba Area Core Solutions*

Figures UP-8A-ESC and UP-8B-ESC summarize the core needs identified in the Escanaba area. The planning needs are low voltages and overloaded facilities throughout the 69-kV system in central Delta County. The primary asset renewal concerns are a 69-kV transmission line between Powers and Chalk Hills, and a 69-kV transmission circuit northwest from Escanaba to Gwinn. There are numerous system operations needs associated with the Escanaba area, including several outage coordination issues that make maintenance work very difficult or expensive to perform, as well as local issues associated with lack of generation availability or possible network transmission service additions.

The solution development process identified four core solutions groups that could address different levels of the various planning needs as well as the asset renewal and system operations concerns. The Escanaba area core transmission solution sets that were considered are shown in Figure UP-8C-ESC.

Performance matrices were developed to summarize how each of the considered core solution sets addressed the needs in each planning future, including asset renewal and system operations needs. Table UP-8A-ESC shows the performance matrix of the considered core solution sets for the six original planning futures and the asset renewal issues. Table UP-8B-ESC shows the performance matrix of the solution sets for the various system operations issues.

Solution Set D was identified in the Escanaba area, and includes the following projects:

- Uprate the Escanaba area 69-kV loop lines to 167/200<sup>o</sup> operation (C2a, in progress)
- Increase the capacity of the 138/69-kV transformer or add a 2<sup>nd</sup> 138/69-kV transformer at the Chandler Substation (C3)
- Add a new 345/138-kV transformation at the Arnold Substation (C21)
- Extend the 138-kV system into the major load areas of Escanaba (C5, C6, C8)
- New Escanaba 69-kV substation (C22, non-ATC)
- Uprate Delta-Escanaba 69-kV lines #1 & #2 to 55 MVA (C25, C26, one line non-ATC)
- Minimum Asset Renewal Projects on the Chandler and 6910 69-kV lines (C-AR3, C-AR4)



These provisional projects have projected in-service dates in the 2014-2015 timeframe.

#### *Munising/Newberry Area Core Solutions*

Figures UP-8A-MN and UP-8B-MN summarize the core needs identified in the Munising/Newberry area. This area consists of transmission facilities from Forsyth Substation in Gwinn to Seney Substation, and from Newberry to 9 Mile Substation near Brimley. The planning needs are low voltages and overloaded facilities throughout this area. The asset renewal concerns are the 138/69-kV transmission lines between Forsyth and Seney, and the 69-kV transmission circuit east from Newberry. There are a few system operations needs associated with the transmission lines and transformers in the Forsyth and Munising areas that make maintenance work very difficult or expensive to perform.

The solution development process identified five core solutions groups that could address different levels of the various planning needs as well as the asset renewal and system operations concerns. The Munising/Newberry area core transmission solution sets that were considered are shown in Figure UP-8C-MN.

Performance matrices were developed to summarize how each of the considered core solution sets addressed the needs in each planning future, including asset renewal and system operations needs. Table UP-8A-MN shows the performance matrix of the considered core solution sets for the six original planning futures and the asset renewal issues.

Solution Set B was identified in the Munising/Newberry area, and includes the following projects:

- New Gwinn-Forsyth 69-kV line (C10)
- Close the normally open Seney-Blaney Park 69-kV line and uprate the entire Munising-Seney-Blaney Park 69-kV circuit (Inland line) to 167° F operation (C17)
- Minimum Asset Renewal Projects on the Munising 138 138-kV line, AuTrain 69-kV line, Inland 69-kV line, and 69-kV line 6952 (C-AR1, C-AR2, E-AR3)

These projects are provisional in nature, and have projected in-service dates in the 2012-2015 timeframe.

The performance matrix for the Munising/Newberry area shows that the selection of Solution Set B presents a level of risk should certain futures develop. Should additional load development from these futures actually occur, consideration of contingent solutions may be required, perhaps Solution Set C.

#### *Western Area Core Solutions*

Figures UP-8A-W and UP-8B-W summarize the core and contingent needs identified in the Western area of the U.P. The planning futures needs are low voltages and overloaded facilities throughout this area. Note that the core needs are associated with the transfer of power to the Houghton area and north, and occur in 5 of the six planning futures. The contingent needs are more region-wide in the western U.P., occurred in 3 or the 6 planning futures, and are associated with the much higher imports into the entire northwestern U.P. due to either higher load forecasts or drastically reduced western U.P. generation. The asset renewal concerns are the 69-kV transmission lines between Baraga and Houghton and between Conover and Mass. There are



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system operations needs associated with the maintenance outage of either 138-kV line southeast of Baraga, either Baraga-Houghton line, or the 138/69-kV transformer at Atlantic or M38.

It should be noted that the M38 138-kV capacitor bank project to be completed in 2009 will add a new 138-kV bus and capacitor bank at M38 that will greatly improve the availability of maintenance outages at M38.

The solution development process identified several possible core solutions that could address different levels of the various planning needs as well as the asset renewal and system operations concerns. The western U.P. core transmission solutions that were considered are shown in [Figure UP-8C-W](#).

Performance matrices were developed to summarize how each of the considered core solutions in the western U.P. addressed the needs in each planning future, including asset renewal and system operations needs. [Table UP-8A-W](#) shows the performance matrix of the considered core solutions for the six original planning futures and the asset renewal issues.

The core projects that were identified in the western U.P. area include:

- Upgrade the M38-Atlantic 69-kV overhead line (Atlantic69) to 167° F (W13)
- Minimum Asset Renewal Projects on the Atlantic69 line and 69-kV line 6530 (W-AR1, W-AR2)

These projects are provisional in nature, and have projected in-service dates in the 2013-2014 timeframe.

One contingent project was identified that was determined only to be needed in three planning futures:

- Rebuild the Lakota Road-Mass-Winona 69-kV overhead lines at 138-kV operation (W1)

Note that this contingent project was not selected to be implemented due to the contingent nature of the needs driving this project. Should load and generation profiles in the northwestern U.P. change enough to result in large imports of power to that area, this project will be revisited.

### *Conclusions*

In 2009, we continue to work with stakeholders, including commission staff, to develop plans that will provide continued reliability and additional operational flexibility for the eastern, central and western U.P. areas. We will post our meeting results to allow for input from all interested stakeholders. We are currently in the process of reviewing our identified projects with stakeholders and seeking their input towards a goal of developing a collaborative set of solutions in the U.P. Please refer to [Table UP-2](#) and [Table UP-3](#) for the strategic flexibility decision matrix utilized in the U.P. Collaborative analyses.

### *Other area concerns*

It should be noted that our area plans may impact the Lower Peninsula of Michigan, northern Wisconsin, or Canada as well as the U.P. of Michigan.



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## *Remaining Work*

At the time of writing this document there is still additional work remaining to complete the U.P. collaborative study effort and begin project development:

- Stakeholder review – Complete the process of reviewing our identified projects with stakeholders to seek their comments.
- Economic benefits analysis – It is undecided at this point if an economic benefits analysis will be performed in the U.P., specifically to identify the impact that the selected core projects from the U.P. Collaborative will provide with regard to U.P. access to the energy market.
- Final report – Develop a final summary document for the entire ATC Energy Collaborative – Michigan study effort. This report would include all steps completed so far as well as any studies listed above. It is not known when this document will be completed due to the uncertain nature of the studies above, although it is possible that multiple versions of the summary document could be developed as various study initiatives are completed.
- Core Project Development – Significant work remains with regard to the development of the core projects from their current provisional status through project completion.





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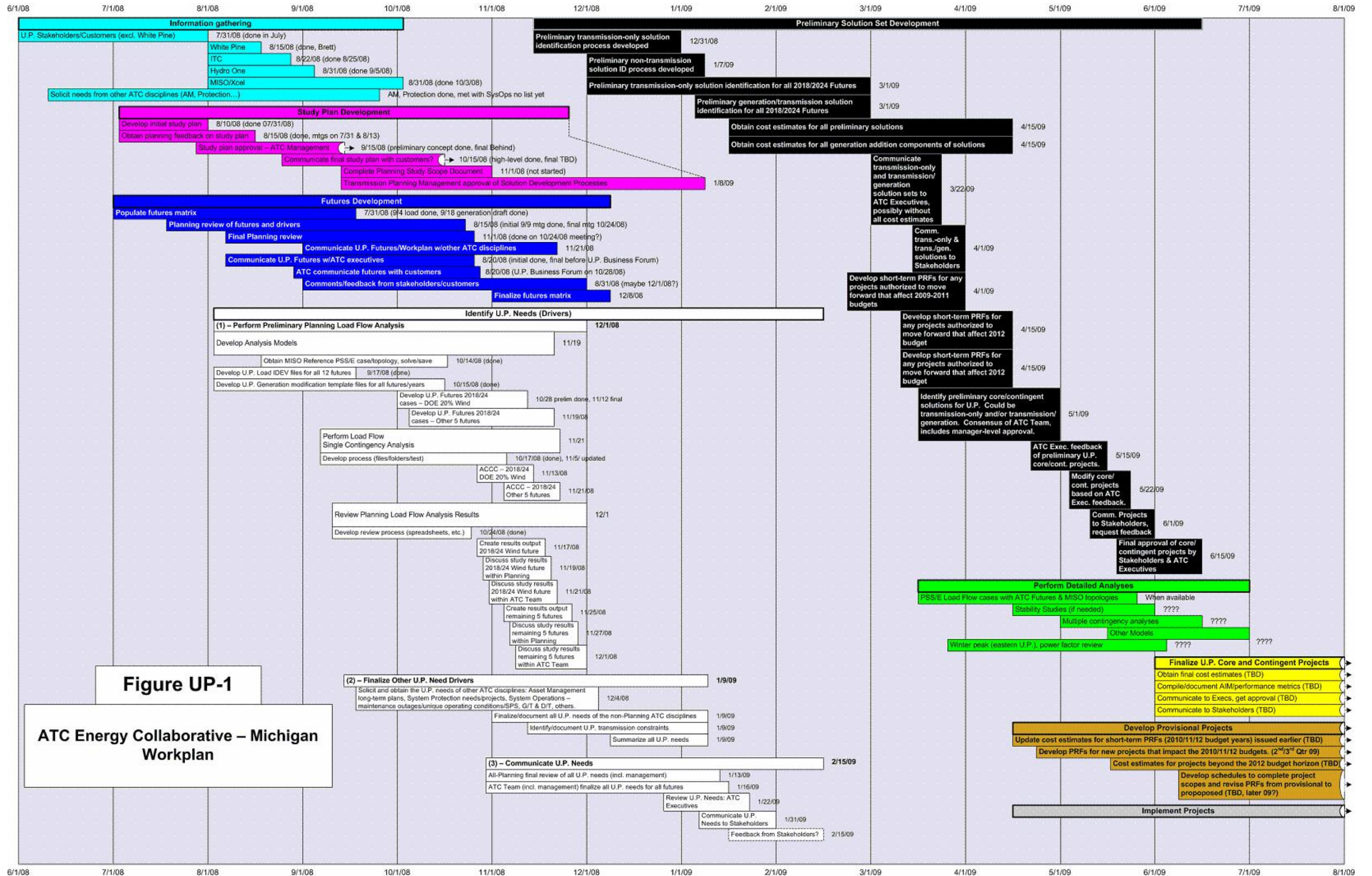
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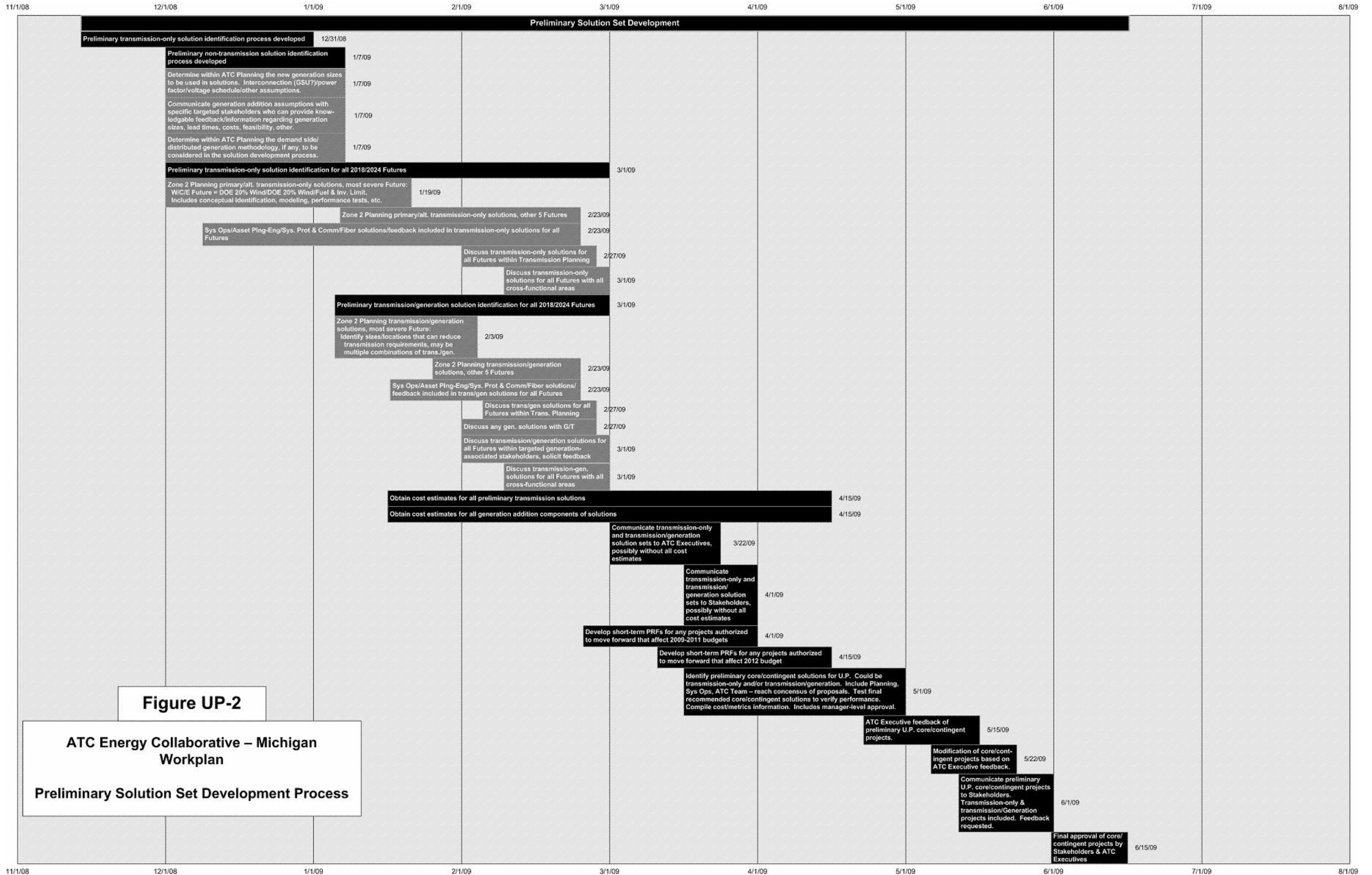
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## Key to Sources referred to:

- 1 – “ATC Energy Collaborative – Michigan Update,” February 13, 2009, filename: 01 ATC\_Energy\_Collaborative\_Michigan\_Update\_021309.doc
- 2 – “ATC Energy Collaborative – MI Scope of Work to Present...,” June 26, 2009, filename: 02 July 17<sup>th</sup> Concise presentation for Dale and Carol.doc
- 3 – “ATC Energy Collaborative – Michigan detailed analysis plan – DRAFT,” June 12, 2009, filename: ATC\_Energy\_Collaborative-Michigan\_Detailed\_Analysis\_Plan\_061209 Update.doc
- 4a – “ATC Energy Collaborative – Michigan Core Solutions Discussion and Feedback,” June 22-23, 2009, filename: 04a Core Solutions Stakholder Feedback 06-22-2009.ppt
- 4b – “U.P. Collaborative Core Solutions,” 6/22/2009, filename: 04b U P \_Collaborative\_Core\_Solutions\_Stakeholders\_062209.doc {Probably don’t need this one because it is included in the 7-22-09 AIM Governance package}
- 5 – “ATC Energy Collaborative – MI Update for AIM Governance Team,” July 22, 2009, filename: 05 AIM\_072209\_UP\_Collaborative\_Core\_Solutions\_071709\_final.doc
- 6 – “UP Collaborative Strategic Options,” May 14, 2009, filename: 06 UP Collaborative Strategic Projects (Rev 2).ppt
- 7 – “UP Needs projects,” July 30, 2009, filename: 07 UP\_needs\_projects\_073009.doc





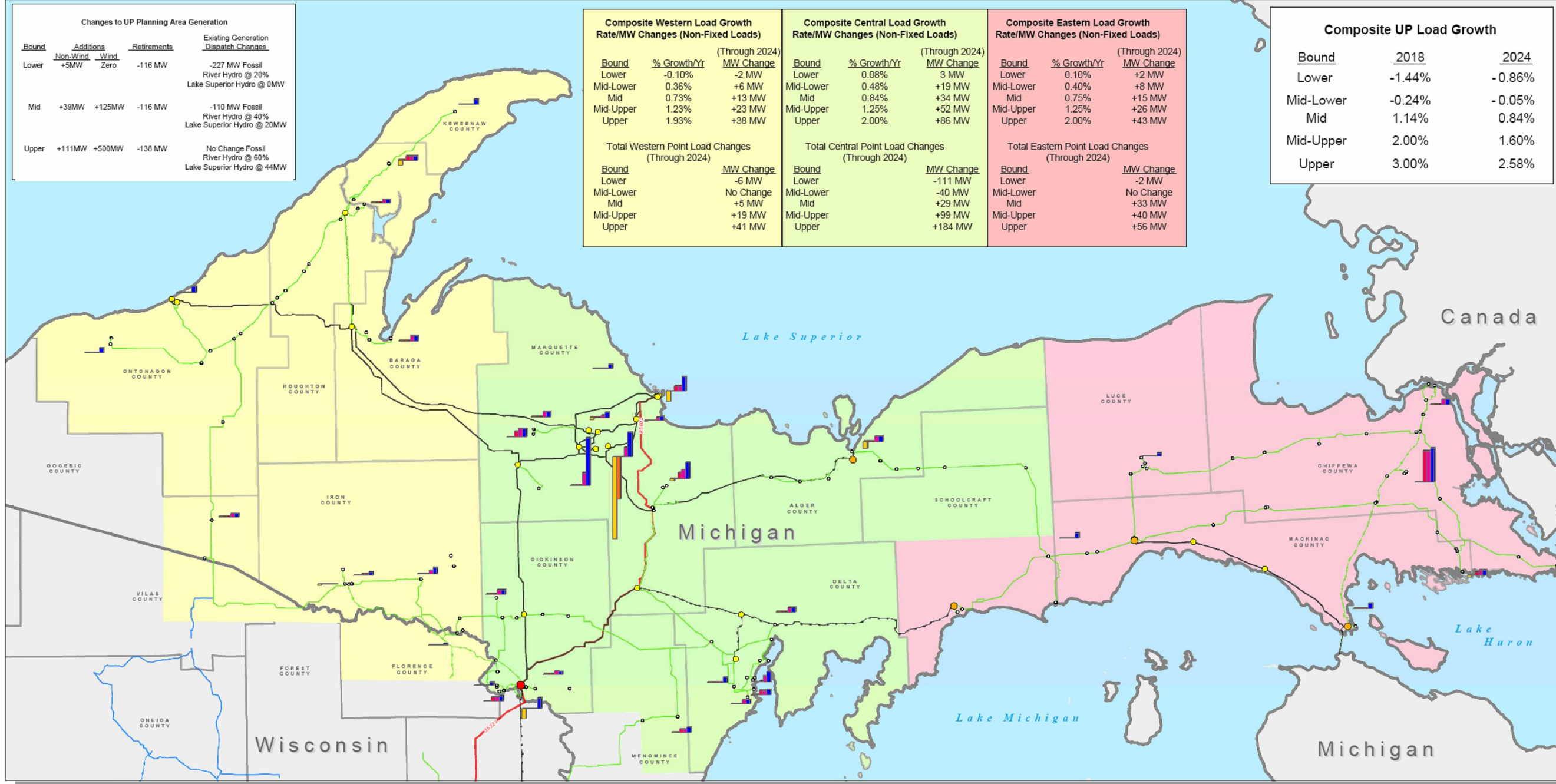
**Figure UP-2**

**ATC Energy Collaborative – Michigan Workplan**  
**Preliminary Solution Set Development Process**

## Table UP-1 - Study Plan, U.P. Operational Needs

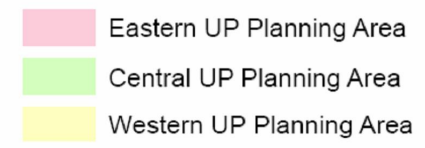
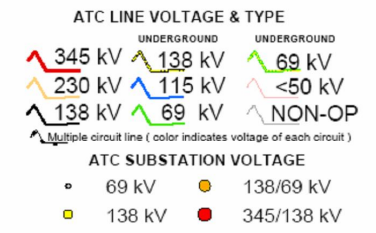
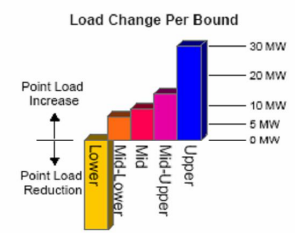
1. West-to-east U.P. bias flows
  - a. Planning to perform modeling and studies
  - b. System Operations to provide input and feedback
  - c. Preferred and alternate solutions developed, team consensus
  - d. Cost estimates for alternatives to be obtained from Asset Management
2. West-to-east U.P. bias flows
  - a. Planning to perform modeling and studies
  - b. System Operations to provide input and feedback
  - c. Preferred and alternate solutions developed, team consensus
  - d. Cost estimates for alternatives to be obtained from Asset Management
3. High voltage issues
  - a. Planning to perform modeling and studies
  - b. System Operations to provide input and feedback
  - c. Preferred and alternate solutions developed, team consensus
  - d. Cost estimates for alternatives to be obtained from Asset Management
4. Maintenance or N-1-1 Outages, not be comprehensive screening instead:
  - a. Not to be comprehensive screening
  - b. System Operations to identify more prominent concerns
  - c. Determine if any of the core solutions mitigate the issues
    - i. Perform studies to verify performance if necessary
  - d. Develop solution if core solutions do not mitigate the issues
    - i. Perform studies to verify performance if necessary
  - e. Team to agree on additional solutions, if any, needed to address issues
5. Op Guides
  - a. System Operations to identify U.P. Operating Guides
  - b. Team to identify conceptually if any core solutions affect the existing guides
    - i. Perform studies if needed
  - c. Team to develop new solutions if justified
6. Determine eastern U.P. core projects without Frontier
  - a. Planning to perform studies on expected future without Frontier
    - i. Identify needs
    - ii. Determine required solutions
7. Study all core projects together to ensure they are compatible
  - a. Planning to perform modeling and studies
  - b. Study the two worst U.P. futures, DOE 20% Wind and Fuel/Investment Limitations)
    - i. Other futures to be studied if required and time permits
  - c. Verify that only contingent projects are required along with the core projects for reliability needs
  - d. Verify contingent project list for the U.P.
    - i. Identify all contingent projects
    - ii. Summarize the contingent projects, including what needs they address, and the future load or generation scenario that triggers the need
8. Team to develop presentation and proposal to ATC Executives

**Figure UP-3 – U.P. Drivers and Futures, Geographic View**



**Upper Michigan Energy Collaborative Futures**

Currently, ATC owns or operates transmission facilities in 50 Wisconsin counties and in 15 Michigan counties. Facilities include:  
 \* Approximately 9350 miles of transmission lines  
 \* 96 wholly owned substations  
 \* 410 jointly owned substations  
 \* ATC offices in Madison, Cottage Grove, Pewaukee, De Pere, Wausau and Kingsford, WI  
 The information presented in this map document represent the most current and accurate georeferenced compilation of ATC owned and operated transmission facilities available - some facility locations may be approximate. This map is advisory and intended for reference purposes only. Please direct any revisions or corrections to ATC Asset Applications and GIS Group.  
 Base Map Information: ATC, PSCW, MDNR, WDNR



**Table UP-2: ATC Futures - ATC Energy Collaborative - Michigan**  
**January 2, 2009 (ATC Internal Use Only Discussion) (Rev 4.0)**

UP Micro-Drivers	Load Assumptions												Generation Assumptions												New Generation in Northern Michigan			
	Demand Growth Within UP (Demand MWs)			Energy Growth Within UP (Energy MWHrs)			Total Point Loads MW added in the UP (2018/2024)			Total UP Growth (2018)	Total UP Growth (2024)	Demand Growth Outside UP (MWs)	Existing UP Generation Profile (Note: U.P. generation on-line only if dictated by merit order dispatch, or unless noted below)			UP Generation Additions			UP Generation retirements			Wind Generation						
	West	Central	East	West	Central	East	West	Central	East	U.P.	U.P.		West	Central	East	West	Central	East	West	Central	East	West	Central	East				
Lower	-0.10%	0.08%	0.10%	-0.10%	0.08%	0.10%	-6 MW	-111 MW	-2 MW	-1.44%	-0.86%	0.5%	Fossil (-69MW Total) 'WP Mine1-2-3 (40) + SM-ST (11) + Warden (18)	Fossil (-151MW Total) 'PI5-6 Derate (40) + ESC1-2 (26) + Neenah-MUN (5)+NP7 Plus (55) + MBLP (25)	9.4MW Diesel Available	5 MW	116 MW	None	None	5MW Diesel	None	PI3-4 (116)	None	Zero	Zero	Zero	Zero	
Mid-Lower	0.36%	0.48%	0.40%	0.36%	0.48%	0.40%	No Change	-40 MW	No Change	-0.24%	-0.05%	1.0%	(-51MW Total) 'WP Mine1-2-3 (40) + SM-ST (11)	Fossil (-134MW Total) PI5-6 Derate (40) + ESC 1-2 (26) + Neenah-MUN (5) + MBLP (25) + NP7 (38)		None												
Mid	0.73%	0.84%	0.75%	0.73%	0.84%	0.75%	+5 MW	+29 MW	+33 MW	1.14%	0.84%	1.75%	(-40MW Total) 'WP Mine1-2-3 (40)	Fossil (-65MW Total) PI5-6 Derate (40) + MBLP (25)	11.4MW Diesel Available	10MW	29 MW	None	None	5MW Diesel + 24MW Bio Mass	None	None	25MW	50MW	50MW	100MW		
Mid-Upper	1.23%	1.25%	1.25%	1.23%	1.25%	1.25%	+16 / +3	+79 / +20	+35 / +5	2.00%	1.60%	2.0%	Fossil all available	Fossil (-40MW Total) PI 5-6 (40)	11.4MW diesel Available	35MW	93MW	None	None	24MW Bio Mass + 9MW Hydro + 60 MW Mascoma	None	None	50MW	100MW	100MW			
Upper	1.93%	2.00%	2.00%	1.93%	2.00%	2.00%	+19 / +22	+134 / +50	+46 / +10	3.00%	2.58%	3.0%	Fossil all available	Fossil all available	16MW Diesel Available	50MW	101 MW	None	None	8MW Diesel + 24MW Bio Mass + 9MW Hydro + 60 MW Mascoma	None	PI3-4 (116) +GLAD (22)	100MW	200MW	200MW	600MW		

**2018 Futures Descriptions**

Robust Economy	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	-0MW	-0MW	20MW Hydro	(none)	35MW	(+101 MW)	(none)	(-116 MW)	(none)	(+25 MW)	(+50 MW)	(+50 MW)	(+ 600 MW)											
High Retirements	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	-69MW	-151MW	32MW Hydro	(none)	(none)	(+29MW)	(none)	(-138 MW)	(none)	(+25 MW)	(+50 MW)	(+50 MW)	(+ 600 MW)											
High Environmental	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	(-0.10%)	(+0.08%)	(+0.10%)	(-0.10%)	(+0.08%)	(+0.10%)	(-6 MW)	(-111 MW)	(-2 MW)	(-1.44%)	0.5%	-40MW	-65MW	44MW Hydro	(none)	10MW	(+5 MW)	(none)	(-116 MW)	(none)	(+100 MW)	(+200 MW)	(+200 MW)	(none)
Slow Growth	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	(+1.23%)	(+1.25%)	(+1.25%)	(+1.23%)	(+1.25%)	(+1.25%)	(+16 MW)	(+79 MW)	(+35 MW)	(+2.00%)	2.0%	-69MW	-151MW	20MW Hydro	(none)	(none)	(+93 MW)	(none)	(-138 MW)	(none)	(+100 MW)	(+200 MW)	(+200 MW)	(+ 100 MW)
DOE 20% Wind	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	(+0.73%)	(+0.84%)	(+0.75%)	(+0.73%)	(+0.84%)	(+0.75%)	(no change)	(+6 MW)	(no change)	(0.48%)	1.3%	-40MW	-65MW	0MW Hydro	(none)	10MW	(+5 MW)	(none)	(-116 MW)	(none)	(none)	(none)	(none)	(none)
Fuel and Investment Limitations	Mid	Mid	Mid	Mid	Mid	Mid	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower																								

**2024 Futures Descriptions**

Robust Economy	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	-0MW	-0MW	20MW Hydro	(none)	50MW	(+101 MW)	(none)	(-116 MW)	(none)	(+25 MW)	(+50 MW)	(+50 MW)	(+ 600 MW)											
High Retirements	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	Mid	(+0.36%)	(+0.48%)	(+0.40%)	(+0.36%)	(+0.48%)	(+0.40%)	(no change)	(-40 MW)	(no change)	(-0.05%)	1.0%	-51MW	-134MW	20MW Hydro	(none)	(none)	(+5 MW)	(none)	(-116 MW)	(none)	(+50 MW)	(+100 MW)	(+100 MW)	(none)
High Environmental	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	(-0.10%)	(+0.08%)	(+0.10%)	(-0.10%)	(+0.08%)	(+0.10%)	(-6 MW)	(-111 MW)	(-2 MW)	(-0.86%)	0.5%	-40MW	-65MW	44MW Hydro	(none)	10MW	(+5 MW)	(none)	(-116 MW)	(none)	(+100 MW)	(+200 MW)	(+200 MW)	(none)
Slow Growth	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	Lower	(+1.23%)	(+1.25%)	(+1.25%)	(+1.23%)	(+1.25%)	(+1.25%)	(+19 MW)	(+99 MW)	(+40 MW)	(+1.60%)	2.0%	-69MW	-151MW	20MW Hydro	(none)	(none)	(+93 MW)	(none)	(-138 MW)	(none)	(+100 MW)	(+200 MW)	(+200 MW)	(+ 100 MW)
DOE 20% Wind	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	Mid-Upper	(+0.73%)	(+0.84%)	(+0.75%)	(+0.73%)	(+0.84%)	(+0.75%)	(no change)	(+6 MW)	(no change)	(0.45%)	1.3%	-40MW	-65MW	0MW Hydro	(none)	10MW	(+5 MW)	(none)	(-116 MW)	(none)	(none)	(none)	(none)	(none)
Fuel and Investment Limitations	Mid	Mid	Mid	Mid	Mid	Mid	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower	Mid-Lower																								

**Table UP-3: U.P. Futures High Level Summary, Western/Central/Eastern U.P. Zones**

MISO Future	Load Growth Outside ATC	Western U.P. Future	Scalable Load Growth	Point Load Changes	Generation Additions	Generation Retirements	Existing Generation	Wind Gen. Additions	Rogers City Generation	Western U.P. System Summary
Reference	Upper	Robust Economy	Upper	Upper	None	None	Upper	+25 MW	Upper	Large increase in western U.P. import
Environmental	Mid	High Retirements	Mid	Mid	None	None	Lower	+25 MW	Upper	Large increase in western U.P. import
Environmental	Mid-Lower	High Environmental	Mid-Lower	Mid-Lower	None	None	Mid-Lower	+50 MW	Lower	Modest generation/load balance issues
Reference	Lower	Slow Growth	Lower	Lower	None	None	Mid	+100 MW	Lower	Modest generation/load balance issues
20% Wind	Mid-Upper	DOE 20% Wind	Mid-Upper	Mid-Upper	None	None	Lower	+100 MW	Mid	Large increase in western U.P. import
Investment Limitation	Mid-Lower	Fuel & Inv. Limitations	Mid	Mid-Lower	None	None	Mid	None	Lower	Modest generation/load balance issues

MISO Future	Load Growth Outside ATC	Central U.P. Future	Scalable Load Growth	Point Load Changes	Generation Additions	Generation Retirements	Existing Generation	Wind Gen. Additions	Rogers City Generation	Central U.P. System Summary
Reference	Upper	Robust Economy	Upper	Upper	+60/110 MW	-116 MW	Upper	+50 MW	Upper	Large load increase, net generation reductions, Sawyer bio-mass
Environmental	Mid	High Retirements	Mid	Mid	None	-138 MW	Lower	+50 MW	Upper	Maximum Escanaba area import
Environmental	Mid-Lower	High Environmental	Mid-Lower	Mid-Lower	None	-116 MW	Mid-Lower	+100 MW	Lower	High Escanaba area import
Reference	Lower	Slow Growth	Lower	Lower	+10 MW	-116 MW	Mid	+200 MW	Lower	Modest generation/load balance issues
20% Wind	Mid-Upper	DOE 20% Wind	Mid-Upper	Mid-Upper	None	-138 MW	Lower	+200 MW	Mid	Maximum Escanaba area import
Investment Limitation	Mid-Lower	Fuel & Inv. Limitations	Mid	Mid-Lower	+10 MW	-116 MW	Mid	None	Lower	Modest generation/load balance issues

MISO Future	Load Growth Outside ATC	Eastern U.P. Future	Scalable Load Growth	Point Load Changes	Generation Additions	Generation Retirements	Existing Generation	Wind Gen. Additions	Rogers City Generation	Eastern U.P. System Summary
Reference	Upper	Robust Economy	Upper	Upper	+101 MW	None	Mid	+50 MW	Upper	Large load & generation increase, LP Gen. = high E-W flows
Environmental	Mid	High Retirements	Mid	Mid	+29 MW	None	Mid-Upper	+50 MW	Upper	LP Gen. = high E-W flows
Environmental	Mid-Lower	High Environmental	Mid-Lower	Mid-Lower	+5 MW	None	Mid	+100 MW	Lower	Modest generation/load balance issues
Reference	Lower	Slow Growth	Lower	Lower	+5 MW	None	Upper	+200 MW	Lower	Modest generation/load balance issues
20% Wind	Mid-Upper	DOE 20% Wind	Mid-Upper	Mid-Upper	+93 MW	None	Mid	+200 MW	Mid	Modest generation/load balance issues
Investment Limitation	Mid-Lower	Fuel & Inv. Limitations	Mid	Mid-Lower	+5 MW	None	Lower	None	Lower	Hydro off-line = high import + load-serving issues

TABLE UP-4-W															
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Overloaded Facilities, U.P. Western Zone															
U.P. Zone	Map Item #	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.	
				2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating
Western	1	Atlantic-Henry St. Tap 69 kV	Base Case, Atlantic-M38 138 kV, Atlantic 138/69 kV	113%	128%-200%	144%	152%					107%	116%		
Western	2	M38-North Lake 138 kV	M38-Perch Lake 138 kV		100%	150%	156%					144%	Did not solve		
Western	3	M38-Atlantic 69 kV	M38-Atlantic 138 kV, Atlantic 138/69 kV, M38 138/69 kV, M38-Winona 138 kV	147%-148%	240%	100%-142%	101%-153%	119%	121%-122%			98%-113%	121%-146%	139%-140%	145%
Western	4	Ontonagon-UPSCO Tap 69 kV	Victoria-Rockland Jct. 69 kV, Rockland Jct.-Rockland, 69 kV Rockland-Mass 69 kV	132%-133%	114%-115%										
Western	5	Ontonagon 138/69 kV	Victoria-Rockland Jct. 69 kV, Rockland Jct.-Rockland, 69 kV Rockland-Mass 69 kV	102%-103%											
Western	6	Atlantic 138/69 kV	M38-Winona, M38 138/69 kV, Base Case		99%-108%	101%	96%-102%						98%		
Western	7	Osceola-Centennial Mine Tap 69 kV	Atlantic-M38 138 kV, Atlantic 138/69 kV, Base Case, M38-Perch Lake 138 kV		95%-146%		100%								
Western	8	Atlantic-Elevation St. Tap 2 69 kV, Elevation St. Tap 2-Osceola 69kV	Atlantic-Elevation St. Tap 1 69 kV		105%-122%										
Western	9	Winona-Twin Lakes 69 kV, Twin Lakes-Portage Tap 69 kV, Portage Tap-Atlantic 69 kV	Atlantic-M38 138 kV, Atlantic 138/69 kV		140%-145%										
Western	10	Aspen-Crystal Falls 69 kV	Iron Grove 138/69 kV		101%-122%										

TABLE UP-4A-W															
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Low Voltages, U.P. Western Zone															
U.P. Zone	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.		
			2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	
Western	Keweenaw, Centennial Mine, Osceola, MTU 69 kV bus voltages; Atlantic, Winona 138 kV bus voltages	Base Case		92.5%-95.3%	94.7%-95.9%	94.2%-95.7%						94.1%-95.5%	91.3%-95.8%		
Western	Keweenaw, Centennial Mine, MTU, Osceola, Henry St., Elevation St., Portage, Atlantic 69 kV bus voltages; Atlantic 138 kV bus voltage	M38-Atlantic 138 kV, Atlantic 138/69 kV	79.8%-88.9%	48.3%-60.1%	76.0%-84.3%	71.8%-80.4%	89.3%	88.8%				79.7%-87.6%	63.7%-71.9%	87.0%	85.6%-91.9%
Western	Keweenaw, Centennial Mine, Elevation St., Osceola 69 kV bus voltages	Atlantic-Elevation St. Tap #1 69 kV, Elevation St. Tap #1-Osceola 69 kV, Atlantic-Elevation St. Tap #2 69 kV	89.2%-91.8%	79.0%-91.5%	90.3%-92.0%	90.1%-91.7%						90.0%-92.0%	86.5%-90.3%	-91.9%	91.9%
Western	Aspen, Iron Grove, Twin Lakes, Lakota Rd. 138 kV bus voltages	Plains-Aspen 138 kV, Aspen-Iron Grove 138 kV	90.3%-91.9%	89.6%-91.6%		91.8%	91.4%-91.8%	91.3%-91.8%	90.7%-91.9%	90.7%-92.0%	91.2%-91.7%	90.1%-91.6%	91.7%	91.6%-91.7%	
Western	Lakehead, Strawberry Hill, Iron Grove, Lincoln, Crystal Falls 69 kV bus voltages	Iron Grove 138/69 kV	88.0%-91.3%	81.8%-86.3%	91.5%-91.8%	90.8%-91.2%						90.8%-91.2%	87.2%-90.6%		91.7%-91.9%
Western	Conover, Lakota Rd., Land O'Lakes, Watersmeet, Bruce Crossing 69 kV bus voltages	Lakota Rd. 138/69 kV, Lakota Rd.-Conover 69 kV, Conover-Land O'Lakes 69 kV	88.8%-91.1%	74.8%-91.3%								86.2%-91.8%	Did not solve, 58.1%-70.9%		
Western	Keweenaw, Centennial Mine, MTU, Osceola, Henry St., Elevation St., Portage, Atlantic, M38, Baraga, L'Anse, Ontonagon, Twin Lakes, UPSCO, Winona, Lake Mine 69 kV bus voltages; Atlantic, M38, Winona, Stone Container, Ontonagon 138 kV bus voltages	M38-Perch Lake 138 kV		73.4%-90.9%	51.9%-67.2%	47.3%-63.4%						52.9%-67.5%	Did not solve		
Western	Keweenaw, Centennial Mine 69 kV bus voltages; Atlantic 138 kV bus voltage	M38-North Lake 138 kV		89.8%-91.2%	90.9%	90.6%						88.8%-91.2%	Did not solve		
Western	Winona, Stone Container, Ontonagon, Atlantic 138 kV bus voltages; Ontonagon, UPSCO 69 kV bus voltages	M38-Winona 138 kV, Winona-Ontonagon 138 kV			87.1%-91.9%	85.3%-89.7%	89.8%-90.2%	89.7%-90.0%				85.5%-90.2%	76.9%-85.1%		
Western	L'Anse 69 kV bus voltage; Atlantic 138 kV bus voltage	M38 138/69 kV				91.6%-91.9%						85.4%-90.6%	73.8%-85.8%		



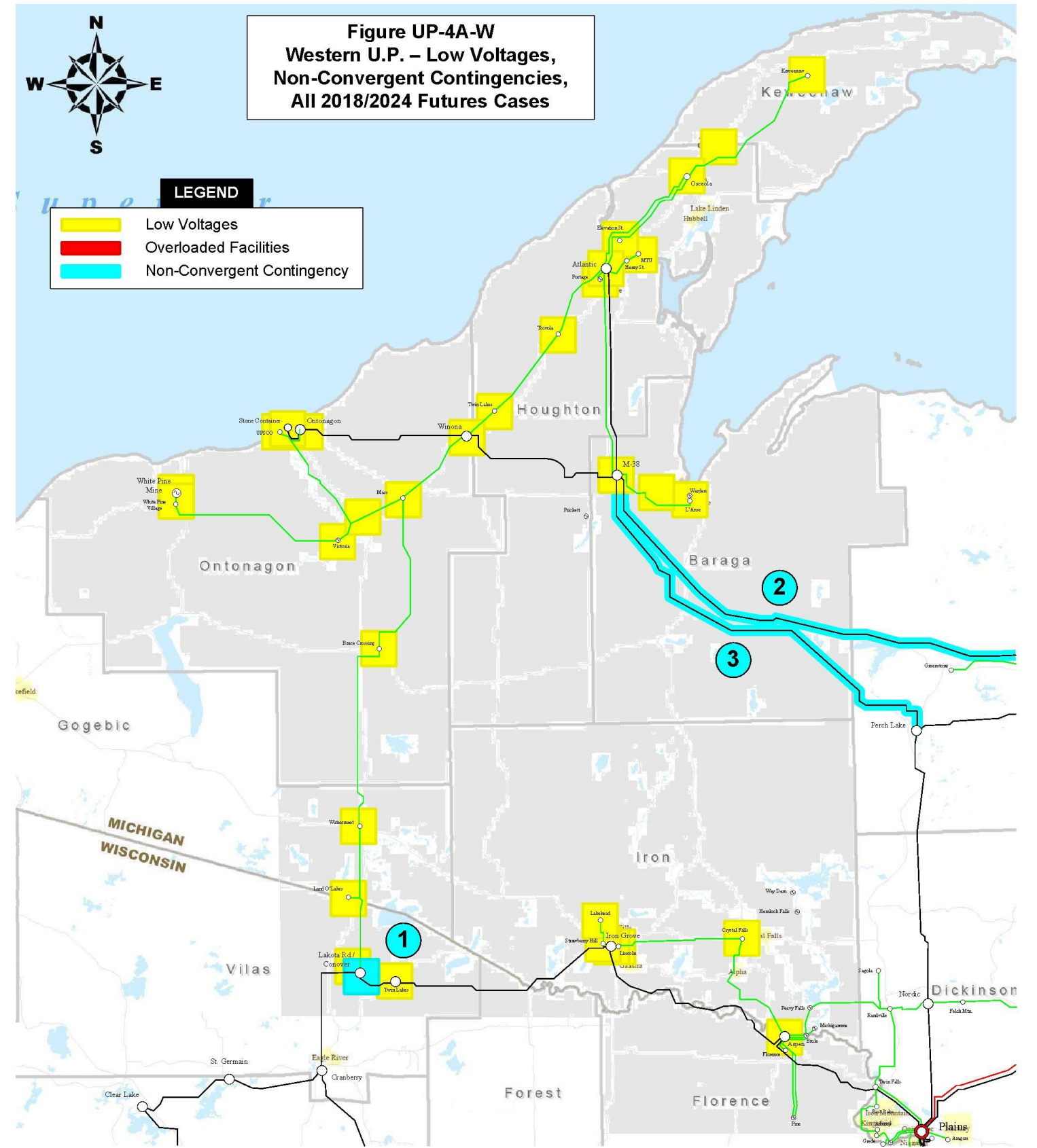
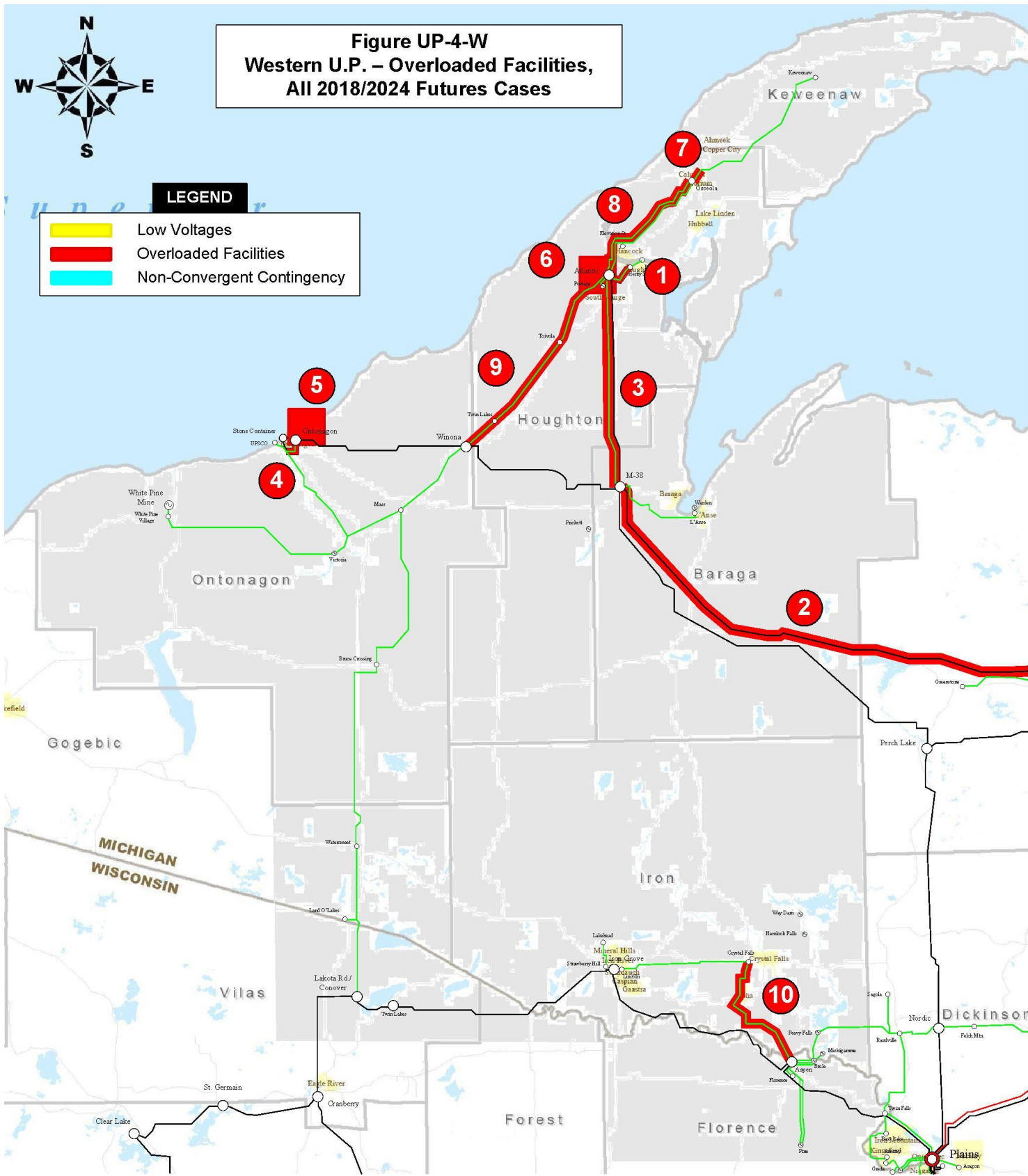


TABLE UP-4-C															
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Overloaded Facilities, U.P. Central Zone															
U.P. Zone	Map Item #	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.	
				2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating
Central	1	Chandler 138/69kV	Base Case, Nordic-Mountain 69 kV, Mountain-Harris Tap 69 kV, Forsyth 138/69kV, Munising 138/69 kV, Nordic 138/69 kV, Plains-Nordic 138 kV	96%	99-105%	150%-211%	149%-201%	110%-135%	112%-137%			157%-218%	152%-211%		
Central	2	Chandler-Delta 69 kV #1	Chandler-Delta 69 kV #2, Base Case, Mead-Bay View Tap 69 kV, Bay View Tap-North Bluff 69 kV	97%-117%	151%	208%-260%	195%-365%	119%-199%	123%-200%			211%-250%	381%		
Central	3	Chandler-Delta 69 kV #2	Chandler-Delta 69 kV #1, Base Case, Mead-Bay View Tap 69 kV, Bay View Tap-North Bluff 69 kV	113%	145%	151%-188%	141%-200%	99%-188%	99%-193%			152%-181%	208%		
Central	4	Gwinn-Sawyer 69 kV	Base Case	206%	429%								112%		
Central	5	Forsyth 138/69 kV	Chandler 138/69kV, Munising 138/69 kV		100%	Did not solve, 152%	Did not solve	102%	104%			153%	177%		
Central	6	Chandler-Cornell Tap 69 kV, Cornell Tap-Watson 69 kV, Watson-Forsyth 69 kV	Chandler 138/69kV	106%-121%	159%-181%	Did not solve	Did not solve	Did not solve	Did not solve			Did not solve	Did not solve		
Central	7	Forsyth-Gwinn 69 kV	Forsyth-Munising 138 kV, Munising 138/69 kV		149%-194%	166%	Did not solve	105%	108%-109%			172%	222%	102%	110%
Central	8	Munising-Alger 69 kV, Alger-AD Hiawatha 69 kV, AD Hiawatha-Forest Lake 69 kV, Forest Lake-Chatham 69kV, Chatham-Gwinn 69 kV	Forsyth-Gwinn 69 kV, Munising 138/69 kV, Munising-Forsyth 138 kV	122%-135%	121%-297%	123%-162%	133%-158%, Did not solve	100%-111%	103%-115%			140%-169%	154%-214%	103%	98-113%
Central	9	Munising 138/69 kV	Forsyth-Gwinn 69 kV		95%	103%	110%					107%	133%		
Central	10	North Lake 138/69 kV #1	North Lake 138/69 kV #2	128%	159%							123%	137%		
Central	11	Delta-Mead 69 kV, Chandler-Delta 69 kV #1, Chandler-Delta 69 kV #2, Masonville-Lakehead Tap 69 kV, Masonville-Gladstone 69 kV, Gladstone-North Bluff 69 kV, Chandler-Lakehead Tap 69 kV, Delta-West Side Tap 69 kV	Base Case, Chandler-Lakehead Tap 69 kV, Lakehead Tap-Masonville 69 kV		104%	242%-350%	370%, Did not solve	113%-197%, Did not solve	114%-200%, Did not solve			98%-244%	95%-211%		
Central	12	Nordic 138/69 kV	Plains-Aspen 138 kV, Peavy Falls-Sagola Tap 69 kV		114%	101%-112%	101%-107%					112%	120%		
Central	13	Plains W-Big Q Tap 69 kV	Plains E-Big Q 69 kV		101%	102%	106%					106%	114%		
Central	14	Presque Isle-Empire 6 138 kV #1	Empire2-3 138kV, Presque Isle-North Lake 138 kV			95%	98%						103%		
Central	15	Big Q-KFM T 69 kV	Twin Falls N-S 69kV, Twin Falls S-Bass Lake 69 kV, Plains-Twin Falls N 69 kV	98%									106%		
Central	16	North Lake-Barnum Tap 69 kV	Base Case		112%										

TABLE UP-4A-C														
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Low Voltages, U.P. Central Zone														
U.P. Zone	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.	
			2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V
Central	Chandler, Delta, Escanaba1, Escanaba2, West Side, Lakehead Tap, Lakehead, Masonville, Gladstone, North Bluff, Bay View, Mead, Harris, Cornell, Watson 69 kV bus voltages	Chandler 138/69 kV	81.3%-89.6%	61.2%-76.0%	Did not solve	Did not solve	Did not solve	Did not solve			Did not solve	Did not solve		
Central	Sawyer, Gwinn, Chatham, Forest Lake, AD-Hiawatha, Alger 69 kV bus voltages; Munising 138 kV bus voltage	Forsyth-Gwinn 69 kV		77.9%-89.0%	60.9%-83.5%	55.4%-81.4%					58.9%-82.9%	37.2%-74.1%	87.2%-89.5%	83.5%-86.1%
Central	West Side, Escanaba1, Escanaba2, Harris, North Bluff, Bay View, Gladstone, Mead, Delta, Masonville, Chandler, Lakehead 69 kV bus voltages	Delta-West Side Tap 69 kV, Delta-Escanaba1 69 kV, Chandler-Delta 69 kV #1, Chandler-Delta 69 kV #2, Chandler-Lakehead Tap 69 kV, Delta-Mead 69 kV, Mead-Bay View Tap 69 kV, Masonville-Gladstone 69 kV		80.0%-81.1%	Did not solve, 63.8%-76.2%	Majority did not solve	82.7%-91.9%	81.2%-91.7%			Did not solve	Did not solve		
Central	Munising 138 kV bus voltage; Munising, Alger, AD-Hiawatha, Forest Lake, Chatham, Gwinn, Sawyer, Forsyth 69 kV bus voltages	Forsyth-Munising 138 kV, Munising 138/69 kV	87.5%-92.0%	73.2%-87.5%	53.9%-79.6%	Did not solve	80.1%-88.9%	79.4%-88.5%			Did not solve, 55.7%-79.4%	Did not solve, 41.0%-88.9%	88.2%	85.0%-91.8%
Central	Mead, Bay View, North Bluff, Delta, Sawyer, Harris, Gwinn, Forsyth, Chatham, West Side 69 kV bus voltages; Munising, Chandler, Perkins, Forsyth 138 kV bus voltages	Base Case	95.6%	93.1%-95.9%	69.7%-94.0%	76.7%-94.7% (Mead Synch Condenser)	95.8%-95.9%	95.1%-95.9%			69.7%-95.0%	67.6%-94.5%		
Central	Sawyer, Gwinn, Forsyth, Chatham, Forest Lake, Alger, AD-Hiawatha, Munising, Watson, Harris, West Side, North Bluff, Gladstone, Bay View, Lakehead, Masonville, Mead 69 kV bus voltages; Munising 138 kV bus voltage	Forsyth 138/69 kV			Did not solve	Did not solve					Did not solve	Did not solve		
Central	Harris, Mountain, West Side, North Bluff, Gladstone, Mead 69 kV bus voltages; Chandler 138 kV bus voltage	Nordic 138/69 kV, Nordic-Mountain 69 kV, Mountain-Harris Tap 69 kV, Harris Tap-Cornell 69 kV, Chandler-Cornell 69 kV	89.6%-91.1%	88.4%-91.0%	65.7%-91.2%	Did not solve					66.3%-90.3%	68.6%-85.2%		
Central	Kingsford Metals, Iron Mt. East, Grede, Armory 69 kV bus voltages	Big Q-KFM Tap 69 kV, KFM Tap-Iron Mt. East 69 kV		91.2%-91.5%								91.2%-91.5%		
Central	Sawyer, Harris, Mead, Gladstone, West Side 69 kV bus voltages; Chandler, Perkins, Munising, Arnold 138 kV bus voltages	Plains-Arnold 138 kV, Plains-Morgan 345 kV, Morgan-Hwy22 345 kV, Empire-Forsyth 138 kV, Dead River-Plains 345 kV		89.9%-91.7%	Did not solve	Did not solve					Did not solve, 64.6%-89.6%	Did not solve, 65.9%-87.3%		

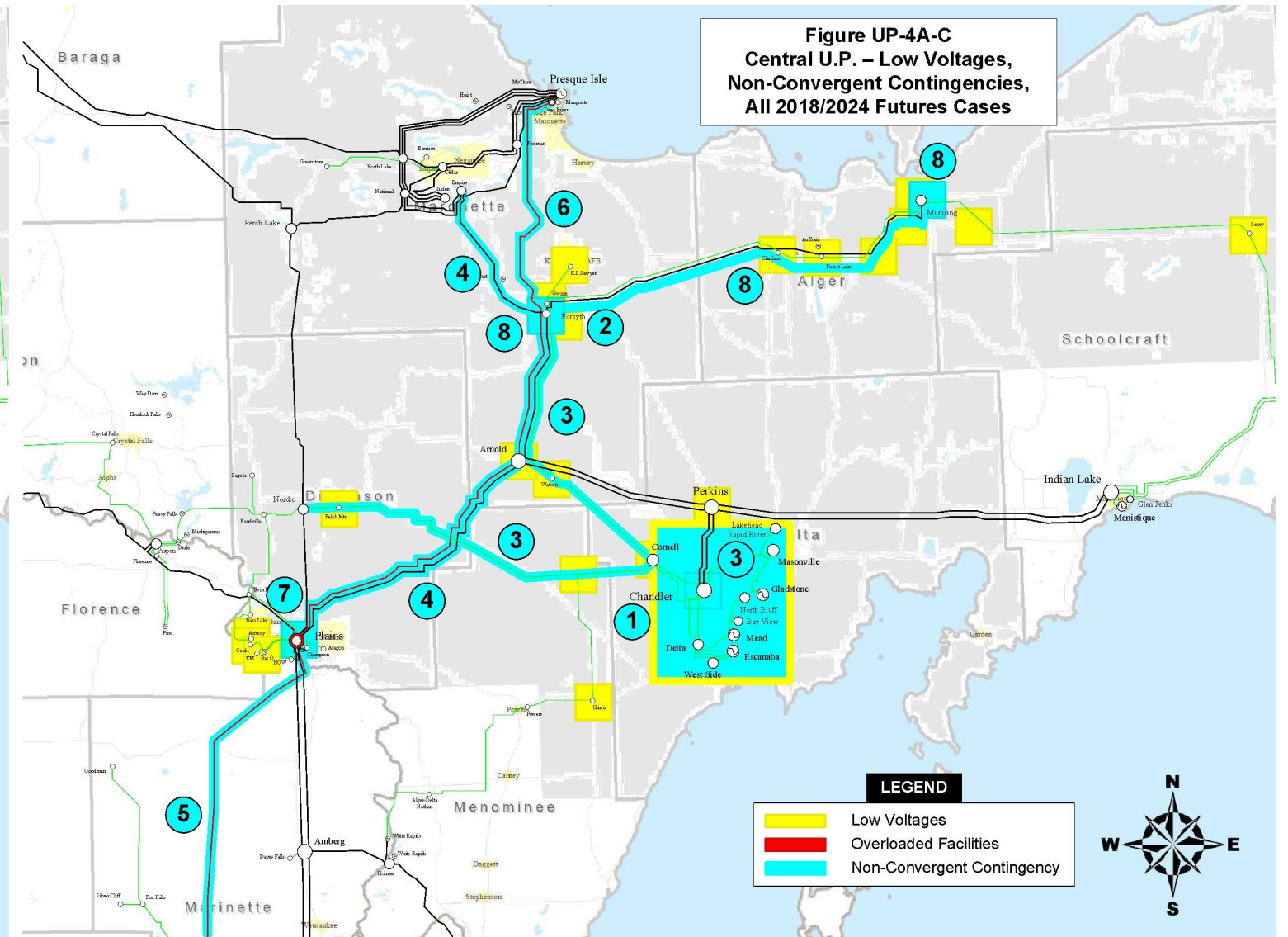
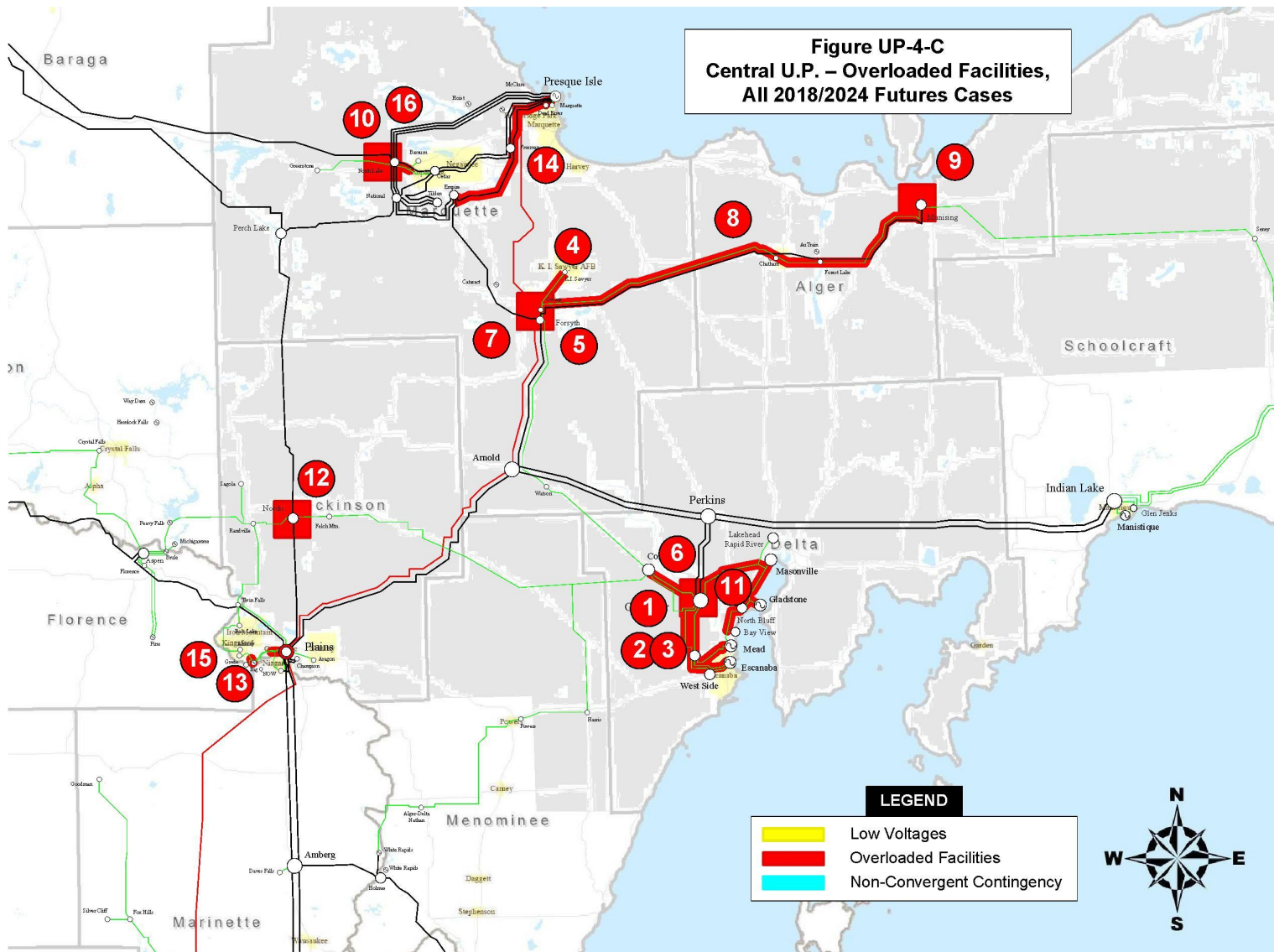
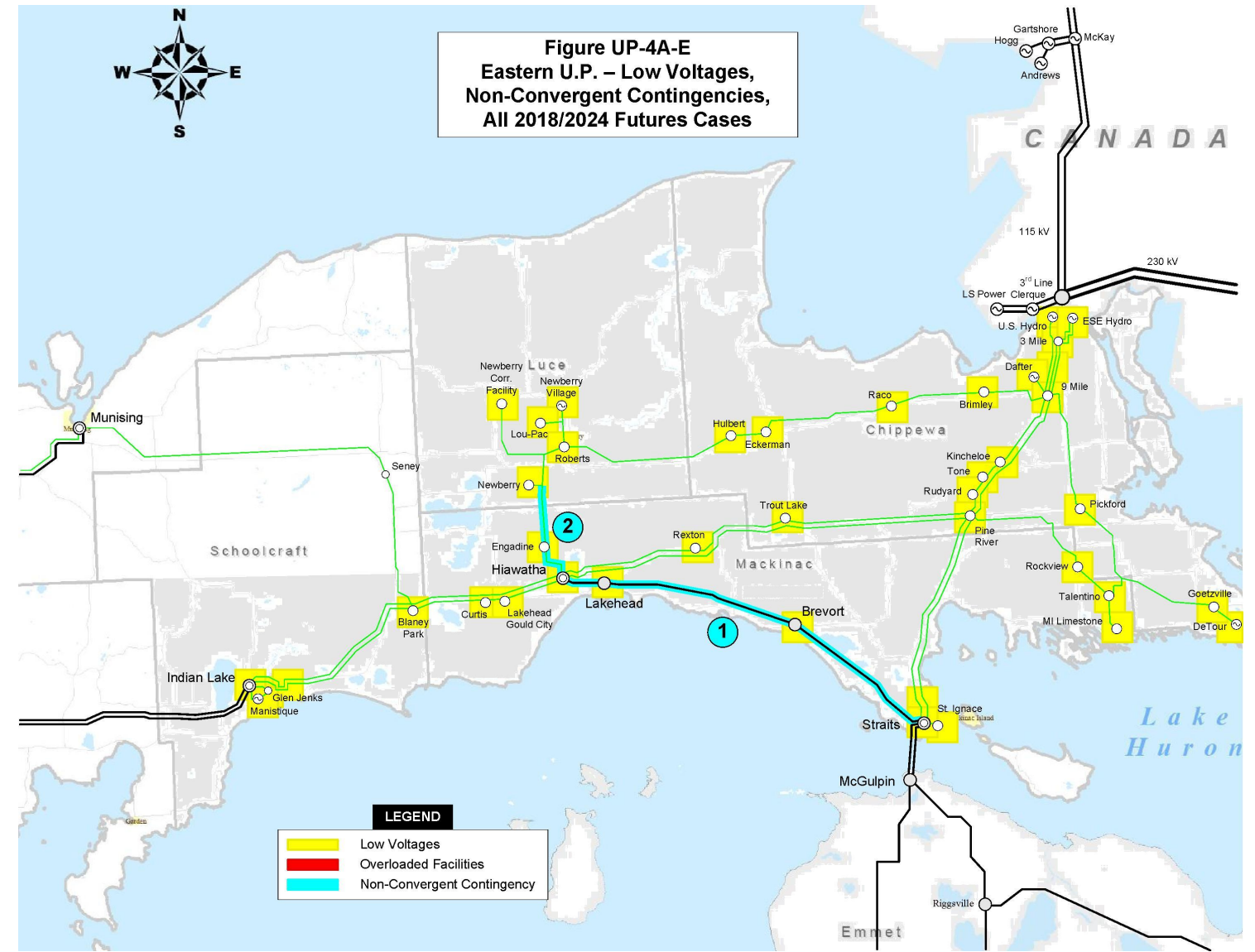
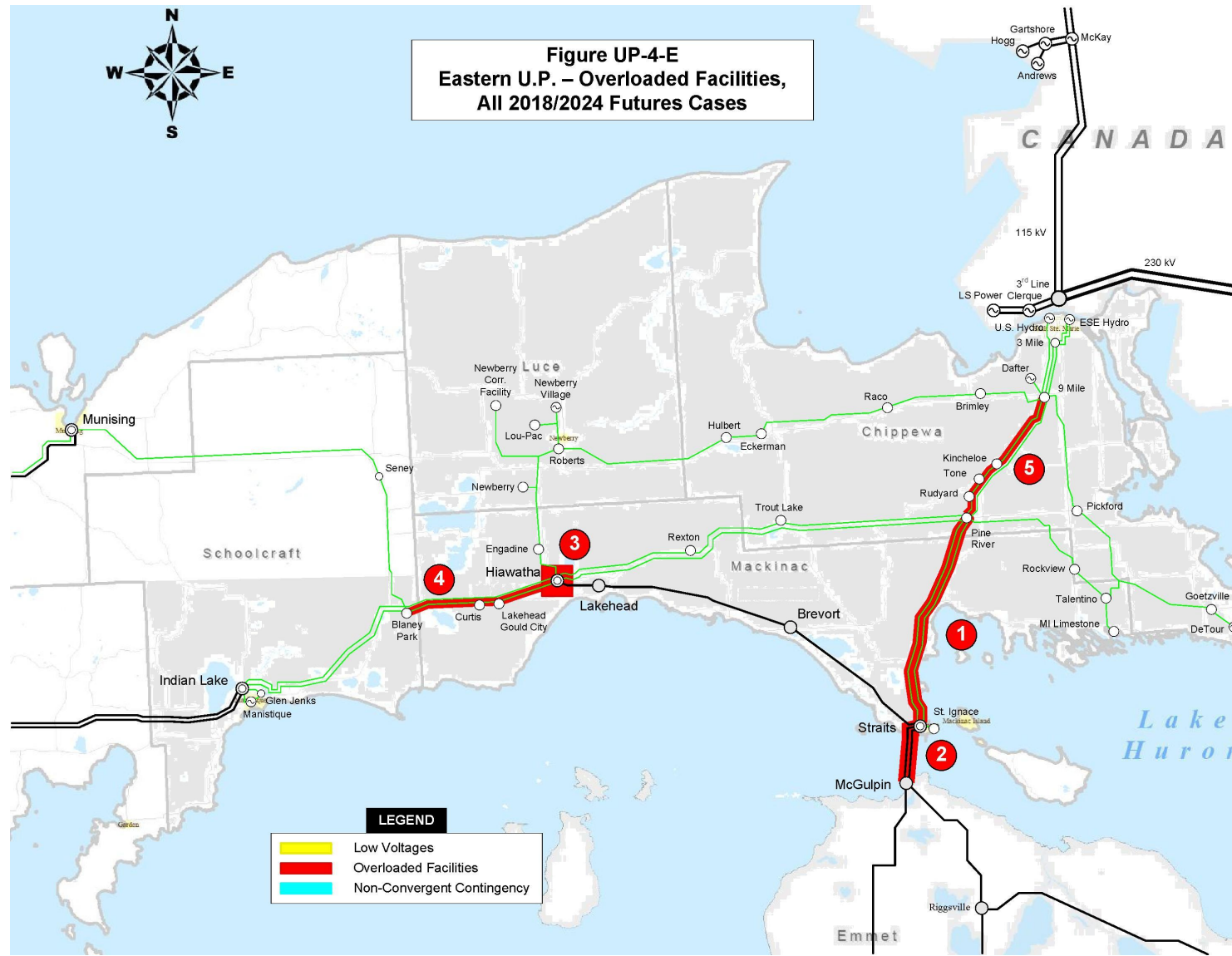


TABLE UP-4-E															
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Overloaded Facilities, U.P. Eastern Zone															
U.P. Zone	Map Item #	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.	
				2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating	2018 % of Facility Rating	2024 % of Facility Rating
Eastern	1	Straits-Pine River 69 kV, Straits-Evergreen-Pine River 69 kV	Straits-Brevort 138 kV, Brevort-Lakehead 138 kV, Lakehead-Hiawatha 138 kV, Straits-Evergreen 69 kV, Evergreen-Pine River 69 kV, Straits-Pine River 69 kV	99%-134%	108%-148%	Did not solve, 149%-175%	Did not solve, 167%-195%	100%-116%	98%-119%				96%-110%	130%-154%	142%-166%
Eastern	2	Straits-McGulpin 138 kV #1 & #3	Straits-McGulpin 138 kV #3 & #1	107%	129%	143%	151%	97%	99%					116%	127%
Eastern	3	Hiawatha 138/69 kV #2	Hiawatha 138/69 kV #1		102%	105%	106%								
Eastern	4	Pine River-Rudyard 69 kV, Rudyard-Tone 69 kV, Tone-Kincheloe 69 kV, Kincheloe-9 Mile 69 kV	Hiawatha-Engadine 69 kV, Engadine-Newberry 69 kV, Pine River-9 Mile 69 kV, Brevort-Straits 138 kV, Pine River-Rudyard 69 kV		97%	134%-176%	144%-182%		96%-101%					117%-176%	106%-189%

TABLE UP-4A-E															
PERFORMANCE CRITERIA LIMITS EXCEEDED AND OTHER CONSTRAINTS – Low Voltages, U.P. Eastern Zone															
U.P. Zone	Criteria Exceeded/Need	Facility Outage	Robust Economy		High Retirements		High Environmental		Slow Growth		DOE 20% Wind		Fuel & Invest. Limit.		
			2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	2018 % of Nominal Bus V	2024 % of Nominal Bus V	
Eastern	Hiawatha, Lakehead, Brevort, Indian Lake 138 kV bus voltages; Michigan Limestone, Talentino, Rockview, DeTour 69 kV bus voltages	Base Case	94.5%-96.0%	92.2%-95.8%	86.9%-91.7%	84.6%-90.6%	95.9%	95.5%			91.0%-94.7%	91.3%-94.1%	83.6%-91.2%	74.2%-95.2%	
Eastern	Hiawatha, Lakehead, Brevort 138 kV bus voltages; Michigan Limestone, Talentino, Rockview, DeTour 69 kV bus voltages	Straits-Brevort 138 kV, Brevort-Lakehead 138 kV, Lakehead-Hiawatha 138 kV		80.3%-82.7%	Did not solve	Did not solve	90.8%-91.4%	90.3%-91.8%			90.9%-91.0%	90.4%-90.7%	59.2%-76.6%	49.8%-70.2%	
Eastern	Hiawatha, Lakehead, Brevort, Indian Lake 138 kV bus voltages	Plains-Arnold 138 kV, Plains-Morgan 345 kV, Morgan-Hwy22 345 kV	91.7%	85.8%-92.0%	Did not solve	Did not solve		91.2%-91.9%					78.0%-91.2%	73.4%-90.6%	
Eastern	Indian Lake 138 kV bus voltage; Indian Lake, Manistique, Glen Jenks, Valley, Blaney Park, DeTour 69 kV bus voltages	Arnold-Perkins 138 kV #1, Arnold-Perkins 138 kV #2, Perkins-Indian Lake 138 kV #1, Perkins-Indian Lake 138 kV #2			84.4%-91.1%	83.1%-88.6%					88.8%-88.9%	87.5%-87.6%	<81%	<75%	
Eastern	Rudyard, Tone, Kincheloe, DeTour, Talentino, Michigan Limestone, 3 Mile, Roberts 69 kV bus voltages	Pine River-Rudyard 69 kV, Rudyard-Tone 69 kV, Tone-Kincheloe 69 kV, Kincheloe-9 Mile 69 kV, Pine River-9 Mile 69 kV			59.4%-90.1%	53.7%-85.5%							59.9%-91.9%	51.1%-85.4%	
Eastern	Engadine, Newberry, LouPac, Newberry Hospital, Roberts, Hulbert, Eckerman, Raco, Brimley 69 kV bus voltages	Hiawatha-Engadine 69 kV, Engadine-Newberry 69 kV, Newberry-Newberry Hospital Tap 69 kV, Newberry Hospital Tap-Roberts 69 kV					80.7%-91.4%	74.9%-92.0%	90.5%-91.0%	91.5%-91.9%			Did not solve, 35.7%-55.4%	Did not solve	



**Table UP-5-RE: U.P. Robust Economy Future –U.P. Preliminary Solutions Groups**

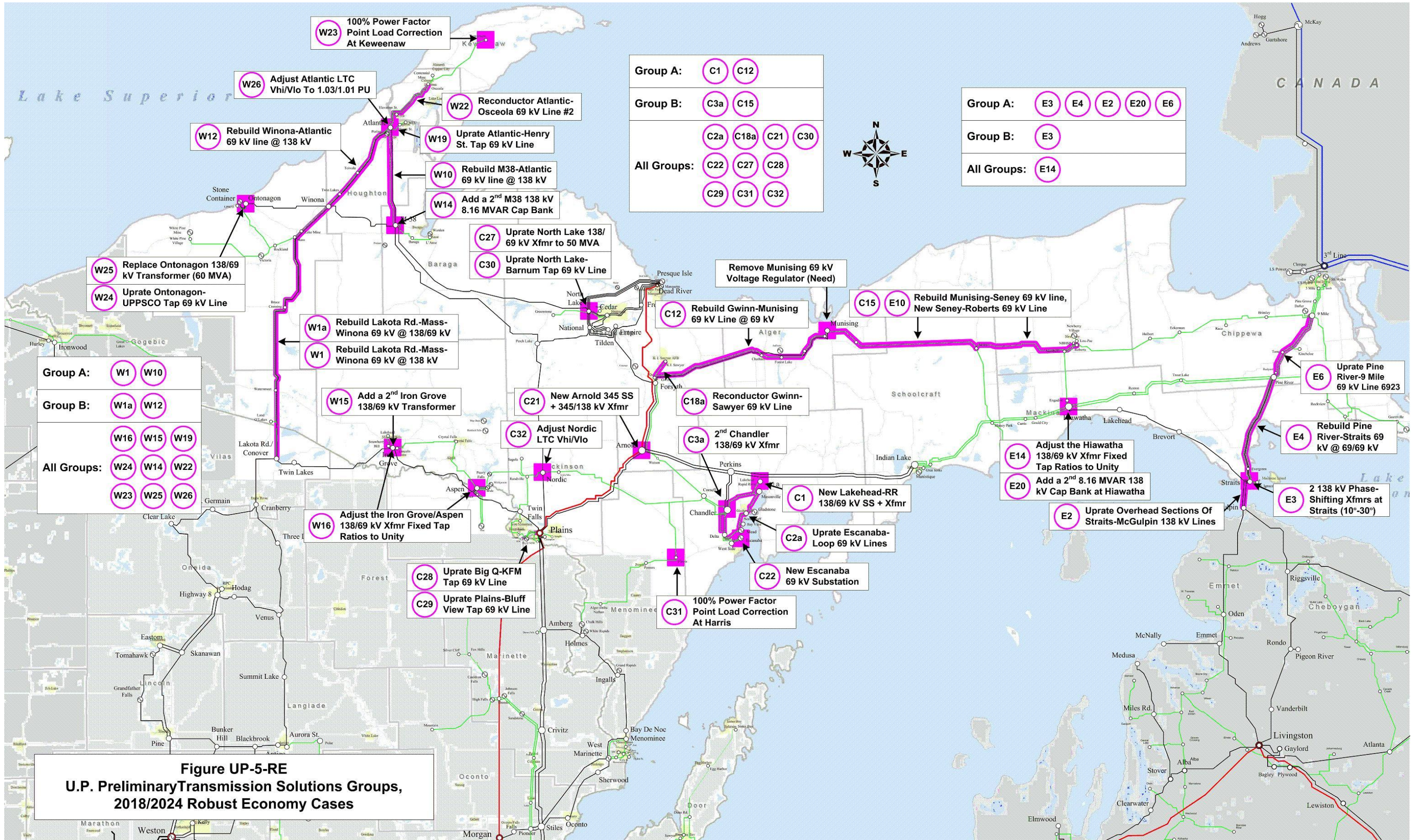
**Individual Solutions Not Common To All Solutions Groups**

U.P. Zone	Solutions Group A		Solutions Group B	
	Map Item #	Solutions Description	Map Item #	Solutions Description
Western	W1	Lakota Rd-Mass-Winona 138 kV rebuild (68 mi) , new Mass 138/69 kV transformer	W1a	Lakota Rd-Mass-Winona 138/69 kV rebuild (68 mi), new Mass 138/69 kV transformer
Western	W10	Rebuild M38-Atlantic 69 kV line at 138 kV (22 mi), add 2 <sup>nd</sup> Atlantic 138/69 kV transformer	W12	Winona-Atlantic 138 kV rebuild (22 mi) , add 2 <sup>nd</sup> Atlantic 138/69 kV transformer
Central	C1	New Lakehead-Rapid River 138/69 kV 150 MVA + reconductor 69 kV line to Lakehead Tap	C3a	Add a 2 <sup>nd</sup> identical Chandler 138/69 kV transformer
Central	C12	Rebuild Gwinn-Munising 69 kV line @ 69 kV (45 mi)	C15	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (34 mi, 24 mi)
Eastern	E3	Add a 138 kV phase-shifting transformer at Straits (10° shift)	E3	Add a 138 kV phase-shifting transformer at Straits (30° shift)
Eastern	E4	Pine River-Straits 2x69 kV rebuild at 69/69 kV (25 mi)		
Eastern	E2	Uprate the overhead portions of Straits-McGulpin 138 kV circuits #1 & #3 to 230° F		
Eastern	E20	Add a 2 <sup>nd</sup> 8.16 MVAR 138 kV capacitor bank at Hiawatha		
Eastern	E6	Uprate Pine River-9 Mile 69 kV line 6923 to 167° F		

All solutions groups assume the retirement of the Munising 69 kV voltage regulator

**Solutions Common to All Solutions Groups**

U.P. Zone	Map Item #	Solutions Description
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV transformer no-load tap ratios to unity
Western	W15	Add a 2 <sup>nd</sup> Iron Grove 138/69 kV transformer
Western	W19	Uprate the Atlantic-Henry St. 69 kV line to 167° F
Western	W24	Uprate the Ontonagon-UPPSCO Tap 69 kV line to 185° F
Western	W14	Add a 2 <sup>nd</sup> M38 138 kV 8.16 MVAR capacitor bank
Western	W22	Reconductor the Atlantic-Elevation St. Tap #2-Osceola 69 kV line
Western	W23	Add 100% power factor correction to the Keweenaw point load
Western	W25	Replace the Ontonagon 138/69 kV transformer with 60 MVA unit
Western	W27	Adjust the Atlantic 138/69 kV transformer(s) LTC Vhigh/Vlow settings to 1.03/1.01 pu
Central	C2a	Uprate Escanaba-area 69 kV loop to 167°/200° F SE
Central	C18a	Reconductor Gwinn-Sawyer 69 kV line with 336 ACSR conductors
Central	C21	Arnold 345 kV SS, 345/138 kV 500 MVA xfmr
Central	C30	Uprate North Lake-Barnum Tap 69 kV line to 120° F
Central	C22	New Escanaba 69 kV substation
Central	C27	Uprate the North Lake 138/69 kV transformer #1 to 50 MVA
Central	C28	Uprate the Big Q-Kingsford Metals Tap 69 kV line to 84 MVA (SS limiters)
Central	C29	Uprate the Plains-Bluff View Tap 69 kV line to 46 MVA (SS limiters)
Central	C31	Add 100% distribution power factor correction to the Harris point load addition
Central	C32	Increase the Nordic 138/69 kV transformer LTC voltage settings by 1%
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity



**Figure UP-5-RE**  
**U.P. Preliminary Transmission Solutions Groups,**  
**2018/2024 Robust Economy Cases**



**Table UP-5-HR: U.P. High Retirements Future –U.P. Preliminary Solutions Groups**

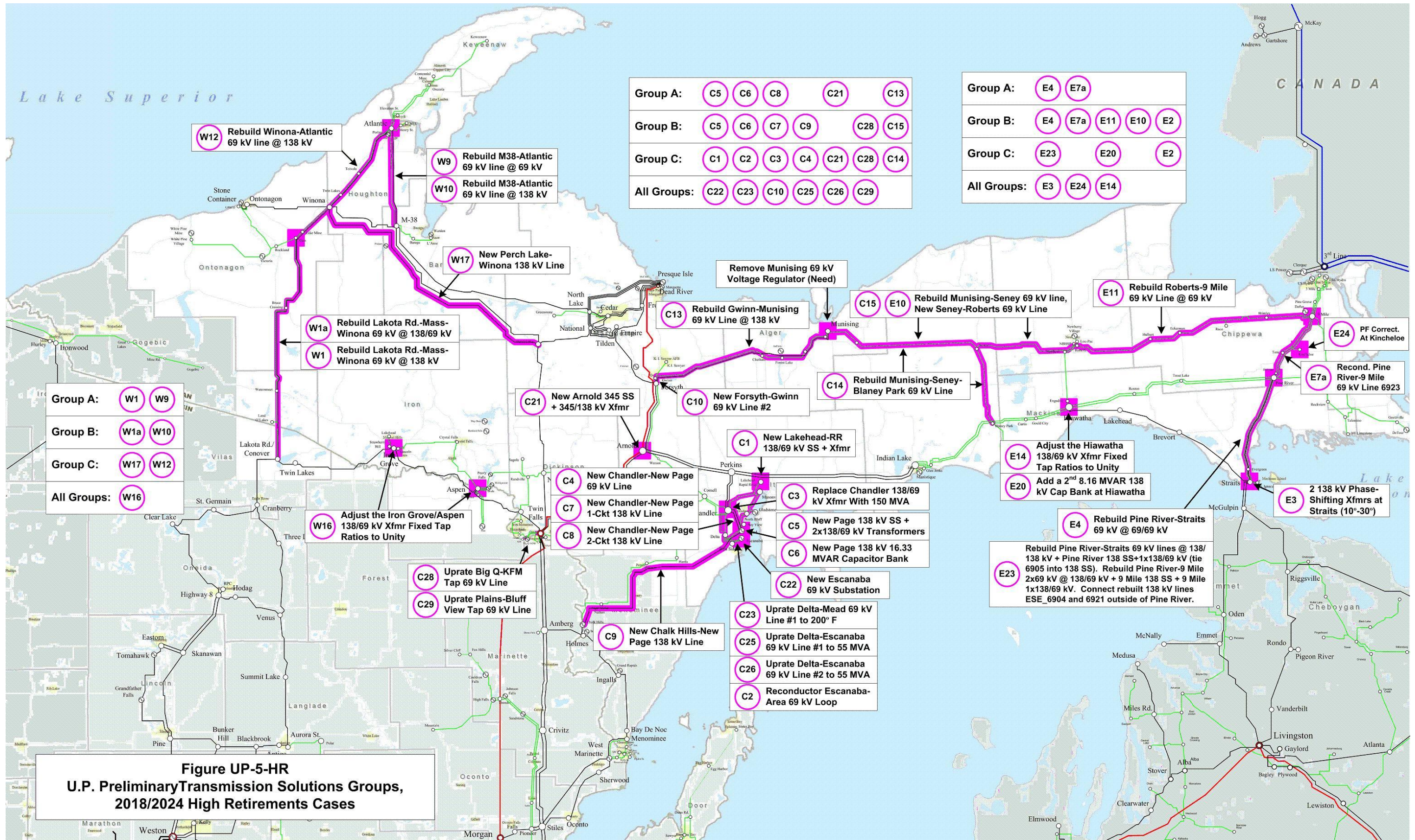
**Individual Solutions Not Common To All Solutions Groups**

U.P. Zone	Solutions Group A		Solutions Group B		Solutions Group C	
	Map Item #	Solutions Description	Map Item #	Solutions Description	Map Item #	Solutions Description
Western	W1	Lakota Rd-Mass-Winona 138 kV rebuild (68 mi)	W1a	Lakota Rd-Mass-Winona 138/69 kV rebuild (68 mi), new Mass 138/69 kV transformer	W17	New Winona-Perch Lake 138 kV line (68 mi)
Western	W9	Rebuild M38-Atlantic 69 kV line at 69 kV (22 mi)	W10	Rebuild M38-Atlantic 69 kV line at 138 kV (22 mi), add 2 <sup>nd</sup> Atlantic 138/69 kV transformer	W12	Winona-Atlantic 138 kV rebuild (22 mi)
Central	C5	New Page 138 kV SS + 2 138/69 kV transformers	C5	New Page 138 kV SS + 2 138/69 kV transformers	C1	New Lakehead-Rapid River 138/69 kV 150 MVA + reconductor 69 kV line to Lakehead Tap
Central	C6	New Page 138 kV 16.33 MVAR capacitor bank	C6	New Page 138 kV 16.33 MVAR capacitor bank	C2	Reconductor Escanaba-area 69 kV loop (38 mi)
Central	C8	New Chandler-New Page 2-ckt 138 kV lines (6 mi)	C7	New Chandler-New Page 1-ckt 138 kV line (6 mi)	C3	Replace Chandler 138/69 kV with 150 MVA
Central			C9	New Chalk Hills-New Page 1-ckt 138 kV line (51 mi)	C4	New Chandler-New Page 69 kV line (6 mi)
Central	C21	Arnold 345 kV SS, 345/138 kV 500 MVA xfm			C21	Arnold 345 kV SS, 345/138 kV 500 MVA xfm
			C28	Uprate the Big Q-Kingsford Metals Tap 69 kV line to 84 MVA (SS limiters)	C28	Uprate the Big Q-Kingsford Metals Tap 69 kV line to 84 MVA (SS limiters)
Central	C13	Rebuild Gwinn-Munising 69 kV line @ 138 kV (45 mi)	C15	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (59 mi)	C14	Rebuild Munising-Seney-Blaney Park 69 kV line (54 mi)
Eastern	E4	Pine River-Straits 2x69 kV rebuild at 69/69 kV (25 mi)	E4	Pine River-Straits 2x69 kV rebuild at 69/69 kV (25 mi)	E23	Rebuild Pine River-Straits 2x69 kV at 138/138 kV + Pine River 138 SS + 138/69 kV xfmr. Rebuild Pine River-9 Mile 2x69 kV @ 138/69 kV + 9 Mile 138 SS + 138/69 kV xfmr. Splice ESE 6904 & 6921 outside of Pine River (bypass) (45 mi)
Eastern	E7a	Reconductor Pine River-9 Mile 69 kV line 6923 with 336 ACSR conductors	E7a	Reconductor Pine River-9 Mile 69 kV line 6923 with 336 ACSR conductors		
Eastern			E11	Rebuild Roberts-9 Mile 69 kV at 69 kV (54 mi)	E20	Add a 2 <sup>nd</sup> 8.16 MVAR 138 kV capacitor bank at Hiawatha
Eastern			E10	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (59 mi)		
Eastern			E2	Uprate the overhead portions of Straits-McGulpin 138 kV circuits #1 & #3 to 200° F	E2	Uprate the overhead portions of Straits-McGulpin 138 kV circuits #1 & #3 to 230° F

All solutions groups assume the retirement of the Munising 69 kV voltage regulator

**Solutions Common to All Solutions Groups**

U.P. Zone	Map Item #	Solutions Description	Differences Between Groups
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV transformer no-load tap ratios to unity	
Central	C22	New Escanaba 69 kV substation	
Central	C23	Uprate Delta-Mead 69 kV line to 200° F	
Central	C10	New Forsyth-Gwinn 69 kV line #2	
Central	C25	Uprate the Escanaba #1 69 kV line (Delta-Escanaba) to 55 MVA	
Central	C26	Uprate the Escanaba #2 69 kV line (Delta-West Side Tap-Escanaba) to 55 MVA	
Central	C29	Uprate the Plains-Bluff View Tap 69 kV line to 46 MVA (SS limiters)	
Eastern	E3	Add two 138 kV phase-shifting transformers at Straits, 10°-30° phase shift	A - 30° phase shift, B - 20° phase shift, C - 10° phase shift
Eastern	E24	Add 99-100% distribution power factor correction to the Kincheloe point load addition	A, B – 100% pf correction, C – 99% pf correction
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity	



**Figure UP-5-HR**  
**U.P. Preliminary Transmission Solutions Groups,**  
**2018/2024 High Retirements Cases**

**Table UP-5-HE: U.P. High Environmental Future – U.P. Preliminary Solutions Groups**

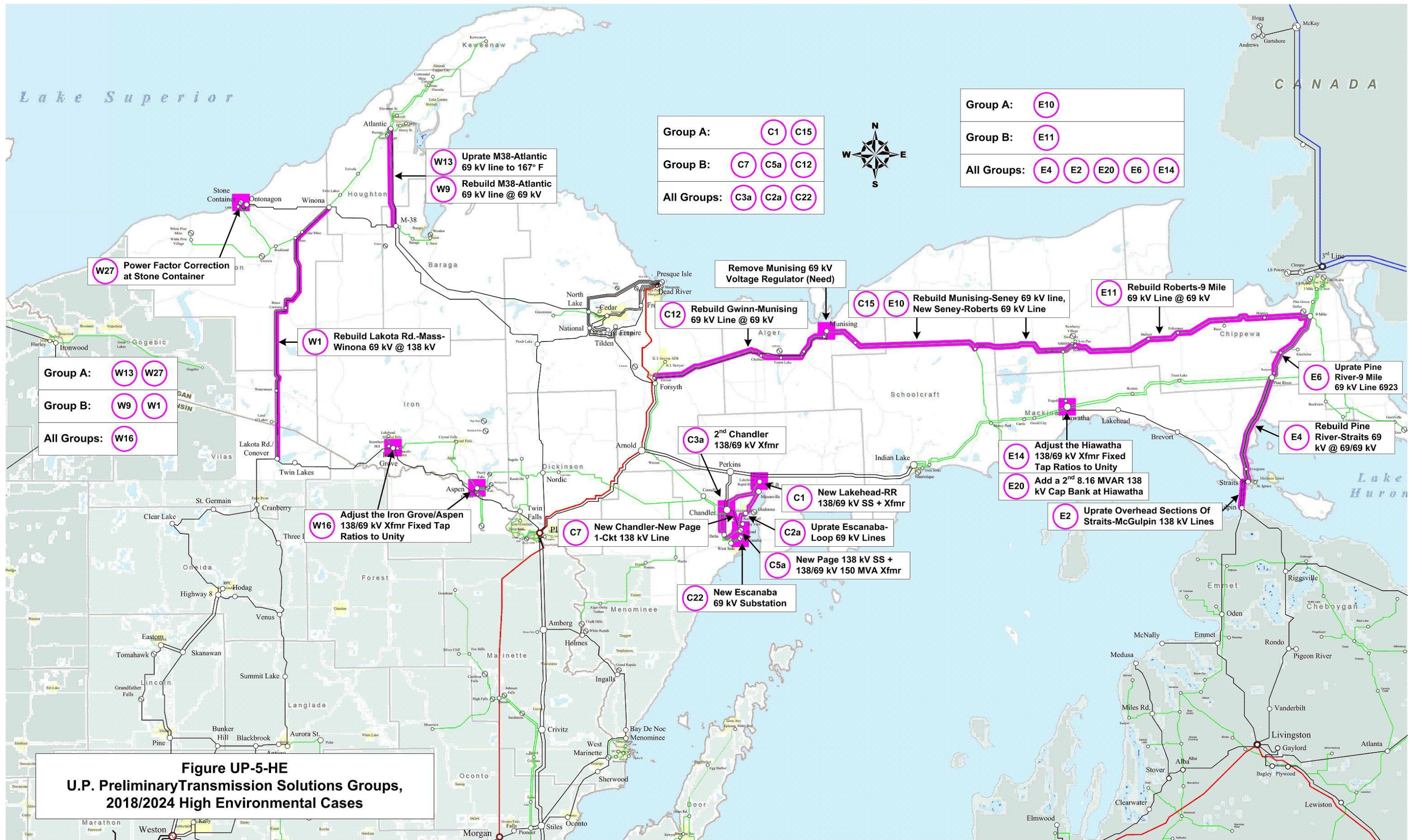
**Individual Solutions Not Common To All Solutions Groups**

U.P. Zone	Solutions Group A		Solutions Group B	
	Map Item #	Solutions Description	Map Item #	Solutions Description
Western	W13	Uprate M38-Atlantic 69 kV line to 167 ° F	W9	Rebuild M38-Atlantic 69 kV line at 69 kV (22 mi)
Western	W27	Add power factor correction at Stone Container	W1	Lakota Rd-Mass-Winona 138 kV rebuild (68 mi) , new Mass 138/69 kV transformer
Central			C7	New Chandler-New Page 1-ckt 138 kV line (6 mi)
Central	C1	New Lakehead-Rapid River 138/69 kV 150 MVA + reconductor 69 kV line to Lakehead Tap	C5a	New Page 138 kV SS + 138/69 kV transformer
Central	C15	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (59 mi)	C12	Rebuild Gwinn-Munising 69 kV line @ 69 kV (45 mi)
Eastern	E10	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (59 mi)	E11	Rebuild Roberts-9 Mile 69 kV at 69 kV (54 mi)

All solutions groups assume the retirement of the Munising 69 kV voltage regulator

**Solutions Common to All Solutions Groups**

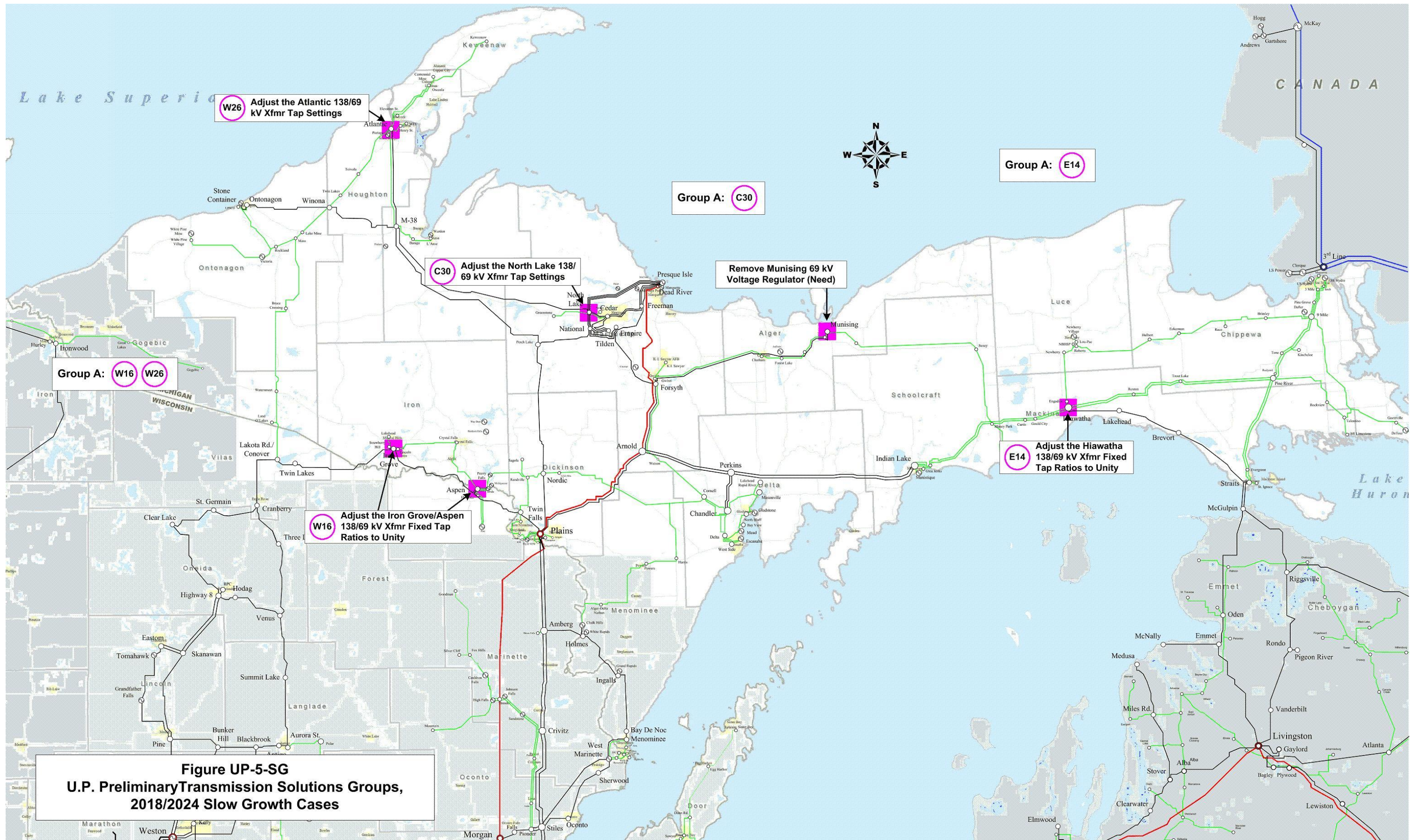
U.P. Zone	Map Item #	Solutions Description
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV transformer no-load tap ratios to unity
Central	C3a	Add a 2 <sup>nd</sup> identical Chandler 138/69 kV transformer
Central	C2a	Uprate Escanaba-area 69 kV loop lines to 167°/200° F SE (38 mi)
Central	C22	New Escanaba 69 kV substation
Eastern	E4	Pine River-Straits 2x69 kV rebuild at 69/69 kV (25 mi)
Eastern	E2	Uprate the overhead portions of Straits-McGulpin 138 kV circuits #1 & #3 to 200° F
Eastern	E20	Add a 2 <sup>nd</sup> 8.16 MVAR 138 kV capacitor bank at Hiawatha
Eastern	E6	Uprate Pine River-9 Mile 69 kV line 6923 to 167° F
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity



**Table UP-5-SG: U.P. Slow Growth Future – U.P. Preliminary Solutions Group**

Solutions Group A		
U.P. Zone	Map Item #	Solutions Description
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV transformer no-load tap ratios to unity
Western	W26	Adjust the Atlantic 138/69 kV transformer tap settings
Central	C30	Adjust the North Lake 138/69 kV transformer tap settings
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity

Also assume the retirement of the Munising 69 kV voltage regulator



**Figure UP-5-SG**  
**U.P. Preliminary Transmission Solutions Groups,**  
**2018/2024 Slow Growth Cases**

**Table UP-5-DW: DOE 20% Wind Future – U.P. Preliminary Solutions Groups**

**Individual Solutions Not Common To All Solutions Groups**

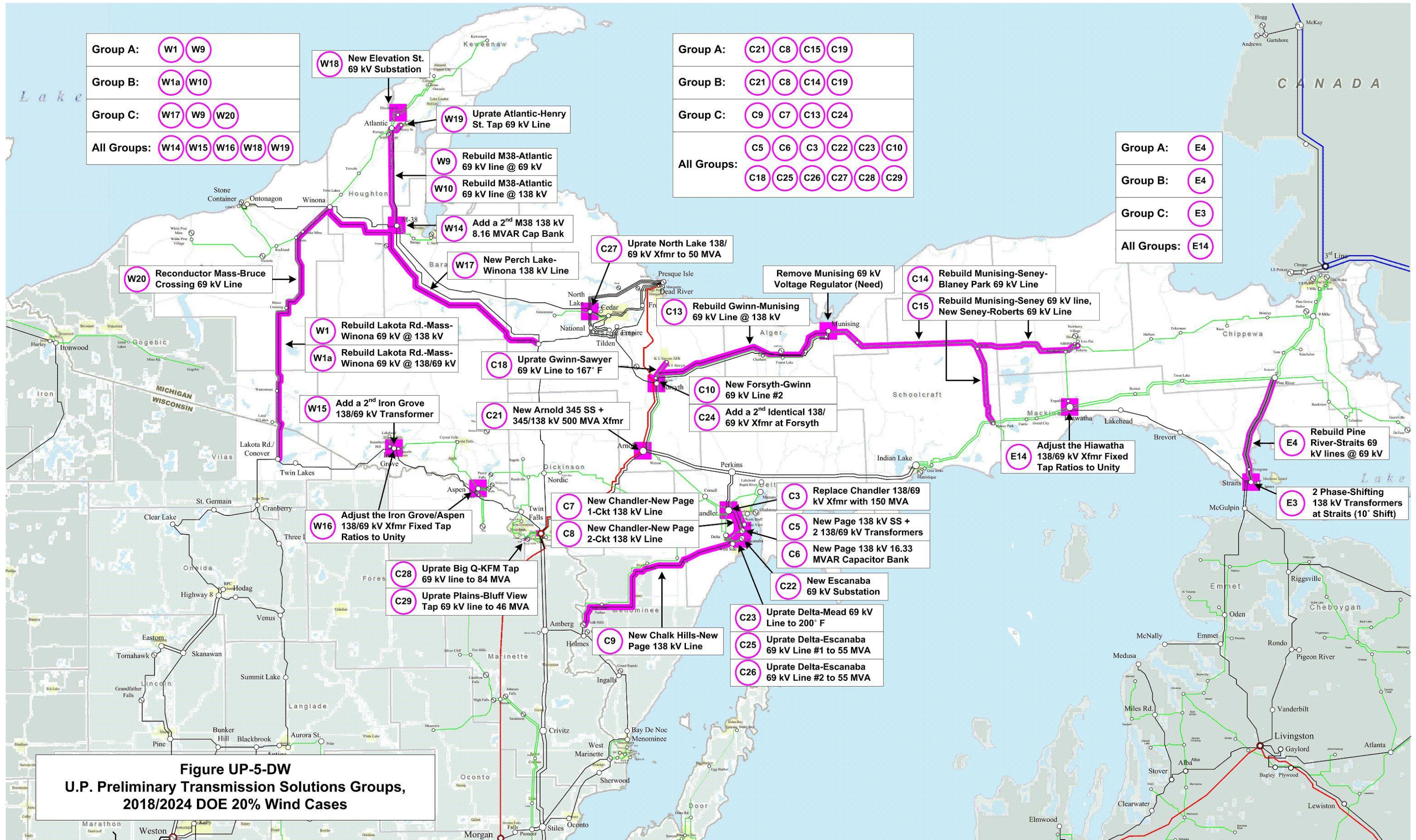
U.P. Zone	Solutions Group A		Solutions Group B		Solutions Group C	
	Map Item #	Solutions Description	Map Item #	Solutions Description	Map Item #	Solutions Description
Western	W1	Lakota Rd.-Mass-Winona 69 kV rebuild at 138 kV (68 mi)	W1a	Lakota Rd.-Mass-Winona 69 kV rebuild at 138/69 kV (68 mi)	W17	New Winona-Perch Lake 138 kV line (68 mi)
Western	W9	M38-Atlantic 69 kV line rebuild at 69 kV (22 mi)	W10	M38-Atlantic 69 kV line (22 mi) rebuild at 138 kV, add a 2 <sup>nd</sup> identical 138/69 kV transformer at Atlantic	W9	M38-Atlantic 69 kV line rebuild at 69 kV (22 mi)
Western					W20	Reconductor the Mass-Bruce Crossing 69 kV line (18.6 mi)
Central	C21	New Arnold 345 kV SS, 345/138 kV 500 MVA xfmr	C21	New Arnold 345 kV SS, 345/138 kV 500 MVA xfmr	C9	New Chalk Hills-New Page 1-ckt 138 kV line (50 mi)
Central	C8	New Chandler-New Page 2-ckt 138 kV lines (6 mi ea)	C8	New Chandler-New Page 2-ckt 138 kV lines (6 mi ea)	C7	New Chandler-New Page 1-ckt 138 kV line (6 mi)
Central	C15	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line (34 mi, 24 mi)	C14	Rebuild Munising-Seney-Blaney 69 kV line (52 mi)	C13	Rebuild the Forsyth-Gwinn-Munising 69 kV line (45 mi) at 138 kV, add a 2 <sup>nd</sup> identical 138/69 kV transformer at Munising
Central					C24	Add a 2 <sup>nd</sup> identical 138/69 kV transformer at Forsyth
Eastern	E4	Rebuild the Pine River-Straits double-circuit 69 kV lines (25 mi ea) at 69 kV, 138 kV standards	E4	Rebuild the Pine River-Straits double-circuit 69 kV lines (25 mi ea) at 69 kV, 138 kV standards	E3	Add a 138 kV phase-shifting transformer at Straits (10° shift)

All solutions groups assume the retirement of the Munising 69 kV voltage regulator

Note: Solutions Group C, which originally included a new 138 kV line between Ironwood (Xcel) and Ontonagon, resulted in unacceptable voltage and loading performance within the Xcel system. It was replaced with the Winona-Perch Lake 138 kV line option.

**Solutions Common to All Solutions Groups**

U.P. Zone	Map Item #	Solutions Description
Western	W14	Add a 2 <sup>nd</sup> M38 138 kV 8.16 MVAR capacitor bank
Western	W15	Add a 2 <sup>nd</sup> Iron Grove 138/69 kV transformer
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV xfmr fixed tap ratios to unity
Western	W18	New Elevation St. 69 kV substation
Western	W19	Uprate Atlantic-Henry St. 69 kV line to 167° F (48 MVA)
Central	C5	New Page 138 kV SS + 2 138/69 kV transformers
Central	C6	New Page 138 kV 16.33 MVAR capacitor bank
Central	C3	Replace Chandler 138/69 kV xfmr with 150 MVA
Central	C22	New Escanaba 69 kV substation
Central	C23	Uprate Delta-Mead 69 kV line to 200° F
Central	C10	New Forsyth-Gwinn 69 kV line #2 (0.8 mi)
Central	C18	Uprate Gwinn-Sawyer 69 kV line to 167° F
Central	C25	Uprate the Escanaba #1 69 kV line (Delta-Escanaba) to 55 MVA
Central	C26	Uprate the Escanaba #2 69 kV line (Delta-West Side Tap-Escanaba) to 55 MVA
Central	C27	Uprate the North Lake 138/69 kV transformer #1 to 50 MVA
Central	C28	Uprate the Big Q-Kingsford Metals Tap 69 kV line to 84 MVA (SS limiters)
Central	C29	Uprate the Plains-Bluff View Tap 69 kV line to 46 MVA (SS limiters)
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity



**Figure UP-5-DW**  
**U.P. Preliminary Transmission Solutions Groups,**  
**2018/2024 DOE 20% Wind Cases**



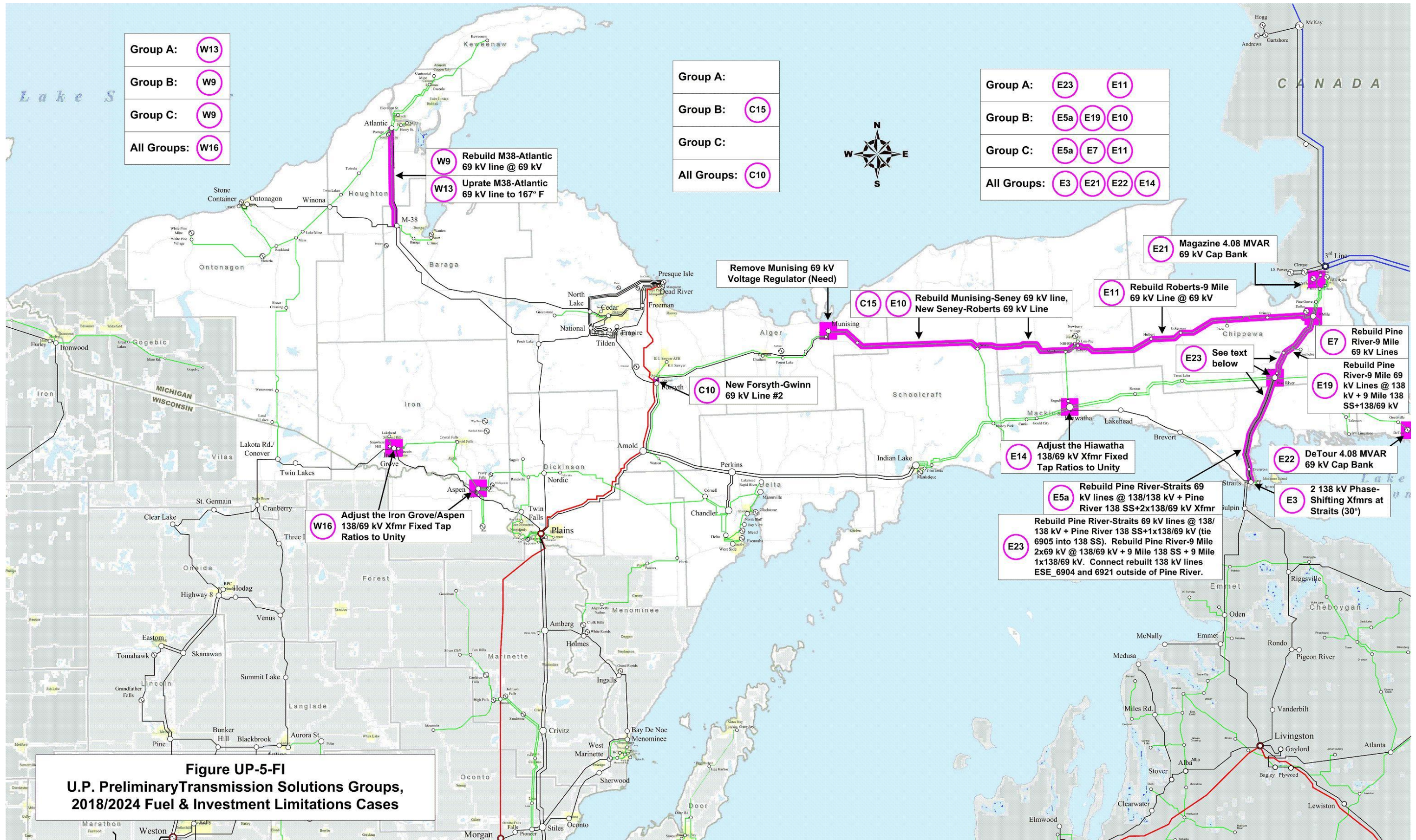
**Table UP-5-FI: Fuel & Investment Limitations Future –U.P. Preliminary Solutions Groups**

**Individual Solutions Not Common To All Solutions Groups**

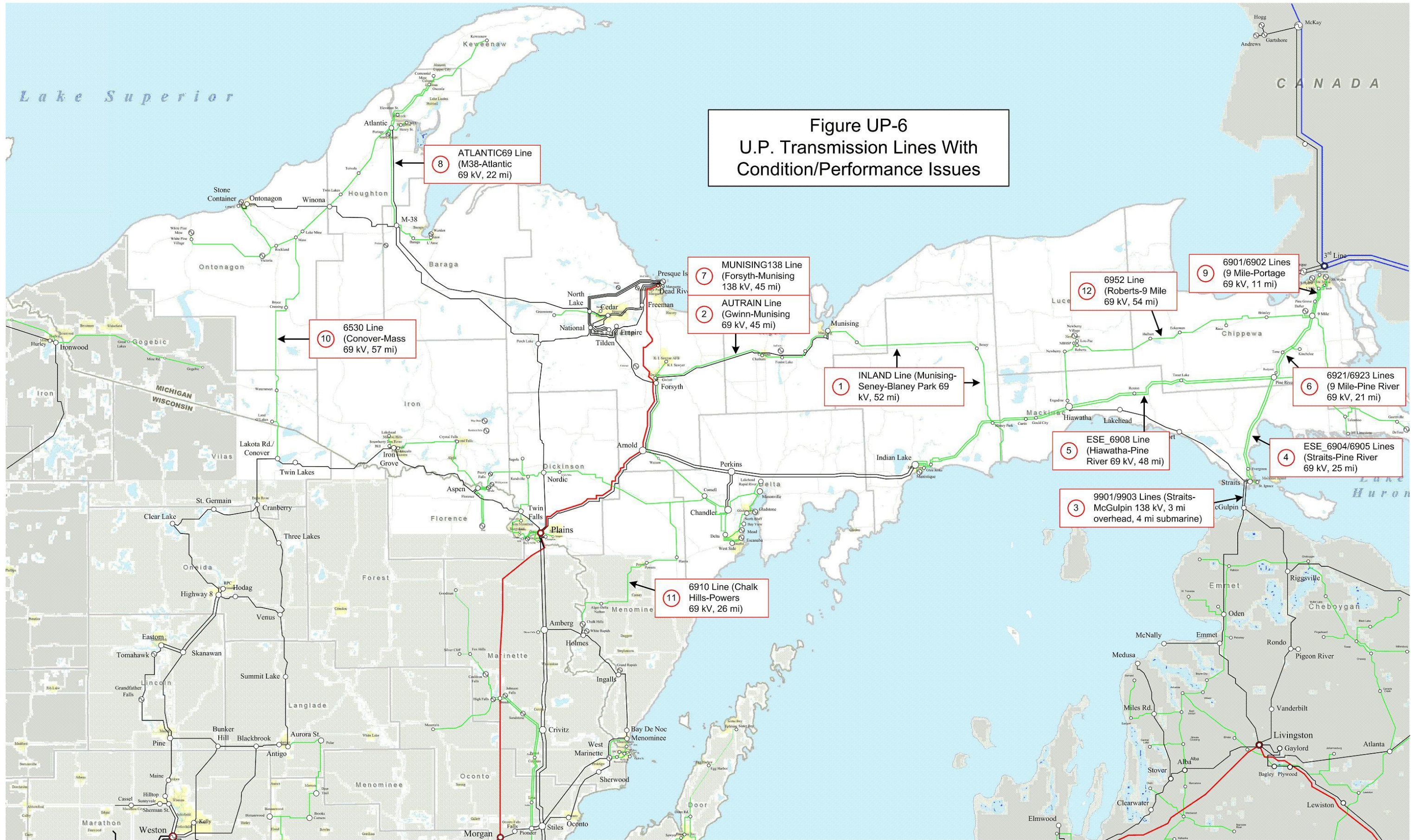
U.P. Zone	Solutions Group A		Solutions Group B		Solutions Group C	
	Map Item #	Solutions Description	Map Item #	Solutions Description	Map Item #	Solutions Description
Western	W13	Uprate M38-Atlantic 69 kV line to 167° F	W9	Rebuild M38-Atlantic 69 kV line at 69 kV	W9	Rebuild M38-Atlantic 69 kV line at 69 kV
Central			C15	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line		
Eastern	E23	Rebuild Pine River-Straits 2x69 kV at 138/138 kV + Pine River 138 SS + 138/69 kV xfmr. Rebuild Pine River-9 Mile 2x69 kV @ 138/69 kV + 9 Mile 138 SS + 138/69 kV xfmr. Tie one Pine River-Straits 138 line (6905) into Pine River, other (ESE_6904) from Straits directly to 9 Mile, bypassing Pine River, and connecting into rebuilt 138 kV line 6921.	E23	Rebuild Pine River-Straits 2x69 kV at 138/138 kV + Pine River 138 SS + 138/69 kV xfmr. Rebuild Pine River-9 Mile 2x69 kV @ 138/69 kV + 9 Mile 138 SS + 138/69 kV xfmr. Tie one Pine River-Straits 138 line (6905) into Pine River, other (ESE_6904) from Straits directly to 9 Mile, bypassing Pine River, and connecting into rebuilt 138 kV line 6921.	E5a	Pine River-Straits 2x69 kV rebuild at 138/138 kV + Pine River 2x138/69 kV 150 MVA
Eastern					E7	Rebuild Pine River-9 Mile 2x69 kV at 69 kV
Eastern	E11	Rebuild Roberts-9 Mile 69 kV at 69 kV	E10	Rebuild Munising-Seney 69 kV line, new Seney-Roberts 69 kV line	E11	Rebuild Roberts-9 Mile 69 kV at 69 kV

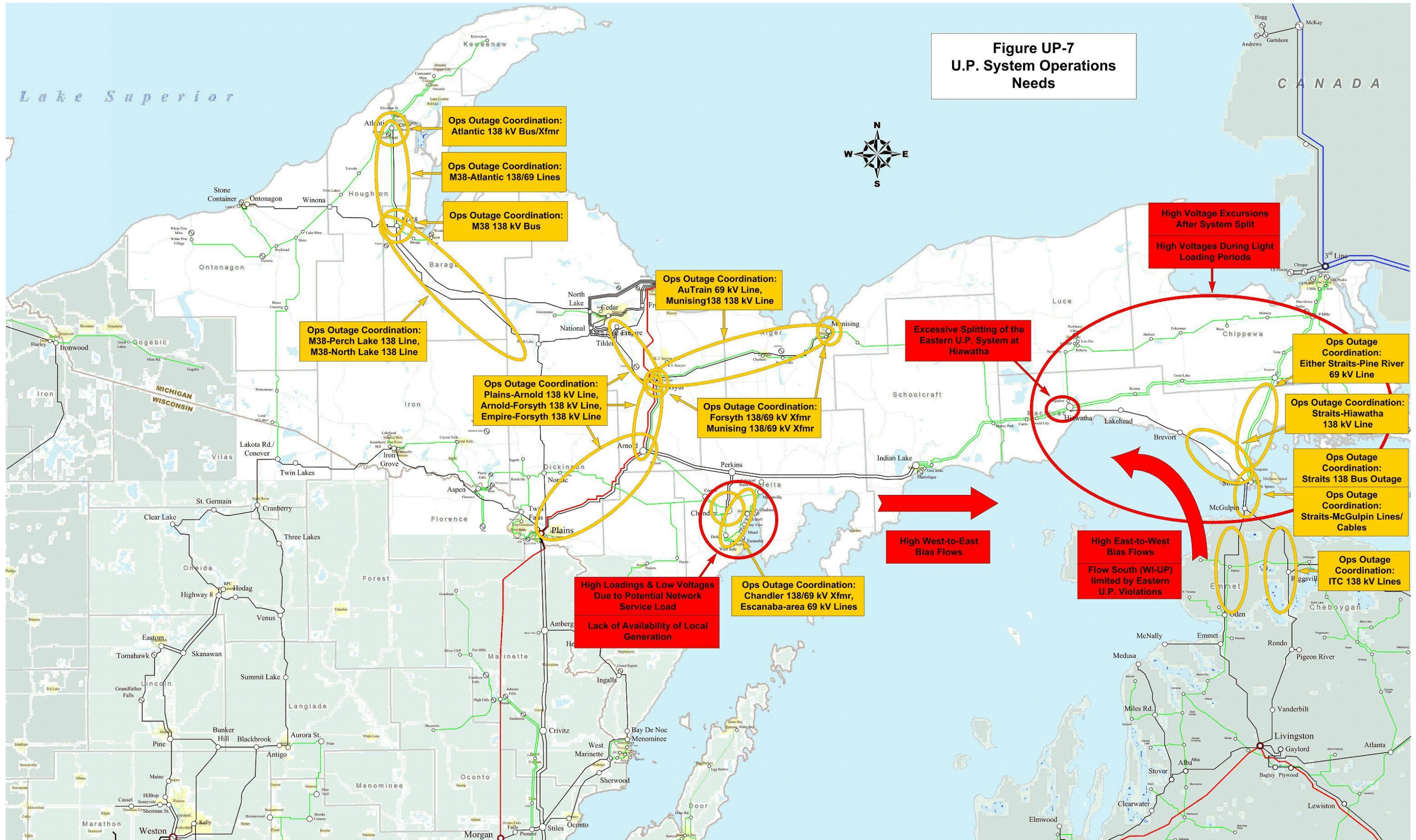
**Solutions Common to All Solutions Groups**

U.P. Zone	Map Item #	Solutions Descriptions
Western	W16	Adjust the Iron Grove/Aspen 138/69 kV transformer no-load tap ratios to unity
Central	C10	New Forsyth-Gwinn 69 kV line #2
Eastern	E3	Add 2 138 kV phase-shifting transformers at Straits (30° shift)
Eastern	E21	Magazine 4.08 MVAR 69 kV capacitor bank
Eastern	E22	DeTour 4.08 MVAR 69 kV capacitor bank
Eastern	E14	Adjust the Hiawatha 138/69 kV transformer no-load tap ratios to unity

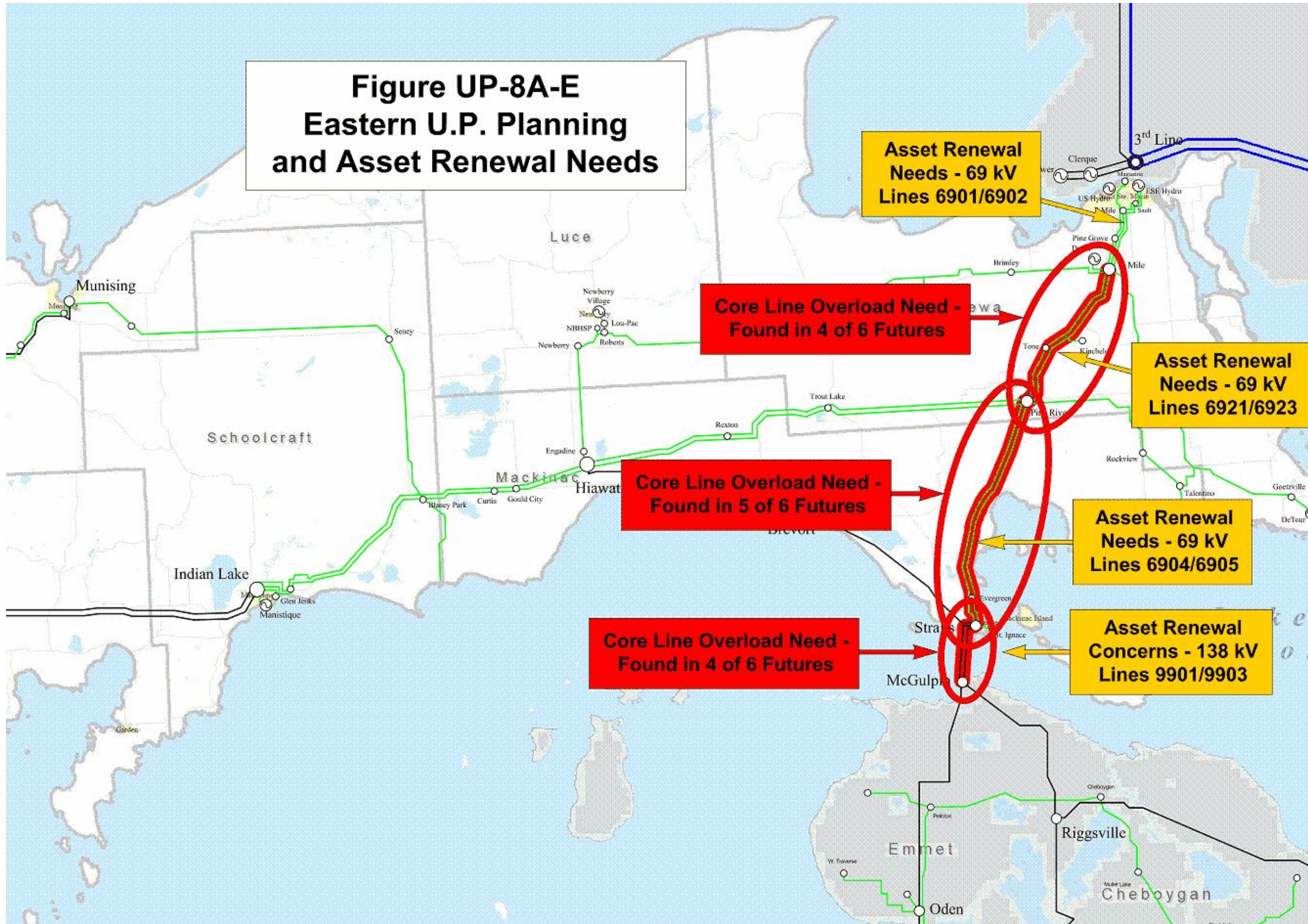


**Figure UP-5-FI**  
**U.P. Preliminary Transmission Solutions Groups,**  
**2018/2024 Fuel & Investment Limitations Cases**

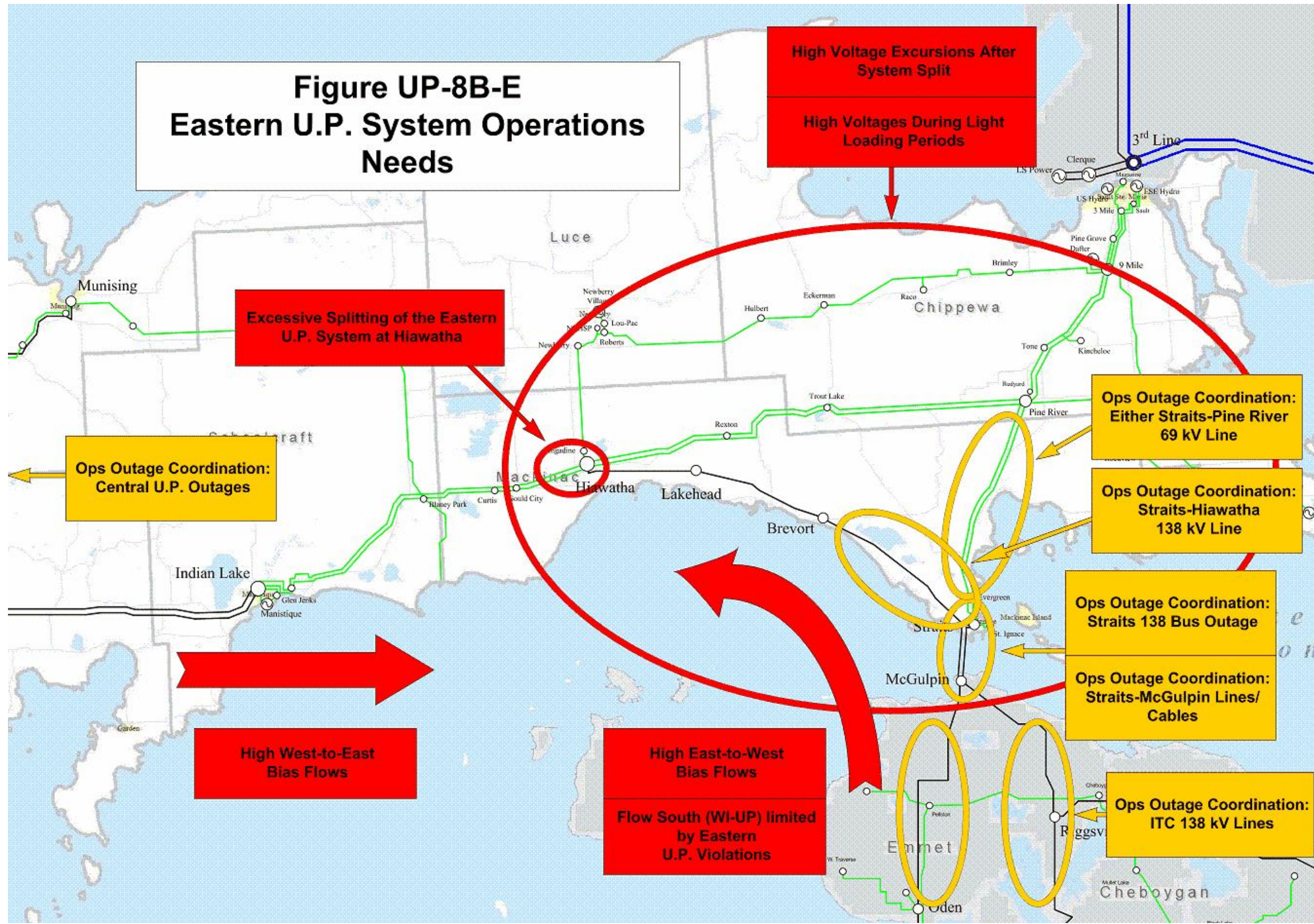




**Figure UP-8A-E  
Eastern U.P. Planning  
and Asset Renewal Needs**



**Figure UP-8B-E  
Eastern U.P. System Operations  
Needs**





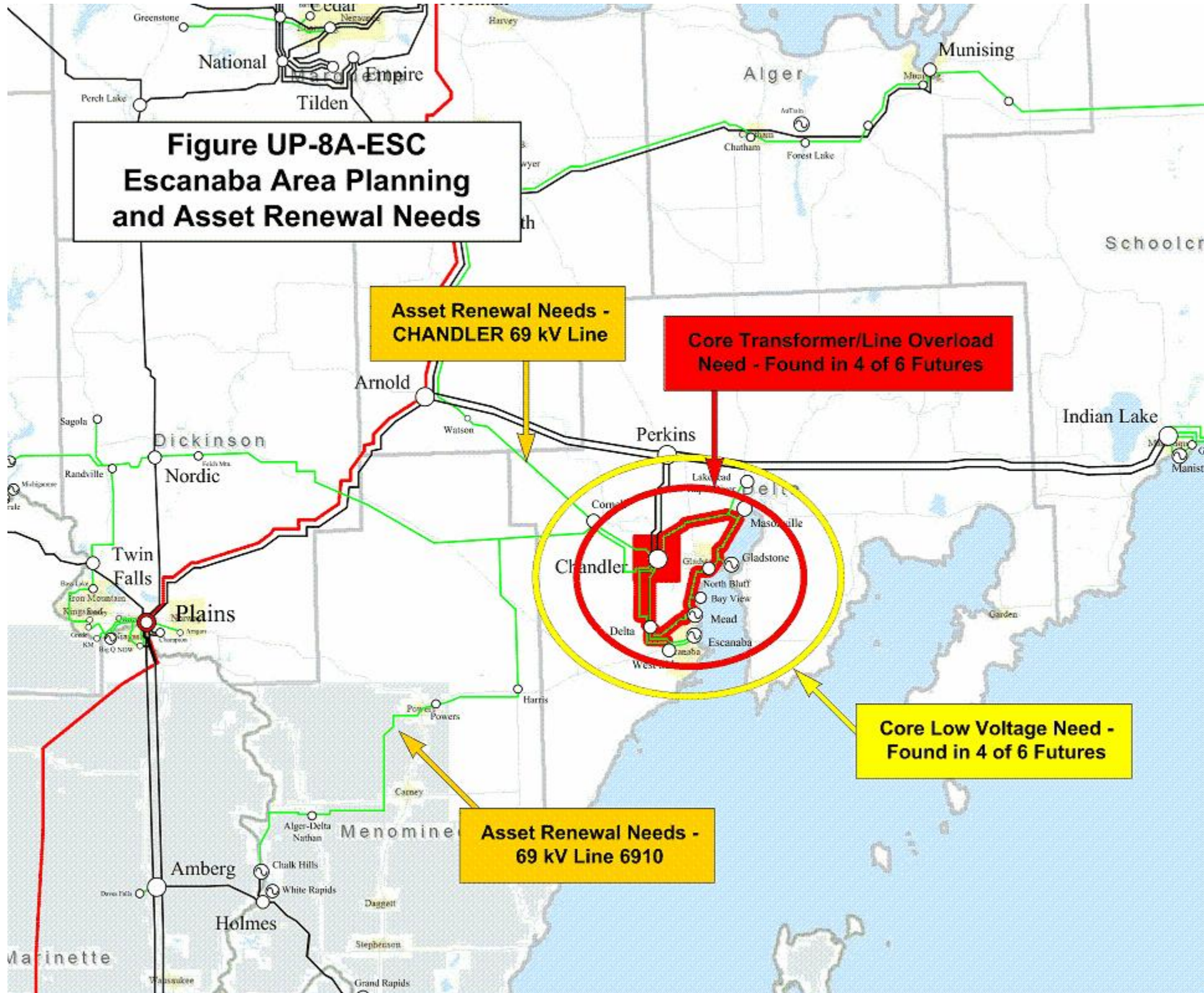
**Table UP-8A-E: UP Collaborative Preliminary Solutions Groups Performance Matrix**

<b>Straits-Pine River 69 kV Lines (ESE_6904/6905)</b>													
U.P. Zone	Map Item #	Solutions Description	Estimated Cost	In Service Year	Strategic Flexibility Future (Planning Needs N-1 @ Peak)					Customer Relations / IC Services Needs		Asset Mgmt. Needs	
					Robust Economy	High Retire.	High Environ.	Slow Growth	DOE 20% Wind	Fuel & Invest. Limit.	Ref. Case with Kinross	Ref. Case w/o Kinross	Asset Renewal
Eastern	E-AR1	Minimum 6904/6905 Asset Renewal	\$5M	2016	Not Adequate	Not Adequate	Not Adequate	Adequate	Not Adequate	Not Adequate	Not Adequate	Not Adequate	Adequate
Eastern	E4a, E-AR1	Uprate + AR Project	N/A	2014,2016	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible
Eastern	E4b, E,AR1	Reconductor + AR Project	N/A	2014,2016	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible	Not Structurally Possible
Eastern	E4	Rebuild @ 69/69kV w/T2-4/0	\$35M	2014	Adequate	Adequate	Adequate	Not needed for Planning	Adequate	Not Adequate	Not Adequate	Adequate	More robust than needed
Eastern	E23	Rebuild @ 138/138kV w/T2-477, 150MVA Xfmr at Pine River	\$47M	2014 (2012 for Frontier)	More robust than needed	More robust than needed	More robust than needed	Not needed for Planning	More robust than needed	Not Adequate	Adequate	More robust than needed	More robust than needed
Eastern	E5a	Rebuild @ 138/138kV w/T2-477, PRV ss/2-150MVA Xfmr at PRV	\$52M	2014	More robust than needed	More robust than needed	More robust than needed	Not needed for Planning	More robust than needed	Not Adequate	More robust than needed	More robust than needed	More robust than needed
Eastern	E23, E3	Rebuild @ 138/138kV w/T2-477, 150MVA Xfmr at Pine River, 2 138 kV 30° PAR @ Straits	\$63M	2014	More robust than needed	More robust than needed	More robust than needed	Not needed for Planning	More robust than needed	Adequate	More robust than needed	More robust than needed	More robust than needed
<b>Pine River-Nine Mile 69 kV Lines (6921/6923)</b>													
U.P. Zone	Map Item #	Solutions Description	Estimated Cost	In Service Year	Strategic Flexibility Future (Planning Needs N-1 @ Peak)					Customer Relations / IC Services Needs		Asset Mgmt. Needs	
					Robust Economy	High Retire.	High Environ.	Slow Growth	DOE 20% Wind	Fuel & Invest. Limit.	Ref. Case with Kinross	Ref. Case w/o Kinross	Asset Renewal
Eastern	E-AR2	Minimum 6921/6923 Asset Renewal	\$4M	2016	Not Adequate	Not Adequate	Not Adequate	Adequate	Adequate	Not Adequate	Not Adequate	Not Adequate	Adequate
Eastern	E6, E-AR2	Uprate 6923 to 167° (May not be structurally possible) + AR Project	N/A	2016	Adequate	Not Adequate	Adequate	Not needed for Planning	Not needed for Planning	Not Adequate	Not Adequate	Adequate	Adequate
Eastern	E7a, E-AR2	Reconductor 6923 w/336 ACSR (May not be structurally possible) + AR Project	N/A	2016	More robust than needed	Adequate	More robust than needed	Not needed for Planning	Not needed for Planning	Not Adequate	Not Adequate	More robust than needed	Adequate
Eastern	E7	Rebuild @ 69/69kV w/T2-4/0	\$20M	2016	More robust than needed	More robust than needed	More robust than needed	Not needed for Planning	Not needed for Planning	Not Adequate	Not Adequate	More robust than needed	More robust than needed
Eastern	E23	Rebuild @ 138/138kV w/T2-477, 150MVA Xfmr @ 9 Mile	\$25M	2016 (2012 for Frontier)	More robust than needed	More robust than needed	More robust than needed	Not needed for Planning	Not needed for Planning	Adequate	Adequate	More robust than needed	More robust than needed
<b>Other Eastern U.P./Frontier Projects</b>													
U.P. Zone	Map Item #	Solutions Description	Estimated Cost	In Service Year	Strategic Flexibility Future (Planning Needs N-1 @ Peak)					Customer Relations / IC Services Needs		Asset Mgmt. Needs	
					Robust Economy	High Retire.	High Environ.	Slow Growth	DOE 20% Wind	Fuel & Invest. Limit.	Ref. Case with Kinross	Ref. Case w/o Kinross	Asset Renewal
Eastern	E2	Uprate the Straits-McGulpin 138 kV lines #1 & #3	\$0.2M	2012	Adequate	Adequate	Adequate	Not needed for Planning	Not needed for Planning	More robust than needed	Adequate	Not needed for Planning	N/A
Eastern	E30	Construct a new 3.1-mile 69 kV radial line from 69 kV line 6923 to Kinross Load	\$3.9M	2012	Adequate	Adequate	Not needed for Planning	Not needed for Planning	Adequate	Not needed for Planning	Adequate	Not needed for Planning	N/A



**Table UP-8B-E: UP Collaborative Preliminary Solutions Groups Performance Matrix**

Eastern U.P. Projects To Address System Operations Needs										
					Eastern U.P. System Operations Needs					(For complete central U.P. solution sets, see Escanaba area)
U.P. Zone	Map Item #	Solutions Description	Estimated Cost	In Service Year	Standing Op Guides (W-E / E-W Splits)	N-1-1 (Maintenance, etc), Straits SS	N-1-1 (Maintenance, etc), Lower MI	High Voltage, Light Load	Post-Split Voltage Excursions	N-1-1 (Maintenance, etc), Central U.P.
Eastern	E-AR1	Minimum 6904/6905 Asset Renewal	\$5M	2016	Not Adequate	Not Adequate	Not Adequate	Not Adequate	Not Adequate	Not Adequate
Eastern	E-AR2	Minimum 6921/6923 Asset Renewal	\$4M	2016	Not Adequate	Not Adequate	Not Adequate	Not Adequate	Not Adequate	Not Adequate
Eastern	E8	New Indian Lake-Hiawatha 138 kV line, energize the non-operative circuit, SS work at ILK/HIA	\$4M	2012	Not Adequate	Improved	Not Adequate	Not Adequate	Not Adequate	Not Adequate
Eastern	E32	Install shunt reactors (10/15 MVAR) on Straits 138/69 xfmr tertiaries	\$0.6M	2012	Not Adequate	Not Adequate	Not Adequate	Adequate	Not Adequate	Not Adequate
Eastern	E4	Rebuild @ 69/69kV w/T2-4/0	\$35M	2014	Improved (E-W only)	Slightly Improved	Slightly Improved	Not Adequate	Improved (E-W only)	Not Adequate
Eastern	E23, E2, E30	Rebuild Straits-Pine River at 138/138 kV, rebuild Pine River-9 Mile at 138/69 kV, 150 MVA 138/69 kV xfmrs at Pine River/9 Mile, uprate the Straits-McGulpin 138 kV lines #1 & #3, new 69 kV radial tap to Frontier	\$76M	2012 for Frontier	Improved (E-W only)	Slightly Improved	Slightly Improved	Not Adequate	Improved (E-W only)	Not Adequate
Eastern	E3_40	2 138 kV 40° PAR (phase-shifters) @ Straits	\$16-20M	2012	Nearly Adequate	Improved	Improved	Improved	Adequate	Improved
Eastern	E31	Install AC-DC-AC 138 kV power flow control at Straits	\$35M	2012	Adequate	Improved	Improved	Adequate	Adequate	Improved
Eastern	E3_40, E8, E32	2 138 kV 40° PAR (phase-shifters) @ Straits, new Indian Lake-Hiawatha 138 line, shunt reactors @ Straits	\$20.6-24.6M	2012	Adequate	Nearly Adequate	Nearly Adequate	Adequate	Adequate	Improved
Eastern	E31, E8	Install AC-DC-AC 138 kV power flow control at Straits, new Indian Lake-Hiawatha 138 line	\$39M	2012	Adequate	Nearly Adequate	Nearly Adequate	Adequate	Adequate	Improved



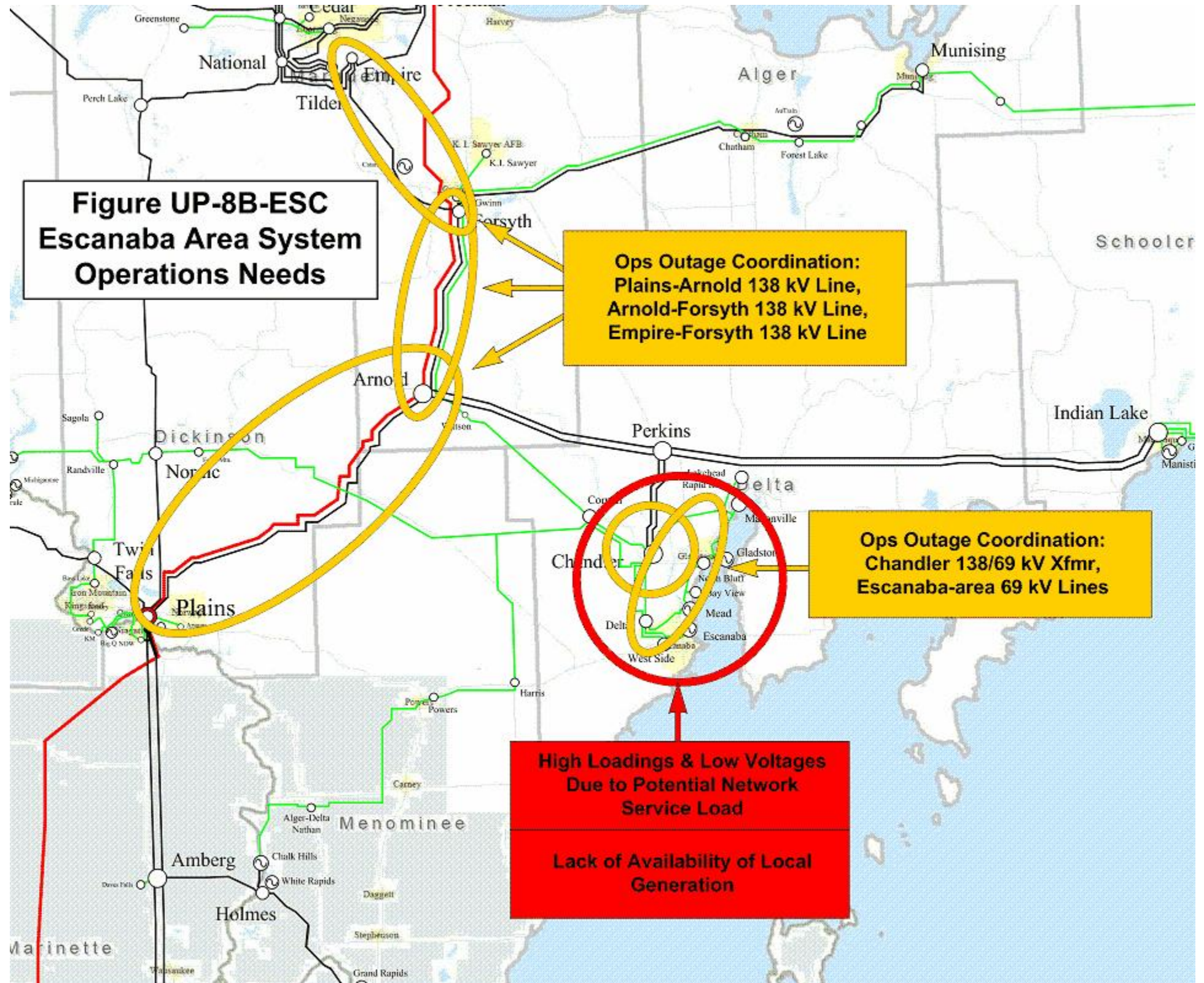
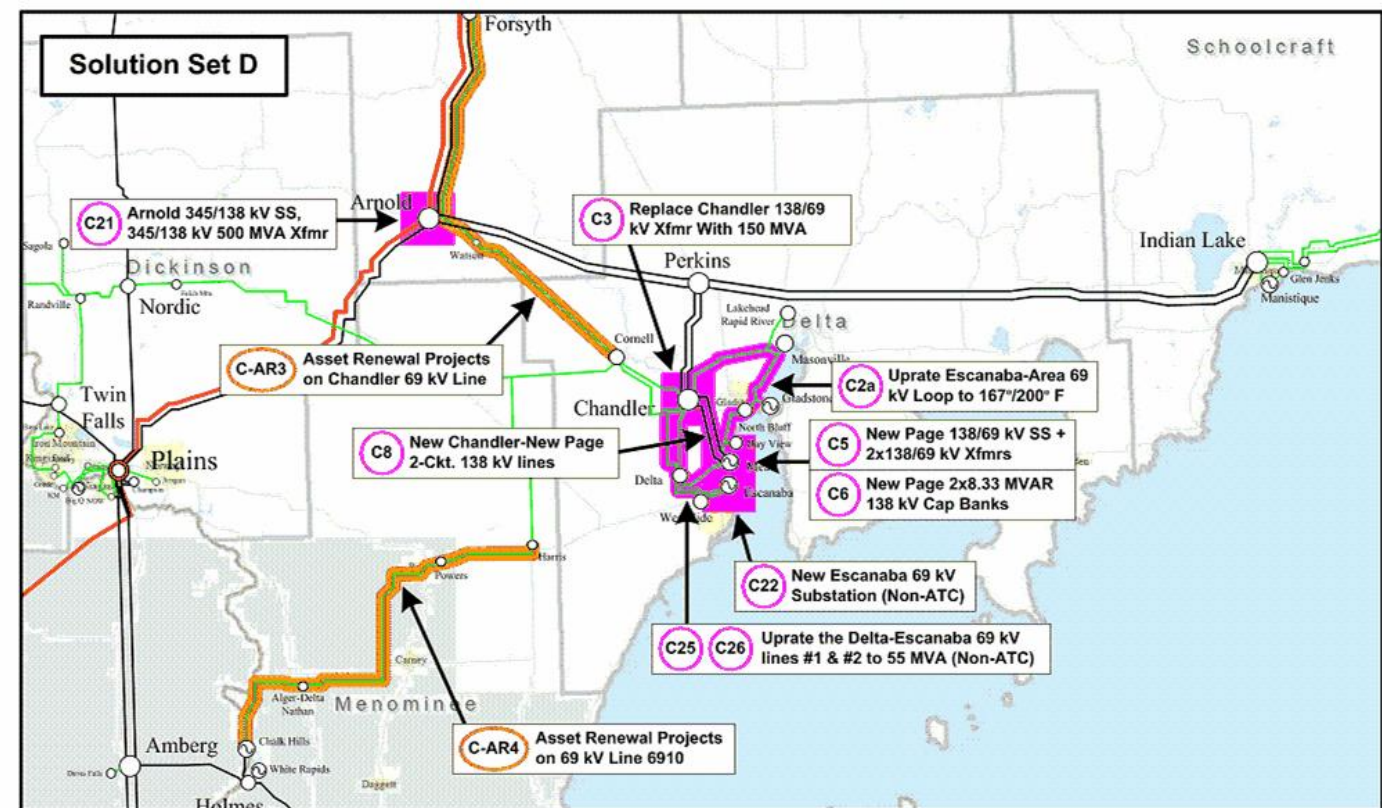
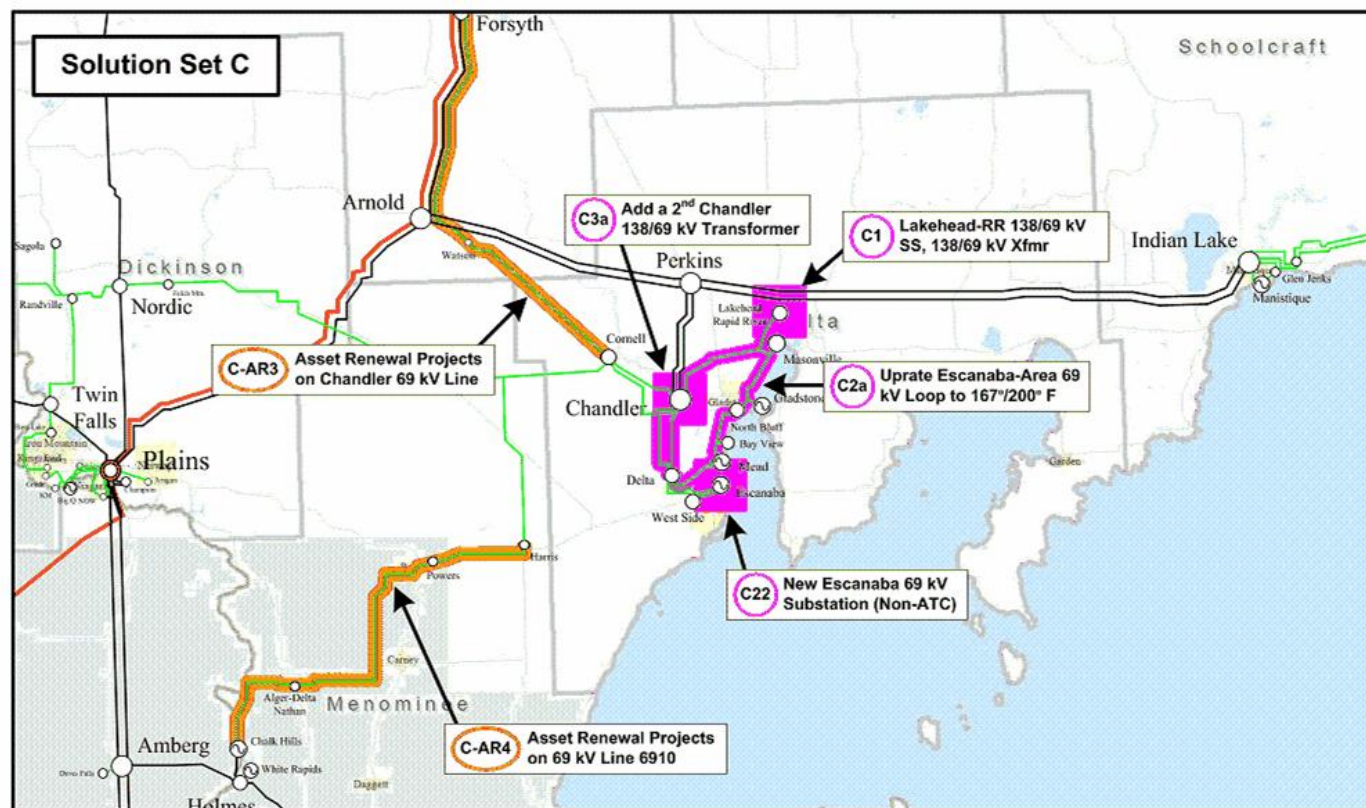
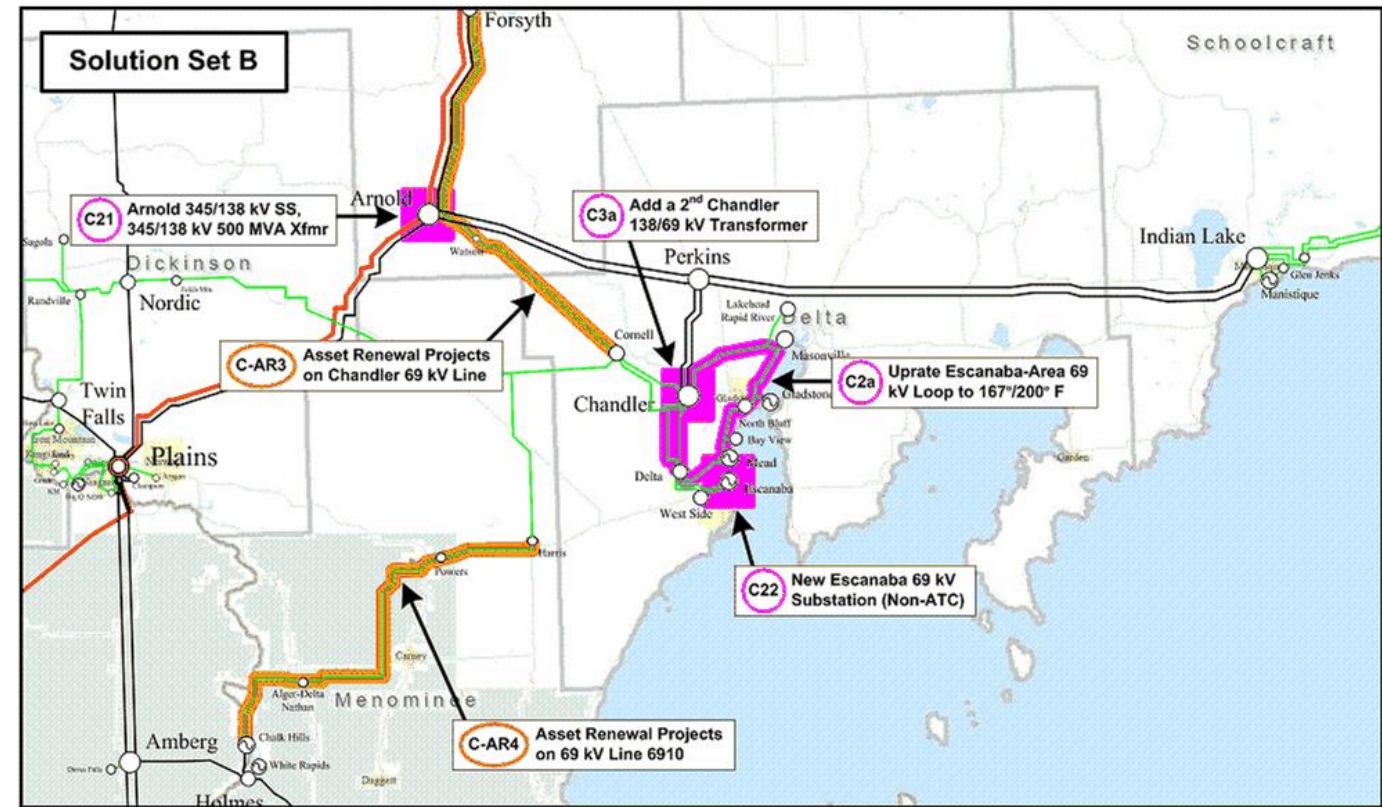
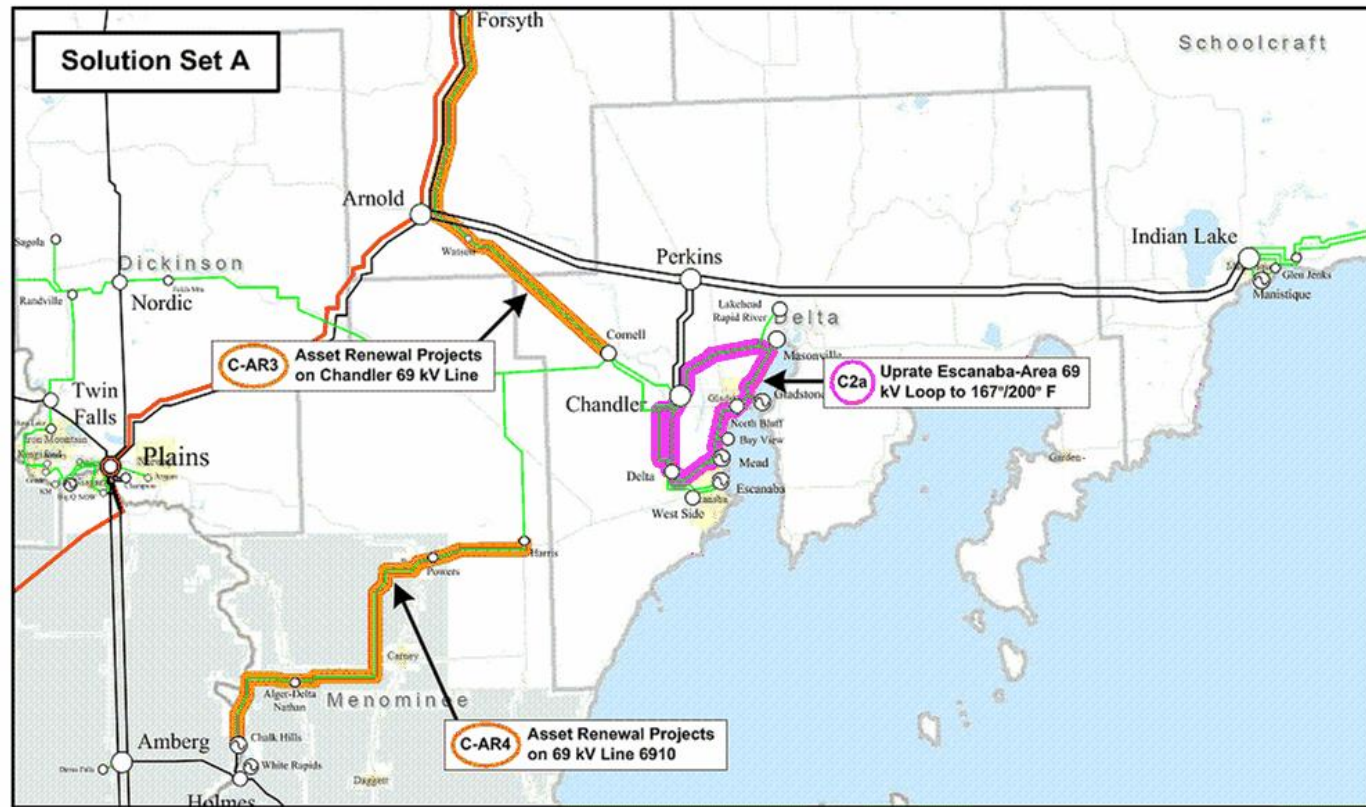


Figure UP-8C-ESC: Escanaba Area Core Transmission Solution Sets Considered



**Table UP-8A-ESC: Escanaba Area Preliminary Solution Sets – Summary**

Solution Set	Map Item #	Solutions Description	In Service Year	Estimated Cost (\$M)	Strategic Flexibility Future (Planning Needs N-1 @ Peak)						Asset Mgmt. Needs
					Robust Economy Future Solutions Group	High Retirements Future Solutions Group	High Environmental Future Solutions Group	Slow Growth Future Solutions Group	DOE 20% Wind Future Solutions Group	Fuel & Investment Limitations Future Solutions Group	Asset Renewal Needs
A	C-AR3 C-AR4 C2a	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F	2009-2018	\$ 2.0	Not Adequate	Not Adequate	Not Adequate	Adequate	Not Adequate	Adequate	Addressed
B	C-AR3 C-AR4 C2a C3a C21 C22	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F Add a 2 <sup>nd</sup> Chandler 138/69 kV transformer New Arnold 345 kV SS + 345/138 kV 500 MVA transformer New Escanaba 69 kV substation (non-ATC)	2009-2018	\$ 20.0	Adequate	Not Adequate	Not Adequate	More Robust Than Needed	Not Adequate	More Robust Than Needed	Addressed
C	C-AR3 C-AR4 C2a C3a C1 C22	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F Add a 2 <sup>nd</sup> Chandler 138/69 kV transformer New Lakehead-RR 138/69 kV SS + 138/69 kV transformer New Escanaba 69 kV substation (non-ATC)	2009-2018	\$ 18.0	More Robust Than Needed	Not Adequate	Adequate	More Robust Than Needed	Not Adequate	More Robust Than Needed	Addressed
D	C-AR3 C-AR4 C5 C6 C8 C2a C3 C21 C22 C25,C26	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 New Page 138/69 kV SS + 2 138/69 kV 150 MVA Xfmrs New Page 2x8.16 MVA 138 kV capacitor banks Chandler-New Page double-ckt. 138 kV lines (6 mi.) Uprate Escanaba Loop 69 kV lines to 167°/200° F Uprate the Chandler 138/69 kV transformer to 150 MVA New Arnold 345 kV SS + 345/138 kV 500 MVA transformer New Escanaba 69 kV substation (non-ATC) Uprate Delta-Escanaba 69 kV lines #1/#2 to 55 MVA (non-ATC)	2009-2018	\$ 39.0	More Robust Than Needed	Adequate	More Robust Than Needed	More Robust Than Needed	Adequate	More Robust Than Needed	Addressed

Note: Lower cost projects in the Escanaba area (C2a, C-AR3) are scheduled for completion in 2009 and 2010, the remainder of the listed projects in later years.

Four possible solution sets to serve all futures' needs:

Solution Set A – can serve “today’s system” or Slow Growth/Fuel & Investment Limitations futures, with 30 MW non-firm to New Page

Solution Set B – solution for Robust Economy future, Escanaba stokers and all New Page generation on-line, but very high load growth and point load additions

Solution Set C – solution for High Environmental future, Escanaba stokers on-line but 38 MW New Page import at peak

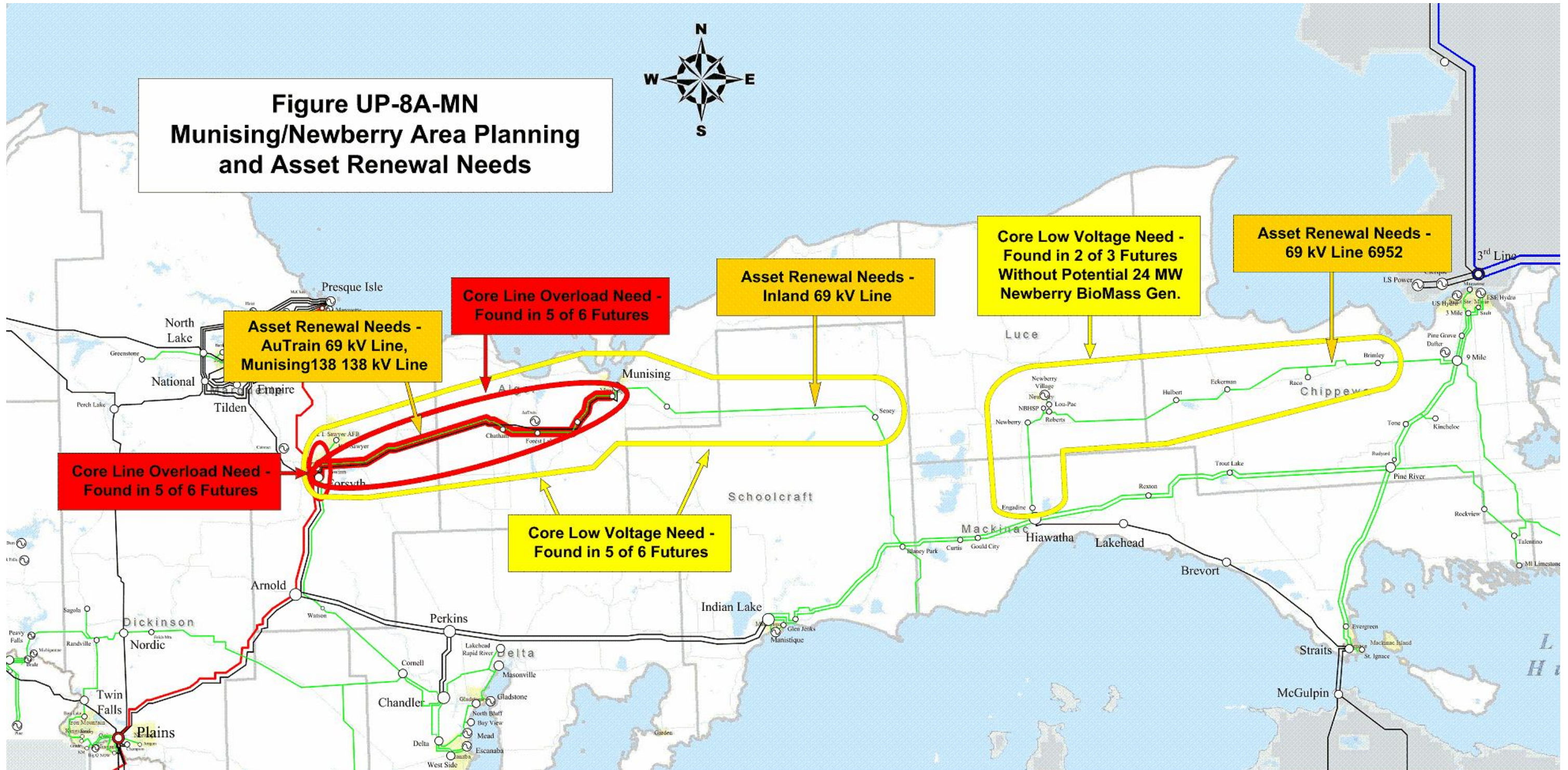
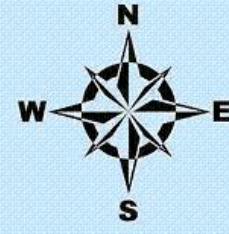
Solution Set D – solution for High Retirements and DOE 20% Wind futures, Escanaba stokers off-line/retired, and 55 MW of New Page import at peak

**Table UP-8B-ESC: Escanaba Area Preliminary Solution Sets – Address System Operations Needs**

					Escanaba Area System Operations Needs				
Solution Set	Map Item #	Solutions Description	In Service Year	Estimated Cost (\$M)	High Loadings/Low Voltages – Potential Network Service Load	Availability of Local Generation	N-1-1 (Maintenance, etc.) Plains-Arnold-Forsyth-Empire 138	N-1-1 (Maintenance, etc.) Chandler 138/69 kV Xfmr	N-1-1 (Maintenance, etc.) Escanaba-Area 69 Lines
East Ops	E3_40 E8 E32	2 138 kV 40° PAR (phase-shifters) at Straits New Indian Lake-Hiawatha 138 kV line Shunt reactors at Straits	2012	\$ 20.6- \$ 24.6	Slightly Improved	Not Adequate	Improved	Not Adequate	Not Adequate
A	C-AR3 C-AR4 C2a	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F	2009-2018	\$ 2.0	Slightly Improved	Slightly Improved	Not Adequate	Not Adequate	Improved
B	C-AR3 C-AR4 C2a C3a C21 C22	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F Add a 2 <sup>nd</sup> Chandler 138/69 kV transformer New Arnold 345 kV SS + 345/138 kV 500 MVA transformer New Escanaba 69 kV substation (non-ATC)	2009-2018	\$ 20.0	Improved	Improved	Adequate	Adequate	Improved
C	C-AR3 C-AR4 C2a C3a C1 C22	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 Uprate Escanaba Loop 69 kV lines to 167°/200° F Add a 2 <sup>nd</sup> Chandler 138/69 kV transformer New Lakehead-RR 138/69 kV SS + 138/69 kV transformer New Escanaba 69 kV substation (non-ATC)	2009-2018	\$ 18.0	Improved	Improved	Not Adequate	Nearly Adequate	Nearly Adequate
D	C-AR3 C-AR4 C5 C6 C8 C2a C3 C21 C22 C25,C26	Minimum Asset Renewal projects on Chandler 69 kV line Minimum Asset Renewal projects on 69 kV line 6910 New Page 138/69 kV SS + 2 138/69 kV 150 MVA Xfmrs New Page 2x8.16 MVA 138 kV capacitor banks Chandler-New Page double-ckt. 138 kV lines (6 mi.) Uprate Escanaba Loop 69 kV lines to 167°/200° F Uprate the Chandler 138/69 kV transformer to 150 MVA New Arnold 345 kV SS + 345/138 kV 500 MVA transformer New Escanaba 69 kV substation (non-ATC) Uprate Delta-Escanaba 69 kV lines #1/#2 to 55 MVA (non-ATC)	2009-2018	\$ 39.0	Adequate	Adequate	Adequate	Adequate	Adequate

Note: Lower cost projects in the Escanaba area (C2a, C-AR3) are scheduled for completion in 2009 and 2010, the remainder of the listed projects in later years.

**Figure UP-8A-MN  
Munising/Newberry Area Planning  
and Asset Renewal Needs**



**Figure UP-8B-MN  
Munising/Newberry Area  
System Operations Needs**

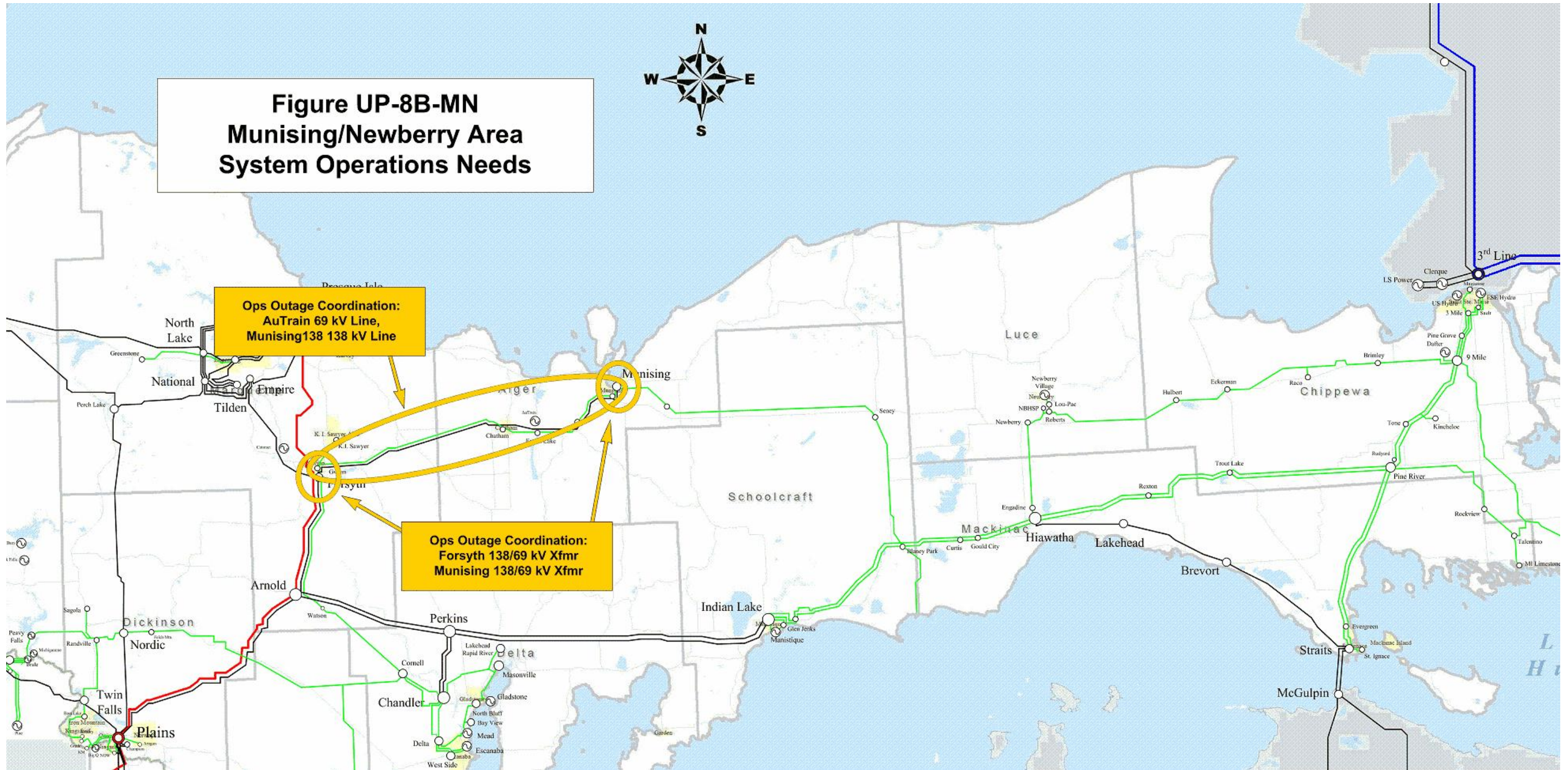
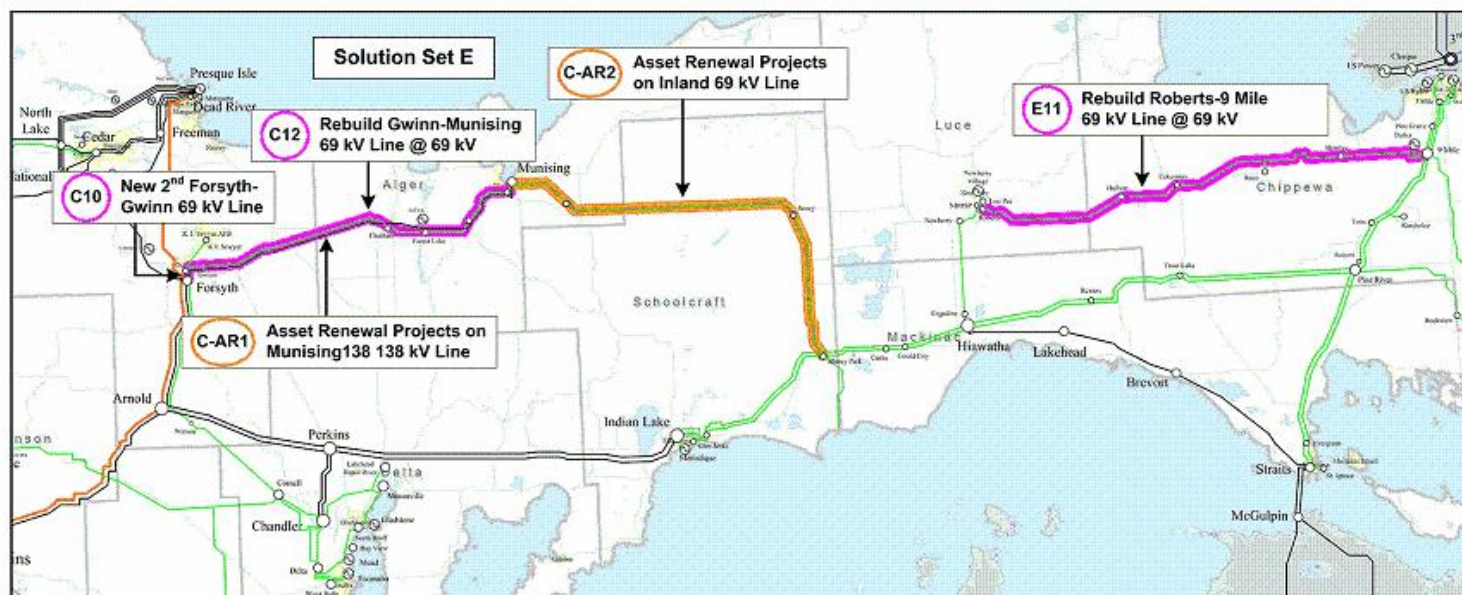
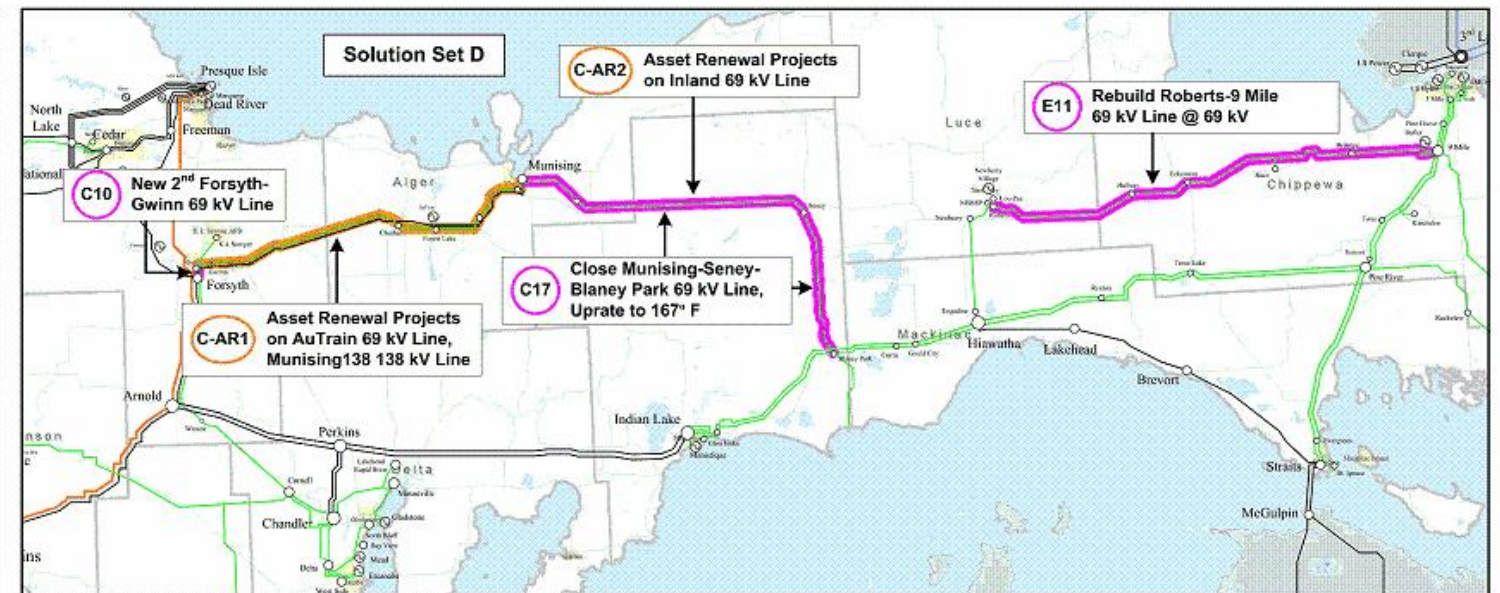
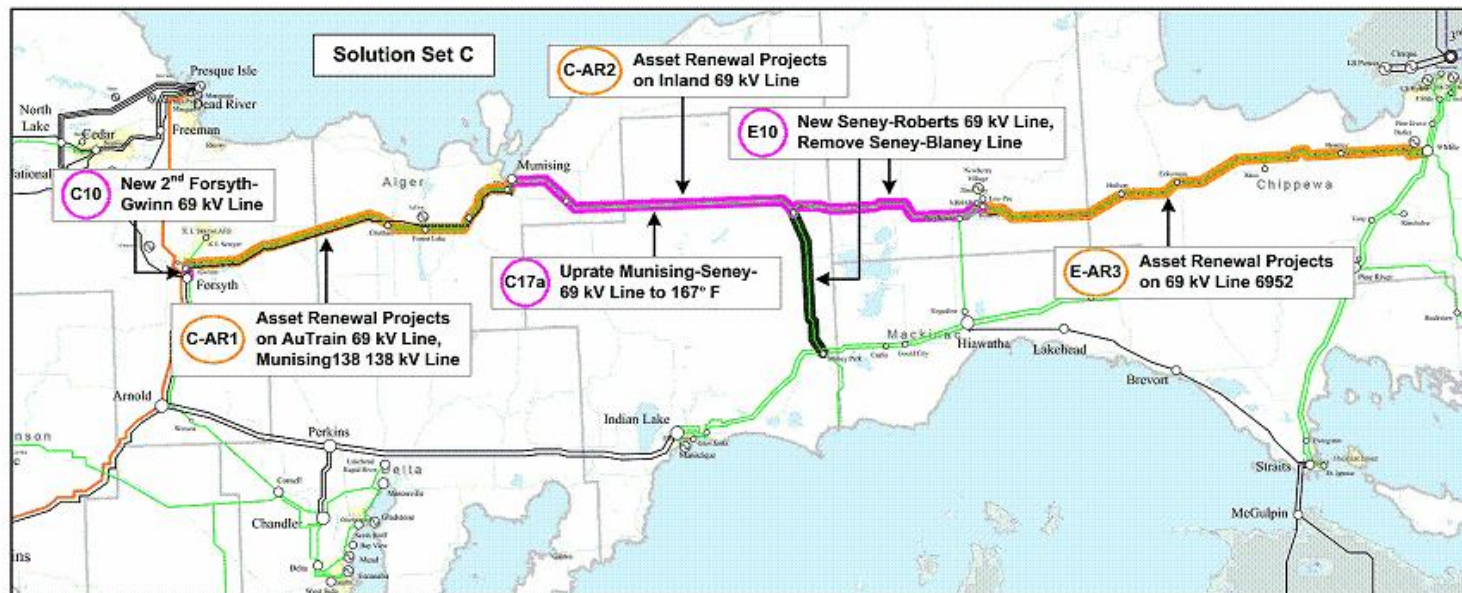
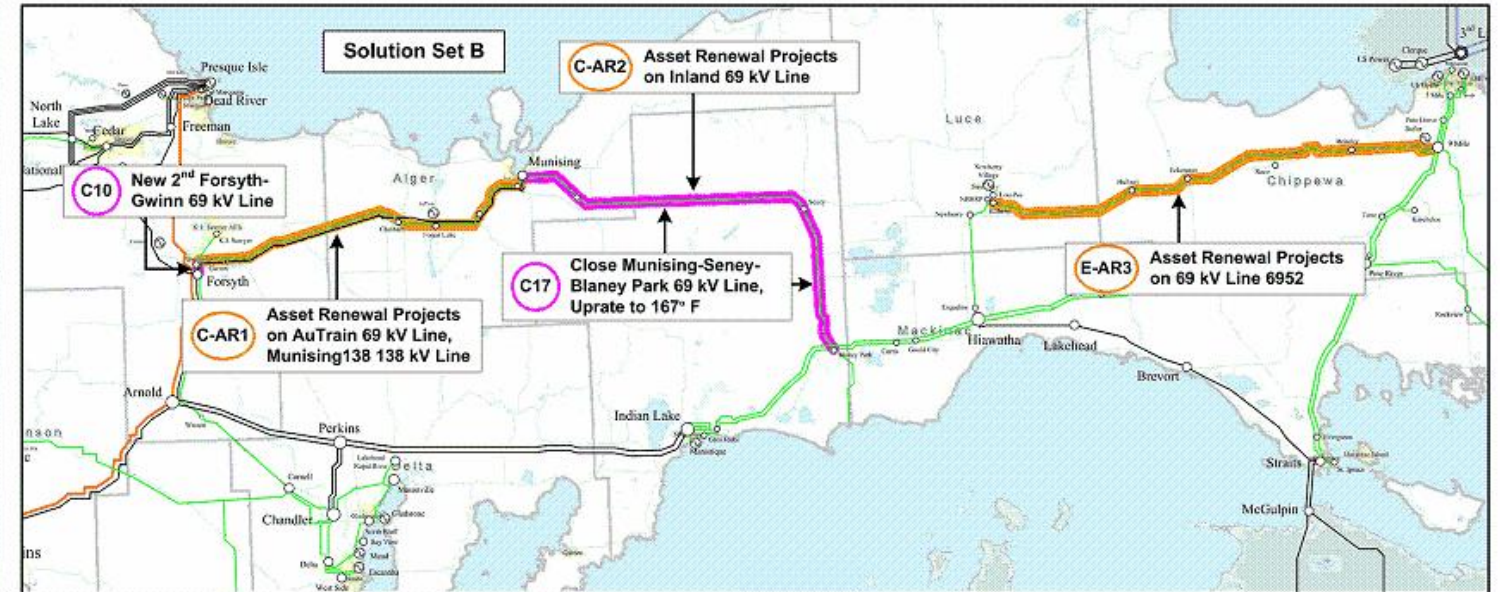




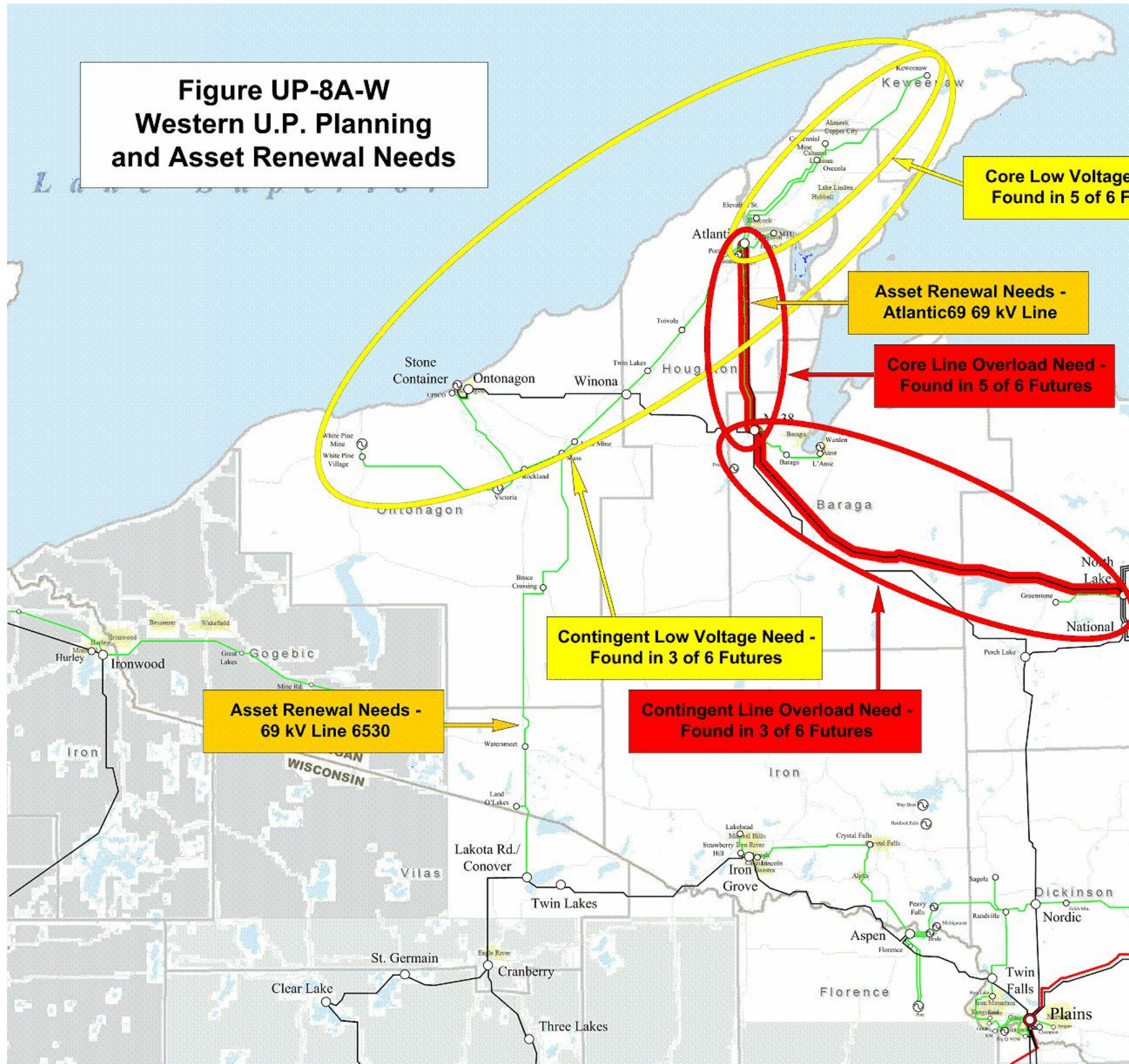
Figure UP-8C-MN: Munising/Newberry Area Core Transmission Solution Sets Considered



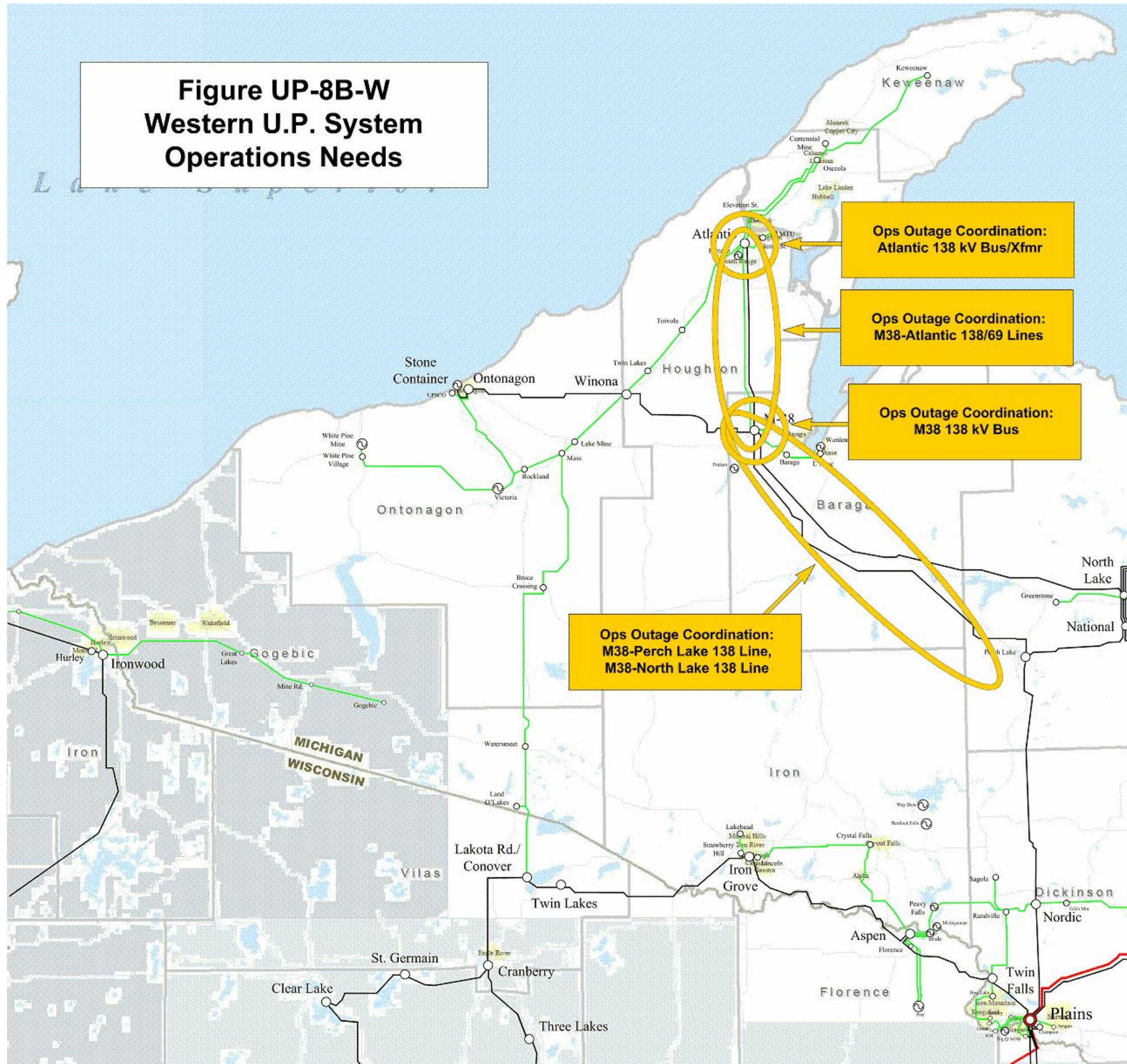
**Table UP-8A-MN: Munising/Newberry Area Preliminary Solution Sets – Summary**

					Strategic Flexibility Future (Planning Needs N-1 @ Peak)						Asset Mgmt. Needs
Solution Set	Map Item #	Solutions Description	In Service Year	Estimated Cost (\$M)	Robust Economy Future Solutions Group	High Retirements Future Solutions Group	High Environmental Future Solutions Group	Slow Growth Future Solutions Group	DOE 20% Wind Future Solutions Group	Fuel & Investment Limitations Future Solutions Group	Asset Renewal Needs
A	C-AR1 C-AR2 E-AR3	Minimum Asset Renewal projects	2012-15	\$51M	Not Adequate	Not Adequate	Not Adequate	Adequate	Not Adequate	Not Adequate	Addressed
B	C10 C17 C-AR1 C-AR2 E-AR3	New Forsyth-Gwinn 69 kV line (0.8 mi) Close Inland line (Munising-Seney-Blaney Park) & uprate to 167° F Minimum Asset Renewal projects	2012-15	\$68M	Adequate	Adequate	Not Adequate East	No Planning Need	Not Adequate Central	Not Adequate East	Addressed
C	C10 E10 C17a C-AR1 C-AR2 E-AR3	New Forsyth-Gwinn 69 kV line (0.8 mi) New Seney-Roberts 69kV line (24 mi), remove Seney-Blaney line Uprate Inland line (Munising-Seney 69 kV) to 167° F Minimum Asset Renewal projects	2012-15	\$82M	Adequate	Adequate	Adequate	No Planning Need	Adequate	Adequate	Addressed
D	C10 C17 E11 C-AR1 C-AR2	New Forsyth-Gwinn 69 kV line (0.8 mi) Close Inland line (Munising-Seney-Blaney Park) & uprate to 167° F Rebuild line 6952 (Roberts-9 Mile 69 kV) at 69 kV (54 mi) Minimum Asset Renewal projects	2013-15	\$118M	Adequate	Adequate	Adequate	No Planning Need	Not Adequate Central	Adequate	Addressed
E	C10 C12 E11 C-AR1 C-AR2	New Forsyth-Gwinn 69 kV line (0.8 mi) Rebuild AuTrain line (Gwinn-Munising 69 kV) @ 69 kV (45 mi) Rebuild line 6952 (Roberts-9 Mile 69 kV) at 69 kV (54 mi) Minimum Asset Renewal projects	2013-16	\$119M	Adequate	Not Adequate Central (AuTrain 138 kV Adequate, C13 vs. C12)	Adequate	No Planning Need	Not Adequate Central (AuTrain 138 kV Adequate, C13 vs. C12)	Adequate	Addressed

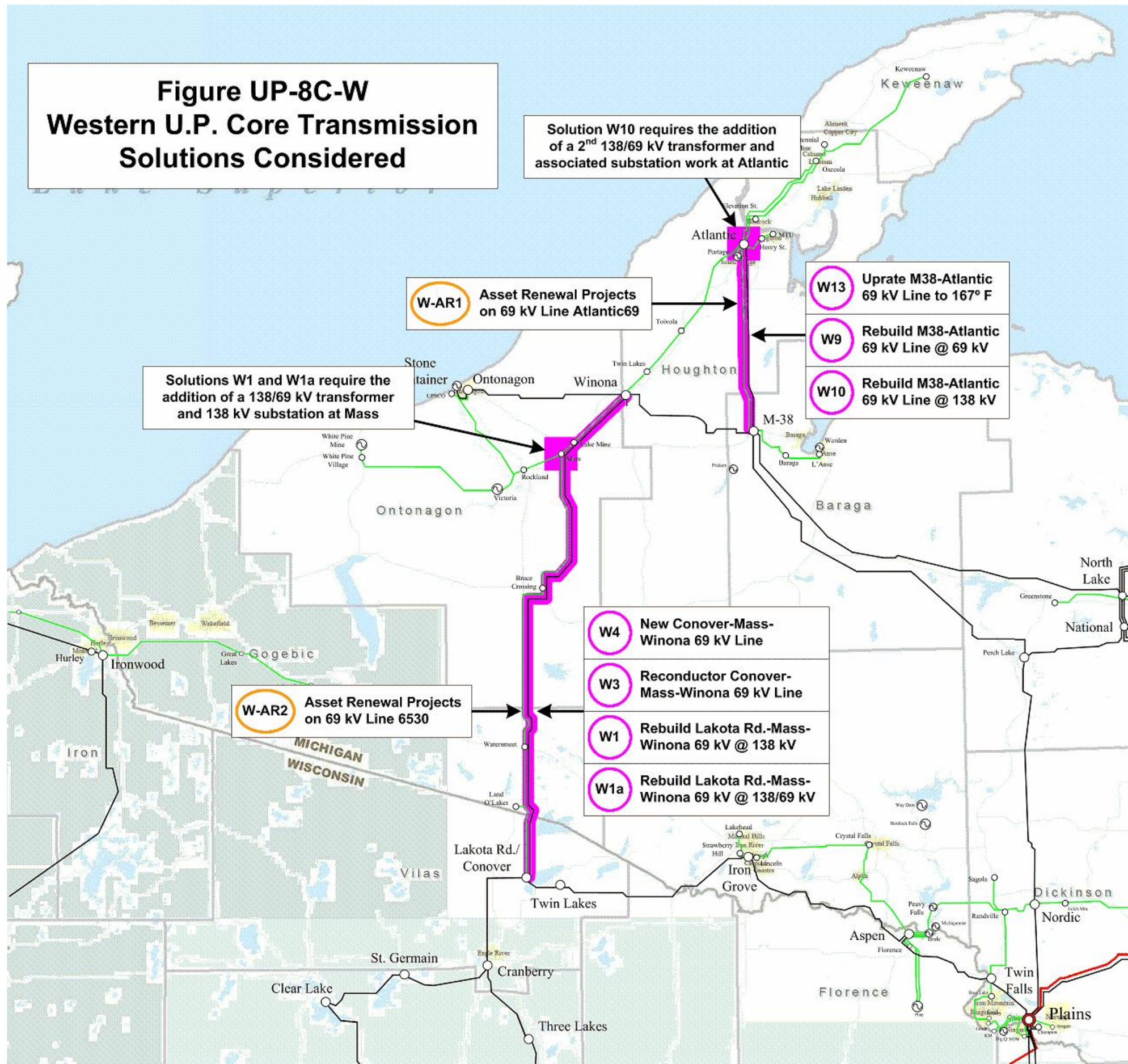
**Figure UP-8A-W  
Western U.P. Planning  
and Asset Renewal Needs**



**Figure UP-8B-W  
Western U.P. System  
Operations Needs**



**Figure UP-8C-W  
Western U.P. Core Transmission  
Solutions Considered**



**Table UP-8A-W: Western U.P. Area Preliminary Solution Sets – Summary**

**Atlantic69 Line (M38-Atlantic 69 kV) – U.P. Preliminary Solutions Groups**

U.P. Zone	Map Item #	Solutions Description	(\$M) Estimated Cost	In Service Year	Strategic Flexibility Future (Planning Needs N-1 @ Peak)						Asset Mgmt. Needs
					Robust Economy Future Solutions Group	High Retirements Future Solutions Group	High Environmental Future Solutions Group	Slow Growth Future Solutions Group	DOE 20% Wind Future Solutions Group	Fuel & Investment Limitations Future Solutions Group	Asset Renewal needs for Atlantic69
Western	W-AR1	Minimum Asset Renewal projects on Atlantic69 line (remove spar arms, install crossarms, replace insulators, clearance issues)	\$5-10M	2012-14	Not adequate	Not adequate	Not adequate	Adequate	Not adequate	Not adequate	Adequate
Western	W13, W-AR1	Uprate M38-Atlantic 69 kV line to 167 ° F (May not be structurally possible) + Minimum Asset Renewal projects	\$10-15M	2013, 2012-14	Not adequate	Not adequate	Adequate	Not needed for Planning	Not adequate	Adequate	Adequate
Western	W9	Rebuild M38-Atlantic 69 kV line at 69 kV (22 mi)	\$22M	2013	Not adequate	Adequate	More robust than needed	Not needed for Planning	Adequate	More robust than needed	More robust than needed
Western	W10	Rebuild M38-Atlantic 69 kV line at 138 kV (22 mi), add 2 <sup>nd</sup> Atlantic 138/69 kV transformer	\$30M	2013	Adequate	More robust than needed	More robust than needed	Not needed for Planning	More robust than needed	More robust than needed	More robust than needed

**6530 Line (Conover-Mass 69 kV) – U.P. Preliminary Solutions Groups**

U.P. Zone	Map Item #	Solutions Description	(\$M) Estimated Cost	In Service Year	Strategic Flexibility Future (Planning Needs N-1 @ Peak)						Asset Mgmt. Needs
					Robust Economy Future Solutions Group	High Retirements Future Solutions Group	High Environmental Future Solutions Group	Slow Growth Future Solutions Group	DOE 20% Wind Future Solutions Group	Fuel & Investment Limitations Future Solutions Group	Asset Renewal needs for 6530
Western	W-AR2	Minimum Asset Renewal projects on line 6530 (replace selected poles/bayonets/crossarms/insulators) \$200k/mi	\$10-15M	2015+	Not adequate	Not adequate	Adequate	Adequate	Not adequate	Adequate	Adequate
Western	W4, W-AR2	Reconductor Conover-Mass-Winona 69 kV line with 336 ACSR + Minimum Asset Renewal projects	\$TBD	TBD, 2015+	Not adequate	Not adequate	Not needed for Planning	Not needed for Planning	Not adequate	Not needed for Planning	Adequate
Western	W4, W-AR2	New Conover-Mass-Winona 69 kV line (68 mi) + Minimum Asset Renewal projects	\$60-65M	TBD, 2015+	Not adequate	Not adequate	Not needed for Planning	Not needed for Planning	Not adequate	Not needed for Planning	Adequate
Western	W1	Rebuild Lakota Rd.-Mass-Winona 69 kV line @ 138 kV (68 mi), add Mass 138 kV SS + 138/69 kV transformer	\$70M	TBD	Adequate	Adequate	Not needed for Planning	Not needed for Planning	Adequate	Not needed for Planning	More robust than needed
Western	W1a	Rebuild Lakota Rd.-Mass-Winona 69 kV line @ 138/69 kV (68 mi), add Mass 138 kV SS + 138/69 kV transformer	\$100M	TBD	More robust than needed	More robust than needed	Not needed for Planning	Not needed for Planning	More robust than needed	Not needed for Planning	More robust than needed