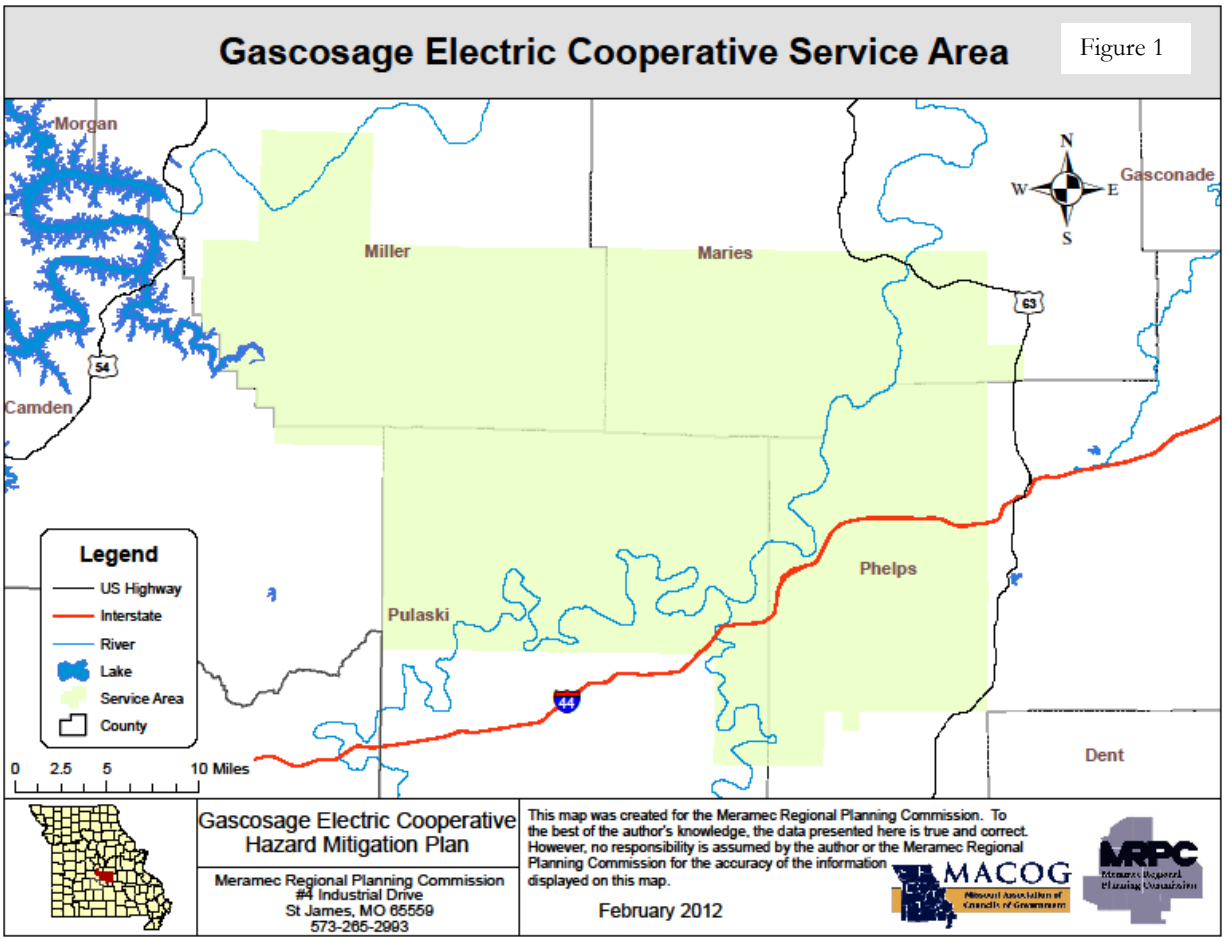
Section 1: Introduction

Gascosage Electric Cooperative (Gascosage) was established in 1938 to provide electric service to the rural areas of south central Missouri. A Touchstone Energy Cooperative, Gascosage is headquartered in Dixon, Missouri, and provides service to customers in portions of Camden, Maries, Miller, Phelps, and Pulaski counties in Missouri. The cooperative is run by a board of nine directors which approve the company's mission and internally developed business policy:

> *"Gascosage Electric Cooperative provides our diverse membership an unsurpassed level of comprehensive service using the latest proven technological advances in the electrical industry to deliver reliable and affordable electricity in the traditional style of personalized service."*

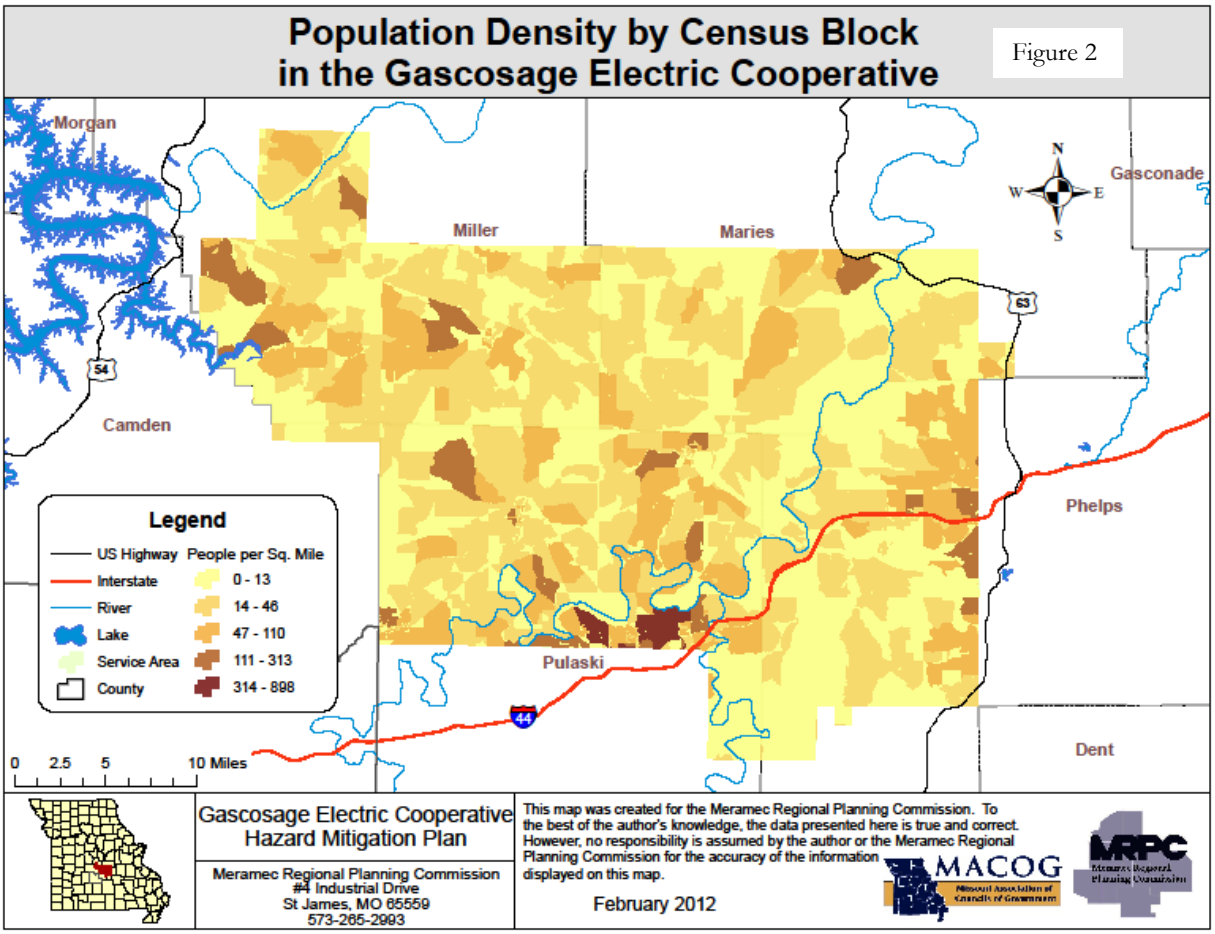
Gascosage's service boundaries within the state of Missouri include portions of Camden, Maries, Miller, Phelps and Pulaski counties. The cooperative owns 1,551 miles of service line within these counties. Figure 1 depicts the service area boundaries of the cooperative.



The customer base of Gascosage is 9,749 members. Residential customers account for 91 percent of memberships (8,861 meters) while non-residential customers make up the remaining 9 percent (863 meters). Table 1.1 provides the summary of metered customers by Missouri county.

Table 1.1	Meters by Missouri County
County	**Number of meters**
Camden	19
Maries	1,049
Miller	2,893
Phelps	1,382
Pulaski	4,406

The average daily customer usage for Gascosage is 54 kilowatt-hours (kWh). Annual total usage of Gascosage customers in 2010 was 191,629,241 kWh of service. Population density for the cooperative service area is depicted in Figure 2 (*Map source: U.S. Census 2010*).



Section 2: Planning process:

Through a partnership between the Association of Missouri Electric Cooperatives and the Missouri Association of Councils of Government, the Meramec Regional Planning Commission was contracted to facilitate a hazard mitigation planning process for Gascosage. The initial meeting between the two entities was held on January 18, 2011 as part of a regional kick-off meeting for southwest Missouri. This informational meeting provided the basic responsibilities for each agency and allowed for initial discussion concerning the project timelines, data collection and other pertinent topics.

One additional planning meeting was held at the Gascosage offices in Dixon, Missouri in September. Table 1.2 summarizes the attendees and topics of each meeting. Meeting minutes are available in the chapter appendix.

Table 1.2	GASCOSAGE Planning Meeting Synopsis	
Meeting Date	**Attendees, Title, Organization**	**Topics of discussion**
January 18, 2011	Carmen Hartwell, Gascosage Tamara Snodgrass, Environmental Programs Mgr., MRPC Lesley Bennish, Regional Planner, MRPC	Overview of project Basic responsibilities Project timelines Data collection
September 7, 2011	Carmen Hartwell, Gascosage Karl Brandt, Operations, Gascosage John Greenlee, General Manager, Gascosage Tamara Snodgrass, Environmental Programs Mgr., MRPC	Review of template Critical facilities information Asset inventory by type and location Data collection assignments Current mitigation strategies Establishment of goals, actions and objectives

Public Involvement

As with all public hazard mitigation plans, public involvement was encouraged through a variety of methods. Gascosage posted their local chapter on the company's website, inviting both cooperative members and the general public to provide comment. Print copies of the chapter were also made available upon request through the local office. Comments from neighboring jurisdictions were also solicited using the standardized AMEC letter which was mailed to the appropriate contacts, including:

- Camden County Commission,
- Maries County Commission,
- Miller County Commission,
- Phelps County Commission,
- Pulaski County Commission,
- Local emergency management directors, and
- Local Red Cross chapter.

In regards to critical facilities, Gascosage provides service to two nursing homes, one ambulance district in Dixon and fire stations in Dixon, Crocker, Swedeborg and Iberia. Gascosage does not provide service to any higher education institutions, or large industrial centers. Additionally, Gascosage's mitigation plan was included in the public comment period for the combined AMEC plan.

Section 3: Asset inventory

Gascosage Electric Cooperative has a wide variety of assets by type. Real estate owned by the company includes office buildings, garages, and other outbuildings located in Dixon. Twenty-four vehicles provide access to customers and infrastructure. Gascosage does not own any electric generation or transmission infrastructure. 1,555 miles of distribution lines are owned and maintained by Gascosage. Table 1.3 provides information concerning total asset valuation.

Table 1.3	**Gascosage Asset Inventory Valuation Summary**	
Asset	**Total Replacement Cost**	**Cost breakdown**
Total Gascosage Assets	$37,070,437	Buildings and contents – $1,633,524 Vehicles and trailers - $1,030,880 Power Operated Equipment - $1,501,192 Communications Equipment - $540,241 Overhead assets - $32,211,000 Underground assets - $153,600
Distribution Lines	$32,211,000 OH $153,600 UG	OH Single-phase lines - $21,664,000 UG Single-phase lines - $145,500 OH Three-phase lines - $10,547,000 UG Three-phase lines - $8,100
Supporting Infrastructure	$72,043,855 OH	Meters - $2,437,250 Poles - $42,102,000 Transformers - $13,273,600 Guys - $2,094,125 Anchors - $9,880,780 Cross-arms - $847,600 Reclosures - $1,026,000 Regulators - $184,500 Capacitors - $198,000
Office Buildings and contents	$1,633,524	
Vehicles	$1,030,880	
Source: Internal Gascosage Accounting and Insurance records, 2011		

Ensuring quality distribution to its customers, Gascosage maintains not only distribution lines, but also the supporting infrastructure as well. Table 1.4 includes a list of asset types, emergency replacement cost per unit or mile, the asset inventory by service county, and total infrastructure numbers.

Table 1.4	Gascosage Asset Inventory by service county						
Asset	**Emergency Replacement Cost per unit or mile**	**Number of units or miles: Camden**	**Number of units or miles: Maries**	**Number of units or miles: Miller**	**Number of units or miles: Phelps**	**Number of units or miles: Pulaski**	**Total number of units or miles:**
Meter	$250/unit	19	1,049	2,893	1,382	4,406	9,749
Pole	$1,500/unit	57	4,576	9,504	4,127	9,804	28,068
SP*** distribution line	$16,000/mile OH $75,000/mile UG ($14.20/foot UG)	10 OH** 0 UG	267 OH 0.5 UG***	461 OH 0.29 UG	186 OH 0.85 UG	430 OH 0.3 UG	1,354 OH 1.94 UG
TP**** distribution line	$53,000/mile OH $135,000/mile UG ($25.57/foot)	0 OH 0 UG	26 OH 0 UG	55 OH 0.06 UG	32 OH 0 UG	86 OH 0 UG	199 OH 0.06 UG
Transformers	$1,600/each OH	54 OH	1,565 OH	2,756 OH	1,165 OH	2,756 OH	8,296 OH
Guys/ anchors	$125/unit $610/unit	27 25	2,688 2,618	5,266 5,118	2,480 2,391	6,292 6,046	16,753 16,198
Cross-arms	$200/ each	0	466	1,036	605	2,131	4,238
Regulators	$4,500	0	13	13	4	11	41
Reclosers	$3,000/each	0	55	98	65	124	342
Capacitors	$2,750/unit	0	12	27	13	20	72
Total Replacement Value by county		$355,275 OH $0 UG	$17,562,930 OH $37,500 UG	$34,094,030 OH $29,850 UG	$15,210,260 OH $63,750 UG	$37,032,360 OH $22,500 UG	$104,254,855 OH $153,600 UG

**OH = overhead ***UG = underground ***SP = Single phase ****TP – Three phase

Source: Internal Gascosage Accounting and Maintenance records

Section 4: Identified Hazards and Risk Assessment Methodology

Natural hazards in south central Missouri vary dramatically with regard to intensity, frequency, and the scope of impact. Some hazards, like earthquakes, happen without warning and do not provide any opportunity to prepare for the threat. Other hazards, such as tornadoes, flooding, or severe winter storms, provide a period of warning which allows for public preparation prior to their occurrence. Regardless, hazard mitigation planning can lessen the negative impact of any natural disaster regardless of onset time. The following natural hazards have been identified as potential threats for the service region of the Gascosage Electric Cooperative:

- Tornadoes
- Severe Thunderstorms, Hail, and High Winds
- Flood
- Dam Failure
- Severe Winter Weather
- Earthquakes
- Severe land subsidence
- Wildfire

Likewise, a number of hazards may be eliminated from consideration in their local plan due to the state's geographic location including tsunamis, hurricanes, coastal storms, volcanic activity, avalanche, and tropical storms. Additionally, a number of hazards may be eliminated specifically for Gascosage because of asset types and geographic location in the state of Missouri. Those hazards eliminated for the Gascosage service region include:

- Drought
- Heat Wave
- Landslides
- Levee Failure

The planning group determined that none of their assets were vulnerable to dam failure, so that hazard was removed. Although drought can potentially impact south central Missouri, water availability does not directly impact the delivery of electric service to Gascosage customers. Similarly, heat wave has been eliminated. Though it may result in additional usage and potentially tax the system, heat waves do not usually cause infrastructure damage to cooperative assets. The results of a heat wave in the Gascosage service area may be considered cascading events rather than damage caused directly by the hazard itself. Landslides have also been eliminated based upon local soil structure categorization by the USGS. As there are no levees in the Gascosage service area, levee failure has also been eliminated.

For the purpose of this risk assessment, the identified hazards for the Gascosage service area have been divided into two categories: **historical and non-historical hazards**.

Historical Hazards are those hazards with a measurable previous impact upon the service area. Damage costs per event and a chronology of occurrences are available. The associated vulnerability assessments utilize the number of events and cost of each event to establish an average cost per incident. For Gascosage, hazards with historical data include tornadoes, severe thunderstorms/high wind/hail, flood, severe winter weather, and wildfire.

Non-historical Hazards are hazards with no previous record of impact upon the local service area. As such, the associated vulnerability assessments for each of these hazards will have an occurrence probability of less than 1% in any given year, but the extent of damage will vary considerably. For Gascosage, hazards without historical data include earthquakes and land subsidence.

Probability of Occurrence

In determining the potential frequency of occurrences, a simple formula was used. For historical events, the number of recorded events for the service area was divided by the number of years of record. This number was then multiplied by 100 to provide a percentage. This formula was used to determine future probability for each hazard. For events that have not occurred, a probability of less than 1% was automatically assigned as the hazard cannot be excluded from the possibility of occurrence. Likewise, when discussing the probable risk of each hazard based upon historical occurrences, the following scale was utilized:

- Less than 1% chance of an event occurrence in any given year.
- 1-10% chance of an event occurrence in any given year
- 10-99% chance of an event occurrence in any given year
- Near 100% chance of an event occurrence in any given year

The number of occurrences was further refined to focus on damage-causing events. Those occasions which had reported damages were divided by the total number of recorded events to obtain a percentage of total storms which result in infrastructure damage. (Formula: Number of damage-causing events / total number of events = Percentage of occurrences which cause damage.)

Potential Extent of Damage

Vulnerability Assessment matrices for each hazard are included on the following pages. These worksheets detail loss estimates for each hazard affecting the cooperative's service area. Loss estimates were calculated using the asset summary created by internal Gascosage accounting records. Each hazard has a unique impact upon the service area, requiring each hazard to utilize a different valuation amount depending upon the level of impact. Non-historical hazards assume damage to all general assets. For Historical Hazards, assets were divided into two groups based upon historical impact which were utilized in the hazard damage analysis:

- Overhead infrastructure assets and buildings
  - Used for Tornado damage assessments
  - Valued at $105,888,379
- Overhead infrastructure assets only
  - Used for:
    - Severe Thunderstorm / High Wind / Hail
    - Flood
    - Severe Winter Weather
  - Valued at $104,254,855

In addition, historical hazards with recorded damages were used to identify an average cost per event. (Formula: Total cost of damages / total number of events = Average damage cost per event.) When discussing the extent of potential damages for all hazards, the following scale was utilized:

- Less than 10% potential damages to total cooperative infrastructure
- 10-25% potential damages to total cooperative infrastructure
- 25-50% potential damages to total cooperative infrastructure
- More than 50% potential damages to total cooperative infrastructure

Regardless of hazard categorization, the following matrix (Table 1.5) will be utilized to identify the potential damage extent and likelihood of occurrence for each natural hazard type.

Table 1.5 **Sample Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix Hazard: _____**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

In many instances, natural hazard events occur without causing significant damage to the cooperative's infrastructure. The more significant impact of natural hazard episodes comes in the form of reported customer outages. The infrastructure may not be significantly harmed by an ice storm, but may result in prolonged and widespread outages in the cooperative's service area. In considering the potential impact of a hazard, loss of

function provides a more concise picture for comparison of events and geographic regions of the state. In addition to system damage, each hazard will be evaluated on the average number of reported or estimated outages per event occurrence. (Formula: Average number of outages reported / Total number of customers = Average percentage of outages reported per event).

Table 1.6 **Sample Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix Hazard: _____**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Section 5: Risk Assessment

A) Historical Hazards:

Tornadoes

In the last 60 years, 14 tornadoes have been reported within the Gascosage cooperative boundaries. Figure 3 provides a pictorial representation of all recorded tornado touchdown sites and recorded paths. *(Data for map collected from NOAA.)*

A data insufficiency exists, however, in both historical hazard records and cooperative records concerning damage estimates. For the purpose of this assessment, the years for which records exist for both data sets have been used. Gascosage was able to provide data for those events that resulted in FEMA claims. From 2007-2011, Gascosage's service area within the state of Missouri has experienced a total of eight tornadic events. Using the previously described methodology, the probability of a tornadic event in the Gascosage service area in any given year is 160 percent (8 events / 5 years = 160%). Estimated cooperative material damages associated with each of these events were compiled by Gascosage staff. Two of the eight occurrences caused damage to cooperative assets, resulting in a 25 percent probability that any given tornadic occurrence will produce damage. Table 1.7 provides a summary of event dates, EF-scale ratings, damage cost estimates and outages reported.

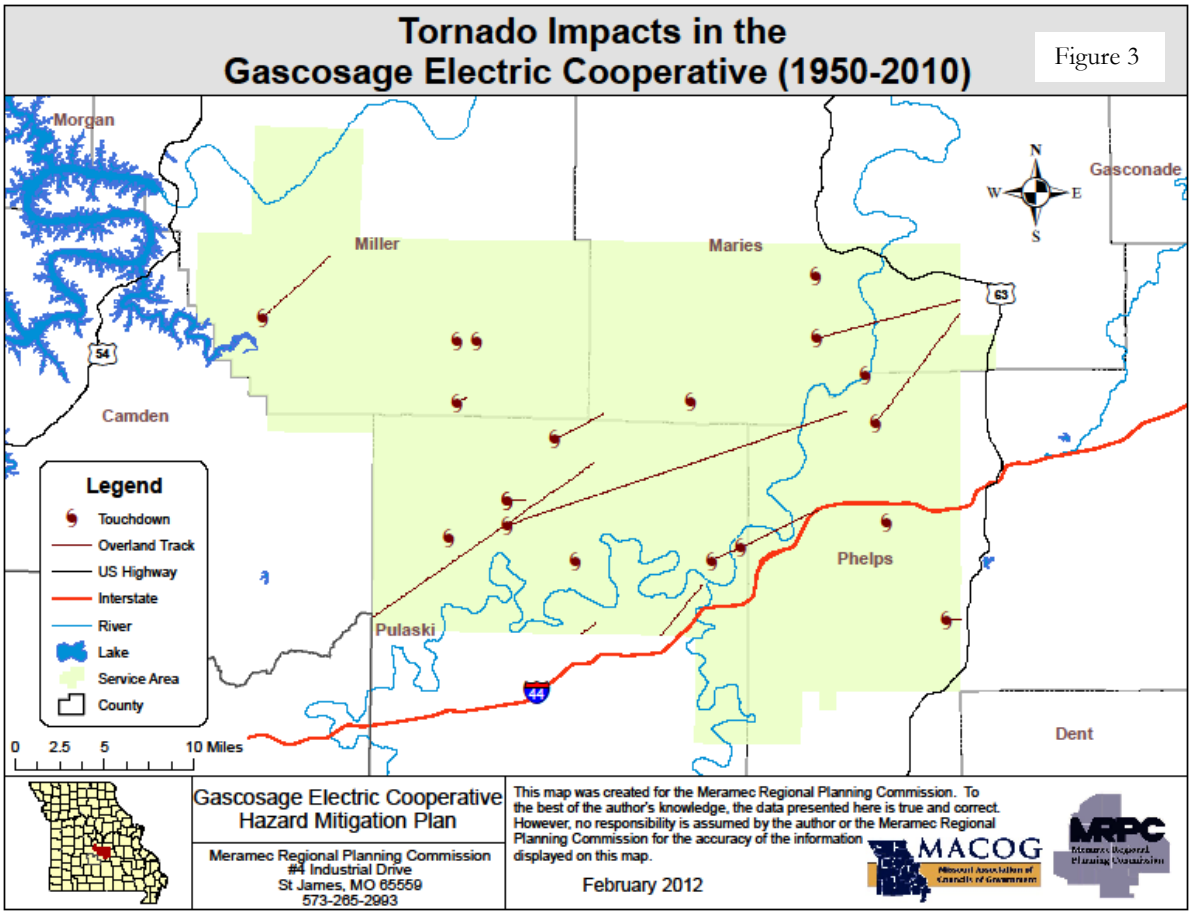


Table 1.7	Gascosage Tornadic Event Summary		
Date of event	**EF Scale rating**	**Damage estimates**	**Outages Reported**
1/7/08 (Maries Co.)	F0	$10,054.88	750
1/7/08 (Phelps Co.)	F3	$28,230.63	125
Data provided based on internal Gascosage Electric records which reflect cost from the referenced event year.			

Based upon the last five years of historical event records, the average tornado to affect the cooperative will include an EF1-EF2 rating, causing an average damage cost of $19,143 per event ($38,286 / 2 events = $19,143). This averaged amount accounts for less than 1% of Gascosage's total overhead assets and building valuation ($19,143 / $105,888,379 = 0.018%). Table 1.8 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.8 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Tornado**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

An average of 438 customers reported outages during recorded tornadoes since 2007. When compared with the total number of customers served by Gascosage, it can be projected that 4.5% of all customers may report outages during any given tornadic event. Table 1.9 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.9 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Tornado**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Severe Thunderstorms, High Wind, and Hail

From 2007-2011, Gascosage's service area within the state of Missouri has experienced a total 146 hail events and 130 thunderstorm/ high wind events. Therefore, the probability of a hail event in the Gascosage service area in any given year is near to 100 percent (146 events / 5 years = 2,920%) while the probability of a thunderstorm/high wind event in any given year is near to 100 percent (130 events / 5 years = 2,600%). Estimated material damages associated with each of these events were compiled by Gascosage staff.

In the past five years there have been no hail events that caused damage to Gascosage infrastructure, resulting in a less than 1 percent probability that any given hail occurrence will produce damage. (0 / 146 = 0%) Based upon historical records, the average hail event to affect the cooperative will cause an average damage cost of $0 ($0 / 146 events = $0). This averaged amount accounts for less than 1% of Gascosage's total overhead asset valuation ($0 / $104,254,855 = 0%).

Based upon damage records provided by Gascosage, thunderstorm/high wind events did not result in measurable damage to cooperative assets. None of the 130 occurrences caused damage to cooperative assets, resulting in a less than 1 percent probability that any given thunderstorm/high wind occurrence will produce damage. (0 / 47 = 70%)

Based upon historical records, the average thunderstorm/high wind event to affect the cooperative will cause an average damage cost of $0 ($0 / 146 events = $0). This averaged amount accounts for less than 1% of Gascosage's overhead asset valuation ($0 / $104,254,855 = 0). Table 1.10 demonstrates the probability of occurrence in conjunction with the potential extent of damage for both hail and thunderstorm/high wind events.

Table 1.10 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: <u>Thunderstorm/High Wind/Hail</u>**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

An average of zero customers reported outages during recorded hail, thunderstorm, and high wind events since 1996. When compared with the total number of customers served by Gascosage, it can be projected that less than 1 percent of all customers may report outages during any given hail, thunderstorm, or high wind event. Table 1.11

demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.11 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Tornado**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Flood

Flooding is a potential threat to the existing infrastructure of the Gascosage Electric Cooperative. The Gasconade River winds through much of the Gascosage's service area in Pulaski, Phelps and Maries counties. Figure 4 below depicts the 100 year floodplain in relation to the cooperative's boundaries. *(Map sources: FEMA HAZUS-MH; DFIRMS; Missouri Office of Administration, and Association of Missouri Electric Cooperatives.)*

From 2007-2011, Gascosage's service area has experienced 149 flooding events. Therefore, the probability of a flood event affecting the cooperative assets in any given year is near 100% (149 events / 5 years = 2,980%). Estimated material damages associated with each of these events were compiled by Gascosage staff. Flood events in March 2008 affected three counties and are shown in Table 1.12 which summarizes flood event dates by month, damage cost estimates, and reported outages. Three of the 149 occurrences caused damage to cooperative assets, resulting in an eight percent probability that any given flood occurrence will produce damage. (3 / 149 = 8%).

Table 1.12	**Gascosage Flood Event Summary**	
Event date	**Damage estimates**	**Outages reported**
March 2008 (Maries Co.)	$1,106.73	11
March 2008 (Phelps Co.)	$15,603.79	33
March 2008 (Pulaski Co.)	$12,374.40	14
Data provided based on internal Gascpsage records which reflect cost from the referenced event year.		

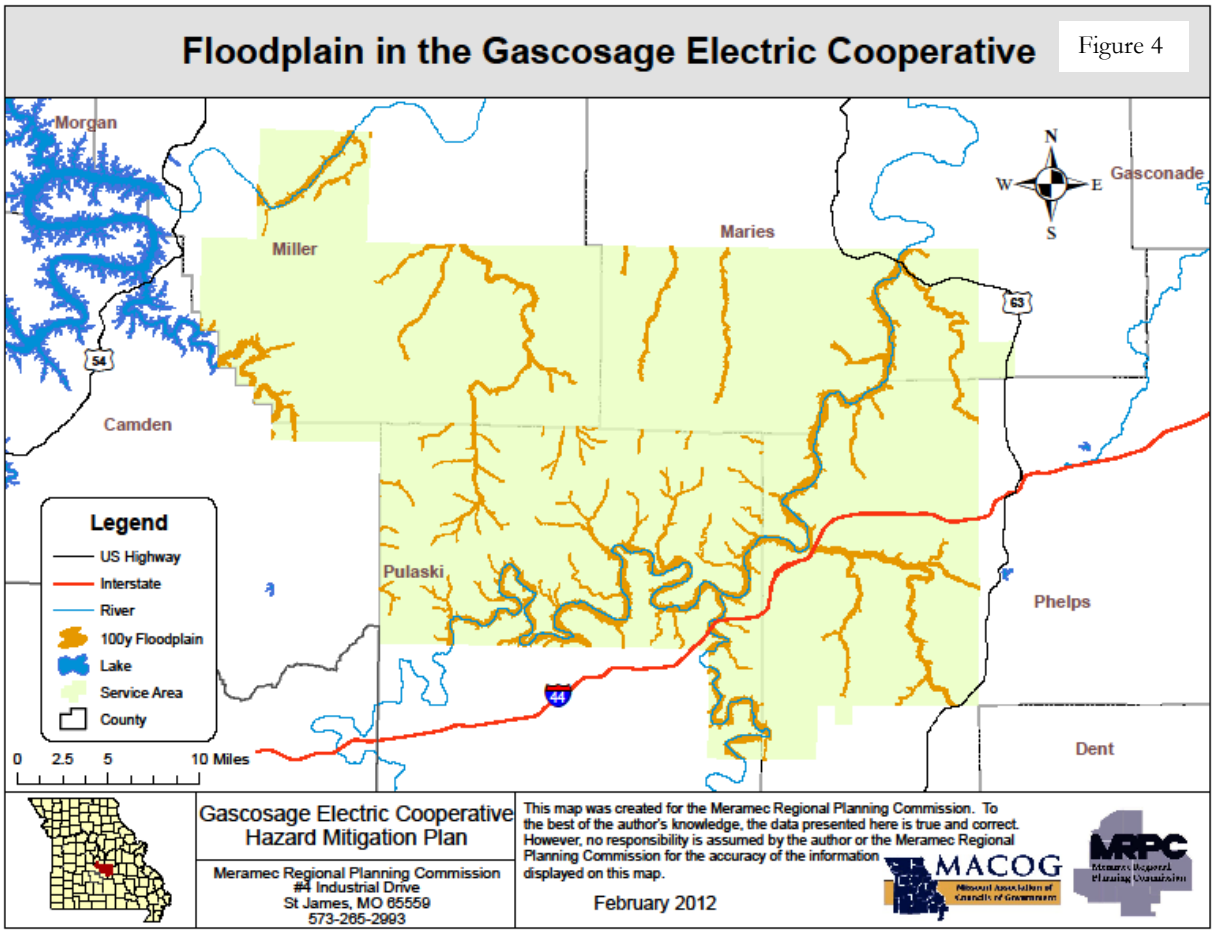
Flood events vary widely based upon numerous factors including, but not limited to, annual precipitation. Not all events, however, are extensive as evidenced in Table 1.14. Based upon historical records, the average flood event to affect the cooperative will cause an average damage cost of $9,695 ($29,085 / 3 events = $9,695). This averaged amount

accounts for less than 1% of Gascosage's overhead asset valuation ($9,695 / $104,254,855 = 0.009%). Table 1.13 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.13 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Flood**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	≥ 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

An average of 19 customers reported outages during recorded flooding events since 2007. When compared with the total number of customers served by Gascosage, it can be projected that less than 1% percent of all customers may report outages during any given flooding event. Table 1.14 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.14 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Flood**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				



Severe Winter Weather

From 2007-2011, Gascosage's service area has experienced a total of 14 severe winter weather events, including significant snowfall and ice storms. Therefore, the probability of a severe winter weather event in the Gascosage service area in any given year is near 100% (14 events / 5 years = 280%). Estimated material damages associated with each of these events were compiled by Gascosage staff. Table 1.15 provides a summary of event dates, types, associated damage estimates, and reported outages. One of the 14 occurrences, an ice storm on January 12, 2007, caused damage to cooperative assets, resulting in a seven percent probability that any given severe winter weather occurrence will produce damage. (1 / 14 = 7%)

Table 1.15	GASCOSAGE Severe Winter Weather Event Summary		
Event date	**Event type**	**Damage estimates**	**Outages reported**
1/12/07	Ice Storm	$2,452,737.18	6,905
Data provided based on internal GASCOSAGE records which reflect cost from the referenced event year.			

Based upon these historical records, the average severe winter weather event to affect the cooperative will cause an average damage cost of $2,452,737.18 ($2,452,737.18 / 1 event = $2,452,737.18). This averaged amount accounts for 2.35% of Gascosage's total overhead asset valuation ($2,452,737.18 / $104,254,855 = 2.35%). Table 1.16 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.16 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Severe Winter Weather**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

An average of 6,905 customers reported outages during recorded severe winter weather events since 2007. When compared with the total number of customers served by Gascosage, it can be projected that 70 percent of all customers may report outages during any given severe winter weather event. Table 1.17 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.17 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Severe Winter Weather**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Wildfire

The incidence of wildfire in the Gascosage service area presents a unique risk assessment. Wildfire events have occurred in each of the five counties. According to the Missouri Department of Conservation, Camden, Maries, Miller, Phelps and Pulaski counties have experienced 1,313 wildfires between 2004 and 2008. Table 1.18 summarizes the incidences of wildfire within the five counties. Therefore, the probability of a wildfire event in the Gascosage service area in any given year is near 100% (1,313 events / 5 years = 26,260%). Although Gascosage does not have records of any significant damage from wildfires, for the purposes of this assessment, wildfire and its associated impacts cannot be eliminated from the realm of possibility.

Table 1.18 Wildfire summary by county

County	# of Wildfires, 2004-08	Average Annual # of Wildfires	Likelihood (1-5)	Acres Burned	Average Annual Acres Burned	Total Buildings Damaged	Vulnerability
Camden	739	147.8	5	18,454.31	3,691	19	High
Maries	54	10.8	1	686.5	137	2	Medium-low
Miller	248	49.6	2	1,457.16	291	5	Medium
Phelps	168	33.6	2	1,050.12	210	3	Medium
Pulaski	104	20.8	1	827.5	166	1	Medium-low
Totals	1,313	262.6	2	22,475.59	4,495	30	Medium

Source: Missouri State Hazard Mitigation Plan, 2010

The potential extent of damage caused by wildfire is difficult to determine. Like earthquakes and dam failure, wildfires have had no measurable impact upon the Gascosage service area. To date, 1,313 fires have burned a total of 22,475.59 acres, for an average of 17.1 acres affected per event. Gascosage sustained no damage related to wildfires in its service area during this time period. With an average of 17.1 acres per fire in the service area, it is unlikely that infrastructure damage would exceed one percent based upon asset location and the unlikeliness of an uncontrollable wildfire. This initial assessment assumes a limited impact upon electric distribution infrastructure of less than one percent (Table 1.19). Further study will be required to create a model for damage assessments related to wildfire.

Table 1.19 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Wildfire**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

No customers have reported outages during recorded wildfires between 2007 and 2011. When compared with the total number of customers served by Gascosage, it can be projected that less than 1 percent of all customers may report outages during any given wildfire event. Table 1.20 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.20 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Wildfire**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

B. Non-historical Hazards

Earthquakes

The closest source of earthquake risk in the Gascosage service area is the New Madrid Fault, which runs from Northern Arkansas through Southeast Missouri and Western Tennessee and Kentucky to the Illinois side of the Ohio River Valley. The other major earthquake fault in Missouri is the Nemaha Uplift which affects the northwest and western side of the state. Most of Missouri's earthquake activity has been concentrated in the southeast corner of the state, which lies within the New Madrid seismic zone.

The New Madrid fault has the potential to cause damage throughout the state of Missouri, including the CEC service area. Scientists from the U.S. Geological Survey (USGS) and the Center for Earthquake Research and Information (CERI) at the University of Memphis have estimated the probability of a magnitude 6.0 or greater earthquake from the New Madrid Fault is 25-40 percent through the year 2053. The probability of an earthquake increases with each passing day.

The projected earthquake intensity ratings for the cooperative region changes based upon the Modified Mercalli Scale. Given a New Madrid earthquake with a 6.7 rating, the region would experience Level V intensity characteristics. In the event of an earthquake with a 7.6 rating, the region would experiences Level VI intensity characteristic while an earthquake with an 8.6 rating would most likely cause Level VII intensity characteristics. In the event of an earthquake with a 7.6 rating, the CEC service area would most likely experience minor building damage as well as damage to the electrical distribution system. This damage would most likely be significantly less when compared with the southeast corner of the state where the fault is located. Distribution lines overhead and underground could become disconnected or severed, and transformers could be damaged. Though the probability of occurrence is very small, the potential extent of damage could significantly impact both the cooperative and its customers as demonstrated in Table 1.21.

Table 1.21 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Earthquake**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

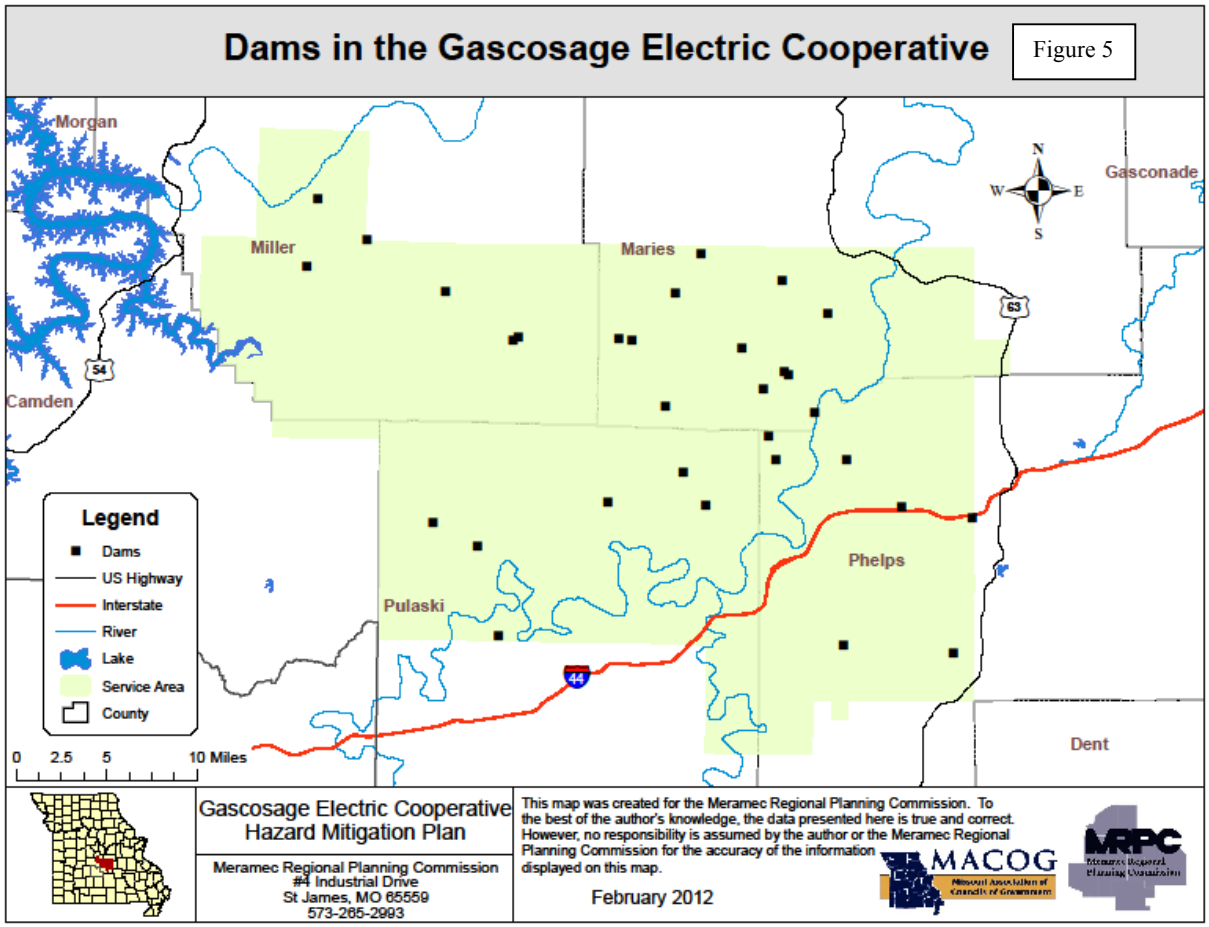
Based upon information from CERI, FEMA, and SEMA, it may be estimated that 974 customers could report outages related to an earthquake event. When compared with the total number of customers served by Gascosage, it can be projected that ten percent of all customers may report outages during any given seismic event. Table 1.22 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.22 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Earthquake**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Dam Failure

Like earthquakes, dam failures have had no measurable impact upon the Gascosage service area to date. According to Missouri DNR's Dam Safety Division, 110 dams currently exist within the cooperative boundaries: 21 in Camden County, 30 in Maries County, 15 in Miller County, 29 in Phelps County, and 15 in Pulaski County. Of these dams, 11 in Camden County, three in Maries County, two in Miller County, three in Phelps County, and one in Pulaski County are regulated by the state due to the fact that they are non-agricultural, non-federal dams which exceed 35 feet in height. Figure 5 shows the locations of all known dams located within Gascosage's service area. *(Map sources: www.msdis.missouri.edu; www.dnr.mo.gov/env/wrc.)*

26 dam failures have occurred within the state of Missouri over the past 100 years. However, no such event has occurred within or near the cooperative's boundaries. However, for the purposes of this assessment, dam failure and its associated impacts cannot be eliminated from the realm of possibility. In order to allow for a risk assessment, the probability of this event has been included as less than 1%.



Determining the potential extent of dam failure is currently impossible due to a lack of data concerning inundation zones. Further study concerning existing dams and their impact is required to make a more comprehensive assessment of potential damages. Based on discussions with Gascosage staff on location of infrastructure relative to dams, this initial assessment assumes a limited impact upon downstream electric distribution infrastructure of less than 10% for both infrastructure damage and service interruption. (Tables 1.25 and 1.26).

Table 1.25 **Gascosage Electric Cooperative Infrastructure Vulnerability Assessment Matrix** **Hazard: Dam Failure**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

Table 1.26 **Gascosage Electric Cooperative Service Interruption Vulnerability Assessment Matrix** **Hazard: Dam Failure**		Probability of Damage-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Land Subsidence (Sinkhole Collapse)

Gascosage's location in the southern half of Missouri places it squarely in a region where karst topography is common. This type of geological feature is characterized by springs, caves and sinkholes – the result of the collapse of a cave ceiling. Although there have not been any reported incidents of sinkholes collapsing and causing personal injury or damage to Gascosage infrastructure, this type of land subsidence has occurred before in Missouri.

Determining the potential impact of land subsidence on CEC infrastructure is currently impossible due to a lack of historical data. Further study concerning land subsidence and its impact on power generation is required to make a more comprehensive assessment of

potential damage. The fact that Gascosage does extensive engineering and environmental impact studies prior to construction of infrastructure also reduces the potential threat of damage from land subsidence. If an incident of land subsidence occurred, it would be localized to a relatively small area which would further limit its impact on the cooperative. This initial assessment assumes a limited impact upon infrastructure of less than one percent, and less than one percent of service interruption. (Tables 1.23 and 1.24).

Table 1.23 Gascosage Electric Cooperative, Infrastructure Vulnerability Assessment Matrix Hazard: Land Subsidence		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent of Damage	Less than 10% of damage to system				
	10-25% damage of system				
	26-50% damage of system				
	More than 50% damage of system				

Table 1.24 **Gascosage Electric Cooperative, Service Interruption Vulnerability Assessment Matrix** **Hazard: Land Subsidence**		Probability of Damaging-causing Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	> Near 100% probability in any given year
Potential Extent of Impact	Less than 10% of customers report outages				
	10-25% of customers report outages				
	26-50% of customers report outages				
	More than 50% of customers report outages				

Section 6: Mitigation strategies

Previous efforts at mitigation

For organizations like Gascosage, mitigation is considered to be part of prudent business operations. In order to ensure the delivery of a quality product and minimize service interruptions, a number of mitigation strategies are continually utilized. Routine maintenance and upgrades to existing equipment are completed as part of daily tasks. Vegetation management is utilized to limit the cascading effects of natural hazards. Safety and reporting information are disseminated to the public through various types of media. Mutual aid agreements and partnerships create relationships which provide for future support in the event of a natural disaster.

Additionally, mitigation is considered prior to any expansion of service into special hazard areas. Before any service is built, it is first "staked out" in coordination with local builders and property owners. This process, completed by the Line Superintendent and contracted engineers, identifies and addresses foreseeable hazards and safety issues before any new service lines area constructed. USDA-RUS specifications regarding operation and safety are utilized in every step of the process. Steps are taken to practically minimize the exposure of equipment to loss due to foreseeable hazards, particularly flooding. Historically, customers who reside in the floodplain are not charged for repairs or losses associated with flooding unless they purposefully destroy or restrict the cooperative from protecting their distribution system assets. However, this particular policy is currently under review. The cooperative is considering making customers partially responsible for replacement costs in flood-prone areas.

Existing and potential resources

As stated above, mitigation is a key component of good business practices. Gascosage Electric Cooperative includes mitigation strategies as part of regular work activities to ensure service with minimal interruptions. Funding for these activities is provided through the cooperative's normal budgetary process for maintenance.

In order to expand mitigation efforts beyond normal maintenance, it is likely that Gascosage will need to seek outside funding sources. These may include private, state, or federal programs which provide grant and loan funding. Upon passage of this plan, Gascosage will be eligible for funding through FEMA in the following categories:

- Hazard Mitigation Grant Program
- Flood Mitigation Assistance Program
- Pre-Disaster Mitigation Program
- 406 Stafford Act

Development of goals, objectives, and actions

Establishing mitigation goals, objectives, and actions for a business entity requires a slightly different approach than public agencies. Certainly, a number of similarities exist; both entities must consider which hazards most commonly occur and have the greatest potential for causing disruption to members or residents. They must also consider which types of actions will maximize benefits and minimize costs, how mitigation strategies will be implemented, who will enforce implementation, and how the overall plan will be maintained and updated.

The Gascosage mitigation planning committee, with assistance from MRPC staff, worked to identify goals, actions, and objectives which addressed hazard mitigation issues. The committee first identified ongoing mitigation strategies as well as potential strategies which seek to improve service and limit disruptions resulting from natural hazards. Action items were then analyzed for common characteristics and summarized to create nine objectives. Likewise, these nine objectives were grouped into similar categories and used as the basis for the four overarching goals. Table 1.25 provides a simple synopsis of the goals and objectives before prioritization.

Traditionally, the STAPLEE (Social, Technical, Administrative, Political, Legal, Environmental, and Economic) method is used to prioritize mitigation actions. These categories, however, do not necessarily align with the private sector in the same way they are applicable to governmental agencies. A number of action items could be included with multiple goals and objectives, for example. As a result, the committee chose to use a different method to prioritize their mitigation strategy.

Table 1.25	**Gascosage goals and objectives**
Identified Goals	**Identified Objectives**
Goal 1: Protect the health and safety of the community.	**Objective 1:** Prevent injury, loss of life, and damage to property.
	Objective 2: Reduce outage time to critical facilities.
Goal 2: Reduce future losses due to natural hazard events.	**Objective 1**: Protect, strengthen, and maintain existing infrastructure.
	Objective 2: Research and develop plans for future infrastructure improvements, seeking implementation where feasible.
	Objective 3: Research and develop plans for future communication and data collection improvements where feasible.
Goal 3: Improve emergency management capabilities and enhance local partnerships.	**Objective 1:** Improve assessment of outages and reduce response time.
	Objective 2: Create or maintain partnerships with outside agencies.
Goal 4: Continue to promote public awareness and education.	**Objective 1:** Utilize media resources to promote public education.
	Objective 2: Continue interaction with local schools and civic groups.

After identifying ongoing and potential action items, the committee created three priority tiers:

- **First tier** actions focus on physical infrastructure protection and improvements which ensure continued, quality service and seek to reduce power outages. These types of actions are the highest priority of Gascosage.
- **Second tier** actions create and maintain working relationships to reduce and prevent the impact of power outages. These include improvements to safety and reporting information, mutual aid agreements, and other efforts which seek to expand and improve both customer service and disaster planning.
- **Third tier** actions identify potential projects for other system improvements. These include mapping efforts, technological improvements, and research related to the expansion of mitigation efforts.

Actions within each tier may be funded through regular budgetary methods or identified outside sources. Tables 1.26, 1.27, and 1.28 provide lists of action items by tier as well as the goals and objectives identified with each.

Table 1.26 Prioritized Mitigation Actions for Gascosage Electric Cooperative – Tier 1

Tier 1			
Action item:	*Goal/Objective*	*Timeframe for completion*	*Cost-benefit score*
Perform routine maintenance and utilize upgraded equipment where possible to ensure quality of system. Tasks may include part replacement and/or upgrades. Identified work includes, but is not limited to: • Addition of lightning arresters, electronic reclosures, conductors, guidewires. • Replacement or repair on poles, cross-arms, lines.	Goal 1 / Objective 1 Goal 2 / Objective 1	Ongoing effort	Low cost High benefit Score: 9
Upgrade to class IV wooden poles where possible.	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 2 / Objective 1 Goal 2 / Objective 2	Dependent upon additional funding.	High cost High benefit Score: 7
Use vegetation management to prevent interference with delivery of power.	Goal 1 / Objective 1 Goal 2 / Objective 1	Ongoing effort	Low cost Medium benefit Score: 6
Complete inspections every 3 years on lines and poles.	Goal 1 / Objective 1 Goal 2 / Objective 1	Completed annually.	Low cost Medium benefit Score: 6
Add alternate source wiring to eliminate or reduce time of outages. Upgrading lines to heavier wire (6A & 8A wire being replaced with 4/0 aluminum).	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 2 / Objective 2	Ongoing effort; Completed as funding allows.	Medium cost High benefit Score: 4
Convert overhead lines to underground lines or vice versa in troubled areas based on vulnerability and feasibility.	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 2 / Objective 1 Goal 2 / Objective 2	Ongoing effort; Dependent upon funding.	High cost High benefit Score: 7

Table 1.27 Prioritized Mitigation Actions for Gascosage Electric Cooperative – Tier 2			
Tier 2			
Action item:	*Goal/Objective*	*Timeframe for completion*	*Cost-benefit Score*
Provide safety and reporting information to the general public through varying methods: • Company website • Social media sites • Local newspapers • Weekly radio spots • Presentations in cooperation with Show-Me Power • Publications	Goal 1 / Objective 1 Goal 4 / Objective 1	Ongoing effort	Low cost Medium benefit Score: 6
Encourage customer base to buy generators for use in special needs and critical facilities for use in outages	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 2 / Objective 2	Dependent upon additional funding.	Medium cost High benefit Score: 4
Maintain mutual aid agreements with other rural electric cooperatives.	Goal 3 / Objective 2	Ongoing effort.	Low cost Low benefit Score: 3
Continue to partner with county emergency management agencies to ensure power for local shelters, fuel stations, and public safety.	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 3 / Objective 2	Ongoing effort.	Low cost High benefit Score: 1
Cooperate with local law enforcement and government officials to reduce the impact of power outages.	Goal 1 / Objective 1 Goal 3 / Objective 2	Ongoing effort.	Low cost High benefit Score: 1

Table 1.28 Prioritized Mitigation Actions for Gascosage Electric Cooperative – Tier 3			
Tier 3			
Action item:	*Goal/Objective*	*Timeframe for completion*	*Cost-benefit*
Research methods for waterproofing meters in flood-prone areas.	Goal 2 / Objective 2	Ongoing effort.	Low cost High benefit Score: 9
Investigate the use of GPS for hazard mitigation planning purposes.	Goal 2 / Objective 1 Goal 2 / Objective 3 Goal 3 / Objective 1	Dependent upon additional funding.	High cost High benefit Score: 7
Monitor developments in data availability concerning the impact of all hazards upon the Gascosage service area through local, state, and federal agencies.	Goal 1 / Objective 1 Goal 2 / Objective 1	Ongoing effort.	Low cost Low benefit Score: 3

Section 7 – Plan Implementation and Maintenance

Plan incorporation

The goals, objectives, and actions of the previous section identify both ongoing efforts at mitigation and potential methods for expanding efforts. The plan has been reviewed and adopted by the Board of Directors as part of the company's operations policy. This mitigation plan necessitates involvement from every Gascosage employment level as the organization strives to ensure quality service to their customers.

Other Local Planning Mechanisms

Beyond the Gascosage plan, few planning mechanisms exist at the local level. The Missouri counties of Camden, Maries, Miller, Phelps and Pulaski each have a FEMA-approved Natural Hazard Mitigation Plan in place. County emergency management directors have Local Emergency Operations Plans which seek to mitigate the same hazards for residents. These same counties are also included in the Regional Transportation Plan (RTP) as well as a Comprehensive Economic Development Strategy (CEDS). Gascosage's plan can be easily incorporated into these local plans and allow for coordination across agencies in the event of an emergency.

Gascosage is located within the rural portions of third-class counties which are prohibited from enforcing building codes and zoning by the state of Missouri. The cooperative provides service to the communities of Crocker, Dixon, Iberia, Jerome, Newburg, Brumley, Swedeborg, Hancock, Hawkeye, Ullman and Doolittle. None of these very small communities currently have comprehensive plans or capital improvement plans in place.

Plan Maintenance

Gascosage will conform to the requirements established by the Association of Missouri Electric Cooperatives (AMEC) for monitoring, evaluating, and updating the plan.

Continued Public Involvement Opportunities

Gascosage will conform to the requirements established by the Association of Missouri Electric Cooperatives (AMEC) for continued public involvement. Opportunities for public comment will continue to be offered through various media outlets, the cooperative's website, and the physical office of Gascosage.