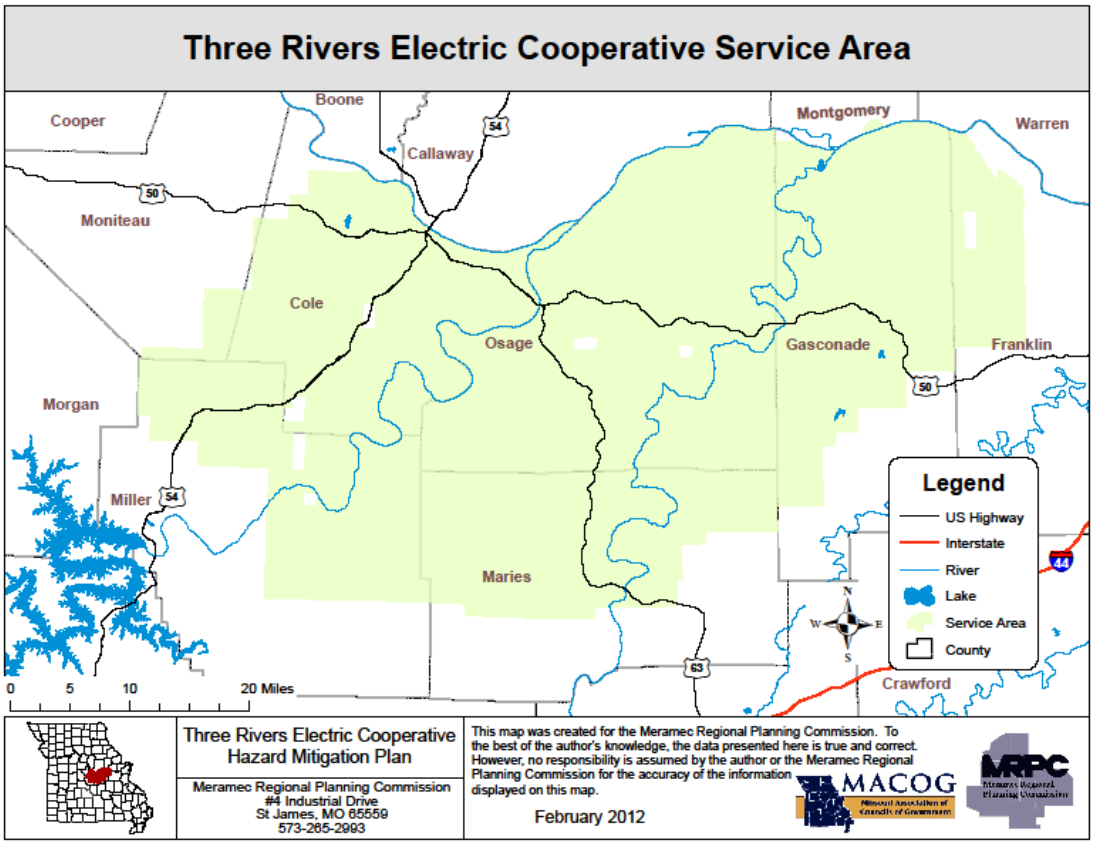
Section 1: Introduction

Three Rivers Electric Cooperative (Three Rivers) was established in 1939 to provide electric service to the rural areas of central Missouri, south of the Missouri River. Three Rivers is headquartered in Linn, Missouri, and provides service to customers in Cole, Franklin, Gasconade, Maries, Miller, Moniteau and Osage counties. The cooperative is run by a board of nine directors which approve the company's mission and internally developed business policy:

> *"Three Rivers Electric Cooperative mission is to provide the best possible service at rates consistent with sound business practices. We will invest in technology to improve reliability, operations and efficiency."*

Three Rivers' service boundaries are shown in Figure 1 *(source: Three Rivers Electric Cooperative)*. This map illustrates that the service area includes all of Osage County, the northern half of Gasconade County, a portion of western Franklin County, northern Maries County, southeastern Cole County, northeastern Miller County, and the southeastern corner of Moniteau County. The cooperative owns 3,983 miles of service line within these counties.

Figure 1

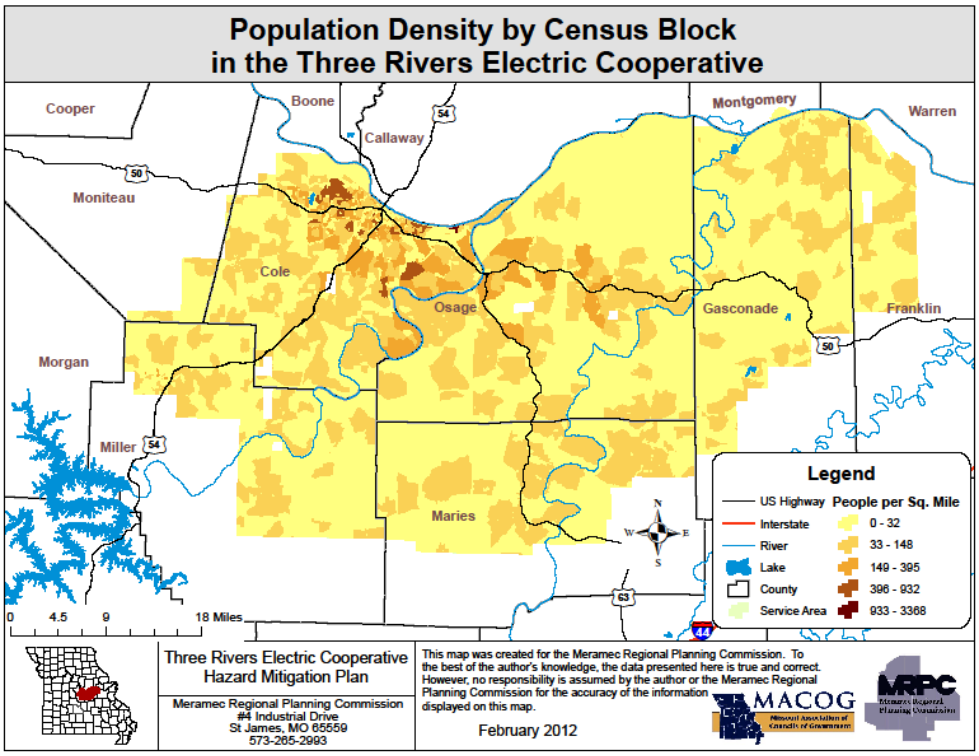


As of December 2010, the customer base of Three Rivers currently serves 21,555 accounts in the seven counties of service. Residential customers account for 92% of memberships (19,899 members) while non-residential customers make up the remaining 8% (656 members). Table 1.1 provides the summary of metered customers by Missouri county.

Table 1.1	Meters by Missouri County
County	**Number of meters**
Cole	8,102
Franklin	593
Gasconade	3,474
Maries	1,838
Miller	2,384
Moniteau	121
Osage	5,043

The average daily customer usage for Three Rivers is 41 kilowatt-hours (kWh). Annual total usage of Three Rivers customers in 2010 was 393,020,011 kWh of service. Population density for the cooperative service area is depicted in Figure 2 (*Map source: U.S. Census 2010*).

Figure 2



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 Three Rivers. The initial meeting between the two entities was held on February 4, 2011 as part of a regional kick-off meeting for central 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 Three Rivers offices in Linn, Missouri during the month of September. Table 1.2 summarizes the attendees and topics of each meeting. Meeting notes are available in the chapter appendix.

Table 1.2	Three Rivers Planning Meeting Synopsis	
Meeting Date	**Attendees, Title, Organization**	**Topics of discussion**
September 22, 2011	Roger Kloeppel, Manager of Operations, Three Rivers Electric Cooperative Tom Werdenhause, General Manager, Three Rivers Electric Cooperative Scott Struemph, Accounting Suprevisor, Three Rivers Electric Cooperative Tamara Snodgrass, Regional Planner, MRPC	Three Rivers Customer information Critical facilities information Asset inventory by type and location Data collection assignments Goals and Objectives Discussion

Public Involvement

As with all public hazard mitigation plans, public involvement was encouraged through a variety of methods. Three Rivers 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:

- Cole County Commission,
- Franklin County Commission,
- Gasconade County Commission,
- Maries County Commission,
- Miller County Commission,
- Moniteau County Commission,
- Osage County Commission,
- Local emergency management directors, and
- Local Red Cross chapter.

Three Rivers provides service to a variety of facilities that could be considered critical infrastructure. These include: Linn Technical College, a federal aviation facility, Osage County Emergency Management facility, Linn Fire Protection District, Westphalia Fire Protection District, Morrison Volunteer Fire Department, Osage County 911 offices,

Argyle Volunteer Fire Department and St. Mary's Belle Family Health Center – all in Osage County; Missouri State Highway Patrol Troop F facility, Cole County Fire Protection Districts, and Osage Fire Protection District – all in Cole County; New Haven-Berger Fire and Ambulance District in Franklin County; Hermann Area District Hospital, Stony Hill Community Fire Department, Hermann Fire Company #1, Missouri State highway Patrol facility and Gasconade County Sheriff's Department – all in Gasconade County; Dixon Rural Volunteer Fire Department Missouri State Highway Patrol facility and Meta Fire and Rescue Fire Protection District in Maries County; and Moreau Fire Protection District in Moniteau County. Additionally, Three Rivers' mitigation plan was included in the public comment period for the combined AMEC plan.

Section 3: Asset inventory

Three Rivers Electric Cooperative has a wide variety of assets by type. Real estate owned by the company includes office buildings and warehouses located in Linn. In addition, Three Rivers owns garages located in Brazito. Thirty-eight vehicles provide access to customers and infrastructure. Three Rivers does not own any electric generation or transmission infrastructure. 3,983 miles of distribution lines are owned and maintained by Three Rivers. Table 1.3 provides information concerning total asset valuation.

Table 1.3	**Three Rivers Asset Inventory Valuation Summary**	
Asset	**Total Replacement Cost**	**Cost breakdown**
Total Three Rivers Assets	$259,596,555	Buildings and vehicles - $12,714,885 Overhead assets - $223,663,170 Underground assets - $23,218,500
Distribution Lines	$81,847,920 OH $18,232,500 UG	OH Single-phase lines - $69,045,020 UG Single-phase lines - $16,917,000 OH Three-phase lines - $12,802,900 UG Three-phase lines - $1,315,500
Supporting Infrastructure	$141,815,250 OH $4,986,000 UG	Meters - $4,311,000 Poles - $90,765,600 OH Transformers - $24,721,500 UG Transformers - $4,986,000 Guys - $8,906,100 Anchors - $8,277,850 Cross-arms - $2,902,200 Regulators - $539,000 Reclosures - $1,257,000 Capacitors - $135,000
Office Buildings	$4,615,000	
Warehouses	$4,441,000	
Vehicles	$3,658,885	
Source: Internal Three Rivers Accounting and Insurance records, 2011		

Ensuring quality distribution to its customers, Three Rivers 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	Three Rivers Asset Inventory by service county								
Asset	**Emergency Replacement Cost per unit or mile**	**Number of units or miles: Cole**	**Number of units or miles: Osage**	**Number of units or miles: Gasconade**	**Number of units or miles: Miller**	**Number of units or miles: Maries**	**Number of units or miles: Franklin**	**Number of units or miles: Moniteau**	**Total number of units or miles:**
Meter	$200/unit	8,102	5,043	3,474	2,384	1,838	593	121	21,555
Pole	$1,200/unit	16,186	22,306	14,630	9,837	9,014	3,168	497	75,638
SP*** distribution line	$22,000/mile OH $50,000/mile UG	587.92 OH** 159.66 UG***	941.11 OH 48.61 UG	616.22 OH 24.87 UG	417.93 OH 90.28 UG	414.35 OH 8.68 UG	138.75 OH 5.87 UG	22.13 OH .37 UG	3,138.41 OH 338.34 UG
TP**** distribution line	$22,000/mile OH $50,000/mile UG	142.6 OH 13.51 UG	191.16 OH 7.88 UG	104.27 OH 3.07 UG	70.47 OH 1.59 UG	51.76 OH .15 UG	19.79 OH .11 UG	1.9 OH 0 UG	581.95 OH 26.31 UG
Transformers	$1,500 OH $3,000 UG	4,568 OH 1,168 UG	4,453 OH 210 UG	2,894 OH 147 UG	2,130 OH 92 UG	1,742 OH 22 UG	582 OH 23 UG	112 OH 0 UG	16,481 OH 1,662 UG
Guys	$175/unit	12,443	14,263	9,747	6,572	5,454	2,067	346	50,892
Anchors	$175/unit	11,469	13,540	8,620	6,209	5,236	1,893	335	47,302
Cross-arms	$200/unit	3,556	4,767	2,600	1,757	1,291	493	47	14,511
Regulators	$7,000/unit	20	29	15	9	3	1	0	77
Reclosures	$3,000/unit	140	154	0	64	56	0	5	419
Capacitors	$1,000/unit	44	36	22	16	9	6	2	135
Total Replacement Value by county		$49,466,840 OH $12,162,500 UG	$65,885,165 OH $3,454,500 UG	$42,303,805 OH $1,838,000 UG	$29,080,075 OH $4,869,500 UG	$26,378,770 OH $507,500 UG	$9,085,680 OH $368,000 UG	$1,462,835 OH $18,500 UG	$223,663,170 OH $23,218,500 UG

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

Source: Internal Three Rivers Accounting and Maintenance records

Section 4: Identified Hazards and Risk Assessment Methodology

Natural hazards in 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 of any natural disaster regardless of onset time. The following natural hazards have been identified as potential threats for the service region of the Three Rivers Electric Cooperative:

- Tornadoes
- Severe Thunderstorms, Hail, and High Winds
- Flood and Levee Failure
- Severe Winter Weather
- Earthquakes
- Dam Failure

- 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 Three Rivers because of asset types and geographic location in the state of Missouri. Those hazards eliminated for the Three Rivers service region include:

- Drought
- Heat Wave
- Landslides

Although drought can potentially impact northwest Missouri, water availability does not directly impact the delivery of electric service to Three Rivers 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 Three Rivers 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.

For the purpose of this risk assessment, the identified hazards for the Three Rivers 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 Three Rivers, 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 for example levee failure. 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 Three Rivers, hazards without historical data include earthquakes, land subsidence and dam failure.

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 Three Rivers 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 $232,719,170
- Overhead infrastructure assets only
    - Used for:
        - Severe Thunderstorm / High Wind / Hail
        - Flood
        - Severe Winter Weather
    - Valued at $223,663,170

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 Three Rivers 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 Three Rivers 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, 48 tornadoes have been reported within the Three Rivers 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, between 1950 and 2003 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. From 2003-2011, Three Rivers' service area within the state of Missouri has experienced a total of 12 tornadic events. Using the previously described methodology, the probability of a tornadic event in the Three Rivers service area in any given year is 133% (12 events / 9 years = 133%). Estimated cooperative material damages associated with each of these events were compiled by Three Rivers staff. None of the 12 occurrences caused physical damage to cooperative assets, but nine of the twelve events had associated reported outages, resulting in a 75% probability that any given tornadic occurrence will produce damage or outages (9 events / 12 occurrences = 75%). Table 1.7 provides a summary of event dates, EF-scale ratings, damage cost estimates and outages reported.

Figure 3

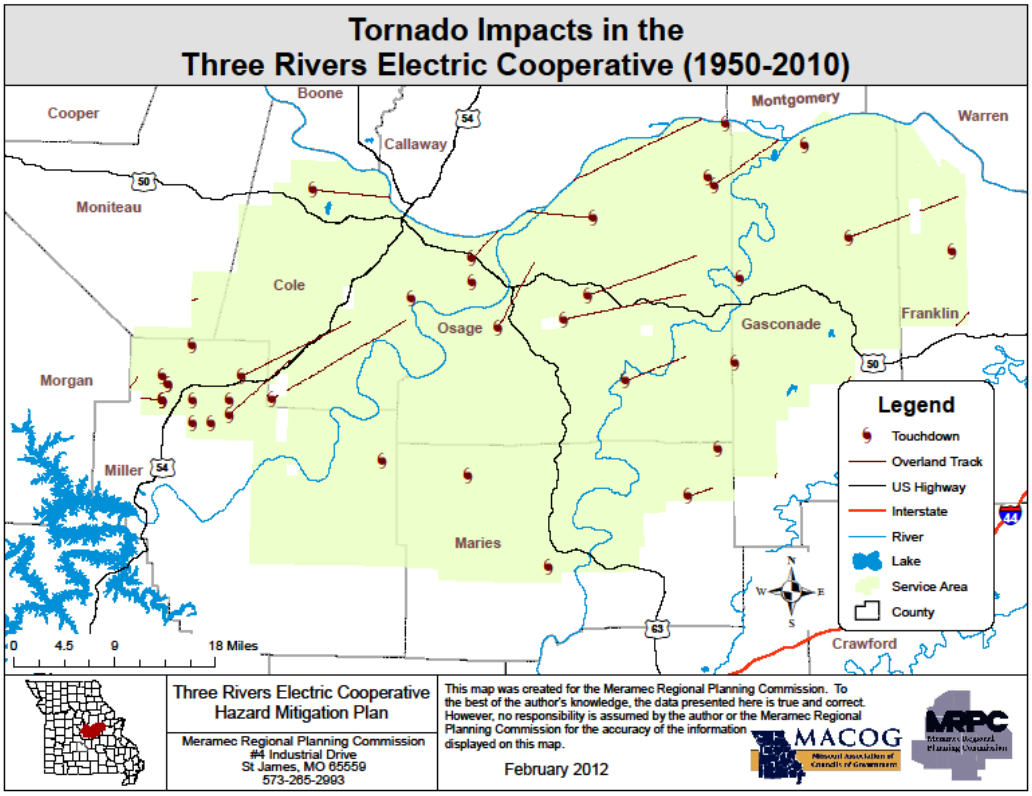


Table 1.7	Three Rivers Tornadic Event Summary		
Date of event	**EF Scale rating**	**Damage estimates**	**Outages Reported**
5/4/03	F0	$0	275
5/6/03	F0-F1	$0	5,970
9/26/03	F0	$0	225
5/27/04	F0	$0	12
7/5/04	F1	$0	650
1/7/08	F0	$0	456
6/10/09	F1	$0	238
12/31/10	F0-F2	$0	19
2/27/11	F1	$0	1,156
Data provided based on internal Three Rivers records which reflect cost from the referenced event year.			

Based upon the last nine years of historical event records, the average tornado to affect the cooperative will include an EF0-EF1 rating, causing an average damage cost of $0 per event ($0 / 12 events = $0). This averaged amount accounts for less than 1% of Three Rivers' total overhead assets and building valuation ($0 / $232,719,170 = 0%). Table 1.8 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.8 **Three Rivers 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 1,000 customers reported outages during recorded tornadoes since 2003. When compared with the total number of customers served by Three Rivers, it can be projected that 4 percent 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 **Three Rivers 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

According to the National Oceanic and Atmospheric Administration (NOAA), from 2003-2011, Three Rivers' service area has experienced a total of 200 hail events and 277 thunderstorm / high wind events. Therefore, the probability of a hail event in the Three Rivers service area in any given year is near to 100% (200 events / 9 years = 2,222%) while the probability of a thunderstorm/ high wind event in any given year is also near to 100% (277 events / 9 years = 3,077%). Estimated material damages associated with these types of events were compiled by Three Rivers staff. The data has been organized by month rather than by event. Since January 2003, Three Rivers has had no damage related to hail, resulting in a less than 1% probability that any given hail event will result in damage (0 / 200 = 0%).

Based upon historical records, the average hail event to affect the cooperative will cause an average damage cost of $0 ($0 / 200 events = $0). This averaged amount accounts for less than 1% of Three Rivers' total overhead asset valuation ($0 / $223,663,170 = 0).

Table 1.10 provides a summary of those thunderstorm/high wind events which caused damage to cooperative infrastructure by month/date, cost estimate of damage and reported outages. 89 of the 277 occurrences caused outages, resulting in a 32.1% probability that any given thunderstorm/high wind occurrence will produce damage and/or outages. (89 / 277 = 32.1%)

Table 1.10	Three Rivers Thunderstorm/High Wind/Hail Event Damage Summary By Month/Date								
Event date	**Damage estimates**	**Outages reported**		**Event date**	**Damage estimates**	**Outages reported**		**Event date**	**Damage estimates**	**Outages reported**
3/2003	$0	636		6/2006	$0	897		3/2009	$0	761
5/2003	$149,000	2,318		7/2006	$0	216		4/2009	$0	10
6/2003	$0	1,586		8/2006	$0	1,038		5/2009	$0	839
7/2003	$0	376		9/2006	$0	118		6/2009	$0	225
8/2003	$0	521		10/2006	$0	33		7/2009	$0	1,175
9/2003	$0	175		11/2006	$0	84		8/2009	$0	115
10/2003	$0	56		1/2007	$0	195		9/2009	$0	24
11/2003	$0	5		2/2007	$0	627		10/2009	$0	638
3/2004	$0	68		3/2007	$0	125		12/2009	$0	479
4/2004	$0	5		4/2007	$0	48		1/2010	$0	31
5/2004	$0	271		5/2007	$0	52		3/2010	$0	201
6/2004	$0	95		6/2007	$0	174		4/2010	$0	626
7/2004	$0	185		7/2007	$0	202		5/2010	$0	286
8/2004	$0	1,792		8/2007	$0	877		6/2010	$0	1,277
9/2004	$0	1		9/2007	$0	240		7/2010	$0	680
10/2004	$0	219		10/2007	$0	188		8/2010	$0	676
1/2005	$0	204		12/2007	$0	190		9/2010	$0	167
2/2005	$0	29		1/2008	$0	804		10/2010	$0	281
3/2005	$0	186		2/2008	$0	108		11/2010	$0	10
4/2005	$0	850		3/2008	$0	869		12/2010	$0	14
5/2005	$0	88		4/2008	$0	240		1/2011	$0	1
6/2005	$0	1,347		5/2008	$0	1,409		2/2011	$0	228
7/2005	$0	639		6/2008	$0	1,525		3/2011	$0	361
8/2005	$0	364		7/2008	$0	842		4/2011	$0	211
9/2005	$0	2,529		8/2008	$0	217		5/2011	$0	2,166
10/2005	$0	18		9/2008	$0	1,210		6/2011	$0	2,100
11/2005	$0	632		10/2008	$0	28		7/2011	$0	296
3/2006	$0	168		11/2008	$0	12		8/2011	$0	1,824
4/2006	$0	125		12/2008	$0	1,098		9/2011	$0	56
5/2006	$0	87		2/2009	$0	65		**TOTAL**	**$149,000**	
Data provided based on internal Three Rivers records which reflect cost from the referenced event year.										

Based upon historical records, the average thunderstorm/high wind event to affect the cooperative will cause an average damage cost of $1,674 ($149,000 / 89 events = $1,674). This averaged amount accounts for less than 1% of Three Rivers' overhead asset valuation ($1,674 / $223,663,170 = 0.007). Table 1.11 demonstrates the probability of occurrence in conjunction with the potential extent of damage for both hail and thunderstorm/high wind events.

Table 1.11 **Three Rivers Electric Cooperative Infrastructure Vulnerability Assessment Matrix Hazard: Thunderstorm/High Wind/Hail**		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 506 customers reported outages during recorded hail, thunderstorm, and high wind events since 2003. When compared with the total number of customers served by Three Rivers, it can be projected that 2.3% of all customers may report outages during any given hail, thunderstorm, or high wind event. Table 1.12 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.12 **Three Rivers Electric Cooperative Service Interruption Vulnerability Assessment Matrix Hazard: Thunderstorm/High Wind/Hail**		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 and Levee Failure

Flood and levee failure are both potential threats to the existing infrastructure of the Three Rivers Electric Cooperative. Three Rivers service territory is bordered on the north by the Missouri River and is crisscrossed by the Osage and Gasconade rivers. Significant portions of the service area are located in the 100 year floodplain. Figure 4 below depicts the 100 year floodplain in relation to the cooperative's boundaries. Currently, inundation data for levee failure is lacking due to issues surrounding mapping, appropriate models, and its close association with flooding events. Figure 5 below provides the location of known state and federal levees within the cooperative's boundaries. All levees are located along the Missouri River on the north border of the service area.

Figure 4

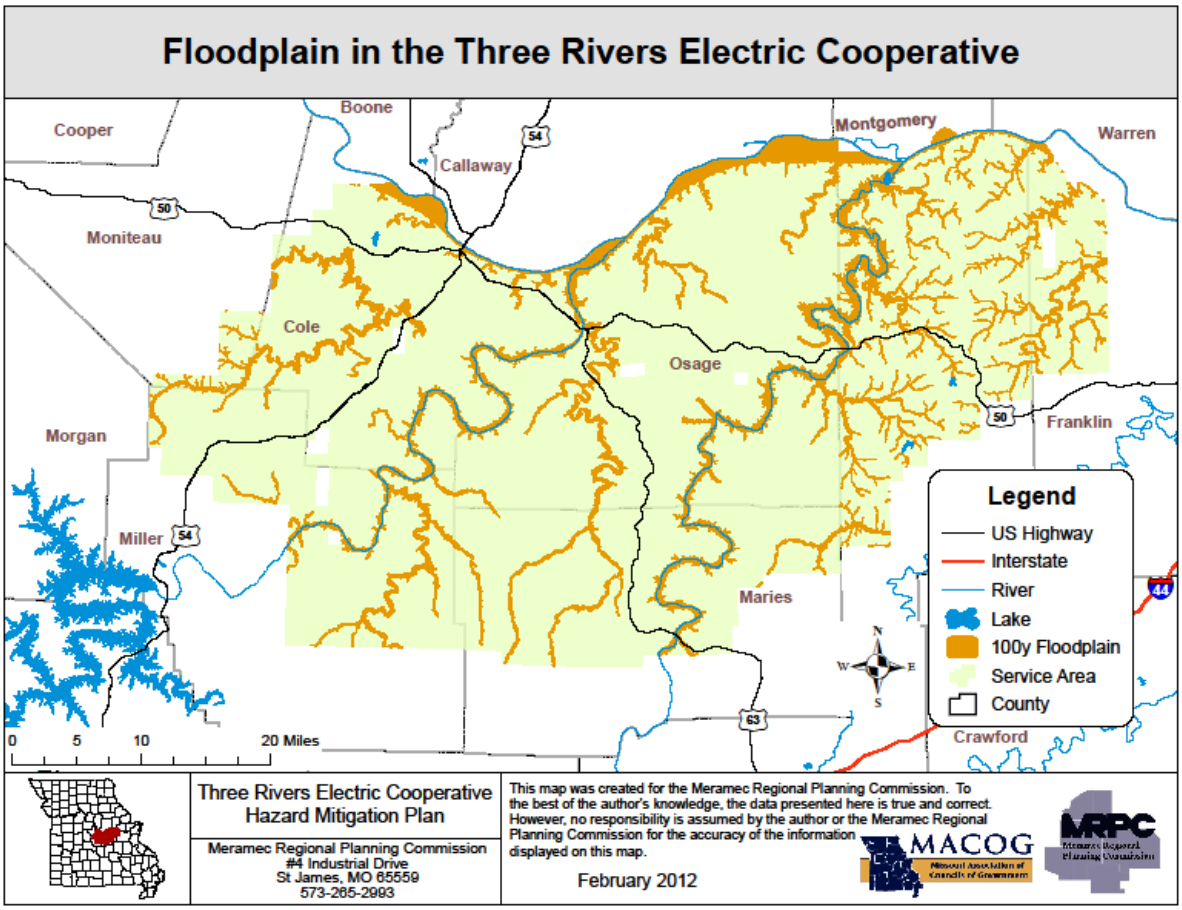
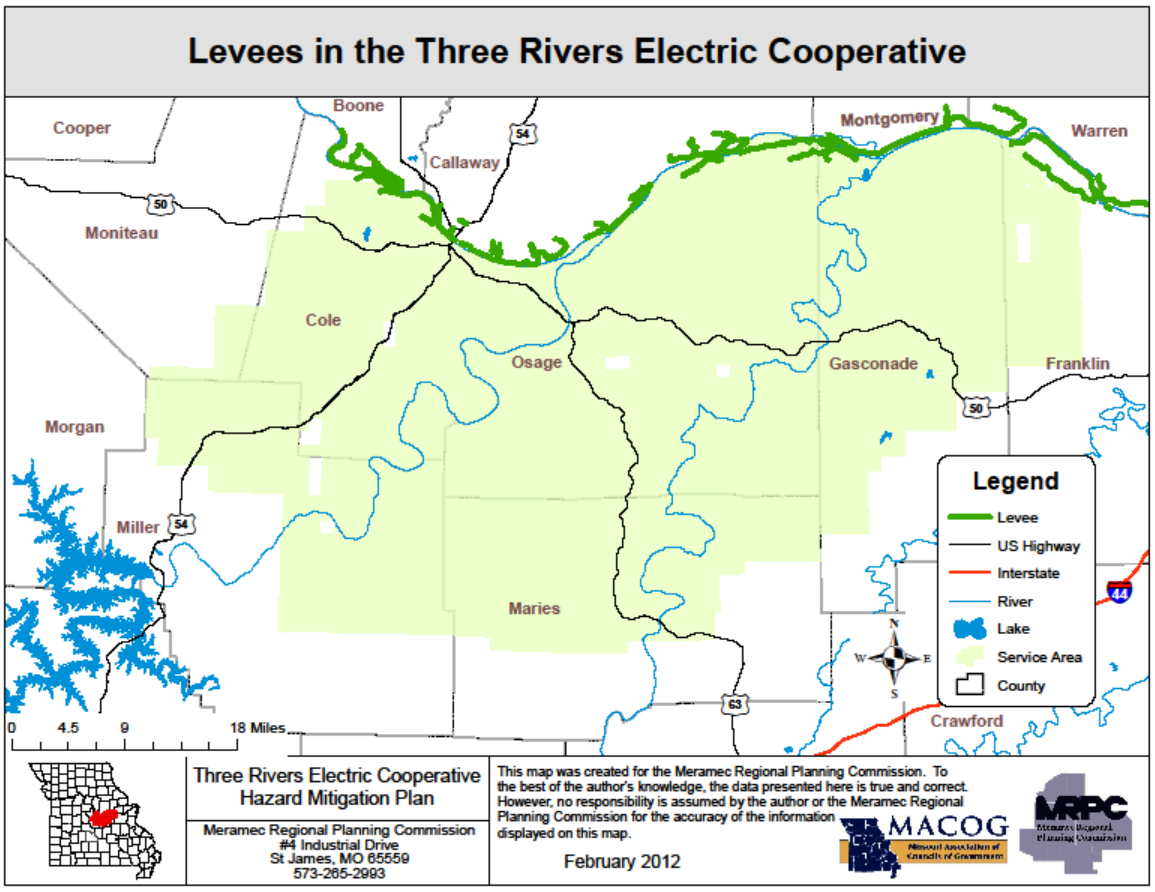


Figure 5



From 2003-2011, Three Rivers's service area has experienced 123 flooding events. Currently, no data concerning levee failure damage can be separated from flood damage data. Therefore, the probability of a flood/levee failure event affecting the cooperative assets in any given year is near 100% (123 events / 9 years = 1,366%). Estimated material damages associated with each of these events were compiled by Three Rivers staff. Table 1.14 summarizes flood event dates by month, damage cost estimates, and estimated reported outages. Outages are estimated because cooperative records do not include specific reasons for outages. Damage estimates are based solely on FEMA disaster declarations. One of the 123 occurrences caused damage to cooperative assets, resulting in a less than 1% probability that any given flood occurrence will produce damage. (1 / 123 = 0.8%)

Table 1.13	Three Rivers Flood Event Summary	
Event date	**Damage estimates**	**Outages reported**
March 2008	$1,129,000	300 (est.)
Data provided based on internal Three Rivers records which reflect cost from the referenced event year.		

Flood and levee failure events vary widely based upon numerous factors including, but not limited to, annual precipitation and extent of levee damage. Based upon historical records, the average flood/levee failure event to affect the cooperative will cause an average damage cost of $1,129,000 ($1,129,000 / 1 events = $1,129,000). This averaged amount accounts for less than 1% of Three Rivers' overhead asset valuation ($1,129,000

/ $223,663,170 = 0.5%). Table 1.14 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.14 **Three Rivers 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 300 customers reported outages during recorded flooding events since 1995. When compared with the total number of customers served by Three Rivers, it can be projected that 1% of all customers may report outages during any given flooding event. Table 1.15 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.15 **Three Rivers 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 2003-2011, Three Rivers's service area has experienced a total of 21 severe winter weather events, including significant snowfall and ice storms. Therefore, the probability of a severe winter weather event in the Three Rivers service area in any given year is near

100% (21 events / 9 years = 233%). Estimated material damages associated with each of these events were compiled by Three Rivers staff, but damage estimates are available from 2003-2011 only. Table 1.16 provides a summary of event dates, types, associated damage estimates, and reported outages. Nine of the 21 occurrences caused either damage to cooperative assets and/or outages, resulting in a 42.8% probability that any given severe winter weather occurrence will produce damage. (9 / 21 = 42.8%)

Table 1.16	**Three Rivers Severe Winter Weather Event Summary**		
Event date	**Event type**	**Damage estimates**	**Outages reported**
1/25/04	Winter storm		47
11/24/04	Winter storm		3,525
11/29/06	Winter storm		55
12/1/06	Winter storm		2
1/12/07	Ice storm	$597,000	6,765
1/20/07	Winter storm		347
12/8/07	Ice storm	$307,000	7,865
12/15/07	Snow		28
1/31/11	Winter storm		1
Data provided based on internal Three Rivers 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 $100,444 ($904,000 / 9 events = $100,444). This averaged amount accounts for less than 1% of Three Rivers' total overhead asset valuation ($100,444 / $223,663,170 = 0.044%). Table 1.17 demonstrates the probability of occurrence in conjunction with the potential extent of damage.

Table 1.17 **Three Rivers 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 887 customers reported outages during recorded severe winter weather events since 2003. When compared with the total number of customers served by Three Rivers, it can be projected that 4% of all customers may report outages during any given severe winter weather event. Table 1.18 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.18 **Three Rivers 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 Three Rivers service area presents a unique risk assessment. According to the Missouri Department of Conservation, Cole, Franklin, Gasconade, Maries, Miller, Moniteau and Osage counties have all experienced wildfires between 2004 and 2008. Although there is anecdotal information that wildfire has damaged some poles, Three Rivers does not have hard data on any wildfire damage that has occurred in the past ten years. Table 1.19 summarizes the incidences of wildfire within the seven counties. Therefore, the probability of a wildfire event in the Three Rivers Cooperative service area in any given year is near 100%. (860 events / 4 years = 21,500%). Although Three Rivers 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 1.20 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
Cole	43	8.6	1	103.05	21	0	Low
Franklin	334	66.8	3	914.74	183	7	Medium
Gasconade	48	9.6	1	395	79	2	Low
Maries	54	10.8	1	686.5	137	2	Medium-low
Miller	248	49.6	2	1457.16	291	5	Medium
Moniteau	74	14.8	1	368.91	74	1	Low
Osage	59	11.8	1	361.3	72	0	Low
Totals	860	35.6	1-2	4,286.66	857	17	Low

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 Three

Rivers service area. Between 2004 and 2008, 860 fires have burned a total of 4,286.66 acres, for an average of 4.98 acres affected per event. Three Rivers sustained no damage related to wildfires in its service area during this time period. Cooperative assets are located throughout the service area rather than being located at a single central site. With an average of 4.98 acres per fire in the service area, it is unlikely that infrastructure damage would exceed 1% based upon asset location and unlikeliness of an uncontrollable wildfire. This initial assessment assumes a limited impact upon electric distribution infrastructure of less than 10% (Table 1.20). Further study will be required to create a model for damage assessments related to wildfire.

Table 1.20 **Three Rivers 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 2004 and 2008. When compared with the total number of customers served by Three Rivers, it can be projected that less than 1% of all customers may report outages during any given wildfire event. Table 1.21 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.21 **Three Rivers Electric Cooperative Service Interruption 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 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 Three Rivers' 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 Three Rivers' 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 - VI intensity characteristics. In the event of an earthquake with a 7.6 rating, the region would experiences Level VI - VII intensity characteristic while an earthquake with an 8.6 rating would most likely cause Level VII - VIII intensity characteristics.

In the event of an earthquake with a 7.6 rating, the Three Rivers service area would most likely experience minor building damage as well as damage to the electrical distribution system. This damage, however, would most likely be relatively minimal and localized when compared with the southeast corner of the state. 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 1.22.

Table 1.22 **Three Rivers 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 3,000 - 5,000 customers could report outages related to an earthquake event. When compared with the total number of customers served by Three Rivers, it can be projected that 10 - 25% of all customers may report outages during any given seismic event. Table 1.23 demonstrates the probability of occurrence in conjunction with the potent extent of impact upon local customers.

Table 1.23 **Three Rivers 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 Three Rivers service area to date. According to Missouri DNR's Dam Safety Division, 345 dams currently exist within the cooperative boundaries: 33 in Cole County, 144 in Franklin County, 83 in Gasconade County, 30 in Maries County, 15 in Miller County, 19 in Moniteau County and and 21 in Osage County. Of these dams, eight in Cole County, 23 in Franklin County, 14 in Gasconade County, three in Maries County, two in Miller County, two in Moniteau County and one in Osage 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 6 shows the locations of all known dams located within Three Rivers's service area. *(Map sources: www.msdis.missouri.edu; www.dnr.mo.gov/env/wrc.)*

The dam with the potential to cause the most extensive damage in the event of failure is Bagnell Dam at the Lake of the Ozarks, on the southwestern border of Three Rivers' service area. This dam is part of a federally regulated system of reservoirs under the authority of the U.S. Corps of Engineers. Due to homeland security concerns, more detailed information on vulnerability in relation to this dam was not released.

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. 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).

Figure 6

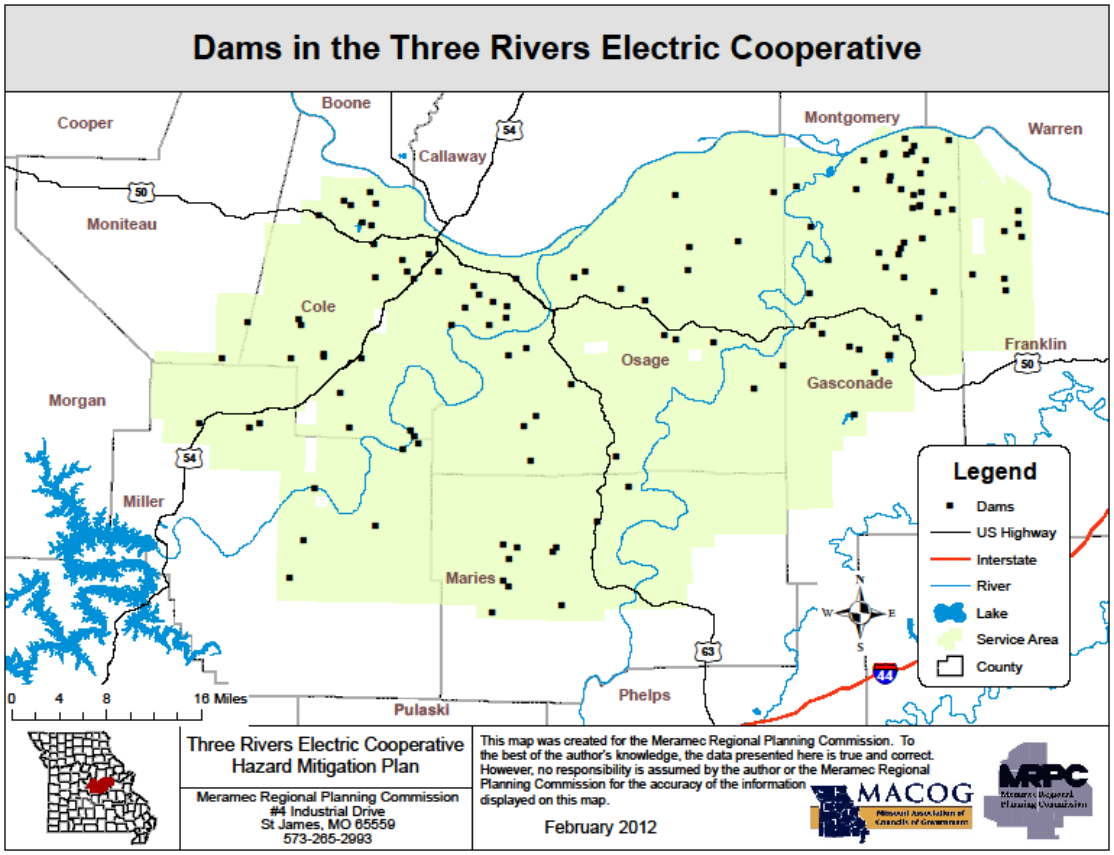


Table 1.25 **Three Rivers Electric Cooperative Infrastructure Vulnerability Assessment Matrix Hazard: Dam Failure**		Probability of Hazard Occurrence			
		Less than 1% in any given year	1-10% chance in any given year	10- 99% chance in any given year	Near 100% probability in any given year
Potential Extent 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 Three Rivers 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				

Section 6: Mitigation strategies

Previous efforts at mitigation

For organizations like Three Rivers, 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 build, 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. 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.

Existing and potential resources

As stated above, mitigation is a key component of good business practices. Three Rivers 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 Three Rivers 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, Three Rivers 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 Three Rivers 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 1.27 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 1.27	**THREE RIVERS 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 and maintain existing infrastructure.
	Objective 2: Research and develop plans for future infrastructure improvements, seeking implementation where feasible.

Table 1.27	THREE RIVERS goals and objectives
Identified Goals	**Identified Objectives**
	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 Three Rivers.
- **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 1.28, 1.29, and 1.30 provide lists of action items by tier as well as the goals and objectives identified with each.

Table 1.28 Prioritized Mitigation Actions for Three Rivers Electric Cooperative – Tier 1			
Tier 1			
Action item:	*Goal/Objective*	*Timeframe for completion*	*Cost-benefit score*
Use vegetation management to prevent interference with delivery of power.	Goal 1 / Objective 1 Goal 2 / Objective 1	Ongoing effort	Low cost High benefit Score: 9
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, guide wires. • Replacement or repair on poles, cross-arms, lines.	Goal 1 / Objective 1 Goal 2 / Objective 1	Ongoing effort	Low cost High benefit Score: 9

Table 1.28 Prioritized Mitigation Actions for Three Rivers Electric Cooperative – Tier 1			
Tier 1			
• Replacement of copper wire.			
Complete annual inspections of 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.	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.	Goal 1 / Objective 1 Goal 1 / Objective 2 Goal 2 / Objective 1 Goal 2 / Objective 2	Ongoing effort; Dependent upon funding.	Medium cost High benefit Score: 4

Table 1.29 Prioritized Mitigation Actions for Three Rivers 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 • Presentations • Publications	Goal 1 / Objective 1 Goal 4 / Objective 1	Ongoing effort	Low cost Medium benefit Score: 6
Increase number of generators owned for use in critical asset 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
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 1.30 Prioritized Mitigation Actions for Three Rivers 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

Table 1.30 Prioritized Mitigation Actions for Three Rivers Electric Cooperative – Tier 3			
Tier 3			
Collect GPS data for all existing infrastructure.	Goal 2 / Objective 1 Goal 2 / Objective 3 Goal 3 / Objective 1	Dependent upon additional funding.	High cost High benefit Score: 7
Utilize GIS technology to reduce site identification and response time.	Goal 2 / Objective 2 Goal 2 / Objective 3 Goal 3 / Objective 1	Dependent upon additional funding.	Medium cost Medium benefit Score: 5
Consider implementation of automated voice response systems to improve outage reporting.	Goal 1 / Objective 2 Goal 3 / Objective 1	Dependent upon additional funding.	High cost Medium benefit Score: 4
Monitor developments in data availability concerning the impact of dam failure and wildfire upon the THREE RIVERS 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 Three Rivers employment level as the organization strives to ensure quality service to their customers.

Other Local Planning Mechanisms

Beyond the Three Rivers plan, few planning mechanisms exist at the local level. The Missouri counties of Cole, Franklin, Gasconade, Maries, Miller, Moniteau and Osage 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). Three Rivers's plan can be easily incorporated into these local plans and allow for coordination across agencies in the event of an emergency.

Three Rivers is located within the rural portions of third-class counties which are prohibited from enforcing building codes and zoning by the state of Missouri. They do not provide service to any municipality within these counties. Comprehensive plans and Capital Improvement plans do not exist inside of the Three Rivers service areas.

Plan Maintenance

Three Rivers 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

Three Rivers 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 Three Rivers.