Bellows Falls Reliability Report 2022

Docket No. DE 21-004

May 2, 2022

Table of Contents

Section 1: Bellows Falls Area Assessment

The Bellows Falls area of Liberty's service territory is rural and residential, with a few small commercial town centers. It was historically supplied from a hydro generating plant developed at Bellows Falls on the Connecticut River by New England Power Company. The area contains two small load centers connected by a long circuit branch running along the Connecticut River. The two substations in the Bellows Falls area are Michael Ave 40 and Vilas Bridge 34. Michael Ave supplies approximately 1,736 customers via the 40L1 and 40L3 circuits. Vilas Bridge supplies approximately 3,757 customers via the 12L1 and 12L2 circuits. The following table shows a breakdown of the substations' supply, circuits, customer count, circuit miles, as well as circuit percent of the total area served in Bellows Falls.

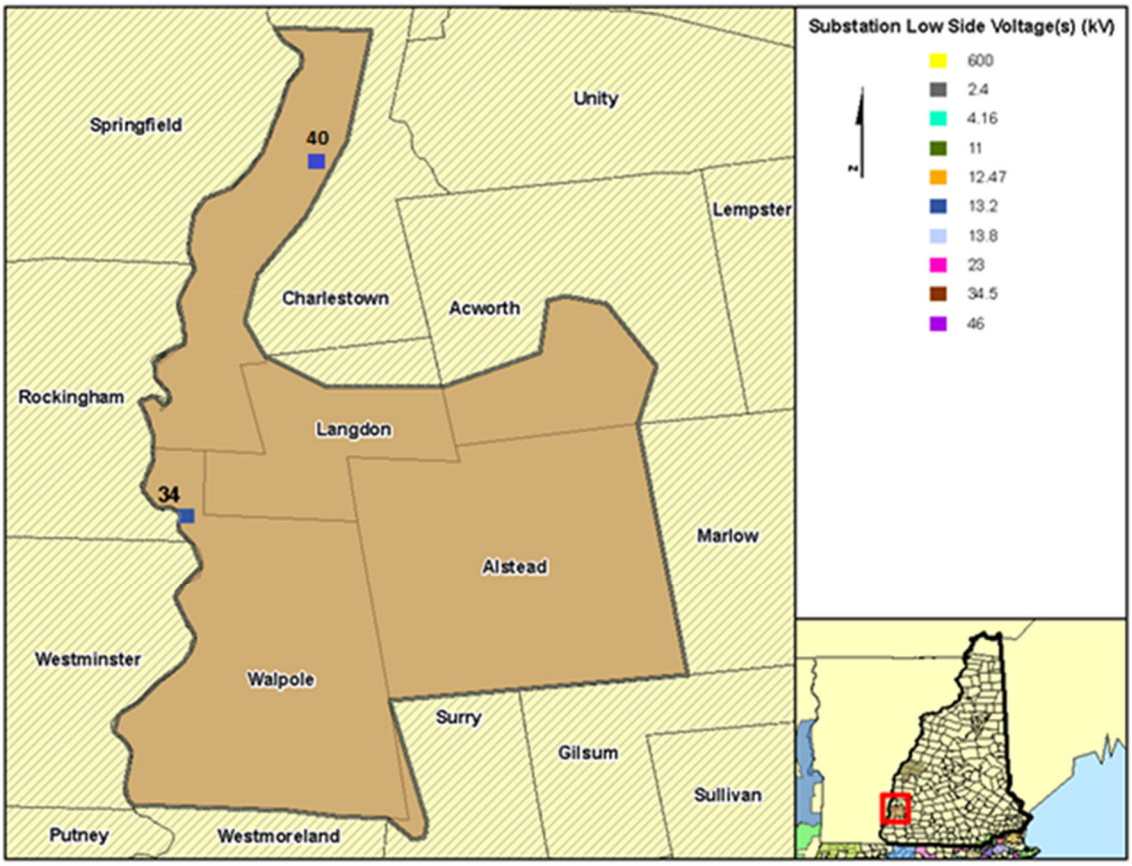
Table 1: Bellows Falls Substation Data

Supply	Alternate supply	Substation	Circuit	Customers	Circuit Length Miles	% of Area
4402	4401	Vilas Bridge (NGrid)	12L1	2471	128	54.74%
			12L2	1286	60	25.77%
W-149S	None	Michael Ave	40L1	544	15	6.22%
			40L3	1192	31	13.27%
			Total	5493	234	100.00%

Vilas Bridge 34 is a National Grid-owned and operated substation in Rockingham, Vermont. This substation sits across the Connecticut River from Walpole, New Hampshire. The two circuits from Vilas Bridge feed the towns of Walpole, Langdon, Alstead, Acworth, Westmoreland, Surry, and Marlow. These two circuits have one tie with each other close to the beginning of each circuit. The 12L1 shares the one tie with the 40L3. The 40L1 and 40L3 out of Michael Ave Substation have acceptable reliability and have multiple circuit ties to one another to aid in restoration switching should a main line fault occur.

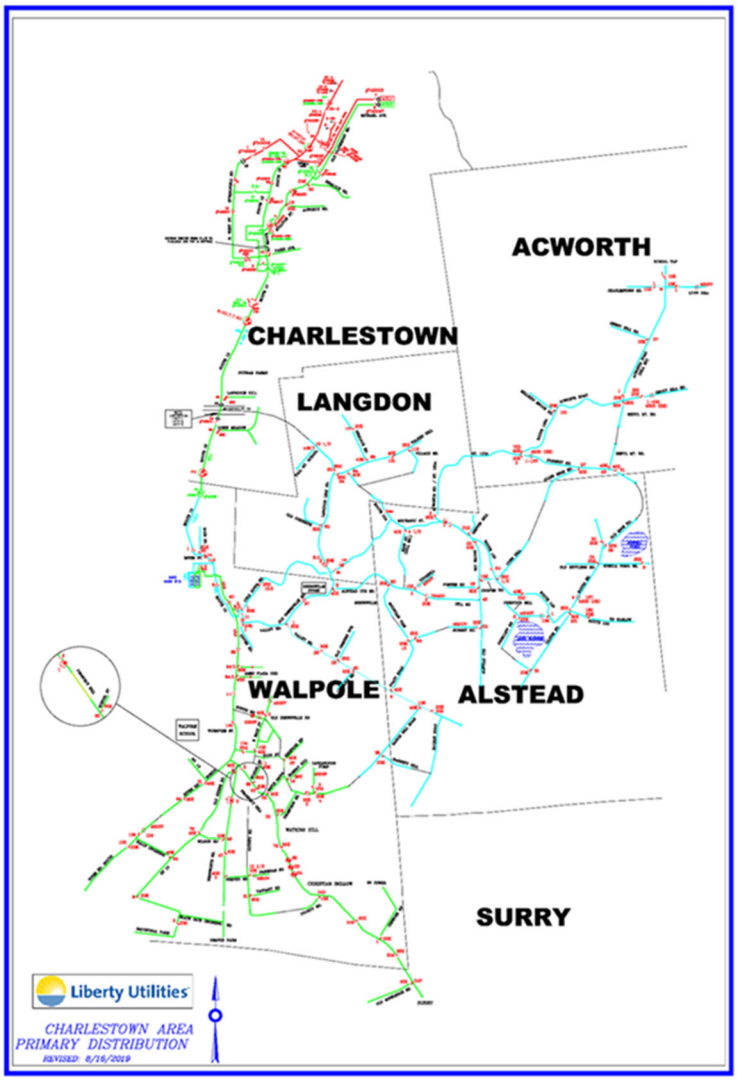
The following map shows the footprint of the areas served by the 12L1 and 12L2 (Vilas Bridge 34) and the 40L1 and 40L2 (Michael Ave 40).

Figure 1: Bellows Falls Geographical Map



The map below depicts the primary distribution of the Bellows Falls area. The 40L1 and 40L3 fed from the Michael Ave substation are to the north in red and green. The 12L1 and 12L2 are the central and southern portions in blue and green. The 12L1 and 12L2 cover a much greater portion of the territory versus the 40L1 and 40L3.

Figure 2: Bellows Falls 13.2 kV Distribution System



The 12L1 and 12L2 circuits are largely radial and single phase. Outage duration ultimately depends on the damage caused. For example, an outage caused by a tree limb contacting the overhead wires and causing a line fuse to operate will have a shorter restoration time than an outage caused by a fallen tree that has broken poles and has damaged the overhead wires and equipment. Without the ability to conduct isolation and restoration switching for a mainline fault, the entire customer base beyond the protective device upstream of the fault would be without

power for the duration of the repairs. Historically, the 12L1 and 12L2 circuits have had a higher number of outages as compared to other circuits due to the landscape being thickly wooded. The Company has completed some reconductoring in the area and installed pole top reclosers and cutout mounted reclosers to address reliability issues in the area.

The following figures depict the 12L1 and 12L2 circuit maps. Figure 3 below separates each circuit by color, the 12L1 in red and the 12L2 in yellow.

Figure 3: 12L1 and 12L2 Circuit Map

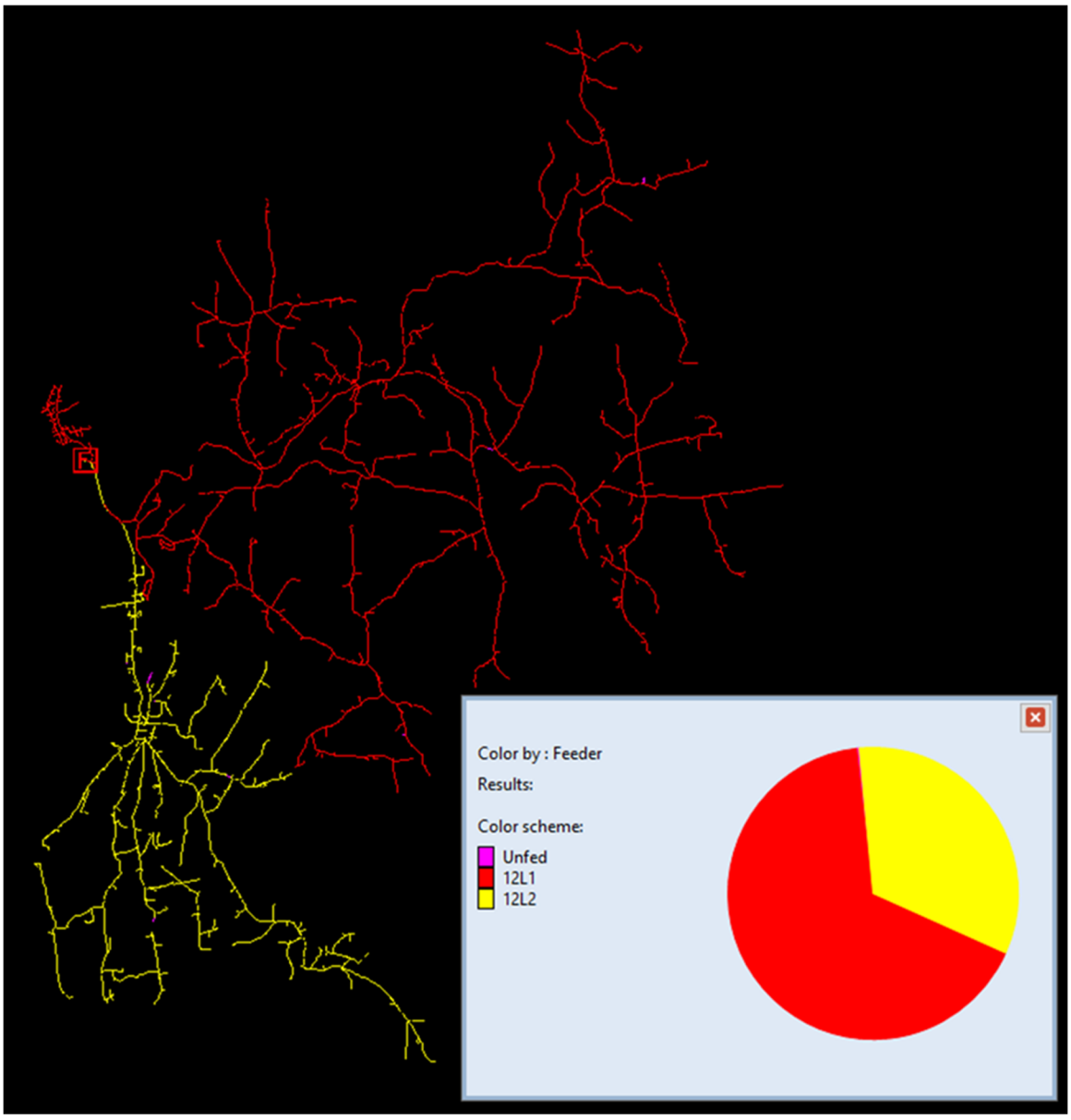
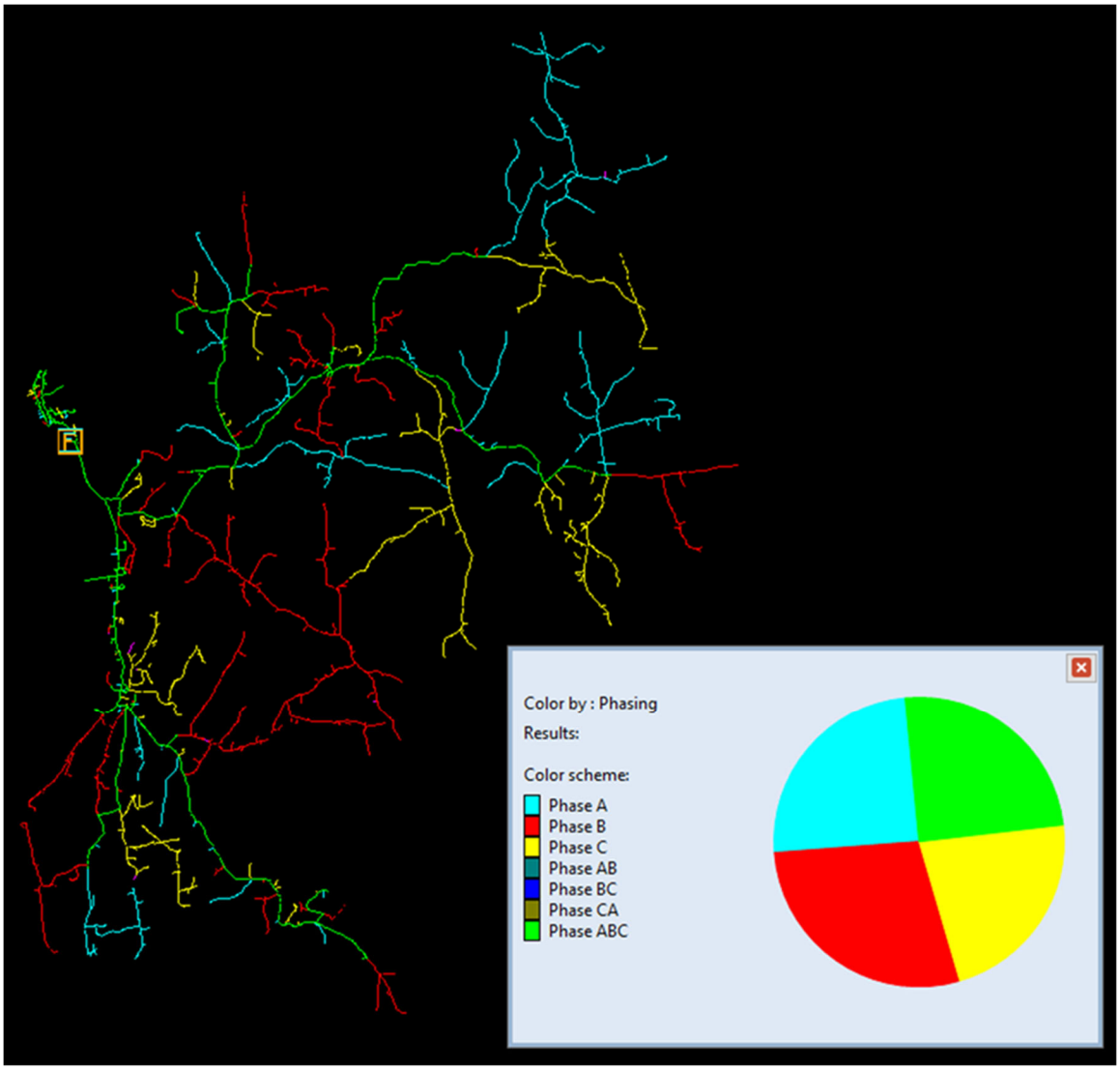


Figure 4 below provides the two circuits by phase. The Green color represents 3-phase circuit mainline for both the 12L1 and 12L2. There are no 3-phase ties between the 12L1 and 12L2. The limited number of single-phase circuit ties between 12L1 and 12L2 can result in increased customer restoration times should a main line permanent fault occur.

Figure 4: 12L1 and 12L2 Circuits by Phase



Section 2: Scope of Reliability Issues

As requested in the Commission's March 4, 2022, directing the Company to provide what measures Liberty has taken, or plans to take, to address certain reliability issues, the Company has identified reliability issues in the Bellows Falls area discussed further in this report, along with mitigation plans for 2022. The mitigation plans for 2022 are traditional wires solutions. The non-wires solution opportunities will be included in the Company's June 1, 2022, NWS Proposal Filing.

Reliability Issues Addressed in Report

- Outage counts
- Customer minutes interrupted
- Outage Causes

2022 Mitigation Plans

- Vegetation Management 12L2
- Reconductoring 12L2

Section 3: Problem Identification

Over 8% of Liberty's entire customer base is served from the 12L1 and 12L2 circuits, and these circuits account for approximately 68% of our Bellows Falls customers with the remaining 32% of the area customers being served by the 40L1 and 40L3 circuits. Although serving 8% of the Company's customer base, in 2021 the 12L1 and 12L2 circuits accounted for 20.87% of SAIFI and 40.86% of SAIDI system outage statistics, as provided in Table 5. The following table displays outage causes on the 12L1 and 12L2 for 2017 to 2021. The largest cause of outages for these circuits is vegetation-related, accounting for 62% of total incidents and 74% of total customer minutes interrupted (CMI).

Table 2 Outage Causes

Incident Count			Customer Minutes Interrupted		
Cause	12L1	12L2	Cause	12L1	12L2
Tree Fell	187	81	Tree Fell	4,234,376	2333193
Tree - Broken Limb	68	43	Tree - Broken Limb	952,467	340237
Animal	28	28	Vehicle	297,518	477952
Unknown	26	25	Device Failed	503,175	175361
Device Failed	30	16	Unknown	211,385	422053
Lightning	6	15	Deterioration	13,294	518573
Vehicle	11	8	Non-Company Activities	27,172	13248
Planned Outage	6	10	Insulation Failure - Cable	38,610	0
Deterioration	9	4	Animal	21,417	9851
Non-Company Activities	4	3	Lightning	2,002	24180
Vines	1	8	Planned Outage	4,963	3099
Tree Growth	1	1	Tree Growth	592	6336
Other Company Activities	1	0	Vines	410	0
Insulation Failure - Cable	1	0	Other Company Activities	1,014	0
Fire on Company Equip.	1	0	Fire on Company Equip.	374	0

The following table displays the Company's worst-performing circuits for the past five years. Note that the circuit statistics used for these measurements are a rolling five-year average (2017–2021), not individual year totals. As depicted in the table below, the 12L1 and 12L2 have been in the top five worst-performing circuits every year since 2018 with respect to CKAIDI (Circuit Average Interruption Duration Index). For CKAIFI (Circuit Average Interruption Frequency Index) the 12L1 and 12L2 have been in the top five worst-performing circuits numerous times over the last five years. The circuit labels in red denote that the circuit appeared the previous year, as well. A circuit on the worst-performing circuit list two years in a row is a "problem circuit," and three years in a row is a "chronic circuit." Both the 12L1 and 12L2 are chronic circuits for CKAIDI.

Table 3: Five Year Worst-Performing Circuits List

RANK	2017 WORST CKAIDI	2018 WORST CKAIDI	2019 WORST CKAIDI	2020 WORST CKAIDI	2021 WORST CKAIDI	2017 WORST CKAIFI	2018 WORST CKAIFI	2019 WORST CKAIFI	2020 WORST CKAIFI	2021 WORST CKAIFI
1	41-15H1	43-12L2	41-7L1	43-12L2	43-12L2	42-14L3	43-12L2	41-7L1	43-12L2	43-12L2
2	41-6L4	43-12L1	43-12L1	41-7L1	43-12L1	41-39L2	41-7L2	42-14L3	41-7L1	42-14L2
3	41-39L2	41-16L1	43-12L2	43-12L1	41-16L1	41-6L4	42-14L4	41-1L1	42-14L2	42-14L3
4	41-6L3	42-9L3	42-9L3	41-6L3	41-39L2	41-6L2	41-6L3	41-39L2	42-9L2	43-12L1
5	41-6L2	41-39L2	42-14L3	42-14L4	41-7L1	43-12L2	42-14L2	43-12L1	42-13L1	41-7L1

The table below is the current 2021 values for the worst-performing circuits. The 12L1 and 12L2 are on both CKAIDI and CKAIFI lists, and number one and two on CKAIDI by a wide margin. To give a full picture of the severity of this problem, the 12L2 circuit's CKAIDI is 363% of the Company's average circuit, and the 12L1 circuit's CKAIDI is 332% of the average circuit.

Table 4: 2021 Worst-Performing Circuits List CKAIDI and CKAIFI Values

	2021		2021	
RANK	Circuit	CKAIDI	Circuit	CKAIFI
1	43-12L2	415.86	43-12L2	1.91
2	43-12L1	379.89	42-14L2	1.36
3	41-16L1	181.09	42-14L3	1.34
4	41-39L2	171.04	43-12L1	1.31
5	41-7L1	170.13	41-7L1	1.29

The next table lists SAIDI and SAIFI from 2017 to 2021, as well as the combined contributions to those numbers from the 12L1 and 12L2. Though the 12L1 and 12L2 circuits account for 8% of Liberty's customer base, in the last five years they accounted for over 40% of SAIDI twice (2018 and 2021).

Table 5: Five Year SAIDI and SAIFI Values

Year	SAIDI	12L1 and 12L2 SAIDI	% of Total	SAIFI	12L1 and 12L2 SAIFI	% of Total
2017	117.74	23.56	20.01%	0.91	0.13	13.85%
2018	121.79	49.31	40.49%	0.74	0.11	15.04%
2019	70.66	18.59	26.31%	0.61	0.09	15.01%
2020	104.75	16.97	16.20%	0.85	0.11	12.89%
2021	114.46	46.76	40.86%	0.69	0.14	20.87%

Below are CKAIDI and CKAIFI tables for the 12L1 and 12L2. The dotted line shows the portion of the total value that was vegetation-related. Outages caused by fallen trees can be large contributors to CKAIDI due to the level of damage and the time it takes to remove the tree and make repairs. Note that the 4-year cycle circuit vegetation trimming was conducted on the 12L1 in 2018, and on the 12L2 in 2017. CKAIDI and CKAIFI on the 12L1 showed some improvements to tree-related outages after trim cycle was conducted. The 12L1 is a much larger circuit, with twice the customers as the 12L2. The 12L2 circuit has tree-resistant wire from the Vilas Bridge substation up to where it branches off to the three-phase branches to the south. The 12L1 still has pockets of bare wire on the main line and is more radial than the 12L2.

Table 6: Five Year CKAIDI 12L1 and 12L2

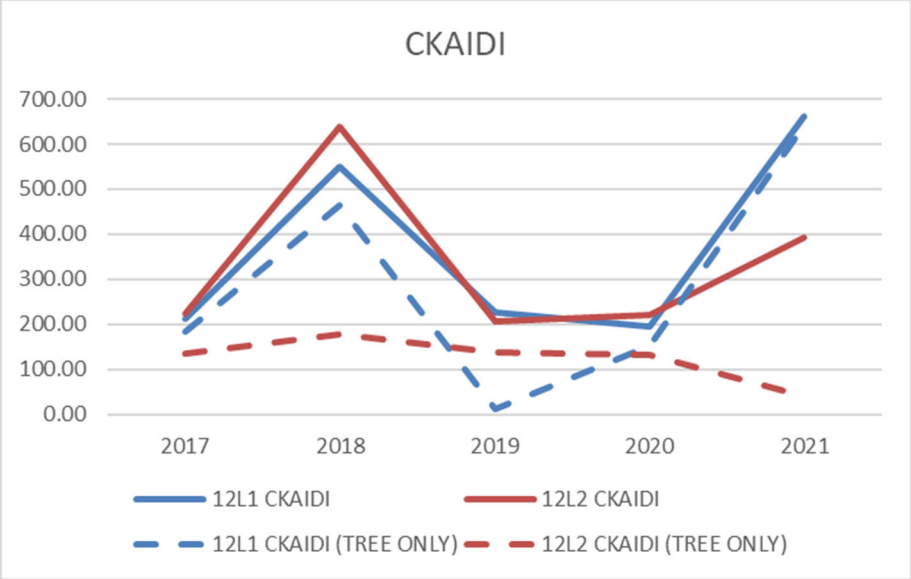
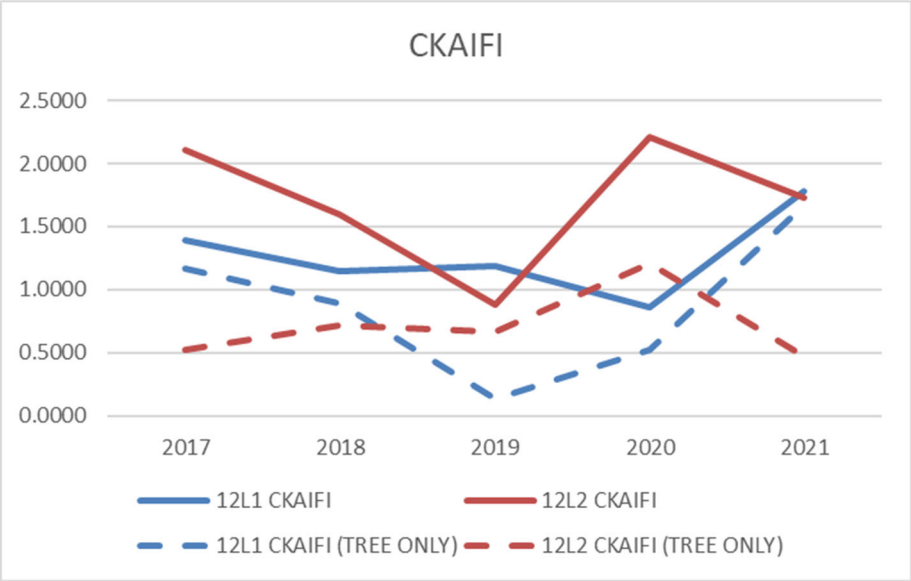
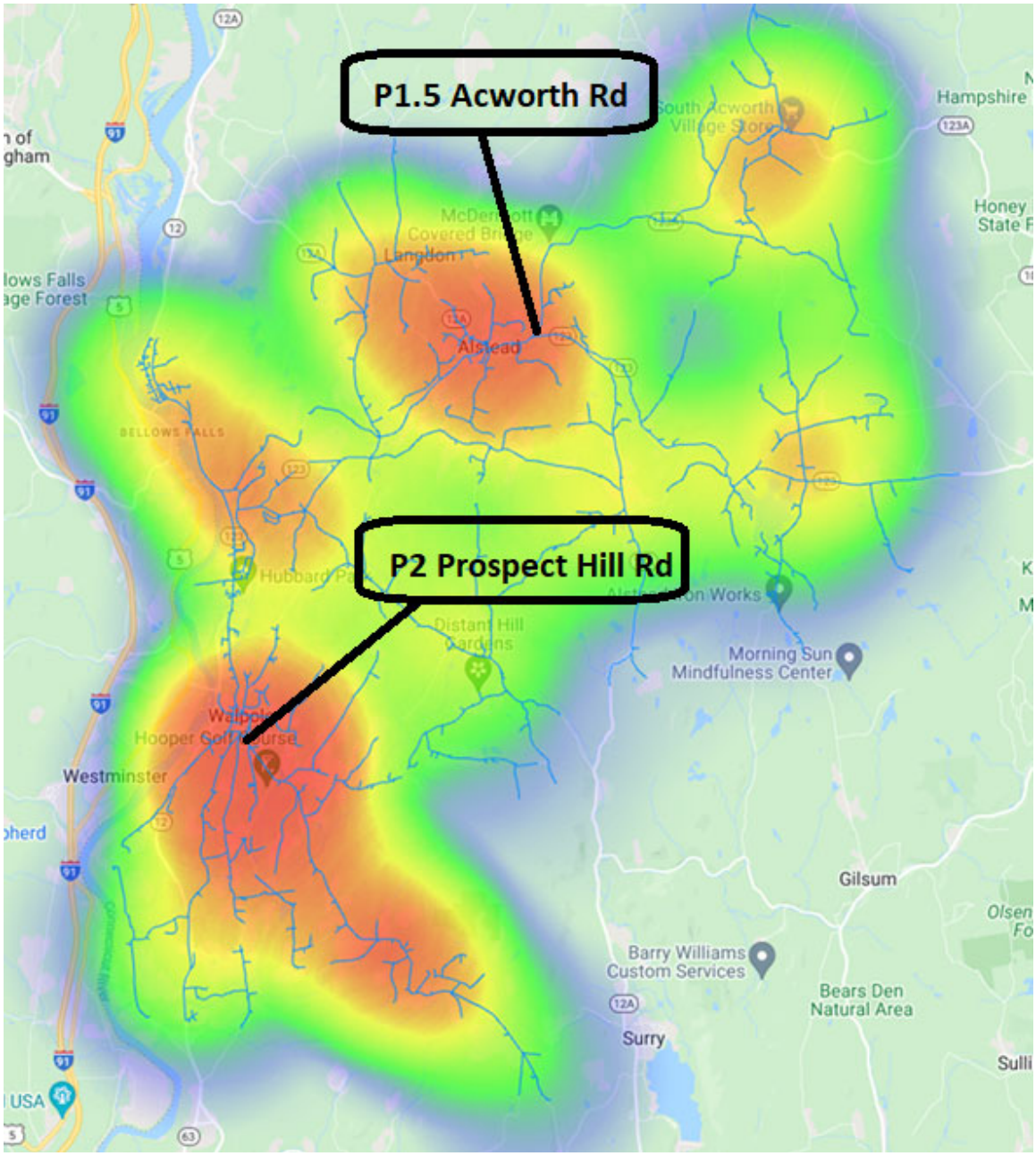


Table 7: Five Year CKAIDI 12L1 and 12L2



In the figure below, 2017 through 2021 outage data is plotted on a map utilizing the Hexagon platform that shows the pockets through a heatmap of poor performance in the Bellows Falls area. The heatmap below shows one large and dark pocket on 12L1 and one on the 12L2. The pocket on the 12L1 is fed from a pole top recloser at pole 1.5 Acworth Road., Alstead. The 12L2 area is fed from a pole top recloser at pole 2 Prospect Hill Road., Walpole. There have been multiple, and quite lengthy, outages at these two locations over the years. Both locations are radial and are still fed with bare primary conductor.

Figure 5: Five Year Outage Heatmap



Section 4: 2022 Mitigation

In 2022, the Company has two traditional solutions it is working toward to help mitigate the reliability issues in the Bellows Falls area. The first is the cycle trimming of the 12L2. This circuit is approximately 55 miles long and is the main focus of trimming for 2022.

The second traditional solution the Company is working towards in 2022 is reconductoring the 12L2. Bare mainline primary conductors are targeted for replacement with spacer cable. Spacer cable is installed in areas prone to tree outages that are too costly to rely on vegetation management practices alone to mitigate circuit lockouts. The application of spacer cable, a covered conductor resistant to tree-related outages, significantly improves mainline circuit performance during windy and stormy conditions as well as affording protection against incidental tree-conductor contact at the end of the trim cycle and contact resulting from branches falling from above the trim zone.

This project replaces primary overhead bare conductors with spacer cable in areas prone to tree contact. The scope of this strategy includes the replacement of at least 1.5 miles of bare wires on the 12L2 circuit along Watkins Hill Road in Walpole, which is considered a pocket of poor performance on this circuit.

Section 5: Conclusion

In conclusion, the Company has identified that the 12L1 and 12L2 circuits that serve the Bellows Falls area have low reliability, significant tree issues, and the inability to switch load during an outage due to the lack of circuit ties. As such, the Company is continuing to look at wires and non-wires solutions to address the reliability problems over the next 0–5 years.