2015 McClellanville Study

Prepared for Berkeley Electric Cooperative, Inc

By McCall Thomas Engineering, Inc

Background

The McClellanville area has historically been, and continues to be, served by a twenty-six (26) mile, 25 kV distribution circuit from SCE&G's Hamlin Substation. In the past ten (10) years, the area served by Berkeley Electric Cooperative (BEC) from Mt. Pleasant through Awendaw and around the town of McClellanville has experience rapid growth. While some areas of the BEC system experienced very little growth during the recent recession, this area has continued to grow. Large tracts of land that could be developed remain in the area so the current growth rate is expected to continue well into the future.

To meet this continuing growth and to improve reliability to its members in the area, BEC has purchased a substation site in the McClellanville area with plans to retire the Awendaw Delivery Point from SCE&G. For a number of years, Central Electric Cooperative, Inc. (CECI) has been working to provide transmission service to BEC's McClellanville Substation site and has encountered many obstacles. Given the opposition to the current proposed northern transmission route along Highway 17 by the public and environmental groups, CECI is exploring an alternate transmission route from the west. Given the uncertainty in the final transmission route and the time that will be required for environmental analysis, right-of-way acquisition and construction of the line, it may be many years before the McClellanville Substation has transmission service.

Study Scope

McCall-Thomas Engineering Co, Inc. (MCT) has been retained by BEC to look at the options for long-term service to the McClellanville area assuming transmission service to the McClellanville Substation is delayed indefinitely.

This study will analyze the McClellanville/Commonwealth/Jamestown area and determine the following:

1. The maximum number of years and area load for which the McClellanville Substation can be delayed without violating distribution facility loading and voltage criteria, assuming all

other Projects identified in the current Construction Work Plan (CWP) are constructed as planned.

2. The alternative distribution projects, schedules and costs necessary to serve the area over the next ten (10) to fifteen (15) years while maintaining all distribution facilities within their loading and voltage criteria.
3. The advantages and disadvantages of each set of alternative projects, and recommendations for the proposed projects BEC should construct, assuming the McClellanville Substation is delayed indefinitely.

Assumptions

A banded load forecast approach will be used in this Study to reflect a high, median, and low Load Forecast for the Commonwealth, Awendaw, and McClellanville areas. Growth rates in these areas have varied from 4.40% to 9.34% in the last LRP and last two (2) CWPs and reflect pre-recession, recession, and post-recession growth rates. The Jamestown area has been relatively constant during this period at a 1.02% growth rate. Growth rates for Commonwealth, Awendaw and Jamestown along with their 2018 peak loads are as follows:

Commonwealth Area	36,505 kW 2018 Peak	4.32%, 6.83%, 9.34%
Awendaw Area	6,711 kW 2018 Peak	4.32%, 6.83%, 9.34%
Jamestown Area	8,895 kW 2018 Peak	1.02%

Balancing the phase loads on the feeders in this study will be critical and can result in significantly lower line ratings. For this study, all feeders are assumed to have phase loads within 15% from highest to lowest. This will reduce the line kVA ratings to 85% of their balanced ratings.

The Awendaw Delivery Point and the Commonwealth Circuit #8 provide backup service to each other. Based on BEC design criteria, this will limit the loading on each of these circuits to 50% of their rating.

The CWP has a number of critical projects planned in this area which are assumed to be constructed as scheduled. The new Long Point Substation is the most critical of these projects as

it will reduce the load on the Commonwealth Substation from 36,505 kW to 18,982 kW. This will allow the possibility of additional load in the Awendaw/McClellanville area to be served from the Commonwealth Substation.

The estimated cost of facilities identified in this study will be based on the cost estimates listed in Section 2.2.0 Distribution Line Equipment Cost in the latest CWP. These cost estimates are in 2014 dollars and must be escalated to the appropriate year. Over the past several years the inflation rate has been 3% which is historically low. For this Study, a high, median and low annual inflation rate of 7%, 5%, and 3% are used to produce a range of projected costs. The annual inflation rates are used to escalate project costs to the year the projects must be constructed and energized.

Current System

Awendaw Delivery Point – The Awendaw Delivery Point is served by a twenty-six (26) mile 23.9 kV distribution line from SCE&G's Hamlin Substation. The conductor size of the line is a combination 477 SAC overhead and 750 Al underground, and the line has a thermal rating of 536 amps or 18,860 kVA. From the Awendaw Delivery Point, BEC has constructed a short 477 ACSR overhead line to a set of regulators located adjacent to Highway 17. The 477 ACSR line has a thermal rating of 670 amps or 24,600 kVA. Another short section of 477 ACSR overhead line connects the regulators to the main distribution line which runs north and south parallel to Highway 17. The conductor size of the main line is 477 ACSR which has a thermal rating of 670 amps; however, the disconnect switches installed at various location along this main line are only rated 600 amps or 22,030 kVA. A set of disconnect switches is located just south of the regulators and separates the Awendaw service area from the Commonwealth service area.

The Awendaw Metering Point is projected to serve 6,760 kVA in 2018. Given the current switching arrangement, the Awendaw Delivery Point only serves load north of the Awendaw Delivery Point Station, while Commonwealth Circuits #7 and #8 serve the load south of the Awendaw Delivery Point Station back to Commonwealth Substation. A set of switches outside the Awendaw Delivery Point Station allows the distribution line from Circuit #8 of the Commonwealth Substation to provide backup service to the Awendaw Delivery Point and vice

versa. Also, Commonwealth Circuits #7 and #8 are able to provide backup service to each other as well.

Commonwealth Substation – The transmission service to the Commonwealth Substation is provided by the SCE&G 115 kV transmission line that also provides transmission service to SCE&G's Hamlin Substation. The Commonwealth Substation contains one 24,000/32,000/40,000/44,800 kVA power transformer. There are eight (8) 25 kV circuits at the substation with Circuits #7 and #8 serving the load north of the Commonwealth Substation to the Awendaw Delivery Point. Commonwealth Circuits #7 and #8 also have switching capability to provide backup service to each other. The conductor size on Circuits #7 and #8 is a combination of 750 Al underground and 477 ACSR overhead with a thermal rating 536 amps or 19,655 kVA.

The Commonwealth Substation is projected to serve 18,982 kVA in 2018, assuming the Long Point Substation is constructed in the next four (4) years and 17,523 kVA of load is transferred from the Commonwealth Substation to the Long Point Substation. Commonwealth Circuit #7 is projected to serve 5,603 kVA of load in 2018. It serves the load north of the Commonwealth Substation along Highway 17 to a point near the second intersection of Highway 17 and Seewee Road. Circuit #8 is projected to serve 6,224 kVA of load in 2018. It serves load along Seewee Road and then returns to Highway 17 where it ties back into the disconnect switches at the Awendaw Delivery Point.

Jamestown Delivery Point – Santee Cooper provides BEC the Jamestown Delivery Point at a bay in its Jamestown 115-12.47 kV Substation. The thermal rating of the breaker and switches at the bay are 600 amps or 12,959 kVA. From the Jamestown Delivery Point, BEC has a set of regulators and two (2) short 336 ACSR circuits to Highway 45. The 336 ACSR conductor has a thermal rating of 530 amps or 11,447 kVA. The loading on the east circuit is 3,844 kVA and serves load along and adjacent to Highway 45 toward McClellanville. The loading on the west circuit is 4,939 kVA and serves load along Highway 17-A toward Macedonia and Highway 41. There is no distribution line connection between Jamestown and McClellanville. In addition, Jamestown voltage is 12.47 kV while the McClellanville voltage is 24.94 kV.

Future System Loads

As mentioned in the assumptions, Commonwealth and Awendaw area loads will be calculated for a low, median, and high case. The Tables below show the projected loads by year assuming the annual growth rate of 4.40%, 6.87%, and 9.34% after 2018. In 2018 the Commonwealth Substation is projected to have 18,982 kVA, with Circuit #7 projected to serve 5,603 kVA while Circuit #8 is projected to serve 6,224 kVA. The Awendaw Delivery Point is projected to serve 6,760 kVA in 2018. Below are the projected loads for each of these four (4) locations.

TABLE 1 – Low Annual Growth Rate – 4.40%

YEAR	COMMONWEALTH SUBSTATION	CIRCUIT 7	CIRCUIT 8	AWENDAW DP
2018	18,982	5,603	6,224	6,760
2019	19,817	5,850	6,498	7,057
2020	20,689	6,107	6,784	7,368
2021	21,599	6,376	7,082	7,692
2022	22,550	6,656	7,394	8,031
2023	23,542	6,949	7,719	8,384
2024	24,578	7,255	8,059	8,753
2025	25,659	7,574	8,413	9,138
2026	26,788	7,907	8,784	9,540
2027	27,967	8,255	9,170	9,960
2028	29,198	8,618	9,574	10,398
2029	30,482	8,998	9,995	10,856
2030	31,824	9,393	10,435	11,333
2031	33,224	9,807	10,894	11,832

TABLE 2 – Median Annual Growth Rate – 6.87%

YEAR	COMMONWEALTH SUBSTATION	CIRCUIT 7	CIRCUIT 8	AWENDAW DP
2018	18,982	5,603	6,224	6,760
2019	20,286	5,988	6,652	7,224
2020	21,680	6,399	7,109	7,721
2021	23,169	6,839	7,597	8,251
2022	24,761	7,309	8,119	8,818
2023	26,462	7,811	8,677	9,424
2024	28,280	8,347	9,273	10,071
2025	30,223	8,921	9,910	10,763
2026	32,299	9,534	10,590	11,503
2027	34,518	10,189	11,318	12,293
2028	36,889	10,889	12,096	13,137
2029	39,424	11,637	12,927	14,040
2030	42,132	12,436	13,815	15,004
2031	45,026	13,291	14,764	16,035

TABLE 3 – High Annual Growth Rate – 9.34%

YEAR	COMMONWEALTH SUBSTATION	CIRCUIT 7	CIRCUIT 8	AWENDAW DP
2018	18,982	5,603	6,224	6,760
2019	20,755	6,126	6,805	7,391
2020	22,693	6,699	7,441	8,082
2021	24,813	7,324	8,136	8,837
2022	27,131	8,008	8,896	9,662
2023	29,665	8,756	9,727	10,564

2024	32,435	9,574	10,635	11,551
2025	35,465	10,468	11,628	12,630
2026	38,777	11,446	12,715	13,810
2027	42,399	12,515	13,902	15,099
2028	46,359	13,684	15,201	16,510
2029	50,689	14,962	16,620	18,052
2030	55,423	16,359	18,173	19,738
2031	60,600	17,887	19,870	21,581

Current Facility Capability

The thermal ratings of the distribution facilities serving the McClellanville area are listed below. The first thermal rating is the maximum continuous rating, while the second thermal rating is 50% of the maximum continuous rating based on BEC's design criteria for main circuits providing backup service. All of these main circuits provide backup service to adjacent main circuits. Again, this assumes no more than a 15% phase imbalance on each circuit. The thermal ratings in bold below are used in the study analysis to determine when additional distribution facilities need to be constructed.

- SCE&G service to the Awendaw Delivery Point – **18,860 kVA**.
- 477 ACSR overhead main feeder along Highway 17 – 22,030 kVA or **11,015 kVA at 50% loading**.
- Commonwealth Circuit #7 and #8 – 19,680 kVA or **9,840 kVA at 50% loading**.
- Commonwealth Substation Transformer – 24,000/32,000/40,000//44,800 kVA or **35,840 kVA at 65 degree rise and FA**.

Results

Study Objective 1 - Determine the maximum number of years and area load for which the McClellanville Substation can be delayed without violating distribution facility loading and voltage criteria, assuming the Projects identified in the current CWP are constructed as planned.

The maximum area loading will occur when either the Awendaw Delivery Point loading reaches 11,015 kVA or the Commonwealth #7 or #8 circuit loading reaches 9,840 kVA. This will occur in 2023 in the high load case, 2025 in the median load case, and 2029 in the low load case. The area loading in all three cases will be approximately 41,000 kVA.

Study Objective 2 - Identify the alternative distribution projects, schedules, and costs necessary to serve the area over the next ten (10) to fifteen (15) years while maintaining all distribution facilities within their loading and voltage criteria.

Commonwealth Circuit #8 is projected to exceed 50% of its thermal rating between 2023 and 2029 depending on the annual growth rate. In addition, the circuit from the Awendaw Delivery Point and the main circuit along Highway 17 are all operating above 95% of their 50% rating criteria; therefore, shifting load from Commonwealth Circuit #8 to the Awendaw Delivery Point is not an option. At this point, additional distribution capacity will need to be built to the area served by the Awendaw Delivery Point.

There are two (2) options to provide additional distribution capacity into the Awendaw Delivery Point area. The two (2) options are listed below with projects and estimated costs identified for each option.

Option 1 is to construct one 750 Al underground circuit from the Commonwealth Substation to the intersection of Highways 17 and 45 near the town of McClellanville. Add another bank of regulators near the intersection of Highway 17 and Highway 45 to provide voltage support for the new circuit from the Commonwealth Substation. Also, an additional transformer will be needed in the Commonwealth Substation which is also nearing its design criteria loading.

Option 2 is to construct a new Jamestown 115-24.94 kV Substation with a 15,000 kVA power transformer and four (4) bays. Next, construct one (1) 750 Al underground circuit from the new Jamestown Substation along Highway 45 to the intersection of Highway 17 near the town of McClellanville. Add another bank of regulators near the intersection of Highway 17 and Highway 45 to provide voltage support for the new circuit from the new Jamestown Substation.

Option 1 Cost

Project 1 – Install a new electronic recloser and regulator in the Commonwealth Substation for the new circuit to McClellanville. The estimated cost is $76,700 in 2014 dollars.

Project 2 – Install a new 24,000/32,000/40,000//44,800 kVA transformer in the Commonwealth Substation. The estimated cost is $775,000 in 2014 dollars.

Project 3 – Construct a 23.2-mile 750 Al underground circuit from the Commonwealth Substation along Highway 17 to Highway 45 near the Town of McClellanville. The estimated cost is $11,948,000 in 2014 dollars.

Project 4 – Install a bank of three (3) 432 kVA voltage regulators near the intersection of Highway 17 and Highway 45 to provide voltage regulation for the new circuit from Commonwealth. The estimated cost is $45,000 in 2014 dollars.

Total Cost for Option 1 is $12,844,700 in 2014 dollars with a median cost of $21,969,000 in year 2025 and a range of costs from $16,760,000 - $33,120,000 depending on the year the projects are installed and the actual annual inflation rate.

Option 2 Cost

Project 1 - Construct a new 115-24.94 kV substation at Jamestown with a 15 MVA transformer and four (4) 24.94 kV circuits. The estimated cost is $2,277,700 in 2014 dollars.

Project 2 – Construct a 19.9-mile 750 Al underground line from Jamestown along Hwy 45 to Highway 17 near the Town of McClellanville. The estimated cost is $10,248,500 in 2014 dollars.

Project 3 - Install a bank of three (3) 432 kVA voltage regulators near the intersection of Highway 45 and Highway 17 to provide voltage regulation for the new circuit from Jamestown. The estimated cost is $45,000 in 2014 dollars.

Total Cost for Option 2 is $12,571,200 in 2014 dollars with a median cost of $21,501,000 in year 2025 and a range of costs from $16,403,000 - $32,415,000 depending on the year the projects are installed and the actual annual inflation rate.

At the current growth rate, either of these two (2) options will provide an additional ten (10) to fifteen (15) years of growth before transmission service to the McClellanville Substation will be required. Either of these sets of improvements will provide BEC a hedge for the transmission service uncertainty; however, either of these two (2) sets of improvements will become only marginally beneficial to BEC and somewhat of a stranded cost once transmission service is established to BEC's McClellanville Substation.

Study Objective 3 - List the advantages and disadvantages of each set of alternative projects.

The advantages of Option 1 are:

- There is an existing unused bay at the Commonwealth Substation and only a breaker and set of regulators need to be added to the substation for the new circuit.
- The new circuit will be built along Highway 17 which has very wide right-of-way and road shoulders within which to work.
- BEC has existing lines and right-of-way from Commonwealth Substation to Highway 41 so no new environmental work is necessary.

The disadvantages of Option 1 are:

- The transmission service will be the same as the other two (2) distribution circuits in the McClellanville area.
- There is no backup distribution service from another substation area.
- There will be inherently less reliable service during major weather events due to a lack of diversity in transmission and distribution.

The advantages of Option 2 are:

- Transmission service will be provided by Santee Cooper.
- Transmission service to Jamestown is looped between Jefferies and Winyah generation stations on the Santee Cooper system.
- Transmission service at Jamestown is twenty (20) miles from the coast and not as vulnerable to damage during major weather events.
- The distribution line from Jamestown provides service and backup service to McClellanville from an adjacent substation area.
- Santee Cooper has agreed in principle to lease a part of their existing substation property to BEC for a new 115-24.94 kV substation.

The disadvantages of Option 2 are:

- A new substation at Jamestown will need to be constructed.
- The Highway 45 road shoulder is relatively narrow making construction somewhat more difficult.
- BEC does not have a distribution line for 6.1 miles of the 19.9 miles along Highway 41 between Jamestown and Highway 17 so some environmental work is necessary.
- There are four (4) to six (6) creeks and wetlands areas along Highway 45 that must be drilled under.
- The new line must cross approximately five (5) miles of National Forest Service Wambaw Swamp Wilderness area.

Recommendation

The existing facilities serving the Commonwealth, Awendaw, and McClellanville areas are capable of serving 41,000 kVA. Once the area loading exceeds this limit, I recommend the Option 2 projects be constructed should the transmission service to McClellanville be delayed beyond 2020 assuming a high growth rate, or if load levels reach 9,800 kVA on Commonwealth Circuit #8 or 11,000 kVA on the Awendaw Delivery Point. These projects are the lowest cost option and provide the greatest benefit. The substation construction will take three (3) years so a decision to move forward needs to be made in 2020 to allow time for necessary permitting and construction of all projects identified in Option 2. This plan should be reviewed in the next Construction Work Plan.