# I. EXECUTIVE SUMMARY

## A. PURPOSE OF THIS REPORT

In 2003 Okanogan Electric Cooperative commissioned a long range planning study of the Mazama Feeder by D'Hittle and Associates. In that study an orderly feeder improvement plan was developed assuming moderate growth over the decade. The feeder experienced a fairly high growth rate during that time frame and had a peak load of 5.7 MW during the winter of 2009. The feeder peak load in 2009 exceeded the name plate rating of the step up transformer installed outside of the Winthrop Substation. This was several years before the study had indicated that the feeder levels would reach these levels. This prompted concern by the Cooperative's staff that the existing plan for the Mazama Feeder might be out of date. This report is an update to the original 2003 study and provides two alternative approaches and the costs to adequately serve the potential load growth on the Mazama Feeder.

## B. APPROACH USED

The approach used in this study is different than that used in 2003 study prepared by D'Hittle and Associates. This study does not merely project future load cases off of regression analysis data point extension as the previous study did. Recent history, with the housing bubble and its corresponding burst and fall in housing prices nationwide and its ensuing recession has shown us that load growth occurs in "fits and starts" and not in a smooth predictable fashion. Because of this, we use a land use study approach which looks at existing vacant platted lots, and potential development of dwelling units to size the maximum theoretical build out load potential of the area. By looking at the existing member count on the feeder during the last peak we determine the average diversified load per member in kW and can use this information along with the number of potential new dwelling units to develop a maximum full build out load for the feeder. Regression analysis is used to determine the range of years it might take the feeder to reach its full build out potential.

Okanogan Electric Cooperative's ESRI GIS system database was used to create a computer model of the Mazama Feeder in Milsoft's Windmil™ distribution analysis software. Each line section, type of conductor, and transformer is modeled in the software. Present system peak loads are allocated based on a transformer's connected kVA using load control points at the Mazama Feeder Breaker, the Weeman Bridge Recloser, and the Mazama Voltage Regulators. The system is then analyzed at present loads and problems identified.

Future loads associated with vacant undeveloped lots in existing subdivisions are added to the model as discrete spot loads in the geographic area of each subdivision to obtain the system load at full build out of existing subdivisions. The unidentified area loads associated with future developments that are possible, but not yet platted as discussed in the Okanogan Load Study of June 2010 are added as a spot load in the Mazama area to obtain the full theoretic build out loading on the feeder.

Simulations are run at present peak load, feeder load at full build out of existing platted subdivisions, and at full theoretical feeder peak load at full build out and system weaknesses identified and system improvements proposed to adequately serve the load. Conductor sizes for system improvements are based on the results of the economic conductor analysis of Appendix C, maintaining voltage levels in accordance with ANSI C84.1 and the design criteria of Appendix A. Project cost estimates are based on the typical utility cost estimates of Appendix B which are based on recent costs from other utilities for various construction types.

## C. PROBLEMS IDENTIFIED

At the present Mazama Feeder peak loading levels, areas of low voltage were found along the entire feeder. At a feeder loading level of 5.2 MW voltages ranged from 126 Volts with the system distributions voltages referred to a 120 Volt basis near the Winthrop Substation to a low of 103.7 Volts in the Lost River Airport area. ANSI C84.1 would require voltage levels between 118 and 126 Volts under normal operation. Loading levels on the 5 MVA step up transformer outside the Winthrop Substation coupled with this transformer's relatively high impedance causes the majority of the low voltage issues seen in the simulations close to the substation. However, even with this affect taken into account, pockets of low voltage occur between the Weeman Bridge and the voltage regulator bank at Mazama and in the Lost River Airport Area.

Assuming full build out of existing platted subdivisions, the feeder peak load will grow to approximately 9.15 MW. At this level, the 5 MVA step up transformer at Winthrop and the 5 MVA step down transformer at the Weeman Bridge are severely over loaded. The Winthrop Substation power transformer is at its name plate rating and the feeder voltage collapses. The worst case voltage level is found in the Lost River Airport area and is 95.7 Volts. As the feeder load approaches its theoretical maximum full build out value of 14.5 MW the Winthrop Substation Power Transformer is over 6 MW above its rating assuming no load growth on any other feeders out of the substation.

The Mazama Feeder is the classic long radial distribution feeder scenario. As load increases equipment is overloaded and the voltage collapses. Limitations of transformer capacity exist at the Winthrop Substation and at the two transitional step up and step down 5 MVA transformers along the feeder. Long feeder conductor lengths and load imbalances add to the problem. More transformer capacity and a stronger source to the area is needed to fix the problem. Simple line reconductors and adding additional voltage regulator banks will not solve the root problem by themselves.

Unfortunately the fix is very expensive and involves adding a new substation and a way to transport the power to the Mazama area. Section D below outlines the two proposed solutions identified during the analysis.

## D. PROPOSED SOLUTION

Three proposed solutions to the capacity and voltage problems were identified during the analysis of the system. All three of the solutions are expensive. Unfortunately, there is not a cheap solution other than curtailing all load growth on the feeder to solve the issues identified above in Section C. All of the solutions utilize the addition of voltage regulator banks and line reconductors to three phase the Wolf Creek, Lost River Road, and Lost River Airport areas to better balance the feeder load. The main difference between the proposed approaches is on how the additional system capacity is added. Option 1 utilizes the classic approach of adding a substation at Mazama and building a 115 kV transmission line to that substation. Option 2 proposes building a 115 kV to 24.9 kV two feeder substation adjacent to the Winthrop Substation and then constructing a heavy conductor double circuit tie to Mazama. It also requires the construction of a small 10 MVA pad mount 24.9 kV to 12.47 kV substation at Mazama. Option 3 involves the building of a 115 kV to 34.5 kV single feeder substation adjacent to the Winthrop Substation and then constructing an express feeder overbuilt on the existing Mazama feeder to a new 34.5 kV to 12.47 kV, 12/16/ 20 MVA, three feeder substation at Mazama. Once the proposed improvements are completed under any of the three options, the Mazama Feeder should be able to reliably and adequately serve loads up to 15 MW.

Project Identifier codes listed in Tables 1 and 2 generally follow the RUS 740 categorization scheme. We understand that Okanogan Electric Cooperative is not a RUS borrower, however CFC and CoBank generally follow similar accounting methods and such a categorization scheme may prove helpful when discussing these projects with the financing institution. The categories used are as follows:

| Category | Description |
| --- | --- |
| 300 | Distribution Line Reconductors and Rebuilds |
| 400 | New Distribution Substations |
| 601 | Transformers |
| 603 | Sectionalizing Devices |
| 604 | Voltage Regulators |
| 608 | Underground Distribution Lines |
| 800 | Transmission Lines |

**Table 1 Proposed Construction Alternative Option 1 Summary**

| Project # | Description | Cost $ |
| --- | --- | --- |
| 301 | Reconductor 2.5 miles of OH Line on Wolf Creek Tap to 3-Phase 1/0 ACSR between M11 and M11-49L to better balance load and correct low voltage problems. | $270,000 |
| 302 | 3-phase 1.5 miles of existing 2/0 ACSR OH Line between UG Mainline Riser and Lost River Airport to better balance load. | $172,000 |
| 303 | 3-phase 1.0 miles of existing 1-phase #4 ACSR OH line and .25 miles of existing #1 AL, 15 kV UG line between Mazama Corners and the Foster Guest Ranch Tap to better balance load. | $89,500 |
| 401A | Construct a 115 kV to 12.47 kV, 12/16/20 MVA 3 feeder substation at Mazama to provide additional transformation capacity and correct feeder voltage issues. | $3,000,000 |
| 601 | Add an additional 500 kVA, 14.4 kV to 7.2 kV step down transformer at the Wolf Creek Tap take off to convert the existing 2-phase step down bank to 3-phase. Allows 3-phasing of Wolf Creek Tap | $25,000 |
| 603A | Replace two existing 50 Amp V4L reclosers at pole number M11-3LB with three 100 Amp, Type V4L reclosers. Corrects protective device miscoordination and removes reclosers that are projected to be overloaded. | $14,550 |
| 603B | Relocate two existing 35 Amp V4L reclosers from M121-25L to after Pole M11-49L. Moves OCRs beyond new 1/0 ACSR line to protect existing #6 hard drawn copper line. | $6,000 |
| 604A | Install a new 3-phase, 7.2 kV, 100 Amp Voltage Regulator bank just north of the main line underground riser south of the Lost River Airport to correct end of line voltage problems. | $49,200 |
| 801 | Construct 13.7 miles of 115 kV, 266 kCM ACSR conductor transmission line from the Winthrop Substation to the new Mazama Substation. This transmission line would provide the power source for the substation in Project 401A | $5,480,000 |
| | **Total Option 1 Costs** | **$9,106,250** |

**Table 2. Proposed Construction Alternative Option 2 Summary**

| Project # | Description | Cost $ |
|---|---|---|
| 301 | Reconductor 2.5 miles of OH Line on Wolf Creek Tap to 3-Phase 1/0 ACSR between M11 and M11-49L to better balance load and correct low voltage problems. | $270,000 |
| 302 | 3-phase 1.5 miles of existing 2/0 ACSR OH Line between UG Mainline Riser and Lost River Airport to better balance load. | $172,000 |
| 303 | 3-phase 1.0 miles of existing 1-phase #4 ACSR OH line and .25 miles of existing #1 AL, 15 kV UG line between Mazama Corners and the Foster Guest Ranch Tap to better balance load. | $89,500 |
| 304 | Rebuild approximately 8.2 miles of existing 3-phase, 266 kCM ACSR OH 24.9 kV distribution line to double circuit, 3-phase, 556 kCM/266 kCM ACSR conductor 24.9 kV OH distribution line between the Winthrop Substation and the Weeman Bridge step up transformer location. | $2,214,000 |
| 305 | Rebuild approximately 5.5 miles of existing 3-phase, 266 kCM ACSR OH 12.47 kV distribution line to double circuit, 3-phase, 556 kCM/266 kCM ACSR conductor OH distribution line with the upper 556 kCM circuit at 24.9 kV and the lower 266 kCM ACSR circuit at 12.47 kv between the Weeman Bridge step up transformer and the Mazama pad mount substation. | $1,485,000 |
| 401B | Construct a 115 kV to 24.9 kV, 12/16/20 MVA 2 feeder substation adjacent to the Winthrop Substation and remove the existing 5 MVA step up transformer at Winthrop. | $2,500,000 |
| 401C | Construct a small 24.9 kV to 12.47 kV 10 MVA pad mount substation at Mazama. The 5 MVA pad mount transformer removed from Winthrop to be reused here. This project along with Projects 304, 305 and 401B provide the additional feeder capacity needed at Mazama. | $800,000 |
| 601 | Add an additional 500 kVA, 14.4 kV to 7.2 kV step down transformer at the Wolf Creek Tap take off to convert the existing 2-phase step down bank to 3-phase. Allows 3-phasing of Wolf Creek Tap | $25,000 |
| 603A | Replace two existing 50 Amp V4L reclosers at pole number M11-3LB with three 100 Amp, Type V4L reclosers. Corrects protective device miscoordination and removes reclosers that are projected to be overloaded. | $14,550 |
| 603B | Relocate two existing 35 Amp V4L reclosers from M121-25L to after Pole M11-49L. Moves OCRs beyond new 1/0 ACSR line to protect existing #6 hard drawn copper line. | $6,000 |
| 604A | Install a new 3-phase, 7.2 kV, 100 Amp voltage regulator bank just north of the main line underground riser south of the Lost River Airport to correct end of line voltage problems. | $49,200 |
| 604B | Install a new 3-phase, 7.2 kV, 328 Amp voltage regulator bank just north of the Weeman Bridge 5 MVA step down transformer to regulate feeder voltage north of the Weeman Bridge while projects 304 and 305 are being constructed. | $61,400 |
| 608A | Construct approximately 2,900 feet of 3-phase 750 kCM, AL, 260 mil cable underground power line from the new Winthrop Substation addition to the riser pole near M-8 for express 24.9 kV feed to Mazama. Including extending the existing 3-phase underground power line from the present Winthrop Pad Mount 5 MVA transformer location to the new Winthrop Substation addition breaker position. | $200,000 |
| | **Total Option 2 Costs** | **$7,886,650** |

**Table 3. Proposed Construction Alternative Option 3 Summary**

| Project # | Description | Cost $ |
|---|---|---|
| 301 | Reconductor 2.5 miles of OH Line on Wolf Creek Tap to 3-Phase 1/0 ACSR between M11 and M11-49L to better balance load and correct low voltage problems. | $270,000 |
| 302 | 3-phase 1.5 miles of existing 2/0 ACSR OH Line between UG Mainline Riser and Lost River Airport to better balance load. | $172,000 |
| 303 | 3-phase 1.0 miles of existing 1-phase #4 ACSR OH line and .25 miles of existing #1 AL, 15 kV UG line between Mazama Corners and the Foster Guest Ranch Tap to better balance load. | $89,500 |
| 306 | Rebuild approximately 8.2 miles of existing 3-phase, 266 kCM ACSR OH 24.9 kV distribution line to double circuit, 3-phase, 266 kCM ACSR conductor OH distribution line with the top circuit insulated at 34.5 kV and the lower circuit insulated at 24.9 kV between the Winthrop Substation and the Weeman Bridge step up transformer location. | $2,050,000 |
| 307 | Rebuild approximately 5.5 miles of existing 3-phase, 266 kCM ACSR OH 12.47 kV distribution line to double circuit, 3-phase, 266 kCM ACSR conductor OH distribution line with the upper circuit insulated at 34.5 kV and the lower circuit at insulated at 12.47 kV between the Weeman Bridge step up transformer and the Mazama pad mount substation. | $1,375,000 |
| 401D | Construct a 115 kV to 34.5/24.9 kV, 12/16/20 MVA 1 feeder substation adjacent to the Winthrop Substation and remove the existing 5 MVA step up transformer at Winthrop. | $2,300,000 |
| 401E | Construct a 34.5 kV to 12.47 kV, 12/16/20 MVA, three feeder substation at Mazama. This project along with Projects 306, 307 and 401D provide the additional feeder capacity needed at Mazama. | $3,000,000 |
| 601A | Remove the two 14.4 kV to 7.2 kV step down transformers at the Wolf Creek Tap take off. | $2,500 |
| 601B | Remove the 5 MVA, 24.9 to 12.47 kV pad mount transformer at the Weeman Bridge in conjunction with the conversion of the lower Mazama feeder circuit to 12.47 kV. | $10,000 |
| 603A | Replace two existing 50 Amp V4L reclosers at pole number M11-3LB with three 100 Amp, Type V4L reclosers. Corrects protective device miscoordination and removes reclosers that are projected to be overloaded. | $14,550 |
| 603B | Relocate two existing 35 Amp V4L reclosers from M121-25L to after Pole M11-49L. Moves OCRs beyond new 1/0 ACSR line to protect existing #6 hard drawn copper line. | $6,000 |
| 604A | Install a new 3-phase, 7.2 kV, 100 Amp voltage regulator bank just north of the main line underground riser south of the Lost River Airport to correct end of line voltage problems. | $49,200 |
| 604B | Install a new 3-phase, 7.2 kV, 328 Amp voltage regulator bank just north of the Weeman Bridge 5 MVA step down transformer to regulate feeder voltage north of the Weeman Bridge while projects 306 and 307 are being constructed. | $61,400 |
| 608B | Construct approximately 2,900 feet of 3-phase 750 kCM, AL, 345 mil cable underground power line from the new Winthrop Substation addition to the riser pole near M-8 for express 34.5 kV feed to Mazama. | $170,000 |
| | **Total Option 3 Costs** | **$9,570,150** |

The main drawback of Option 1 is the fact that it requires the construction of 13.7 miles of 115 kV transmission line in an area that has a history of litigation to stop or block the construction of transmission lines. Okanogan PUD has been trying to build a 115 kV transmission line into the Methow River Valley for a number of years now and has faced stiff opposition. The main issue seems to be that the opponents feel that if they can block the transmission line they can limit growth in the valley. The adage not in my back yard seems to hold true in the Methow Valley. However, as are often the case, people still come and build homes and expect reliable electric service.

Option 1 is also the more expensive than Option 2 and requires the 13.7 mile 115 kV transmission line and 115 kV to 12.47 kV substation of projects 801 and 401A to be constructed simultaneously. Resulting in a $8,480,000 expenditure almost immediately. This is no small point especially considering that Okanogan Electric Cooperative's 2009 total utility plant in service is listed as being $9,798,973.

Under Option 2 the feeder improvements could be phased in over a couple of years. Given, the existing voltage problems at present feeder peak loads and the step up transformer capacity problems, the feeder improvement costs are felt sooner rather than later. At the very least the 115 kV to 24.9 kV substation adjacent to the Winthop Substation (Project 401B), the voltage regulator banks proposed under Projects 604A and 604B and the sectionalizing improvements of 603A need to be undertaken immediately. The cost of these preliminary steps amounts to $2,625,150. Projects 304 and 305 can be constructed over the next 3 to 4 years. Project 401B should be constructed once Projects 304 and 305 are complete. The other projects should be phased in as the vacant lots in the existing platted subdivisions build out. By the time the feeder load hits 9.15 MW all listed improvements should be completed. Based on the load growth regression analysis this should give the Cooperative between 8 and 12 years to complete the rest of the proposed feeder improvements under Option 2.

As with Option 2, Option 3 offers the benefit of not having to build 13.7 miles of 115 kV transmission line and this option allows the project implementations to be staged in over several years. Under Option 3 a smaller conductor express feeder is proposed to Mazama, but at 34.5 kV not 24.9 kV as proposed under Option 2. Option 3 would require a 115 kV to 34.5/24.9 kV single feeder substation to be built adjacent to the Winthrop Substation almost immediately (Project

401D). Initially the substation addition would operate at a secondary voltage of 24.9 kV until Projects 306, 307 and 401E are constructed, then it would be switched over to 34.5 kV operation. Initially Projects 401D, the sectionalizing improvements of 603A, the voltage regulator banks in Projects 604A and 604B, as well as the underground tie line of Project 608B will need to be completed at a cost of $2,595,150. Projects 306 and 307 can be constructed over the next 3 to 4 years. Project 401E should be constructed once Projects 306 and 307 are complete. The other projects should be phased in as the vacant lots in the existing platted subdivisions build out. By the time the feeder load hits 9.15 MW all listed improvements should be completed.

While Option 3 is more expensive than Option 2 it does allow a 266 kCM ACSR conductor to be used for the express feed to the new Mazama Substation. The Cooperative already has this size conductor in its system and the sags and tensions between the upper and lower conductors will match. Option 3 also allows more additional transformer capacity for future load than does Option 2. Should a large spot load such as a lumber mill appear in the Mazama area, sufficient spare capacity would be present to serve it.

In order to properly budget for the expenditures published inflation rates from 2010 until the date the work is proposed can applied to the 2010 costs listed in this study to account for inflation. Tables of annual inflation rates are available on the intranet from a variety of government publications.