Engineering Connection Assessment

P2630 Transmission Enhancements in the Town of Fox Creek area

NGTL GP Ltd., as general partner on behalf of NGTL Limited Partnership

Date: September 26, 2024

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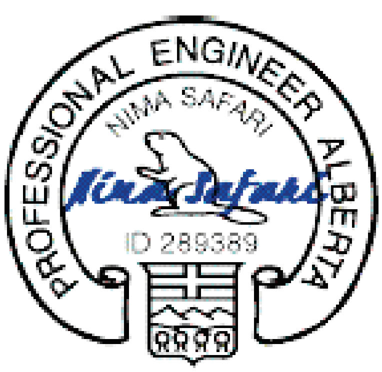
Role	Name	Date	Signature
Prepared	Nima Safari, P.Eng.		Nima Safari -- P. Eng. - APEGA Digitally signed by Nima Safari -- P. Eng. - APEGA Date: 2024.09.26 09:11:36 -06'00'
Reviewed	Mahmoud Ahmed, P.Eng.		Mahmoud Ahmed -- P. Eng. - APEGA Digitally signed by Mahmoud Ahmed -- P. Eng. - APEGA Date: 2024.09.27 10:32:54 -06'00'
Approved	Pravin Koshti, P. Eng.		Pravinkumar Biharilal Koshti -- P. Eng. - APEGA Digitally signed by Pravinkumar Biharilal Koshti -- P. Eng. - APEGA Date: 2024.09.27 10:36:50 -06'00'



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INDEPENDENT SYSTEM OPERATOR
RM SIGNATURE:
RM APEGA ID #: 110749
DATE: 2024-09-27
PERMIT NUMBER: P008200
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Alberta Electric System Operator

Calgary Place, 2500, 330-5th Avenue SW Calgary, AB T2P 0L4

Phone: 403-539-2450 | Fax: 403-539-2949

www.aeso.ca

@theaeso

NOTE:

The conclusions and recommendations in this report are based on the results presented in *Attachment A-1: Engineering Study Results* which was prepared by a third party consultant in accordance with the AESO Connection Process based on the study scope presented in *Attachment A-2: Study Scope*.

The AESO has reviewed the *Engineering Study Results* and finds it acceptable for the purpose of assessing the potential impacts of the proposed connection on the performance of the Alberta interconnected electric system.

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1 Introduction

This Alberta Electric System Operator (AESO) Engineering Connection Assessment describes the engineering studies that were completed to assess the impact of the Project (as defined below) on the performance of the Alberta interconnected electric system (AIES). This report also provides the AESO's conclusions and recommendations based on the results of the engineering studies.

Attached to this Engineering Study Results are the results of the engineering studies (see Attachment A-1) and the scope and methodology used to perform the studies (see Attachment A-2). These attachments provide details regarding the technical criteria, assumptions, and methods for performing these engineering studies, and the results of the engineering studies.

1.1 Project Overview

NGTL GP Ltd. (Market Participant) has submitted a request for system access service to the AESO to serve a new demand for electricity in the Town of Fox Creek area.

The Market Participant's request includes: a request for a new system access service in the area, with a Rate DTS, *Demand Transmission Service*, contract capacity of 37 MW; and a request for transmission development (collectively, the Project).

The scheduled in-service date (ISD) for the Project is May 6, 2026.

2 Assessment Scope

2.1 Objectives

The objectives of the AESO Engineering Connection Assessment are as follows:

- Assess the impact of the Project on the performance of the AIES.
- Evaluate Project connection alternatives and identify the AESO's preferred alternative.
- Recommend mitigation measures, if required, to reliably connect the Project to the AIES.
- Identify Project dependencies, including any TFO projects or AESO plans to expand or enhance the transmission system that must be completed prior to connection.

2.2 Existing System

Geographically, the Project is located in the AESO planning area of Fox Creek (Area 24) which is part of the AESO Northwest planning region. AESO Planning Area of Fox Creek (Area 24) is surrounded by the planning areas of Grand Prairie (Area 20), High Prairie (Area 21), Grande Cache (Area 22), Valleyview (Area 23), Swan Hills (Area 26), Hinton/Edson (Area 29), and Wabamun (Area 40).

From a transmission system perspective, AESO Planning Area Fox Creek (Area 24) consists primarily of 138 / 144 kV and 240 kV transmission systems. The AESO Planning Area Fox Creek (Area 24) is connected to Valleyview (Area 23), Swan Hills (Area 26), and Hinton/Edson (Area 29).

Existing constraints in the Central planning region are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

2.3 Study Area

The Study Area for the Project consists of the AESO planning areas of Fox Creek (Area 24), Swan Hills (Area 26), Hinton/Edson (Area 29), Valleyview (Area 23), and Grande Cache (Area 22), including the tie lines connecting these planning areas to the rest of the AIES. All transmission facilities within the Study Area will be studied and monitored for violations of the Reliability Criteria (defined in Section 3.1 of Attachment A-2).

3 Connection Alternatives

3.1 Overview

The AESO, in consultation with the TFO in the Study Area and the Market Participant, examined 13 transmission alternatives to meet the Market Participant's request for system access service, as detailed in Section 3.2.

3.2 Connection Alternatives Examined

Below is a description of the developments associated with the transmission alternatives that were examined for the Project.

Alternative 1 – New Point of Delivery with a T-tap connection to the 138 kV transmission line 685L

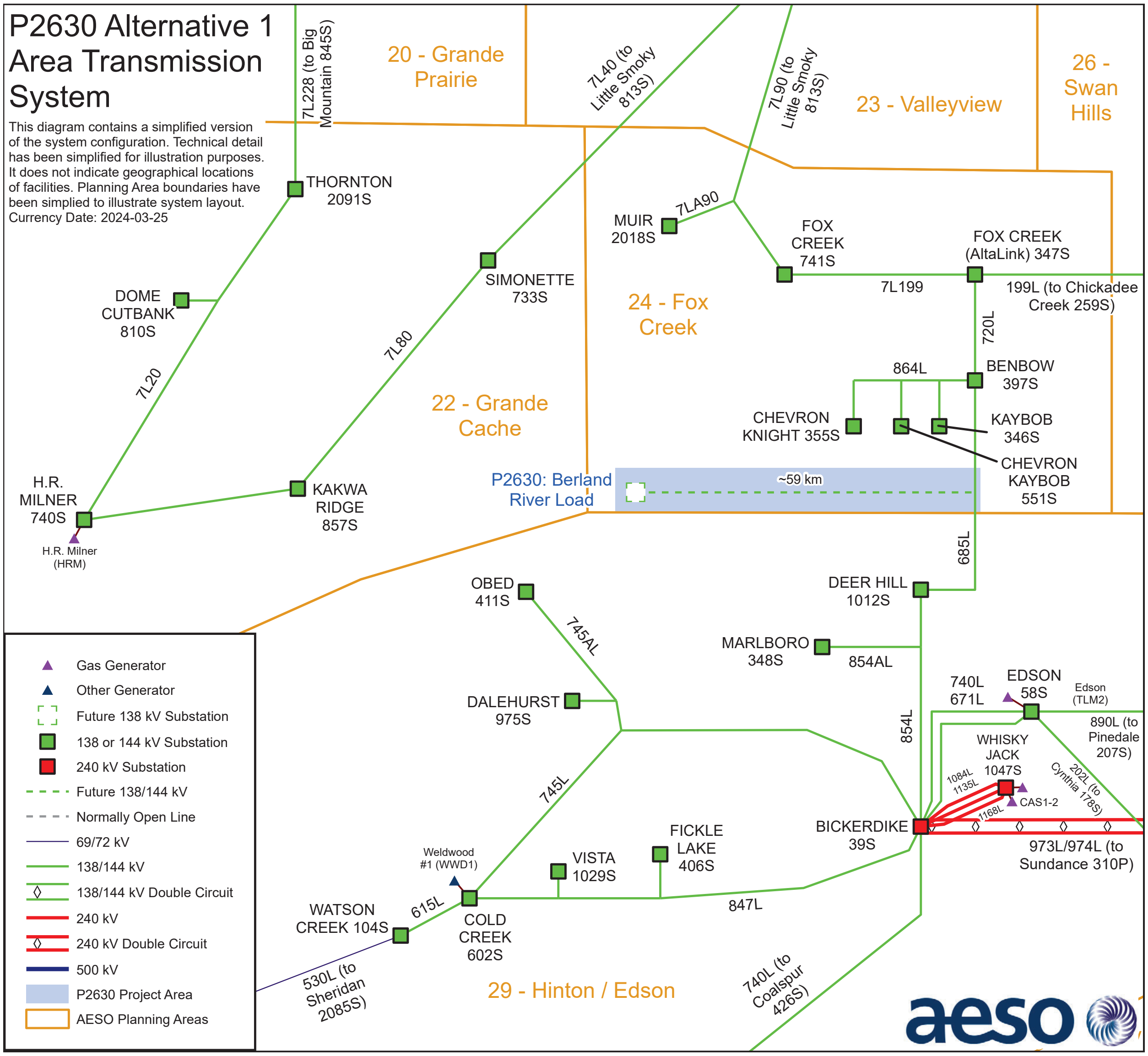
This alternative includes the following developments:

- Add a new 138/25 kV Point of Delivery (POD) substation, designated as Berland River 1182S, including one 138/25 kV transformer and three 138 kV circuit breakers;
- Add one 138 kV circuit, approximately 59 km in length[1], to connect the proposed Berland River 1182S substation to the existing 138 kV transmission line 685L (between Deer Hill 1012S and Benbow 397S substations) using a T-tap configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-1.

[1] Exact line length to be determined by TFO

Figure 3-1: Connection Alternative 1



Alternative 2 – New POD with an in-and-out connection to the 138 kV transmission line 685L

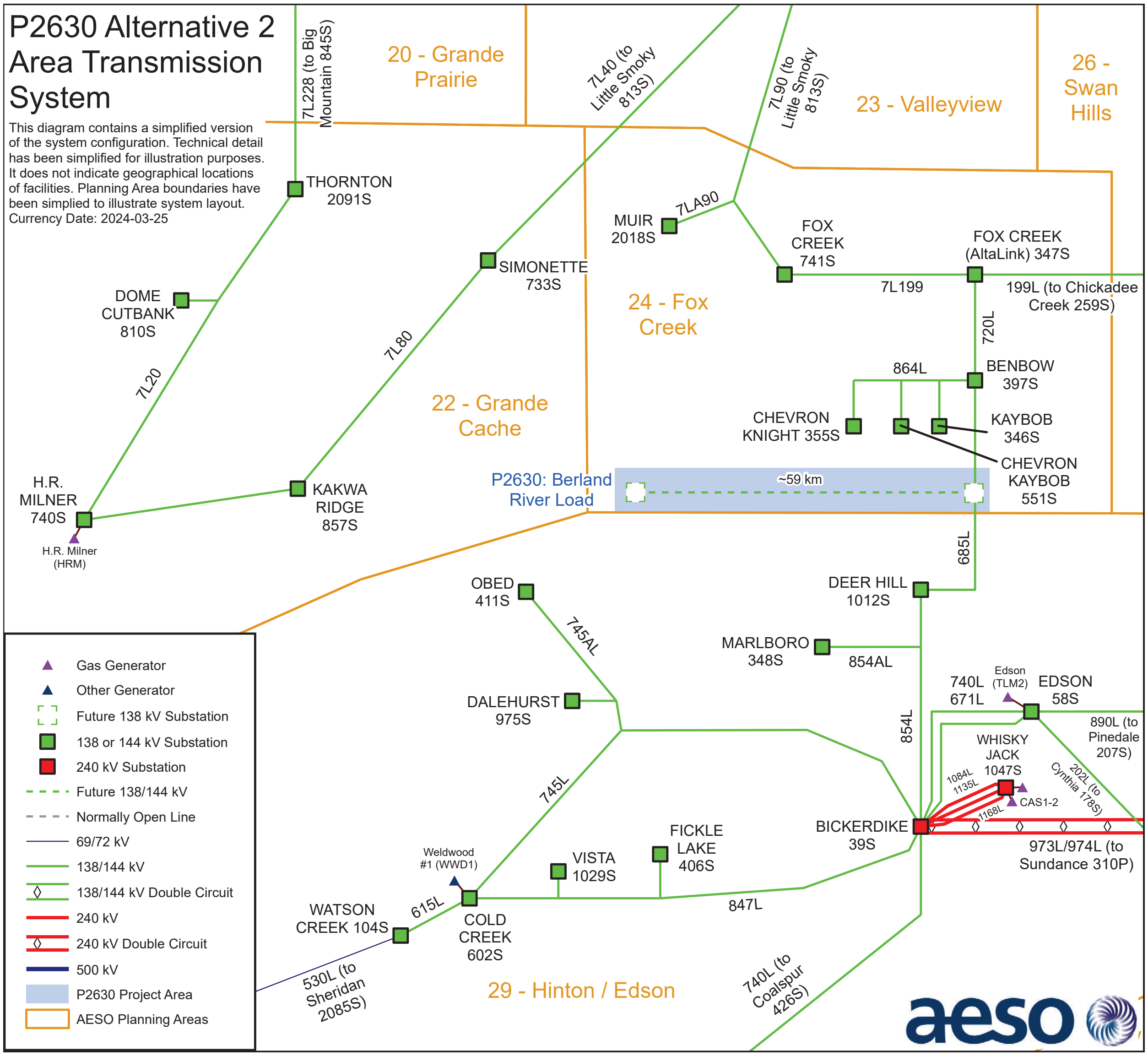
This alternative includes the following developments:

- Add a switching substation, designated as Pine Creek 328S, including three 138 kV circuit breakers to be connected to the existing 138 kV transmission line 685L (between Deer Hill 1012S and Benbow 397S substations) using an in-and-out configuration;
- Add a new 138/25 kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and three 138 kV circuit breakers;
- Add one 138 kV circuit, approximately 59 km in length[2], to connect the proposed Berland River 1182S substation to the proposed Pine Creek 328S substation using a radial configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-2.

[2] Exact line length to be determined by TFO

Figure 3-2: Connection Alternative 2



Alternative 3 – New POD with a T-tap connection to the 138 kV transmission line 720L

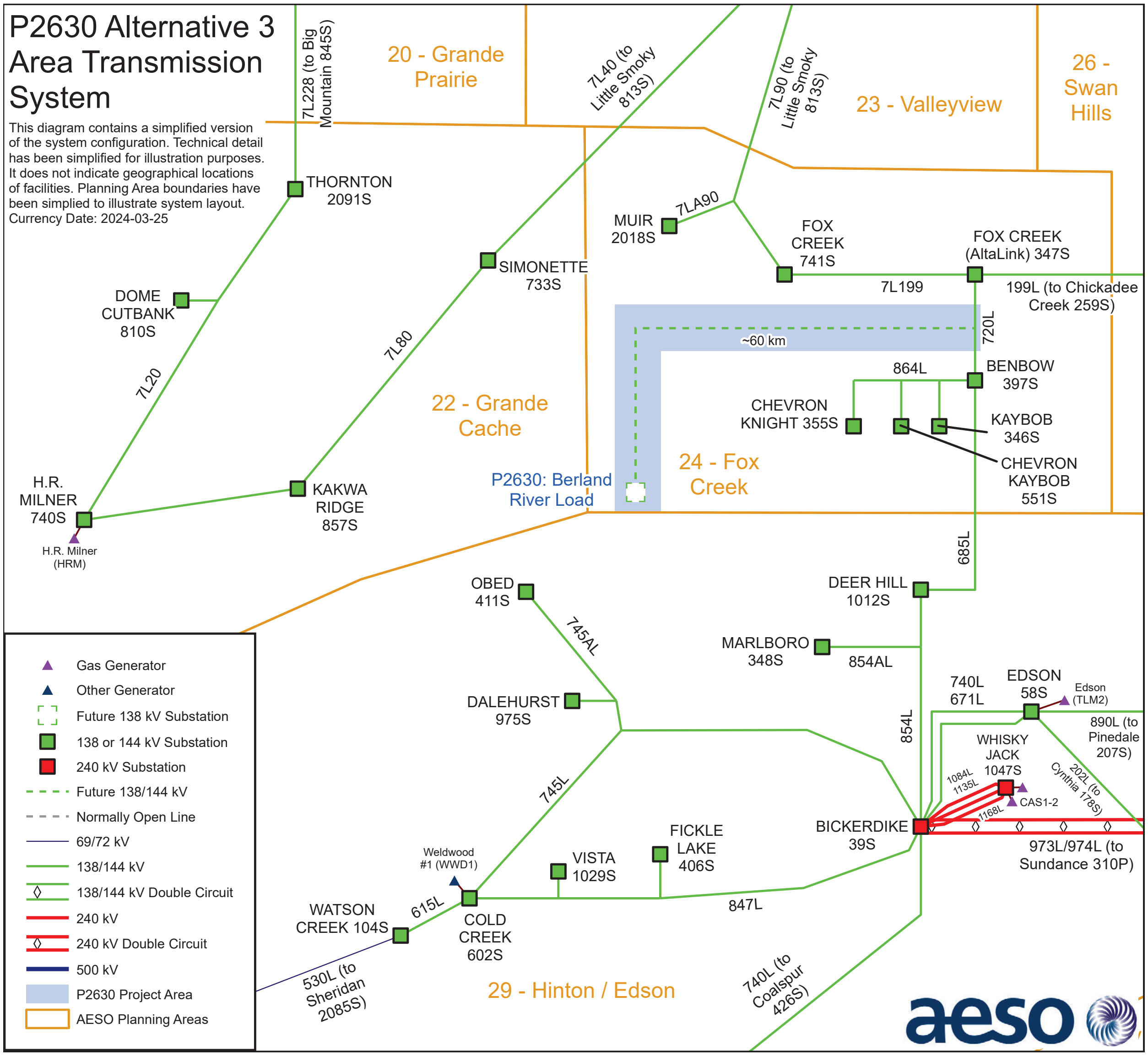
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 60 km in length[3], to connect the proposed Berland River 1182S substation to the existing 138 kV transmission line 720L (between Benbow 397S and Fox Creek (Altalink) 347S substations) using a T-tap configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-3.

[3] Exact line length to be determined by TFO

Figure 3-3: Connection Alternative 3



Alternative 4 – New POD with an in-and-out connection to the 138 kV transmission line 720L

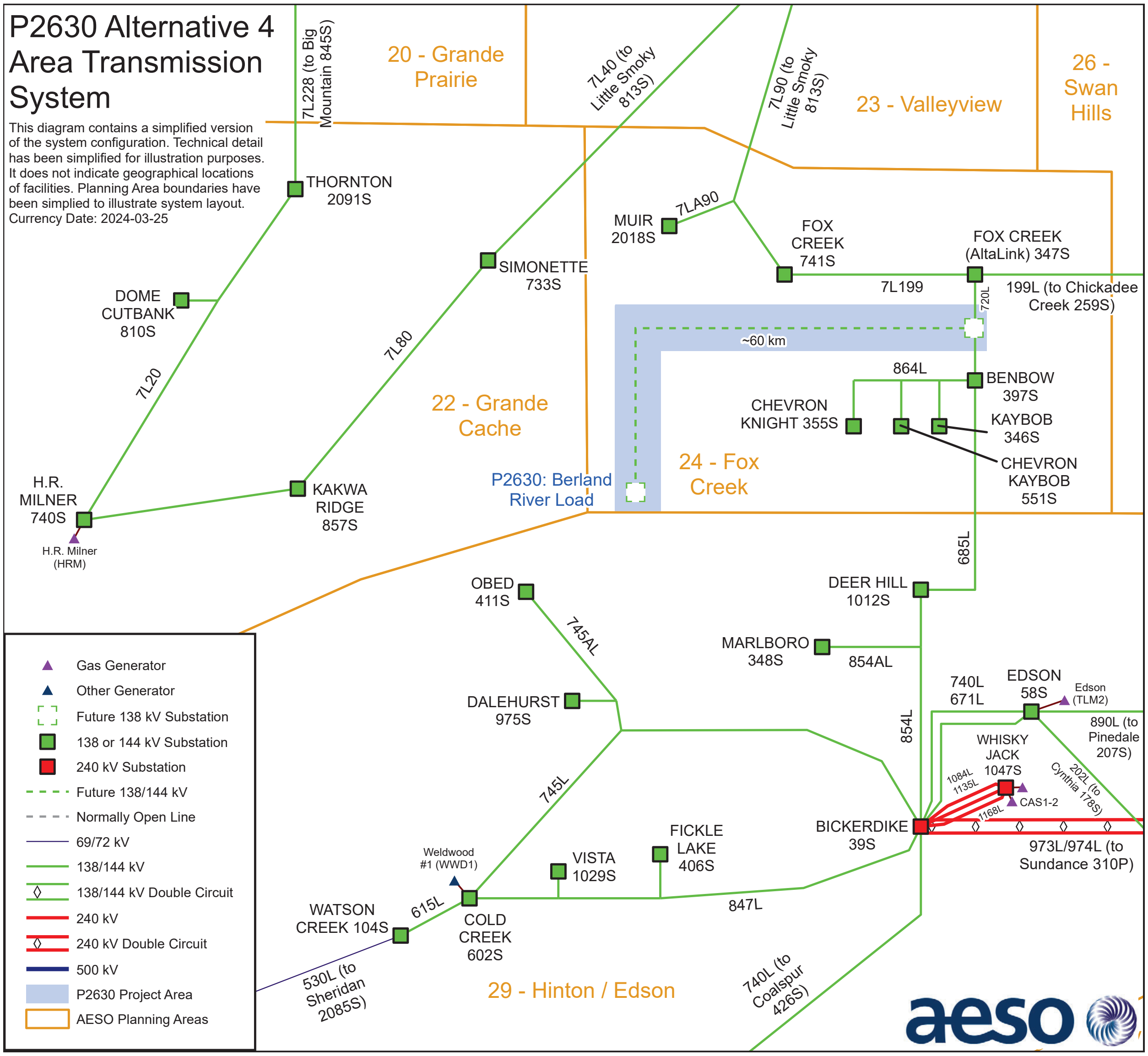
This alternative includes the following developments:

- Add a switching substation, designated as Pine Creek 328S, including three 138 kV circuit breakers to be connected to the existing 138 kV transmission line 720L (between Benbow 397S and Fox Creek 347S substations) using an in-and-out configuration;
- Add a new 138/25 kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 60 km in length[4], to connect the proposed Berland River 1182S substation to the proposed Pine Creek 328S substation using a radial configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-4.

[4] Exact line length to be determined by TFO

Figure 3-4: Connection Alternative 4



Alternative 5 – New POD with a T-tap connection to the 138 kV transmission line 7L199

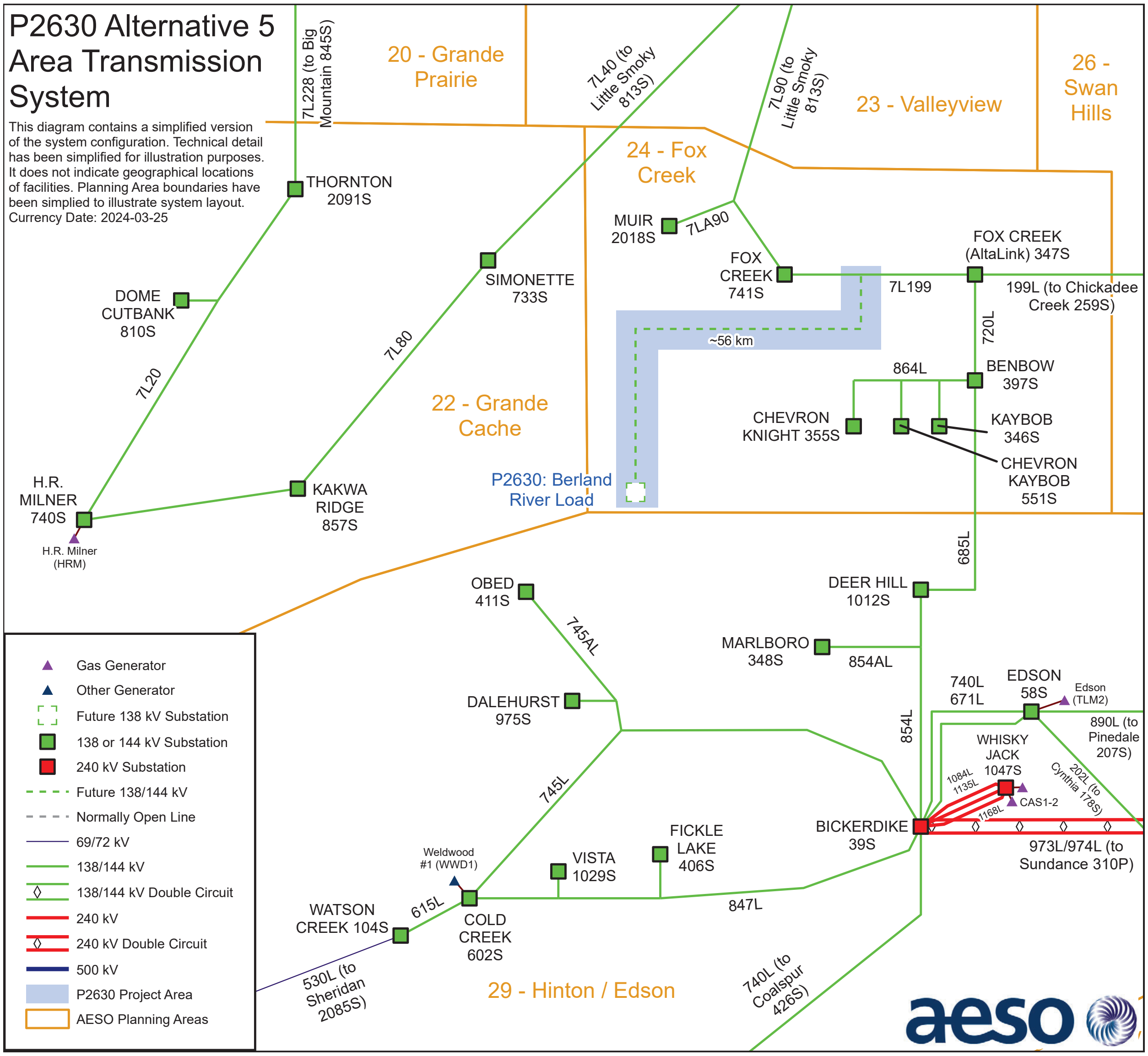
This alternative includes the following developments:

- Add a new 138/25kV POD substation designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 56 km in length[5], to connect the proposed Berland River 1182S substation to the existing 138 kV transmission line 7L199 (between Fox Creek 347S and Fox Creek 741S substations) using a T-tap configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-5.

[5] Exact line length to be determined by TFO

Figure 3-5: Connection Alternative 5



Alternative 6 – New POD with an in-and-out connection to the 138 kV transmission line 7L199

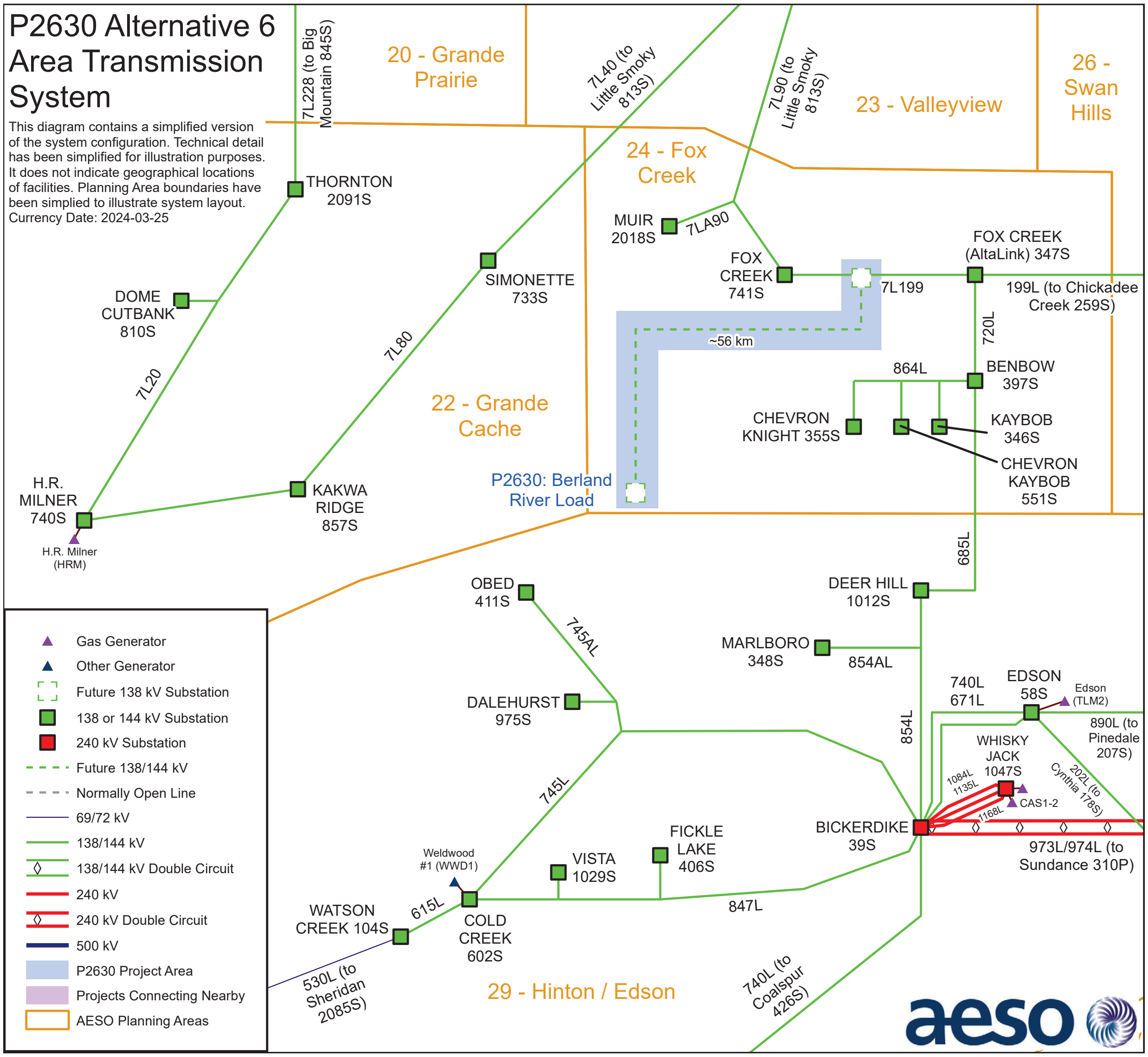
This alternative includes the following developments:

- Add a switching substation, designated as Pine Creek 328S, including three 138 kV circuit breakers to be connected to the existing 138 kV transmission line 7L199 (between Fox Creek 347S and Fox Creek 741S substations) using an in-and-out configuration;
- Add a new 138/25 kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 56 km in length[6], to connect the proposed Berland River 1182S substation to the proposed Pine Creek 328S substation using a radial configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-6.

[6] Exact line length to be determined by TFO

Figure 3-6: Connection Alternative 6



Alternative 7 – New POD with a T-tap connection to the 138 kV transmission line 7L80

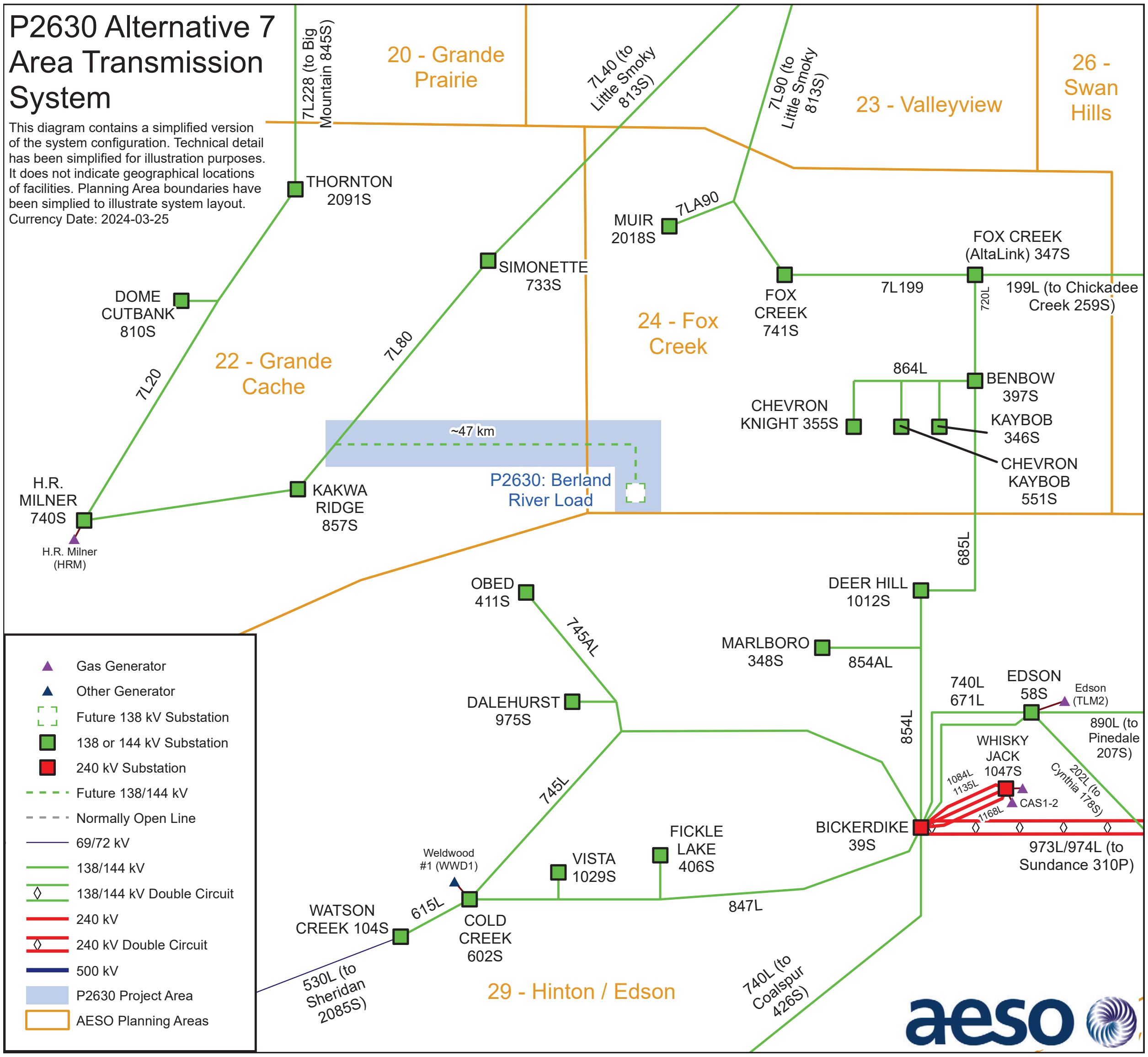
This alternative includes the following developments:

- Add a new 138/25 kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 47 km in length[7], from the proposed Berland River 1182S substation to the existing 138 kV transmission line 7L80 (between Simonette 733S and Kakwa Ridge 857S substations) using a T-tap configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-7.

[7] Exact line length to be determined by TFO

Figure 3-7: Connection Alternative 7



Alternative 8 – New POD with an in-and-out connection to the 138 kV transmission line 7L80

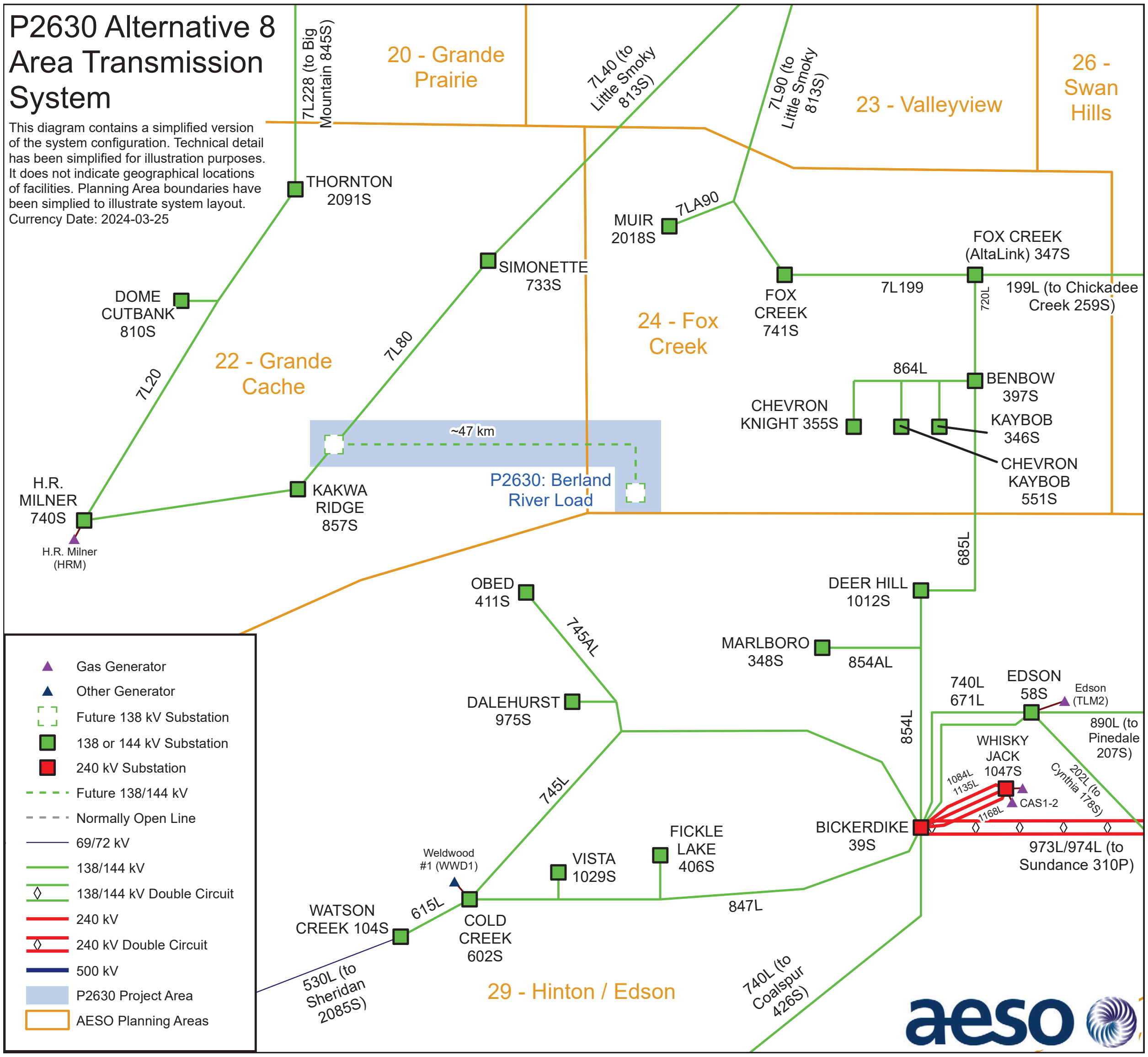
This alternative includes the following developments:

- Add a switching substation, designated as Pine Creek 328S, including three 138 kV circuit breakers to be connected to the existing 138 kV transmission line 7L80 (between Simonette 733S and Kakwa Ridge 857S substations) using an in-and-out configuration;
- Add a new 138/25 kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 47 km in length[8], to connect the proposed Berland River 1182S substation to the proposed Pine Creek 328S substation using a radial configuration; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-8.

[8] Exact line length to be determined by TFO

Figure 3-8: Connection Alternative 8



Alternative 9 – New POD with a radial connection to the Deer Hill 1012S substation

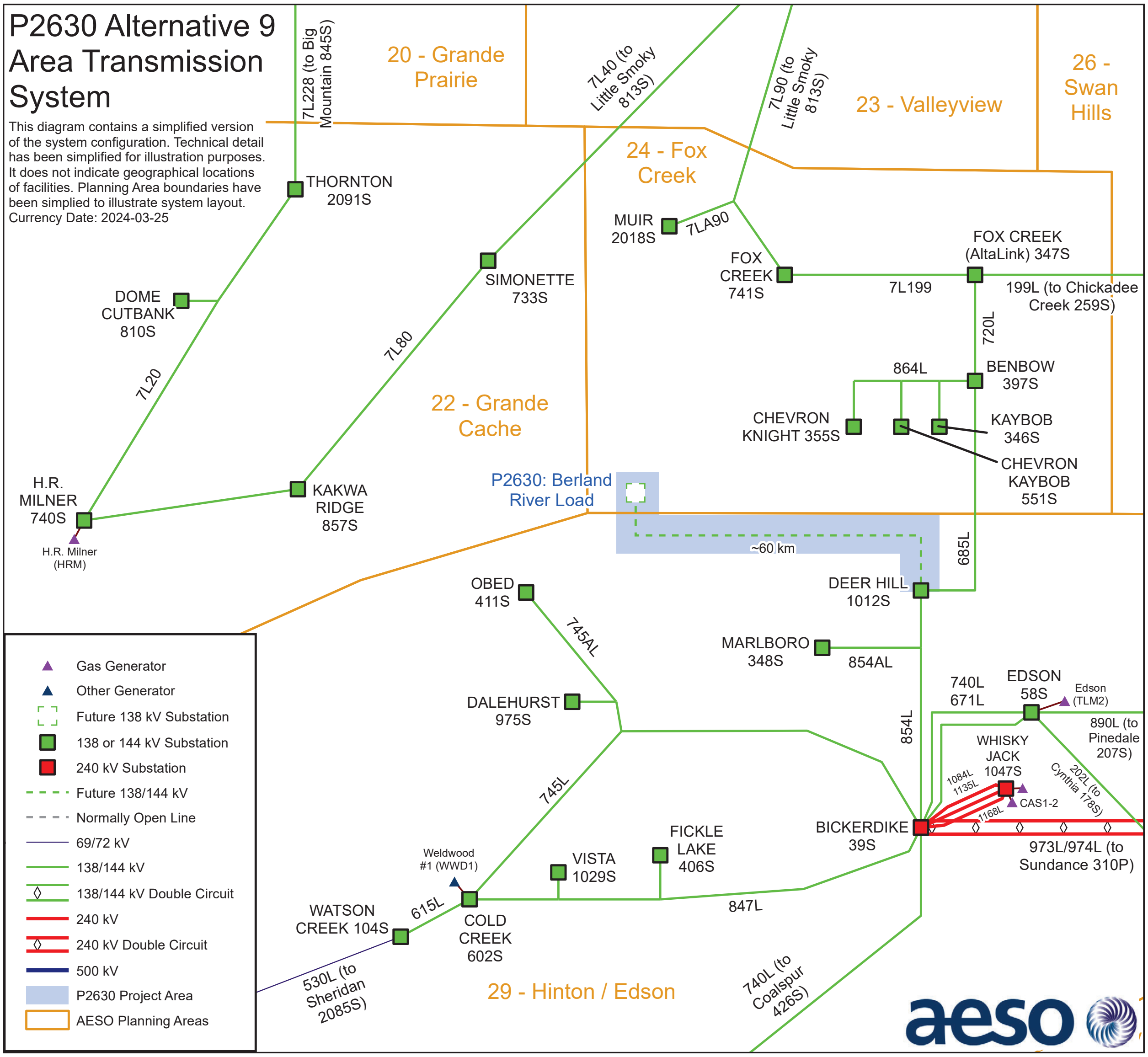
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 60 km in length[9], to connect the proposed Berland River 1182S substation to the existing Deer Hill 1012S using a radial configuration;
- Modify Deer Hill 1012S substation by adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-9.

[9] Exact line length to be determined by TFO

Figure 3-9: Connection Alternative 9



Alternative 10 – New POD with a radial connection to the Benbow 397S substation

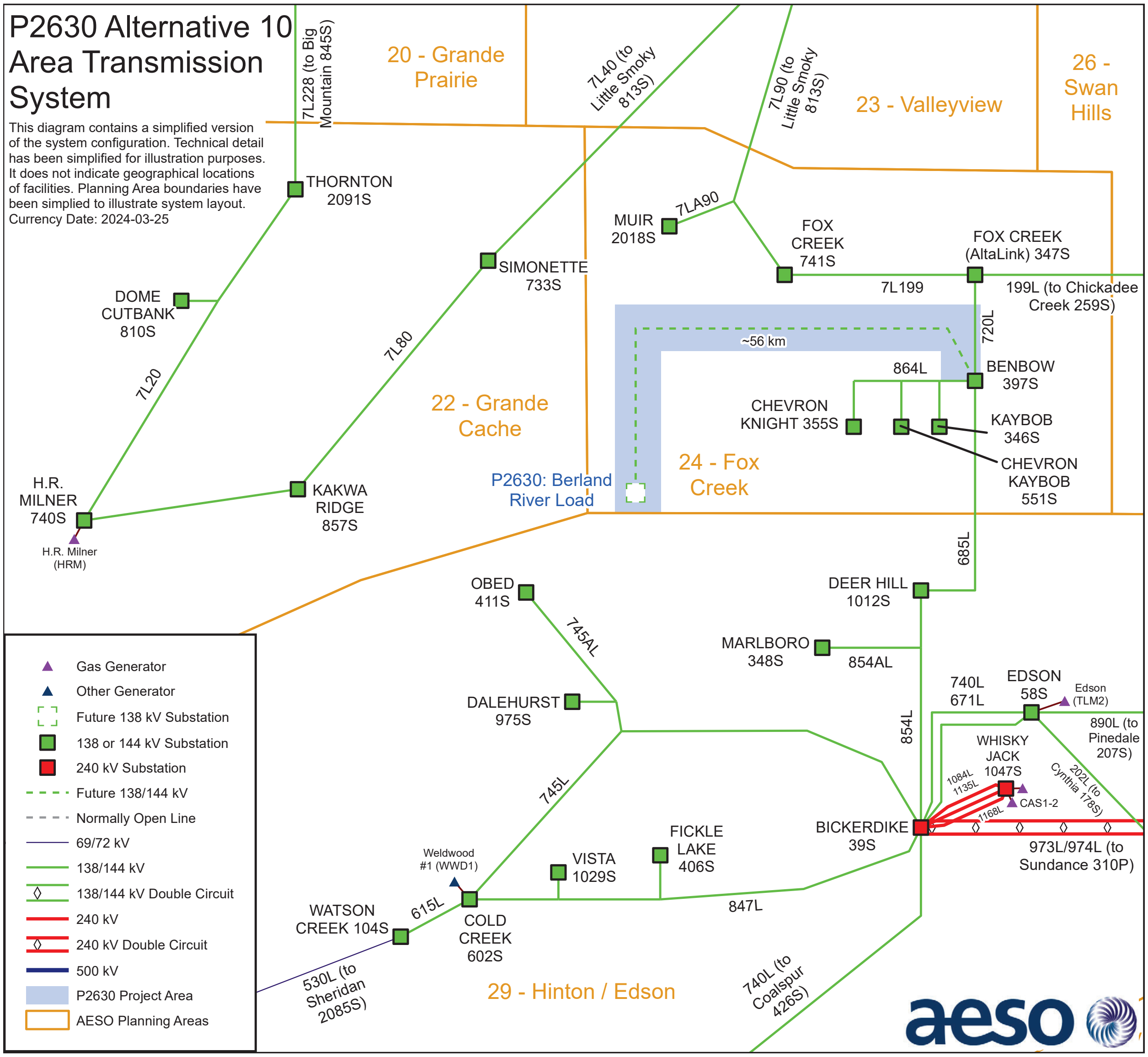
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 56 km in length[10], to connect the proposed Berland River 1182S substation to the existing Benbow 397S substation using a radial configuration;
- Modify Benbow 397S substation by adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-10.

[10] Exact line length to be determined by TFO

Figure 3-10: Connection Alternative 10



Alternative 11 – New POD with a radial connection to the Fox Creek (AltaLink) 347S substation

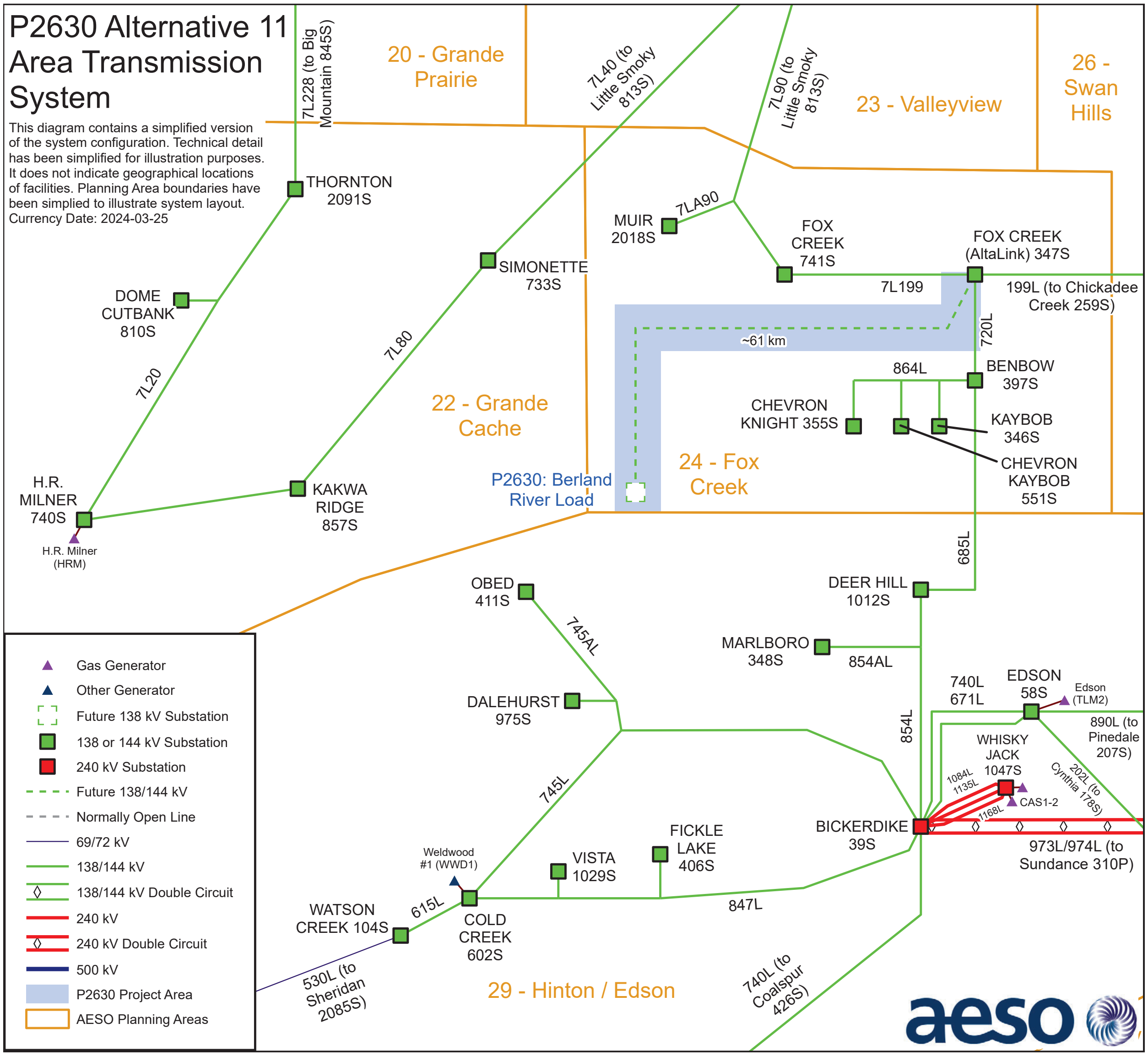
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 61 km in length[11], to connect the proposed Berland River 1182S substation to the existing Fox Creek 347S substation using a radial configuration;
- Modify Fox Creek 347S substation by adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-11.

[11] Exact line length to be determined by TFO

Figure 3-11: Connection Alternative 11



Alternative 12 – New POD with a radial connection to the Fox Creek 741S substation

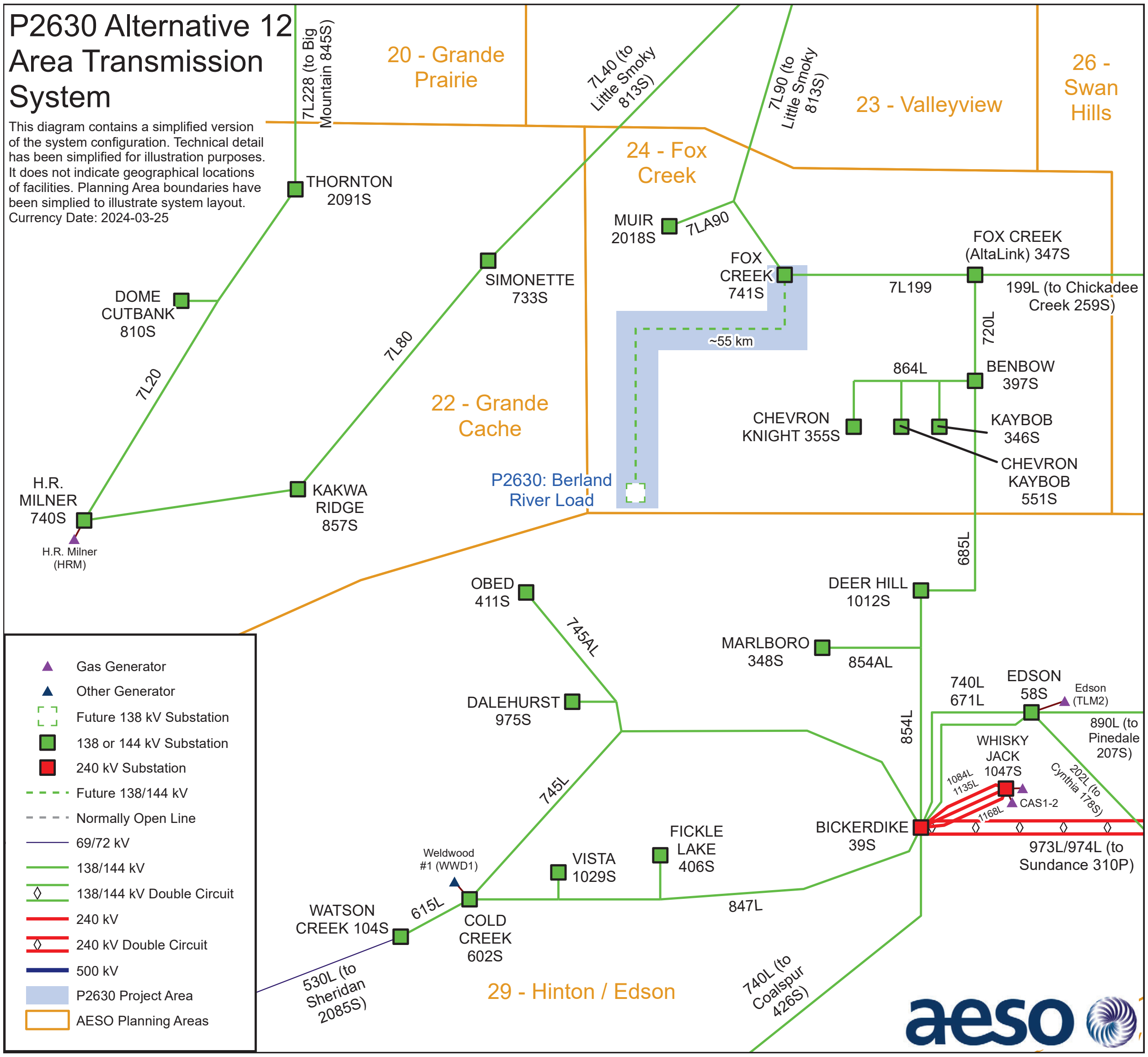
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 55 km in length[12], to connect the proposed Berland River 1182S substation to the existing Fox Creek 741S substation using a radial configuration;
- Modify Fox Creek 741S substation by adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-12.

[12] Exact line length to be determined by TFO

Figure 3-12: Connection Alternative 12



Alternative 13 – New POD radial connection to the Simonette 733S substation

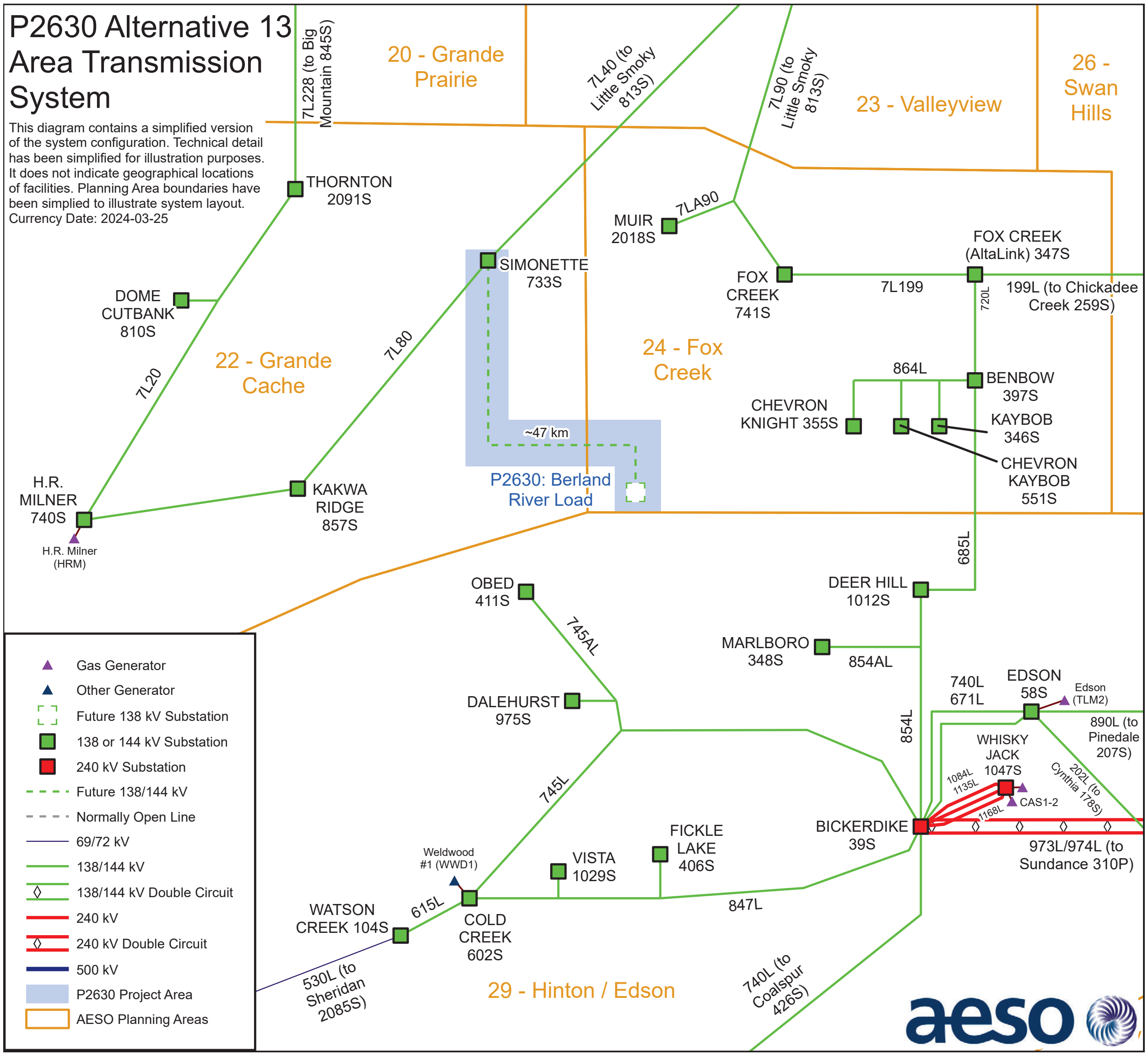
This alternative includes the following developments:

- Add a new 138/25kV POD substation, designated as Berland River 1182S, including one 138/25 kV transformer and one 138 kV circuit breaker;
- Add one 138 kV circuit, approximately 47 km in length[13], to connect the proposed Berland River 1182S substation to the existing Simonette 733S substation using a radial configuration;
- Modify Simonette 733S substation by adding one 138 kV circuit breaker; and
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 3-13.

[13] Exact line length to be determined by TFO

Figure 3-13: Connection Alternative 13



3.3 Connection Alternatives Selected for Further Study

Alternative 2 is considered technically feasible and was selected for further study.

3.4 Connection Alternatives Not Selected for Further Study

The TFO advised that Alternatives 1 and 3 are not technically feasible after conducting protection and control studies.

Alternatives 2 and 4 have a similar development scope, however Alternative 4 involves connecting to the 138 kV transmission line 720L which has a lower capacity than the 138 kV transmission line 685L and limits future load development. Therefore, Alternative 4 was not selected for further study.

Alternatives 5, 6, and 12 involve more complex routes as it’s highly likely there would be topographic, environmental, hydrological or other features requiring avoidance and hence, increased cost compared to Alternative 2. Furthermore, the TFO advised that Alternatives 5, 6, and 12 would require additional line lengths than estimated, which are anticipated to result in greater land and environmental impacts. Therefore, Alternatives 4, 5, and 6 and 12 were not selected for further study.

The TFO advised that Alternatives 7, 8 and 13 would likely cross designated caribou range resulting in greater potential environmental impacts, cost for mitigation and longer construction and permitting timelines than an alternative not crossing designated caribou range, such as Alternative 2. Furthermore, the TFO advised that Alternatives 7, 8 and 13 would require additional line lengths than estimated, which are anticipated to result in greater land and environmental impacts. Therefore, Alternatives 7, 8 and 13 were not selected for further study.

The TFO advised that Alternative 9 would require added line length than estimated which is anticipated to result in greater land and environmental impacts. In addition, this alternative requires three major river crossings. Therefore, Alternative 9 was not selected for further study.

The TFO advised that Alternative 10 involves routing to avoid an existing gas plant and that the vicinity of the Benbow 397S substation includes substantial pipeline infrastructure as well as distribution lines which would constrain access for a new transmission line. Furthermore, the TFO advised this alternative would require added line length as a straight-line route between Benbow 397S and the Berland River substation is unlikely and would be expected to follow existing linear disturbances as well as avoid features on the landscape which is anticipated to result in greater land and environmental impacts. Therefore, Alternative 10 was not selected for further study.

The TFO advised that Alternative 11 would require added line length than estimated which is anticipated to result in greater land and environmental impacts. Furthermore, the TFO advised that the Fox Creek 347S substation is located between Highway 43 and a pipeline corridor, restricting access for a new transmission line connection. Therefore, Alternative 11 was not selected for further study.

4 Assessment Approach

4.1 Standards, Criteria and Assumptions

A detailed description of the standards, criteria, and assumptions that were used for the connection assessment is provided in Attachment A (see Attachment A-2).

4.2 Studies Performed

At the time of study, the scheduled ISD for the Project was December 17, 2025. Therefore, studies were performed using scenarios for 2025 Summer Peak and 2025 Winter Peak. After the completion of the majority of the studies, the ISD of the Project was changed from December 17, 2025 to May 6, 2026. The AESO determined that the ISD change would not have a material impact on the connection alternative, the mitigation measures and the conclusions for the scenario studies conducted.

Short-circuit studies were performed using the 2025 Winter Peak (WP) and 2031 WP scenarios.

Table 4-1 lists the study scenarios. Post-Project scenarios reflect the requested Rate DTS contract capacity of 37 MW at the proposed Berland River 1182S substation.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)	Project Generation (MW)
Pre-Project					
1	2025 Summer Peak (SP)	Low Generation (LG)	2025 SP LG Pre-Project	0	0
2	2025 Winter Peak (WP)	LG	2025 WP LG Pre-Project	0	0
Post-Project					
3	2025 SP	LG	2025 SP LG Post -Project	37	0
4	2025 WP	LG	2025 WP LG Post-Project	37	0
5	2031 WP	All Study Area Generators In-Service	2025 WP Post-Project	37	0

The AESO Planning Region load forecasts used for the connection studies were based on the *AESO's 2021 Long-term Outlook* (2021 LTO).

While the AESO has updated its regional forecasts since the connection studies were performed, the use of the current AESO forecast, the *2023 Long-term Outlook (2023 LTO)* would not materially alter the connection study results or affect the conclusions and recommendations in this report.

4.2.1 Power Flow Studies

The purpose of the power flow studies is to identify and quantify any thermal and voltage criteria violations in the Study Area.

In addition, power flow studies are also used to identify point of delivery (POD) low voltage bus voltage deviations beyond the limits listed in Table 3-1 of Attachment A-2.[14]

Power flow studies were performed for 2025 SP and 2025 WP pre-Project scenarios, and for 2025 SP and 2025 WP post-Project scenarios.

4.2.2 Voltage Stability Studies

The purpose of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability at the busses in the Study Area.

Voltage stability studies were performed for 2025 SP LG and 2025 WP LG post-Project scenarios.

4.2.3 Short-Circuit Current Level Studies

The purpose of short-circuit current level studies is to determine the expected system short-circuit current levels in the vicinity of the Project.

Short circuit studies were performed for the 2025 WP LG pre-Project scenario and for 2025 WP LG and 2031 WP post-Project scenarios.

4.3 Mitigation Measure Development and Evaluation

As explained in Section 6 of Attachment A-2, mitigation measures were developed to address system performance issues that were identified in the post-Project scenarios. Studies performed to assess the effectiveness of mitigation measures are briefly outlined below.

4.3.1 Post-Mitigation Studies

Power flow and voltage stability studies were performed to assess the impact of the Project on the performance of the AIES following implementation of the AESO's proposed mitigation measures.

4.3.2 Constraint Effective Factor Studies

Constraint effective factor studies were used to determine the generator and load constraint effective factors and to identify the most effective generators or loads to manage thermal criteria violations that were observed under Category A conditions and Category B conditions.

[14] The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of Attachment A-2 does not represent a Reliability Criteria violation. Mitigation measures would not be developed to specifically address POD bus voltage deviations that exceed the desired values in Table 3-1 of Attachment A-2.

5 Interpretation of Results

5.1 Results Overview

This section provides an assessment of the impact of the Project on the performance of the AIES. The Reliability Criteria violations observed during the connection assessment studies, and the proposed mitigation measures are summarized in Table 5-1.

- Section 5.2 includes an overview of the pre-Project studies results.
- Section 5.3 includes an overview of the post-Project studies results.
- Section 5.4 includes an overview of the post-mitigation studies results.

Detailed study results are provided in Attachment A-1.

Table 5-1: Summary of Reliability Criteria Violations, Project Impact and Mitigation Measures

Scenario	Type of Reliability Criteria Violation		Contingency (System Element Lost)	Details of Violation	Project Impact	Pre-Project Mitigation Measures	Post-Project Mitigation Measures
	Pre-Project	Post-Project					
2025 SP	None	Voltage	System Normal (N-0)	Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	Thermal – above emergency rating	Thermal – above emergency rating	671L (Bickerdike 39S to Edson 58S)	740L (Bickerdike 39S to Edson 58S)	Marginally decreased	Existing RAS 188	Existing RAS 188
	Thermal – above emergency rating	Thermal – above emergency rating	39ST1 (Bickerdike transformer T1)	39ST2 (Bickerdike transformer T2)	Materially increased	Existing RAS 186	Existing RAS 186
	Thermal – above emergency rating	Thermal – above emergency rating	39ST2 (Bickerdike transformer T2)	39ST1 (Bickerdike transformer T1)	Materially increased	Existing RAS 186	Existing RAS 186
	Thermal – above emergency rating	Thermal – above emergency rating	7L20 (Thornton 2091S to Dome Cutbank 810S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating	7L20 (H.R. Milner 740S to Dome Cutbank 810S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal - above normal rating	Thermal - above normal rating	973L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	RTOP	RTOP
	Thermal – above emergency rating	Thermal - above normal rating		740L (Bickerdike 39S to Edson 58S)	Materially decreased	RTOP	RTOP
	Thermal - above normal rating	None		890L (Edson 58S to Pindale 207S)	Materially decreased	RTOP	None
	Thermal - above normal rating	Thermal - above normal rating	974L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	RTOP	RTOP
	Thermal – above emergency rating	Thermal - above normal rating		740L (Bickerdike 39S to Edson 58S)	Materially decreased	RTOP	RTOP
	Thermal - above normal rating	Thermal - above normal rating	7L28 (Big Mountain 845S to Thornton 2091S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal - above normal rating	Thermal - above normal rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	None	Thermal - above normal rating	685L (Deer Hill 1012S to Berland Switching station – Pine Creek 328S)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Thermal - above normal rating	1012ST1 (Deer Hill 1012S transformer)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Thermal – above emergency rating	854L (Deer Hill 1012S to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage	1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage	854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage	685L (Deer Hill 1012S to Berland Switching station – Pine Creek 328S)	Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation

	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
2025 WP	Thermal – above emergency rating	Thermal – above emergency rating	671L (Bickerdike 39S to Edson 58S)	740L (Bickerdike 39S to Edson 58S)	Marginally decreased	Existing RAS 188	Existing RAS 188
	Thermal – above emergency rating	Thermal – above normal rating	890L (Edson 58S to Pinedale 207S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	Existing RAS 189	Existing RAS 189
	Thermal – above emergency rating	Thermal – above emergency rating	39ST1 (Bickerdike transformer T1)	39ST2 (Bickerdike transformer T2)	Materially increased	Existing RAS 186	Existing RAS 186
	Thermal – above emergency rating	Thermal – above emergency rating	39ST2 (Bickerdike transformer T2)	39ST1 (Bickerdike transformer T1)	Materially increased	Existing RAS 186	Existing RAS 186
	Thermal – above normal rating	Thermal - above normal rating	744L (Pinedale 207S to Niton 228S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	RTOP	RTOP
	Thermal – above emergency rating	Thermal – above emergency rating	7L20 (Thornton 2091S to Dome Cutbank 810S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L40 (Simonette 733S to Little Smoky 813S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating	7L20 (H.R. Milner 740S to Dome Cutbank 810S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L40 (Simonette 733S to Little Smoky 813S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above normal rating	Thermal – above normal rating	202L (Edson 58S to Cynthia 178S)	890L (Edson 58S to Pindale 207S)	Materially decreased	RTOP	RTOP
	Thermal – above emergency rating	Thermal – above emergency rating	973L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	Existing RAS 189	Existing RAS 189
	Thermal - above normal rating	Thermal – above normal rating		890L (Edson 58S to Pindale 207S)	Materially decreased	Existing RAS 185	Existing RAS 185
	Thermal – above emergency rating	Thermal – above emergency rating	974L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	Existing RAS 189	Existing RAS 189
	Thermal – above normal rating	Thermal - above normal rating		890L (Edson 58S to Pindale 207S)	Materially decreased	Existing RAS 185	Existing RAS 185
	Thermal – above emergency rating	Thermal – above emergency rating	7L28 (Big Mountain 845S to Thornton 2091S)	7L80 (Kakwa Ridge 857S to H.R. Milner 740S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L80 (Kakwa Ridge 857S to Simonette 733S)	No Impact	Existing RAS 171	Existing RAS 171
	Thermal – above emergency rating	Thermal – above emergency rating		7L40 (Simonette 733S to Little Smoky 813S)	No Impact	Existing RAS 171	Existing RAS 171
	None	Thermal – above normal rating	1012ST1 (Deer Hill 1012S transformer)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	Thermal - above normal rating	Thermal – above normal rating		202L (Edson 58S to Cynthia 178S)	Marginally decreased	RTOP	RTOP
	None	Thermal – above emergency rating	854L (Deer Hill 1012S to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	Thermal – above normal rating	Thermal – above normal rating		202L (Edson 58S to Cynthia 178S)	Marginally decreased	RTOP	RTOP
	Thermal – above normal rating	None	614L (Benbow 397S to Berland Switching station- Pine Creek 328S)	202L (Edson 58S to Cynthia 178S)	Materially decreased	RTOP	None
	None	Thermal – above normal rating	685L (Deer Hill 1012S to Berland Switching station-Pine creek 328S)	720L (Fox Creek 347S to Benbow 397S)	Materially increased	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	Thermal – above normal rating	Thermal - above normal rating		202L (Edson 58S to Cynthia 178S)	Marginally decreased	RTOP	RTOP
	Thermal – above normal rating	Thermal – above normal rating	207S_T1 (Pinedale 207S transformer T1)	202L (Edson 58S to Cynthia 178S)	Marginally decreased	RTOP	RTOP
	Thermal – above normal rating	Thermal – above normal rating	207S_T2 (Pinedale 207S transformer T2)	202L (Edson 58S to Cynthia 178S)	Marginally decreased	RTOP	RTOP
	Thermal – above normal rating	Thermal – above normal rating	744L (Niton 228S to Entwistle 235S) or 228S Niton transformer T1	202L (Edson 58S to Cynthia 178S)	Materially decreased	RTOP	RTOP
	None	Voltage	1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage	854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation

	None	Voltage		Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage	685L (Deer Hill 1012S to Berland Switching station – Pine Creek 328S)	Kaybob 346S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Kaybob 551S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Benbow 397S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Chevron Knight 355S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation
	None	Voltage		Berland River 1182S	New voltage criteria violation	None	Add two 13.5 MVar filter banks at the proposed Berland River 1182S substation

Notes:

- Marginally increased (or marginally decreased) refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) between 0% and 3% (or -3%).
- Materially increased (or materially decreased) refers to a percent loading difference (post-Project percent loading minus pre-Project percent loading) above or equal to 3% (or below or equal to -3%).
- RAS 171 is an existing RAS (see Table E-1 of Attachment A-1).
- RAS 185 is an existing RAS (see Table E-1 of Attachment A-1).
- RAS 186 is an existing RAS (see Table E-1 of Attachment A-1).
- RAS 188 is an existing RAS (see Table E-1 of Attachment A-1).
- RAS 189 is an existing RAS (see Table E-1 of Attachment A-1).
- The two 13.5 MVar filter banks (two 13.5 Mvar C-type filters, each requiring a 138kV circuit breaker) is required at the proposed Berland River 1182S substation to mitigate the low voltage-driven issues resulting from the connection of the proposed load.

5.2 Pre-Project Study Results

5.2.1 Category A Conditions

No Reliability Criteria violations were observed under the Category A conditions (i.e., all elements in service) for any of the pre-Project scenarios.

The short-circuit fault levels were found to be within the typical capabilities of the nearby facilities.

5.2.2 Category B Conditions

The pre-Project power flow studies identified a number of thermal criteria violations under Category B conditions (i.e., loss of a single system element).

No voltage criteria violations or voltage deviations beyond the limits listed in Table 3-1 of Attachment A-2 (hereafter referred to as POD bus voltage deviations) were observed under Category B conditions.

5.3 Post-Project Study Results

5.3.1 Category A Conditions

A new voltage criteria violation was observed at the proposed Berland River 1182S substation under the Category A condition. No thermal criteria violations were observed under the Category A condition for any post-Project scenarios.

Post-Project short-circuit fault levels were not significantly higher than pre-Project levels. The long-term short circuit levels were found to be within the designed capabilities of the nearby facilities.

5.3.2 Category B Conditions

Post-Project power flow studies identified a number of thermal and voltage criteria violations issues under Category B conditions.

Following the connection of the Project, most of the Category B thermal criteria violations observed in the pre-connection assessment were reduced or remained the same, while a few thermal criteria violations were exacerbated. Several new voltage criteria violations were observed post-Project. In addition, POD bus voltage deviations were observed under Category B conditions.

The voltage stability margin was met for all studied conditions.

5.4 Mitigation Measures

This section discusses the AESO's proposed mitigation measures to address the system performance issues that were identified in the pre-Project and post-Project scenarios.

5.4.1 Pre-Project

Prior to connection of the Project, some of the observed thermal criteria violations can be managed by using RTOPs. The remaining thermal criteria violations can be mitigated with the existing RASs 171, 185, 186, 188, and 189.

5.4.2 Post-Project

After connection of the Project, some of the thermal criteria violations observed can be mitigated by using RTOPs, and other thermal criteria violations can be mitigated with the existing RASs 171, 185, 186, 188, and 189. The remaining thermal criteria violations and all voltage criteria violations can be mitigated with the addition of two 13.5 MVar filter banks at the proposed Berland River 1182S substation.

The decreased voltage stability margin can be improved after adding two 13.5 MVar filter banks at the Berland River 1182S substation.

As part of this Project, mitigation measures will not be specifically developed for the POD bus voltage deviations observed under certain Category B conditions during pre-Project and post-Project scenarios. However, the cap bank is expected to manage the POD bus voltage deviations at the proposed Berland River 1182S substation.

5.4.3 Post-Project Mitigation Study Results

Under Category A and B conditions, with the addition of the two 13.5 MVar filter banks and application of RAS, all of the observed Reliability Criteria violations requiring RAS were mitigated.

6 Project Dependencies

The Project does not require the completion of any other AESO plans to expand or enhance the transmission system prior to connection.

7 Conclusions and Recommendations

Based on the study results, Alternative 2 is technically viable. The connection assessment identified a number of pre-Project and post-Project system performance issues.

These issues can be mitigated through the use of existing RASs 171, 185, 186, 188, 189 and real-time operational practices, alone or in combination, as appropriate. The voltage criteria violations can be mitigated by adding two 13.5 MVar filter banks at the proposed Berland River 1182S substation. With implementation of these mitigation measures, connecting the project with the preferred alternative does not adversely affect the performance of the AIES.

The AESO recommends proceeding with the Project using Alternative 2 as the preferred alternative to respond to the Market Participant's request for system access service. Real-time operational practices and the RAS mentioned above are recommended to mitigate the identified system performance issues.

Alternative 2 involves:

- adding a substation, designated as Pine Creek 328S, including three 138 kV circuit breakers to be connected to the existing 138 kV transmission line 685L using an in-and-out configuration;
- adding a substation, designated as Berland River 1182S, including one 138/25 kV transformer, two 138 kV 13.5 MVar filter banks, and three 138 kV circuit breakers; and,
- adding one 138 kV circuit to connect the Berland River 1182S substation and the Pine Creek 328S substation using a radial configuration.

The conductor used for the 138 kV circuit between the Pine Creek 328S and Berland River 1182S substations should have a minimum capacity of 120 MVA which is the minimum rating of the 138kV circuit. The transformer at the Berland River 1182S should have a minimum rating of 42 MVA to meet the Market Participant's requested DTS.

Attachment A:
Engineering Study Results and Study Scope

NGTL GP Ltd., as general partner on behalf of NGTL Limited Partnership
450 1 St SW, Calgary, Alberta, T2P 5H1
September 11, 2024

Alberta Electric System Operator
Calgary Place 2500, 330 - 5th Ave SW
Calgary, AB T2P 0L4

Attention: **Linda Odogwu**

Re: P2630 – Berland River Load ("Project") – Confidentiality Classification

Use for ANID Filing

NGTL GP Ltd**.** (Market Participant) hereby authorizes the Alberta Electric System Operator (AESO) to file its Project Engineering Study Results version **V2** dated **March 12, 2024** with the Alberta Utilities Commission to be made available on the public record. In addition, the Market Participant authorizes the AESO to publish the Project's Engineering Study Results on the AESO's Project webpage.

Sincerely,

Ben Ho, Project Manager
Date: Sept 11, 2024

Engineering Study Results

P2630 Berland River Load

Nova Gas Transmission Ltd.

Date: March 12, 2024

Version: V2

Classification: Confidential

Role	Name	Date	Signature
Prepared	Joby Varghese, P. Eng.	March 12, 2024	
Reviewed/ Approved	Ryan Cui, P. Eng.	March 12, 2024	

PROFESSIONAL ENGINEER ALBERTA
JOBY VARGHESE
March 12, 2024

PERMIT TO PRACTICE
ALTALINK MANAGEMENT LTD

RM SIGNATURE:

RM APEGA ID #: 95919

DATE: Mar. 13 2024

PERMIT NUMBER: P007862

The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Engineering Study Results

P2630 Berland River Load

Nova Gas Transmission Ltd.

Date: March 12, 2024

Version: V2

Classification: Confidential

Role	Name	Date	Signature
Prepared	Joby Varghese, P. Eng.	March 12, 2024	
Reviewed/ Approved	Ryan Cui, P. Eng.	March 12, 2024	

Contents

Tables

Figures

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Attachments

1 Executive Summary

Project Overview

Nova Gas Transmission Ltd. (Market Participant) has submitted a System Access Service Request (SASR) to the Alberta Electric System Operator (AESO) to connect its proposed Berland River Compressor Station (Facility) to the Alberta Interconnected Electric System (AIES).

The Market Participant's request includes a request for a Rate DTS, Demand Transmission Service, contract capacity of 37 MW: and a request for transmission development (collectively, the Project)[1].

The requested In-Service Date (ISD) for the Project is December 17, 2025, as per the SASR request.

Study Area for the Project

The Study Area for the Project consists of the AESO Planning areas of Grande Cache (Area 22), Valleyview (Area 23), Fox Creek (Area 24), Swan Hills (Area 26) and Hinton/Edson (Area 29), including the tie lines connecting this planning areas to the rest of the AIES. All transmission facilities within the Study Area were studied and monitored for violations of the Reliability Criteria.

Connection alternatives studied.

Alternative 2: A New 138/25kV Point of Delivery connected from 685L via an In-and-out Configuration.

Studies Performed for the Project

Power flow analysis was performed for the 2025 summer peak (SP) and Winter peak (WP) pre-Project and post-Project scenarios, with the 2021 AIES topology in the AESO Central Planning Region peak, to determine the impact of the connection of the Project on the AIES.

Voltage stability analysis was performed for the 2025 SP and 2025 WP pre-project and post-project scenarios to determine the ability of the transmission system to maintain voltage stability margin at all busses under Category A and Category B conditions.

Short-circuit analysis was performed for the 2025 WP pre-Project scenario and for the 2025 WP and 2031 WP post-Project scenarios to determine the short-circuit levels in the vicinity of the Project.

Results of the Pre-Project Studies

<u>Category A Conditions</u>

No Reliability Criteria violations were observed under the Category A conditions (i.e., all elements in service) for any of the pre-Project scenarios. The short-circuit fault levels were found to be within the typical capabilities of the nearby facilities.

<u>Category B Conditions</u>

The pre-Project power flow studies identified several thermal violations under Category B conditions.

In addition, under Category B conditions, no voltage range criteria violation or voltage deviations were observed that were beyond the limits listed in Table 3-1 of the AESO's Study Scope at point-of-delivery

[1] As per the signed study scope executed on March 01, 2023.

(POD) low voltage busses (subsequently referred to as POD bus voltage deviations) for any of the pre-Project scenarios.

<u>Category C5 Conditions</u>

The pre-Project power flow studies identified several thermal violations under Category C5 conditions.

In addition, under Category C5 conditions, no voltage range criteria violation or voltage deviations were observed that were beyond the limits listed in Table 3-1 of the AESO's Study Scope at point-of-delivery (POD) low voltage busses (subsequently referred to as POD bus voltage deviations) for any of the pre-Project scenarios.

Results of the Post-Project Studies (Alternative 2)

<u>Category A Conditions</u>

No thermal Criteria violations were observed under Category A conditions, but 138 kV voltage at new proposed Berland River substation drops below its normal operating range for Category A conditions. It is recommended to install 27 MVAR cap bank at the proposed Berland substation to mitigate the voltage violations. Post-Project short-circuit fault levels were not significantly higher than pre-Project levels.

The long-term short circuit levels were found to be within the designed capabilities of the nearby facilities.

<u>Category B Conditions</u>

Post-Project power flow studies, and voltage stability studies identified several system performances issues under Category B conditions.

The power flow studies showed that some of the same thermal criteria violations which were observed in the pe-project scenarios were also observed in the post-Project scenarios. These violations are unrelated to the addition of the Project. These are existing issues and will be mitigated by existing Remedial Action Schemes (RAS) and Real-time Operational practices.

Due to the lack of VAR support, thermal criteria violations were noticed on 720L (Fox Creek 347S to Benbow 397S) following the contingencies:

- 1012ST1 (Deer Hill 1012S transformer)
- 854L (Deer Hill 1012S to Bickerdike 39S)

It is recommended to install 27 MVAR cap bank at the proposed Berland substation to mitigate 720L overload issue.

In addition, under Category B conditions, voltage range criteria violation and POD bus voltage deviations were observed for the post-Project scenarios. These voltage range violations can be mitigated by adding the cap bank at the new substation.

Voltage stability studies showed a significant reduction in the voltage stability margin due to the connection of load project, particularly under the following contingencies:

- 1012ST1 (Deer Hill 1012S transformer)
- 854L (Deer Hill 1012S to Bickerdike 39S)

The enhancement of voltage stability margin is attainable by adding the cap bank at the new substation.

<u>Category C5 Conditions</u>

The power flow studies showed that some of the same thermal criteria violations which were observed in the pe-project scenarios were also observed in the post-Project scenarios. These violations are unrelated to the addition of the Project. These are existing issues and will be mitigated by existing Remedial Action Schemes (RAS) and Real-time Operational practices.

No voltage range criteria violation or POD bus voltage deviations were observed for the post-Project scenarios for Category C5 conditions.

The voltage stability margin was met for Category C5 conditions.

Mitigation Strategy

720L (Fox Creek 347S to Benbow 397S) overload, voltage violations, and significant reduction in the voltage stability margins can be mitigated by installing a 27 MVAR cap bank at the proposed Berland River substation. All the existing overloading issues can be mitigated by real-time operational practices and exiting Remedial Action Schemes (RAS).

2 Introduction

This report presents the results of the engineering studies that were completed by AltaLink Management LTD (the Studies Consultant) to assess the impact of the Project (as defined in the AESO's Study Scope) on the performance of the Alberta interconnected electric system (AIES). The studies were performed in accordance with the AESO's Study Scope titled "P2630 Berland River Load" dated March 1, 2023, Version 1.

The power system network analysis tool that was used for the studies in this connection assessment was PSS/E version 34.

3 Connection Alternatives

3.1 Connection Alternatives Studied

One alternative was examined in this report. A description of the developments associated with this alternative is provided below.

> **Alternative 2:** Add a new 138/25 kV Point of Delivery (POD) substation next to customer site and then add a new 138 kV transmission line, approximately 53 km in length, to connect the new POD substation to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S substations via In-and-Out configuration.

4 Pre-Project Study Results

This section describes the results of the pre-Project power flow studies.

4.1 Power Flow Studies

Power flow diagrams illustrating the pre-Project power flow studies results for Category A, Category B and selected C5 conditions are provided in Attachment A.

4.1.1.1 Scenario 1: 2025 Summer Peak Low Generation Pre-Project.

Category A Conditions

No Reliability Criteria (as defined in the AESO's Study Scope) violations were observed under Category A conditions.

Category B Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category B conditions as shown in Table 4-1.

Table 4-1: Thermal Criteria Violations under Category B Conditions for Scenario 1

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow[a] (MVA)	% Loading[b]
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*99*	*109*	*144*	*145*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*301*	*112*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*301*	*112*
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*126*	*117*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*126*	*117*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (Kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*138*	*129*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*138*	*129*
973L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*85.1*	*94*	*90*	*106*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*108*	*112*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*

974L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*85.1*	*94*	*90*	*106*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*108*	*112*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*111*	*103*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*111*	*103*
1012ST1 (Deer Hill 1012S transformer)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*
854L (Deer Hill 1012S to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*37*	*43*

Notes:

[a] Power flow (MVA) is current expressed as MVA (i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$)

[b] Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$) relative to the transmission line's Normal Rating (also in MVA), as shown in the AESO's Study Scope.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No voltage deviations beyond the limits listed in Table 3-1 of the AESO's Study Scope (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed.

Category C5 Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category C5 conditions as shown in Table 4-2.

Table 4-2: Thermal Criteria Violations under Category C5 Conditions for Scenario 1

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow[a] (MVA)	% Loading[b]
C5-973L-974L (Sundance 310P to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*200*	*233*
	202L (Edson 58S to Cynthia 178S)	*85.1*	*94*	*197*	*231*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*221*	*230*
	671L (Bickerdike 39S to Edson 58S)	*172*	*189*	*179*	*104*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*171*	*228*

	Bickerdike 39S T1	*269*	*269*	*366*	*136*
	Bickerdike 39S T2	*269*	*269*	*358*	*133*
	744L (Pinedale 207S to Niton 228S)	*75.1*	*83*	*161*	*215*
	744L (Niton 228S to 106S tap)	*75.1*	*83*	*157*	*209*
	685L (Benbow 397S to Project 2630 Tap)	*167*	*184*	*225*	*135*
	685L (Deer Hill 1012S to Project 2630 Tap)	*167*	*184*	*225*	*135*

Notes:

[a] Power flow (MVA) is current expressed as MVA (i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$)

[b] Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$) relative to the transmission line's Normal Rating (also in MVA), as shown in the AESO's Study Scope.

Voltage Criteria Violations

No voltage criteria violations were observed under Category C5 conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category C5 conditions.

4.1.1.2 Scenario 2 :2025 Winter Peak Low Generation Pre-Project.

Category A Conditions

No Reliability Criteria violations were observed under Category A conditions.

Category B Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category B conditions as shown in Table 4-3.

Table 4-3: Thermal Criteria Violations under Category B Conditions for Scenario 2

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow[a] (MVA)	% Loading[b]
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*133*	*146*	*169*	*127*
890L (Edson 58S to Pinedale 207S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*101*	*112*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*315*	*117*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*312*	*116*
744L (Pinedale 207S to Niton 228S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*

7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*238*	*167*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*238*	*167*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*217*	*140*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*257*	*180*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*257*	*180*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*234*	*151*
202L (Edson 58S to Cynthia 178S)	*890L (Edson 58S to Pindale 207S)*	*79*	*87*	*83*	*105*
973L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*108*	*120*
	890L (Edson 58S to Pindale 207S)	*79*	*87*	*85*	*107*
974L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*108*	*120*
	890L (Edson 58S to Pindale 207S)	*79*	*87*	*85*	*107*
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*220*	*154*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*220*	*154*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*199*	*128*
1012ST1 (Deer Hill 1012S transformer)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*
854L (Deer Hill 1012S to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*
685L (Benbow 397S to Deer Hill 1012S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*95*	*105*
207S_T1 (Pinedale 207S transformer T1)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*
207S_T2 (Pinedale 207S transformer T2)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*98*	*109*
744L (Niton 228S to Entwistle 235S) or 228S Niton transformer T1	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*

Notes:

[a] Power flow (MVA) is current expressed as MVA (i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$)

[b] Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$) relative to the transmission line's Normal Rating (also in MVA), as shown in the AESO's Study Scope.

Voltage Criteria Violations

No voltage criteria violations were observed under Category B conditions.

POD Bus Voltage Deviations

No voltage deviations beyond the limits listed in Table 3-1 of the AESO's Study Scope (hereafter referred to as point of delivery (POD) bus voltage deviations) were observed.

Category C5 Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category C5 conditions as shown in Table 4-4.

Table 4-4: Thermal Criteria Violations under Category C5 Conditions for Scenario 2

Contingency (System Element Lost)	Violation Location Details	Thermal Ratings (MVA)		Pre-Project Results	
		Normal Rating	Emergency Rating	Power Flow[a] (MVA)	% Loading[b]
C5-973L-974L (Sundance 310P to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	91.1	100	196	215
	202L (Edson 58S to Cynthia 178S)	90.1	99	213	236
	740L (Bickerdike 39S to Edson 58S)	131	144	233	178
	890L (Edson 58S to Pindale 207S)	79	87	177	224
	Bickerdike 39S T1	269	269	360	134
	Bickerdike 39S T2	269	269	360	134
	744L (Pinedale 207S to Niton 228S)	79.1	87	163	206
	744L (Niton 228S to 106S tap)	79.1	87	157	199
	685L (Benbow 397S to Project 2630 Tap)	201	218	223	111
	685L (Deer Hill 1012S to Project 2630 Tap)	201	218	223	111

Notes:

[a] Power flow (MVA) is current expressed as MVA (i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$)

[b] Reported as a percentage of the power flow (in MVA, i.e., $S = \sqrt{3} \times V_{base} \times I_{actual}$) relative to the transmission line's Normal Rating (also in MVA), as shown in the AESO's Study Scope.

Voltage Criteria Violations

No voltage criteria violations were observed under Category C5 conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category C5 conditions.

4.2 Voltage Stability Studies

4.2.1.1 Scenario 1: 2025 Summer Peak Low Generation Pre-Project

Voltage stability analysis was performed for the 2025 SP Low Generation Pre-Project scenario. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 569.9 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 28.5 MW (0.05 x 569.9 MW = 28.5 MW), to meet the voltage stability criteria.

Table 4-5 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 4-5: Voltage Stability Study Results under Category B Conditions for Scenario 1

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		*890*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*668*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*743*	*Yes*
720L	*Fox Creek 347S*	*Benbow 397S*	*890*	*Yes*
39ST1	*Bickerdike transformer T1*		*770*	*Yes*
58ST1	*Edson 58S transformer T1*		*870*	*Yes*

4.2.1.2 Scenario 2: 2025 Winter Peak Low Generation Pre-Project

Voltage stability analysis was performed for the 2025 WP Low Generation Pre-Project scenario. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 631.2 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 31.56 MW (0.05 x 631.2 MW = 31.56 MW), to meet the voltage stability criteria.

Table 4-6 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 4-6: Voltage Stability Study Results under Category B Conditions for Scenario 2

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	System Normal		*993*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*700*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*770*	*Yes*
720L	*Fox Creek 347S*	*Benbow 397S*	*960*	*Yes*
39ST1	*Bickerdike transformer T1*		*903*	*Yes*
58ST1	*Edson 58S transformer T1*		*960*	*Yes*

5 Post-Project Study Results

This section describes the results of the post-Project power flow studies.

5.1 Power Flow Studies

Power flow diagrams illustrating the post-Project power flow studies results for Category A, Category B and selected C5 conditions are included in Attachment B.

5.1.1 Alternative 2

Alternative 2 included the following developments:

- Add a new 138/25 kV Point of Delivery (POD) substation next to customer site and then add a new 138 kV transmission line, approximately 53 km in length, to connect the new POD substation to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S substations via In-and-Out configuration.

5.1.1.1 Scenario 3: 2025 Summer Peak Low Study Area Generation Post-Project.

Category A Conditions

No thermal Criteria violations were observed under Category A conditions, however voltage Criteria violation observed at the new proposed Berland River substation. Adding a 27 MVAR cap bank can mitigate this violation.

Category B Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category B conditions as shown in Table 5-1.

Table 5-1: Thermal Criteria Violations under Category B Conditions for Scenario 3

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*99*	*109*	*144*	*145*	*143*	*144*	*-1.0*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*301*	*112*	*315*	*117*	*5.0*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*301*	*112*	*323*	*120*	*8.0*

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*126*	*117*	*126*	*117*	*0.0*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*126*	*117*	*126*	*117*	*0.0*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (Kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*138*	*129*	*138*	*129*	*0.0*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*138*	*129*	*138*	*129*	*0.0*
973L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*85.1*	*94*	*90*	*106*	*87*	*102*	*-4.0*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*108*	*112*	*104*	*108*	*-4.0*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*	*74*	*98*	*-4.0*
974L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*85.1*	*94*	*90*	*106*	*86*	*101*	*-5.0*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*108*	*112*	*104*	*108*	*-4.0*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*	*74*	*98*	*-4.0*
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*111*	*103*	*111*	*103*	*0.0*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*111*	*103*	*111*	*103*	*0.0*
1012ST1 (Deer Hill 1012S transformer)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*	*89*	*104*	*67.0*
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*	*89*	*104*	67.0
854L (Deer Hill 1012S to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*37*	*43*	*95*	*111*	*75.0*

Voltage Criteria Violations

Voltage criteria violations were observed under certain Category B conditions as shown in Table 5-2 and Table 5-3.

Table 5-2: Voltage Criteria Violations under Category B Conditions for the Scenario 3: 2025 SP

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		Post-Pre (kV)
	Substation Name and Number	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	
1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	138	124	152	142.5	136.4	139.2	121.2	-15.2
	Chevron Kaybob 551S	138	124	152	142.5	136.4	139.2	121.2	-15.2
	Benbow 397S	138	124	152	142.5	136.5	139.2	121.2	-15.3
	Chevron Knight 355S	138	124	152	142.5	136.4	139.2	121.2	-15.2
	Berland River 1182S	138	124	152	-	-	131.9	109.3	-
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	138	124	152	142.5	136.1	140.1	117	-19.1
	Kaybob 346S	138	124	152	142.5	136.1	139.2	119.7	-16.4
	Chevron Kaybob 551S	138	124	152	142.5	136.1	139.1	119.7	-16.4
	Benbow 397S	138	124	152	142.5	136.1	139.2	119.7	-16.4
	Chevron Knight 355S	138	124	152	142.5	136.1	139.1	119.7	-16.4
	Berland River 1182S	138	124	152	-	-	131.9	107.5	-
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	138	124	152	142.5	136.4	138.4	122.7	-13.7
	Chevron Kaybob 551S	138	124	152	142.5	136.4	138.4	122.7	-13.7
	Benbow 397S	138	124	152	142.5	136.5	138.4	122.7	-13.8
	Chevron Knight 355S	138	124	152	142.5	136.4	138.4	122.7	-13.7
	Berland River 1182S	138	124	152	-	-	131.6	113.9	-

POD Bus Voltage Deviations

Several POD bus voltage deviations were observed under certain Category B conditions.

Table 5-3: Voltage Deviations at POD Low Voltage Busses under Category B (2025 SP)

Contingency (System Element Lost)	Voltage Deviation Location Details			Post-Project Results						
					Voltage Deviations at POD Low Voltage Buses					
	Substation Name and Number	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage[a] (kV)	Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change

1012ST1 (Deer Hill 1012S transformer)	Berland River 1182S	526303	25	21.90	16.92	22.8	-	-	-	-
	Benbow 397S	4412	25	25.20	21.84	13.3	-	-	-	-
854L (Deer Hill 1012S to Bickerdike 39S)	Berland River 1182S	526303	25	21.90	16.49	24.7	-	-	-	-
	Benbow 397S	4412	25	25.20	21.56	14.4	-	-	-	-
	Deer Hill 1012S	2678	25	25.80	21.50	16.7	-	-	-	-
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Berland River 1182S	526303	25	23.92	19.94	16.63	-	-	-	-
	Benbow 397S	4412	25	25.05	22.13	11.67	-	-	-	-

Category C5 Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category C5 conditions as shown in Table 5-4.

Table 5-4: Thermal Criteria Violations under Category C5 Conditions for Scenario 3

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
C5-973L-974L (Sundance 310P to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	86	95	200	233	185	215	-18.0
	202L (Edson 58S to Cynthia 178S)	85.1	94	197	231	190	223	-8.0
	740L (Bickerdike 39S to Edson 58S)	96	106	221	230	214	223	-7.0
	671L (Bickerdike 39S to Edson 58S)	172	189	179	104	172	100	-4.0
	890L (Edson 58S to Pindale 207S)	75.1	83	171	228	166	221	-7.0
	Bickerdike 39S T1	269	269	366	136	374	139	3.0
	Bickerdike 39S T2	269	269	358	133	358	133	0.0
	744L (Pinedale 207S to Niton 228S)	75.1	83	161	215	156	208	-7.0
	744L (Niton 228S to 106S tap)	75.1	83	157	208.7	152	202	-6.7
	685L (Benbow 397S to Pine Creek 328S)	167	184	225	135	205	123	-12.0
	685L (Deer Hill 1012S to Pine Creek 328S)	167	184	225	135	244	146	11.0

Voltage Criteria Violations

No voltage Criteria violations were observed under Category C5 conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category C5 conditions.

5.1.1.2 Scenario 4: 2025 Winter Peak Low Study Area Generation Post-Project.

Category A Conditions

No thermal Criteria violations were observed under Category A conditions, but voltage Criteria violation at the new proposed Berland River substation is observed. Adding a 27 MVAR cap bank can mitigate this violation.

Category B Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category B conditions as shown in Table 5-5.

Table 5-5: Thermal Criteria Violations under Category B Conditions for Scenario 4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
671L (Bickerdike 39S to Edson 58S)	740L (Bickerdike 39S to Edson 58S)	133	146	169	127	166	125	-2.0
890L (Edson 58S to Pinedale 207S)	202L (Edson 58S to Cynthia 178S)	90.1	99	101	112	97	108	-4.0
39ST1 (Bickerdike transformer T1)	39ST2 (Bickerdike transformer T2)	269	269	315	117	325	121	4.0
39ST2 (Bickerdike transformer T2)	39ST1 (Bickerdike transformer T1)	269	269	312	116	334	124	8.0
744L (Pinedale 207S to Niton 228S)	202L (Edson 58S to Cynthia 178S)	90.1	99	97	108	94	104	-4.0
7L20 (Thornton 2091S to Dome Cutbank 810S)	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	142.8	162.9	238	167	238	167	0.0
	7L80 (Kakwa Ridge 857S to Simonette 733S)	142.8	162.9	238	167	238	167	0.0
	7L40 (Simonette 733S to Little Smoky 813S)	155.2	171.5	217	140	217	140	0.0
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	142.8	162.9	257	180	257	180	0.0
	7L80 (Kakwa Ridge 857S to Simonette 733S)	142.8	162.9	257	180	257	180	0.0
	7L40 (Simonette 733S to Little Smoky 813S)	155.2	171.5	234	151	234	151	0.0
202L (Edson 58S to Cynthia 178S)	890L (Edson 58S to Pindale 207S)	79	87	83	105	81	102	-3.0
973L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	90.1	99	108	120	104	115	-5.0
	890L (Edson 58S to Pindale 207S)	79	87	85	107	81	103	-4.0
974L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	90.1	99	108	120	104	115	-5.0
	890L (Edson 58S to Pindale 207S)	79	87	85	107	81	103	-4.0
7L28 (Big Mountain 845S to Thornton 2091S)	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	142.8	162.9	220	154	220	154	0.0

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*220*	*154*	*220*	*154*	0.0
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*199*	*128*	*199*	*128*	0.0
1012ST1 (Deer Hill 1012S transformer)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*35*	*38*	*93*	*102*	64.0
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0
854L (Deer Hill 1012S to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*40*	*44*	*100*	*110*	66
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0
614L (Benbow 397S to Berland Switching station- Pine Creek 328S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*	*90*	*100*	-6.0
685L (Deer Hill 1012S to Berland Switching station- Pine creek 328S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*35*	*38*	*93*	*102*	64.0
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*94*	*104*	-2.0
207S_T1 (Pinedale 207S transformer T1)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0
207S_T2 (Pinedale 207S transformer T2)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*98*	*109*	*96*	*107*	-2.0
744L (Niton 228S to Entwistle 235S) or 228S Niton transformer T1	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*	*94*	*104*	-4.0

Voltage Criteria Violations

Voltage criteria violations were observed under certain Category B conditions as shown in Table 5-6 and Table 5-7.

Table 5-6: Voltage Criteria Violations under Category B Conditions for the Scenario 4: 2025 WP

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Voltage Ratings (kV)			Pre-Project Results		Post-Project Results		Post-Pre (kV)
	Substation Name and Number	Nominal Voltage	Emergency Minimum Voltage	Emergency Maximum Voltage	Initial Voltage (kV)	Post-contingency Steady State (kV)	Initial Voltage (kV)	Post-contingency Steady State (kV)	

1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	138	124	152	142	135.8	139.3	119.8	-16.0
	Chevron Kaybob 551S	138	124	152	142	135.8	139.3	119.8	-16.0
	Benbow 397S	138	124	152	142	135.8	139.3	119.8	-16.0
	Chevron Knight 355S	138	124	152	142	135.8	139.3	119.8	-16.0
	Berland River 1182S	138	124	152	-	-	132.2	107.7	-
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	138	124	152	142	135.3	140.6	115.1	-20.2
	Kaybob 346S	138	124	152	142	135.3	139.3	117.9	-17.4
	Chevron Kaybob 551S	138	124	152	142	135.3	139.3	117.9	-17.4
	Benbow 397S	138	124	152	142	135.3	139.3	117.9	-17.4
	Chevron Knight 355S	138	124	152	142	135.3	139.3	117.9	-17.4
	Berland River 1182S	138	124	152	-	-	132.2	105.3	-
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	138	124	152	142.5	136.4	138.5	121.4	-15.0
	Chevron Kaybob 551S	138	124	152	142.5	136.4	138.5	121.4	-15.0
	Benbow 397S	138	124	152	142.5	136.5	138.5	121.4	-15.1
	Chevron Knight 355S	138	124	152	142.5	136.4	138.5	121.4	-15.0
	Berland River 1182S	138	124	152	-	-	131.7	112.5	-

POD Bus Voltage Deviations

Several POD bus voltage deviations were observed under certain Category B conditions.

Table 5-7: Voltage Deviations at POD Low Voltage Busses under Category B (2025 WP)

Contingency (System Element Lost)	Voltage Deviation Location Details			Post-Project Results						
	Substation Name and Number	Bus No.	Nominal Bus Voltage (kV)	Initial Voltage[a] (kV)	Voltage Deviations at POD Low Voltage Buses					
					Post Transient (kV)	% Change	Post Auto Control (kV)	% Change	Post Manual (kV)	% Change
1012ST1 (Deer Hill 1012S transformer)	Berland River 1182S	526303	25	21.96	16.5	24.8	-	-	-	-
	Benbow 397S	4412	25	25.22	21.58	14.4	-	-	-	-
854L (Deer Hill 1012S to Bickerdike 39S)	Berland River 1182S	526303	25	21.96	15.99	27.2	-	-	-	-
	Benbow 397S	4412	25	25.22	21.22	15.8	-	-	-	-
	Deer Hill 1012S	2678	25	25.85	21.1	18.4	-	-	-	-
685L (Deer Hill 1012S to Berland	Berland River 1182S	526303	25	23.96	19.59	19.59	-	-	-	-

Switching station - Pine Creek 328S)	Benbow 397S	4412	25	25.22	25.75	22.52	-	-	-	-

Category C5 Conditions

Thermal Criteria Violations

Thermal criteria violations were observed under certain Category C5 conditions as shown in Table 5-8.

Table 5-8: Thermal Criteria Violations under Category C5 Conditions for Scenario 4

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Normal Rating (MVA)	Emergency Rating (MVA)	Pre-Project Results		Post-Project Results		% Loading Difference (Post-Pre)
				Observed Power Flow (MVA)	% Loading	Observed Power Flow (MVA)	% Loading	
C5-973L-974L (Sundance 310P to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*196*	*215*	*179*	*196*	-19.0
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*213*	*236*	*204*	*226*	-10.0
	740L (Bickerdike 39S to Edson 58S)	*131*	*144*	*233*	*178*	*224*	*171*	-7.0
	890L (Edson 58S to Pindale 207S)	*79*	*87*	*177*	*224*	*171*	*216*	-8.0
	Bickerdike 39S T1	*269*	*269*	*360*	*134*	*366*	*136*	2.0
	Bickerdike 39S T2	*269*	*269*	*360*	*134*	*355*	*132*	-2.0
	744L (Pinedale 207S to Niton 228S)	*79.1*	*87*	*163*	*206*	*157*	*198*	-8.0
	744L (Niton 228S to 106S tap)	*79.1*	*87*	*157*	*199*	*151*	*191*	-8.0
	685L (Benbow 397S to Berland Switching station - Pine Creek 328S*)*	*201*	*218*	*223*	*111*	*205*	*102*	-9.0
	685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S*)*	*201*	*218*	*223*	*111*	*239*	*119*	8.0

Voltage Criteria Violations

No voltage Criteria violations were observed under Category C5 conditions.

POD Bus Voltage Deviations

No POD bus voltage deviations were observed under Category C5 conditions.

5.2 Voltage Stability Studies

5.2.1 Alternative [2]

5.2.1.1 Scenario 3: 2025 Summer Peak Low Generation Post-Project

Voltage stability analysis was performed for the 2025 SP Low Generation Post-Project scenario. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 606.9 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 30.35 MW (0.05 x 606.9 MW = 30.35 MW), to meet the voltage stability criteria.

Table 5-9 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 5-9: Voltage Stability Study Results under Category B Conditions for Scenario 3

The Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*400*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*65*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*74*	*Yes*
685L	*Deer Hill 1012S*	Pine Creek 328S	*75*	*Yes*
39ST1	*Bickerdike transformer T1*		*288*	*yes*
614L	Benbow 397S	Pine Creek 328S	*345*	*yes*

5.2.1.2 Scenario 4: 2025 Winter Peak Low Generation Post-Project

Voltage stability analysis was performed for the 2025 WP Low Generation Post-Project scenario. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 668.2 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 33.41 MW (0.05 x 668.2 MW = 33.41 MW), to meet the voltage stability criteria.

Table 5-10 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 5-10: Voltage Stability Study Results under Category B Conditions for Scenario 4

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*410*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*63*	*Yes*
685L	*Deer Hill 1012S*	Pine Creek 328S	*150*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*155*	*Yes*

39ST1	*Bickerdike transformer T1*		*390*	*yes*
614L	Benbow 397S	Pine Creek 328S	*400*	*yes*

6 Short Circuit Studies

6.1 Pre-Project Results

Pre-Project short-circuit current levels are provided in Table 6-1[2].

Table 6-1: Pre-Project Short-Circuit Current Levels for Scenario 2 (2025 WP)

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Deer Hill 1012S	138	142.6	6.3	0.014612+ j0.066979	4.4	0.040989+ j0.152428
Bickerdike 39S	138	143.2	16.1	0.003729+ j0.026761	19.9	0.000288+ j0.011532
	240	260.3	13.9	0.002235+ j0.018728	16.0	0.000400+ j0.011081
Marlboro 348S	138	142.9	5.2	0.022202+ j0.079889	3.5	0.058881+ j0.199633
Benbow 397S	138	142.3	4.7	0.027063+ j0.087811	4.0	0.026966+ j0.142101
Fox Creek 347S	138	142.5	5.1	0.029885+ j0.079098	4.3	0.028244+ j0.132522
Fox Creek 741S	138	142.2	4.5	0.037383+ j0.088229	4.3	0.018137+ j0.114451

6.2 Post-Project Results

6.2.1 Scenario 4: 2025 Winter Peak Low Generation Post-Project

Post-Project short-circuit current levels for Alternative 2 for Scenario 4 are provided in Table 6-2.

Table 6-2: Post-Project Short-Circuit Current Levels for Scenario 4

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Deer Hill 1012S	138	142.8	6.3	0.015576+ j0.066775	4.4	0.041359+ j0.151889
Bickerdike 39S	138	144.1	16.1	0.003891+ j0.026962	19.9	0.000292+ j0.011587
	240	259.9	13.9	0.002281+ j0.018674	16.0	0.000397+ j0.011024

[2] Short-circuit current studies were based on modeling information provided to the AESO by third parties. The authenticity of the modeling information has not been validated. Fault levels could change as a result of system developments, new customer connections, or additional generation in the area. It is recommended that these changes be monitored, and fault levels reviewed to ensure that the fault levels are within equipment operating limits. The information provided in this study should not be used as the sole source of information for electrical equipment specifications or for the design of safety-grounding systems.

Marlboro 348S	138	143.4	5.2	0.022693+ j0.079920	3.5	0.058990+ j0.199510
Benbow 397S	138	141.9	4.7	0.029729+ j0.086790	4.0	0.028346+ j0.140176
Fox Creek 347S	138	142.0	5.1	0.031256+ j0.078956	4.3	0.028552+ j0.131881
Fox Creek 741S	138	141.8	4.5	0.038369+ j0.088137	4.2	0.018105+ j0.113630
Pine Creek 328S	138	142.0	4.7	0.028768+ j0.086251	3.9	0.033014+ j0.149949
Berland River 1182S	138	140.2	2.0	0.090916+ j0.192485	1.3	0.159763+ j0.512468

6.2.2 Scenario 5: 2031 Winter Peak Post-Project

Post-Project short-circuit current levels for Alternative 2 for Scenario 5 are provided in Table 6-3.

Table 6-3: Post-Project Short-Circuit Current Levels for Scenario 5

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (pu)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (pu)
Deer Hill 1012S	138	142.3	6.3	0.015722+ j0.066952	4.4	0.041358+ j0.151890
Bickerdike 39S	138	143.5	16.0	0.003958+ j0.027075	19.7	0.000291+ j0.011587
	240	259.1	13.7	0.002329+ j0.018850	15.9	0.000395+ j0.011030
Marlboro 348S	138	142.8	5.2	0.022798+ j0.080058	3.5	0.058990+ j0.199510
Benbow 397S	138	141.9	4.7	0.030039+ j0.087094	4.0	0.028347+ j0.140184
Fox Creek 347S	138	142.1	5.1	0.031758+ j0.079463	4.3	0.028593+ j0.131962
Fox Creek 741S	138	141.9	4.4	0.039388+ j0.089136	4.2	0.018258+ j0.114304
Pine Creek 328S	138	141.9	4.7	0.029062+ j0.086538	3.9	0.033011+ j0.149952
Berland River 1182S	138	140.0	2.0	0.091225+ j0.192710	1.3	0.159631+ j0.512284

7 Mitigation Measure Development and Evaluation

The Studies Consultant, in consultation with the AESO, developed mitigation measures to address the system performance issues that were identified in the post-Project scenarios. Existing remedial action schemes (RASs) are described in the AESO's Connection Study Scope.

[As part of this Project, mitigation measures will not be specifically developed for the POD bus voltage deviations observed under certain Category B conditions during pre-Project and post-Project scenarios.[3]]

7.1 Pre-Project

Pre-Project mitigation measures are summarized in Table 7-1.

Table 7-1: Pre-Project Mitigation Measures

Mitigation Measure	Location of Observed Violation	Contingency
Existing RAS 171	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L20 (Thornton 2091S to Dome Cutbank 810S) 7L28 (Big Mountain 845S to Thornton 2091S)
	7L80 (Kakwa Ridge 857S to Simonette 733S)	
	7L40 (Simonette 733S to Little Smoky 813S)	
	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L20 (H.R. Milner 740S to Dome Cutbank 810S)
	7L80 (Kakwa Ridge 857S to Simonette 733S)	
	7L40 (Simonette 733S to Little Smoky 813S)	
	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L28 (Big Mountain 845S to Thornton 2091S)
	7L80 (Kakwa Ridge 857S to Simonette 733S)	
Planned RAS 185	890L (Edson 58S to Pindale 207S)	973L (Sundance 310P to Bickerdike 39S) 974L (Sundance 310P to Bickerdike 39S) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 186	39ST2 (Bickerdike transformer T2)	39ST1 (Bickerdike transformer T1) C5-973L-974L (Sundance 310P to Bickerdike 39S)
	39ST1 (Bickerdike transformer T1)	39ST2 (Bickerdike transformer T2)

[3] The AESO's desired post-contingency voltage deviations for low voltage busses represent guidelines rather than criteria. A POD bus voltage deviation that exceeds the desired limits shown in Table 3-1 of the AESO's Connection Study Scope does not represent a Reliability Criteria violation.

		C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 188	740L (Bickerdike 39S to Edson 58S)	671L (Bickerdike 39S to Edson 58S) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 189	202L (Edson 58S to Cynthia 178S)	973L (Sundance 310P to Bickerdike 39S) 974L (Sundance 310P to Bickerdike 39S) C5-973L-974L (Sundance 310P to Bickerdike 39S) 890L (Edson 58S to Pinedale 207S) 744L (Pinedale 207S to Niton 228S)
Planned RAS 190	720L (Fox Creek 347S to Benbow 397S)	C5-973L-974L (Sundance 310P to Bickerdike 39S)
Real time operational practices	202L (Edson 58S to Cynthia 178S)	973L (Sundance 310P to Bickerdike 39S)
	740L (Bickerdike 39S to Edson 58S)	
	890L (Edson 58S to Pindale 207S)	
	202L (Edson 58S to Cynthia 178S)	974L (Sundance 310P to Bickerdike 39S)
	740L (Bickerdike 39S to Edson 58S)	
	890L (Edson 58S to Pindale 207S)	

7.2 Post-Project

Post-Project mitigation measures are summarized in Table 7-2.

Table 7-2: Post-Project Mitigation Measures

Mitigation Measure	**Location of Observed Violation**	**Contingency**
Existing RAS 171	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L20 (Thornton 2091S to Dome Cutbank 810S) 7L28 (Big Mountain 845S to Thornton 2091S)
	7L80 (Kakwa Ridge 857S to Simonette 733S)	
	7L40 (Simonette 733S to Little Smoky 813S)	
	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L20 (H.R. Milner 740S to Dome Cutbank 810S)
	7L80 (Kakwa Ridge 857S to Simonette 733S)	
	7L40 (Simonette 733S to Little Smoky 813S)	
	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	7L28 (Big Mountain 845S to Thornton 2091S)

	7L80 (Kakwa Ridge 857S to Simonette 733S)	
Planned RAS 185	890L (Edson 58S to Pindale 207S)	973L (Sundance 310P to Bickerdike 39S) 974L (Sundance 310P to Bickerdike 39S) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 186	39ST2 (Bickerdike transformer T2)	39ST1 (Bickerdike transformer T1) C5-973L-974L (Sundance 310P to Bickerdike 39S)
	39ST1 (Bickerdike transformer T1)	39ST2 (Bickerdike transformer T2) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 188	740L (Bickerdike 39S to Edson 58S)	671L (Bickerdike 39S to Edson 58S) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 189	202L (Edson 58S to Cynthia 178S)	973L (Sundance 310P to Bickerdike 39S) 974L (Sundance 310P to Bickerdike 39S) 614L (Benbow 397S to Berland Switching Station – Pine Creek 328S) 685L (Deer Hill 1012S to Berland Switching Station – Pine Creek 328S) 890L (Edson 58S to Pinedale 207S) 744L (Pinedale 207S to Niton 228S) C5-973L-974L (Sundance 310P to Bickerdike 39S)
Planned RAS 190	720L (Fox Creek 347S to Benbow 397S)	C5-973L-974L (Sundance 310P to Bickerdike 39S)
Add 27 MVAR cap bank at Berland River 1182S new substation	Voltage Range Violation at Berland River 1182S	N-0 condition
	Thermal violation: 720L (Fox Creek 347S to Benbow 397S) Voltage Range Violation at Kaybob 346S, Chevron knight 355S, Benbow 397S, Chevron Kaybob 551S and Deer Hill 1012S	1012ST1 (Deer Hill 1012S transformer)
		854L (Deer Hill 1012S to Bickerdike 39S)
		685L (Deer Hill 1012S to Berland Switching Station – Pine Creek 328S)
Real time operational practices	202L (Edson 58S to Cynthia 178S)	973L (Sundance 310P to Bickerdike 39S)
	740L (Bickerdike 39S to Edson 58S)	
	890L (Edson 58S to Pindale 207S)	
	202L (Edson 58S to Cynthia 178S)	

	740L (Bickerdike 39S to Edson 58S)	974L (Sundance 310P to Bickerdike 39S)
	890L (Edson 58S to Pindale 207S)	

7.3 Evaluation of Mitigation Measures

This section describes the results of the power flow studies and the voltage stability studies that were performed to assess the impact of the Project on the performance of the AIES following the implementation of proposed mitigation measures.

The post-mitigation measures studies were performed under Category B conditions for 2025 SP and 2025 WP using Alternative 1 and the RASs described in the previous section.

The post-mitigation power flow diagrams for selected Category B conditions are provided in Attachment C and D. Post-mitigation power flow diagrams present only those contingencies that result in thermal criteria violations that require RAS mitigation. Contingencies that result in thermal criteria violations that can be mitigated by real-time operational practices, or TFO capital maintenance projects were not studied.

7.3.1 Alternative 2

7.3.1.1 Scenario 3: 2025 SP post-Project

Voltage stability analysis was performed for the 2025 SP Low Generation Post-Project scenario with 27 MVAR cap bank. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 606.9 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 30.35 MW (0.05 x 606.9 MW = 30.35 MW), to meet the voltage stability criteria.

Table 7-3 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 7-3: Voltage Stability Study Results for Scenario 3 with 27 MVAR cap bank (Alternative 2)

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*460*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*149*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*215*	*Yes*
685L	*Deer Hill 1012S*	*Pine Creek 328S*	*215*	*Yes*
39ST1	*Bickerdike transformer T1*		*425*	*Yes*
614L	*Benbow 397S*	*Pine Creek 328S*	*450*	*Yes*

Category B Conditions

Thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies for Alternative 3 were mitigated by adding Cap bank (27 MVAR) as shown in Table 7-4 and Table 7-5 .

Table 7-4: Post-Mitigation Power Flow Study Results for Scenario 3: 2025 SP (Alternative 2)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-Mitigation Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
1012ST1 (Deer Hill 1012S transformer)	720L (Fox Creek 347S to Benbow 397S)	*86*	*95*	*94*	*109*	*75.7*	*88*
854L (Deer Hill 1012S to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	*86*	*95*	*101*	*118*	*82.6*	*96*
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	720L (Fox Creek 347S to Benbow 397S)	*86*	*95*	*89*	*104*	*72*	*84*

Table 7-5: Post-mitigation Voltage Range Violations for Scenario 3: 2025 SP (Alternative 2)

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Post-project Initial Voltage (kV)	Post-project Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	13	138	124	152	139.2	121.2	131
	Chevron Kaybob 551S	82	138	124	152	139.2	121.2	131
	Benbow 397S	412	138	124	152	139.2	121.2	131
	Chevron Knight 355S	411	138	124	152	139.1	121.2	131
	P2630 Berland	526302	138	124	152	131.9	109.3	127
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	678	138	124	152	140.1	117	129
	Kaybob 346S	13	138	124	152	139.2	119.7	130
	Chevron Kaybob 551S	82	138	124	152	139.1	119.7	130

	Benbow 397S	412	138	124	152	139.2	119.7	130
	Chevron Knight 355S	411	138	124	152	139.1	119.7	130
	P2630 Berland	526302	138	124	152	131.9	107.5	124
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	13	138	124	152	138.4	122.7	130.8
	Chevron Kaybob 551S	82	138	124	152	138.4	122.7	130.8
	Benbow 397S	412	138	124	152	138.4	122.7	130.8
	Chevron Knight 355S	411	138	124	152	138.4	122.7	130.8
	P2630 Berland	526302	138	124	152	131.6	113.9	127.6

Thermal violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 7-6.

Table 7-6: Post-RAS Power Flow Study Results for Scenario 3: 2025 SP (Alternative 2)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*99*	*109*	*143*	*144*	*81.2*	*82*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*315*	*117*	*217.9*	*81*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*323*	*120*	*223.3*	*83*
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*126*	*117*	*86.9*	*81*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*126*	*117*	*86.9*	*81*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (Kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*138*	*129*	*99.8*	*93*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*138*	*129*	*99.8*	*93*
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*111*	*103*	*73.0*	*68*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*111*	*103*	*73.0*	*68*

Category C5 Conditions

Thermal violations observed under certain Category C5 conditions in the post-Project studies were mitigated by RASs as shown in Table 7-7.

Table 7-7: Post-RAS Power Flow Study Results for Scenario 3: 2025 SP (Alternative 2)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
C5-973L-974L (Sundance 310P to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*185*	*215*	*49.9*	*58%*
	202L (Edson 58S to Cynthia 178S)	*85.1*	*94*	*190*	*223*	*63*	*74%*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*214*	*223*	*83.5*	*87%*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*166*	*221*	*60.1*	*80%*
	Bickerdike 39S T1	*269*	*269*	*374*	*139*	*177.5*	*66%*
	Bickerdike 39S T2	*269*	*269*	*358*	*133*	*177.5*	*66%*
	744L (Pinedale 207S to Niton 228S)	*75.1*	*83*	*156*	*208*	*51.8*	*69%*
	744L (Niton 228S to 106S tap)	*75.1*	*83*	*152*	*202*	*47.3*	*63%*
	685L (Benbow 397S to Project 2630 Tap)	*167*	*184*	*205*	*123*	*73.5*	*44%*
	685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	*167*	*184*	*244*	*146*	*110.2*	*66%*

7.3.1.2 Scenario 4: 2025WP post-Project

Voltage stability analysis was performed for the 2025 WP Low Generation Post-Project scenario for Alternative 1. The reference load level for the Study area (Areas 22, 23, 24, 26 and 29) is 668.2 MW. For Category B contingencies, the minimum incremental load transfer is 5% of the reference load, or 33.41 MW (0.05 x 668.2 MW = 33.41 MW), to meet the voltage stability criteria.

Table 7-8 provides the voltage stability study results under the Category A condition and for the five worst contingencies under Category B conditions. The voltage stability diagrams are provided in Attachment C.

Table 7-8: Voltage Stability Study Results for Scenario 4 with 27 MAVR cap bank (Alternative 2)

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*485*	*Yes*

1012ST1	*Deer Hill 1012S transformer*		*133*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*200*	*Yes*
685L	*Deer Hill 1012S*	*Pine Creek 328S*	*220*	*Yes*
39ST1	*Bickerdike transformer T1*		*460*	*Yes*
614L	*Benbow 397S*	*Pine Creek 328S*	*510*	*Yes*

Category B Conditions

Thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies for Alternative 3 were mitigated by adding Cap bank as shown in Table 7-9 **Error! Reference source not found.**and Table 7-10.

Table 7-9: Post-mitigation Power Flow Study Results for Scenario 4: 2025 WP (Alternative 2)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
1012ST1 (Deer Hill 1012S transformer)	720L (Fox Creek 347S to Benbow 397S)	91.1	*100*	*97*	*107*	*78*	*86*
854L (Deer Hill 1012S to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	91.1	*100*	*106*	*116*	*87*	*95*
685L (Deer Hill 1012S to Berland Switching station-Pine creek 328S)	720L (Fox Creek 347S to Benbow 397S)	91.1	*100*	*93*	*102*	*75.6*	*83*

Table 7-10: Post-mitigation Voltage Range Violations for Scenario 4: 2025 WP (Alternative 2)

Contingency (System Element Lost)	Substation Name and Number	Bus Numb er	Nomina l kV	Emergenc y Minimum Voltage (kV)	Emergenc y Maximum Voltage (kV)	Post-project Initial Voltag e (kV)	Post-project Steady State Voltage (kV)	Post-Mitigatio n Steady State (kV)
1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	13	138	124	152	139.3	119.8	130
	Chevron Kaybob 551S	82	138	124	152	139.3	119.8	130
	Benbow 397S	412	138	124	152	139.3	119.8	130
	Chevron Knight 355S	411	138	124	152	139.3	119.8	130

	P2630 Berland	526302	138	124	152	132.2	117.9	126
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	678	138	124	152	140.6	115.1	127
	Kaybob 346S	13	138	124	152	139.3	117.9	128
	Chevron Kaybob 551S	82	138	124	152	139.3	117.9	128
	Benbow 397S	412	138	124	152	139.3	117.9	128
	Chevron Knight 355S	411	138	124	152	139.3	117.9	128
	P2630 Berland	526302	138	124	152	132.2	105.3	124
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	13	138	124	152	138.5	121.4	129.6
	Chevron Kaybob 551S	82	138	124	152	138.5	121.4	129.6
	Benbow 397S	412	138	124	152	138.5	121.4	129.7
	Chevron Knight 355S	411	138	124	152	138.5	121.4	129.6
	P2630 Berland	526302	138	124	152	131.7	112.5	126.3

The thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 7-11.

Table 7-11: Post-RAS Power Flow Study Results for Scenario 4: 2025 WP (Alternative 2)

Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*133*	*146*	*166*	*125*	*106*	*80*
890L (Edson 58S to Pinedale 207S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*	*54*	*60*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*325*	*121*	*226*	*84*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*334*	*124*	*231*	*86*
744L (Pinedale 207S to Niton 228S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*94*	*104*	*50*	*56*
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*238*	*167*	*44*	*31*

	7L80 (Kakwa Ridge 857S to Simonette 733S)	142.8	162.9	238	167	44	31
	7L40 (Simonette 733S to Little Smoky 813S)	155.2	171.5	217	140	25	16
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	142.8	162.9	257	180	57	40
	7L80 (Kakwa Ridge 857S to Simonette 733S)	142.8	162.9	257	180	57	40
	7L40 (Simonette 733S to Little Smoky 813S)	155.2	171.5	234	151	36	23
973L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	90.1	99	104	115	50	56
	890L (Edson 58S to Pindale 207S)	79	87	81	103	43	54
974L (Sundance 310P to Bickerdike 39S)	202L (Edson 58S to Cynthia 178S)	90.1	99	104	115	50	56
	890L (Edson 58S to Pindale 207S)	79	87	81	103	43	54
7L28 (Big Mountain 845S to Thornton 2091S)	7L80 (kakwa Ridge 857S to H.R. Milner 740S)	142.8	162.9	220	154	30	21
	7L80 (Kakwa Ridge 857S to Simonette 733S)	142.8	162.9	220	154	30	21
	7L40 (Simonette 733S to Little Smoky 813S)	155.2	171.5	199	128	16	10

Category C5 Conditions

The thermal and voltage criteria violations observed under certain Category B conditions in the post-Project studies were mitigated by RASs as shown in Table 7-12.

Table 7-12: Post-RAS Power Flow Study Results for Scenario 4: 2025 WP (Alternative 2)

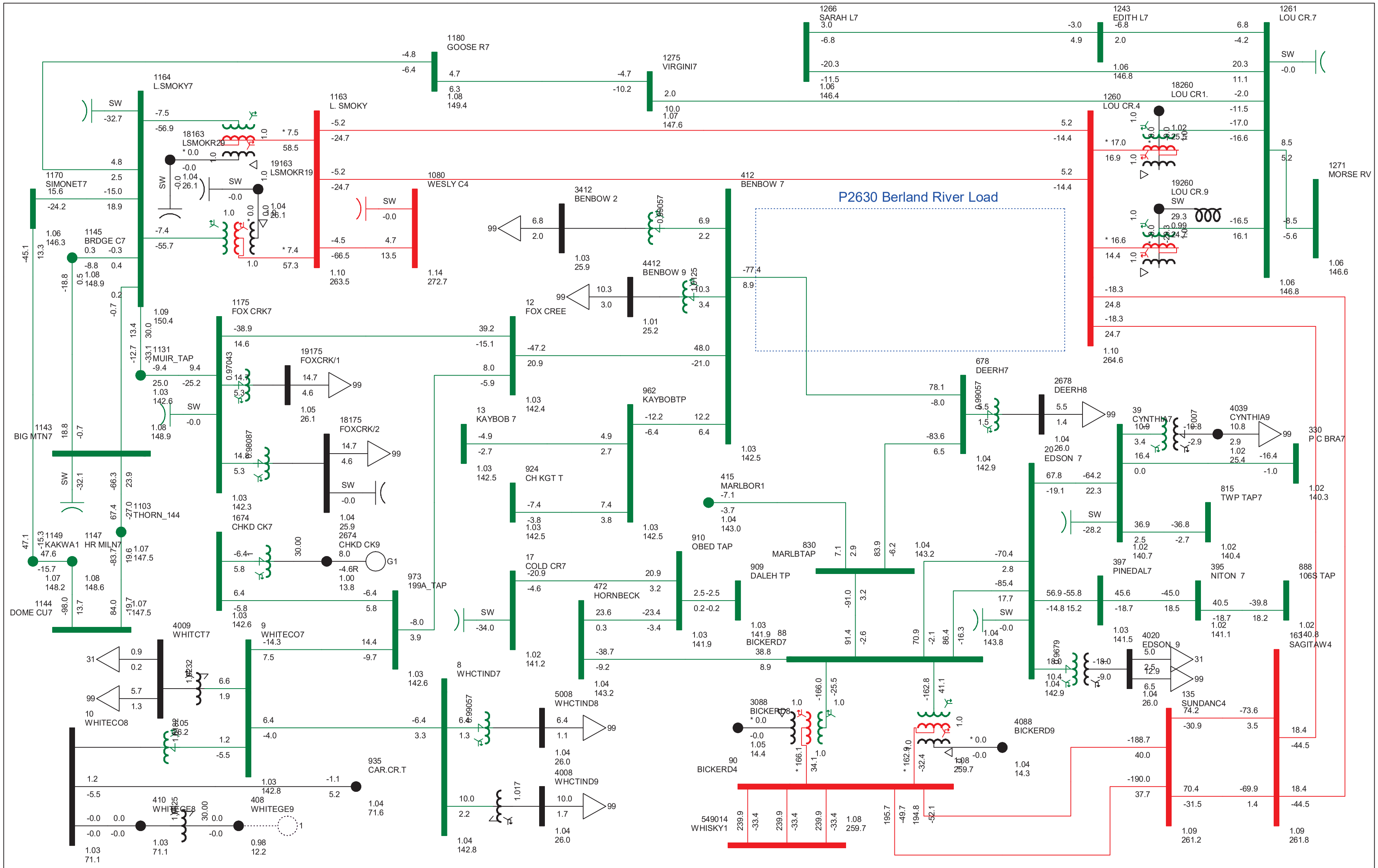
Contingency (System Element Lost)	Details of Violation (Violation Observed On)	Seasonal Continuous Rating (MVA)	Short-term (Emergency) Rating (MVA)	Post-Project Results		Post-RAS Action Results	
				Power Flow (MVA)	% Loading	Power Flow (MVA)	% Loading
C5-973L-974L (Sundance 310P to Bickerdike 39S)	720L (Fox Creek 347S to Benbow 397S)	91.1	100	179	196	32.8	36%
	202L (Edson 58S to Cynthia 178S)	90.1	99	204	226	80.2	89%
	740L (Bickerdike 39S to Edson 58S)	131	144	224	171	96.9	74%
	890L (Edson 58S to Pindale 207S)	79	87	171	216	68.7	87%
	Bickerdike 39S T1	269	269	366	136	177.5	66%

	Bickerdike 39S T2	*269*	*269*	*355*	*132*	177.5	*66%*
	744L (Pinedale 207S to Niton 228S)	*79.1*	*87*	*157*	*198*	56.2	71%
	744L (Niton 228S to 106S tap)	*79.1*	*87*	*151*	*191*	50.6	64%
	685L (Benbow 397S to Berland Switching station - Pine Creek 328S)	*201*	*218*	*205*	*102*	100.5	50%
	685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	*201*	*218*	*239*	*119*	100.5	50%

8 Project Interdependencies

The Project is not dependent on the future developments of the AESO Long Term Plan for the region.

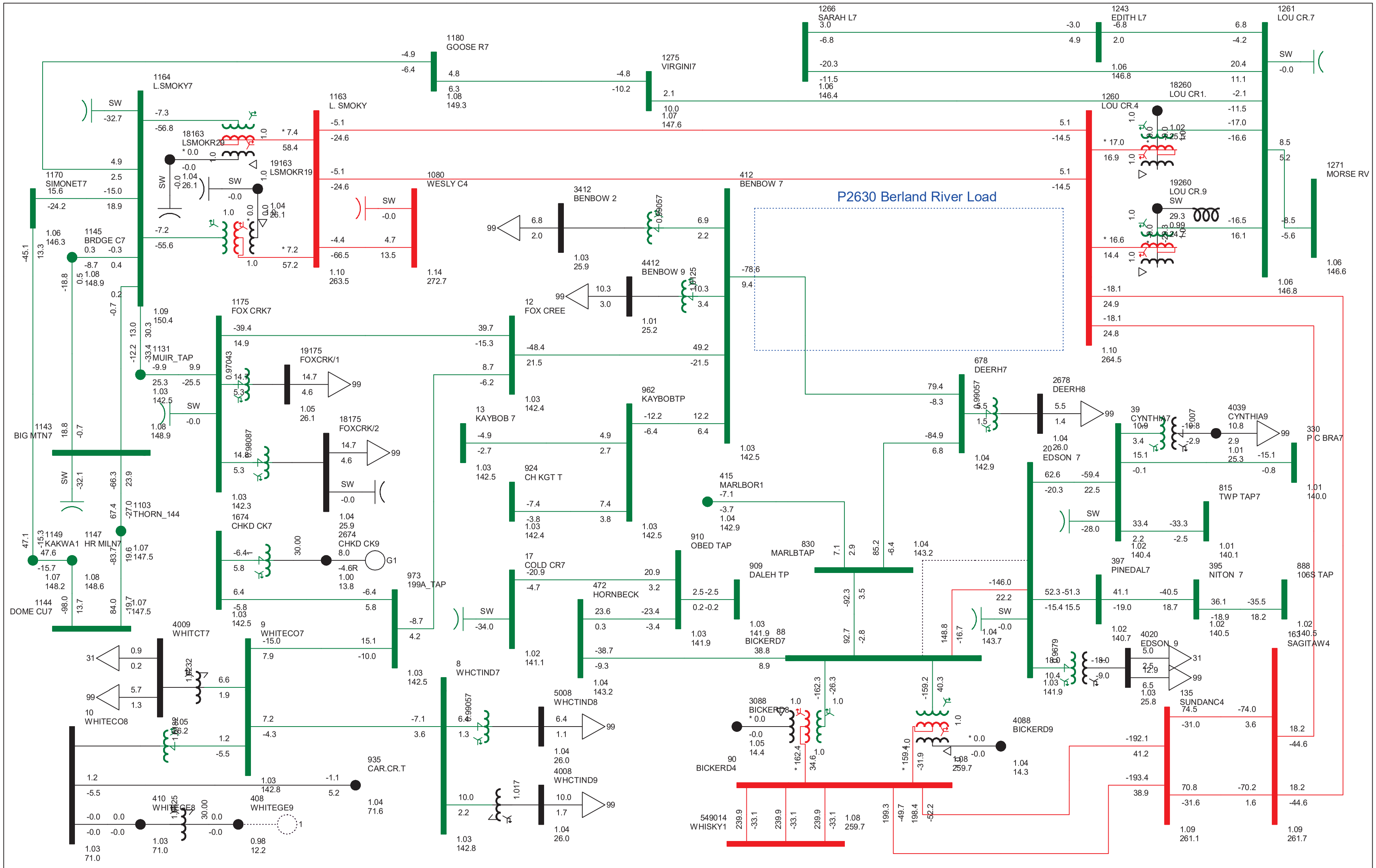
Attachment A: Pre-Project Power Flow Diagrams (Scenarios 1 and 2)



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-1
N-0: NORMAL OPERATION
TUE, MAR 12 2024 13:12

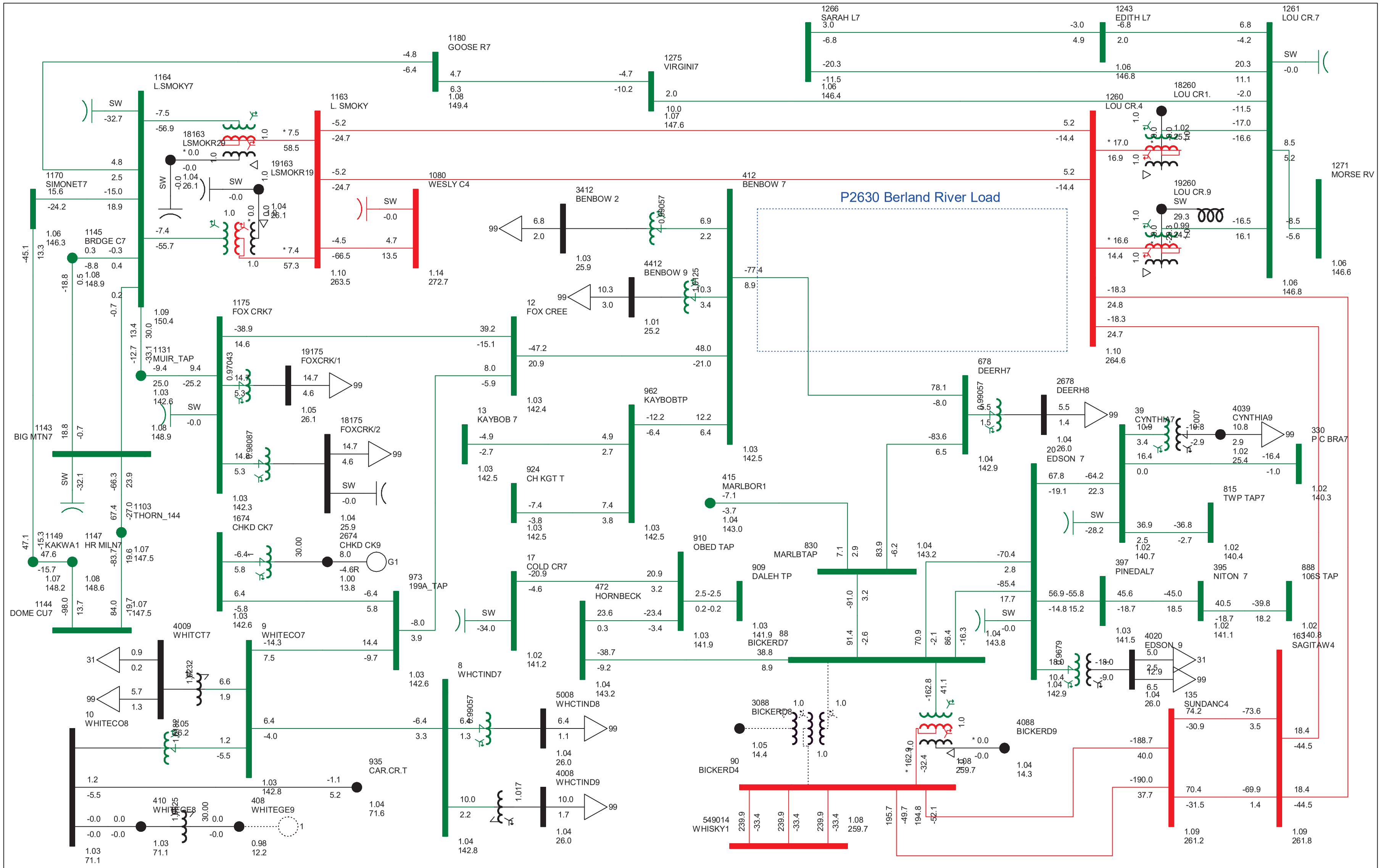
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-2
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, MAR 12 2024 13:13

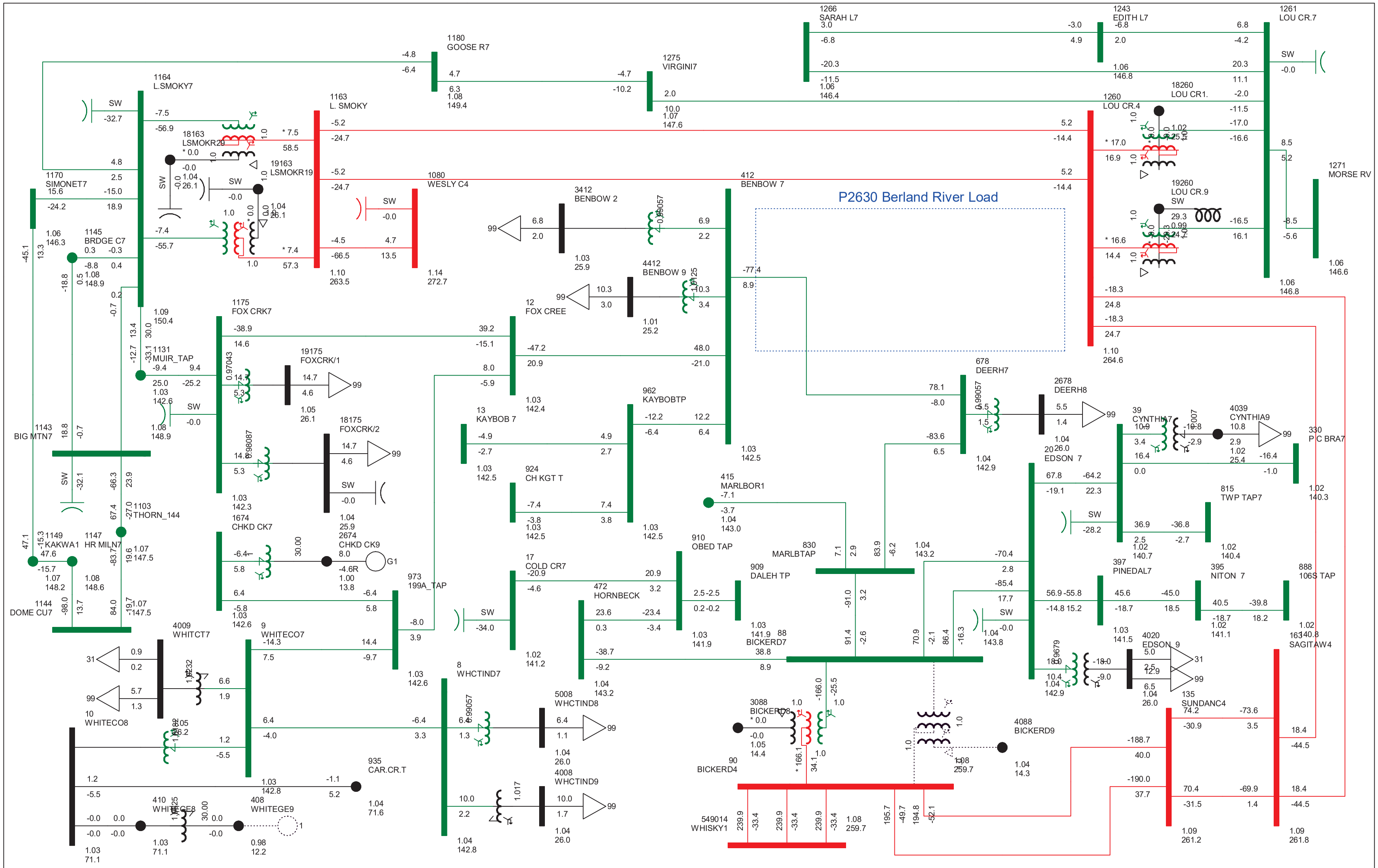
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-3
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:13

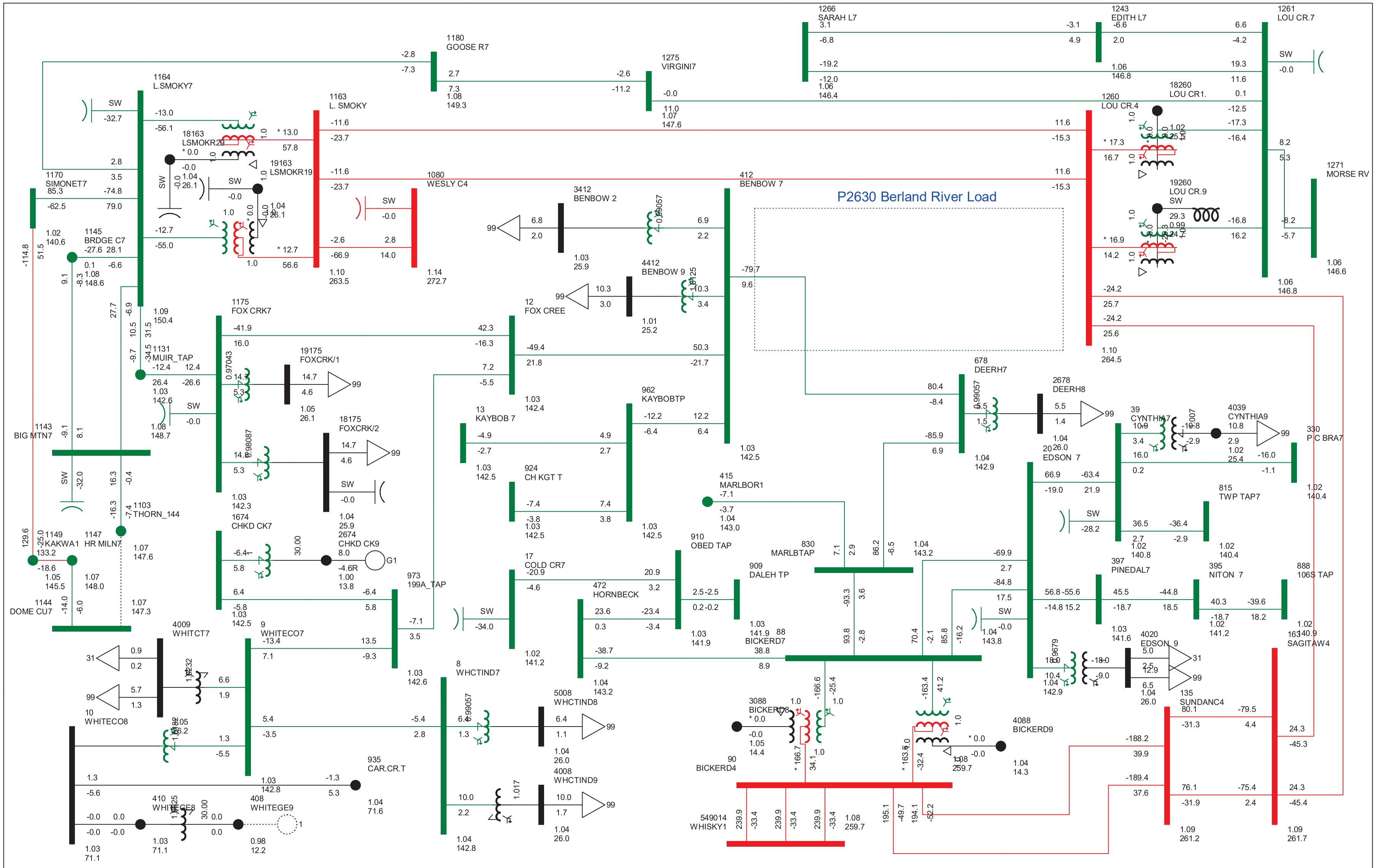
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-4
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:13

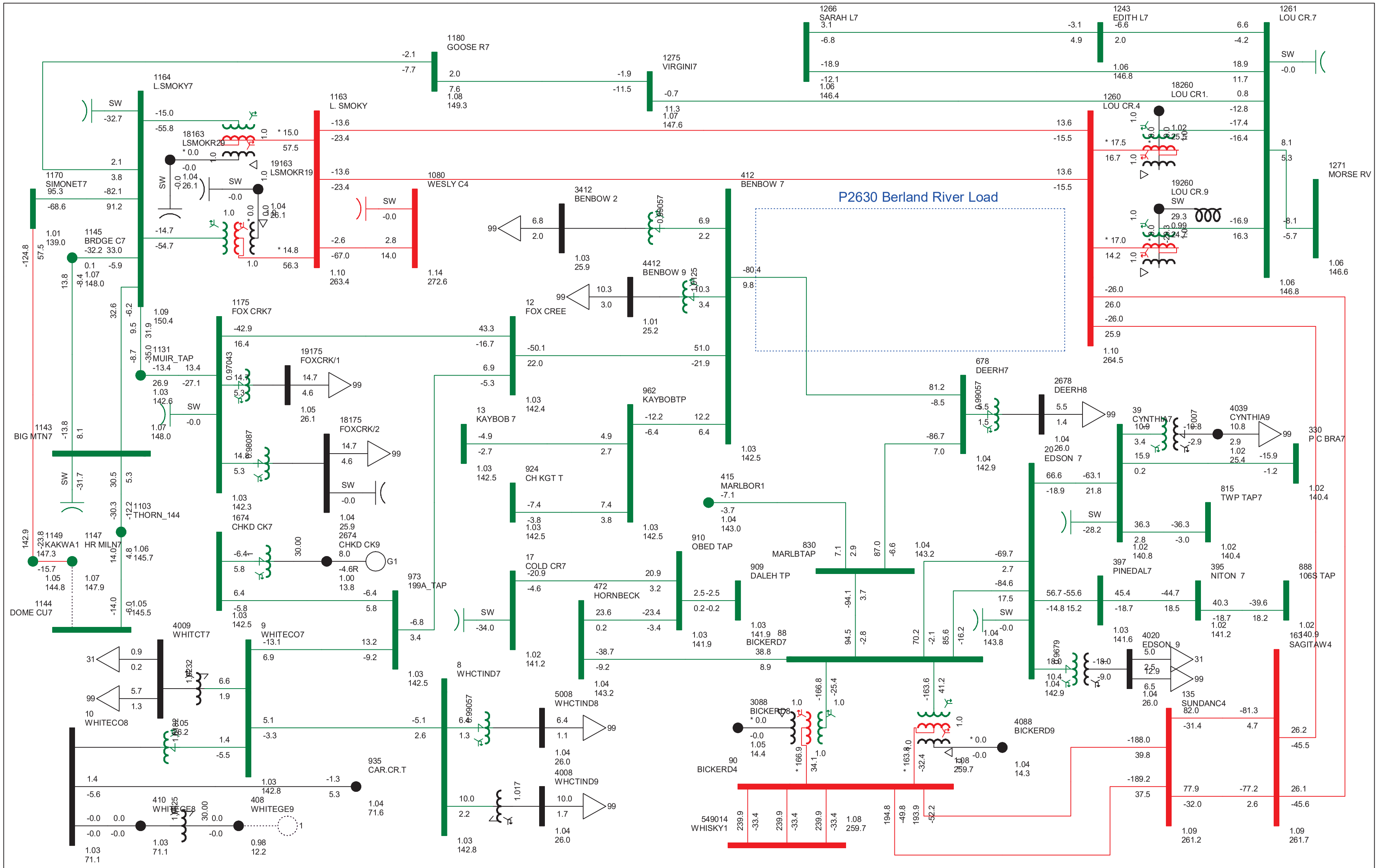
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-5
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:14

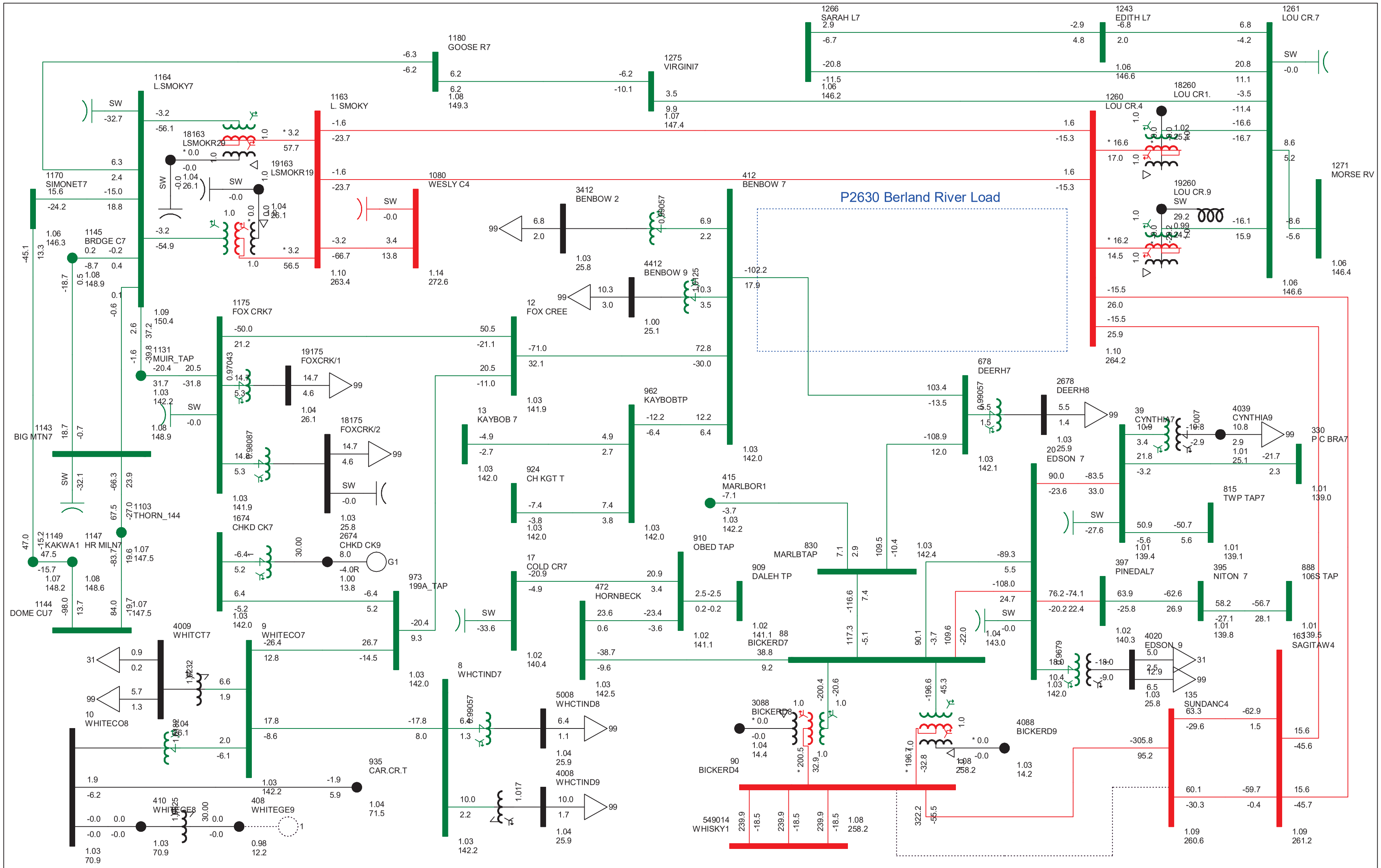
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-6
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:14

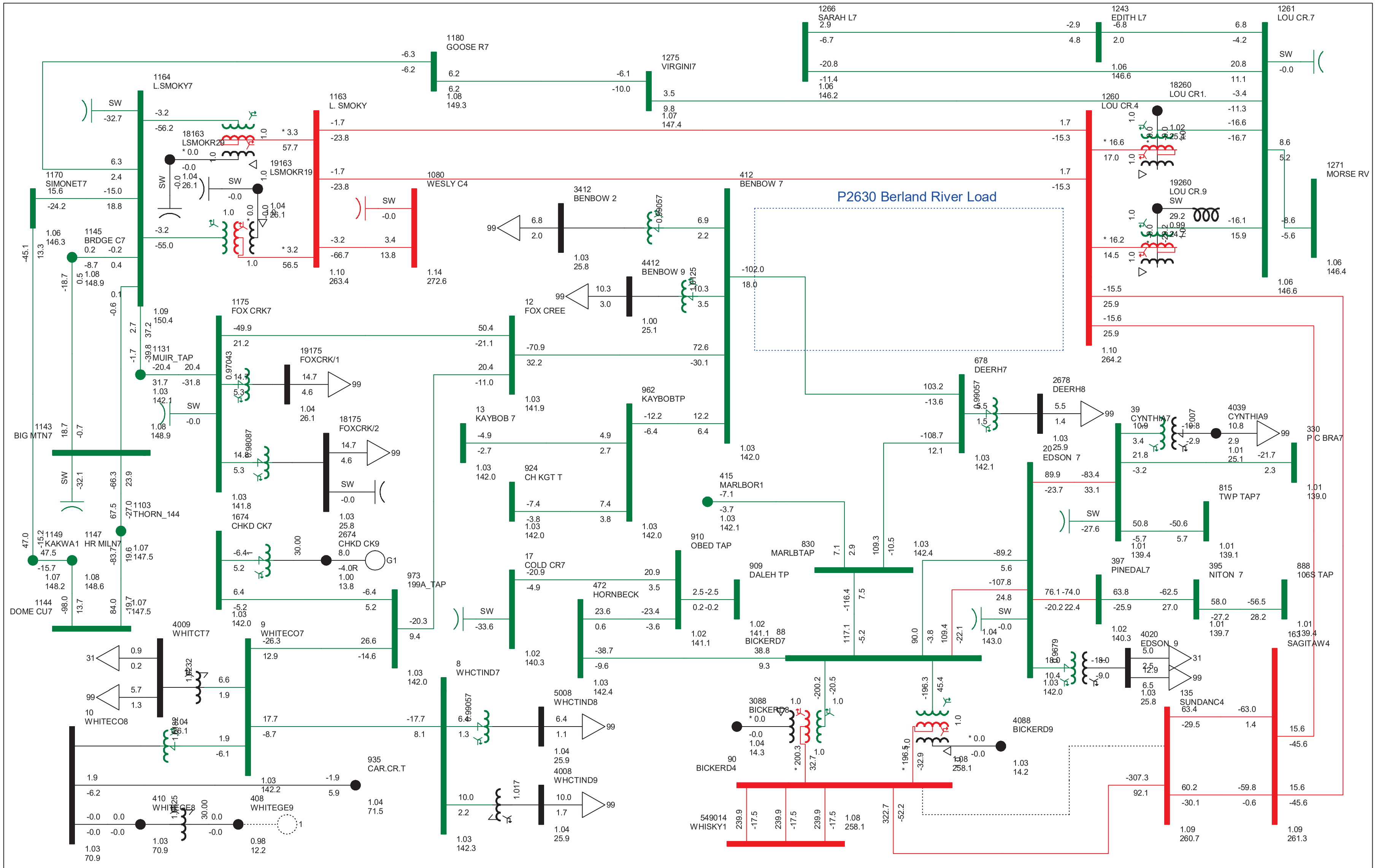
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-7
N-1: 973L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 13:14

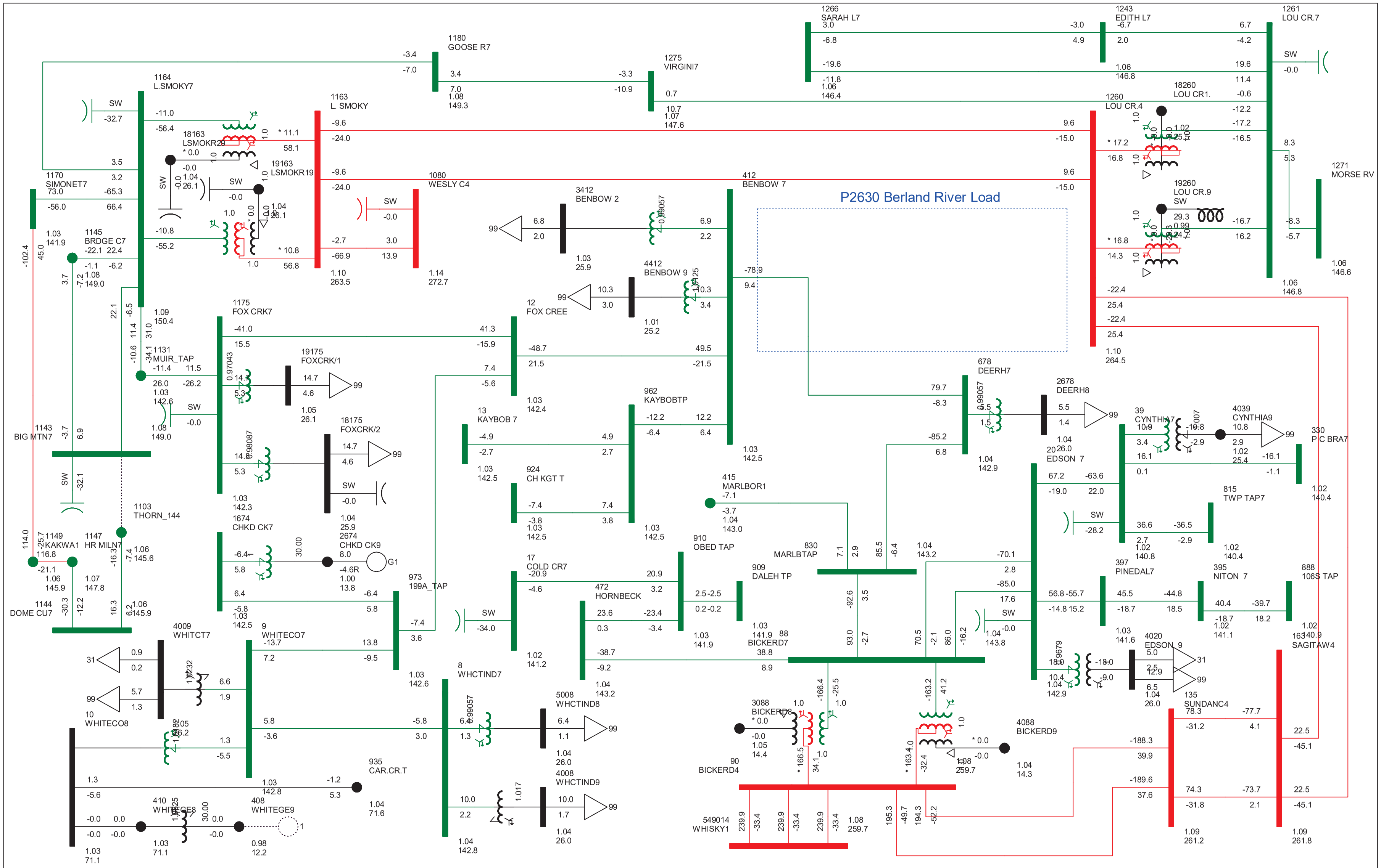
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-8
N-1: 974L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 13:14

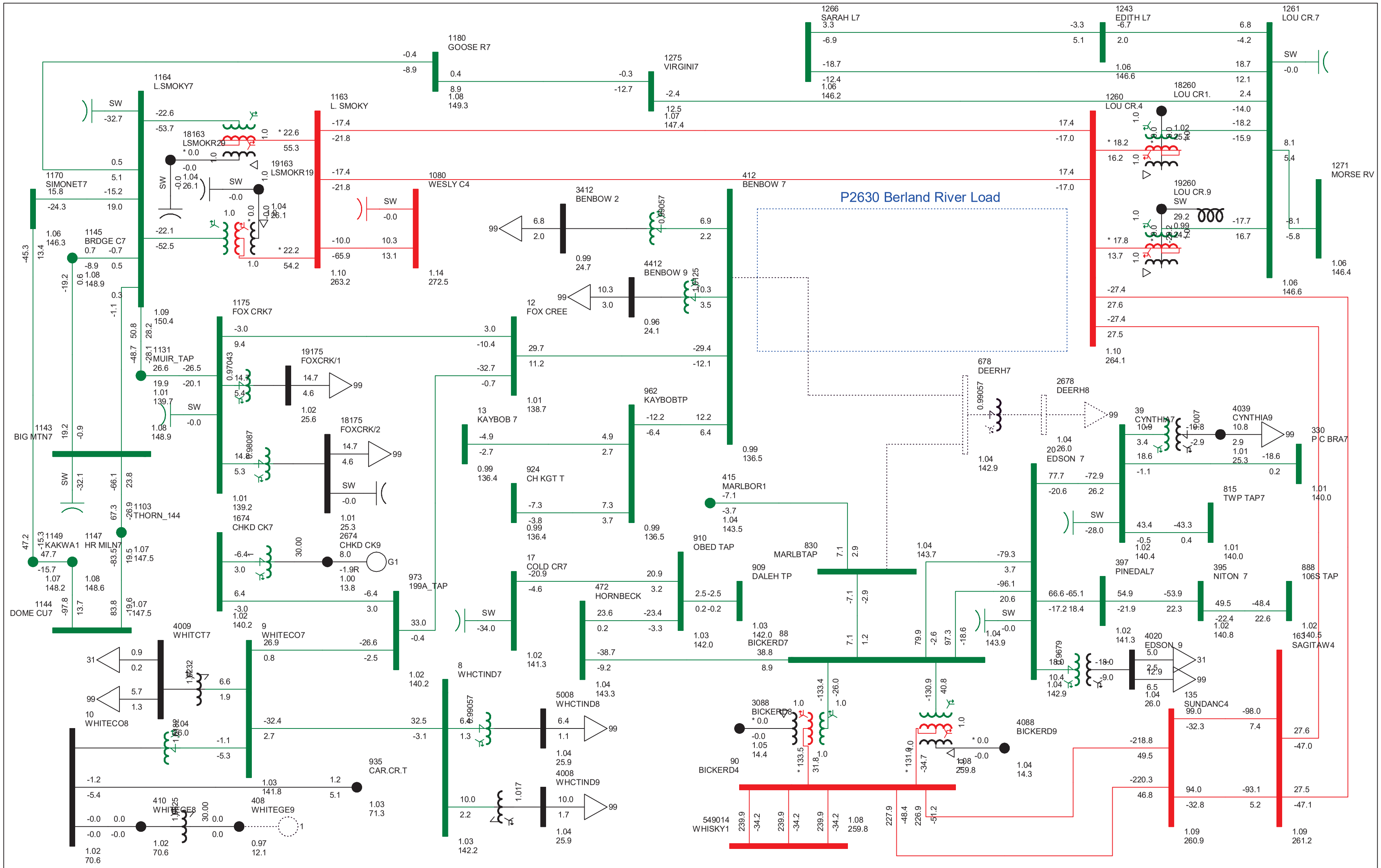
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-9
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:14

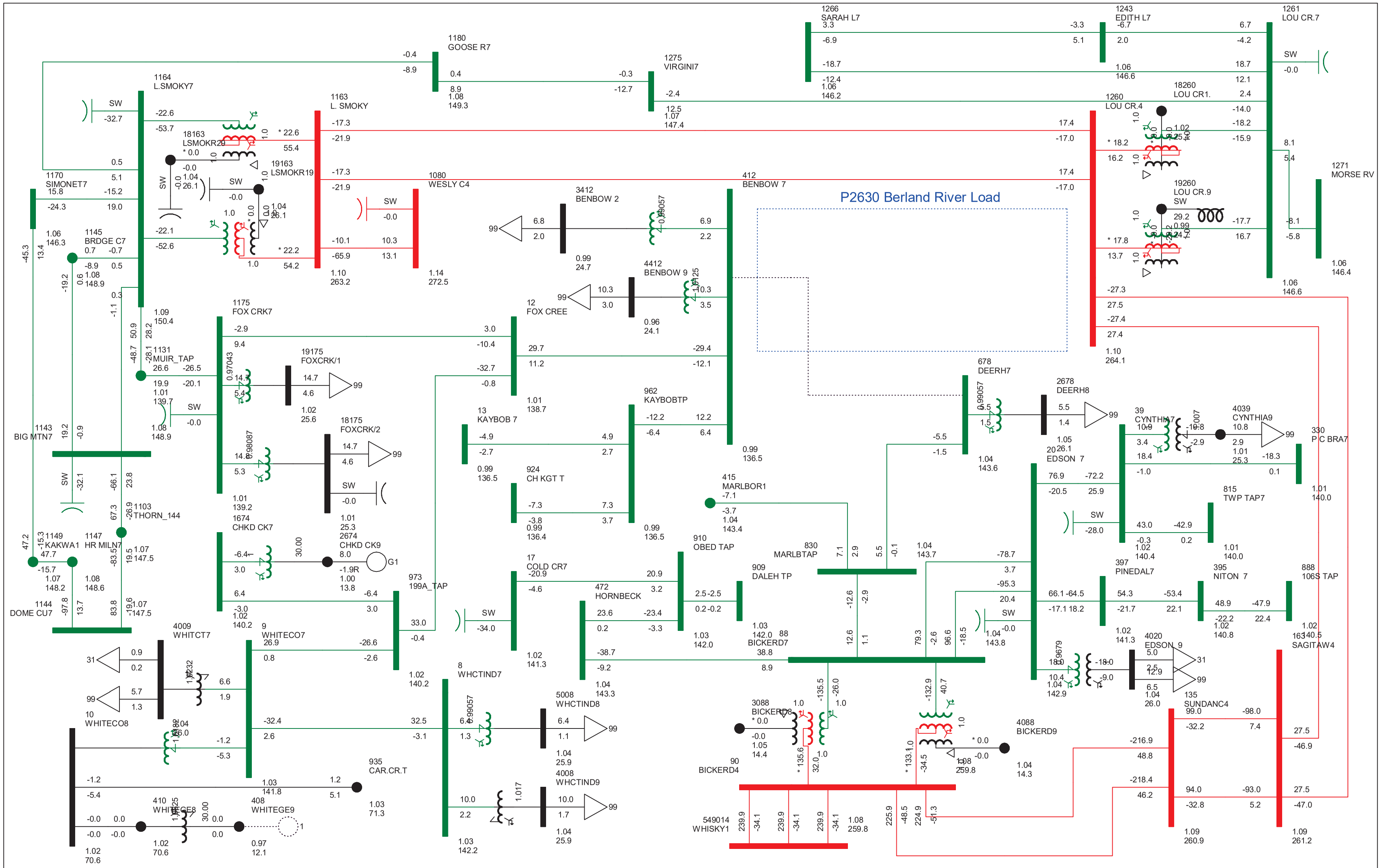
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-10
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, MAR 12 2024 13:15

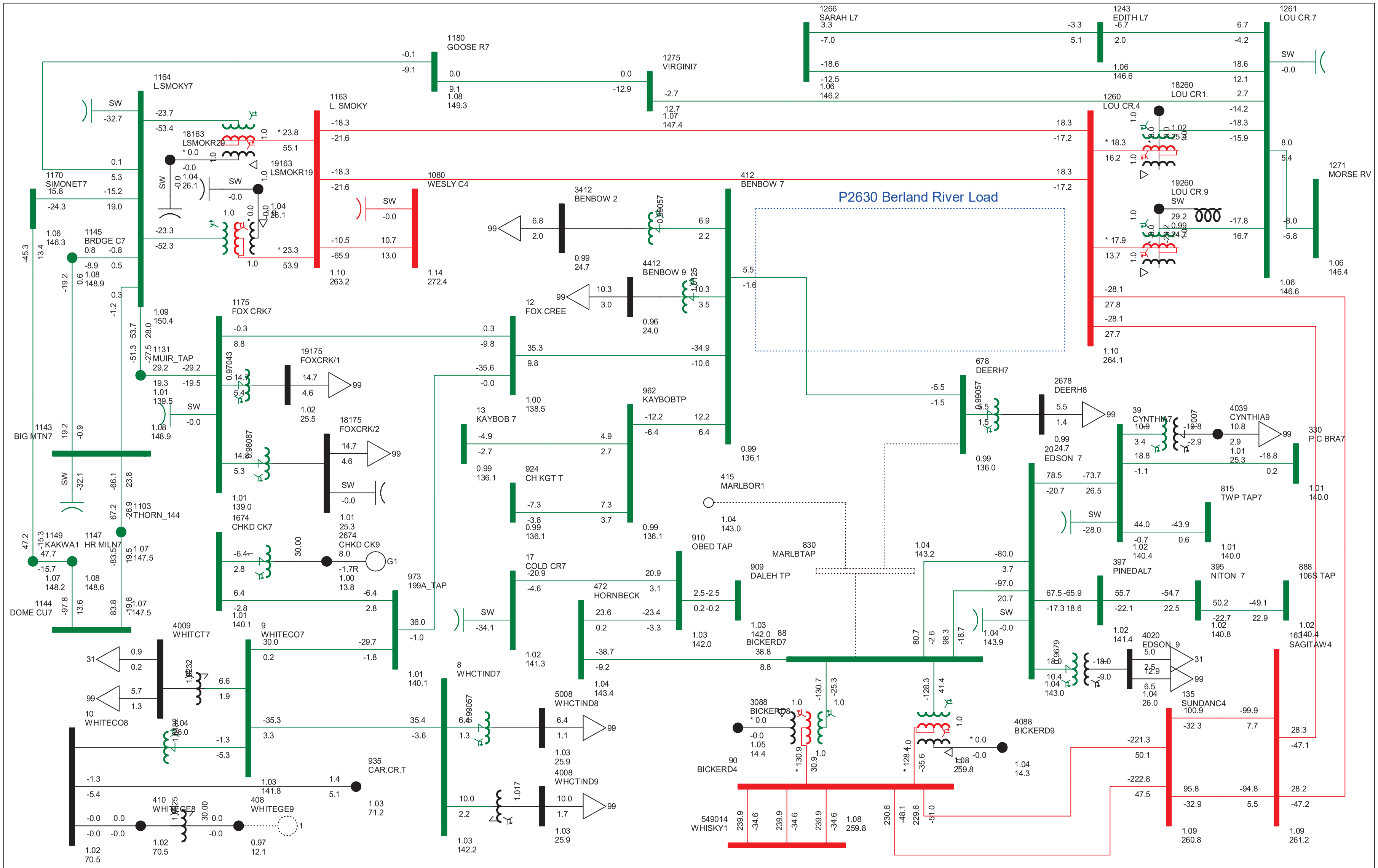
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-11
N-1: 685L (BENBOW 397S TO DEER HILL 1012S)
TUE, MAR 12 2024 13:15

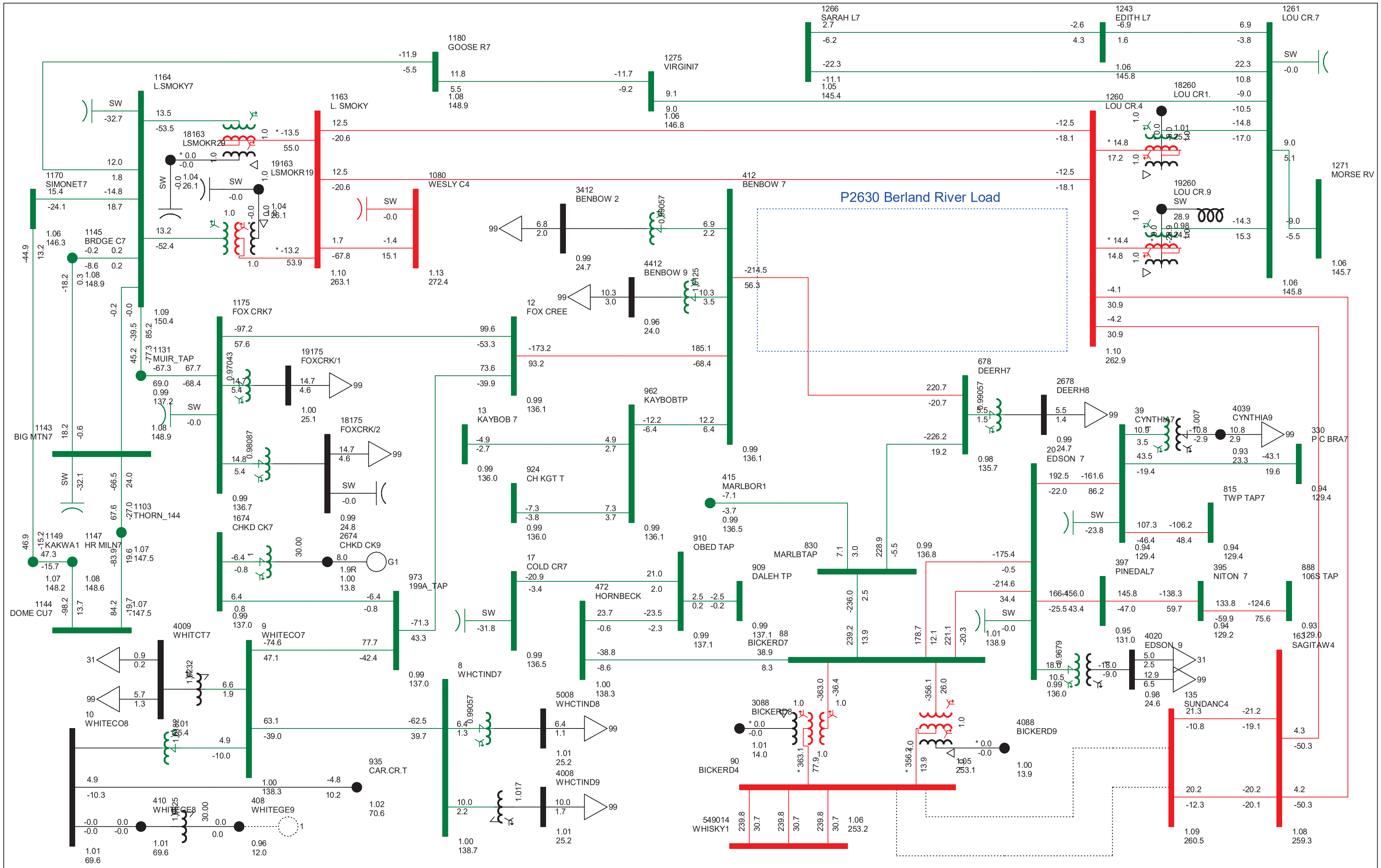
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-12
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, MAR 12 2024 13:15

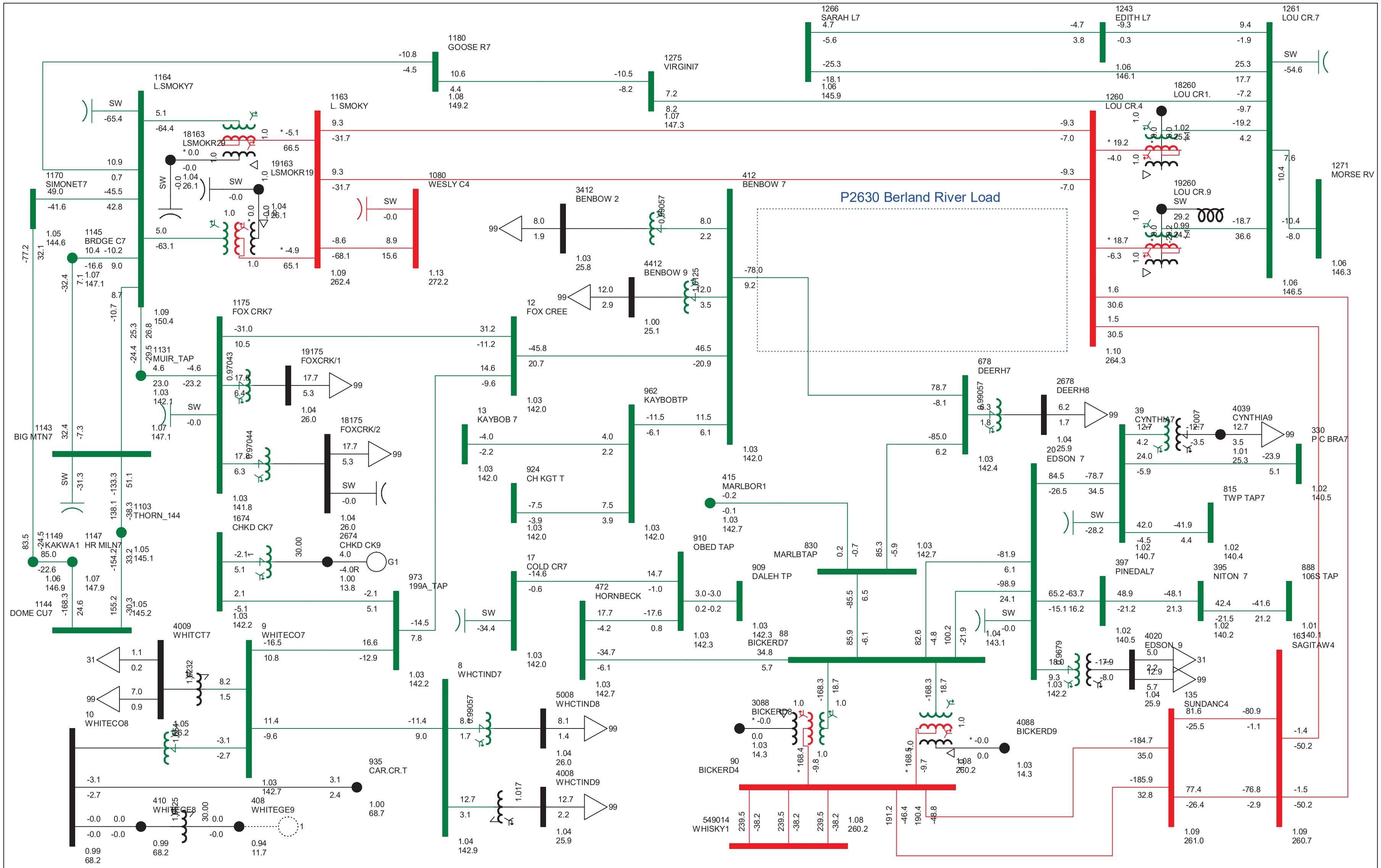
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025SP)- DIAGRAM A-13
C-5: 973L_974L (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:15

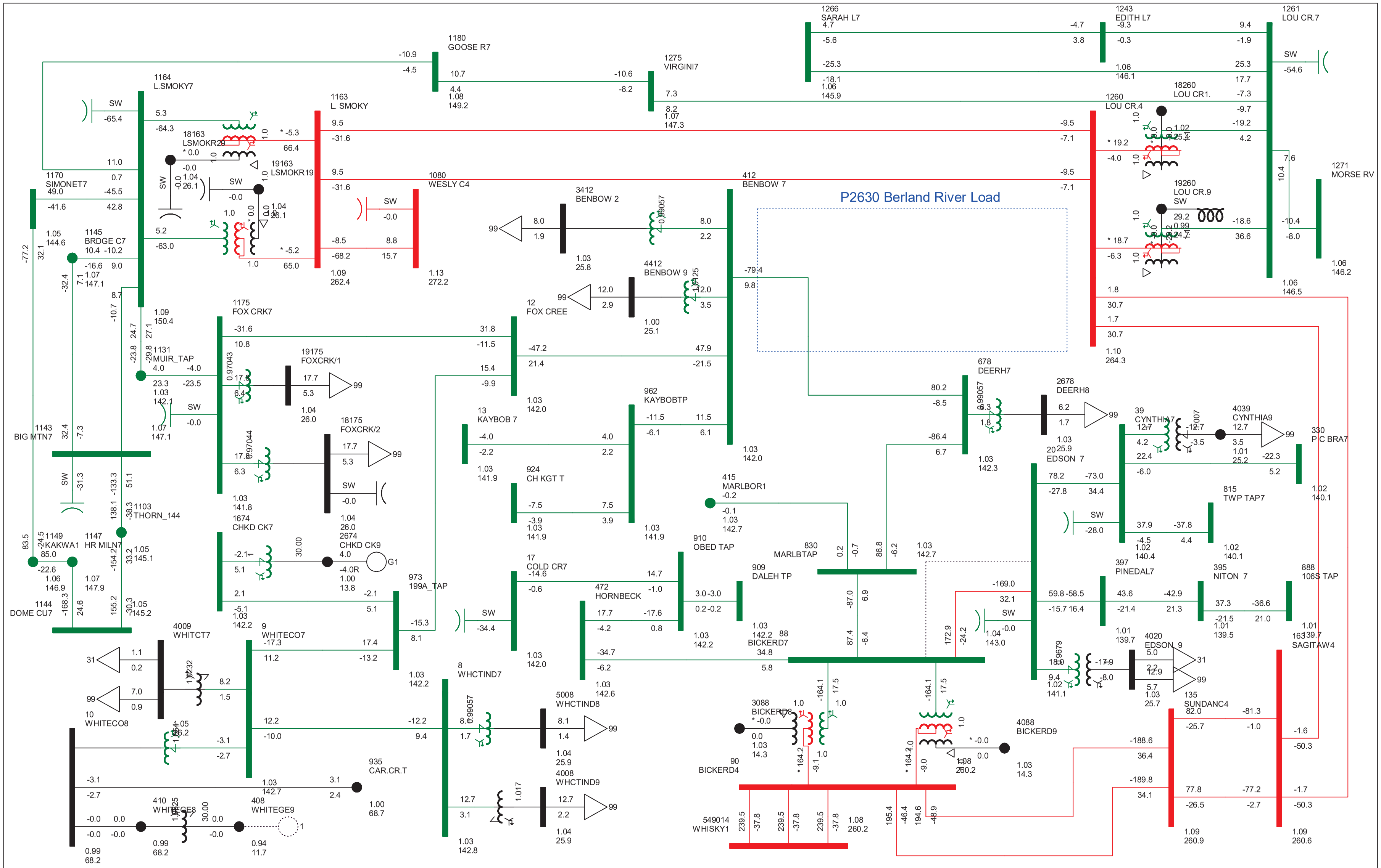
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-14
N-0: NORMAL OPERATION
TUE, MAR 12 2024 13:19

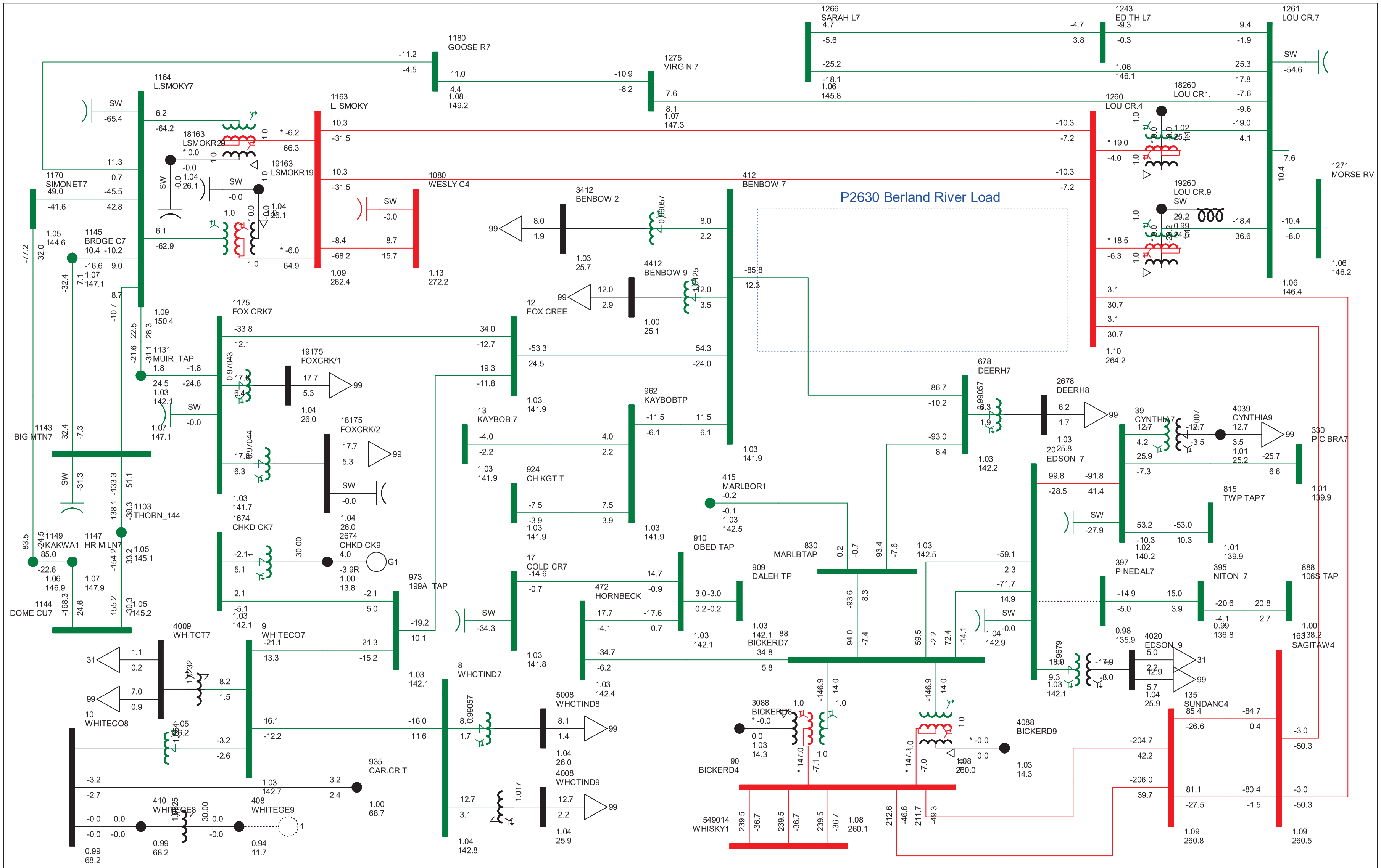
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-15
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, MAR 12 2024 13:19

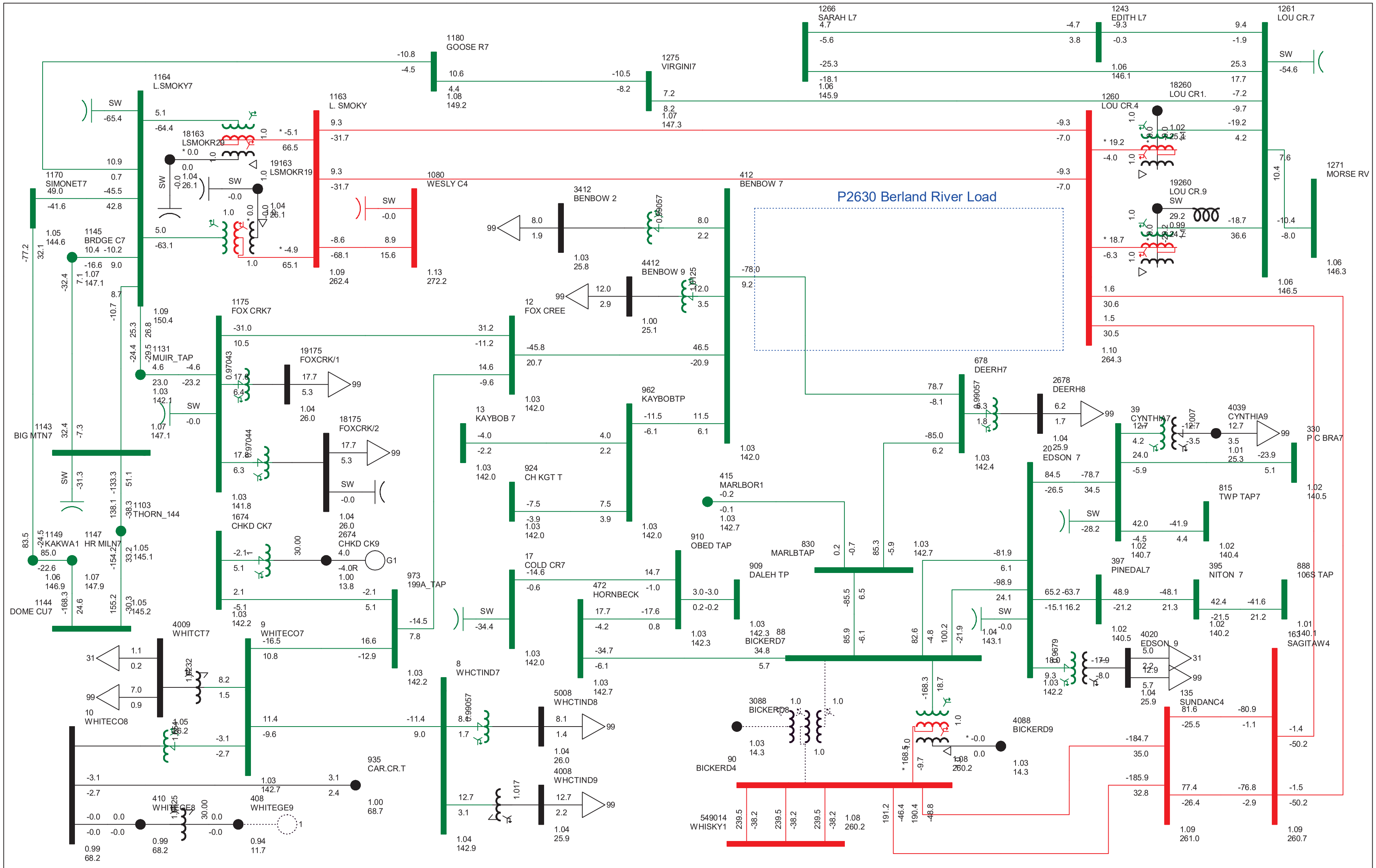
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-16
N-1: 890L (EDSON 58S TO PINEDALE 207S)
TUE, MAR 12 2024 13:19

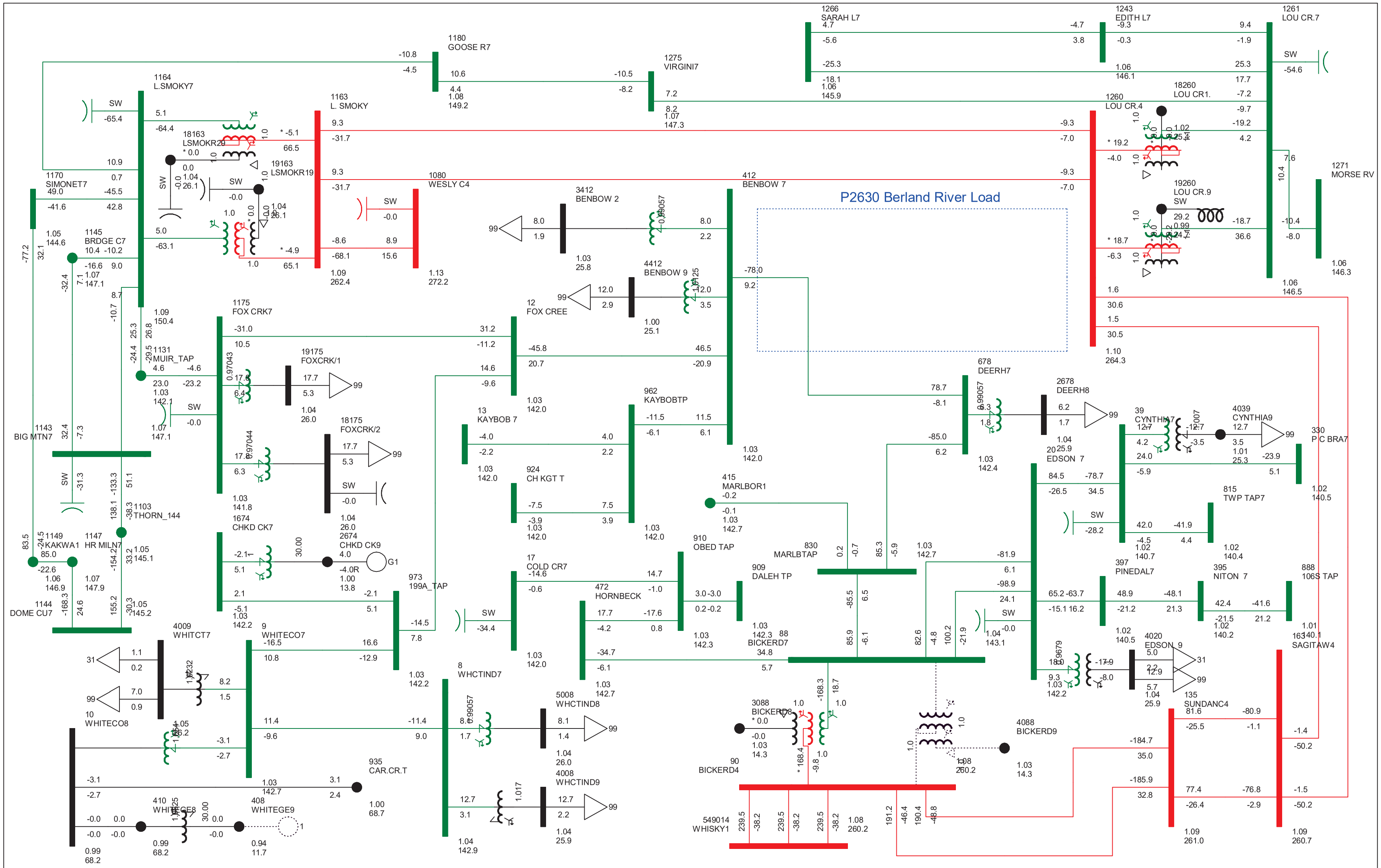
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-17
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:20

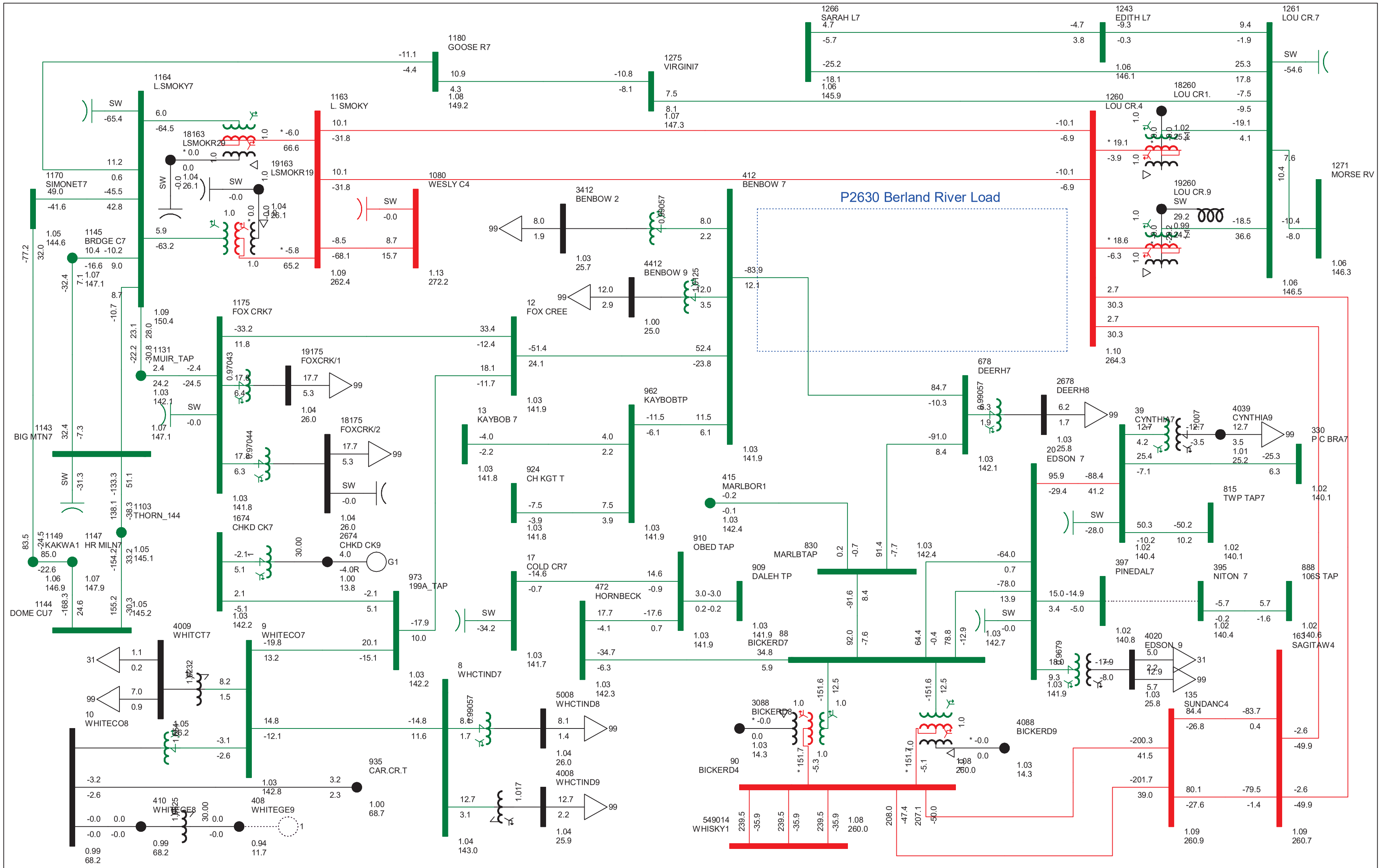
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-18
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:20

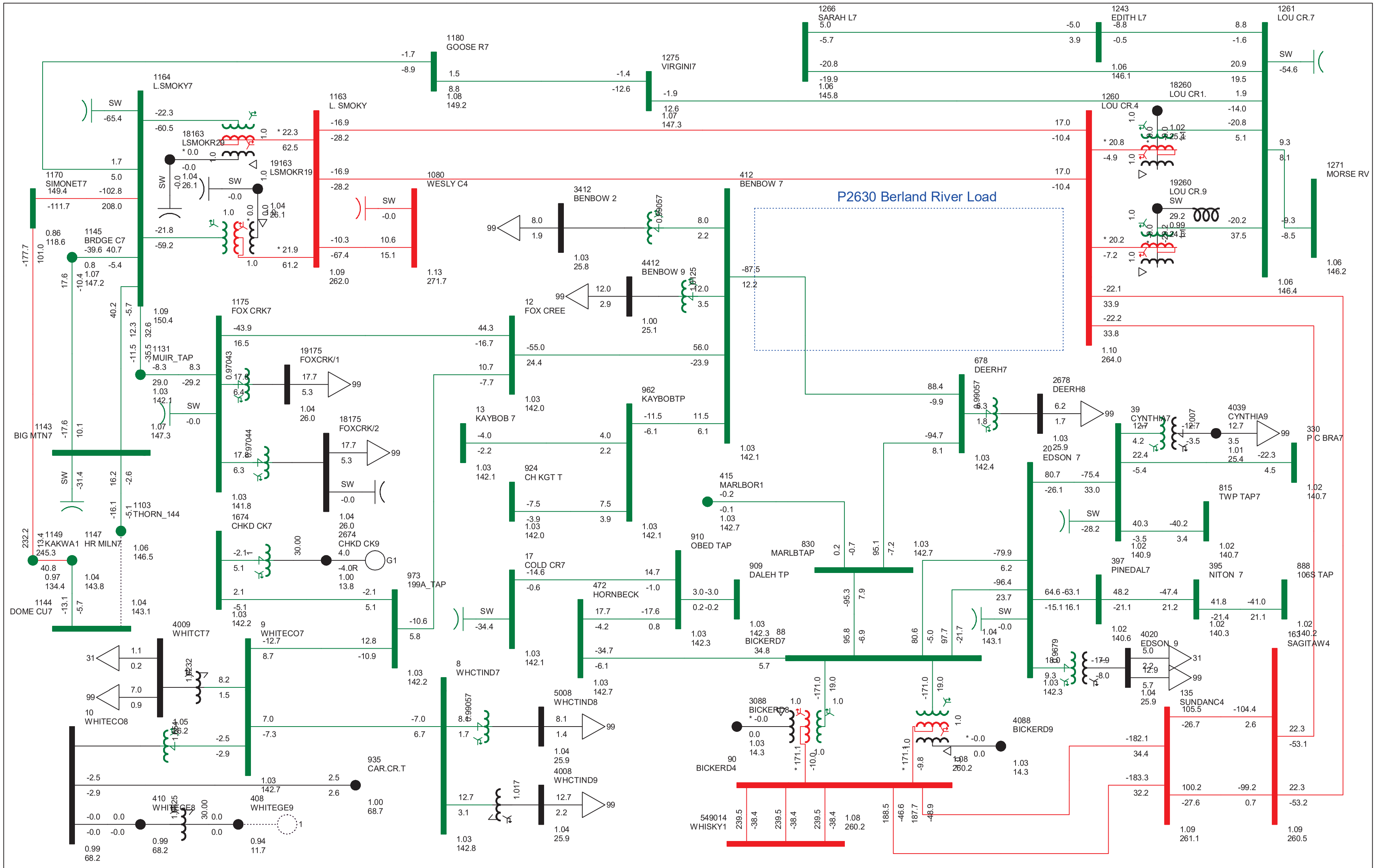
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-19
N-1: 744L (NITON 228S TO PINEDALE 207S)
TUE, MAR 12 2024 13:20

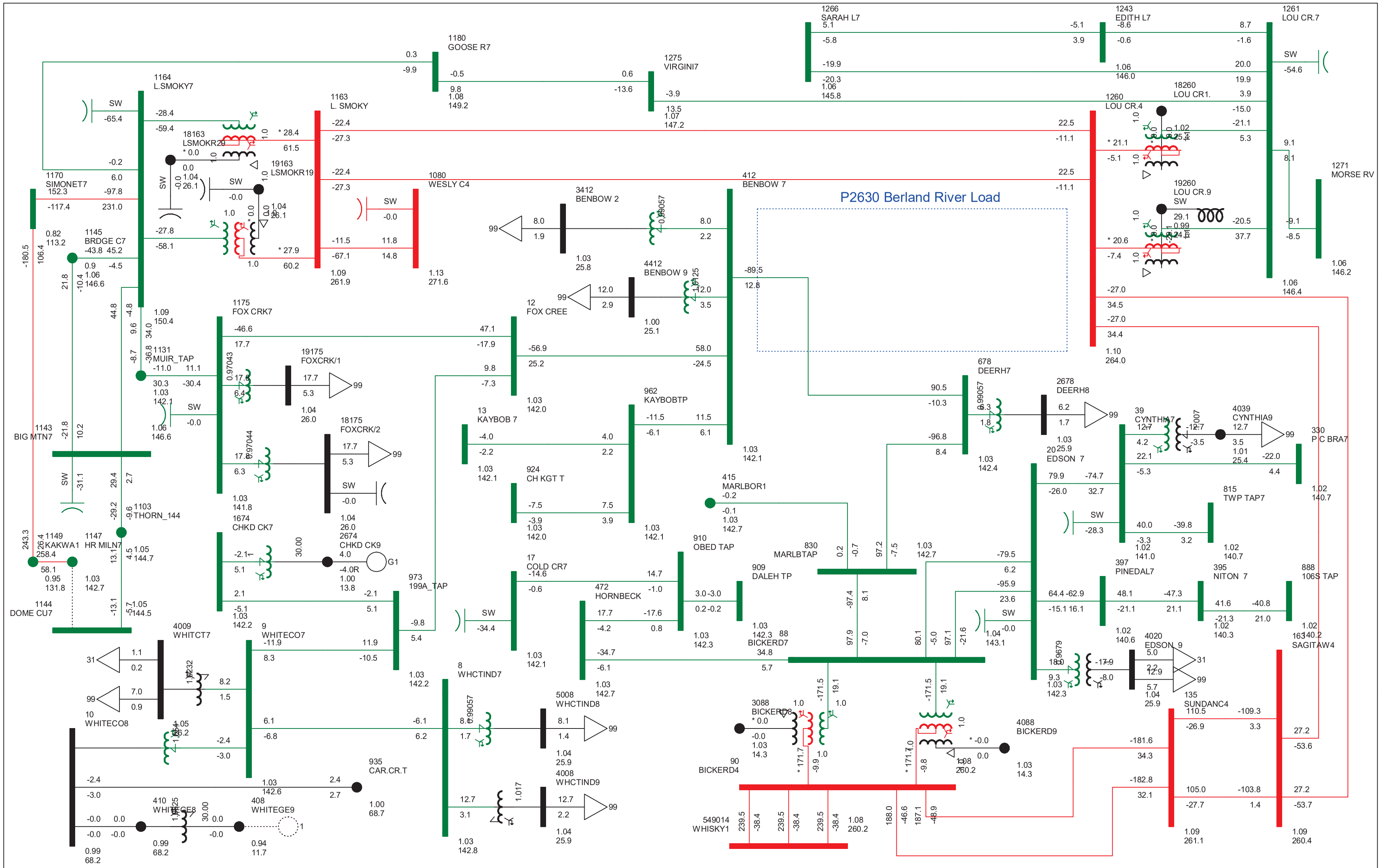
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-20
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:21

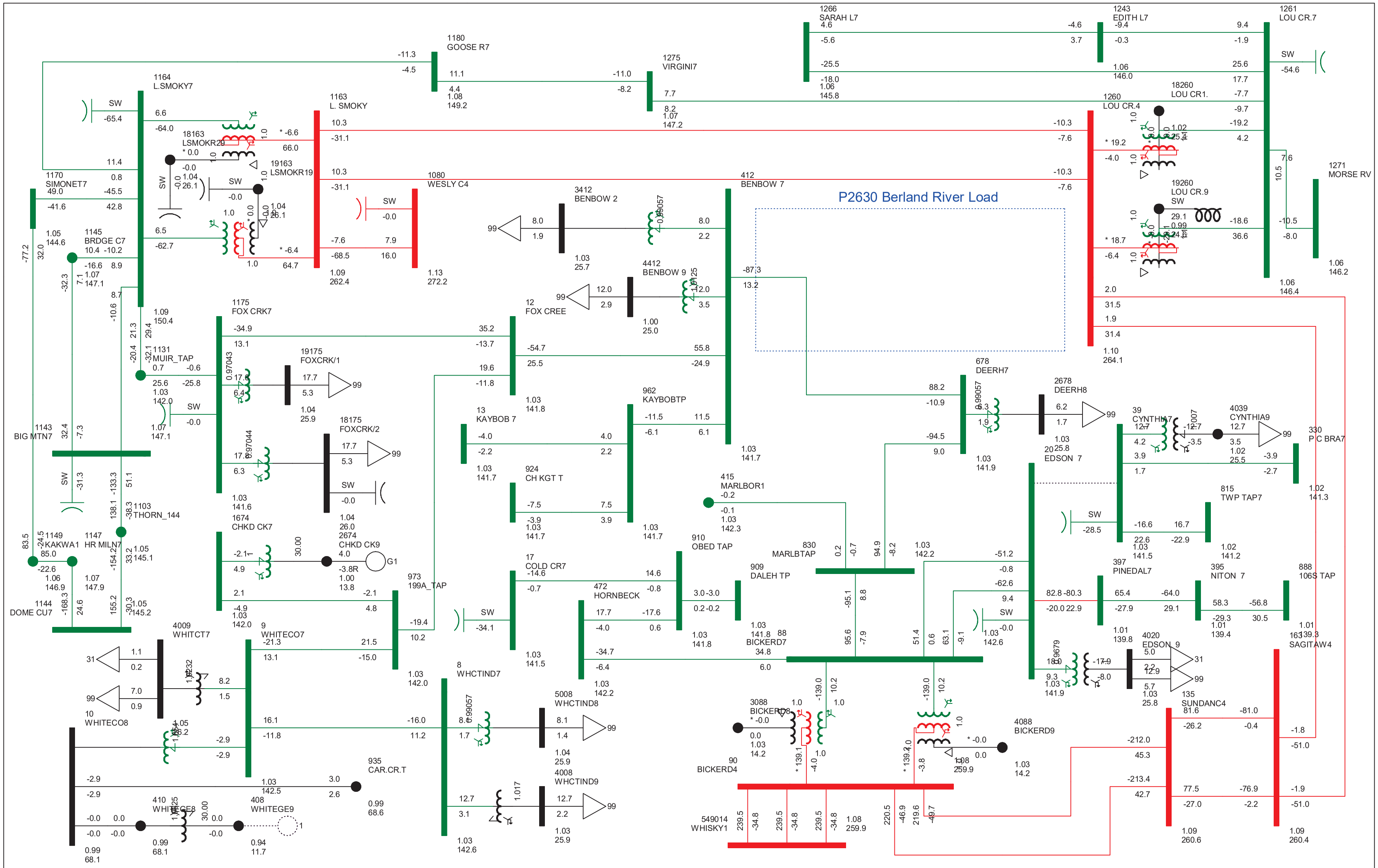
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-21
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:21

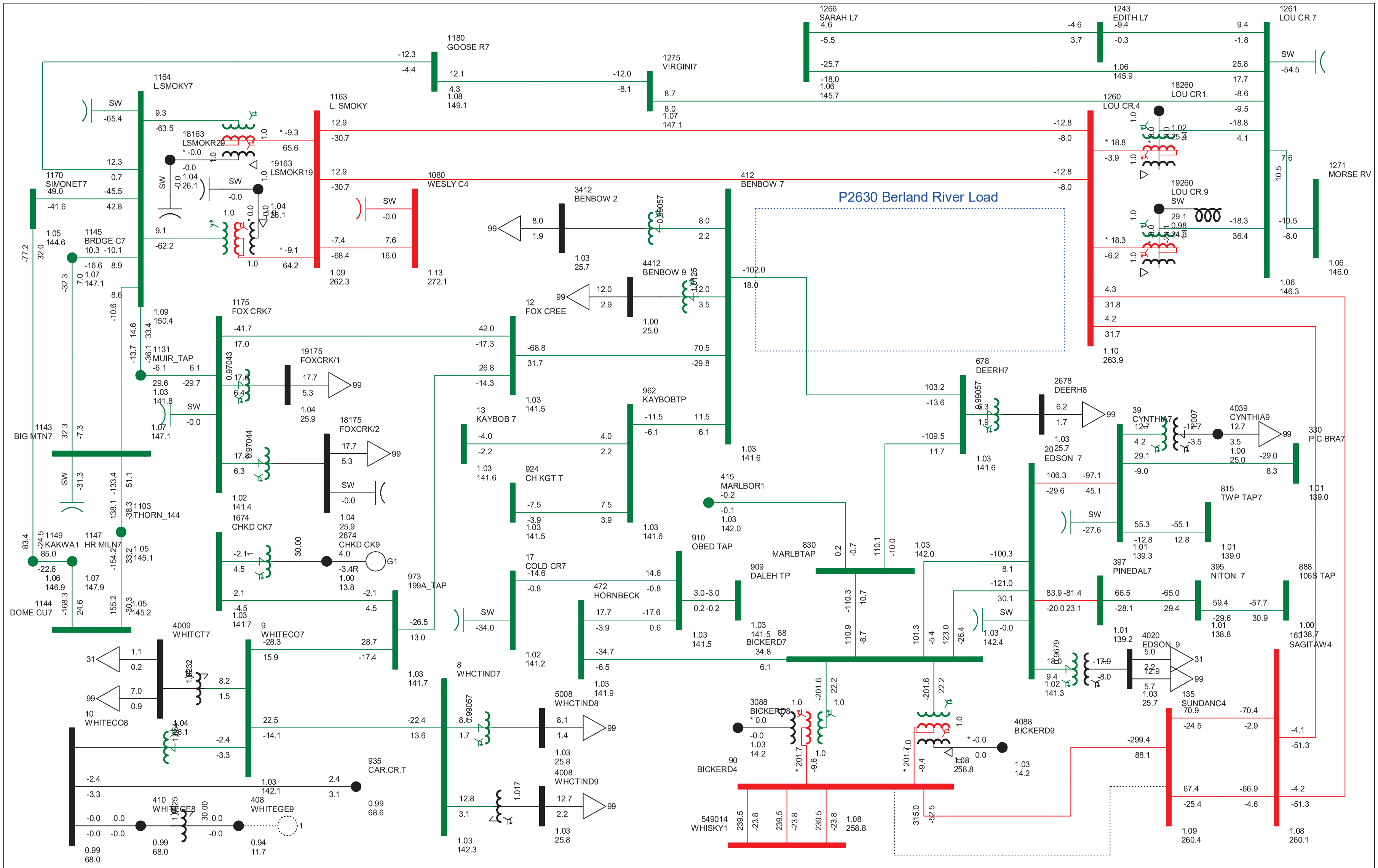
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-22
N-1: 202L (EDSON 58S TO CYNTHIA 178S)
TUE, MAR 12 2024 13:21

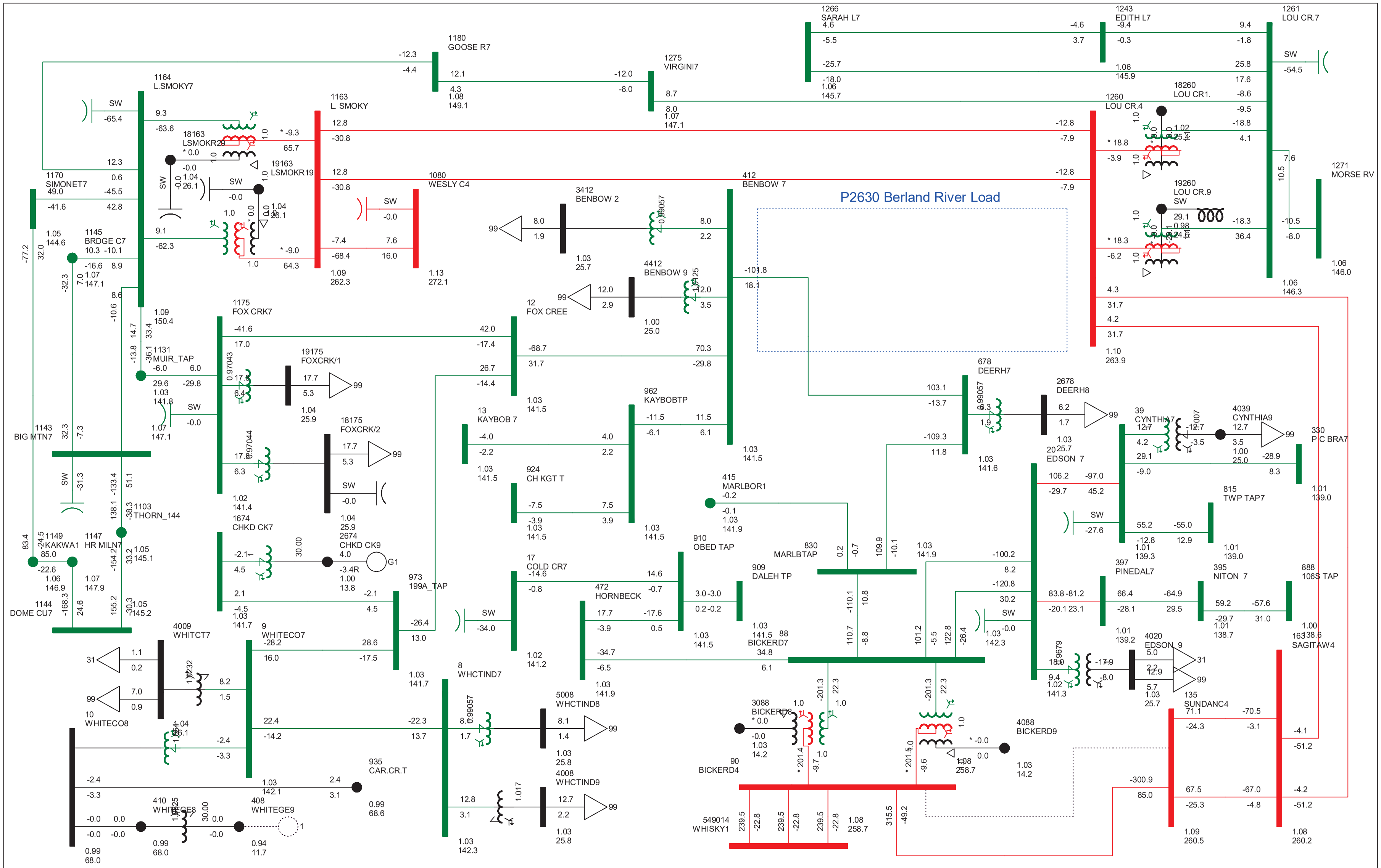
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-23
N-1: 973L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 13:21

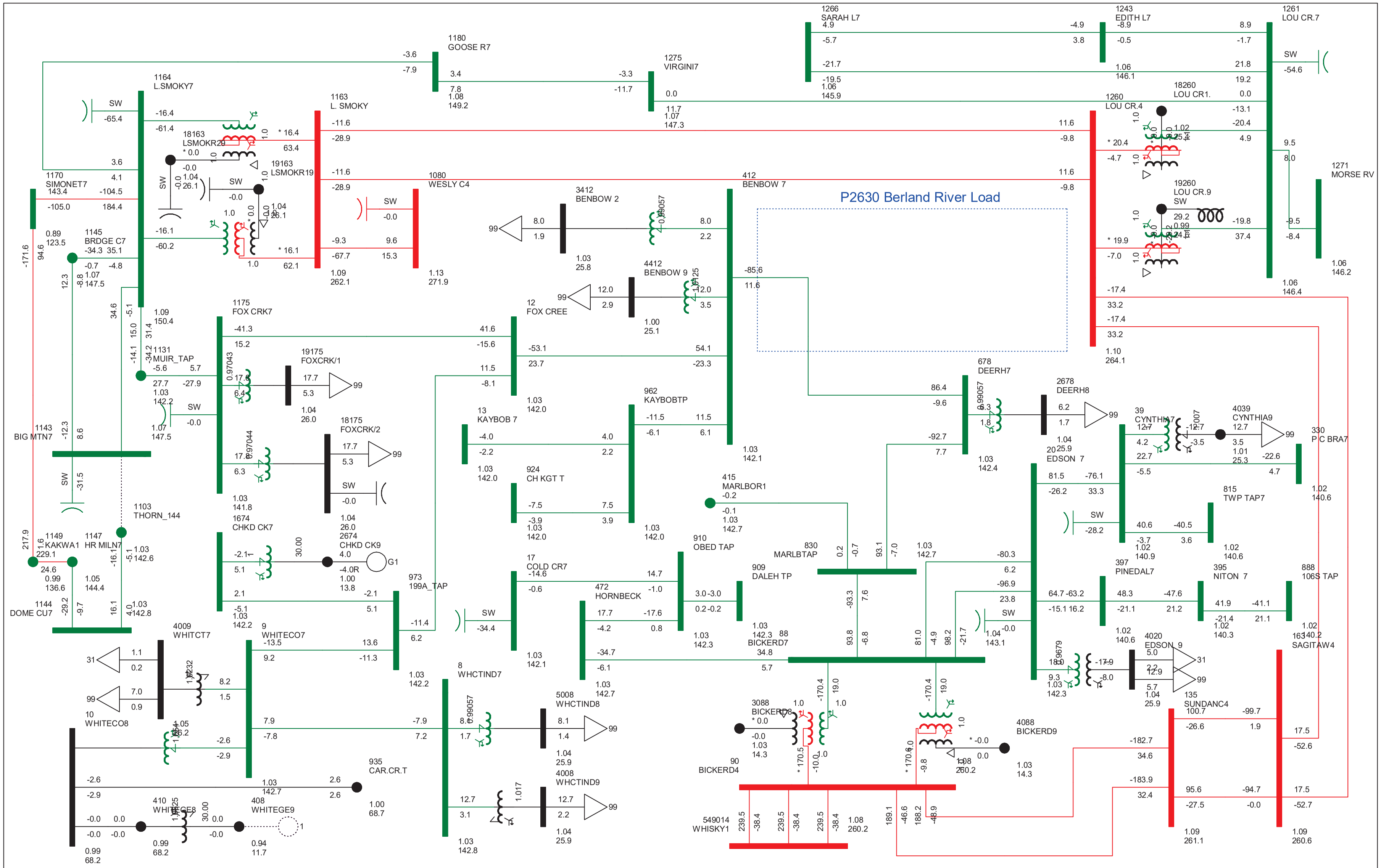
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-24
N-1: 974L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 13:22

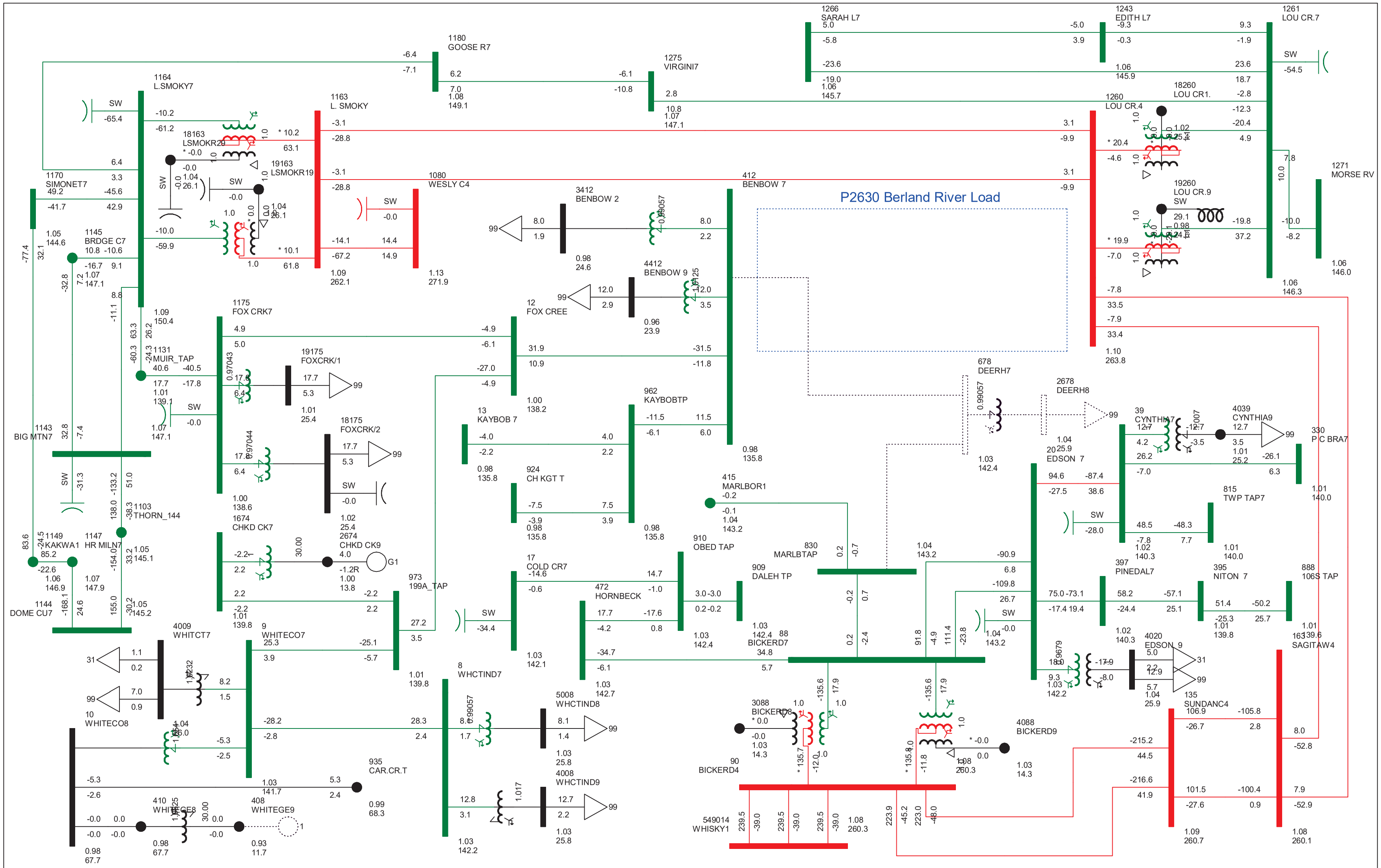
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-25
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:22

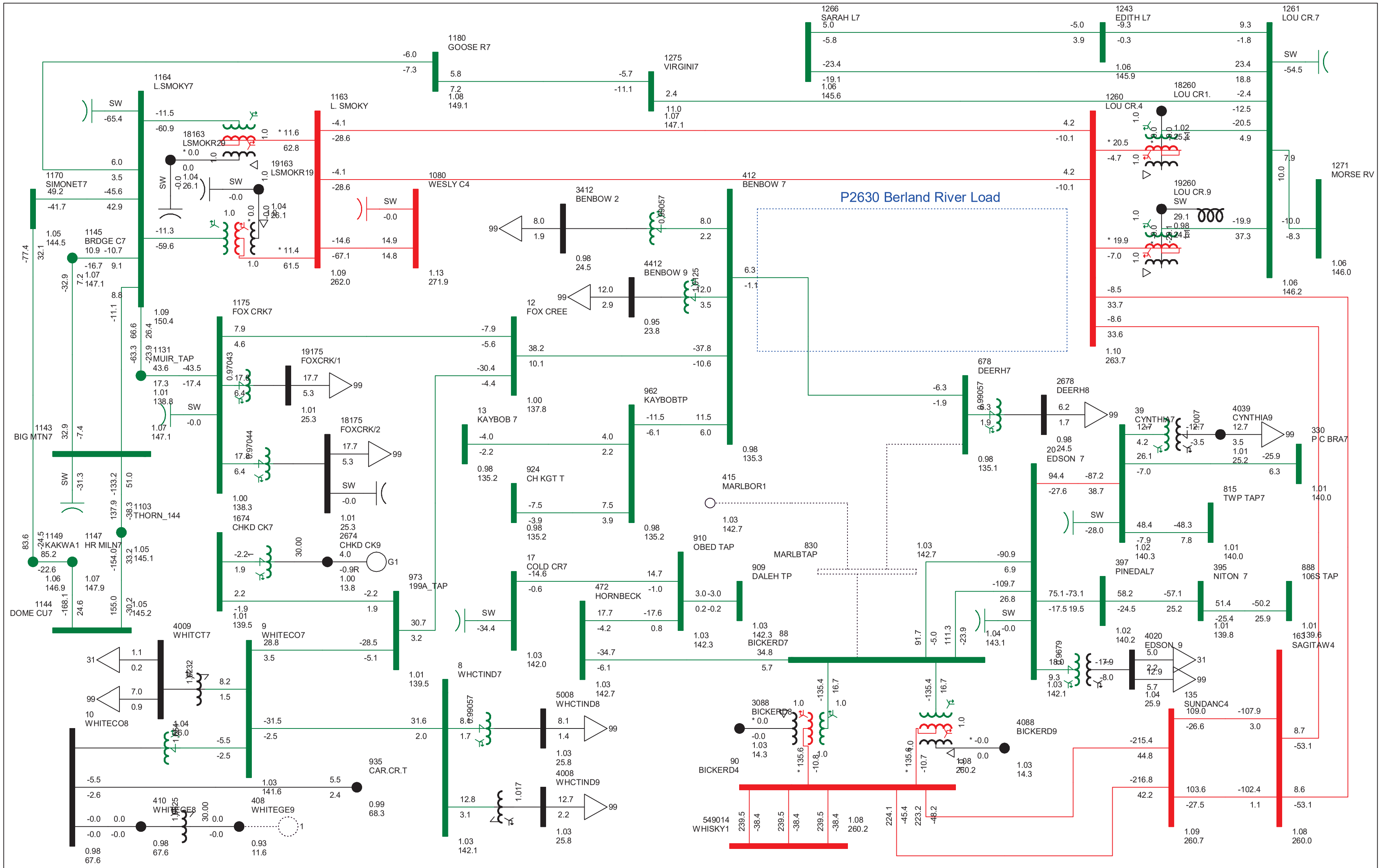
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-26
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, MAR 12 2024 13:22

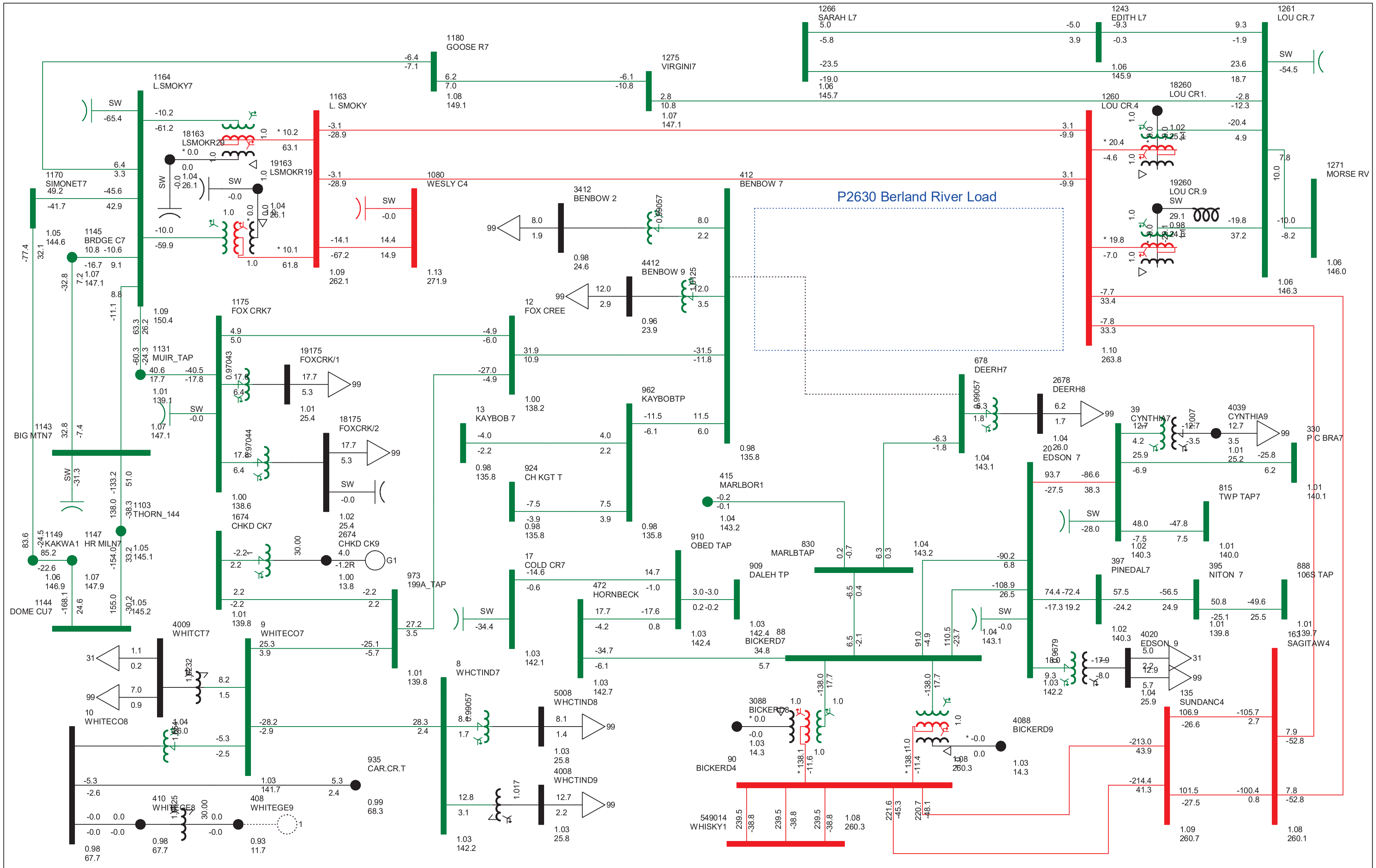
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-27
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, MAR 12 2024 13:22

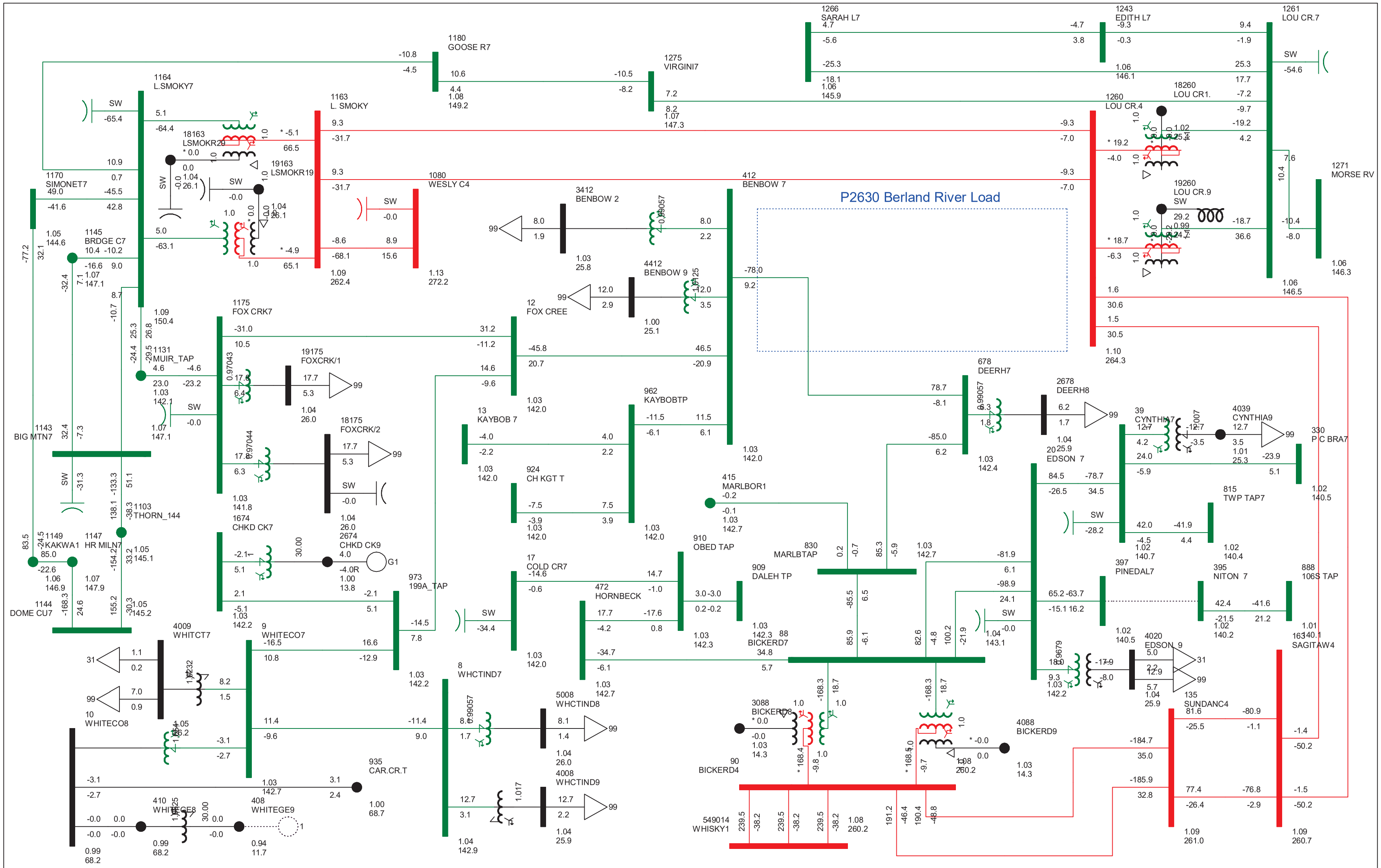
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-28
N-1: 685L (BENBOW 397S TO DEER HILL 1012S)
TUE, MAR 12 2024 13:22

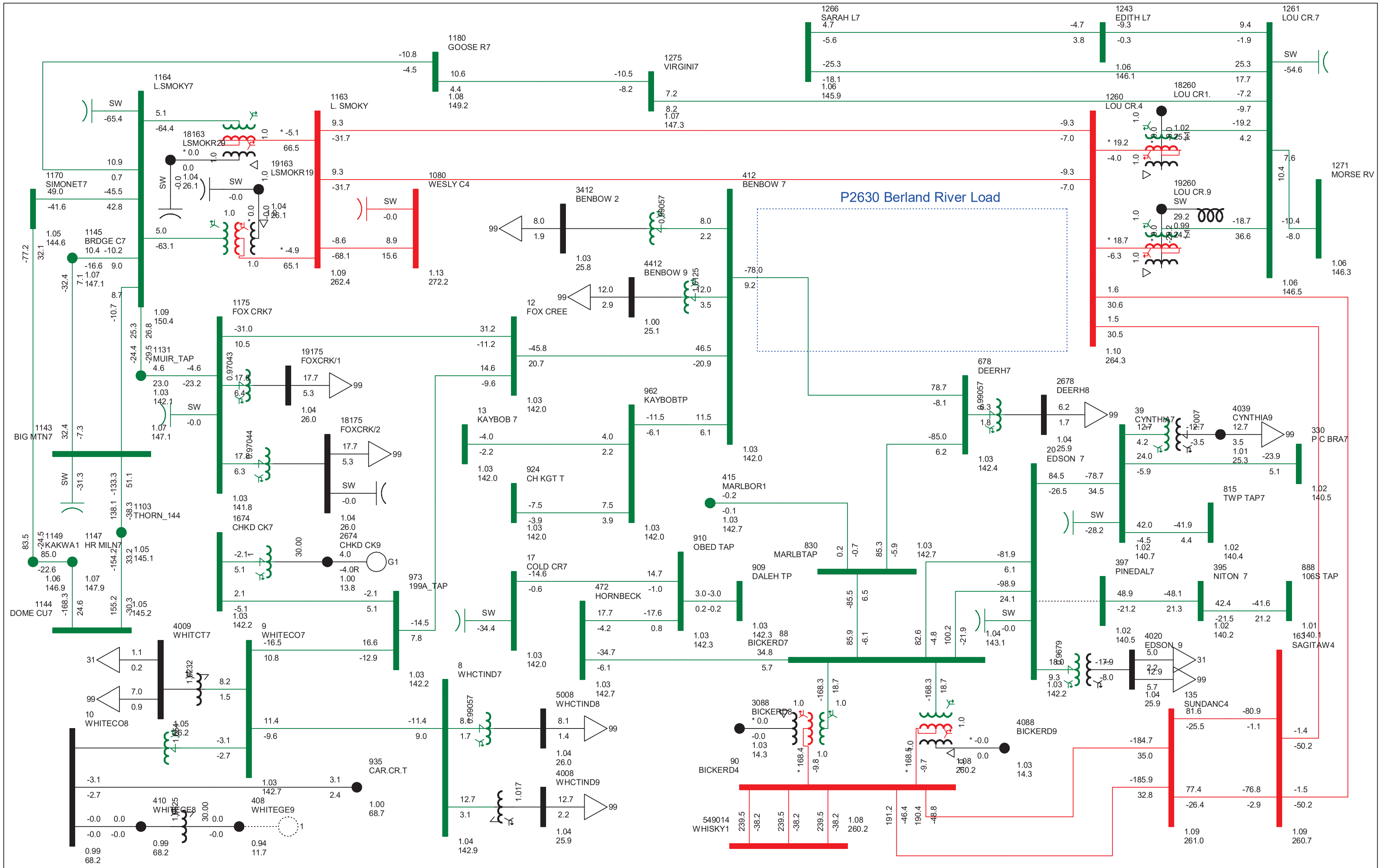
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-29
N-1: 207ST1 (PINEDALE 207S 138/25 KV TRANSFORMER T1)
TUE, MAR 12 2024 13:23

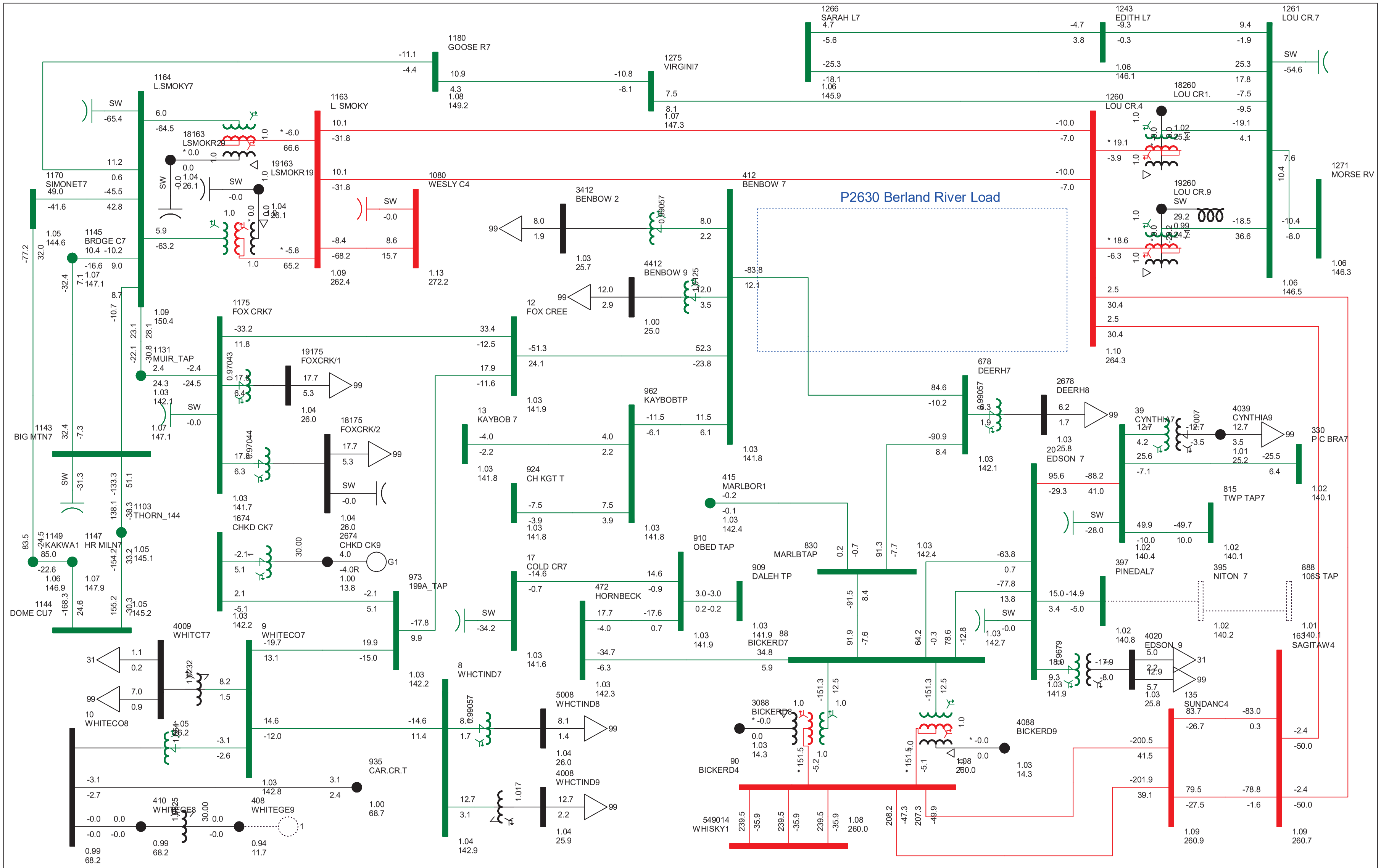
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-30
N-1: 207ST2 (PINEDALE 207S 138/25 KV TRANSFORMER T2)
TUE, MAR 12 2024 13:23

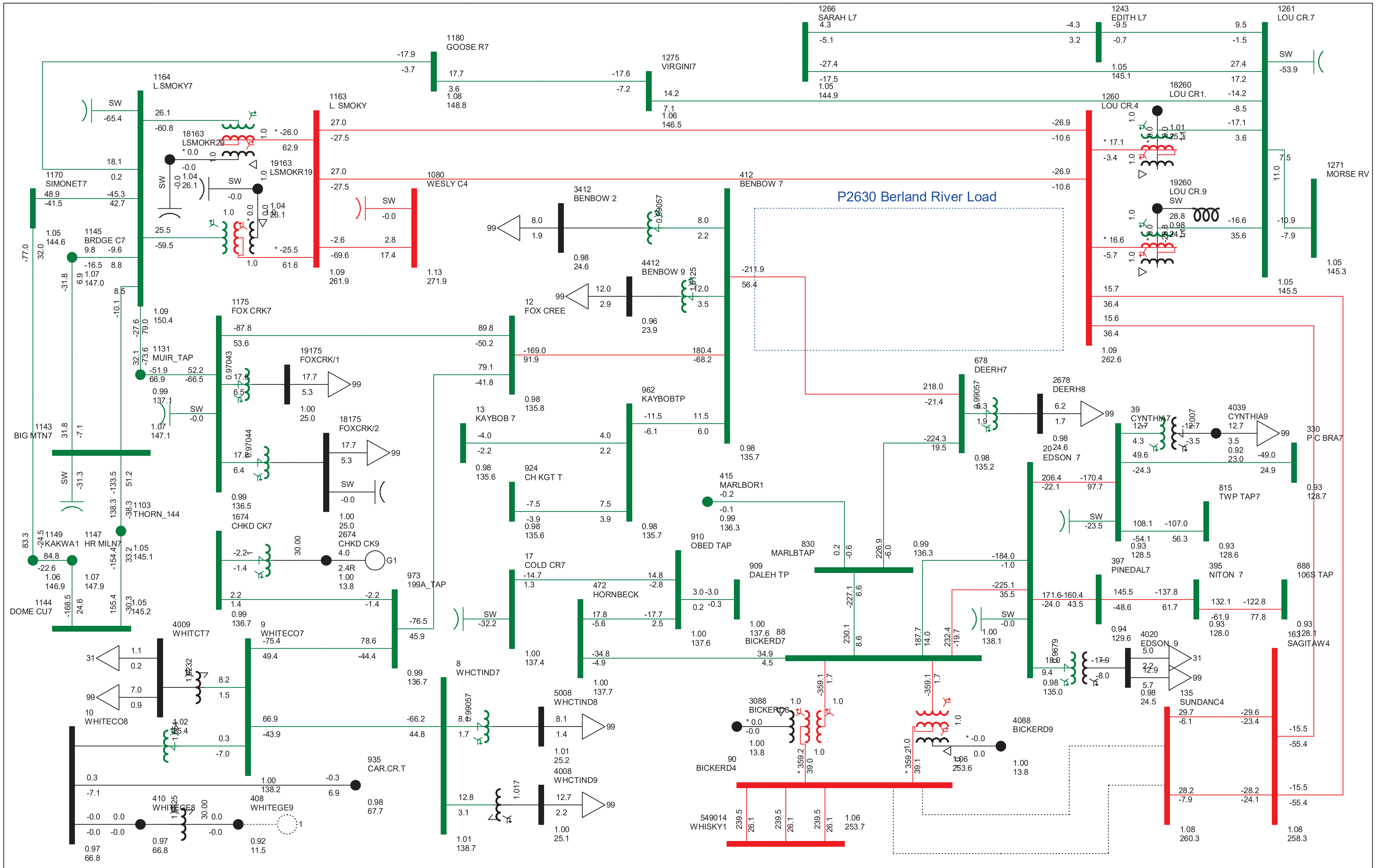
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-31
N-1: 744L (NITON 228S TO ENTWISTLE 235S) OR 228ST1 (NITON 22
TUE, MAR 12 2024 13:23

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000

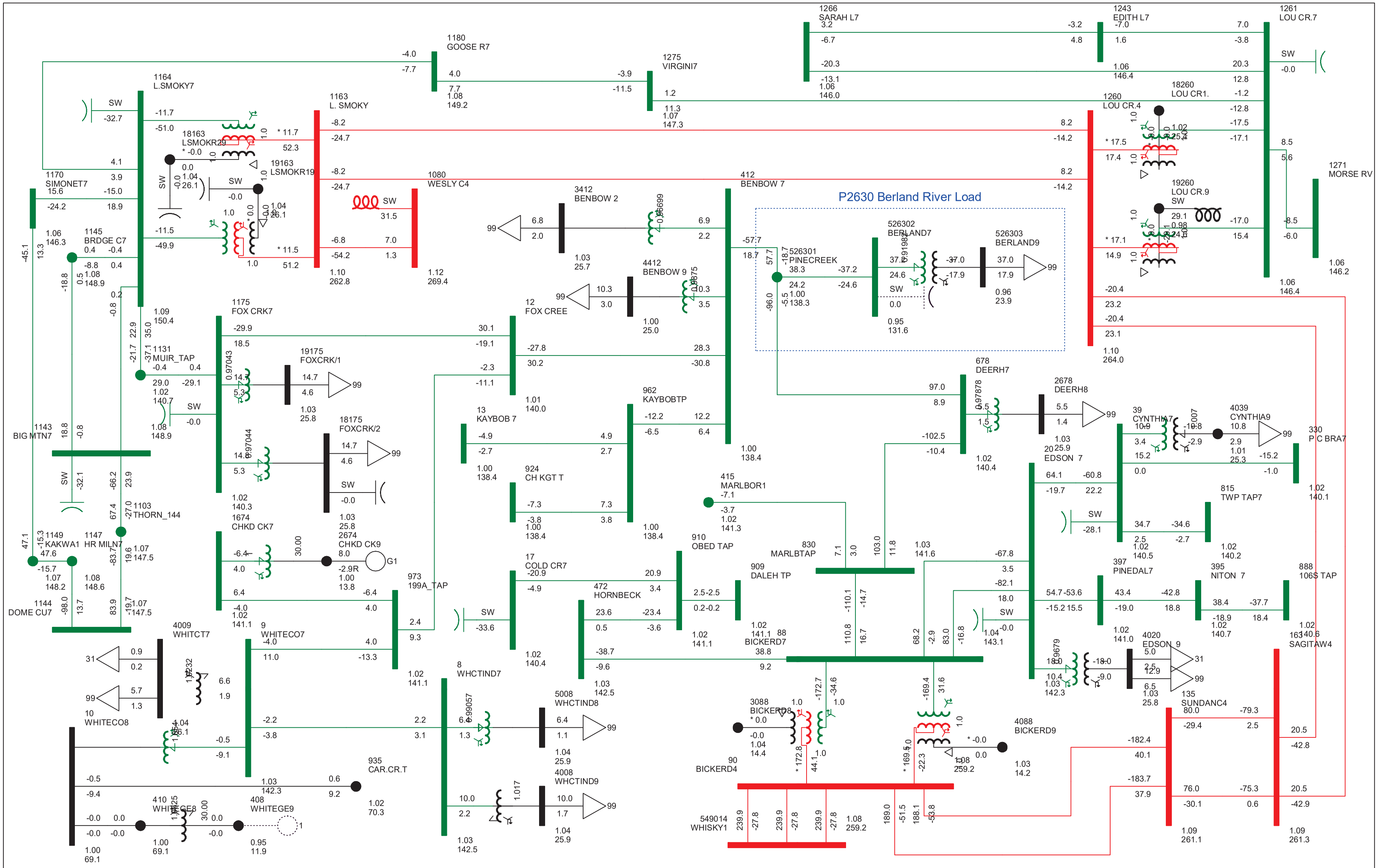


P2630: Berland River Load

P2630 PRE-CONNECTION (2025WP)- DIAGRAM A-32
C-5: 973L_974L (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:24

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000

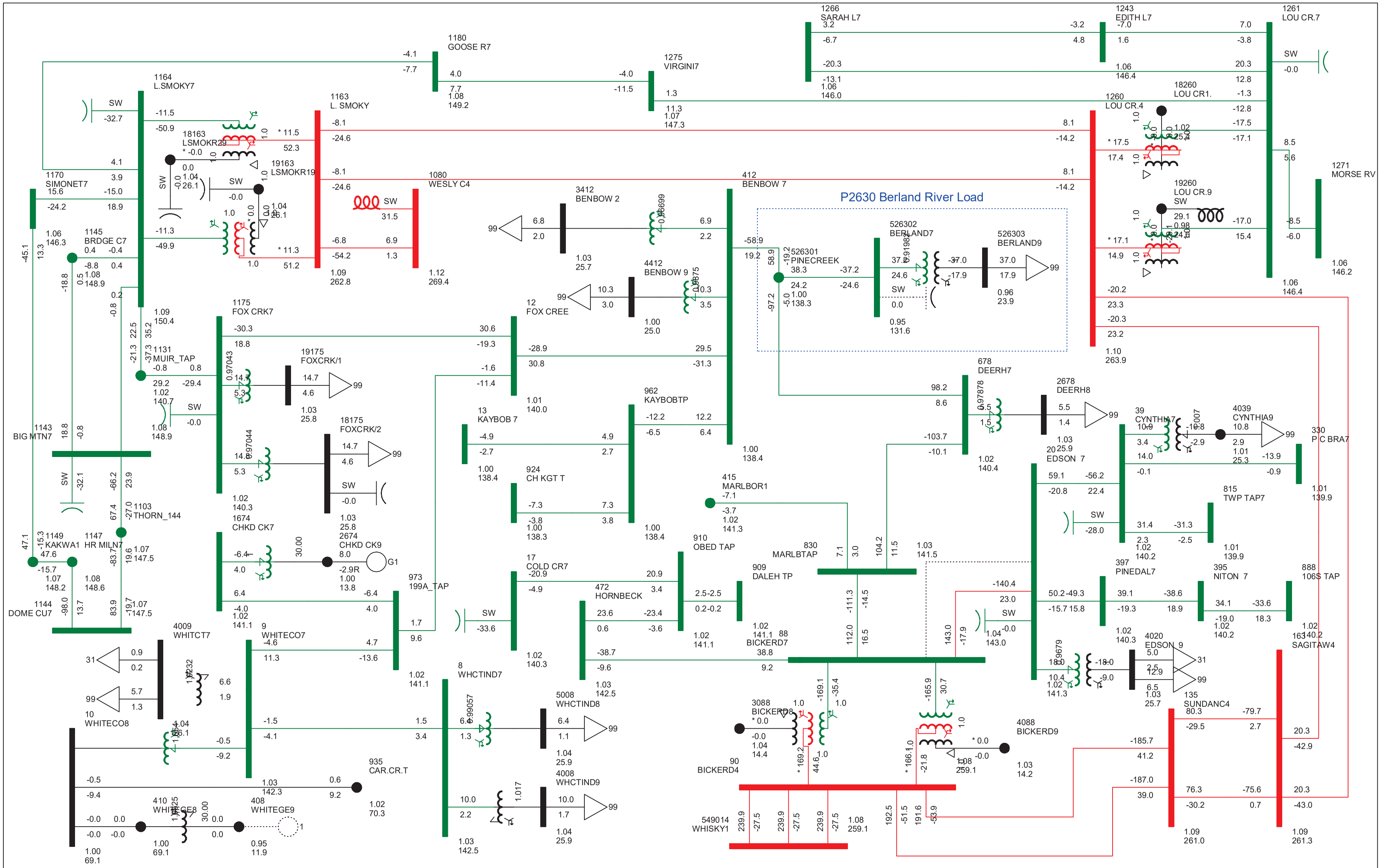
Attachment B: Post-Project Power Flow Diagrams (Scenarios 3 and 4)



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-1
N-0: NORMAL OPERATION
TUE, MAR 12 2024 13:53

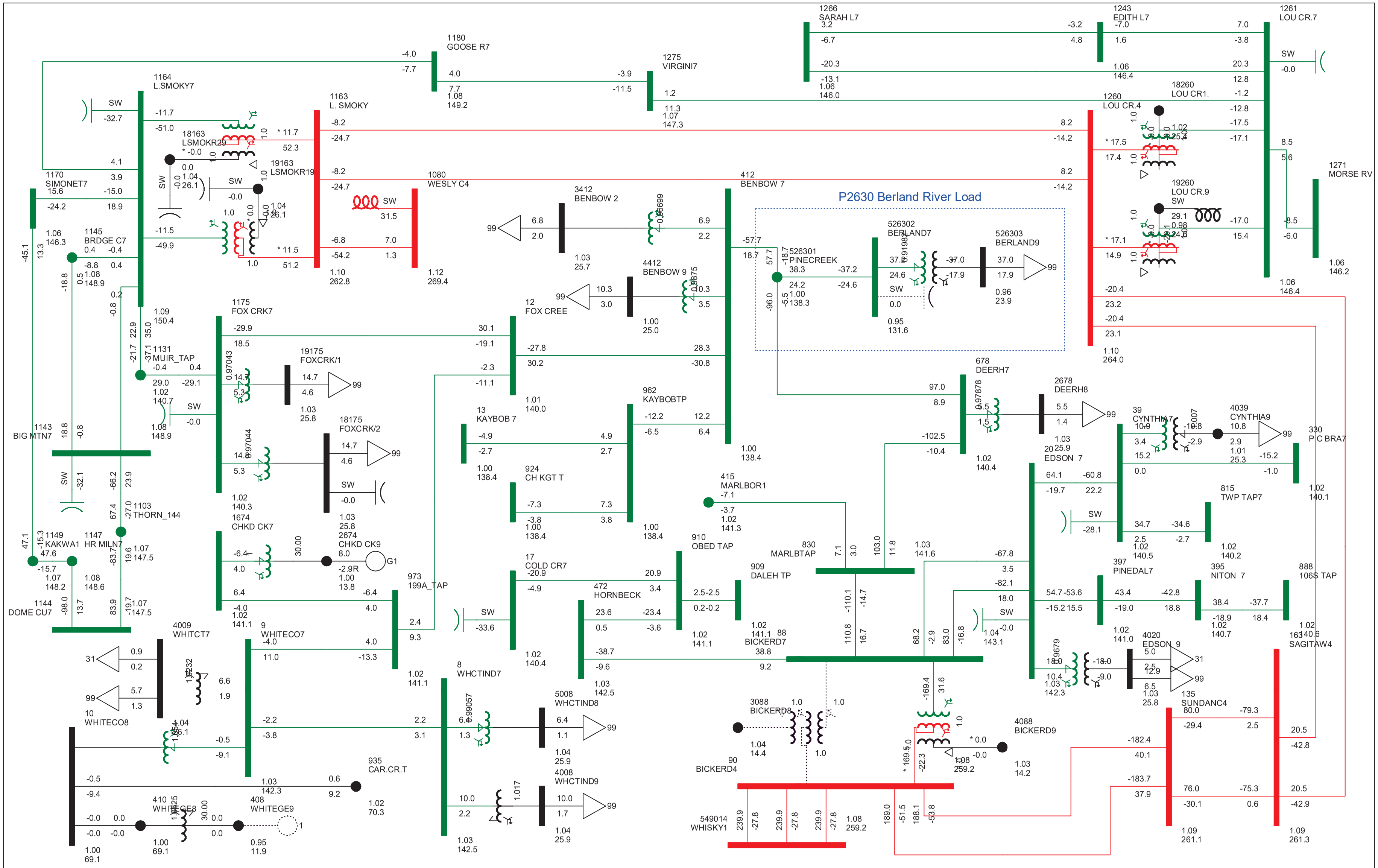
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-2
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, MAR 12 2024 13:54

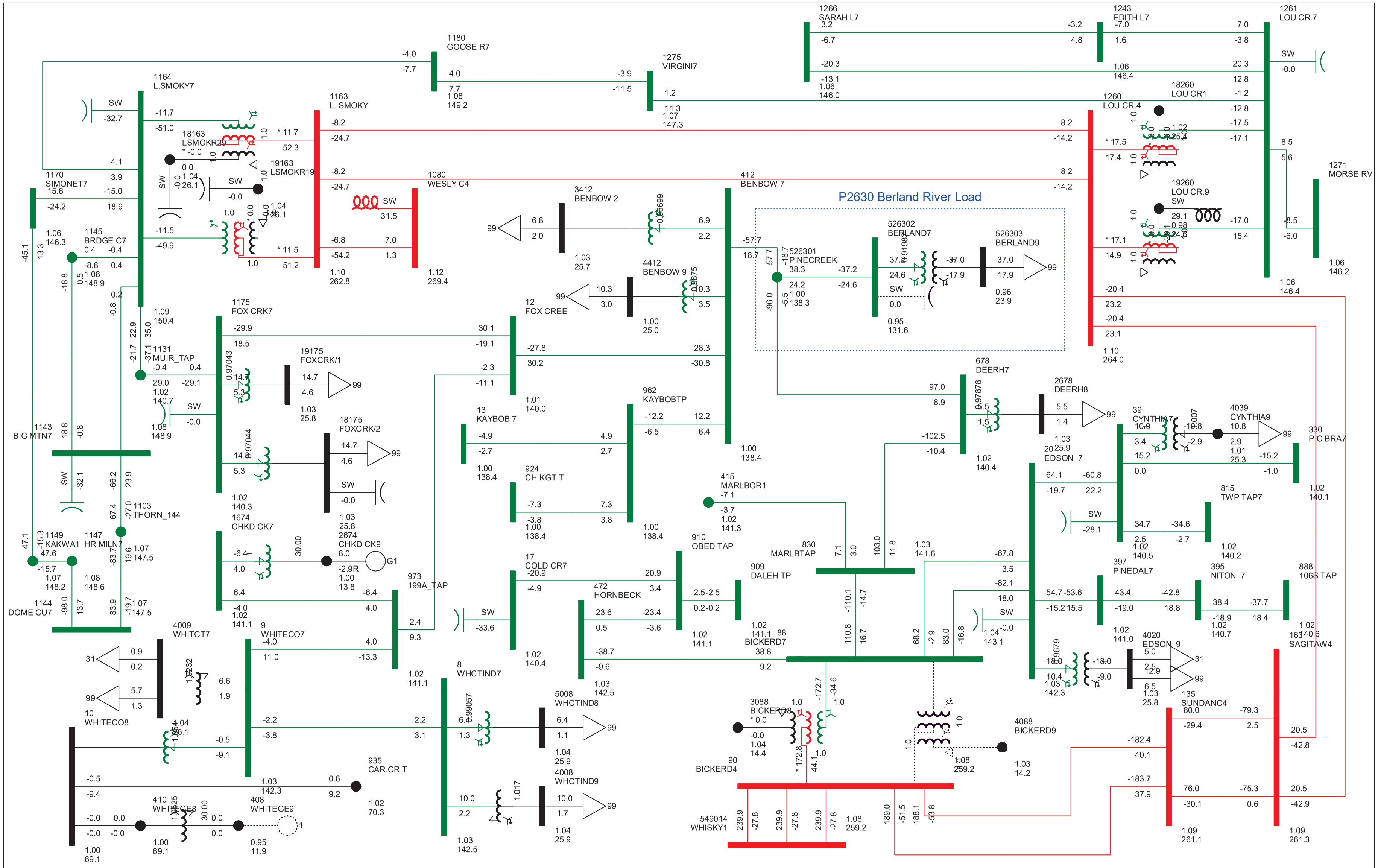
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-3
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:54

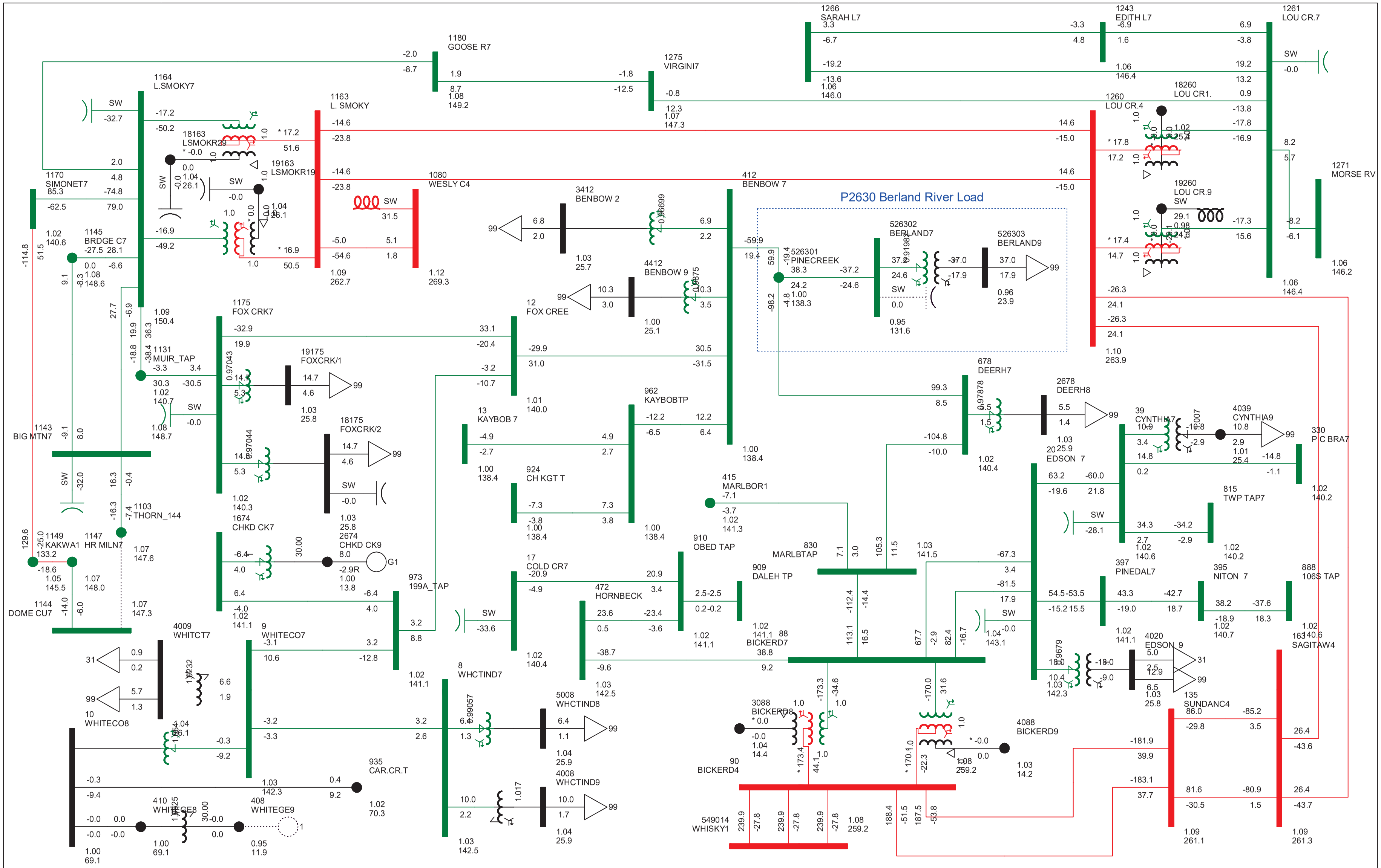
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-4
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 13:55

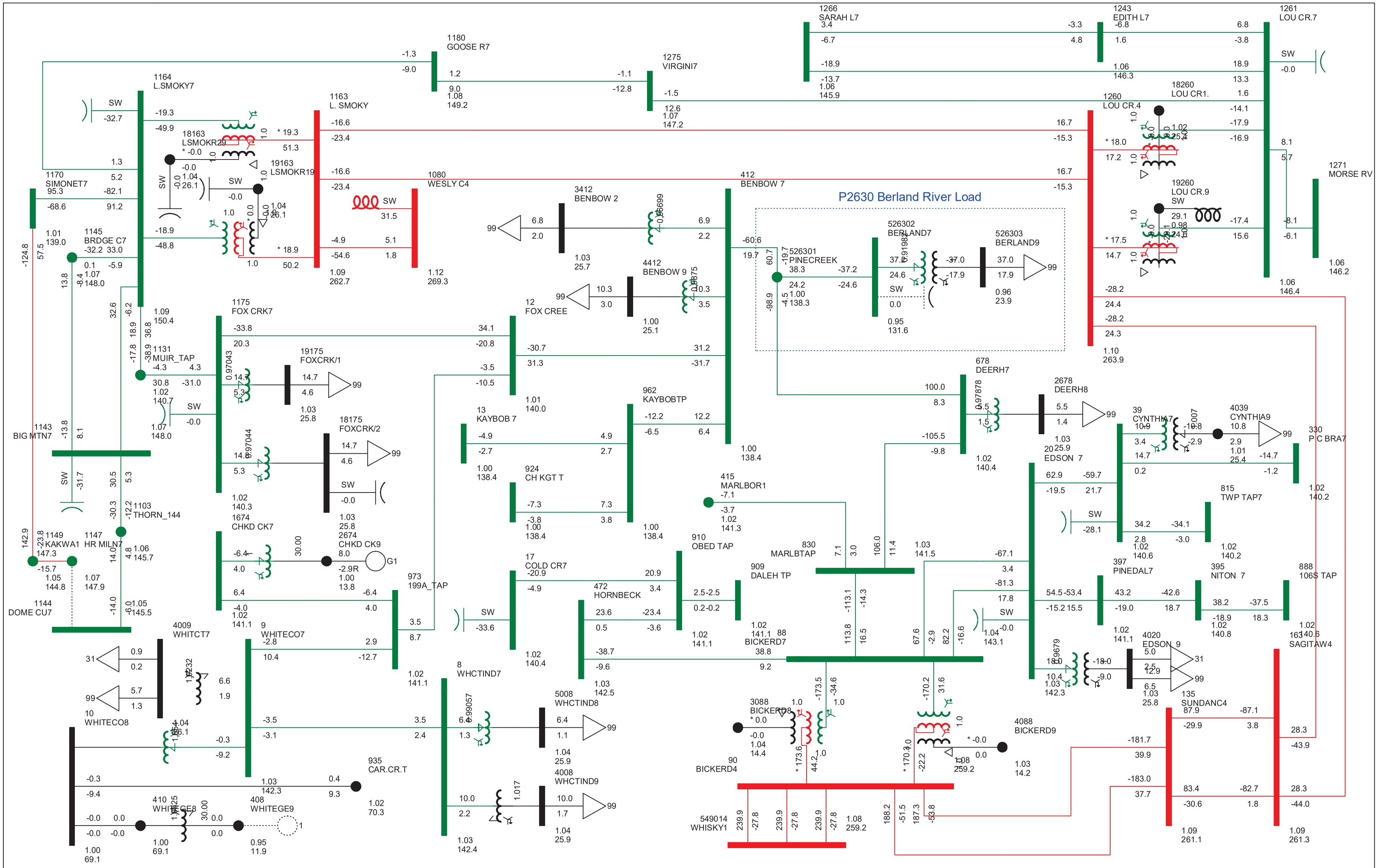
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-5
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:55

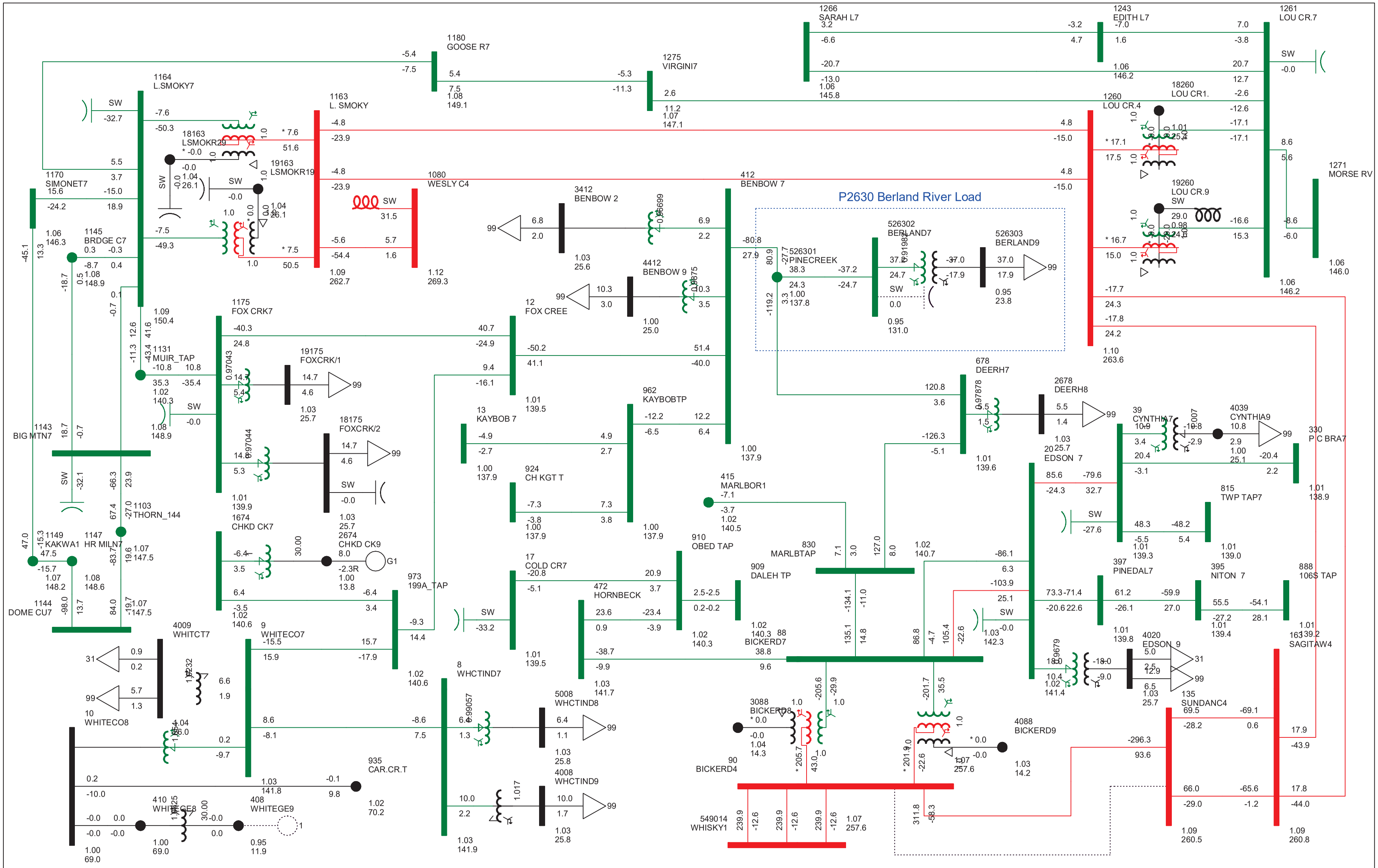
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-6
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 13:56

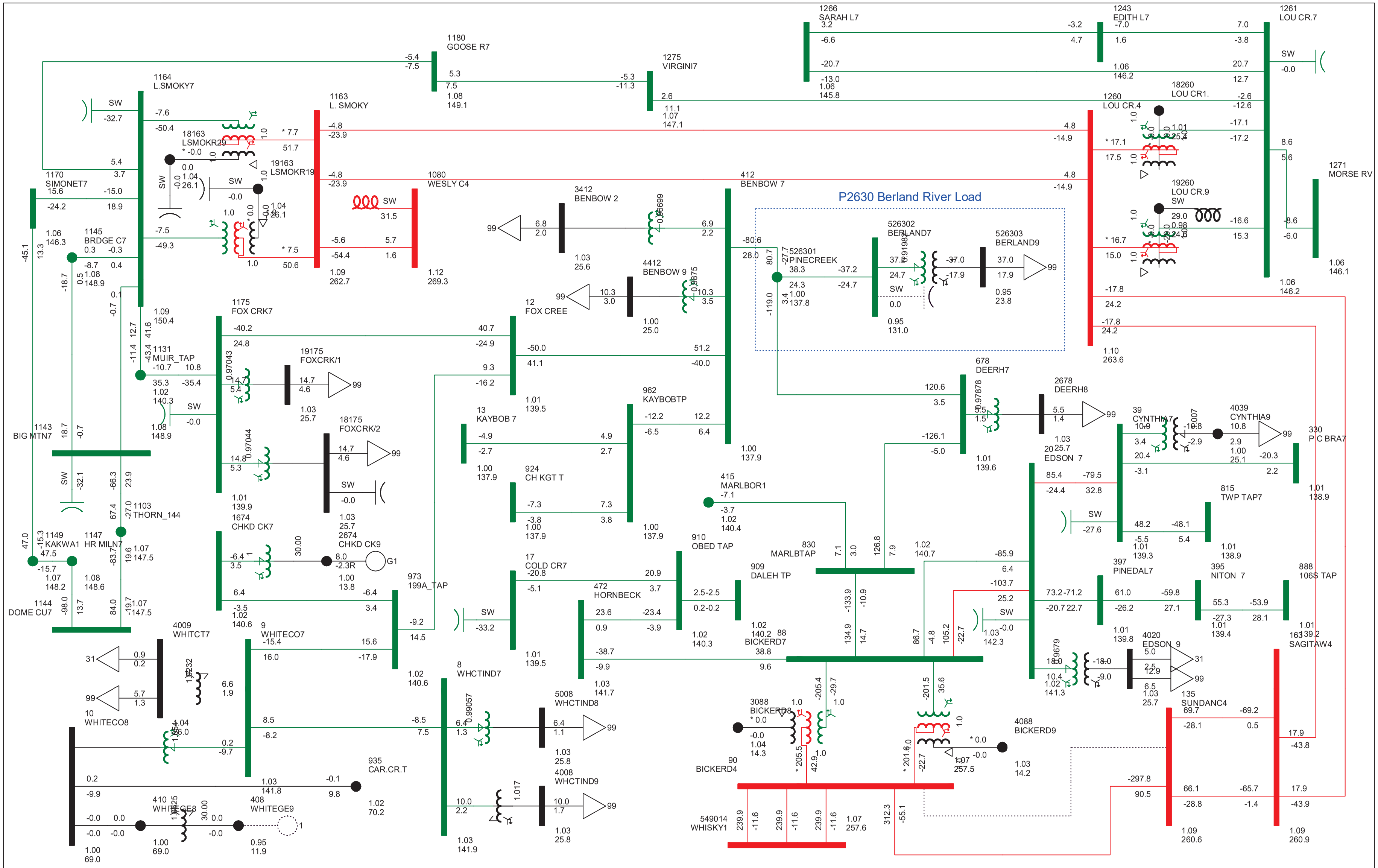
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



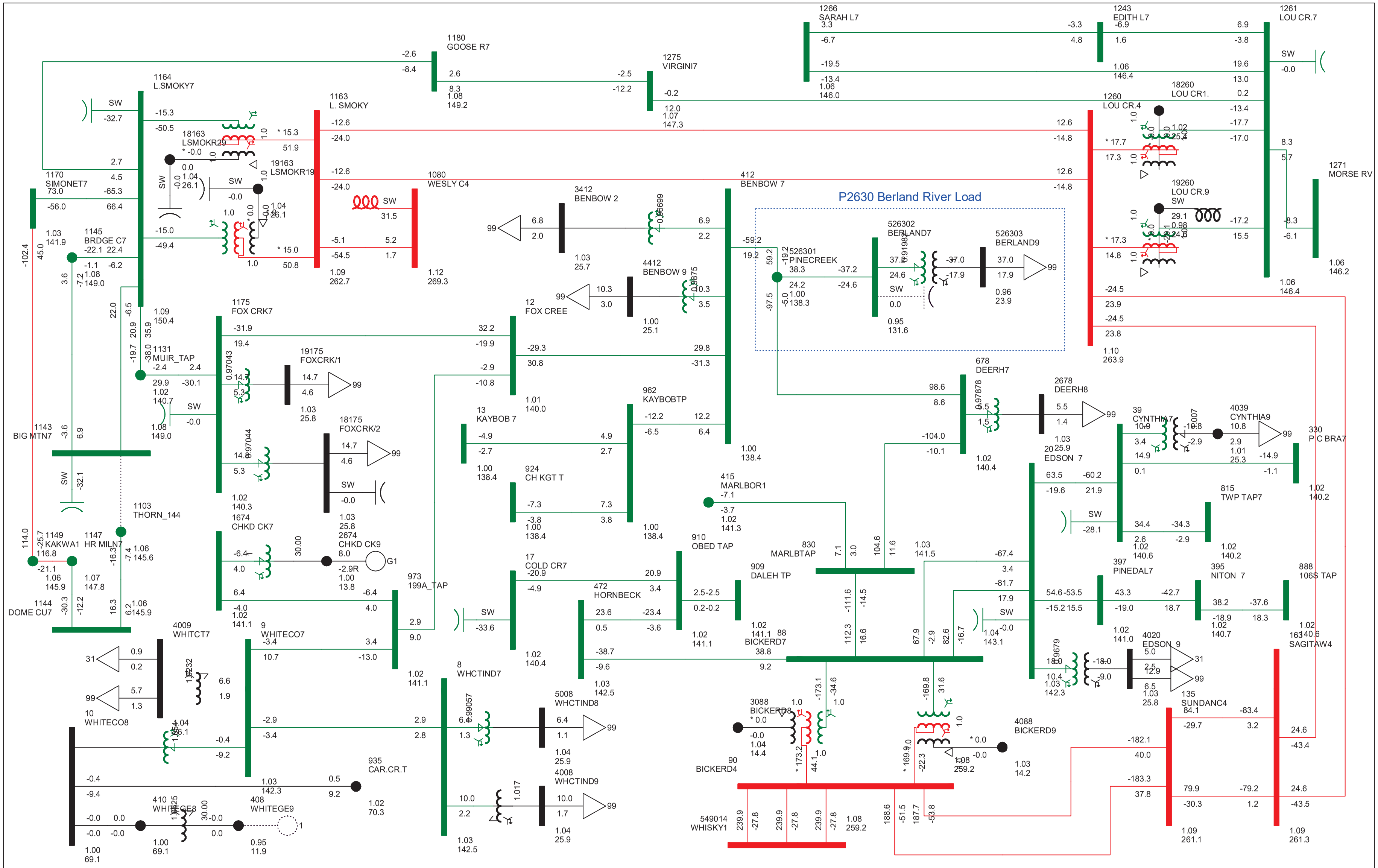
P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-7
N-1: 973L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 13:56

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



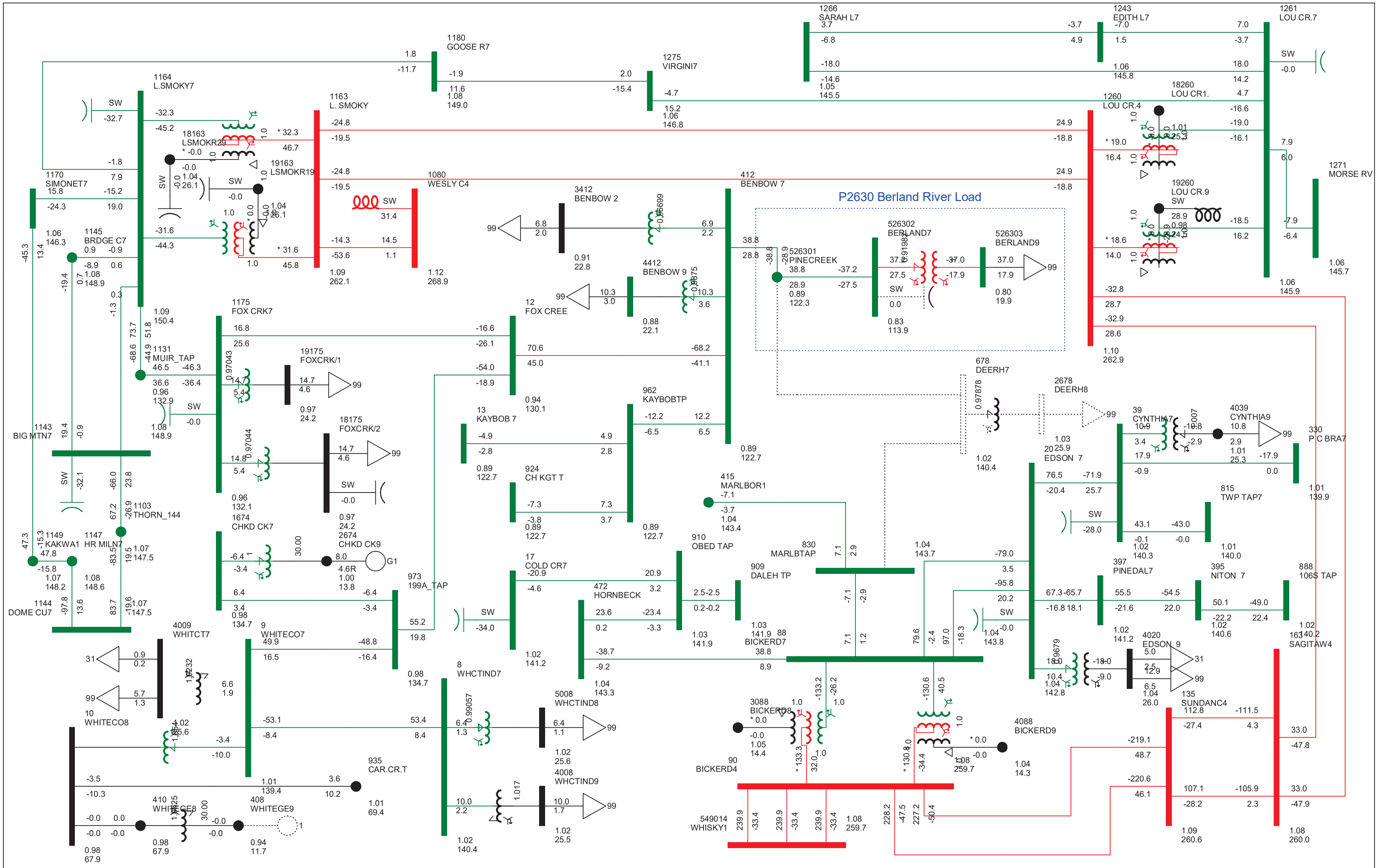
P2630: Berland River Load	P2630 POST-CONNECTION (2025SP)- DIAGRAM B-8 N-1: 974L (SUNDANCE 310P TO BICKERDIKE 39S) TUE, MAR 12 2024 13:56	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%RATE1 1.150OV 0.900UV kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-9
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:57

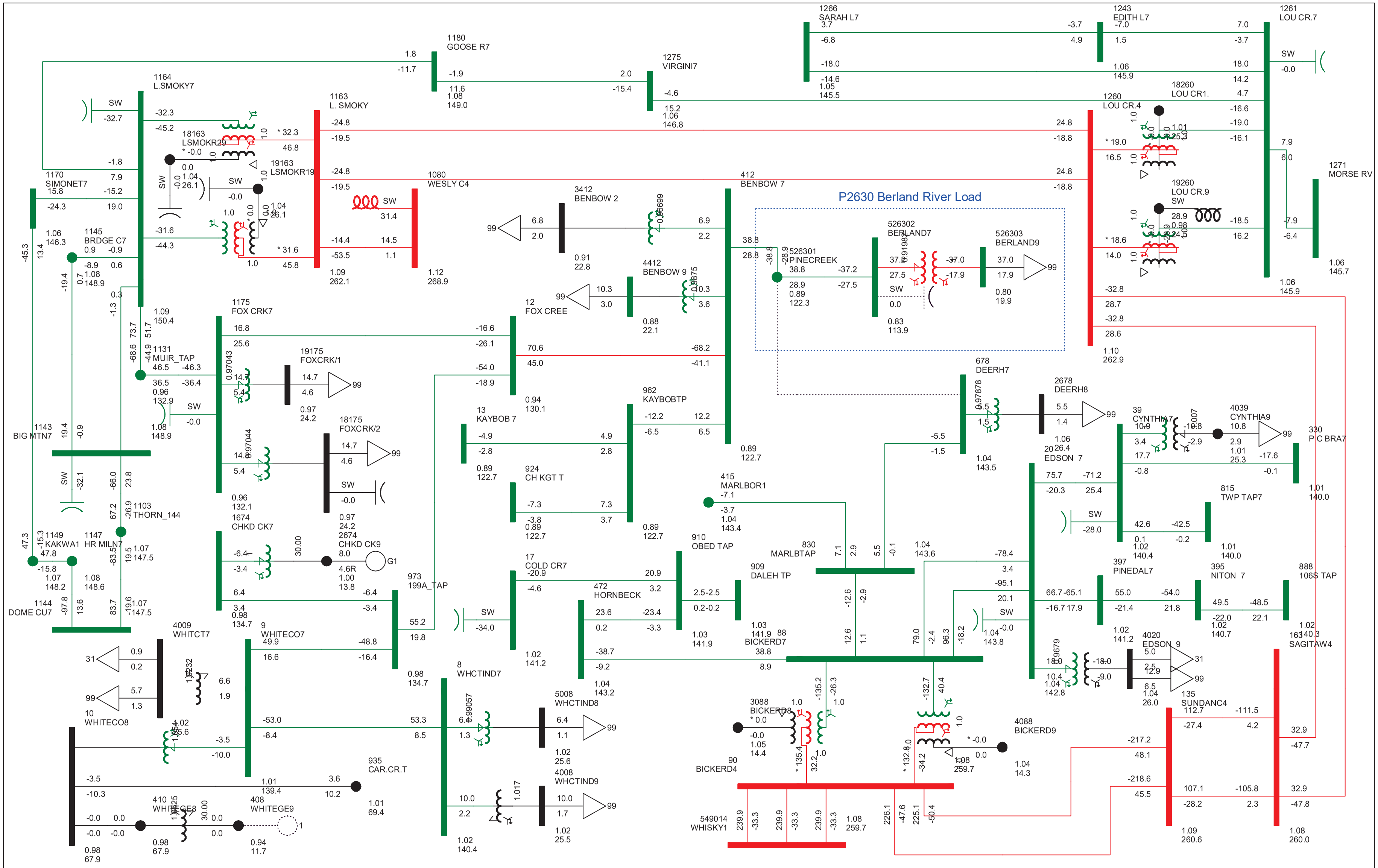
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-10
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, MAR 12 2024 13:57

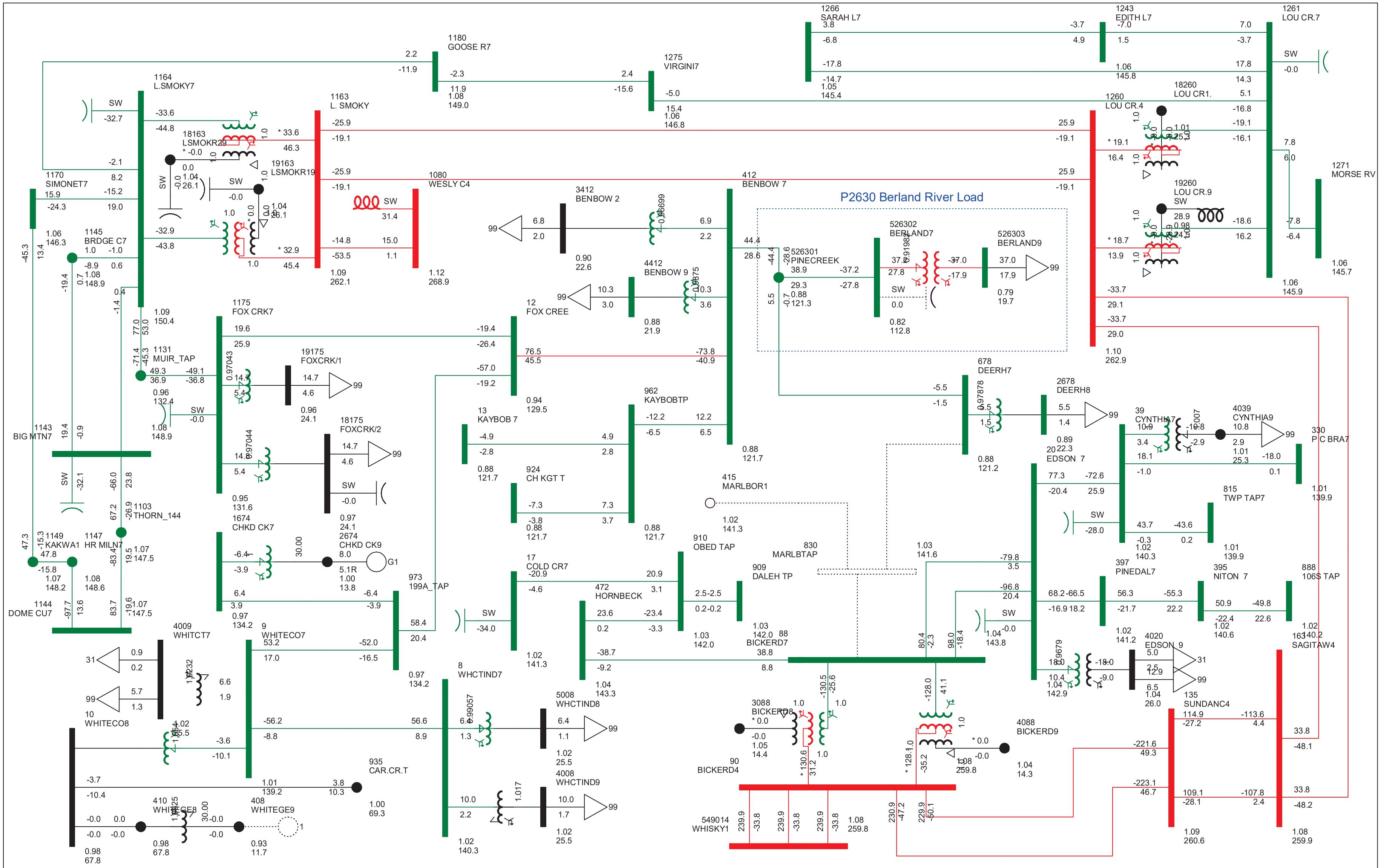
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-11
N-1: 685L (DEER HILL 1012S TO PINE CREEK 328S)
TUE, MAR 12 2024 13:57

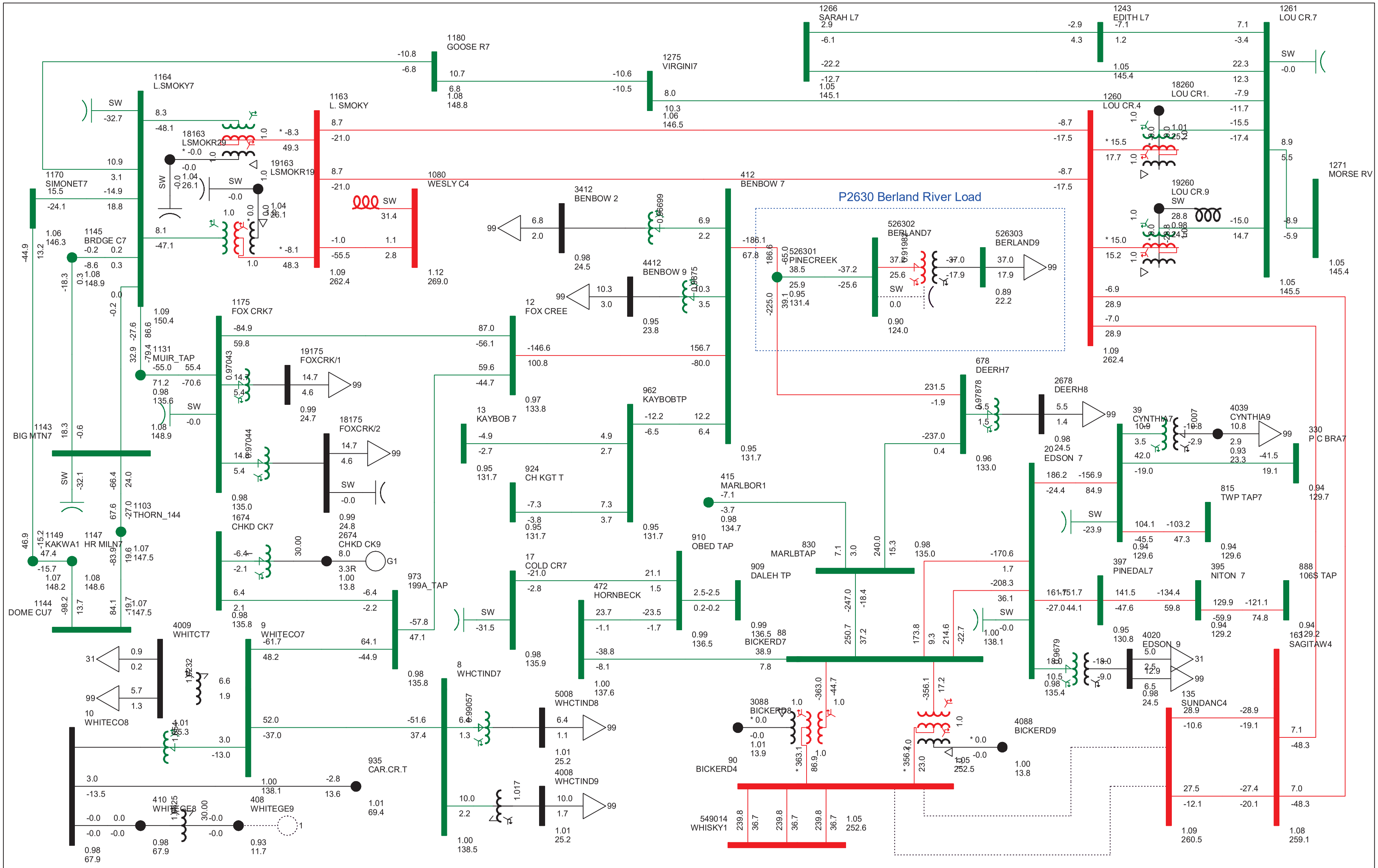
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-12
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, MAR 12 2024 13:58

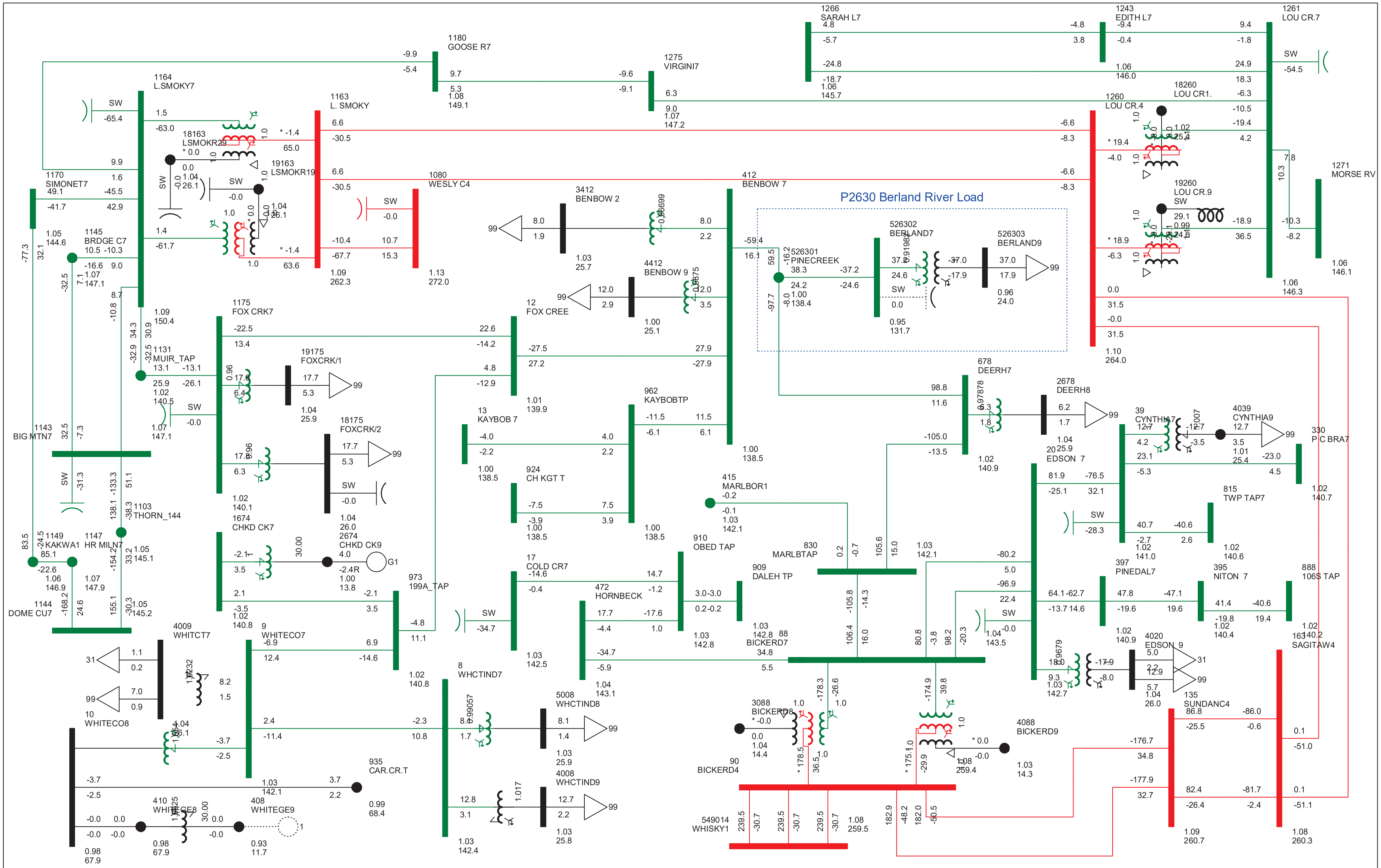
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM B-13
C-5: 973L_974L (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 13:58

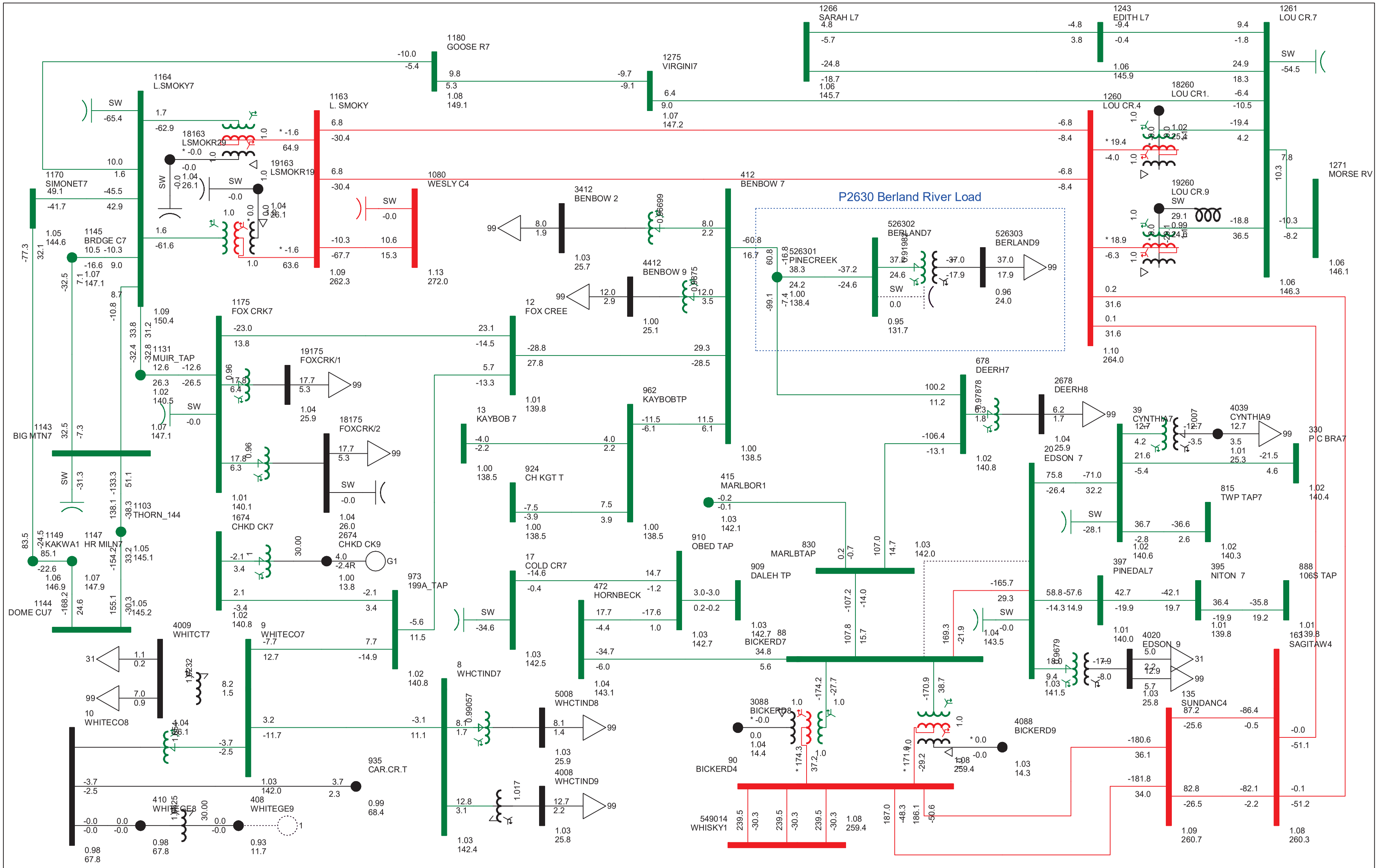
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-14
N-0: NORMAL OPERATION
TUE, MAR 12 2024 13:59

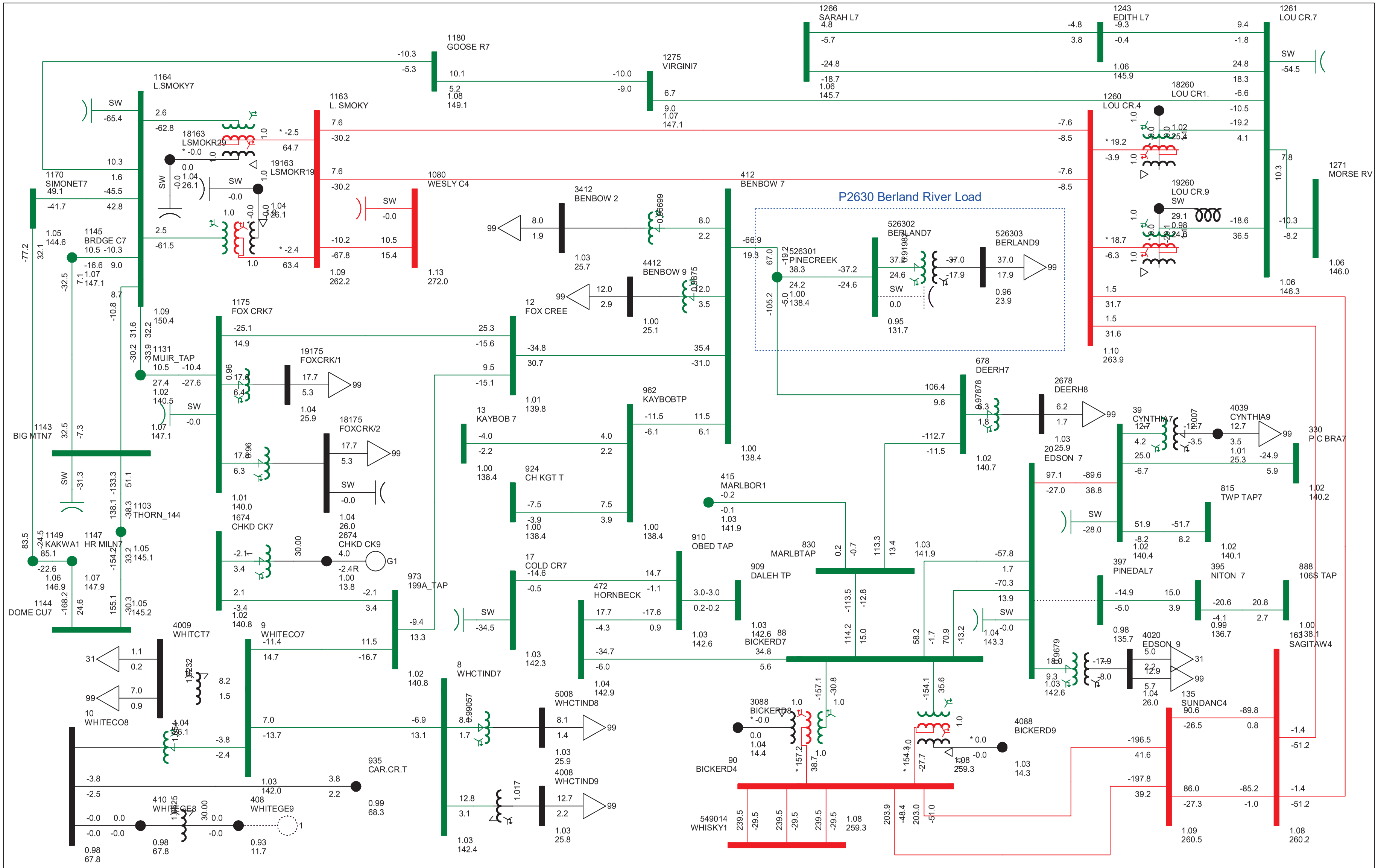
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-15
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, MAR 12 2024 14:00

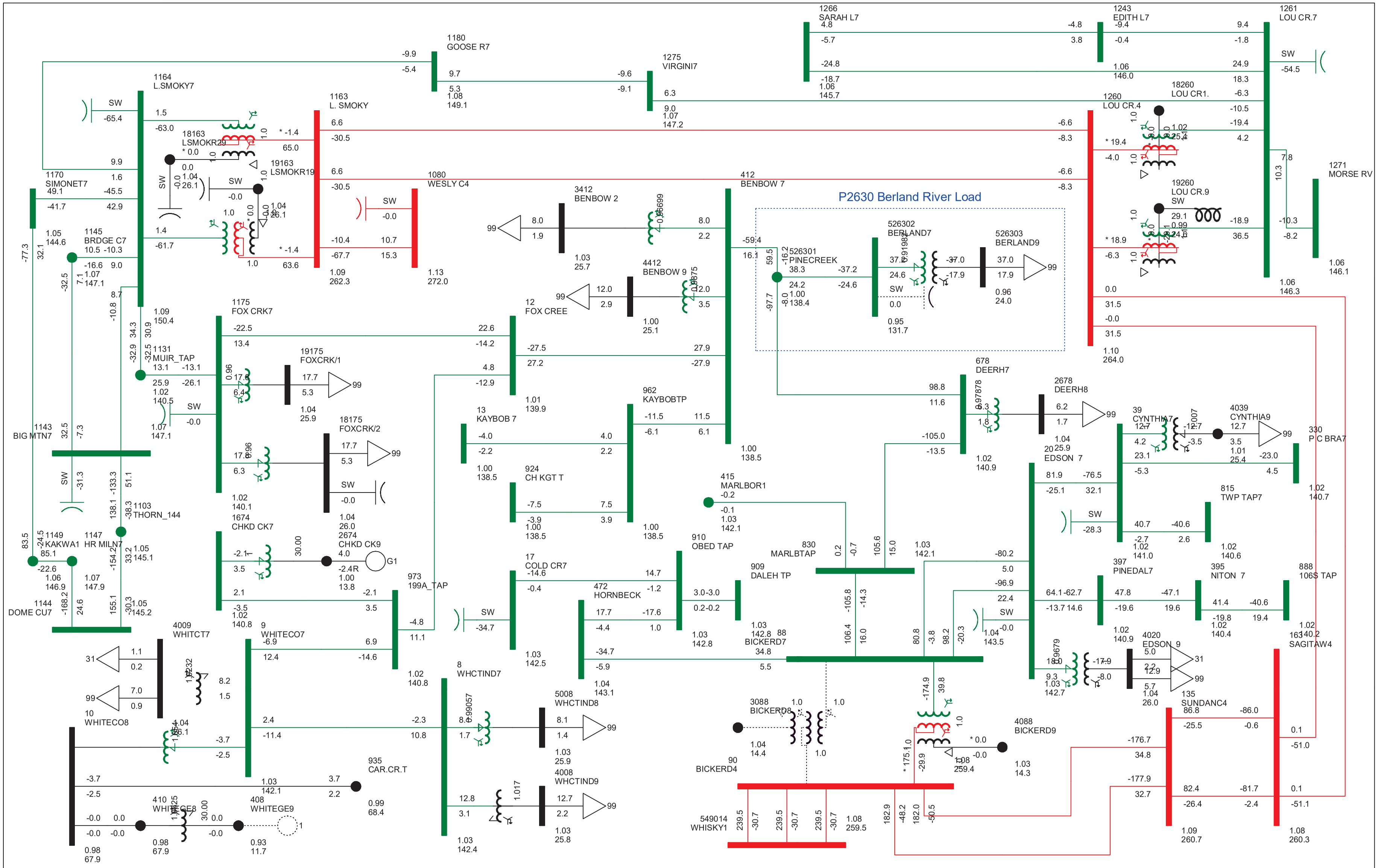
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-16
N-1: 890L (EDSON 58S TO PINEDALE 207S)
TUE, MAR 12 2024 14:01

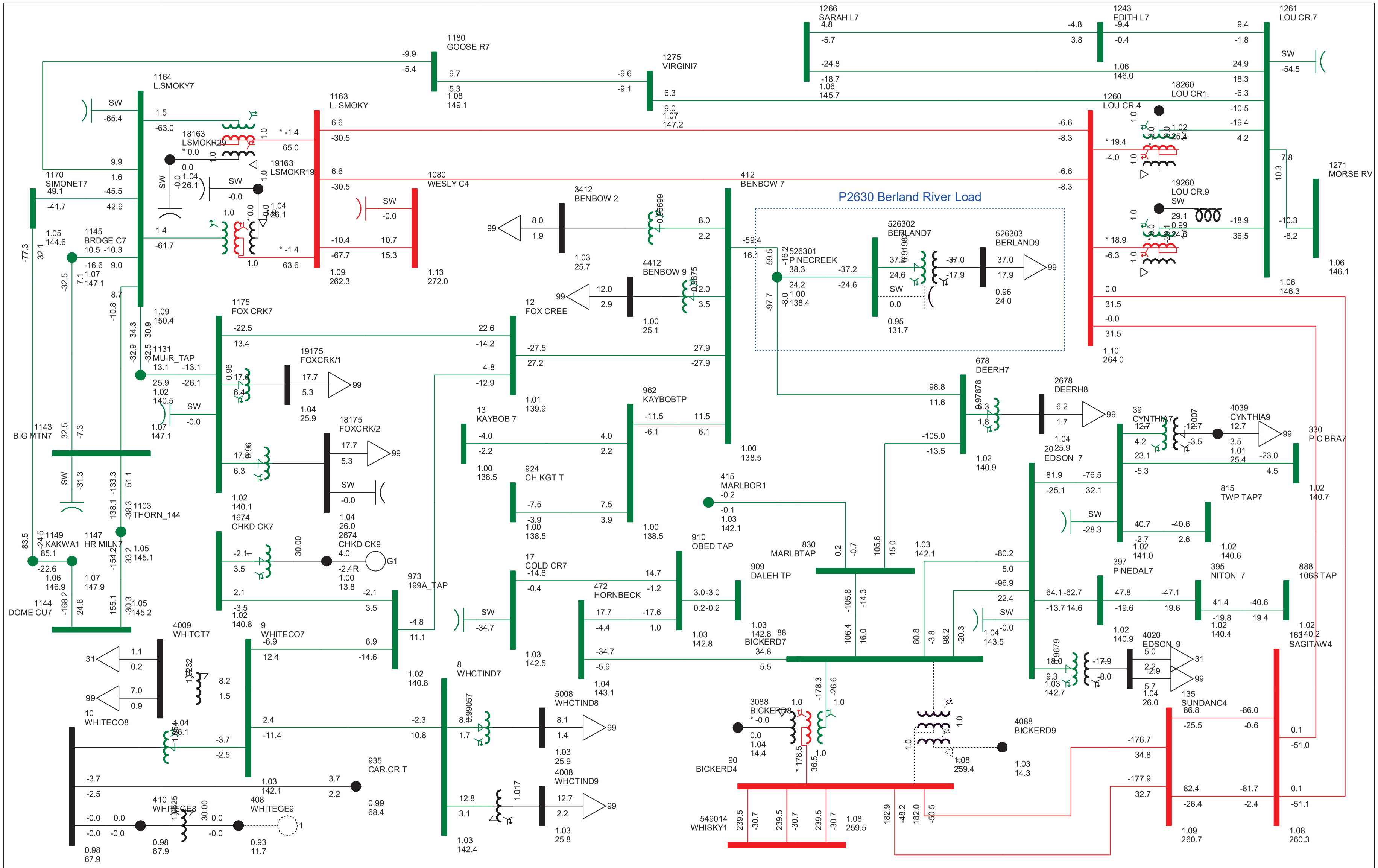
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-17
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 14:01

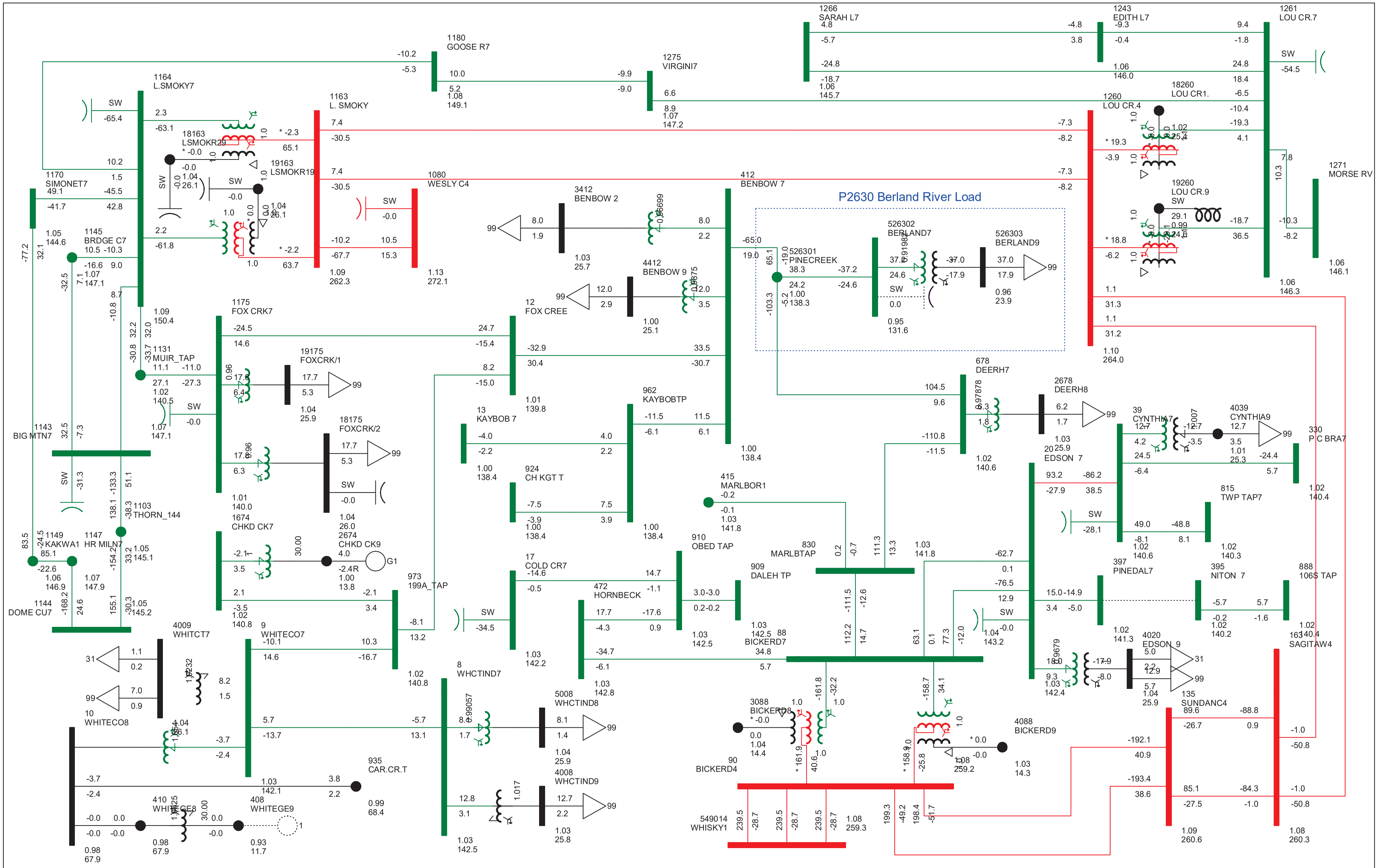
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-18
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, MAR 12 2024 14:01

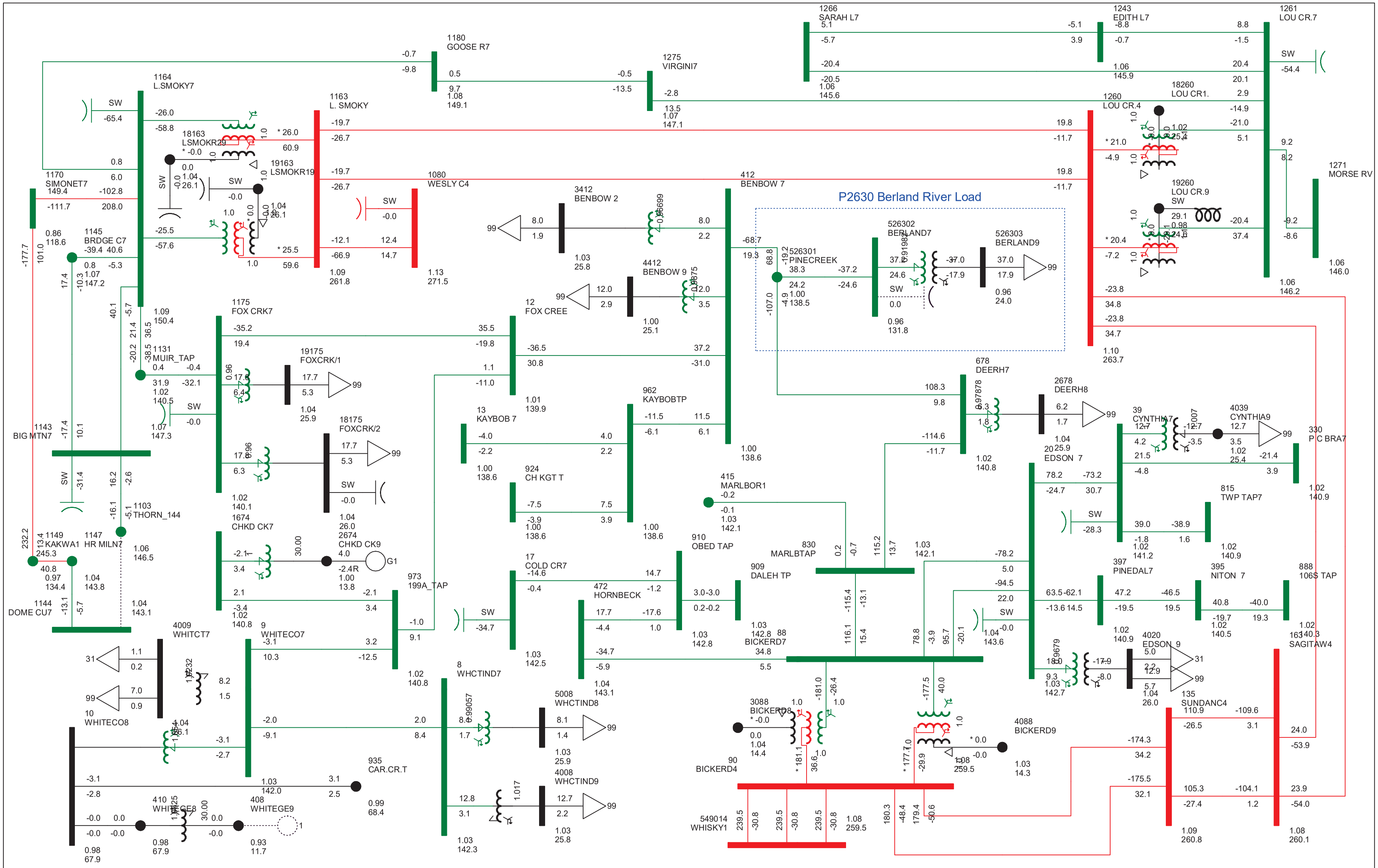
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-19
N-1: 744L (NITON 228S TO PINEDALE 207S)
TUE, MAR 12 2024 14:02

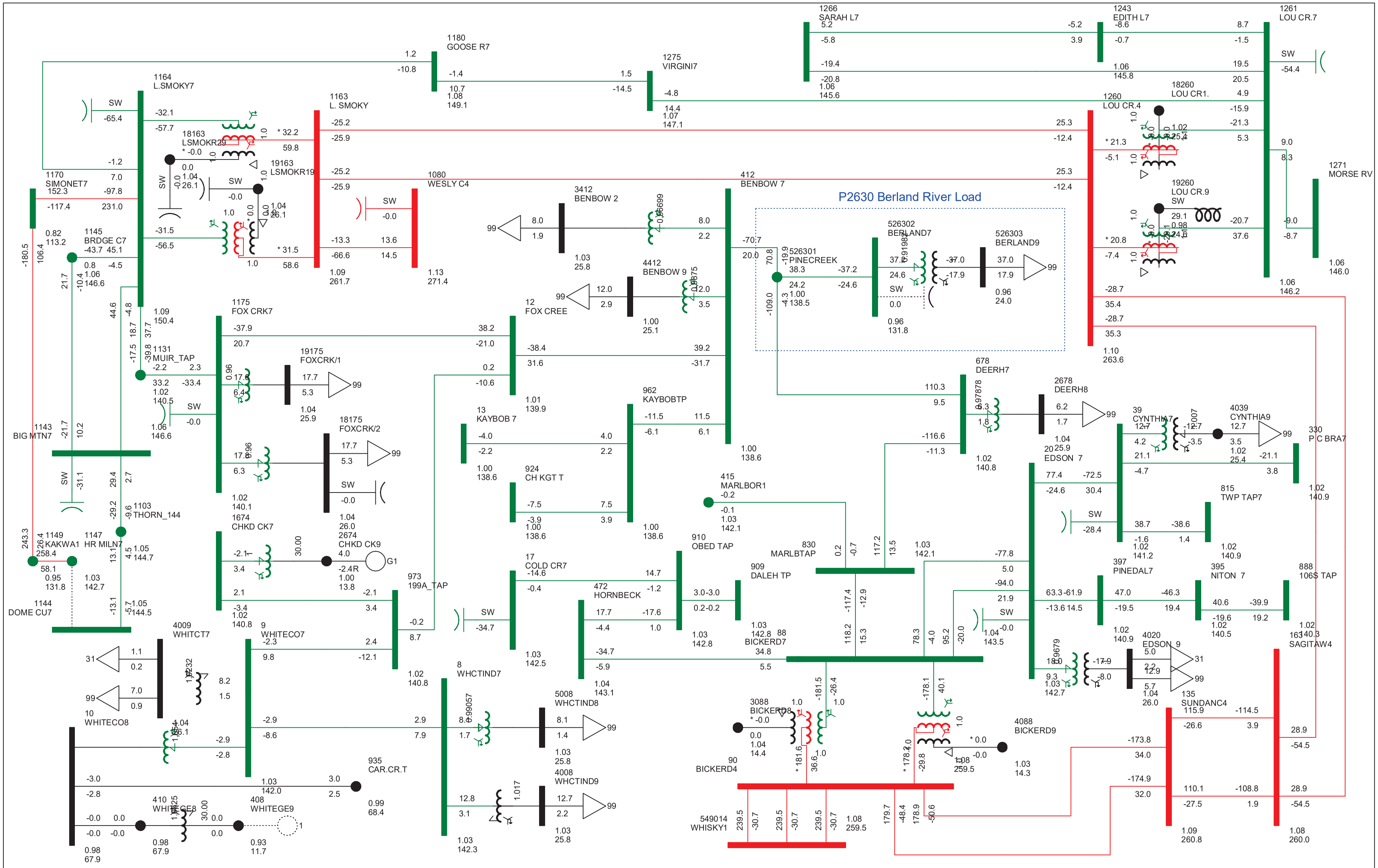
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-20
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 14:02

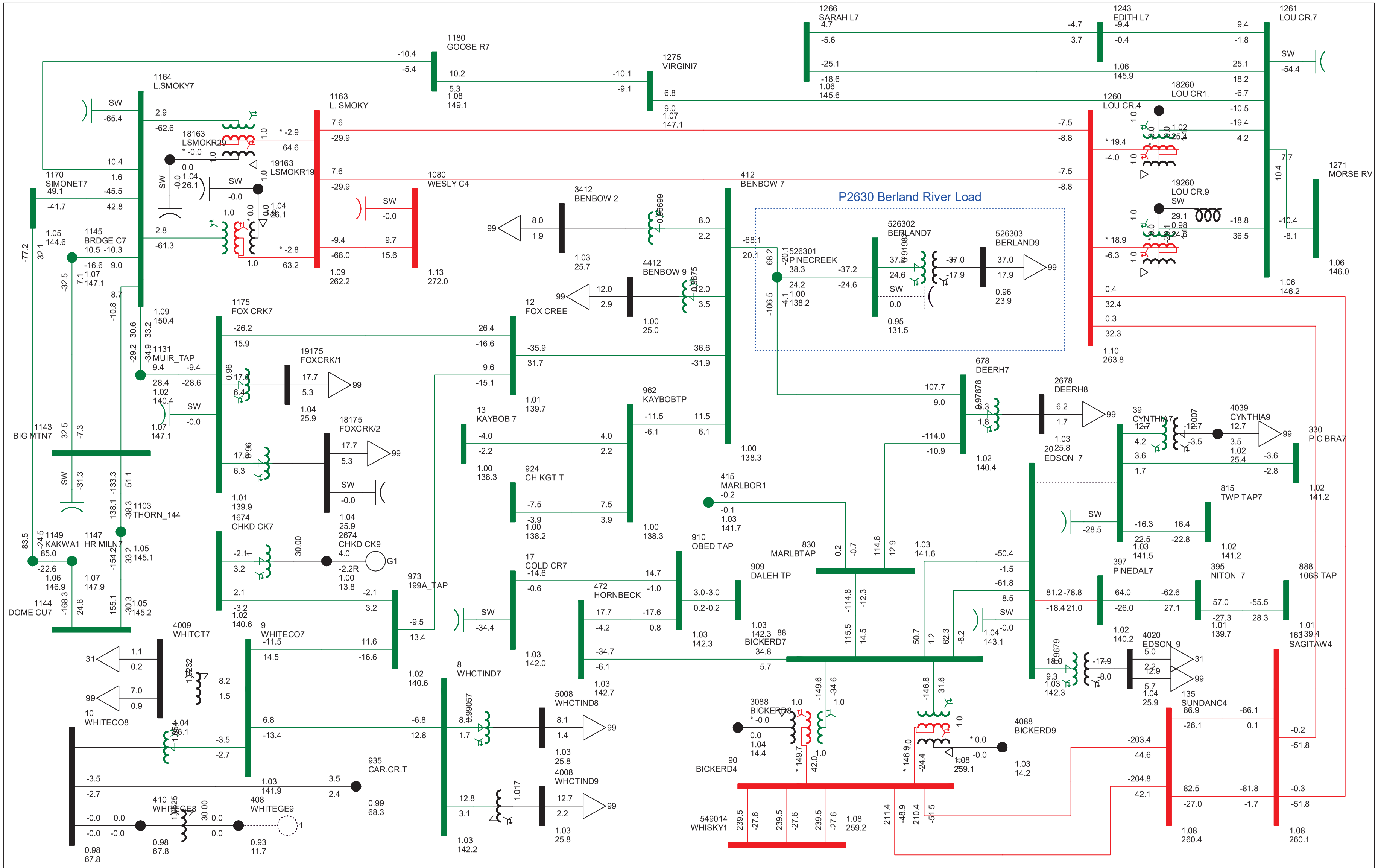
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-21
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, MAR 12 2024 14:03

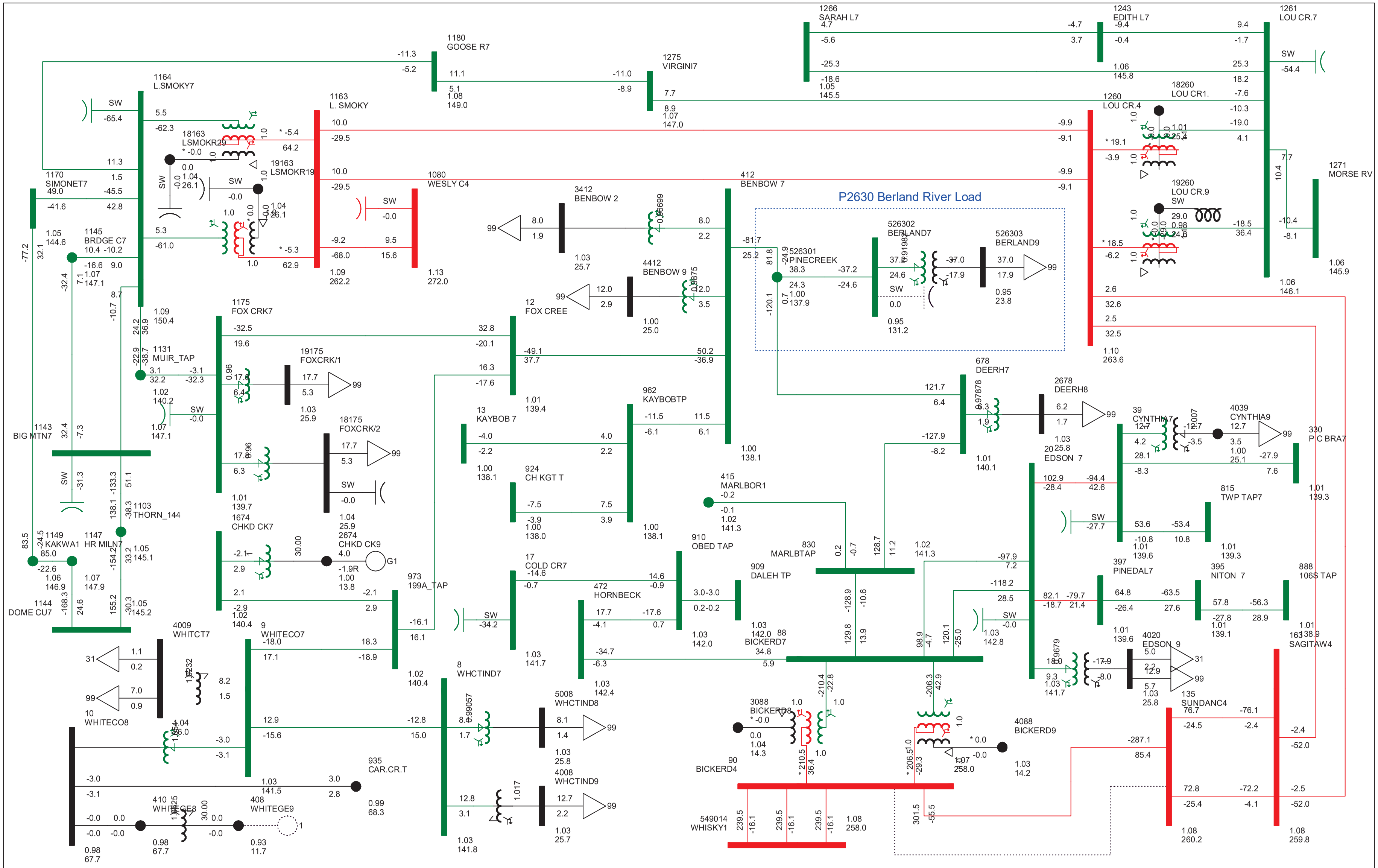
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-22
N-1: 202L (EDSON 58S TO CYNTHIA 178S)
TUE, MAR 12 2024 14:03

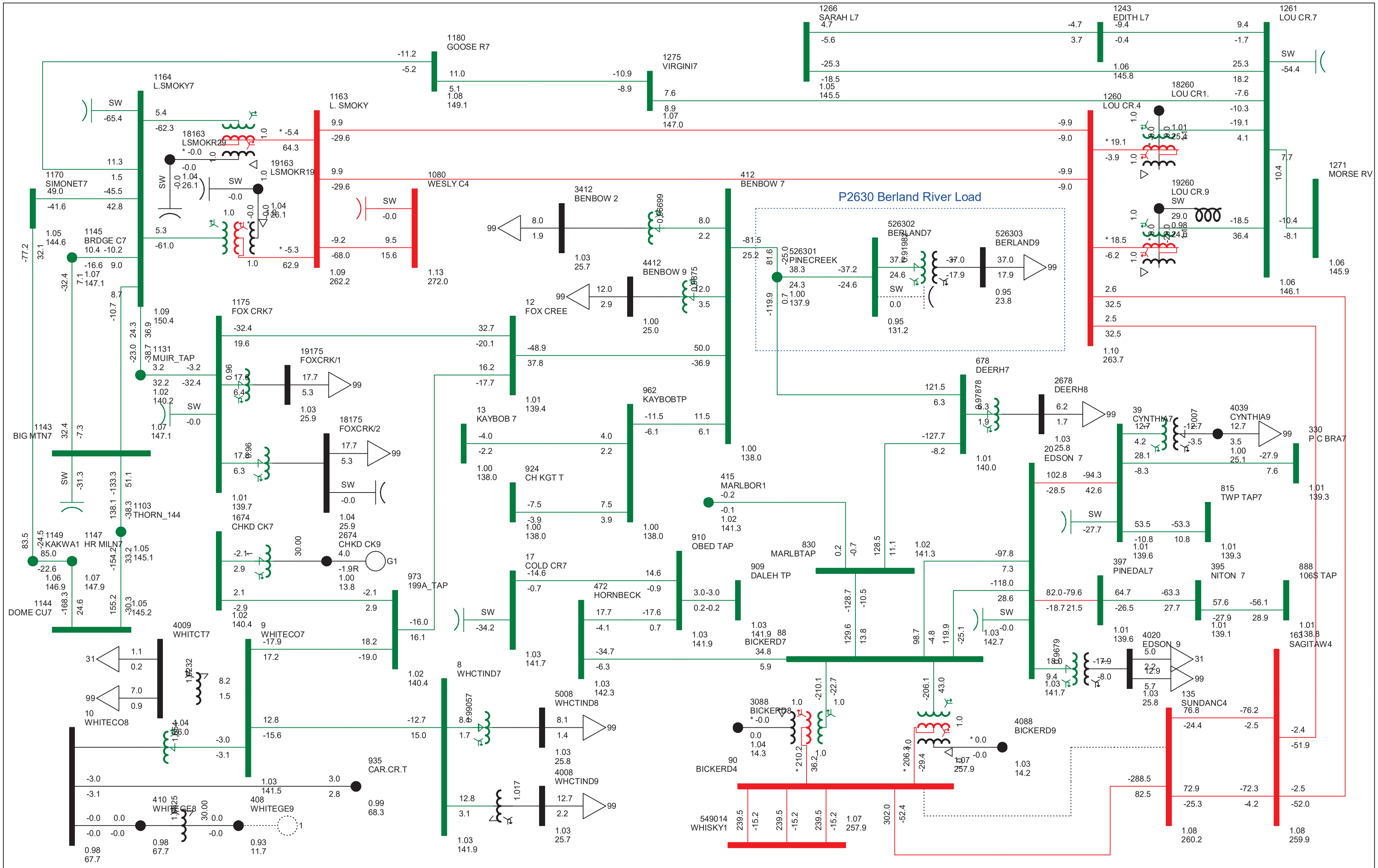
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



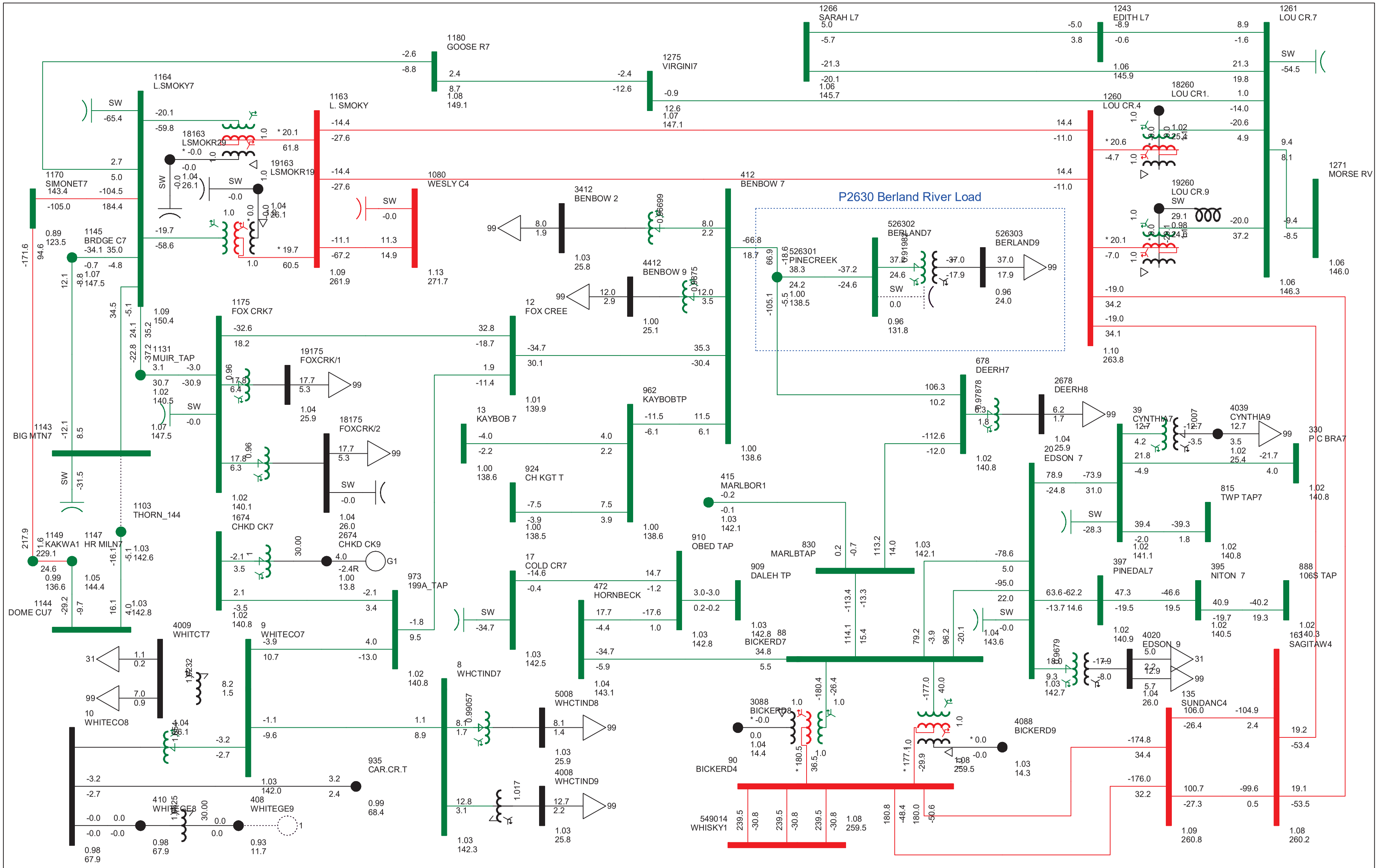
P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-23
N-1: 973L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, MAR 12 2024 14:03

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



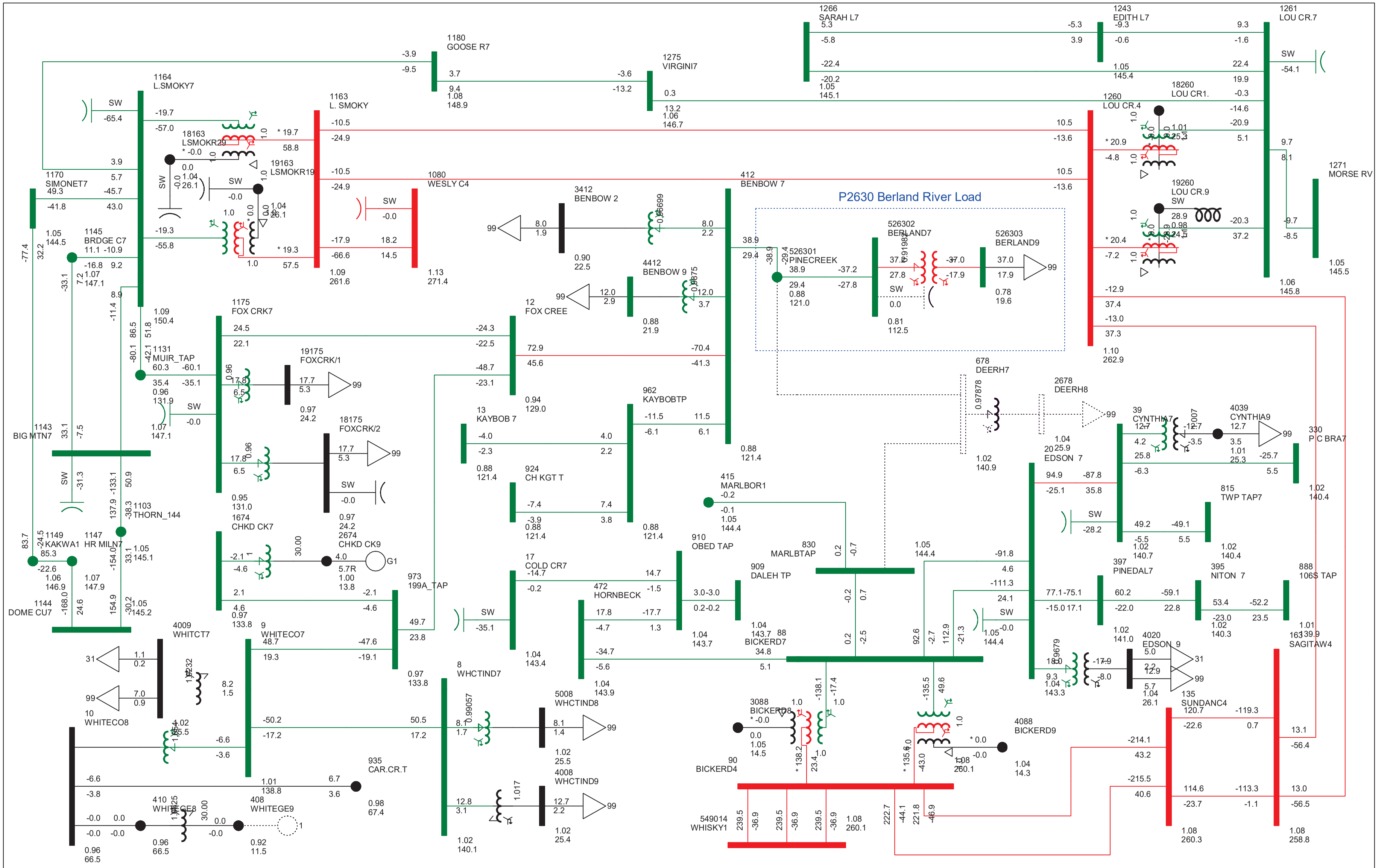
P2630: Berland River Load	P2630 POST-CONNECTION (2025WP)- DIAGRAM B-24 N-1: 974L (SUNDANCE 310P TO BICKERDIKE 39S) TUE, MAR 12 2024 14:03	Bus - Voltage (kV/pu) Branch - MW/Mvar Equipment - MW/Mvar 100.0%RATE2 1.150OV 0.900UV kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-25
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 14:04

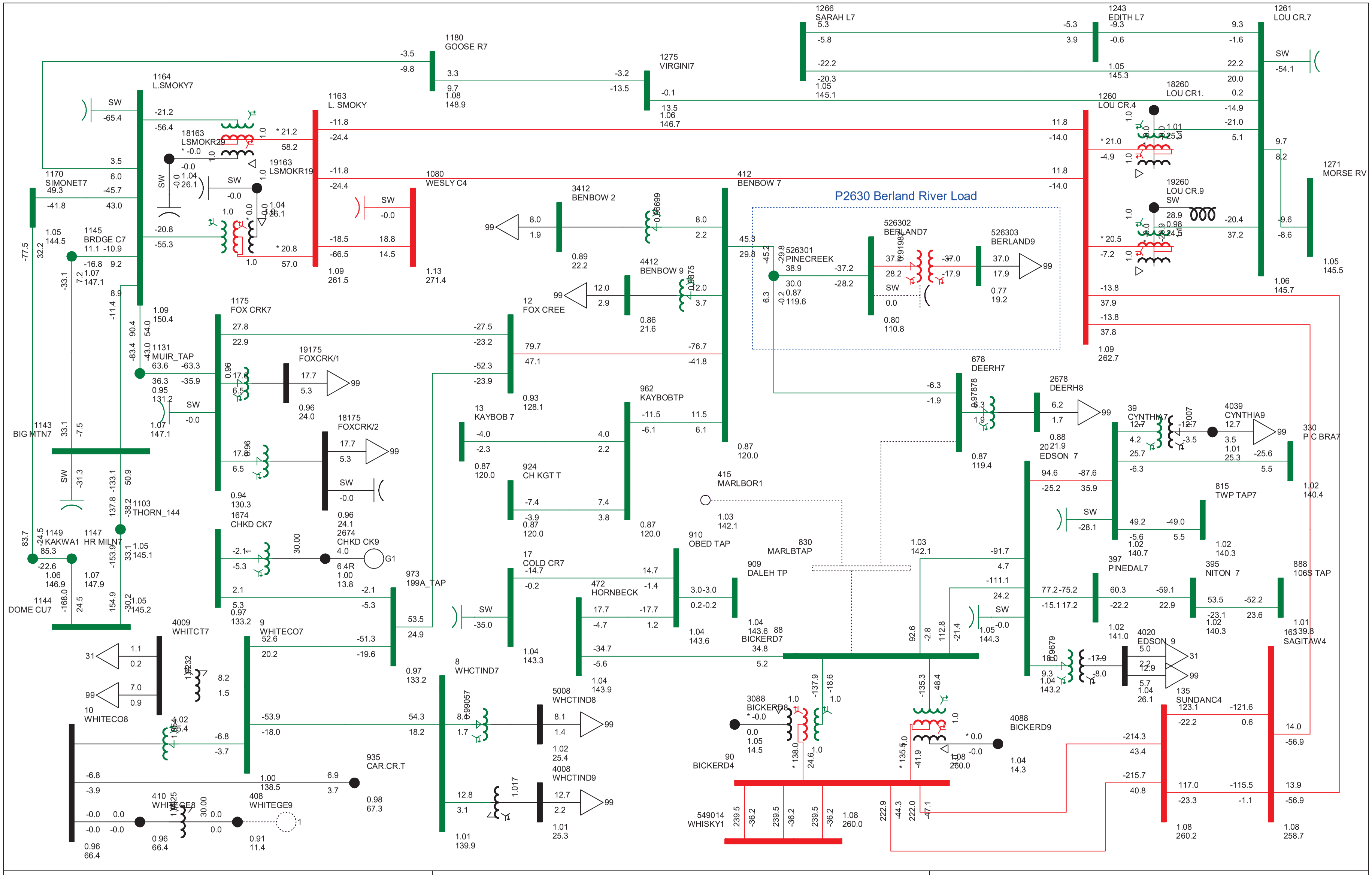
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-26
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, MAR 12 2024 14:04

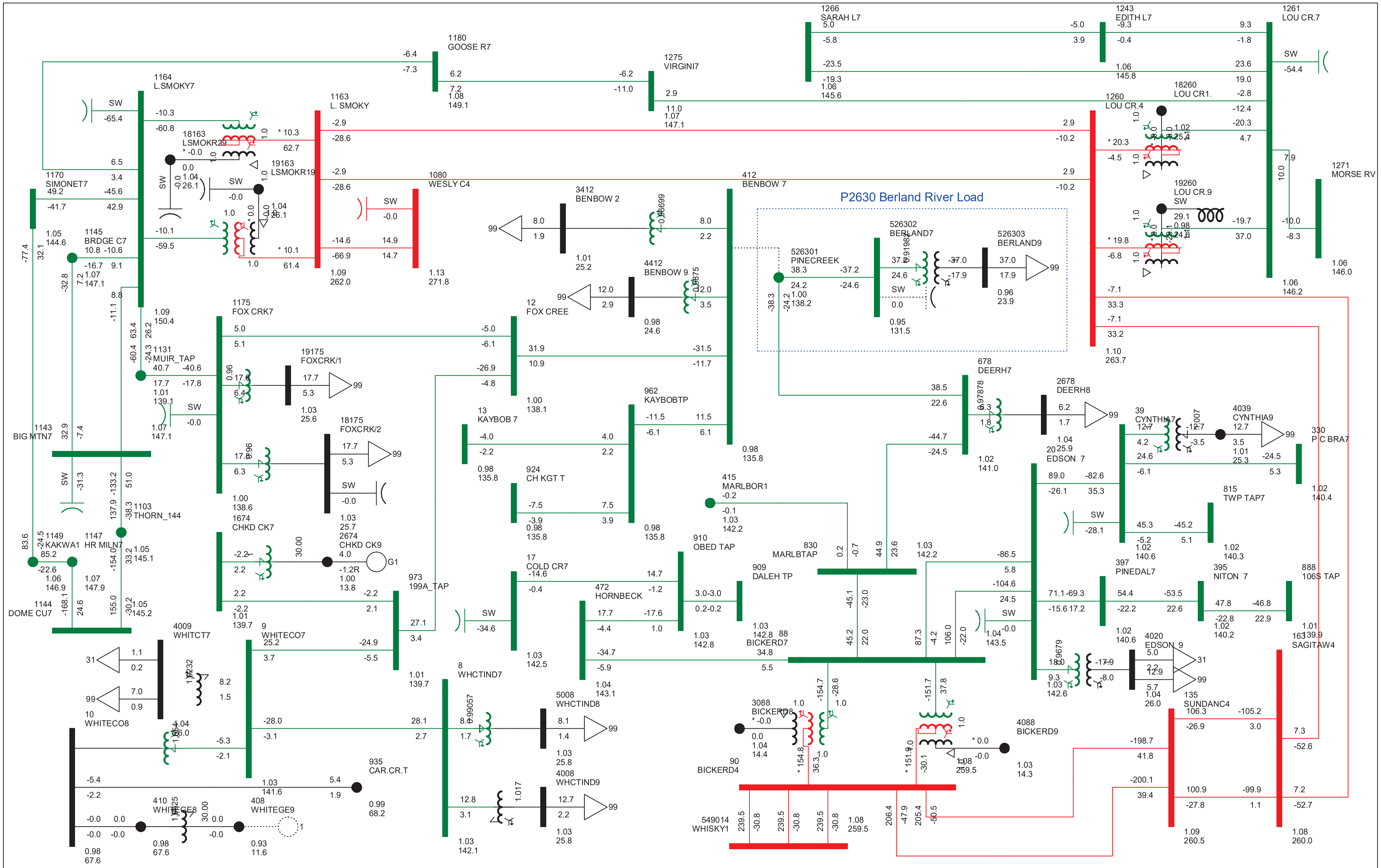
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-27
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, MAR 12 2024 14:04

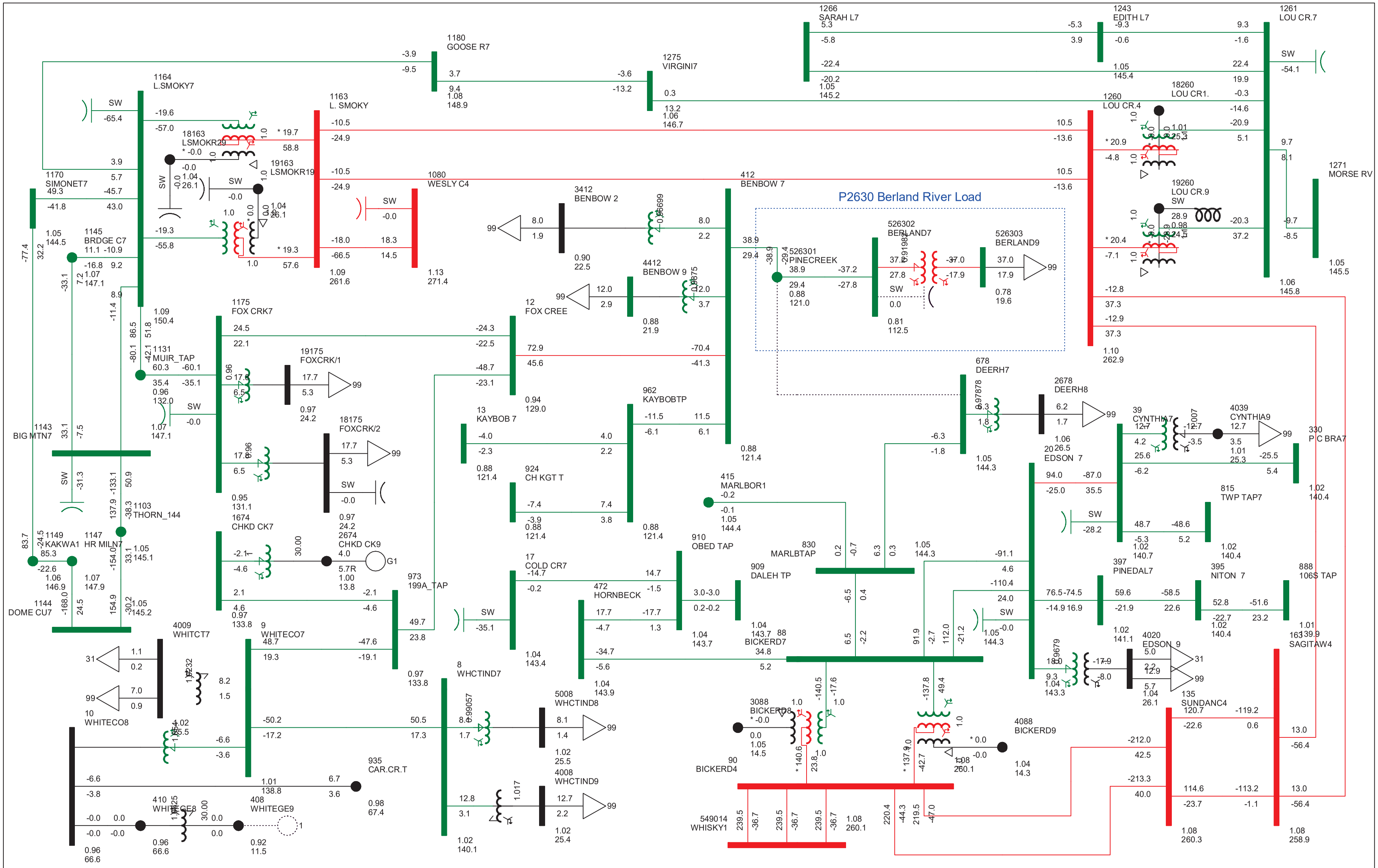
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-28
N-1: 614L (BENBOW 397S TO PINE CREEK 328S)
TUE, MAR 12 2024 14:04

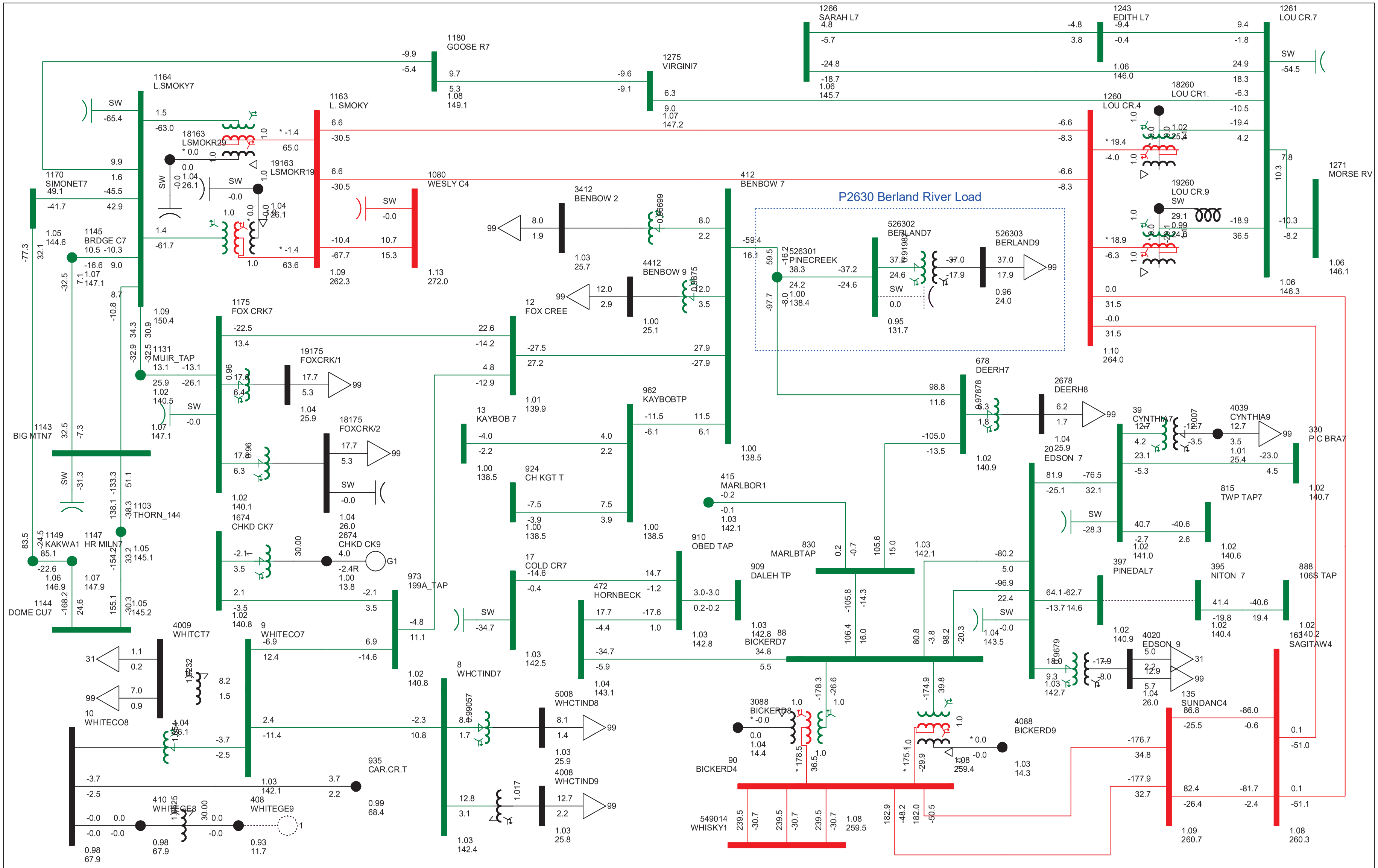
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-29
N-1: 685L (DEER HILL 1012S TO PINE CREEK 328S)
TUE, MAR 12 2024 14:05

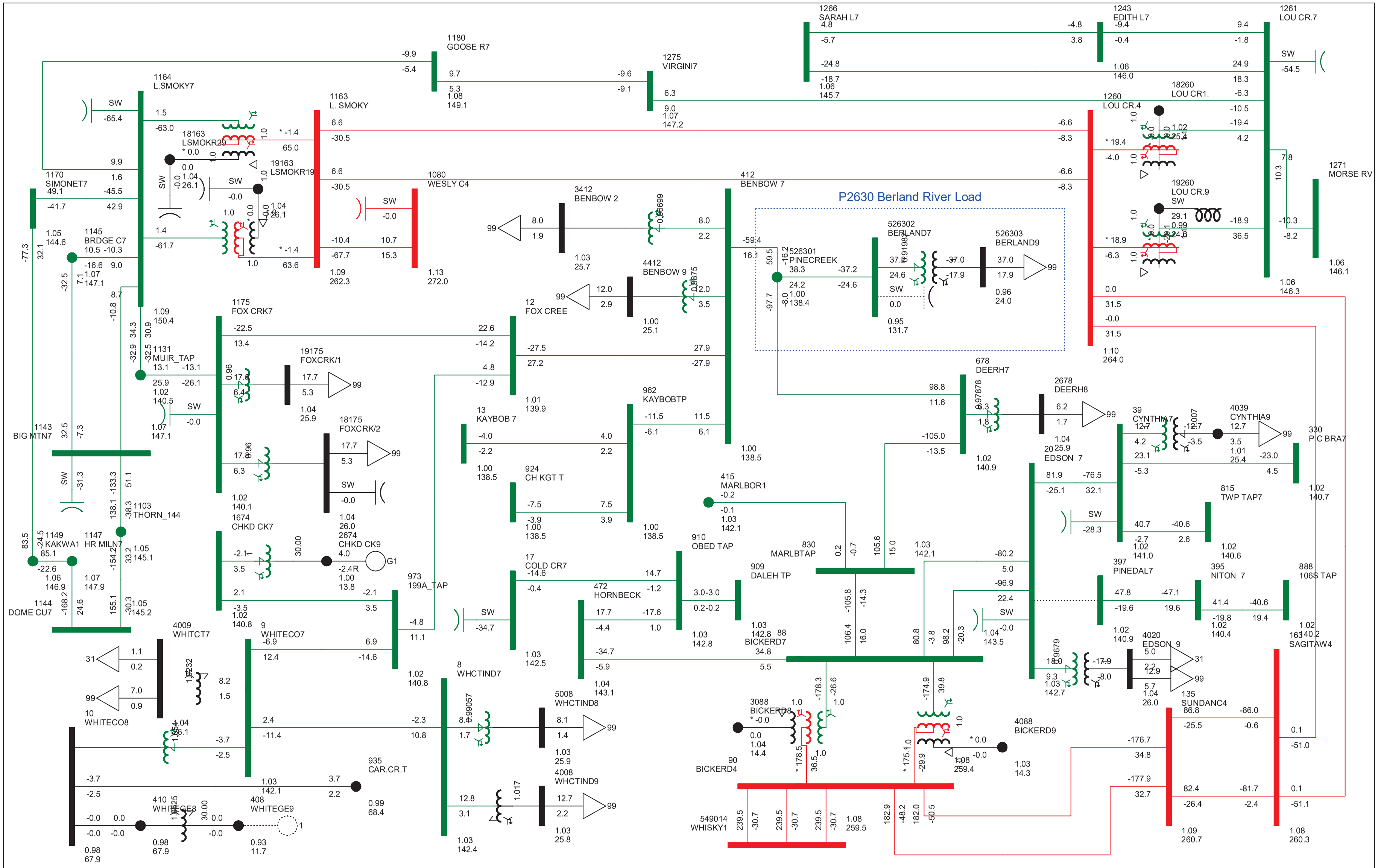
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-30
N-1: 207ST1 (PINEDALE 207S 138/25 KV TRANSFORMER T1)
TUE, MAR 12 2024 14:05

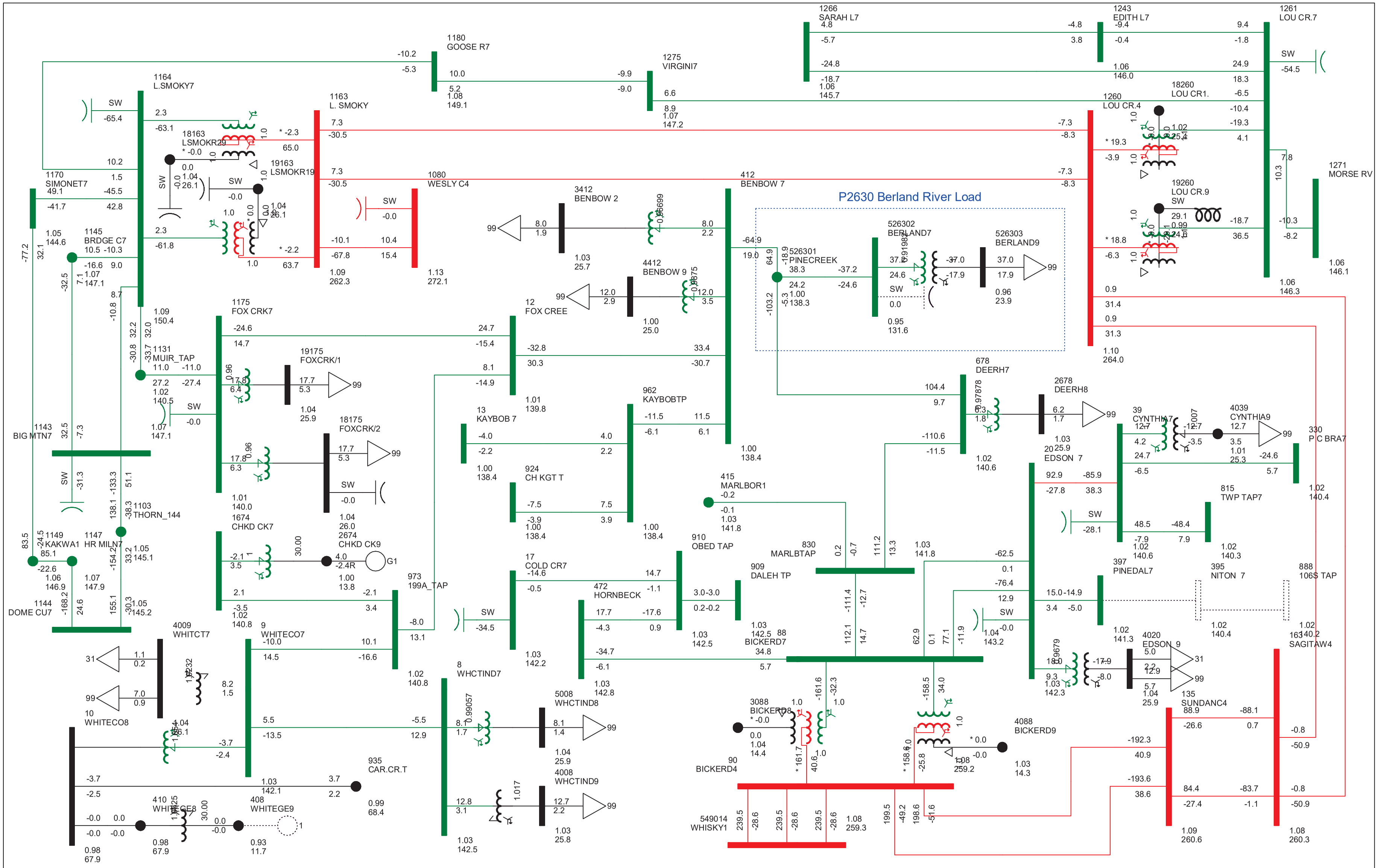
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-31
N-1: 207ST2 (PINEDALE 207S 138/25 KV TRANSFORMER T2)
TUE, MAR 12 2024 14:05

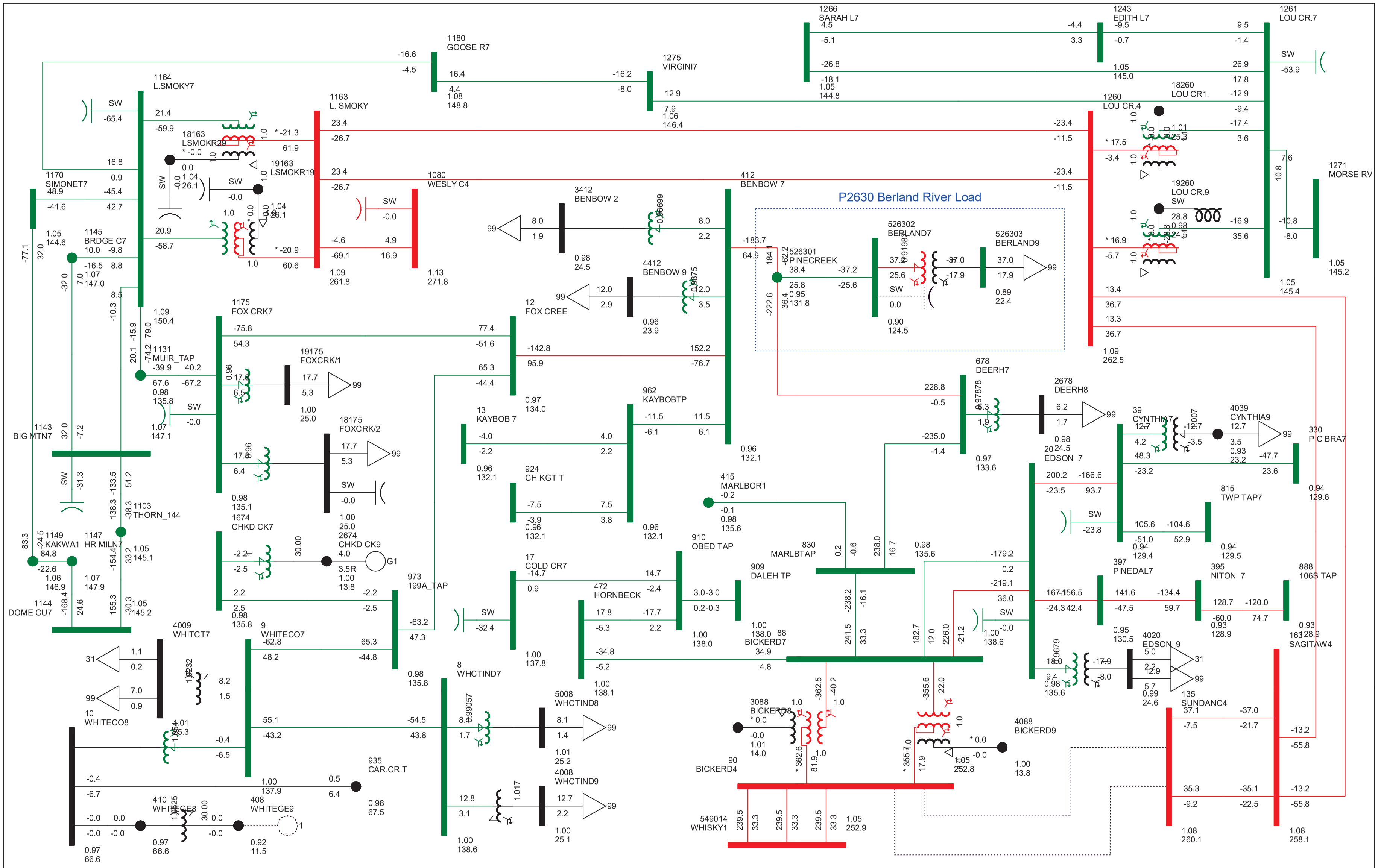
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-32
N-1: 744L (NITON 228S TO ENTWISTLE 235S) OR 228ST1 (NITON 22
TUE, MAR 12 2024 14:05

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000

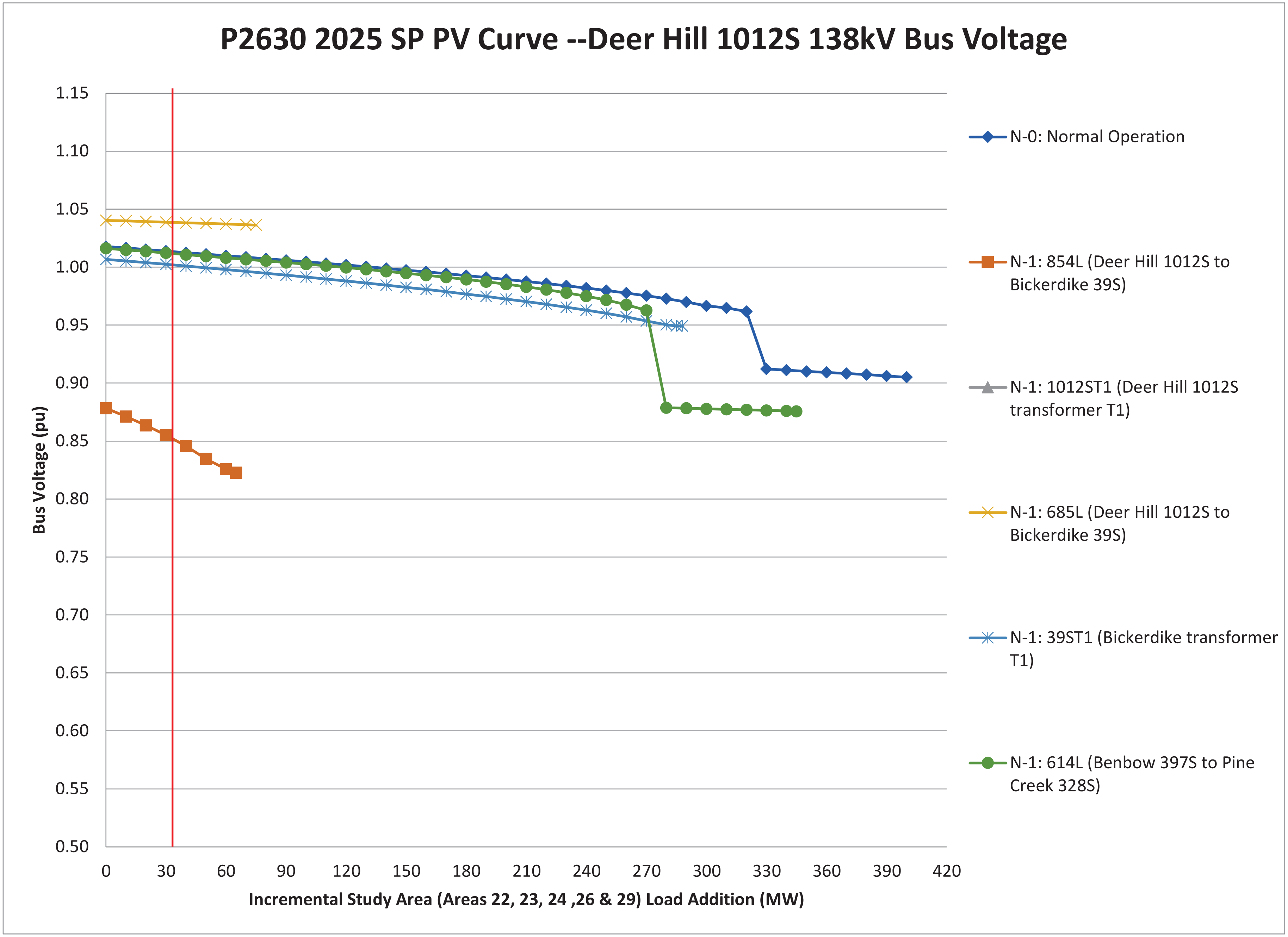


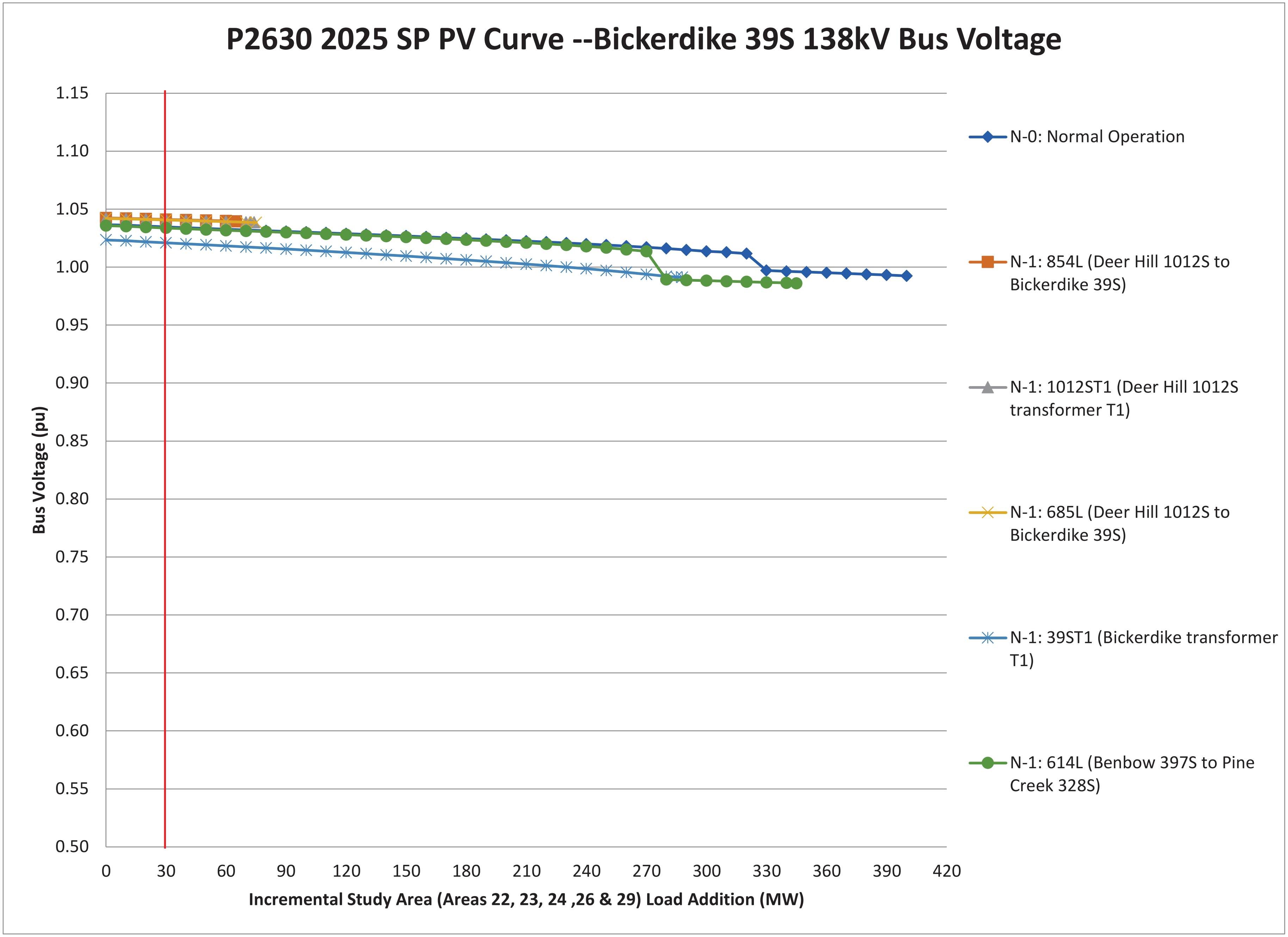
P2630: Berland River Load

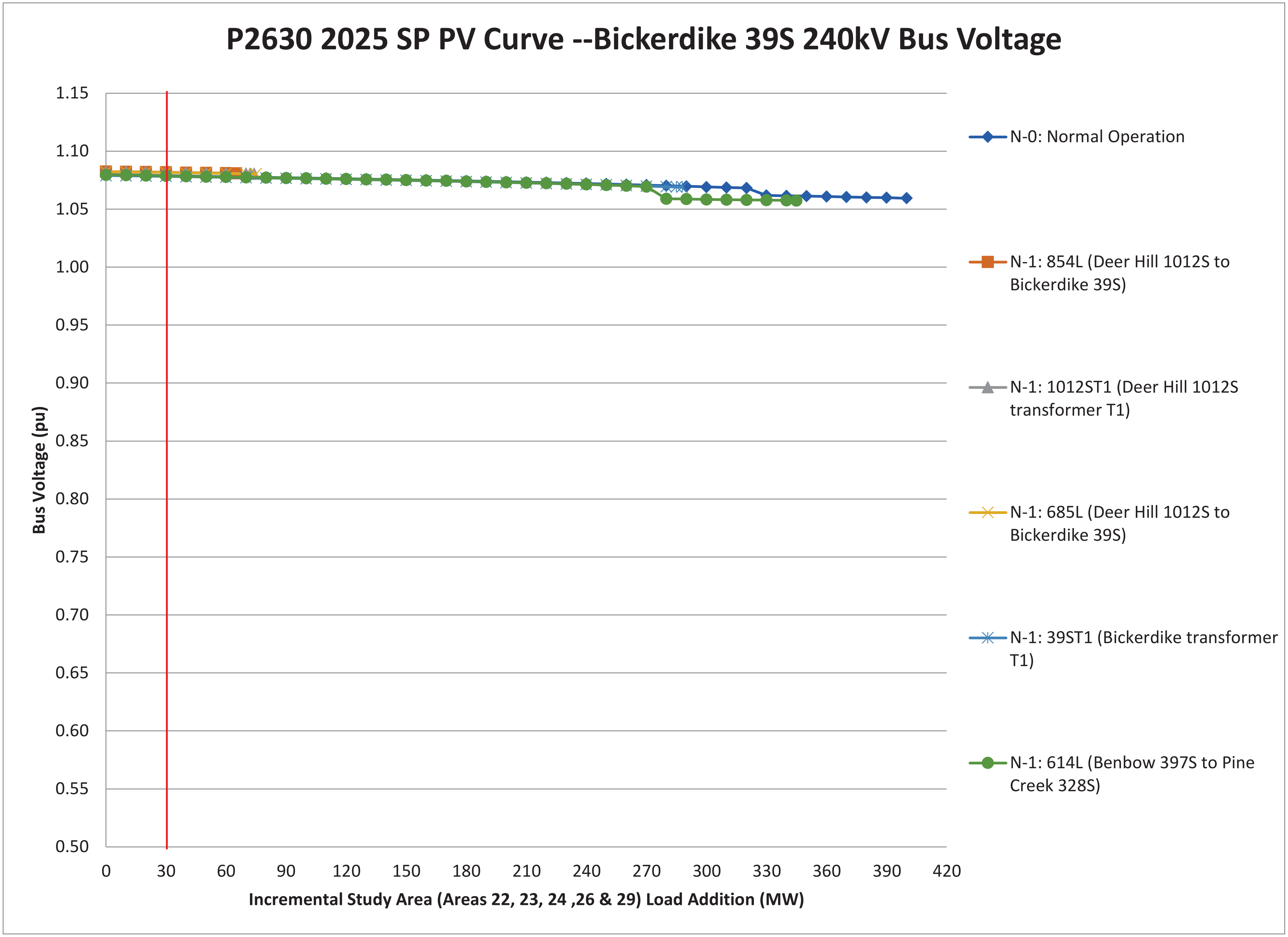
P2630 POST-CONNECTION (2025WP)- DIAGRAM B-33
C-5: 973L_974L (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, MAR 12 2024 14:06

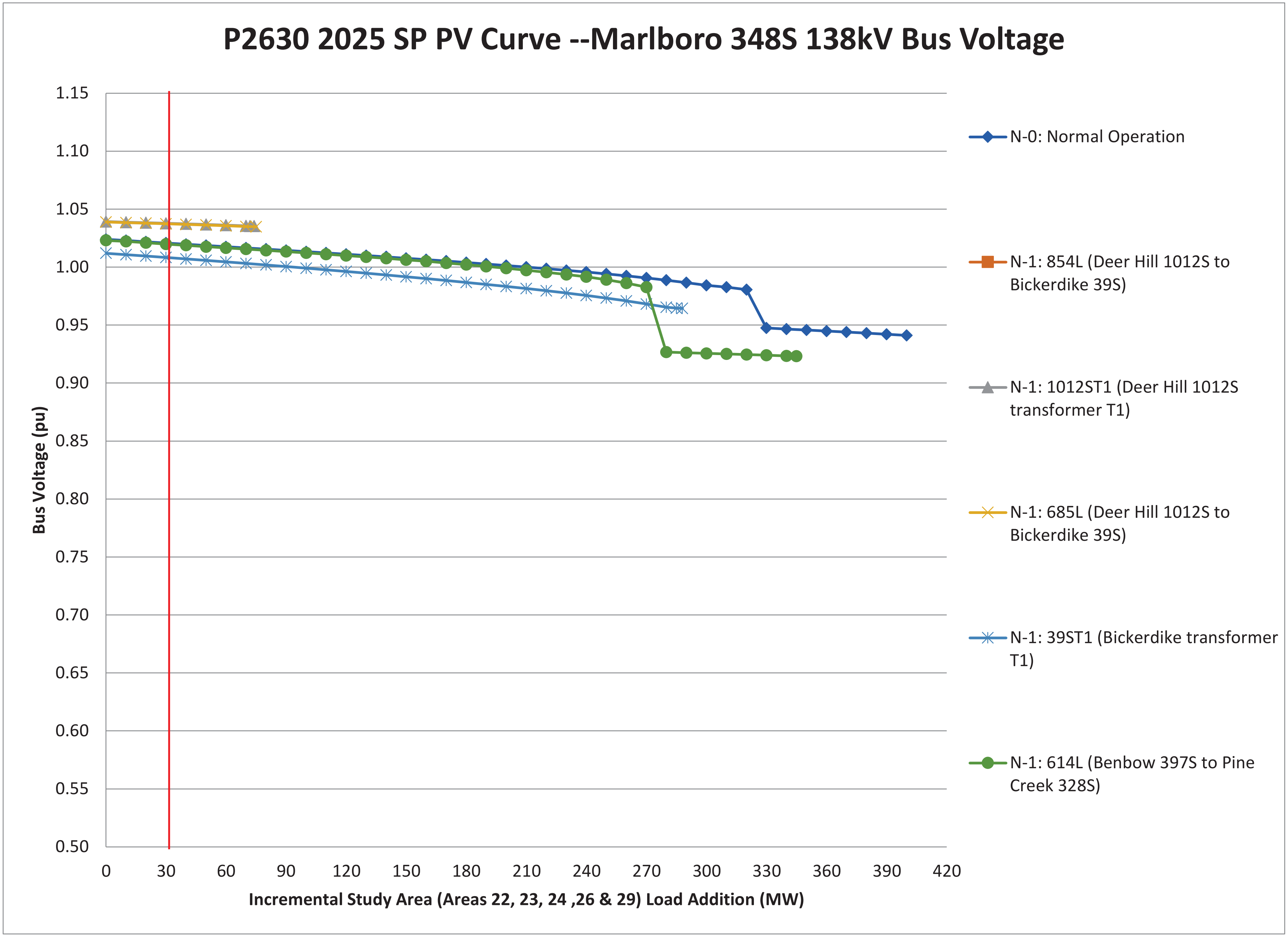
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000

Attachment C: Post-Project Voltage Stability Diagrams (Scenarios 3 and 4)

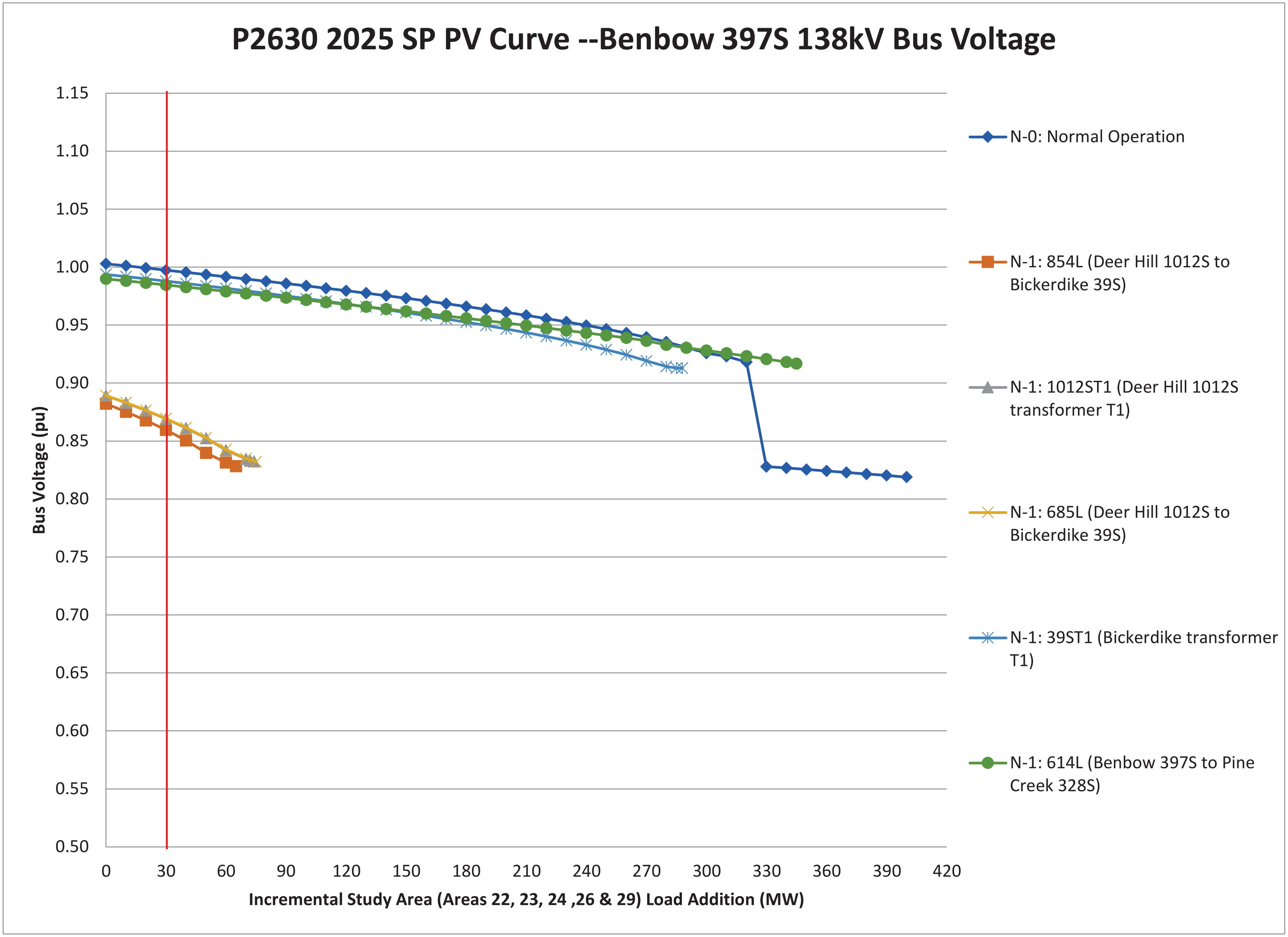

P2630 2025 SP PV Curve --Deer Hill 1012S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

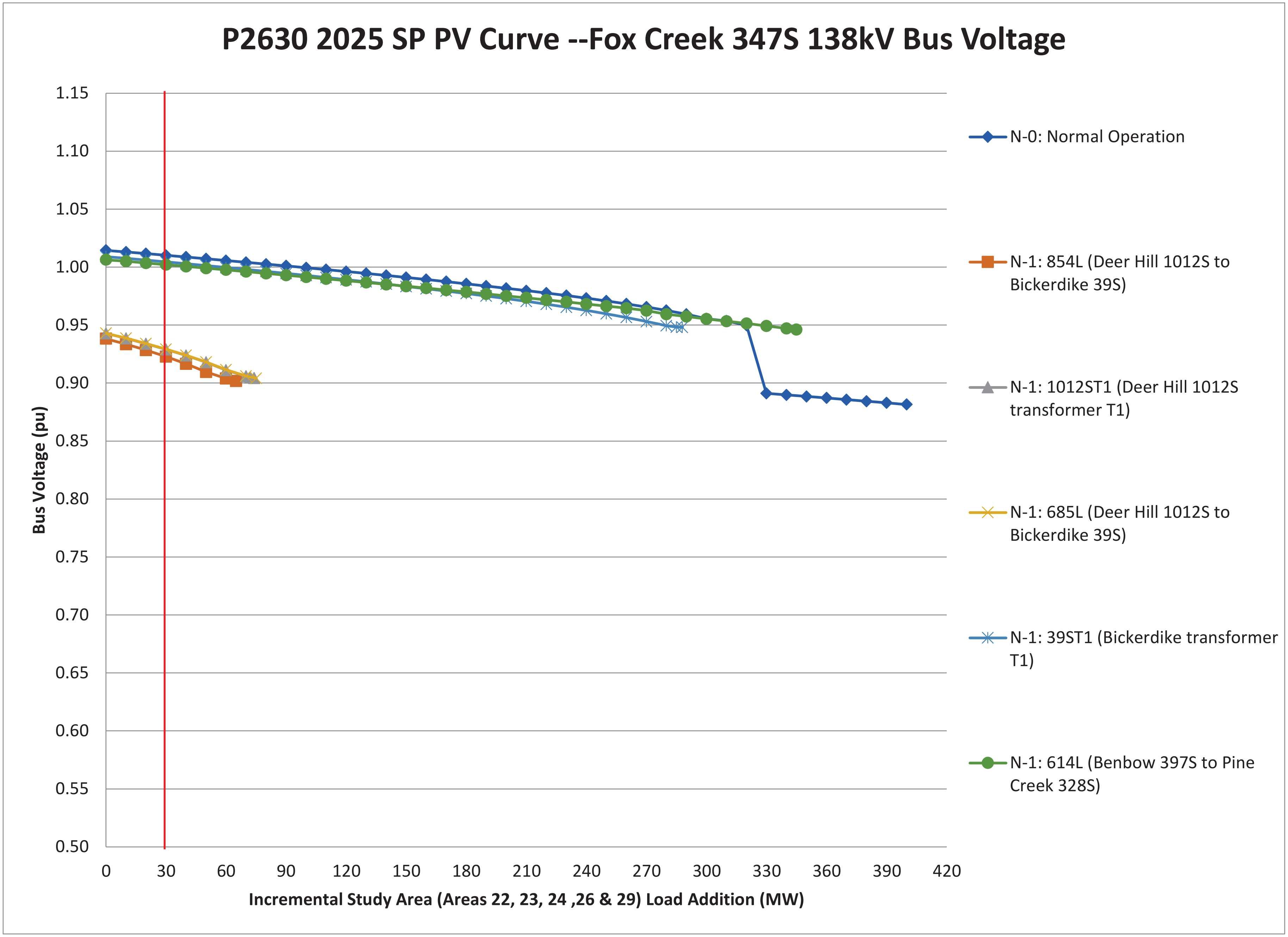

P2630 2025 SP PV Curve --Bickerdike 39S 138kV Bus Voltage
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
Bus Voltage (pu)
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

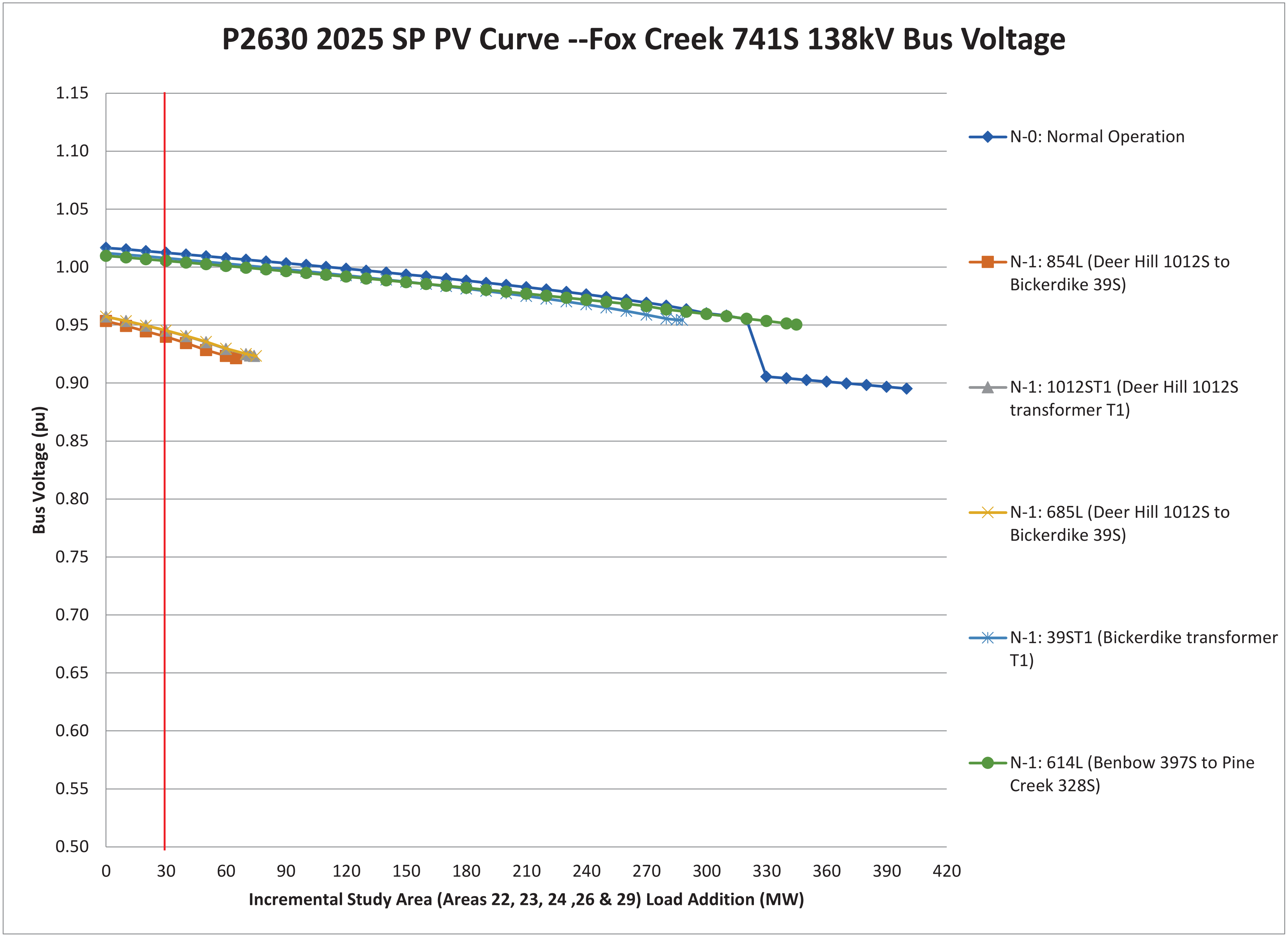

P2630 2025 SP PV Curve --Bickerdike 39S 240kV Bus Voltage
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
Bus Voltage (pu)
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

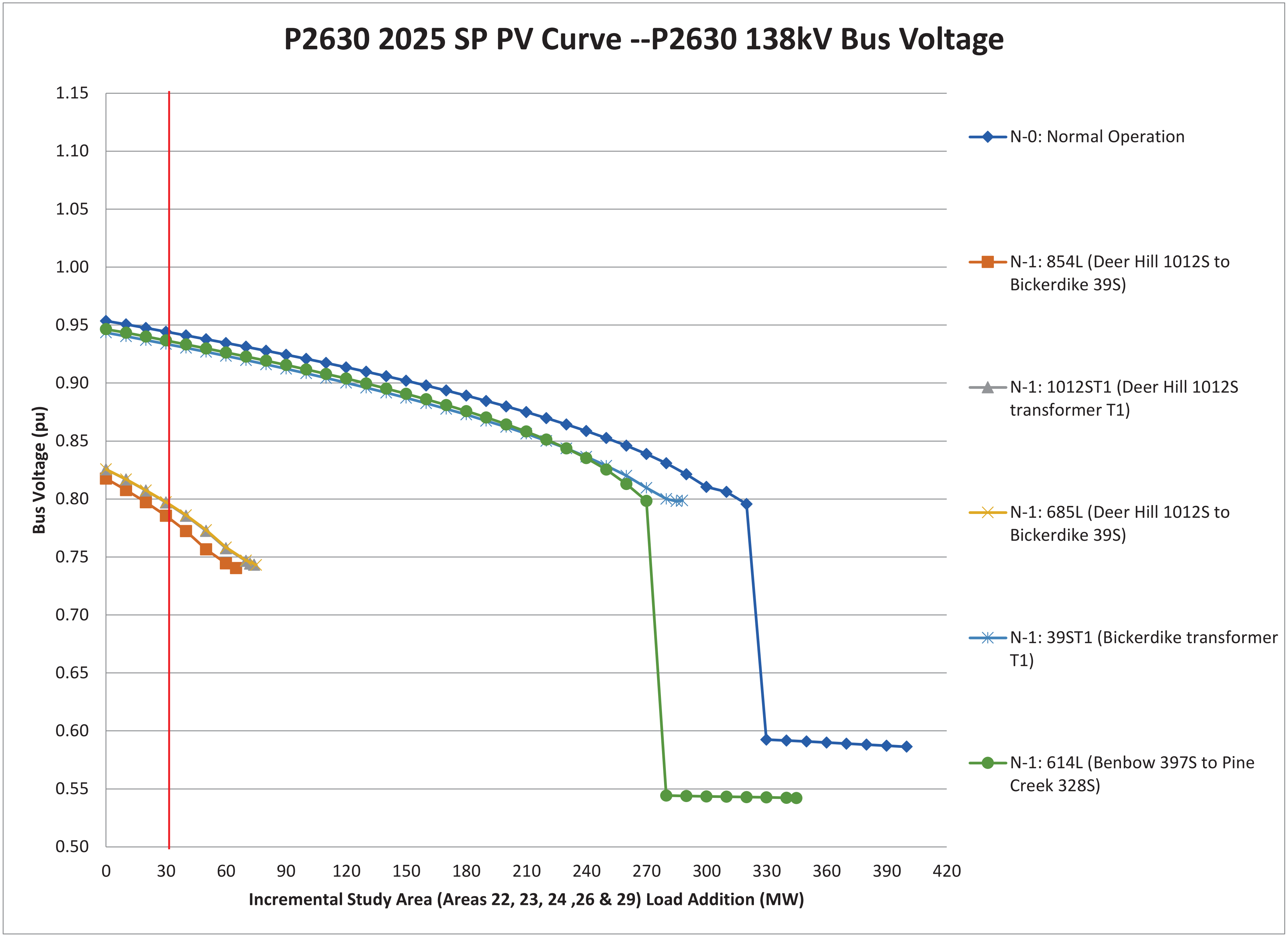


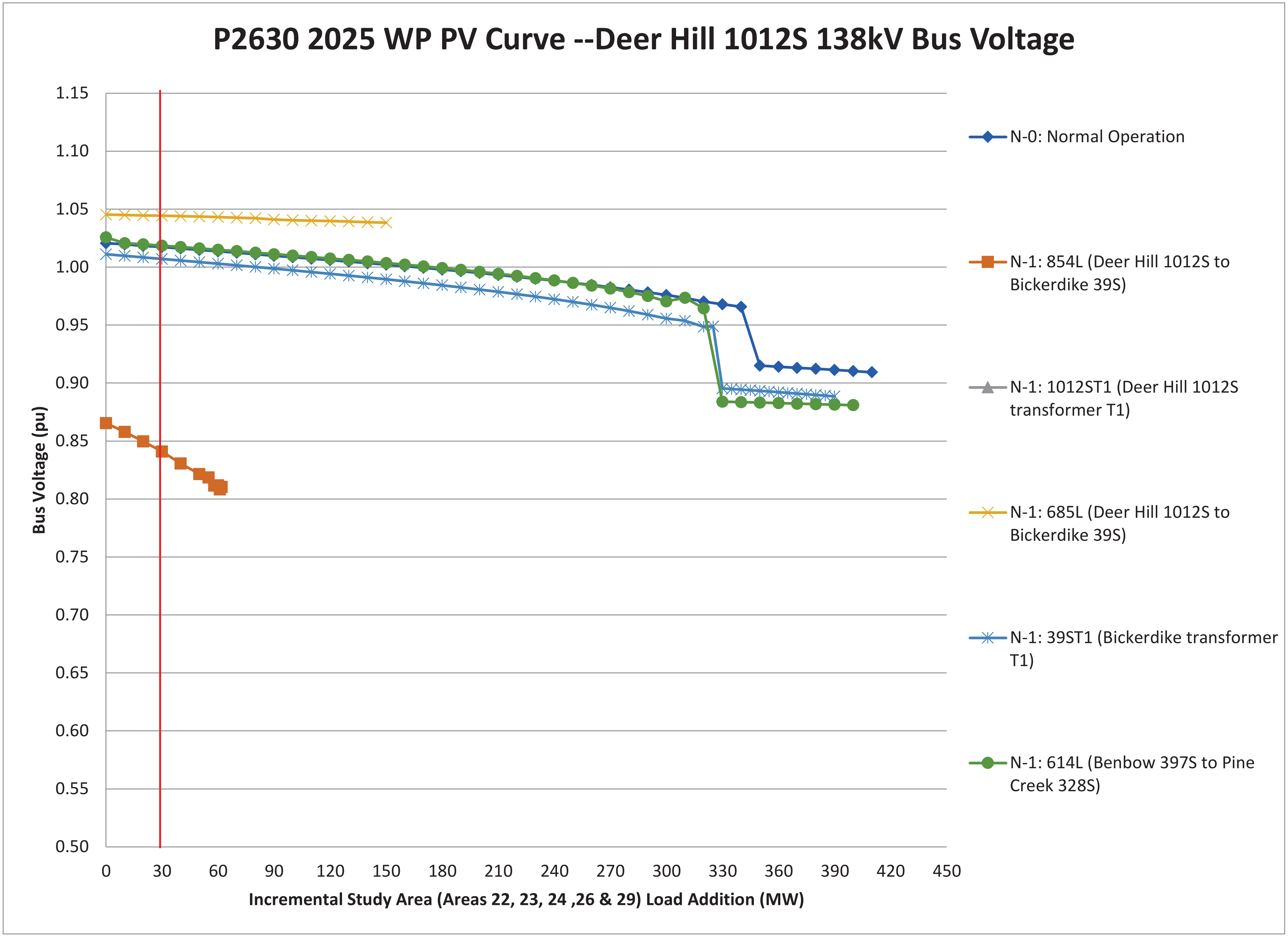
P2630 2025 SP PV Curve --Marlboro 348S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 SP PV Curve --Benbow 397S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

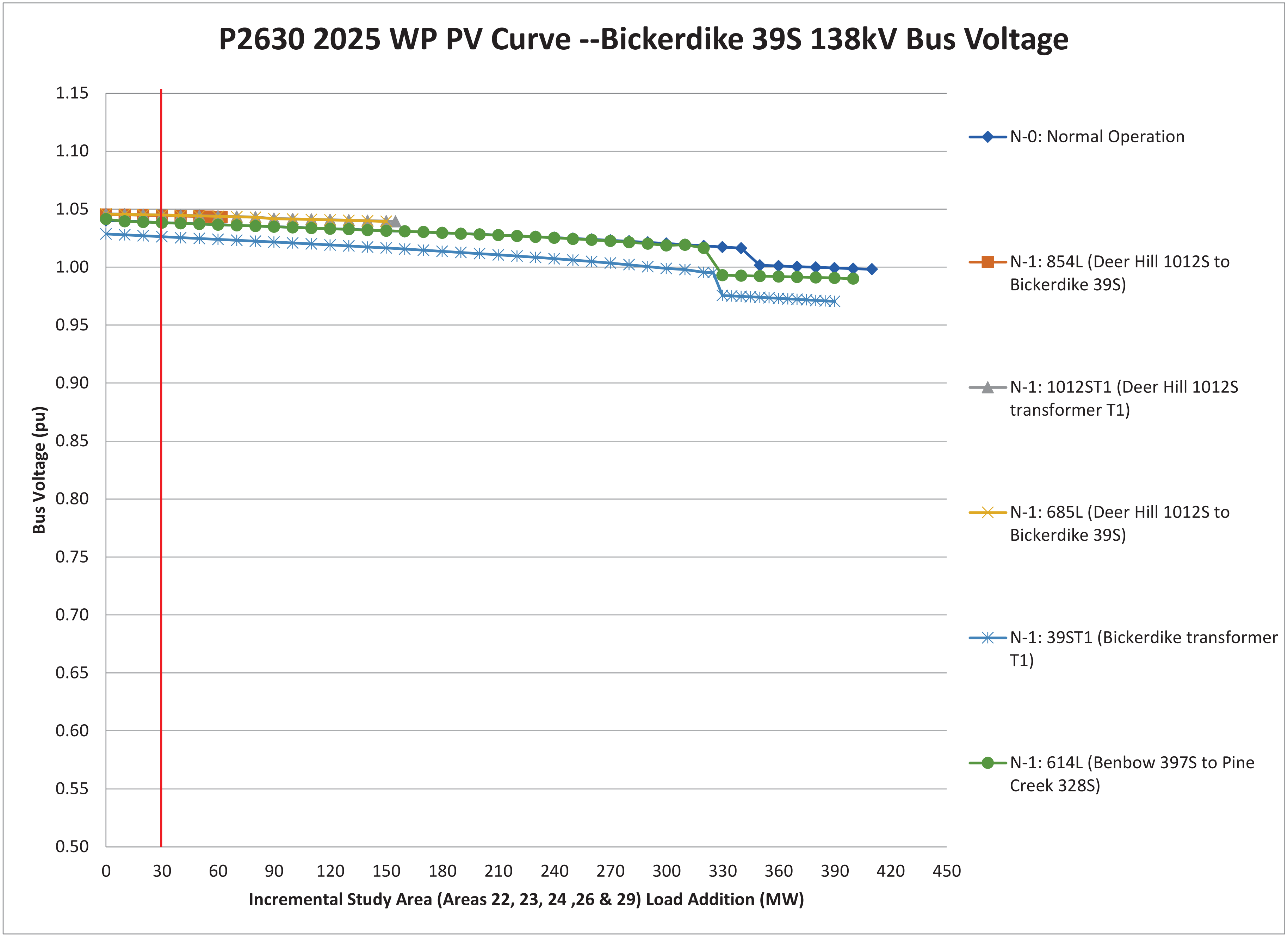

P2630 2025 SP PV Curve --Fox Creek 347S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

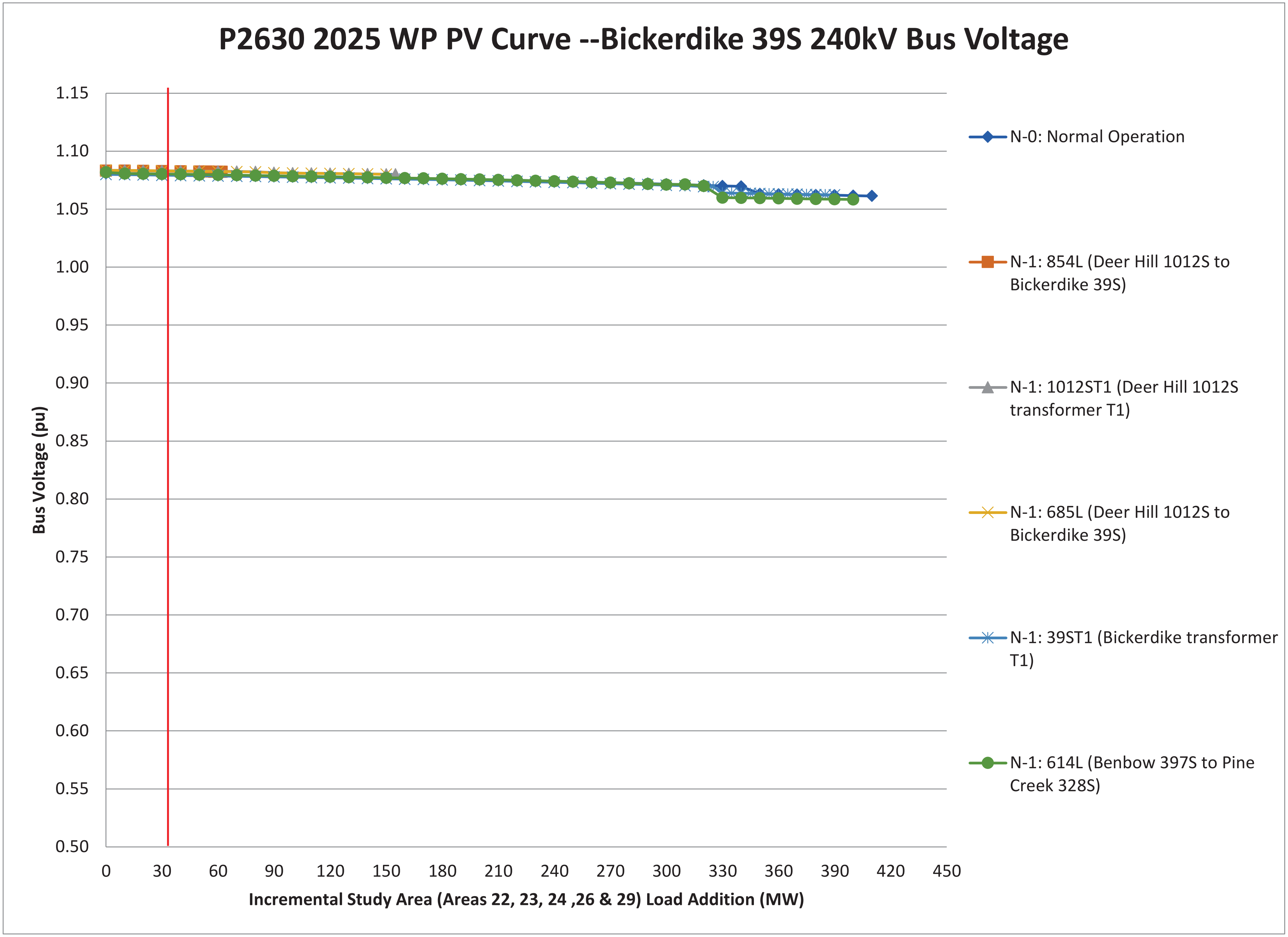

P2630 2025 SP PV Curve --Fox Creek 741S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 SP PV Curve --P2630 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

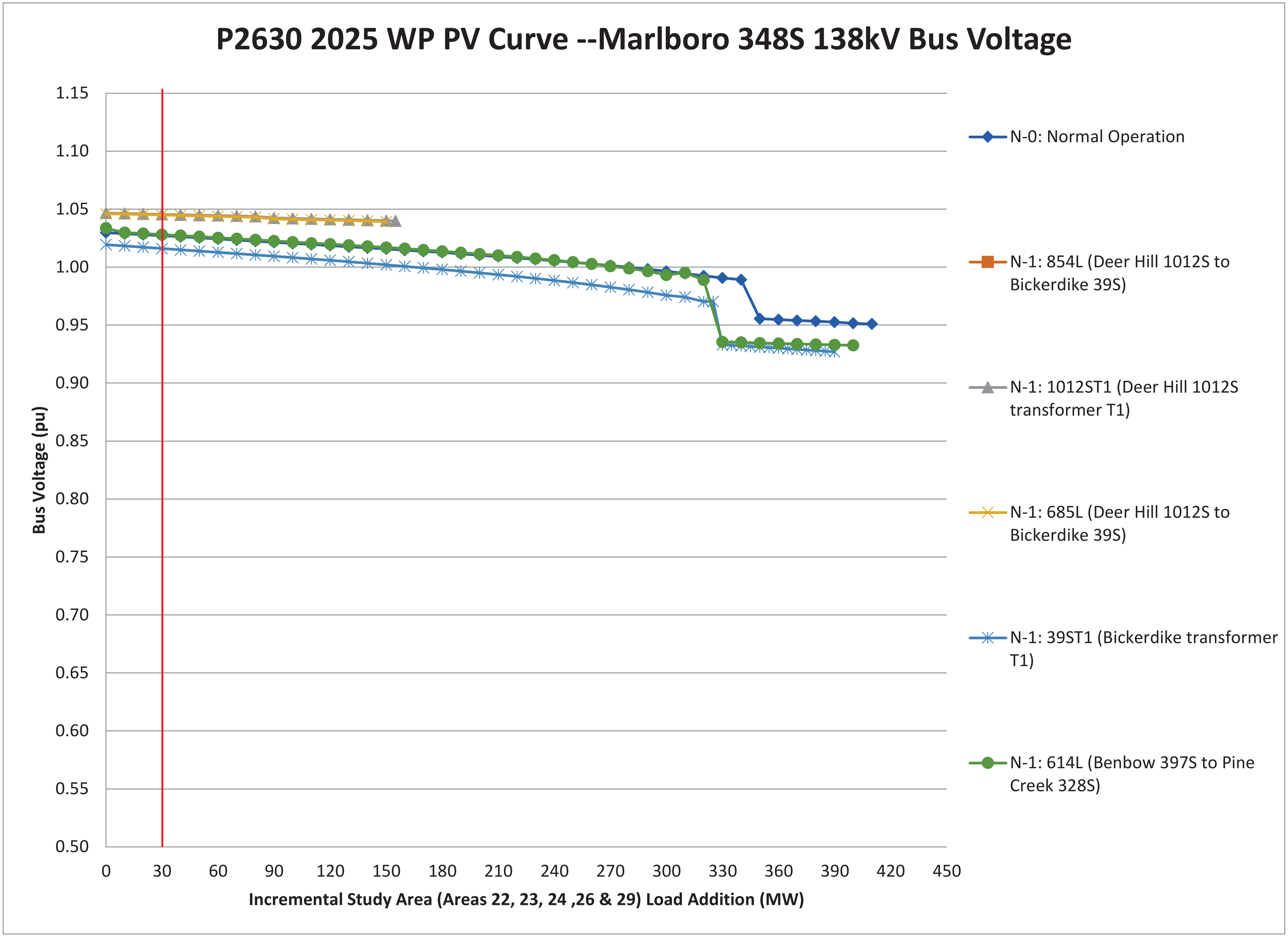


P2630 2025 WP PV Curve --Deer Hill 1012S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

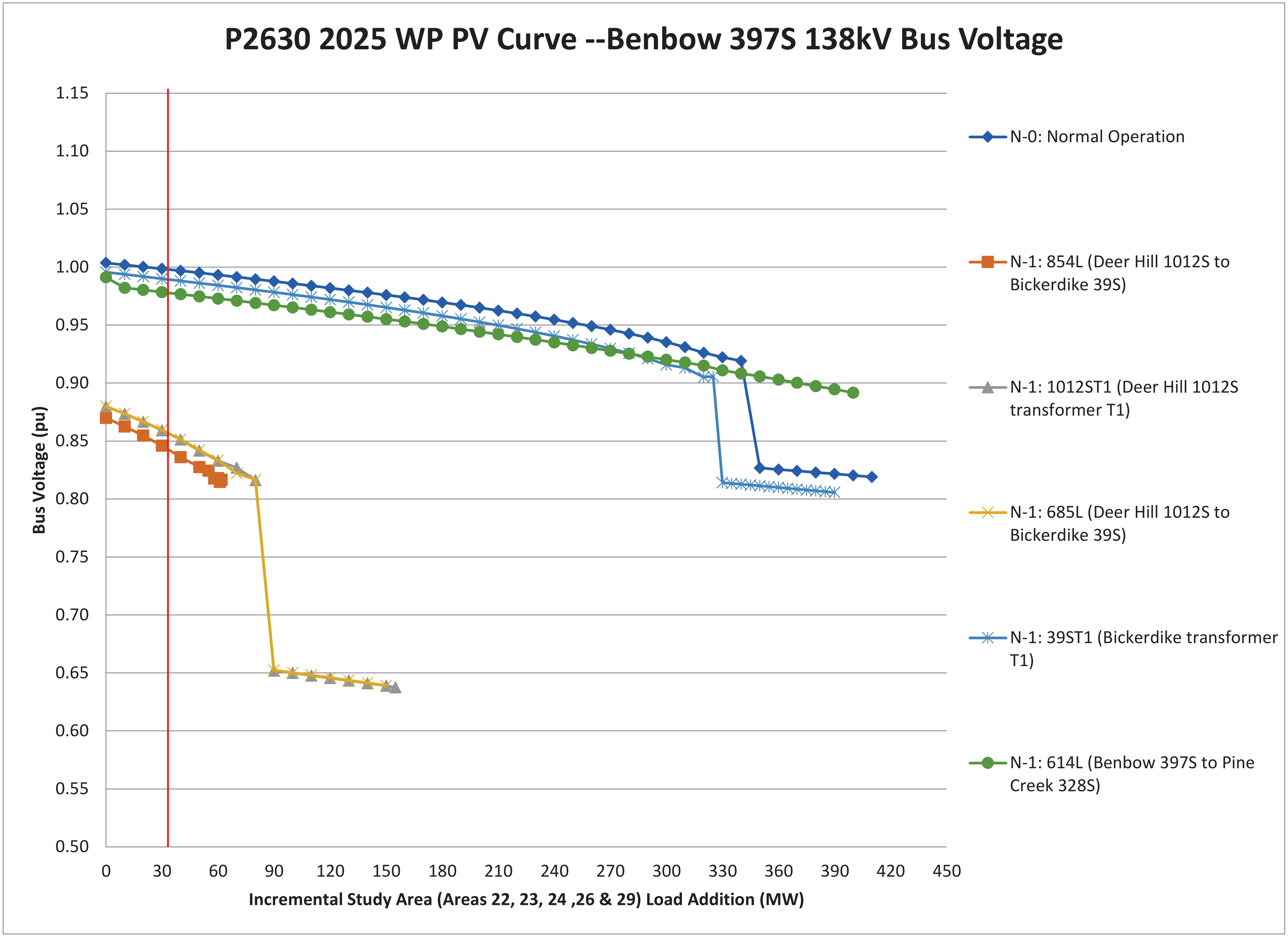

P2630 2025 WP PV Curve --Bickerdike 39S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

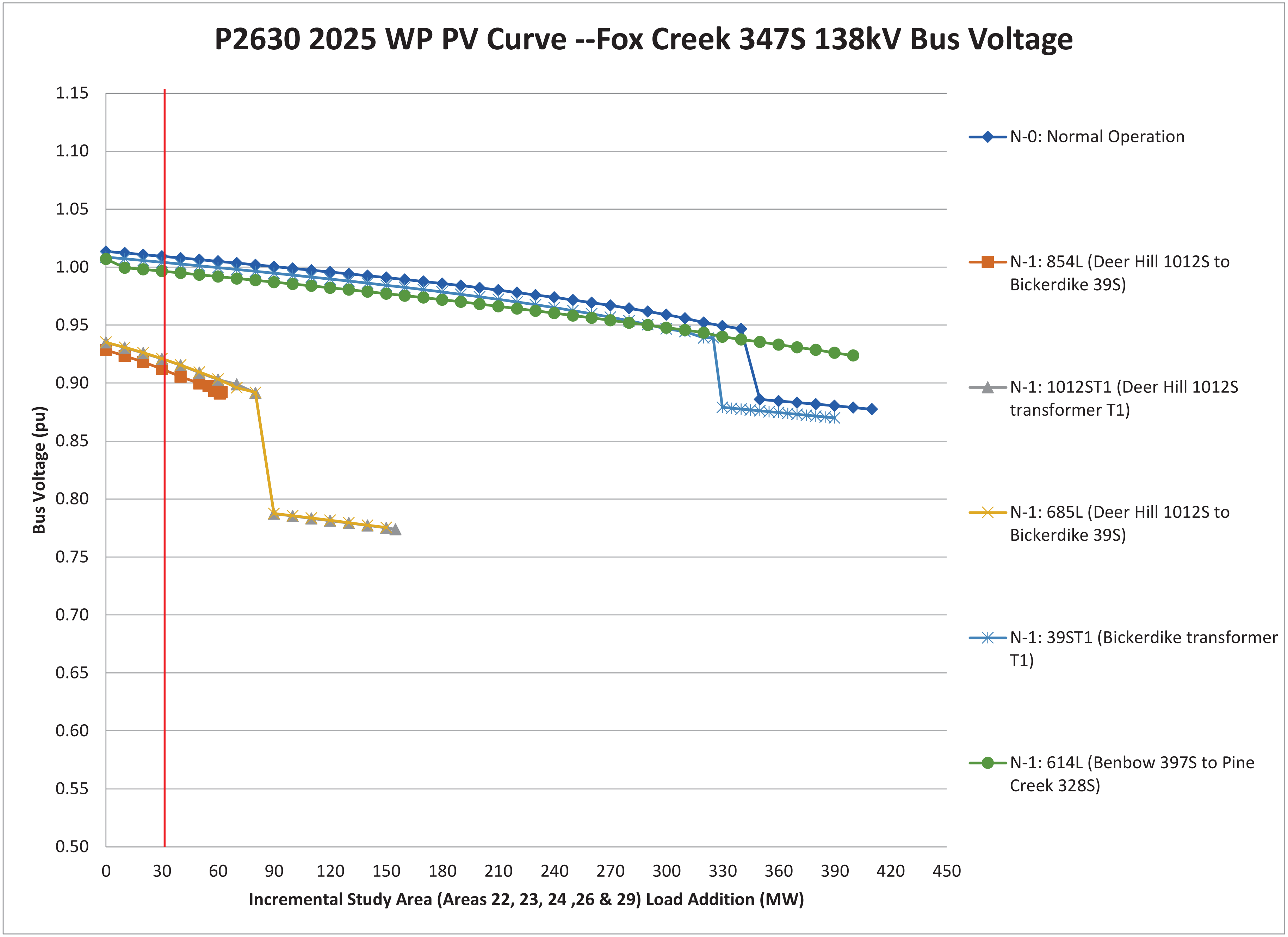


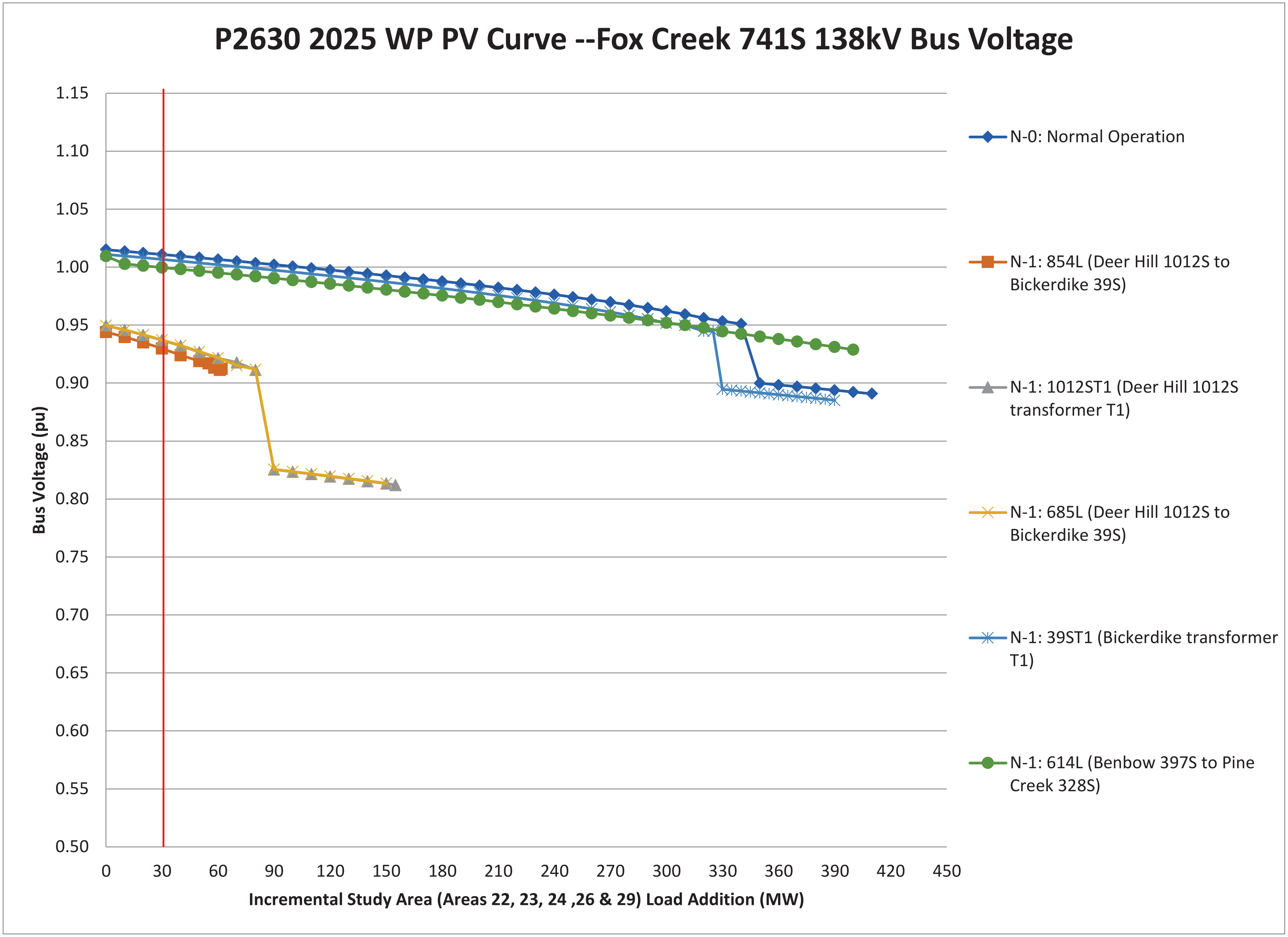
P2630 2025 WP PV Curve --Bickerdike 39S 240kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

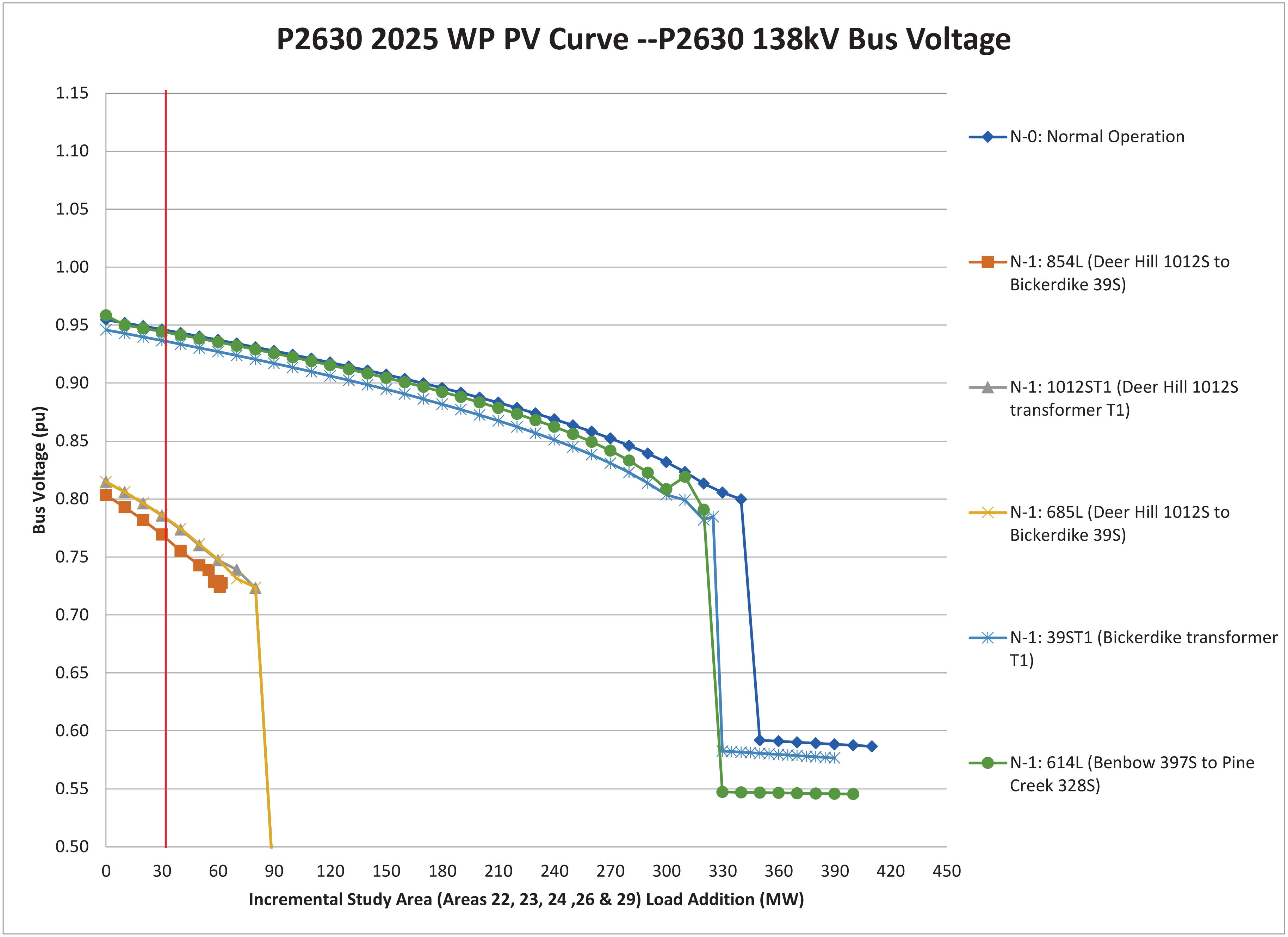


P2630 2025 WP PV Curve --Marlboro 348S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

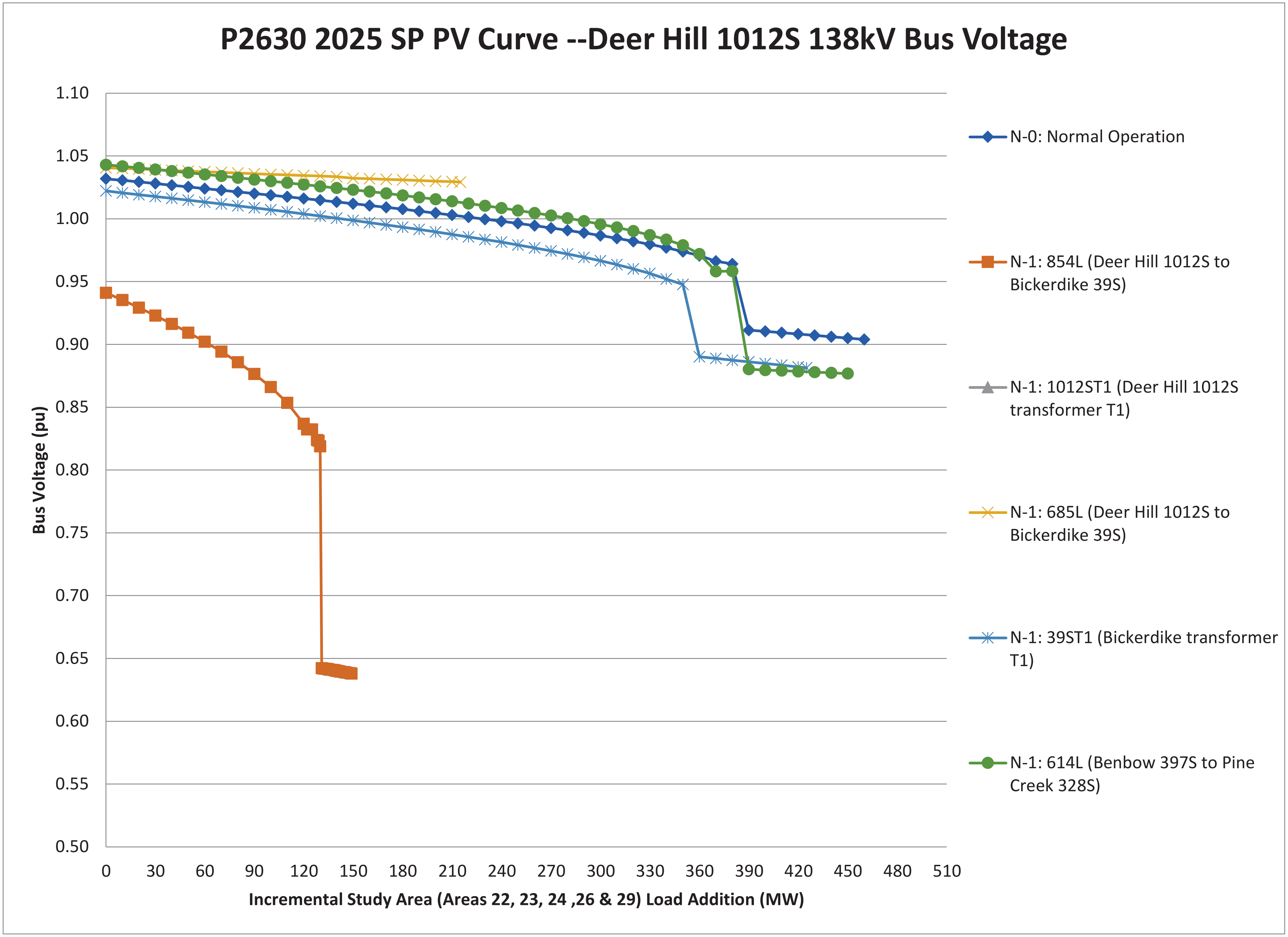

P2630 2025 WP PV Curve --Benbow 397S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --Fox Creek 347S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

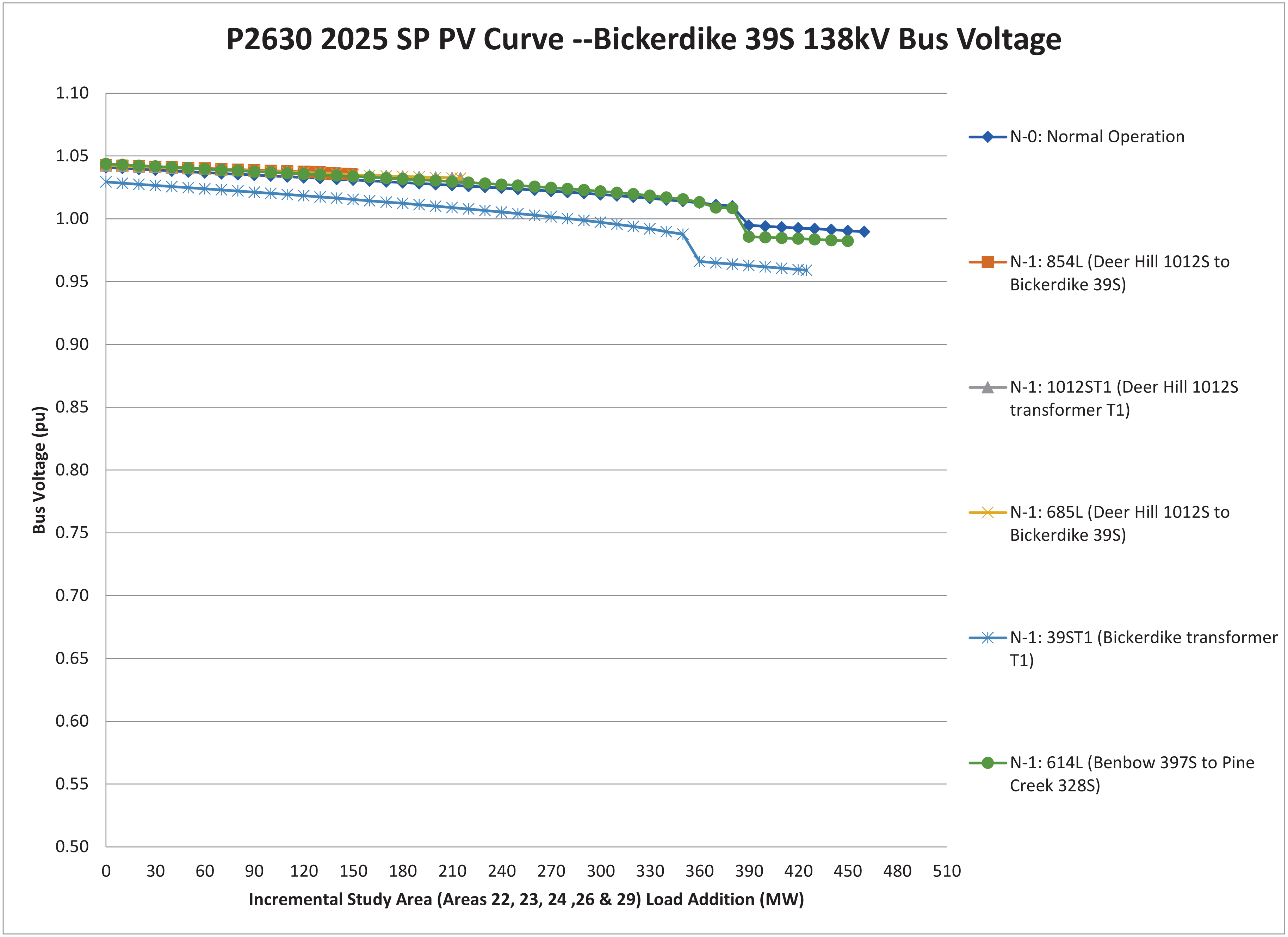

P2630 2025 WP PV Curve --Fox Creek 741S 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --P2630 138kV Bus Voltage
Bus Voltage (pu)
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

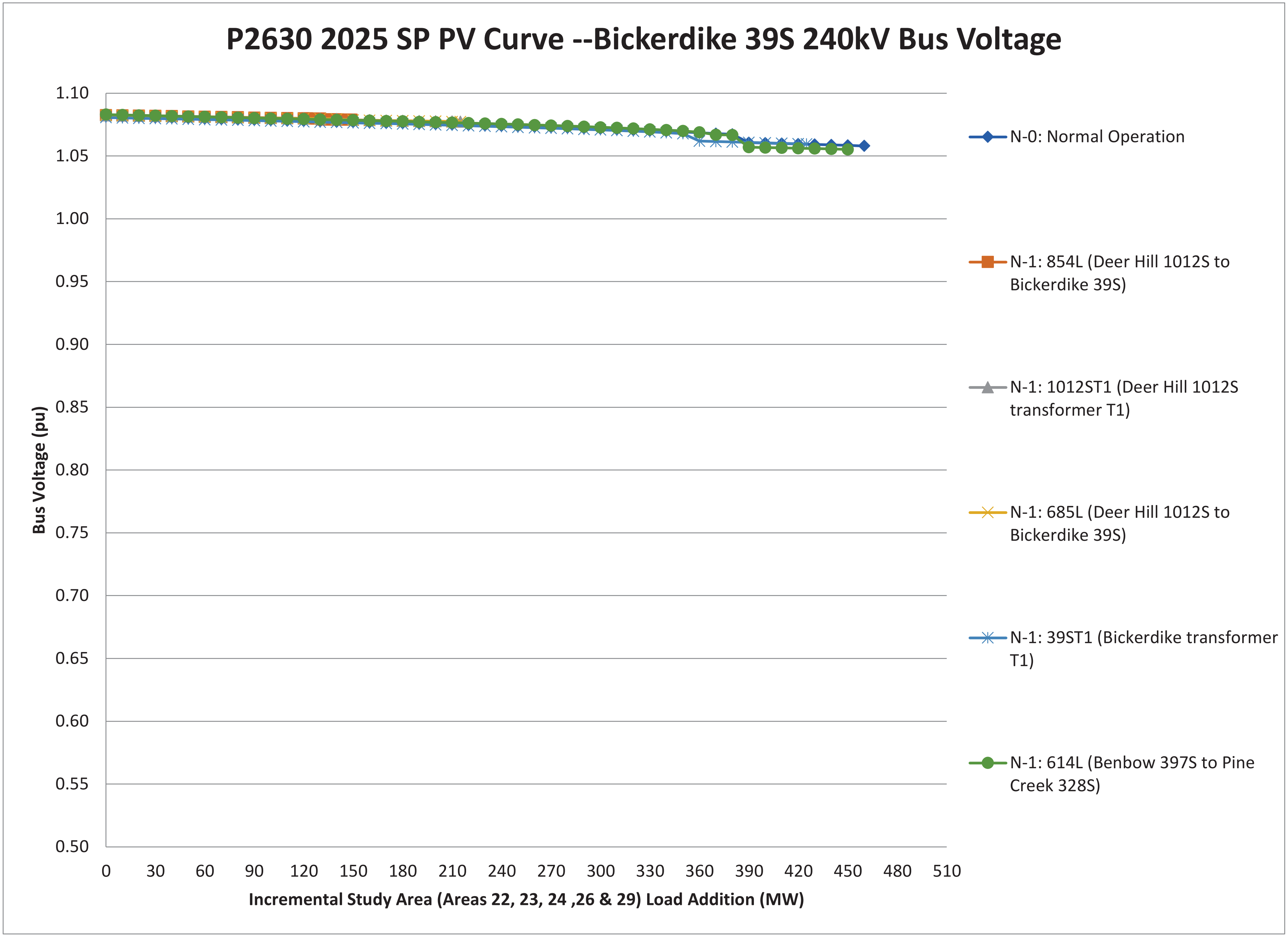
Attachment C-2: Post-Project Voltage Stability Diagrams with Cap Bank (Scenarios 3 and 4)

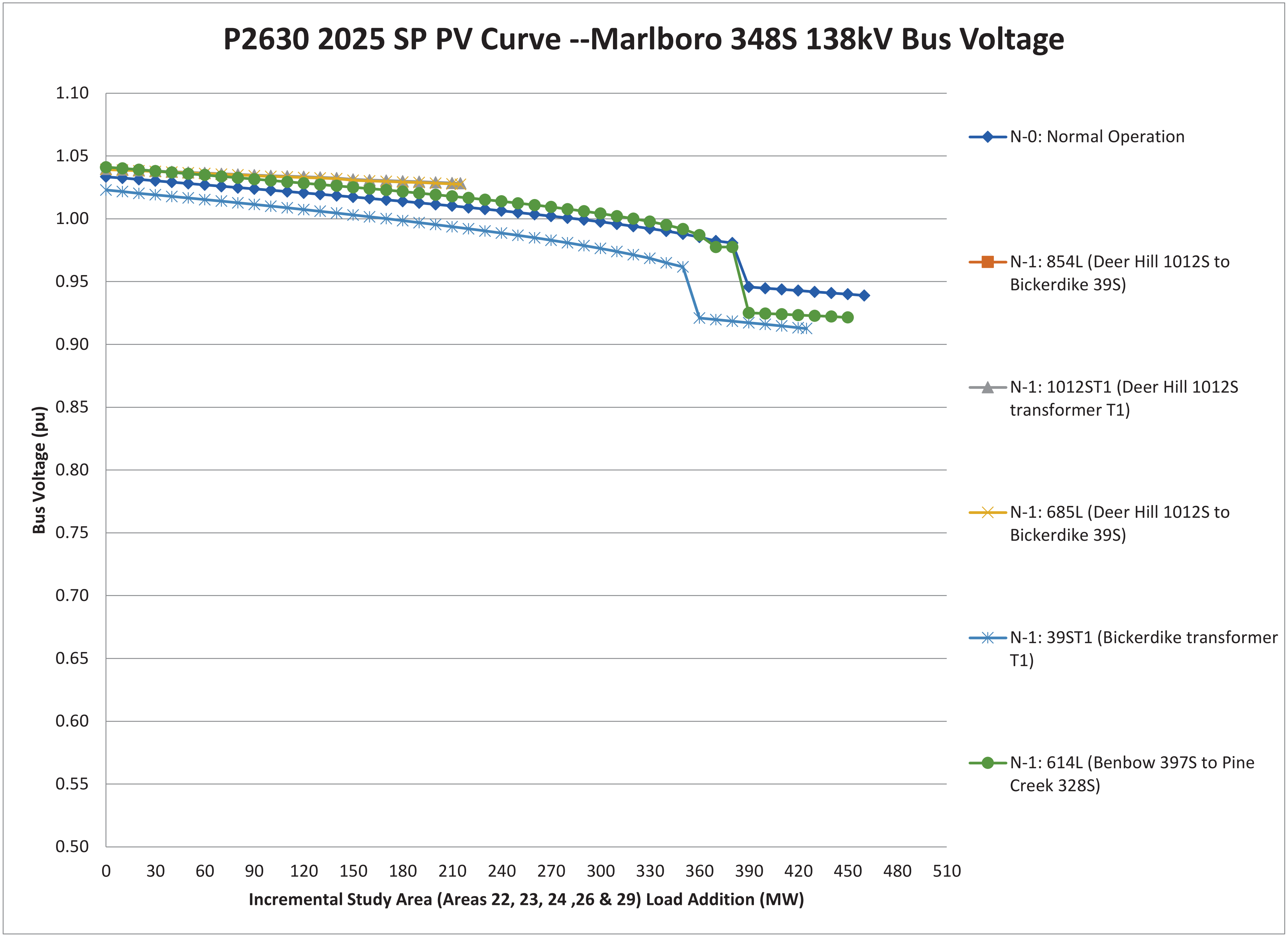


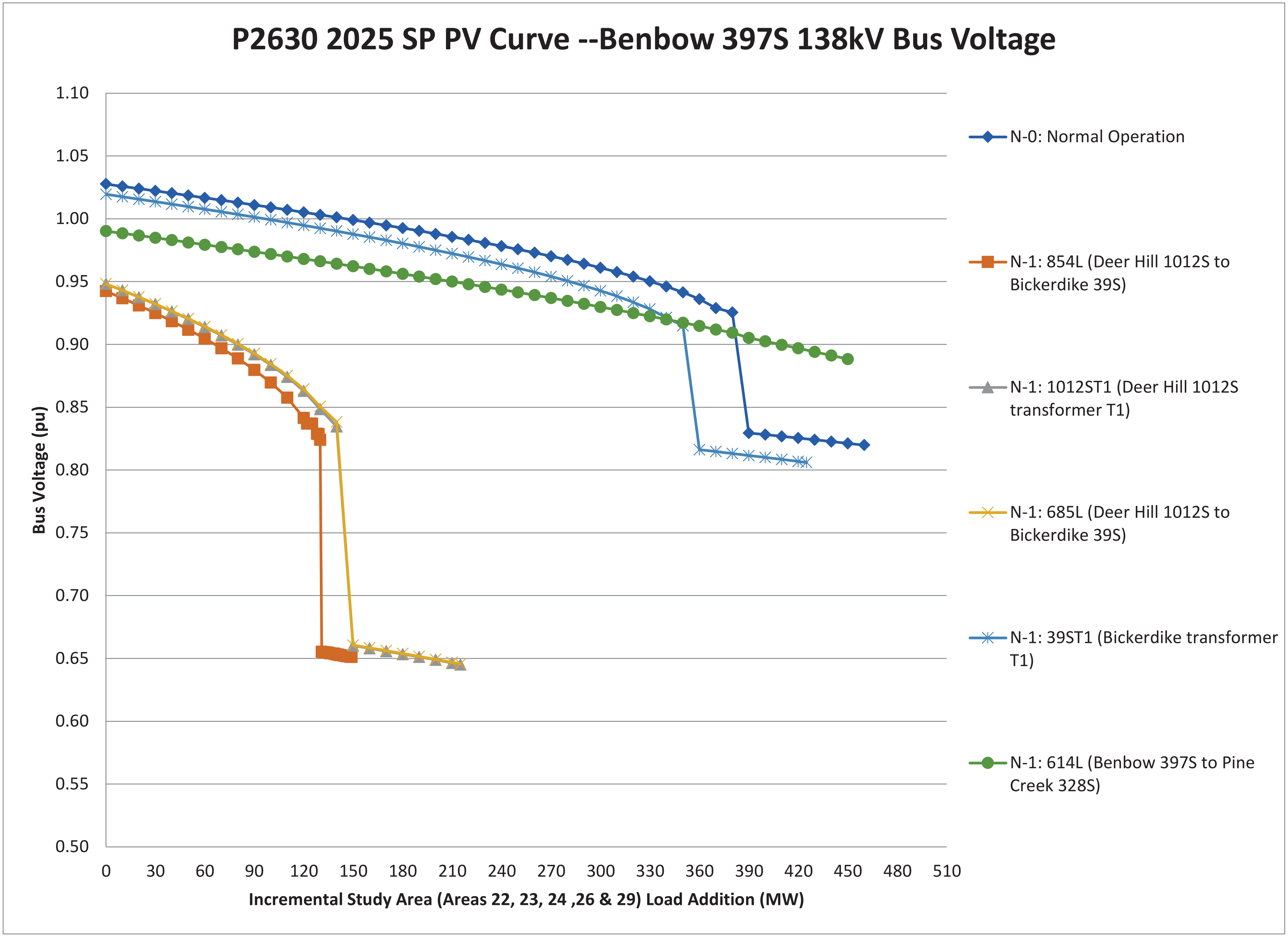
P2630 2025 SP PV Curve --Deer Hill 1012S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)



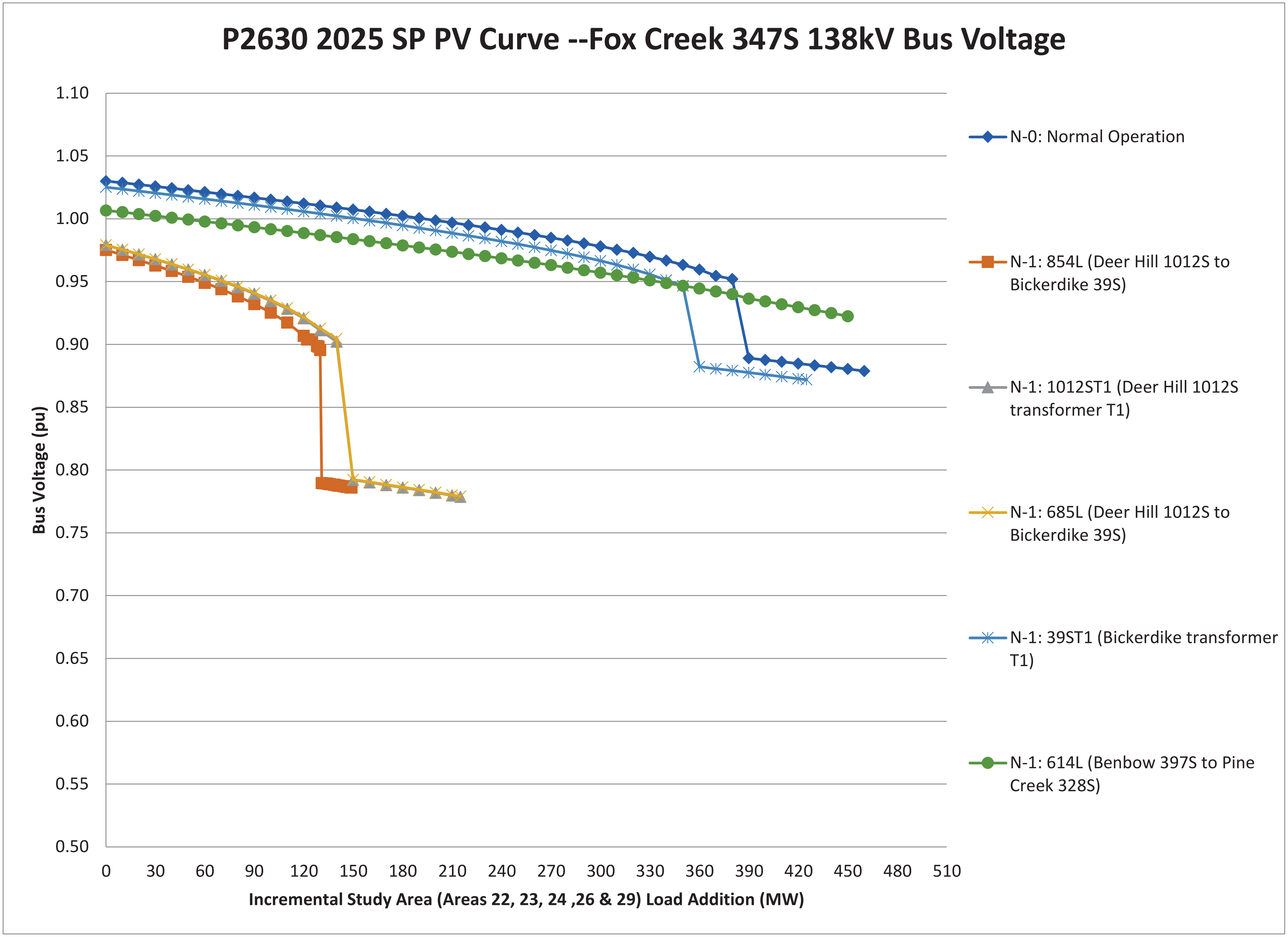
P2630 2025 SP PV Curve --Bickerdike 39S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 SP PV Curve --Bickerdike 39S 240kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

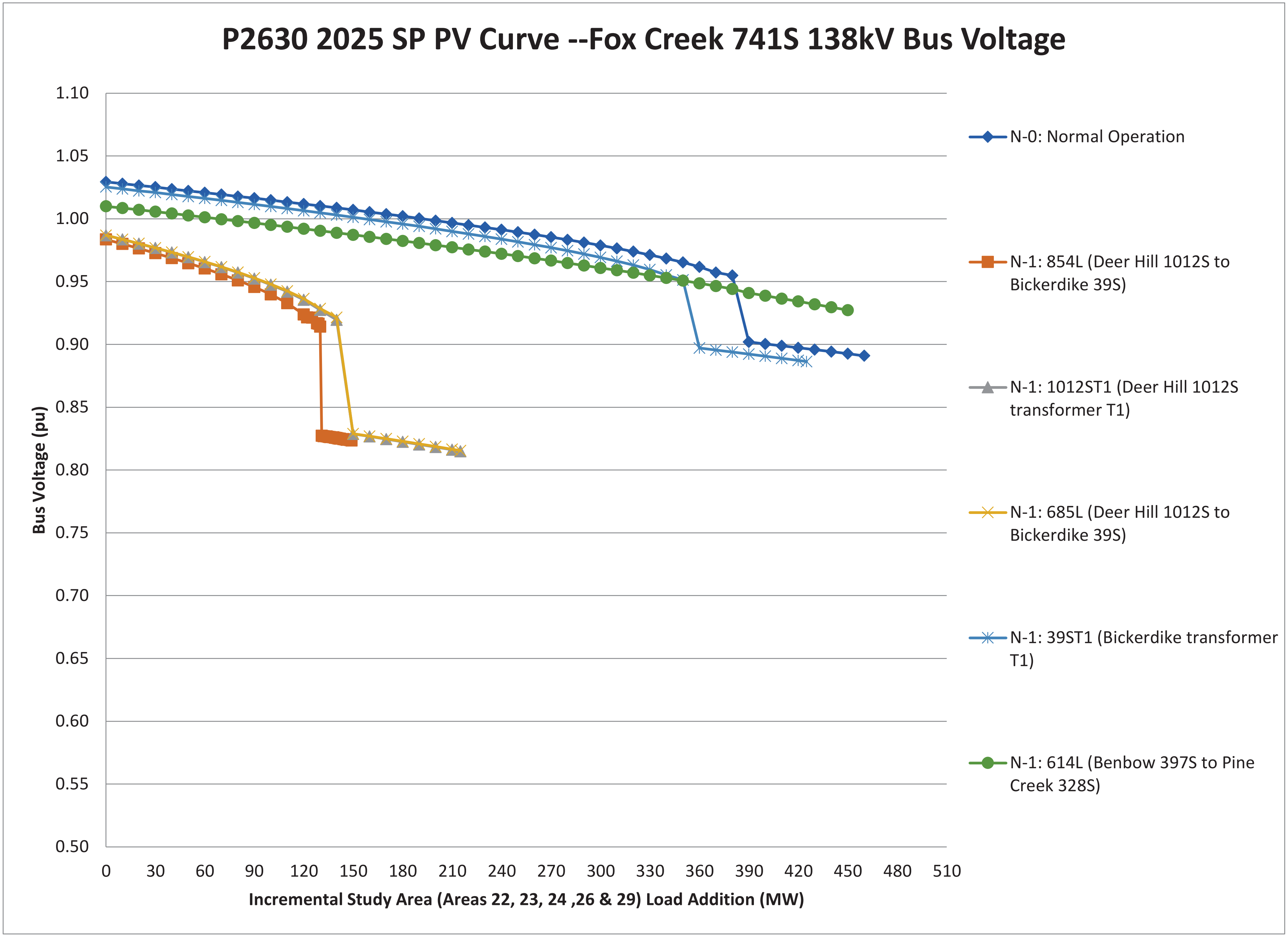

P2630 2025 SP PV Curve --Marlboro 348S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)



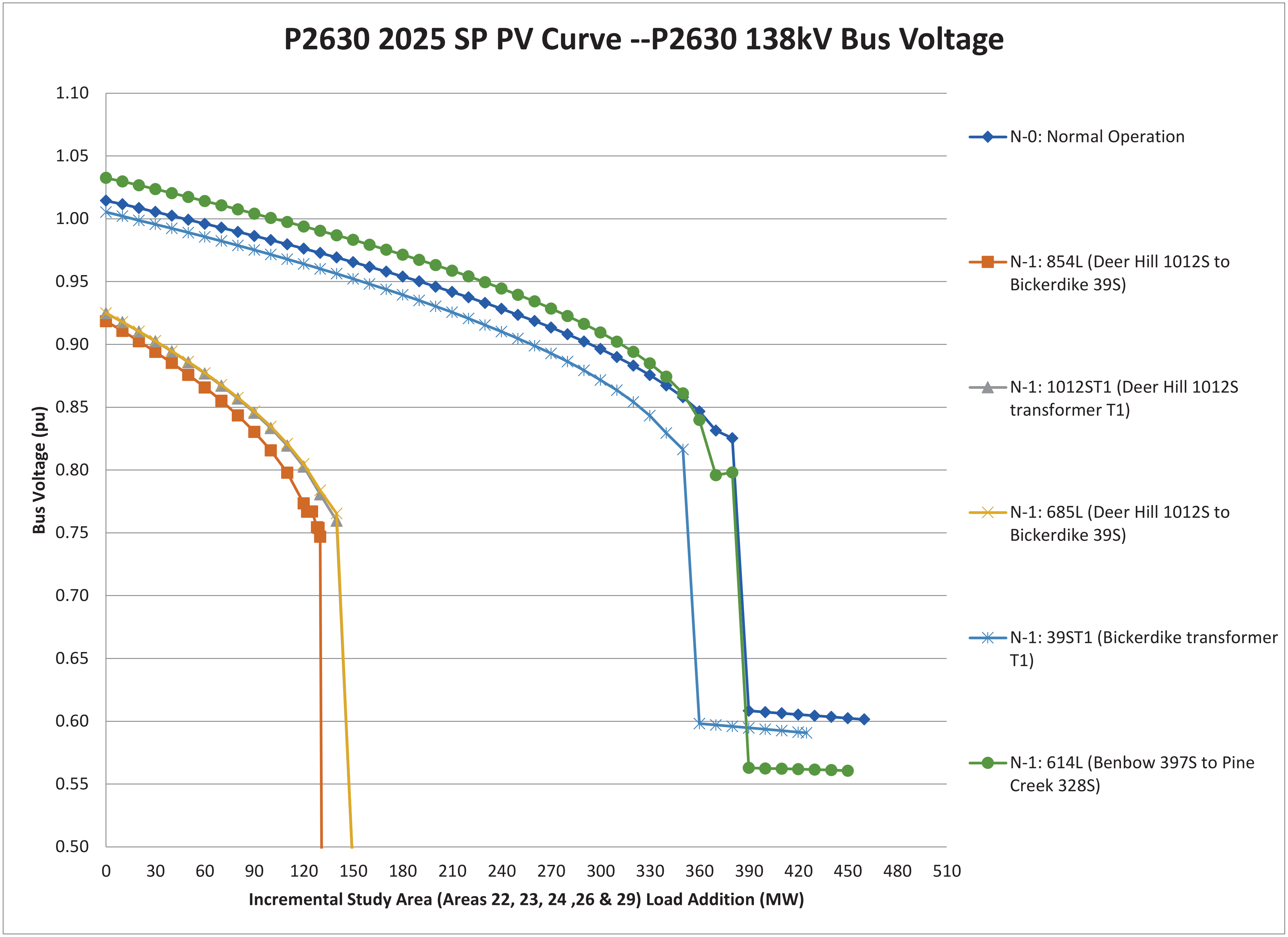
P2630 2025 SP PV Curve --Benbow 397S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)



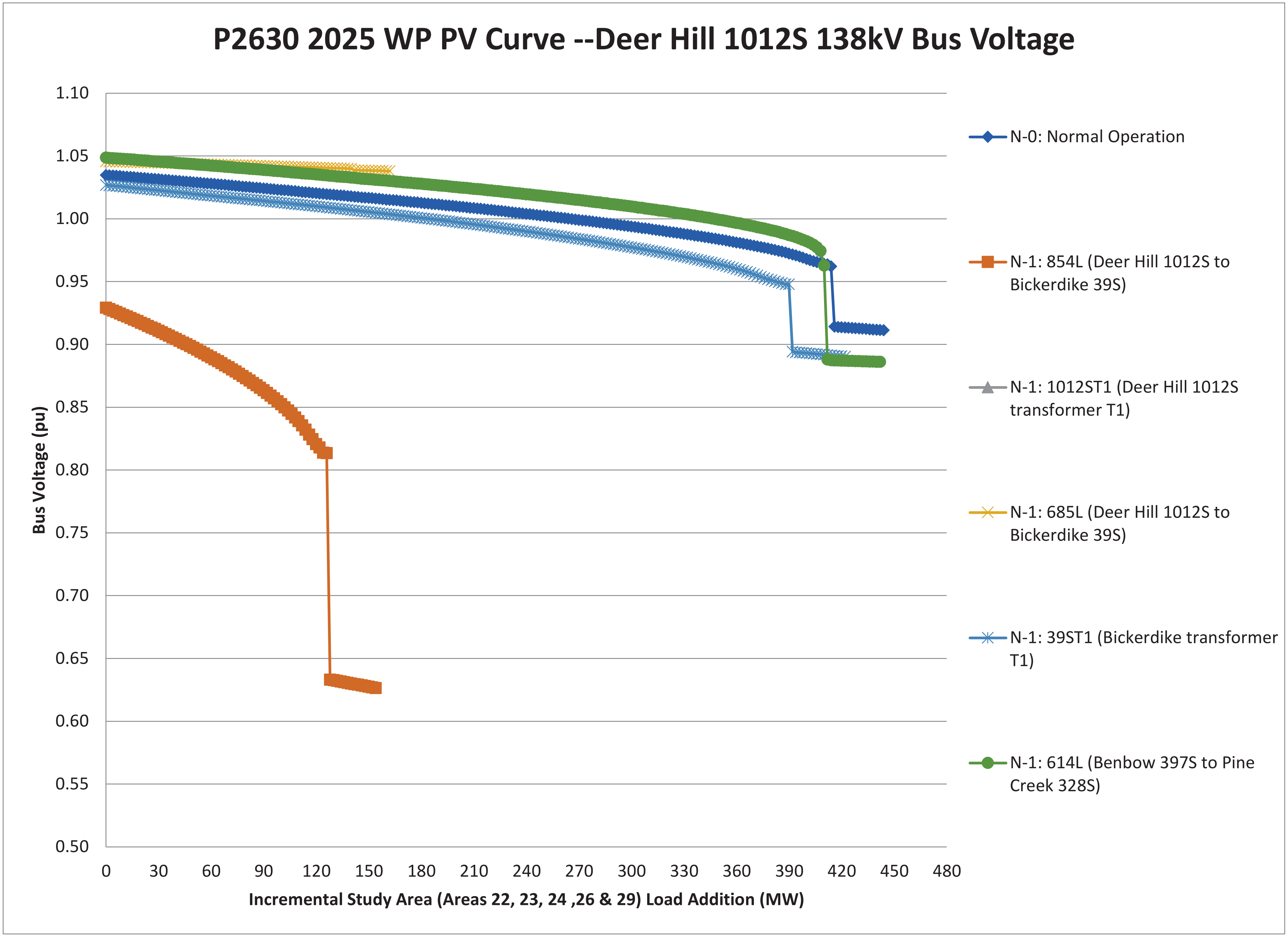
P2630 2025 SP PV Curve --Fox Creek 347S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)



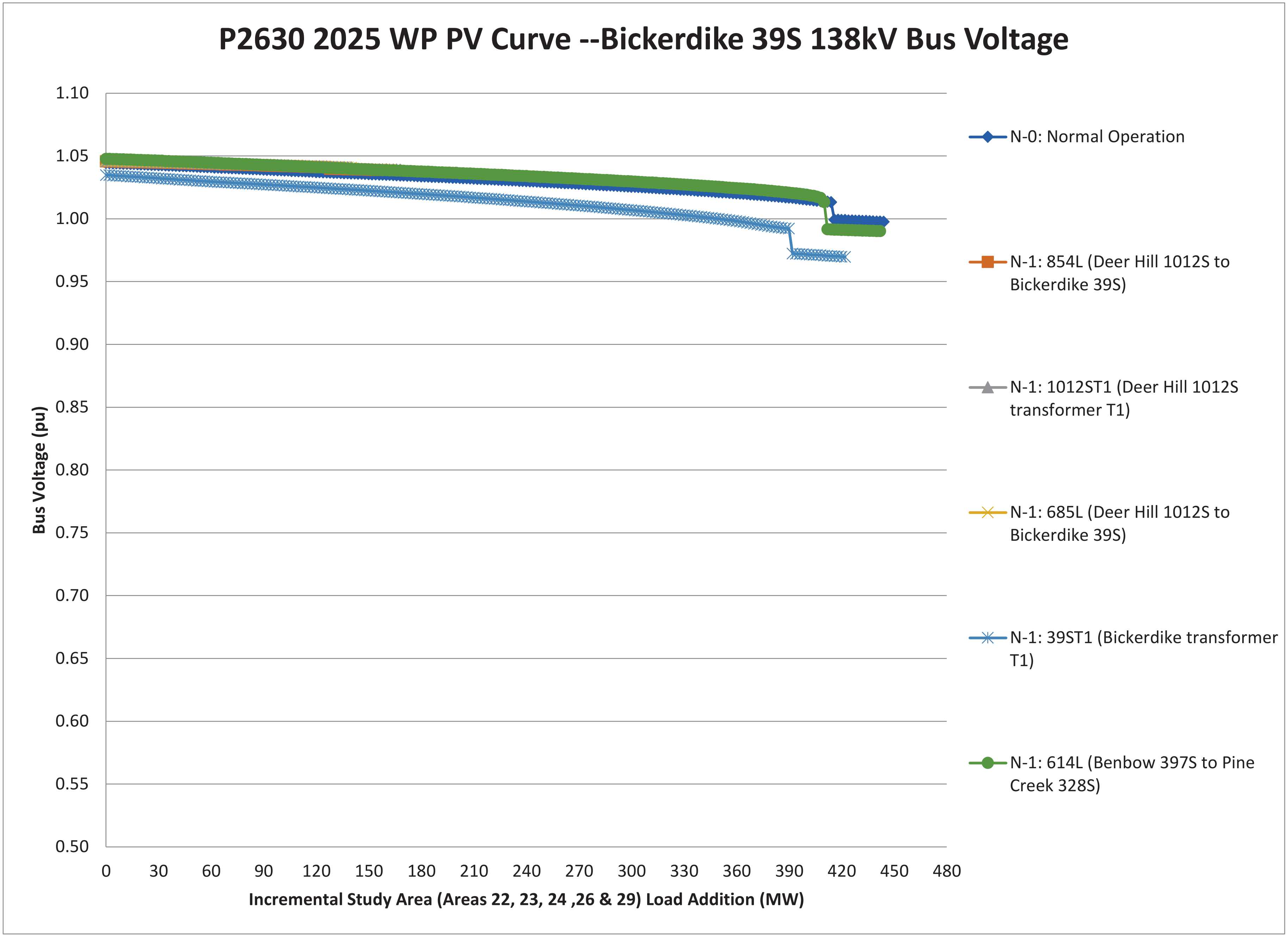
P2630 2025 SP PV Curve --Fox Creek 741S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

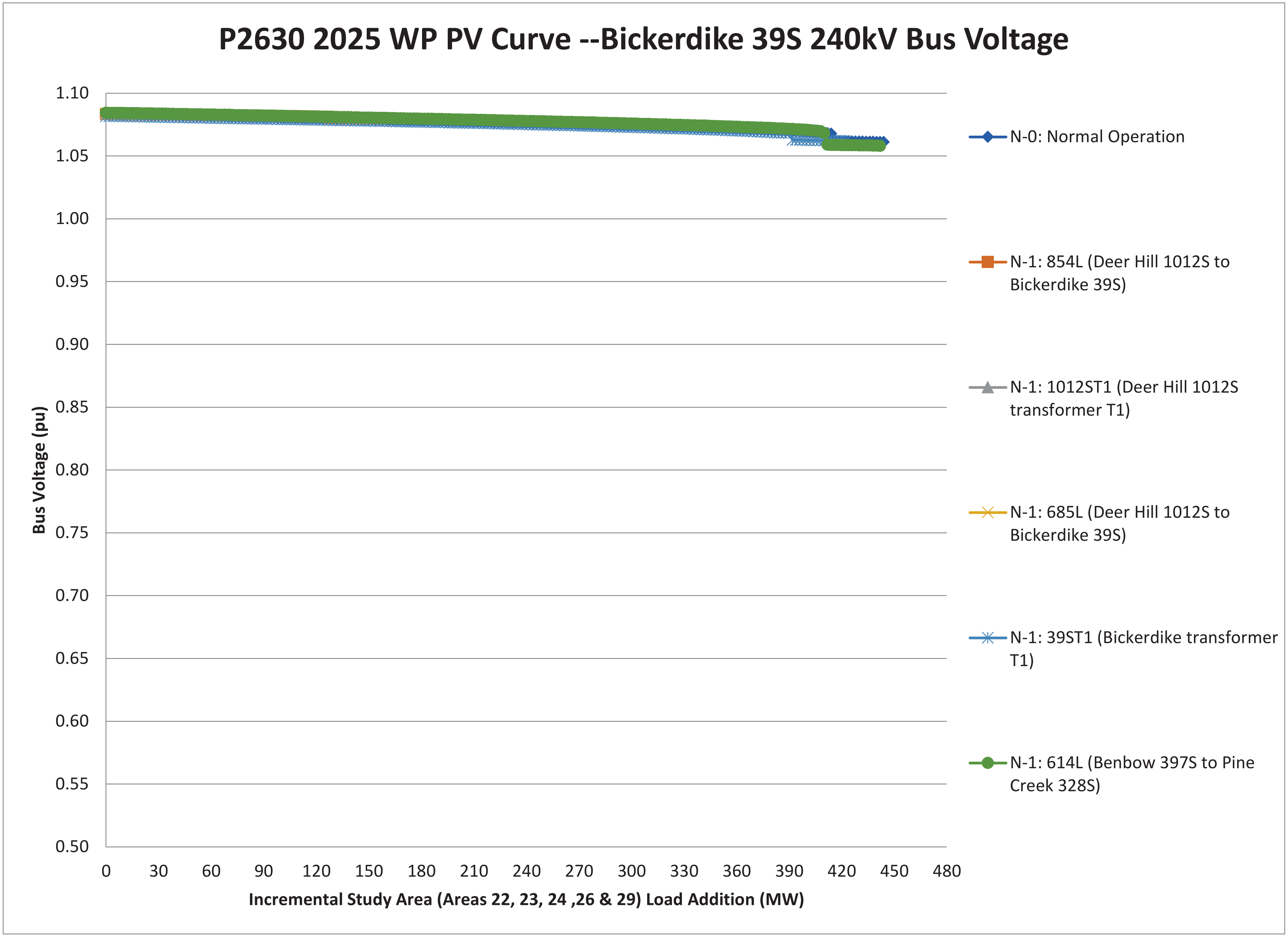


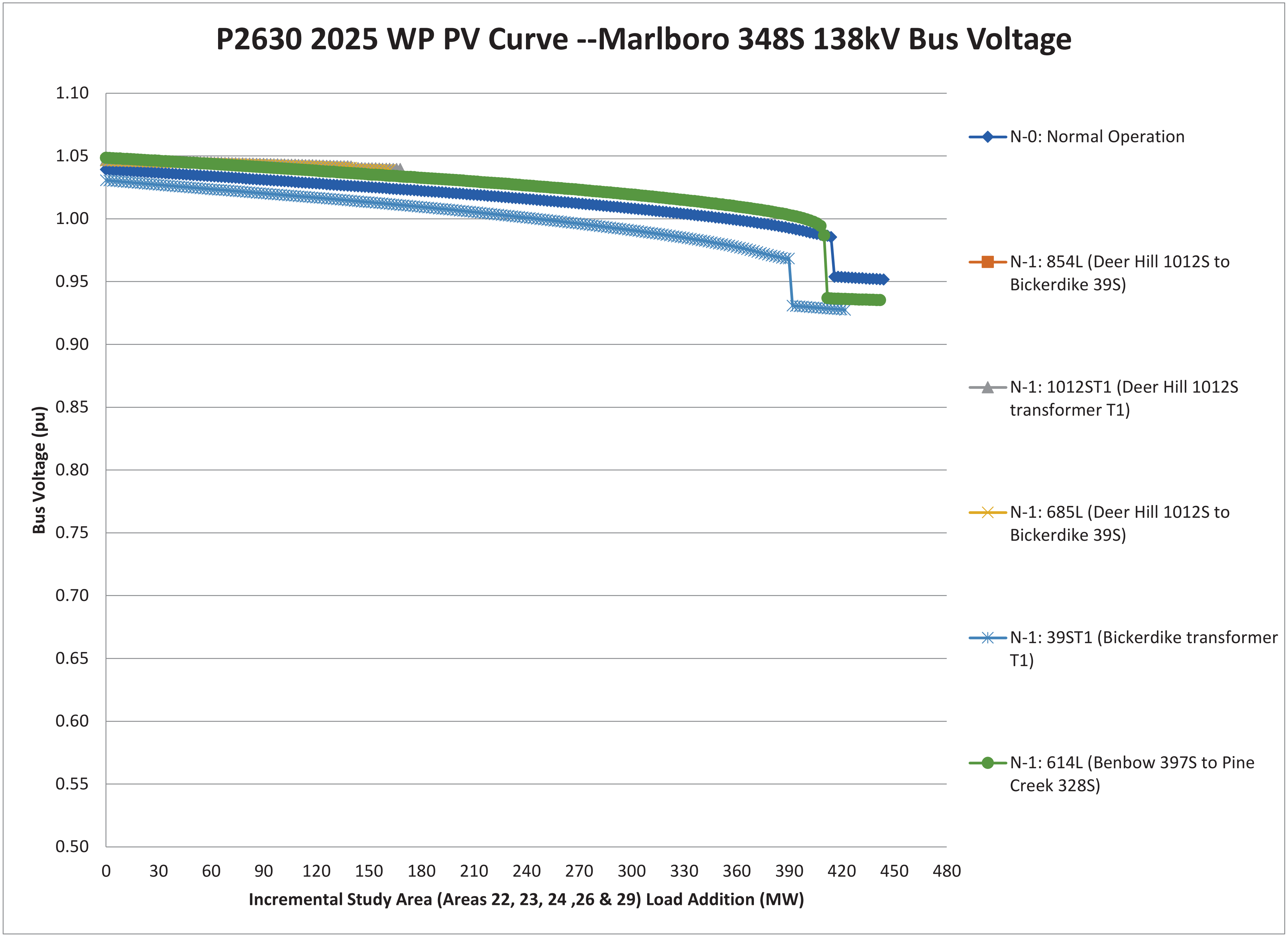
P2630 2025 SP PV Curve --P2630 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

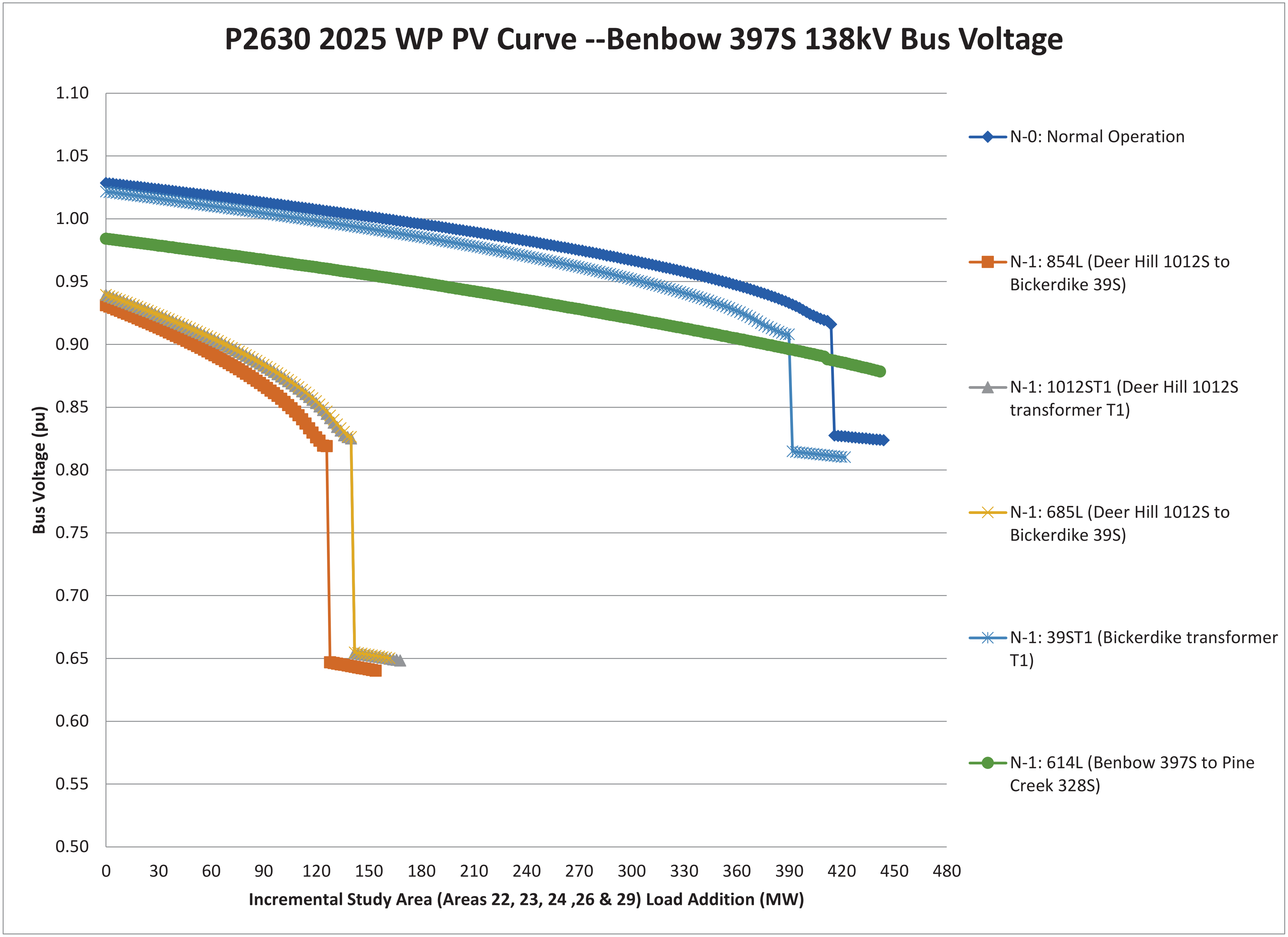


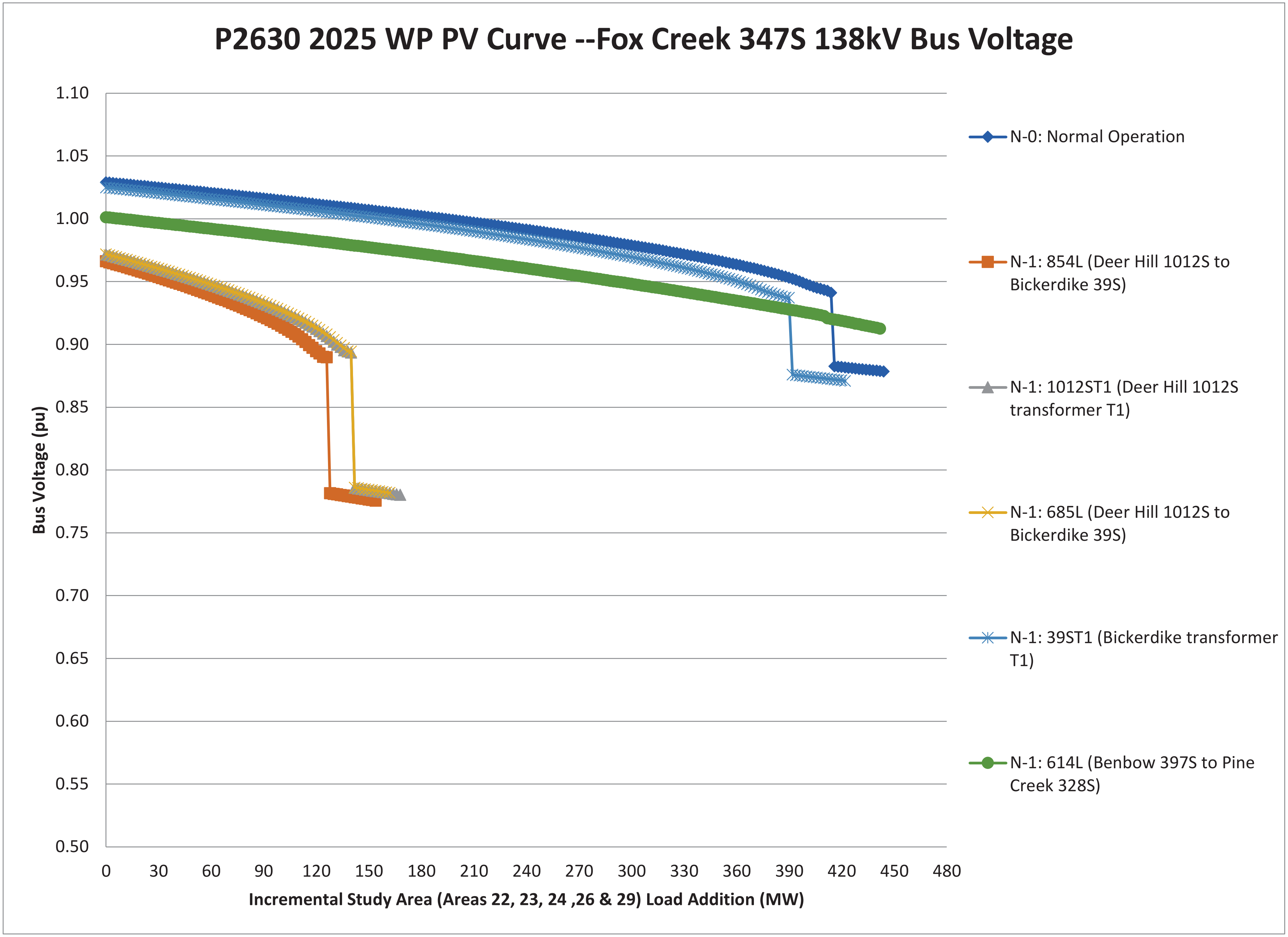
P2630 2025 WP PV Curve --Deer Hill 1012S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --Bickerdike 39S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

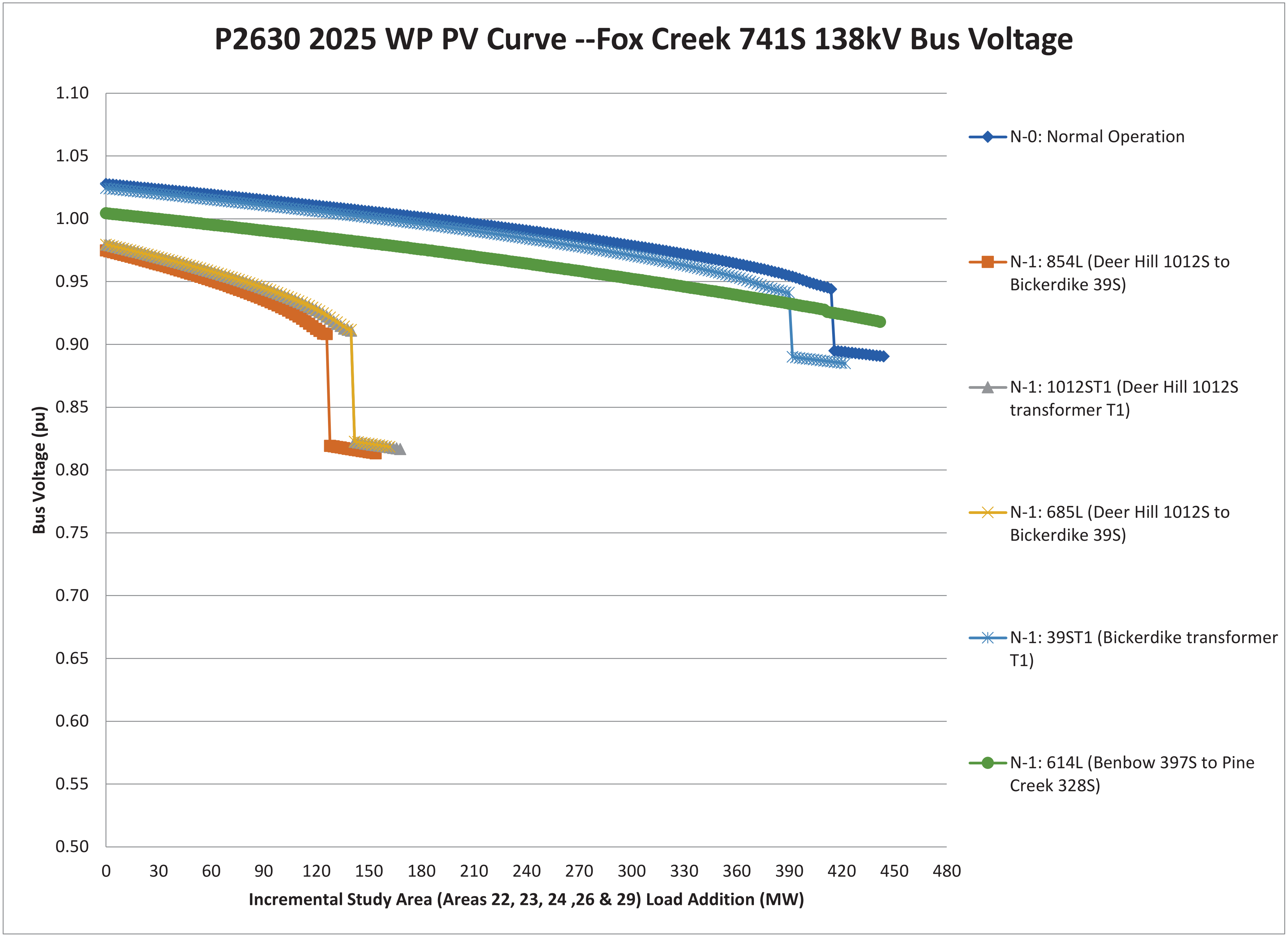

P2630 2025 WP PV Curve --Bickerdike 39S 240kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

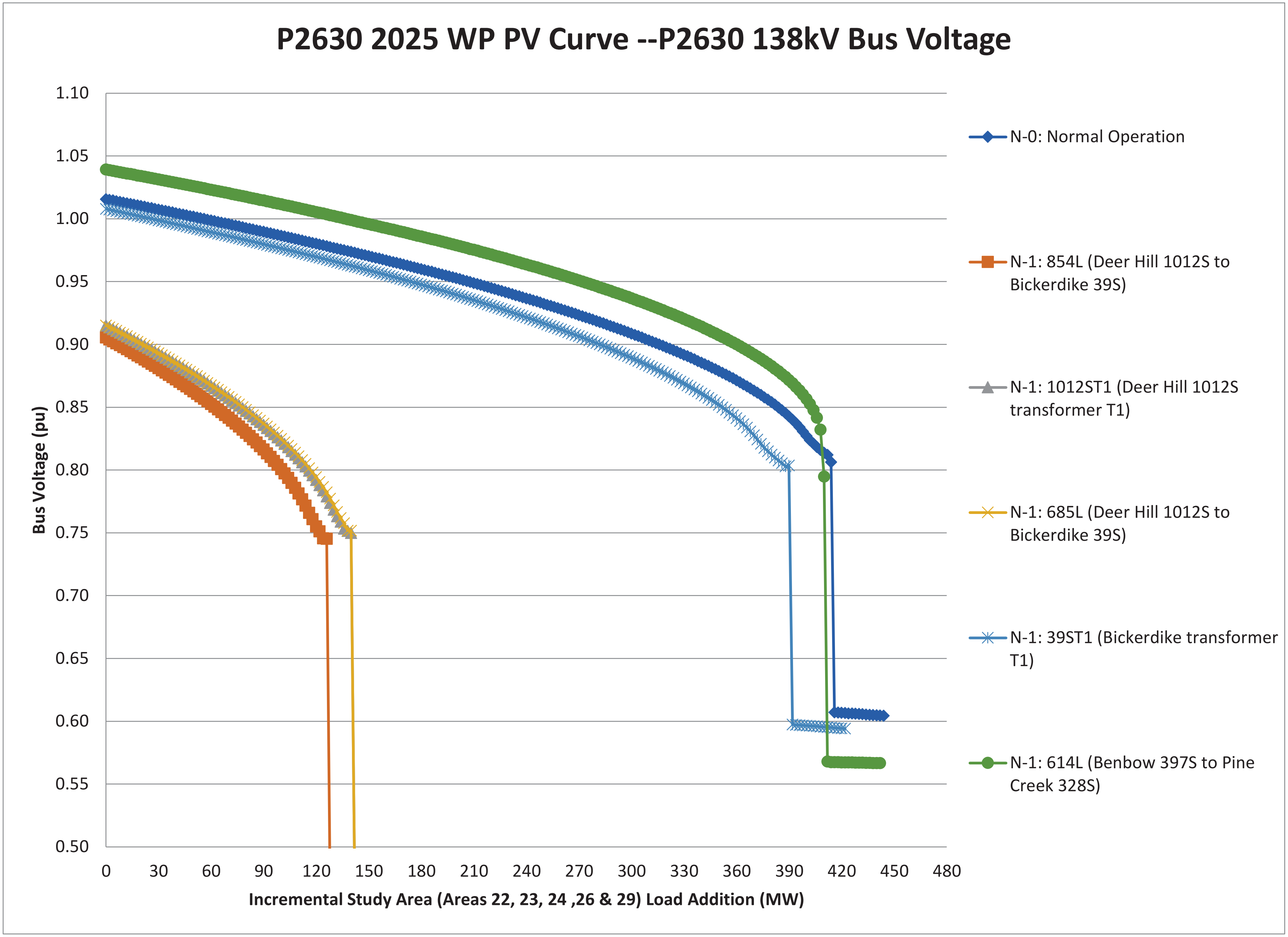

P2630 2025 WP PV Curve --Marlboro 348S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --Benbow 397S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

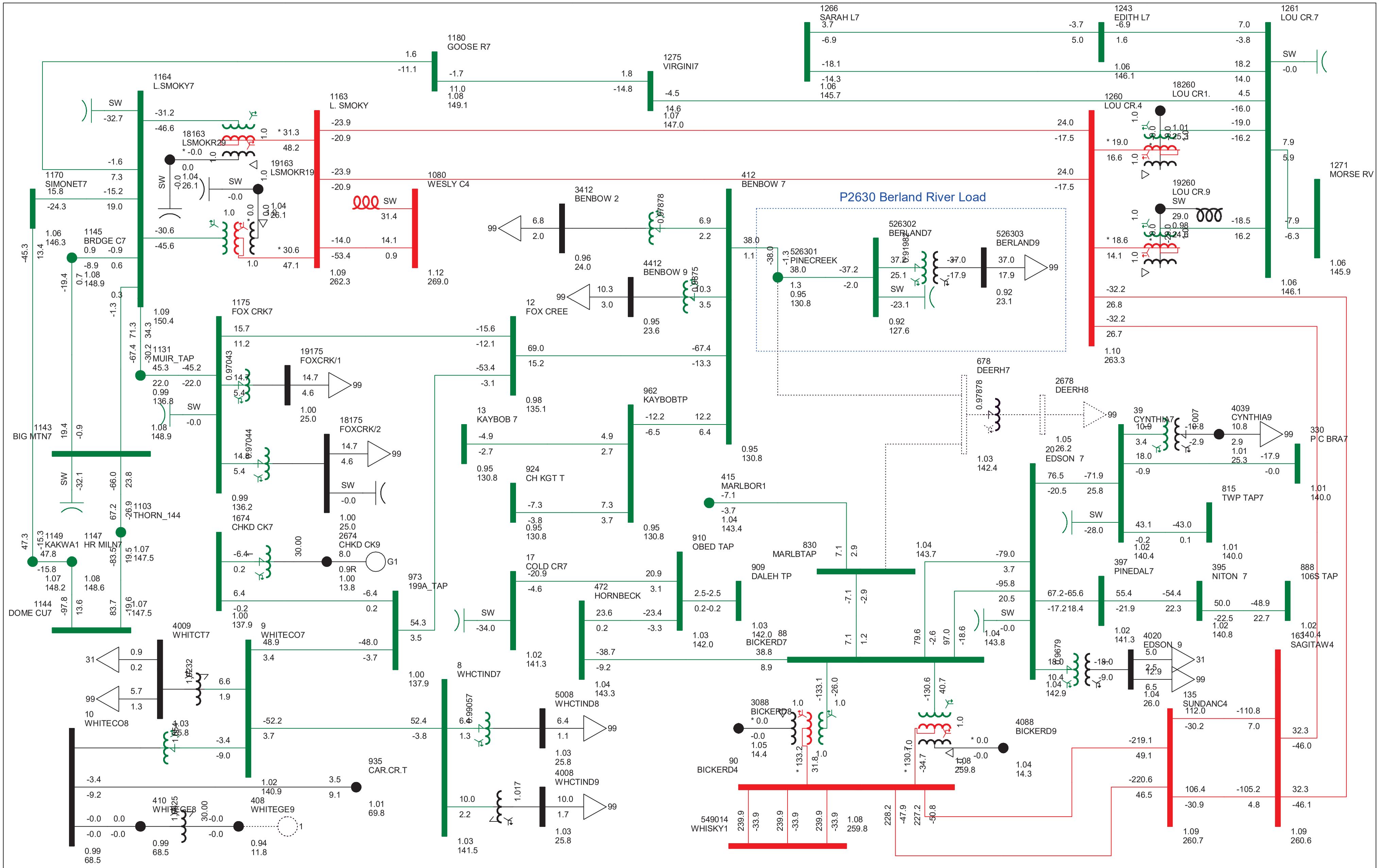


P2630 2025 WP PV Curve --Fox Creek 347S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --Fox Creek 741S 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)


P2630 2025 WP PV Curve --P2630 138kV Bus Voltage
Bus Voltage (pu)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Incremental Study Area (Areas 22, 23, 24 ,26 & 29) Load Addition (MW)
N-0: Normal Operation
N-1: 854L (Deer Hill 1012S to Bickerdike 39S)
N-1: 1012ST1 (Deer Hill 1012S transformer T1)
N-1: 685L (Deer Hill 1012S to Bickerdike 39S)
N-1: 39ST1 (Bickerdike transformer T1)
N-1: 614L (Benbow 397S to Pine Creek 328S)

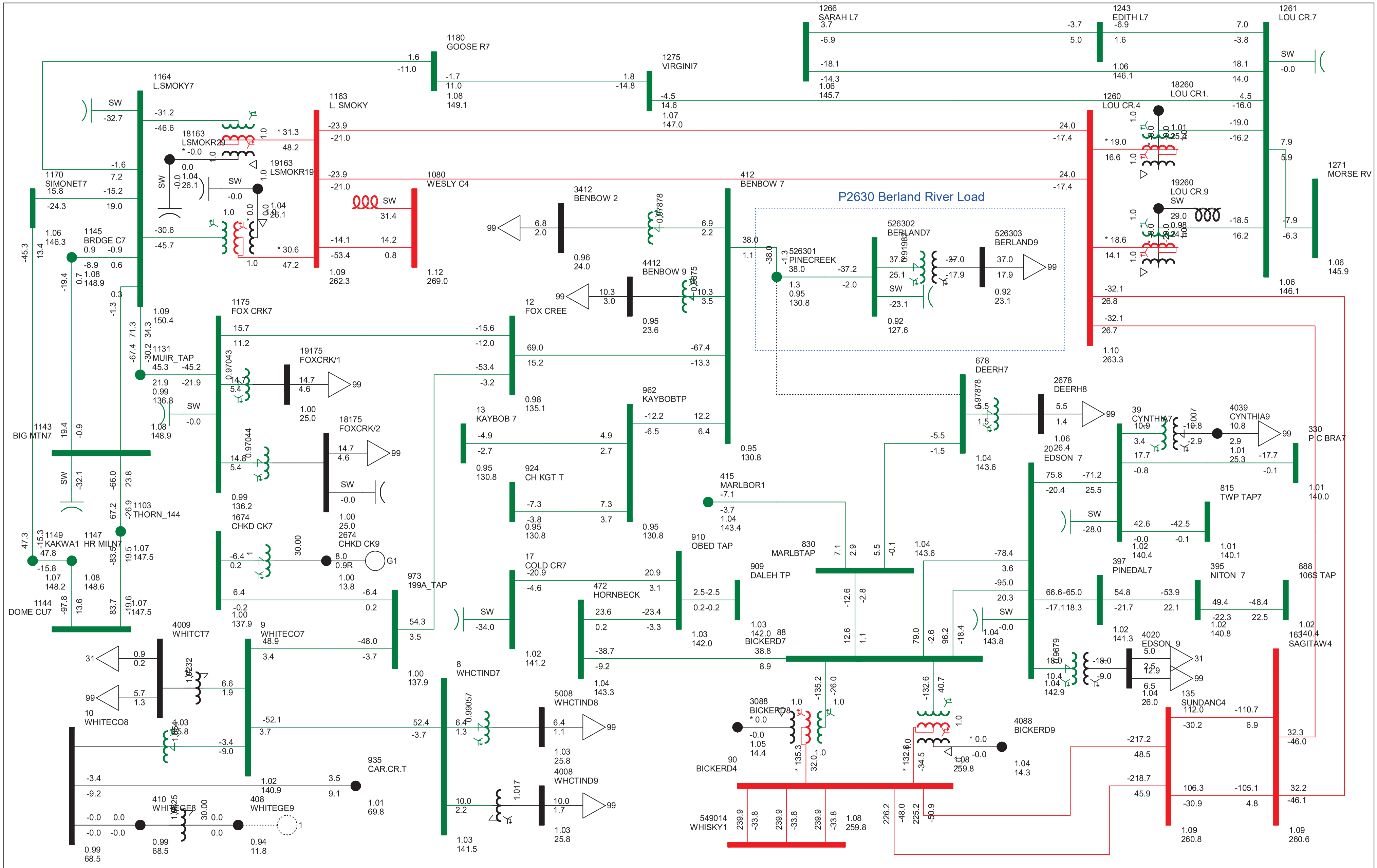
Attachment D: Post-Mitigation Power Flow Diagrams (Scenarios 3 and 4)



P2630: Berland River Load

P2630 WITH 27 MVAR CAP BANK (2025SP)- DIAGRAM D-1
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, DEC 12 2023 18:52

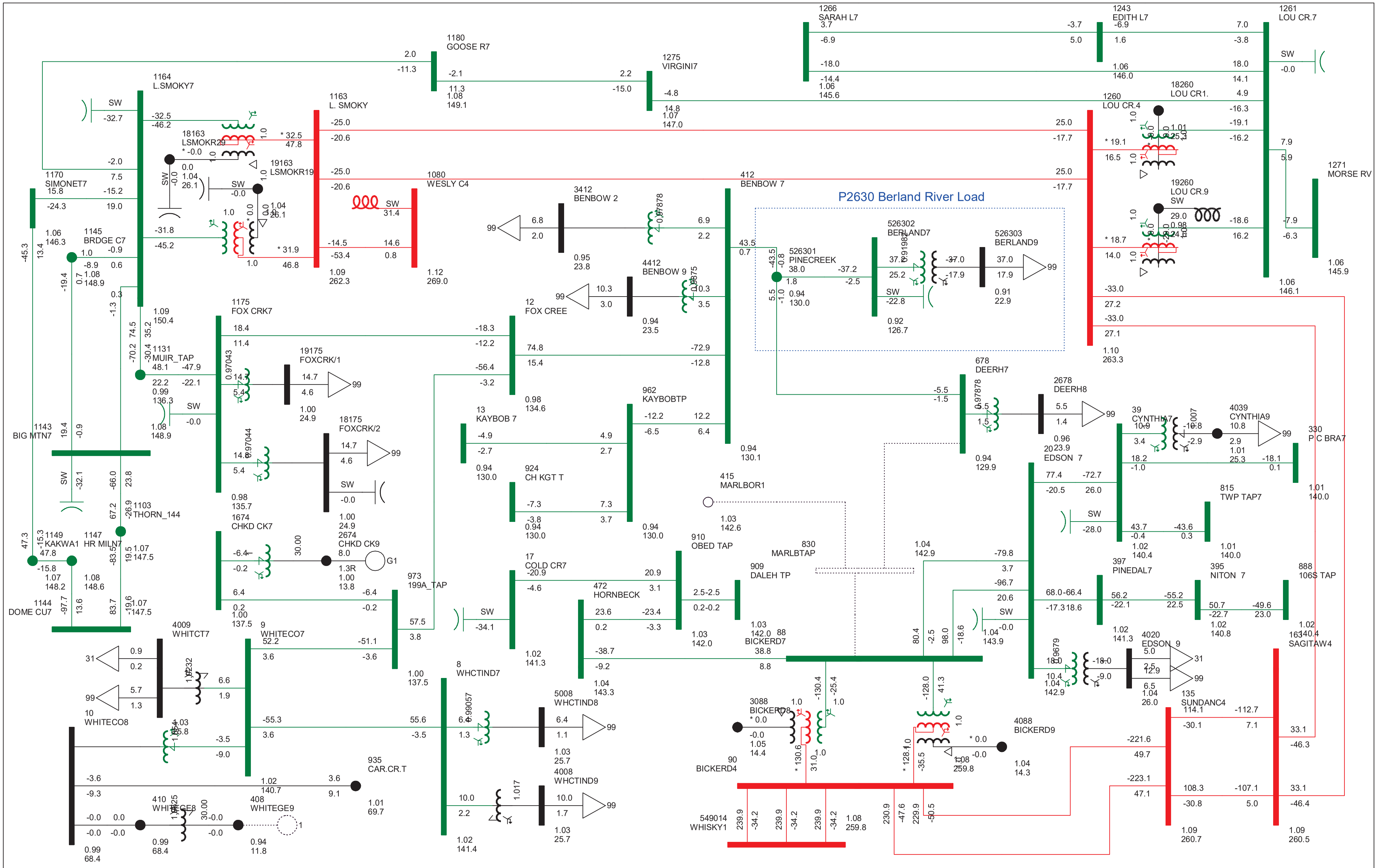
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-2
N-1: 685L (DEER HILL 1012S TO PINE CREEK 328S)
TUE, DEC 12 2023 18:53

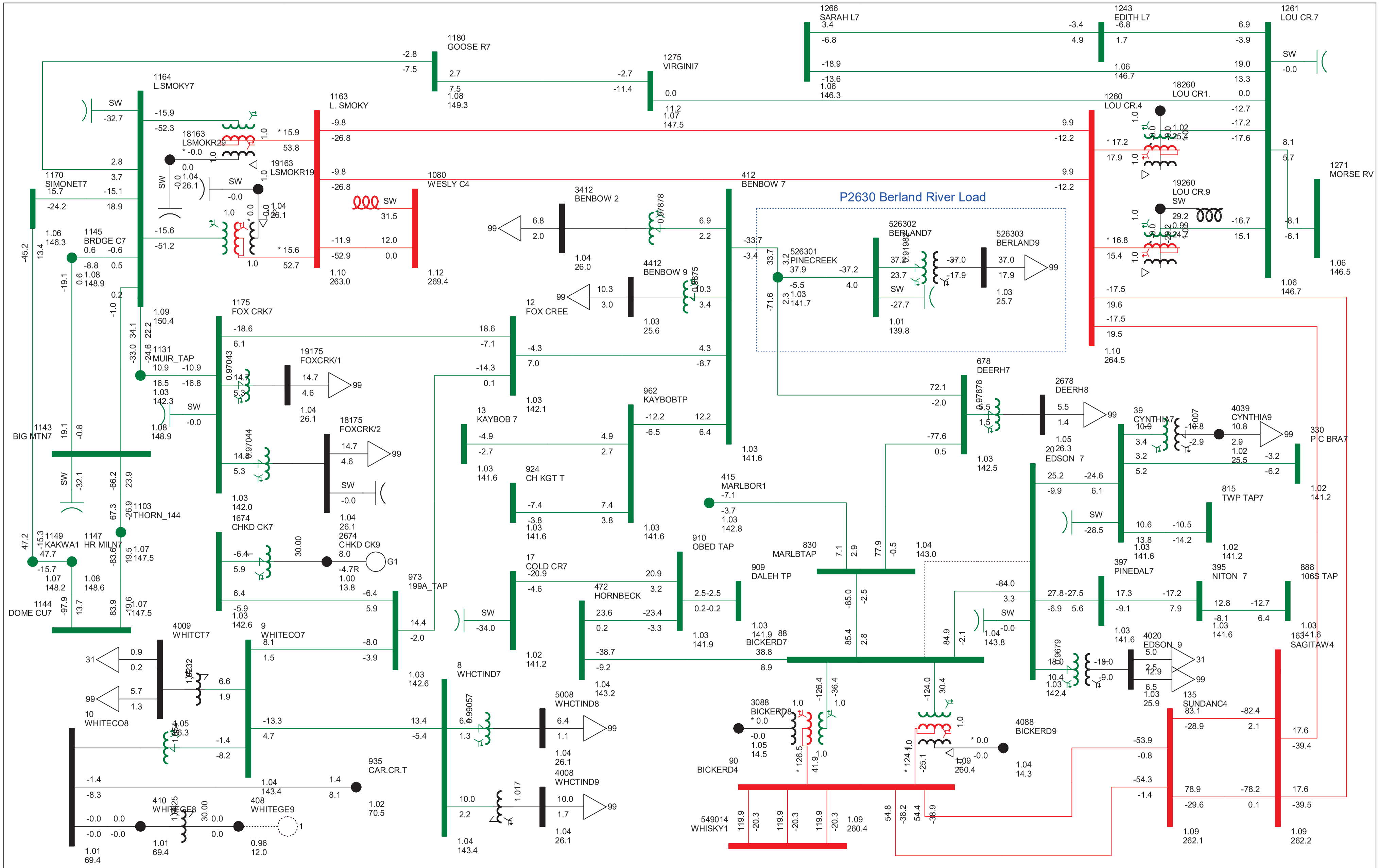
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 WITH 27 MVAR CAP BANK (2025SP)- DIAGRAM D-3
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, DEC 12 2023 18:53

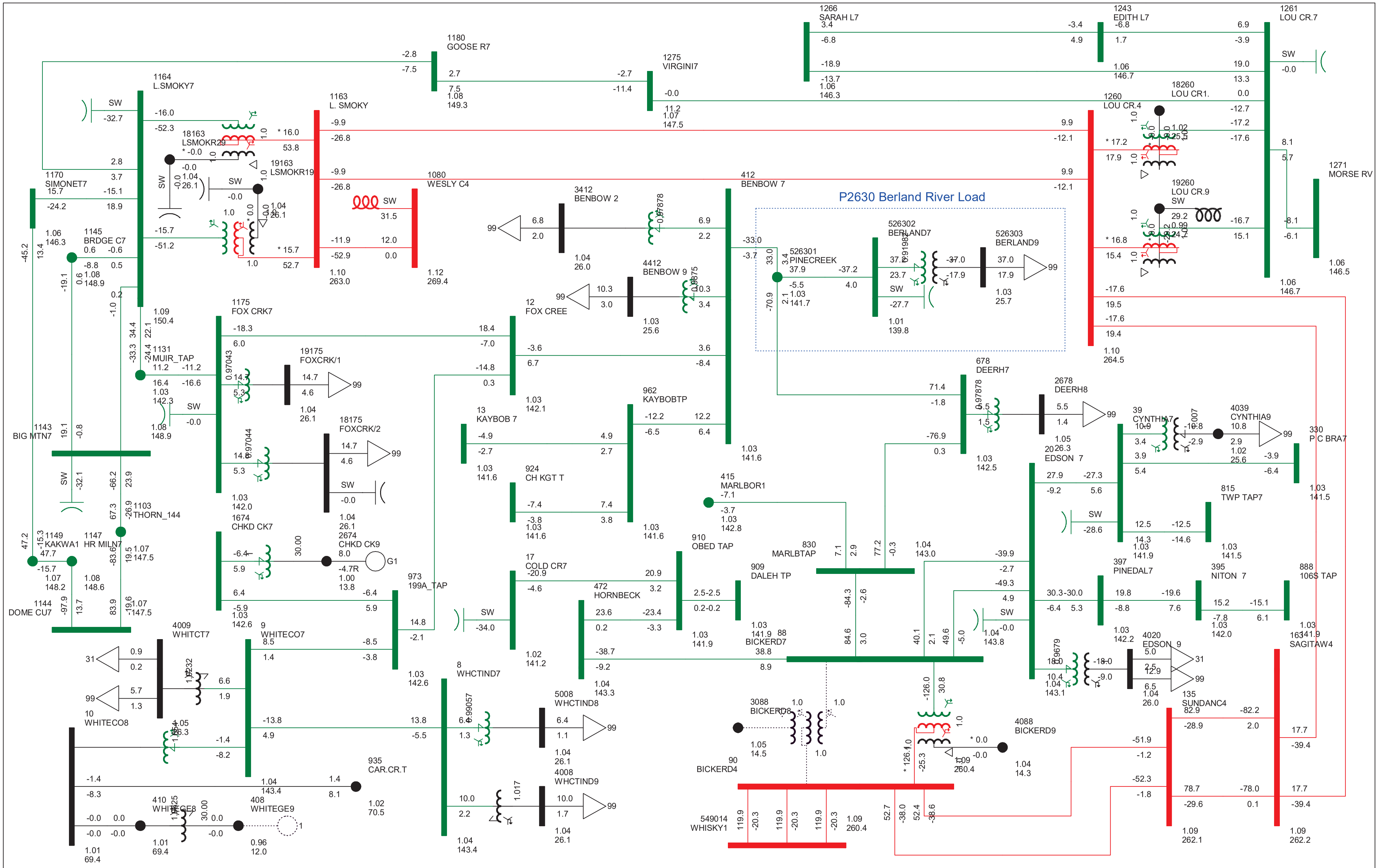
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-4
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, DEC 12 2023 18:53

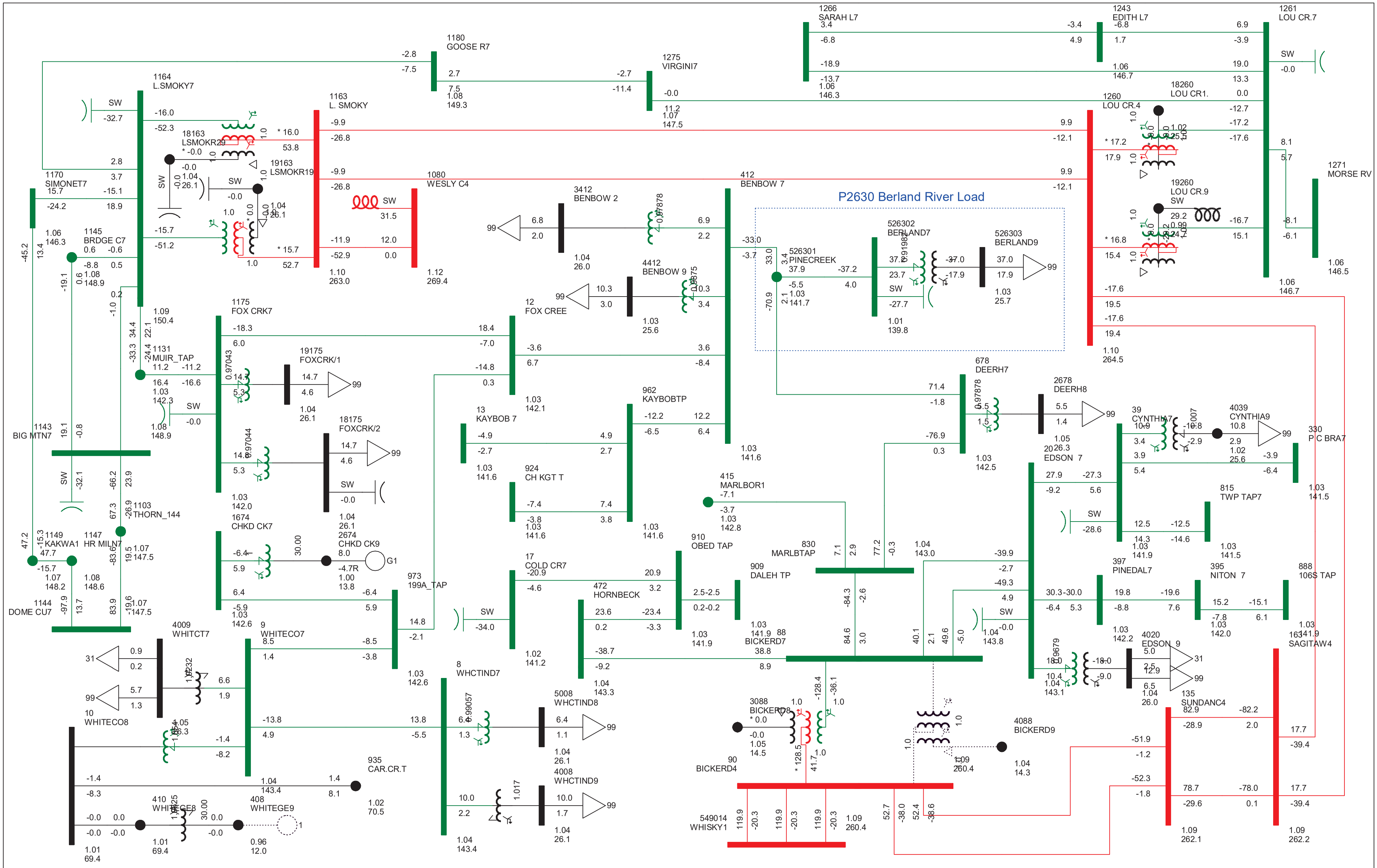
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-5
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, DEC 12 2023 18:54

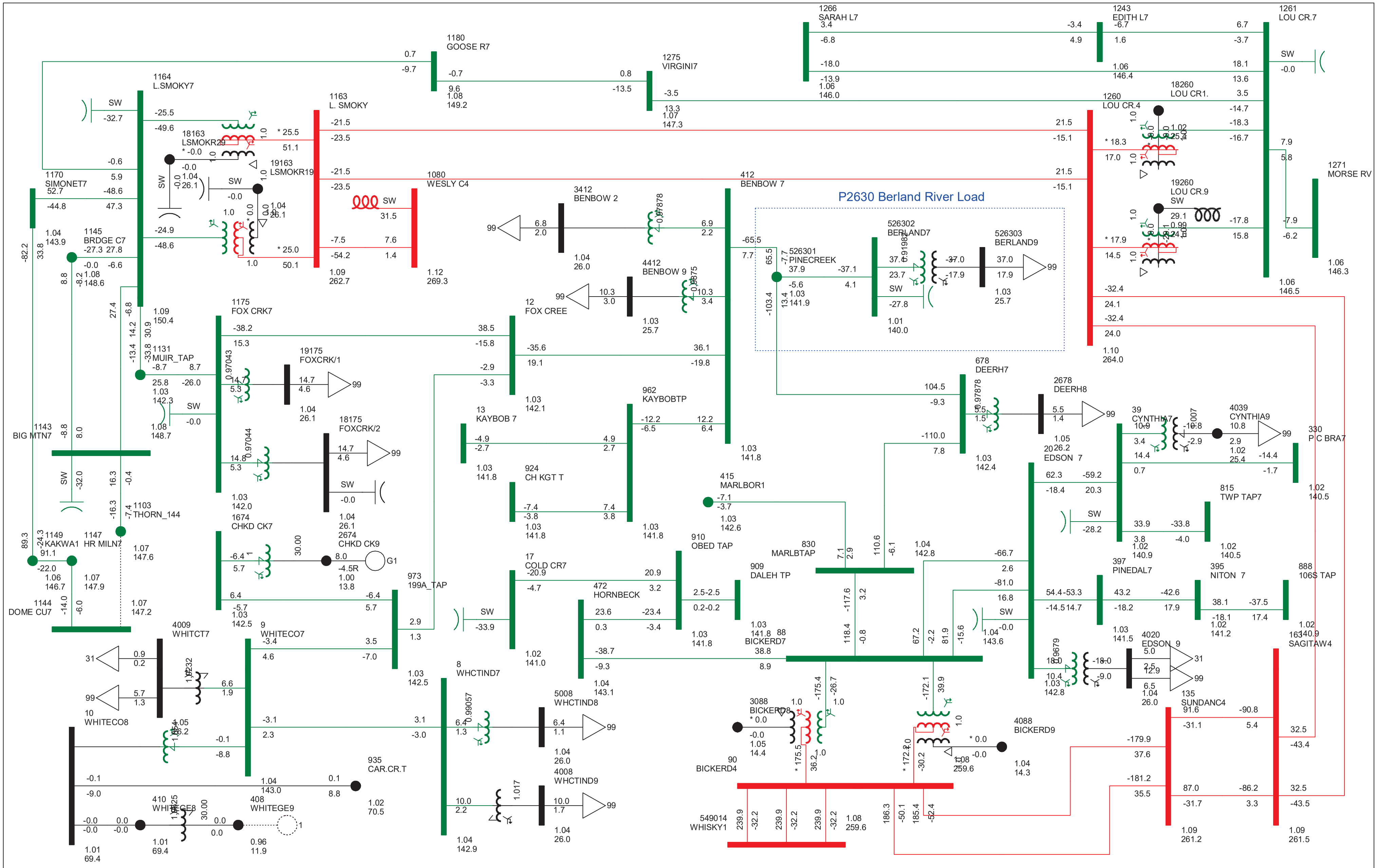
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-6
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, DEC 12 2023 18:54

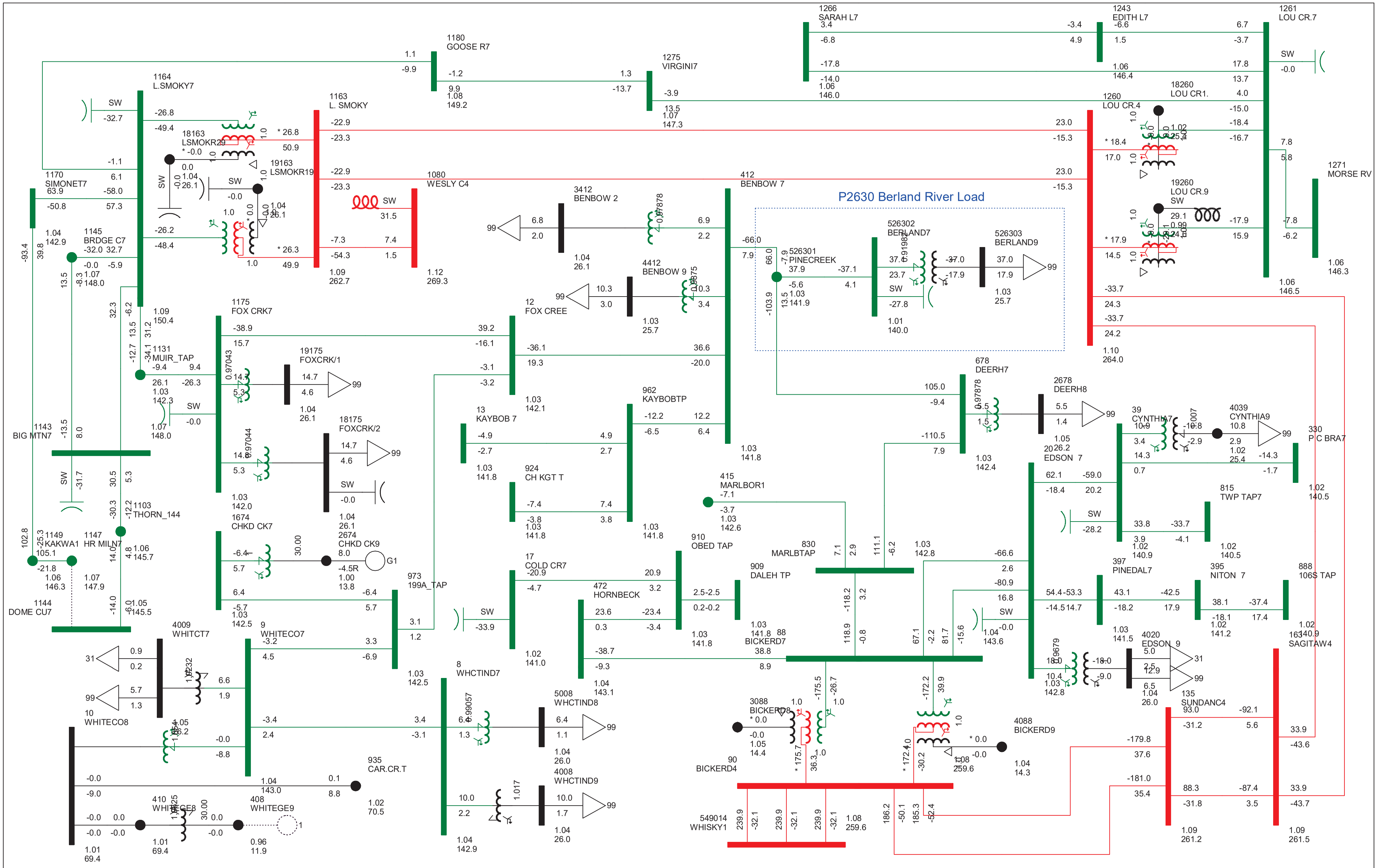
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-7
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, DEC 12 2023 18:54

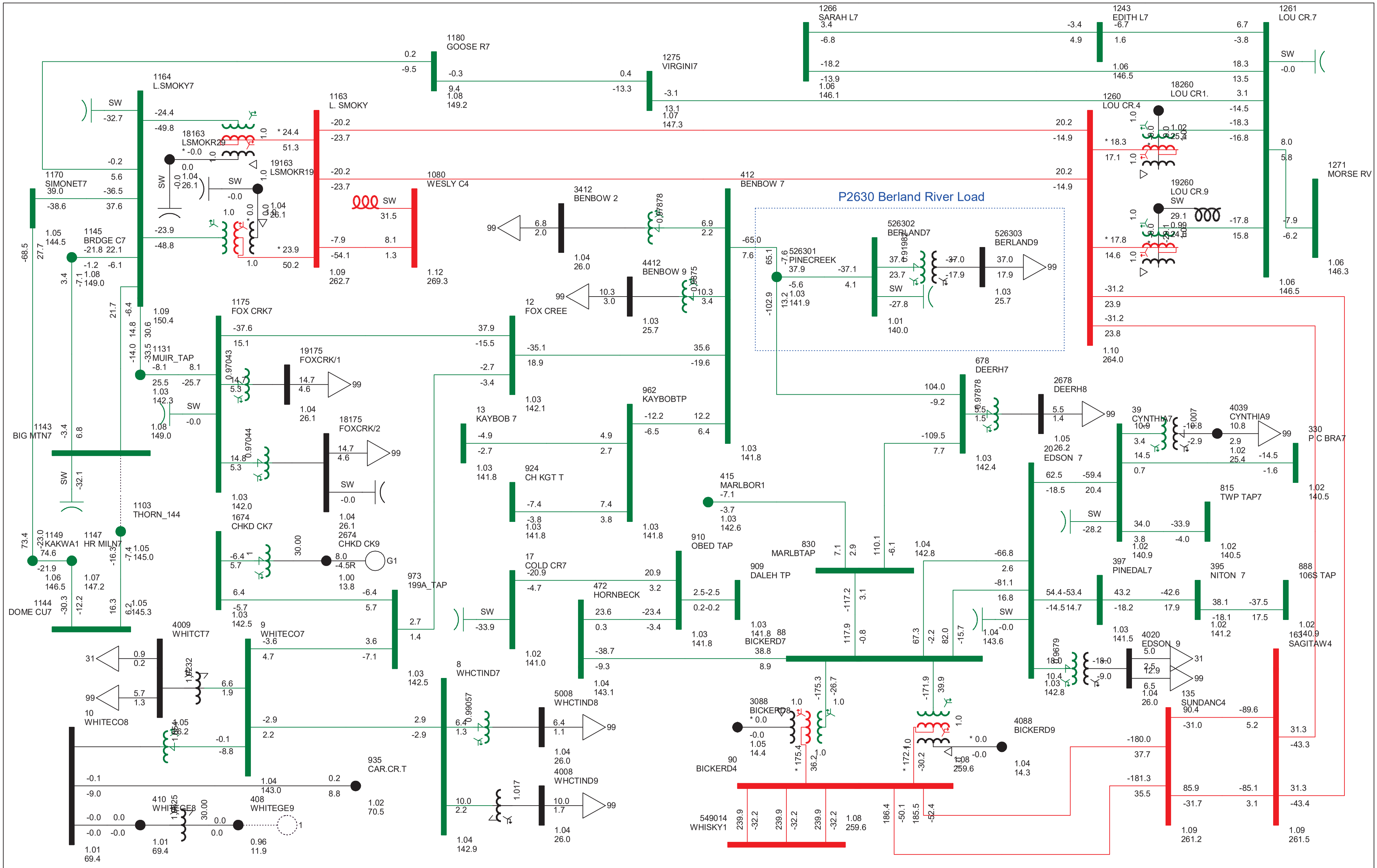
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-8
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, DEC 12 2023 18:54

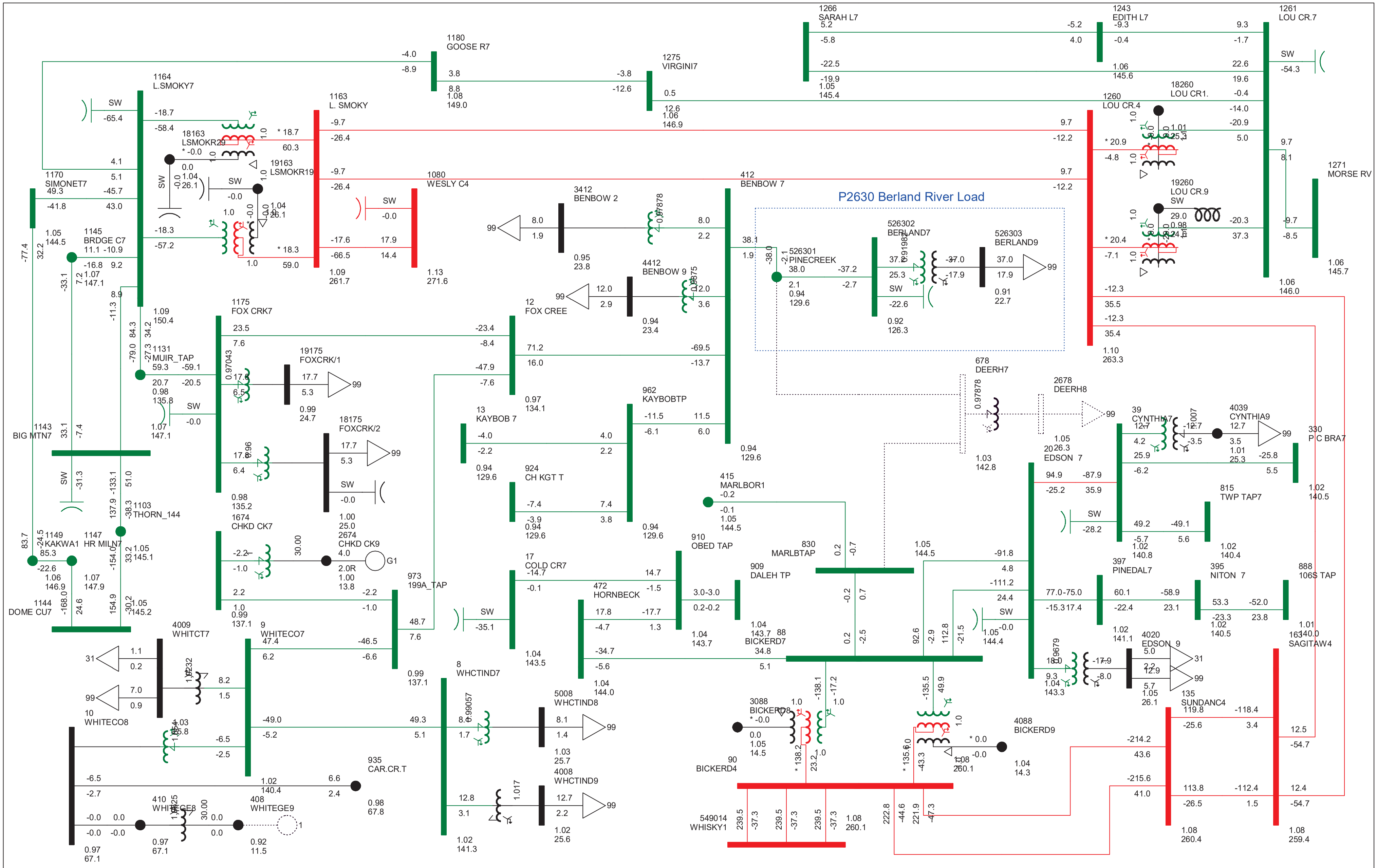
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025SP)- DIAGRAM D-9
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, DEC 12 2023 18:55

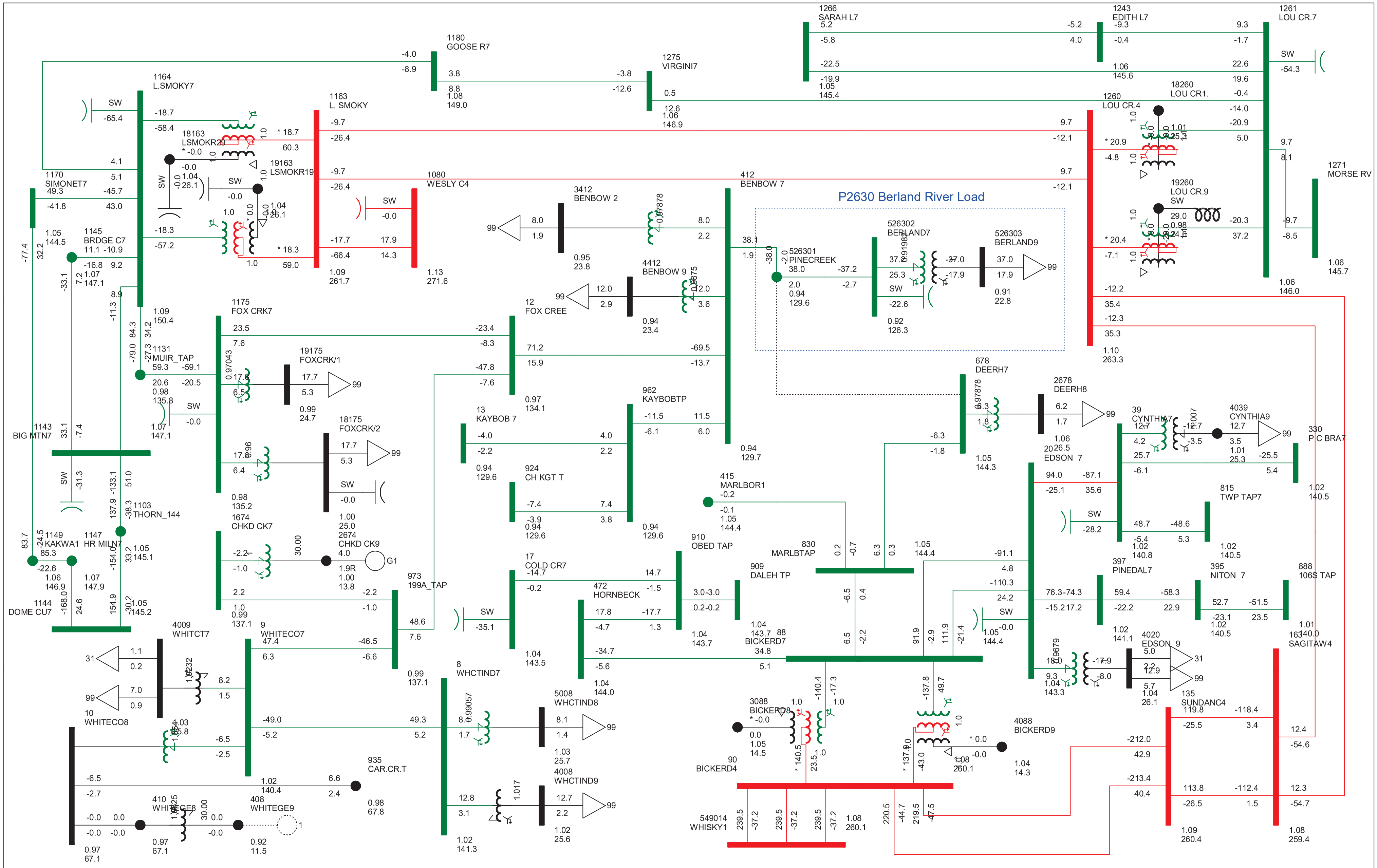
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE1
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 WITH 27 MVAR CAP BANK (2025WP)- DIAGRAM D-10
N-1: 1012ST1 (DEER HILL 1012S 138/25 KV TRANSFORMER)
TUE, DEC 12 2023 18:46

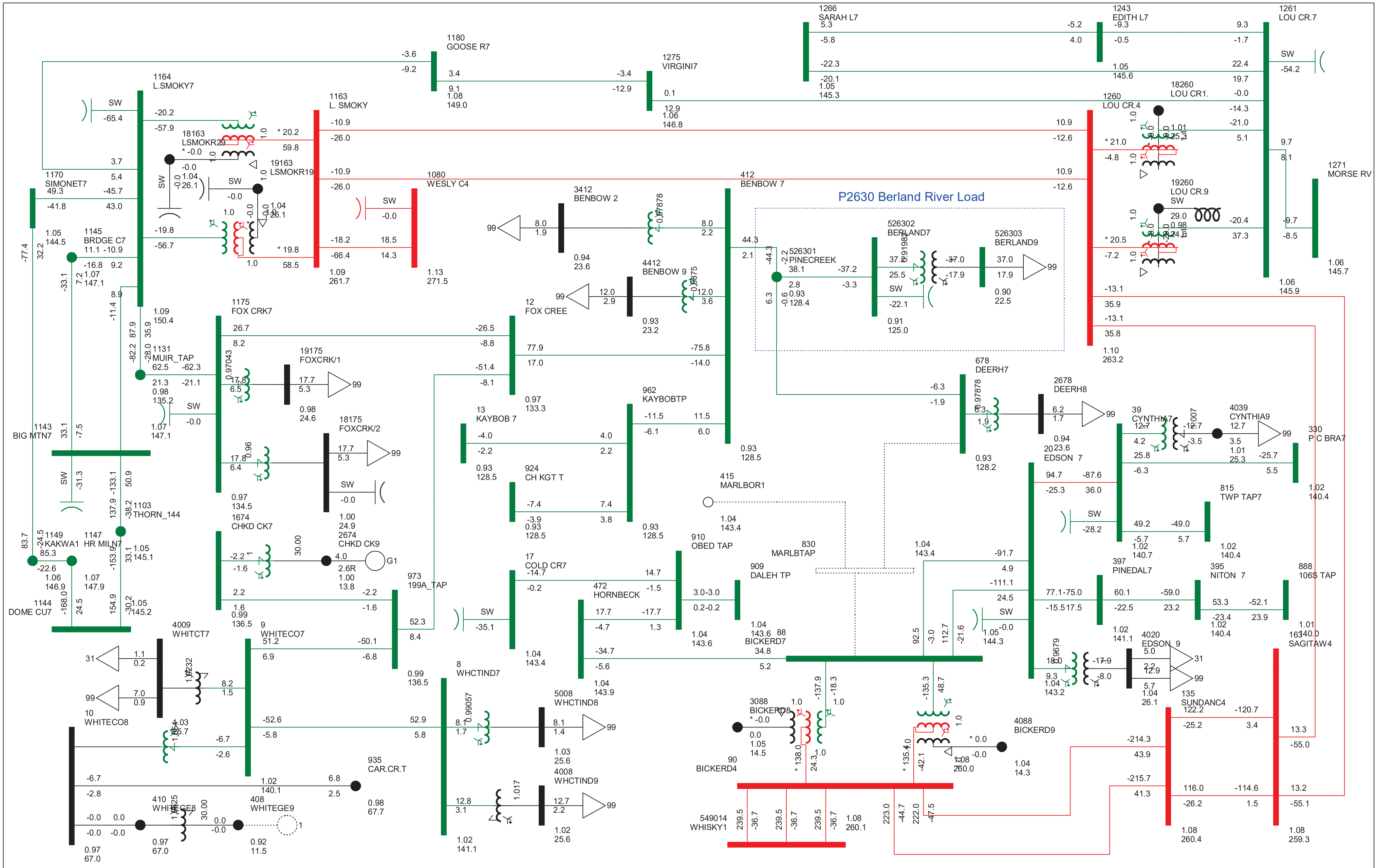
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-11
N-1: 685L (DEER HILL 1012S TO PINE CREEK 328S)
TUE, DEC 12 2023 18:47

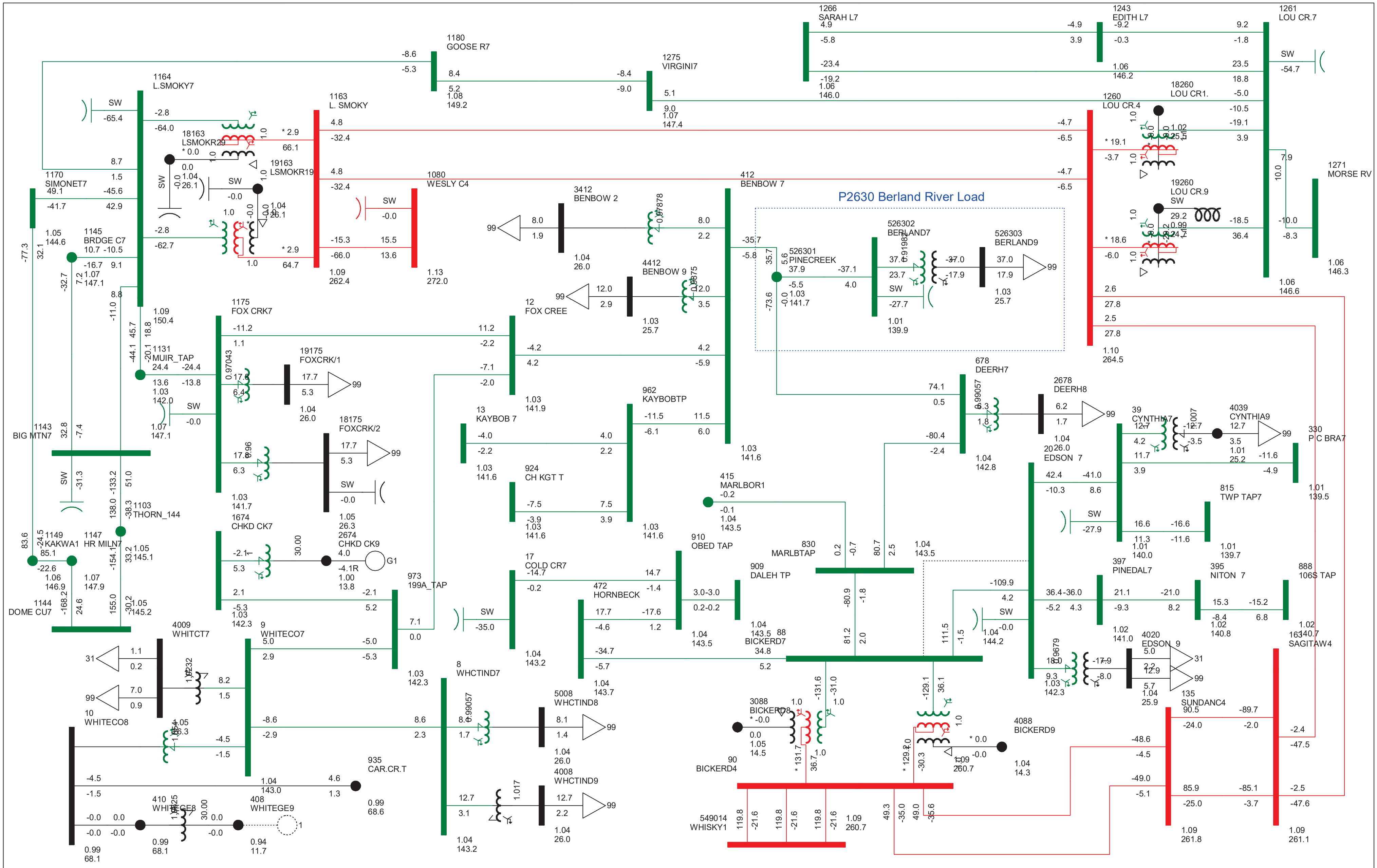
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 WITH 27 MVAR CAP BANK (2025WP)- DIAGRAM D-12
N-1: 854L (DEER HILL 1012S TO BICERDIKE 39S)
TUE, DEC 12 2023 18:47

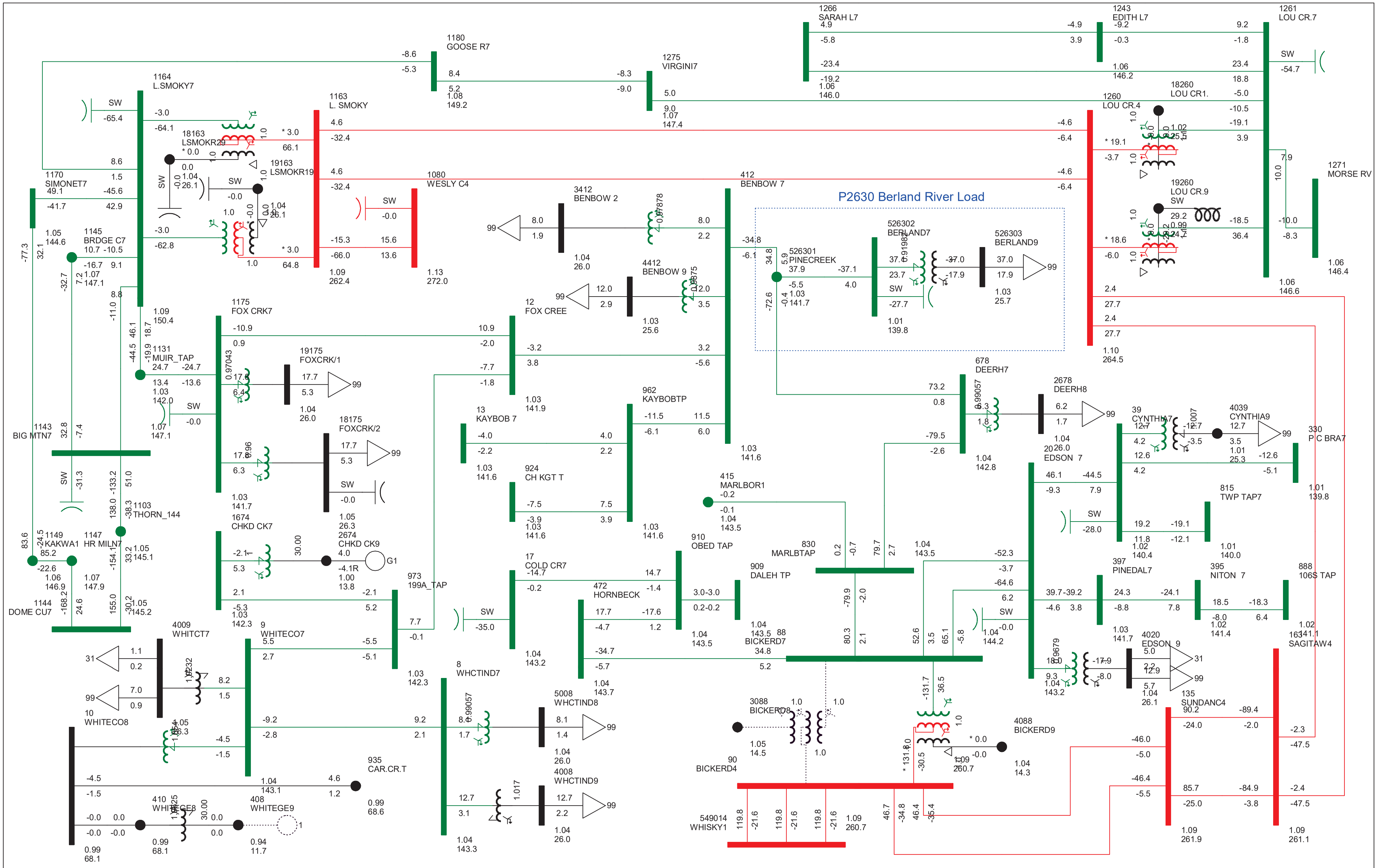
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-13
N-1: 671L (BICKERDIKE 39S TO EDSON 58S)
TUE, DEC 12 2023 18:48

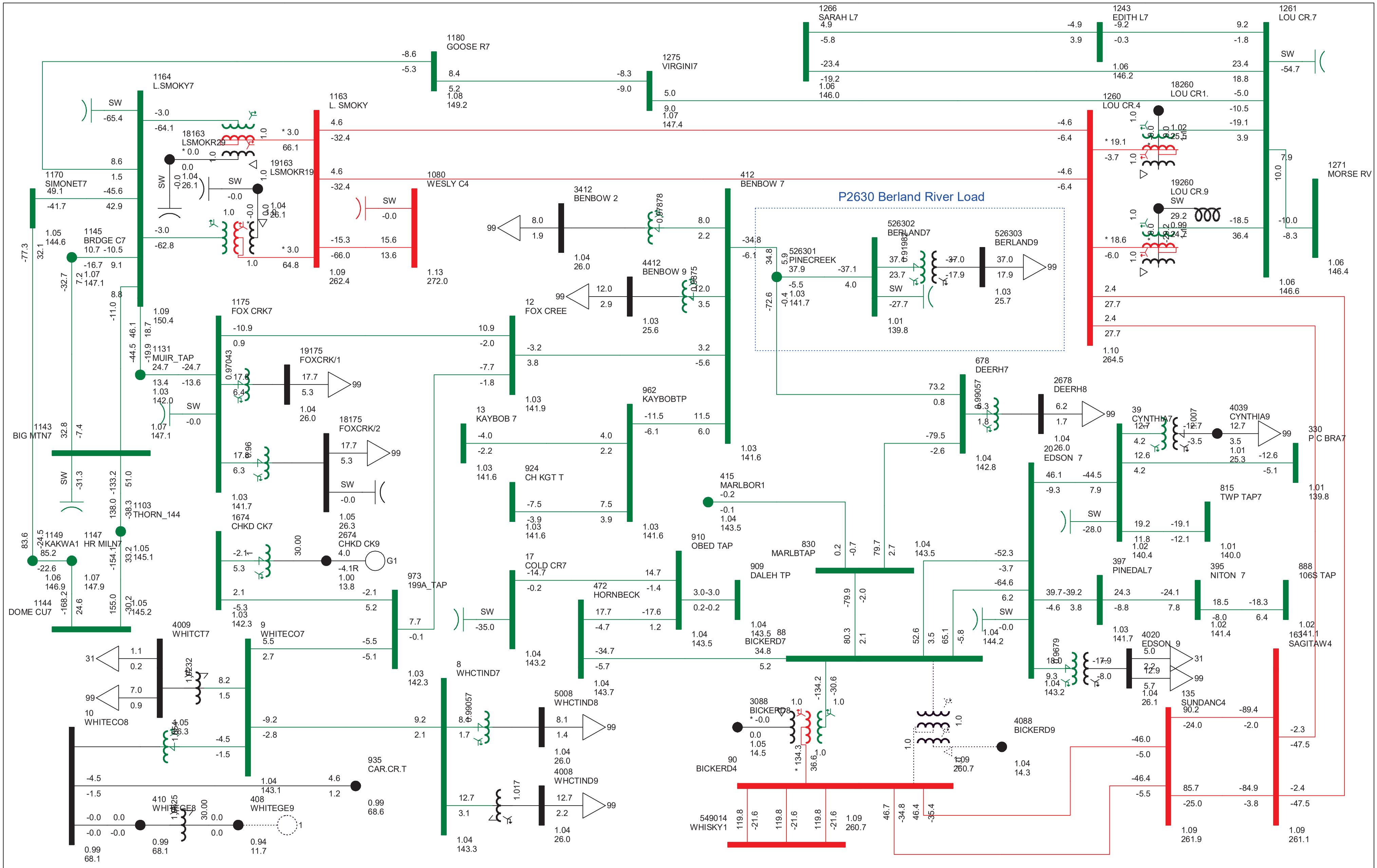
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-14
N-1: 39ST1 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, DEC 12 2023 18:48

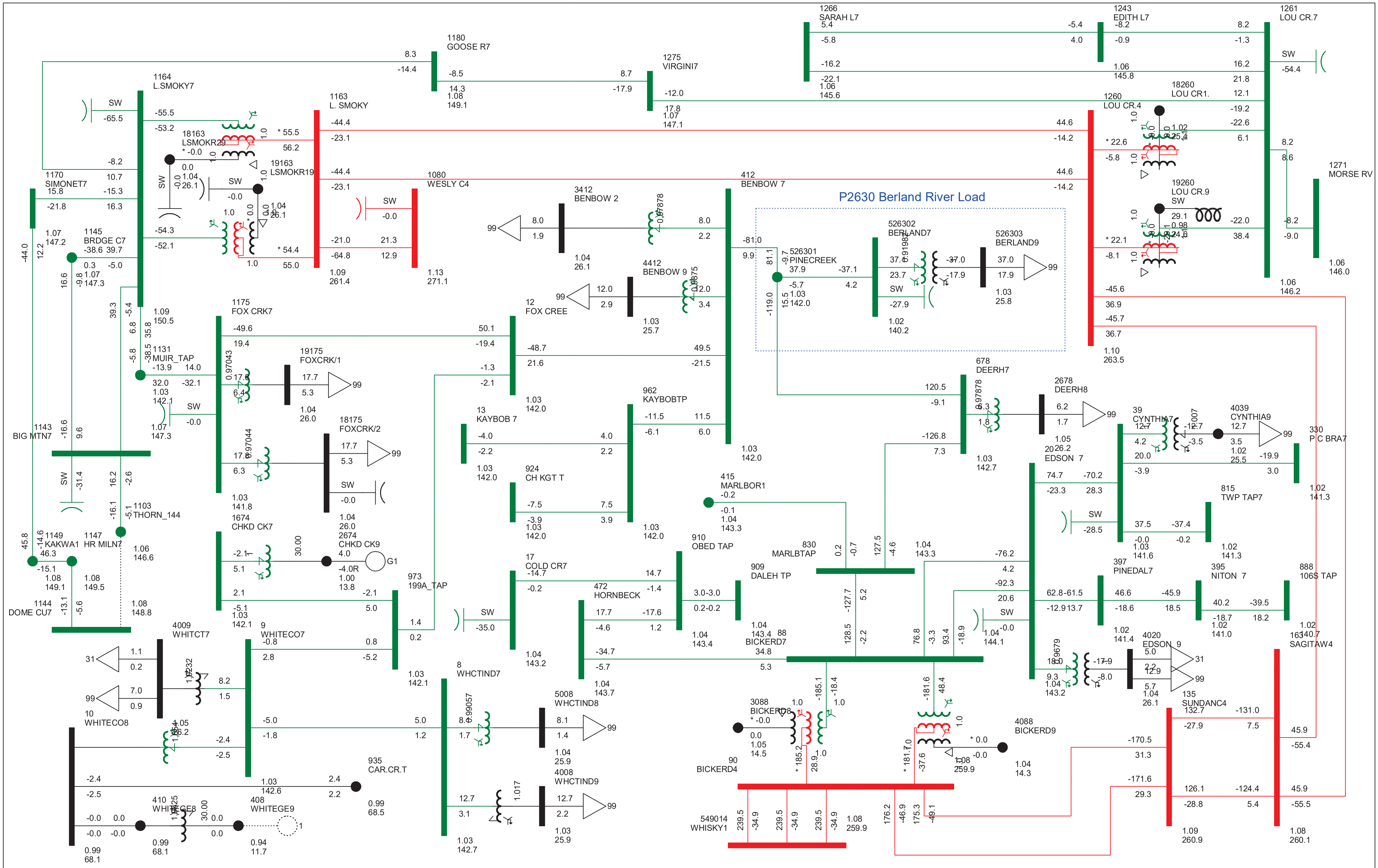
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-15
N-1: 39ST2 (BICKERDIKE 240/138 KV TRANSFORMER)
TUE, DEC 12 2023 18:48

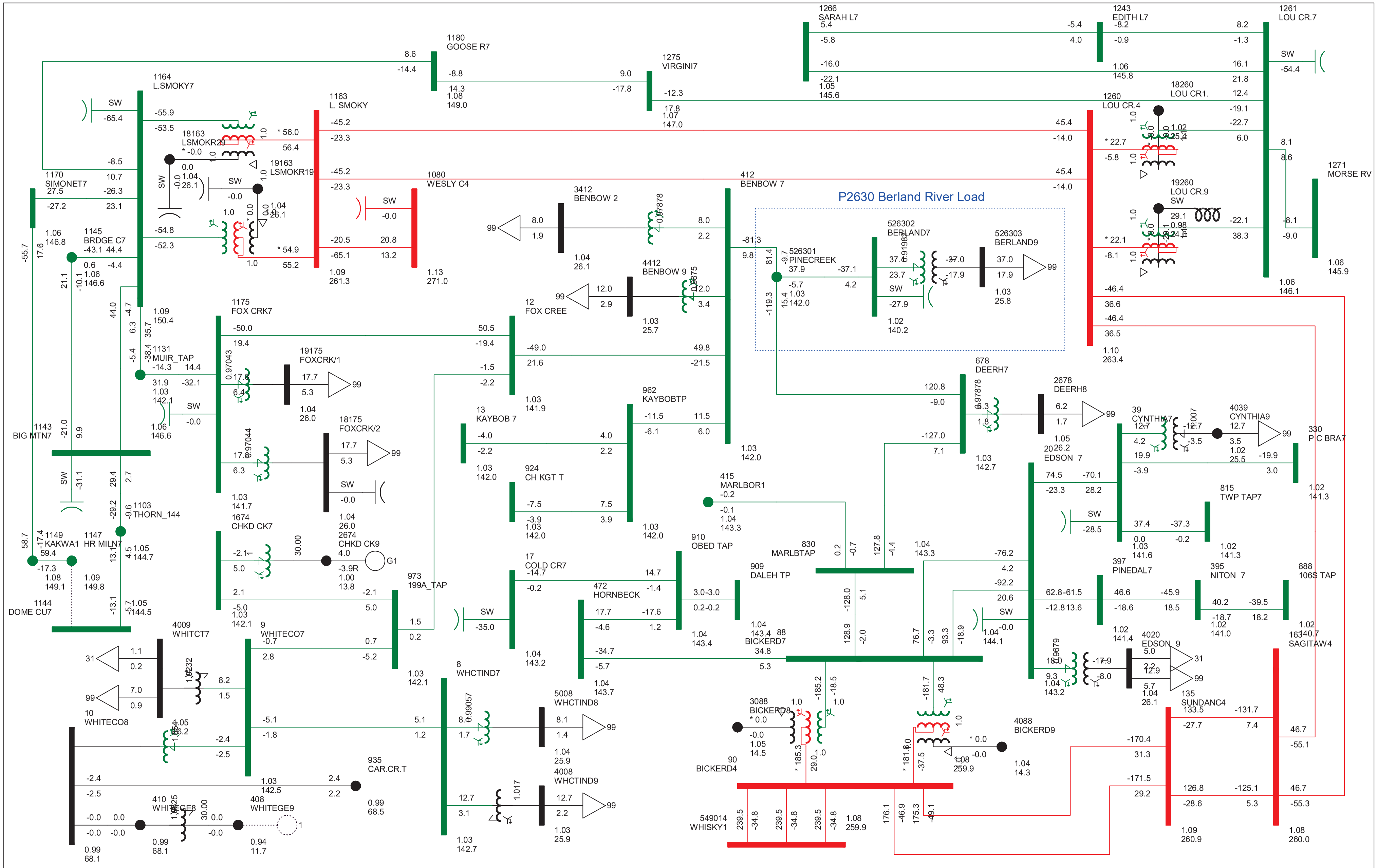
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-16
N-1: 7L20 (THORNTON 2091S TO DOME CUTBANK 810S)
TUE, DEC 12 2023 18:49

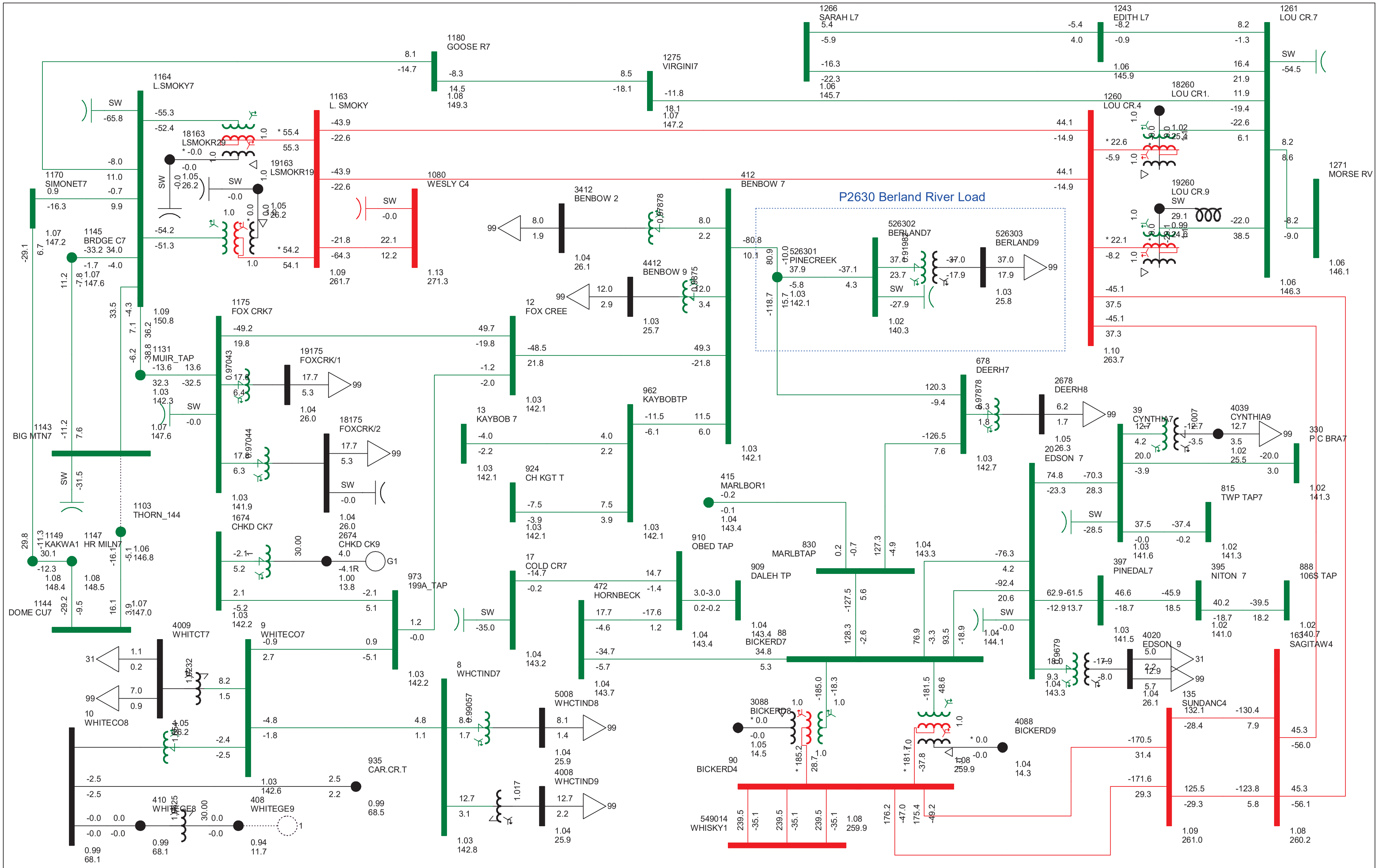
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-17
N-1: 7L20 (H.R. MILNER 740S TO DOME CUTBANK 810S)
TUE, DEC 12 2023 18:49

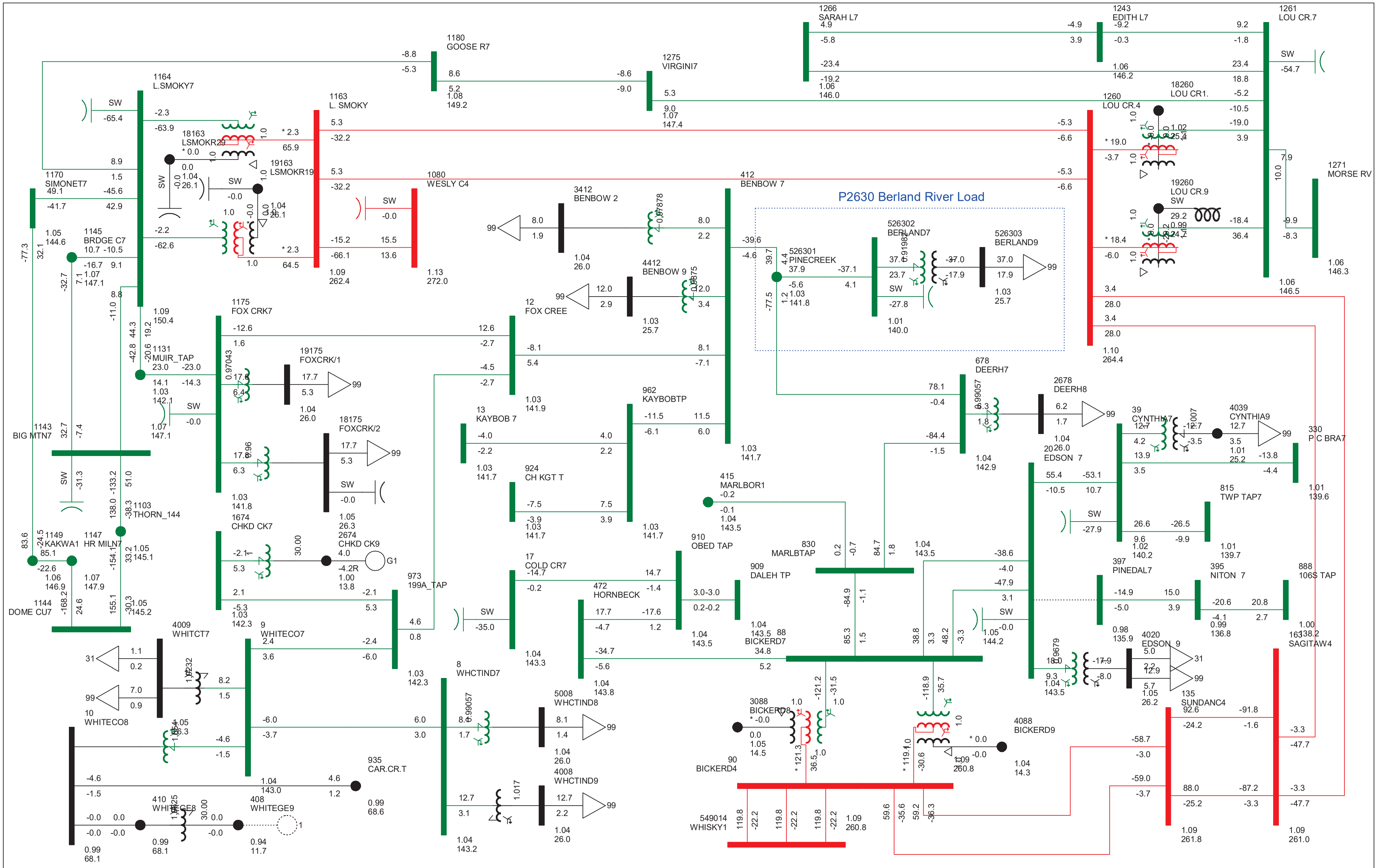
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM D-18
N-1: 7L28 (BIG MOUNTAIN 845S TO THORNTON 2091S)
TUE, DEC 12 2023 18:49

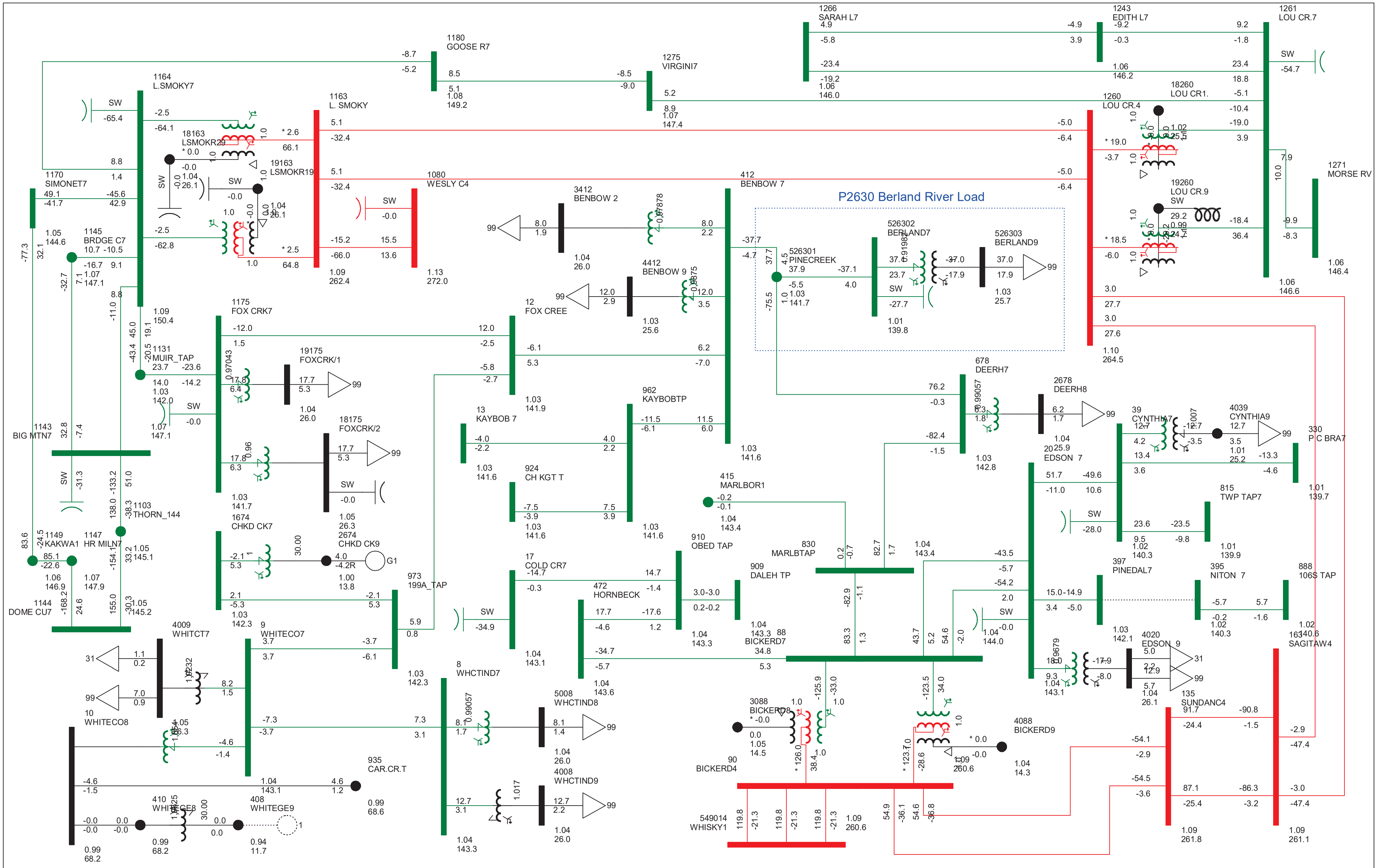
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-19
N-1: 890L (EDSON 58S TO PINEDALE 207S)
TUE, DEC 12 2023 18:49

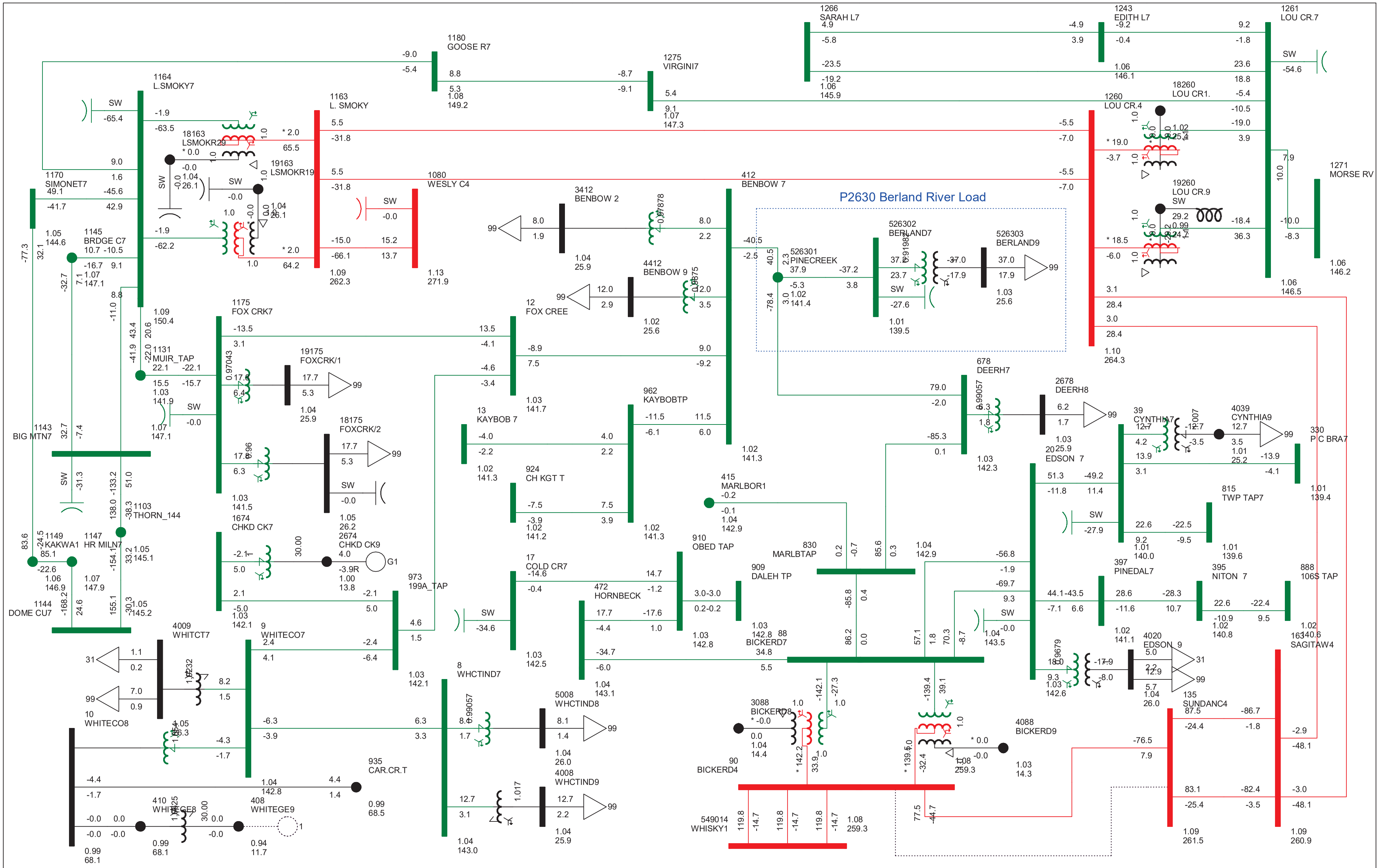
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-20
N-1: 744L (NITON 228S TO PINEDALE 207S)
TUE, DEC 12 2023 18:49

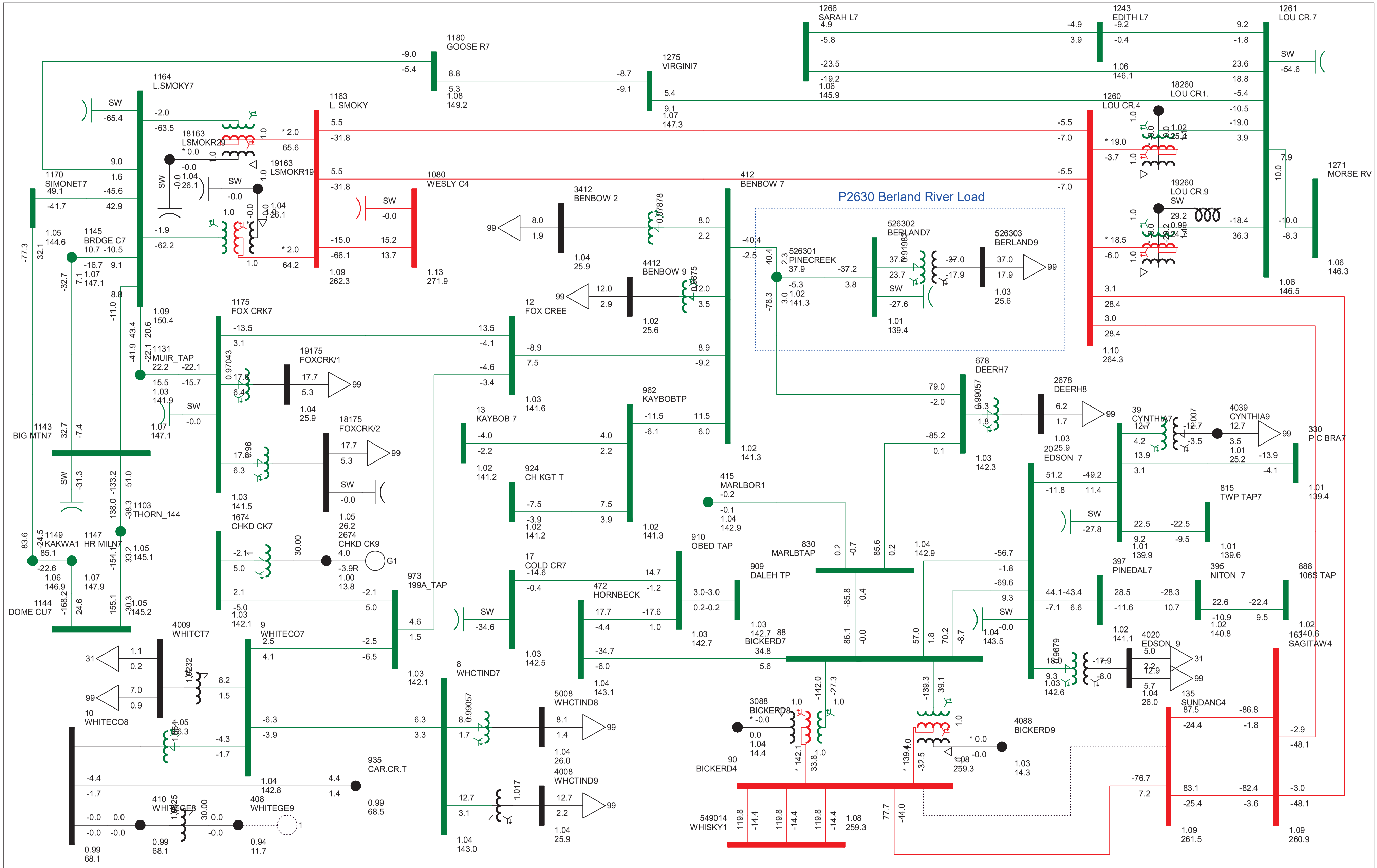
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-21
N-1: 973L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, DEC 12 2023 18:50

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000



P2630: Berland River Load

P2630 POST-CONNECTION (2025WP)- DIAGRAM B-22
N-1: 974L (SUNDANCE 310P TO BICKERDIKE 39S)
TUE, DEC 12 2023 18:50

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%RATE2
1.150OV 0.900UV
kV: >0.000 <=13.800 <=18.000 <=69.000 <=130.000 <=230.000 <=500.000 >500.000

Attachment E: Constraints Summary Table – Loading and Voltage Performance (Scenarios 1 to 4)

Table E-1: Remedial Action Scheme

RAS # and Name	RAS Description
RAS 171 (H.R. Milner 740S Overload)	Send "thermal trip" to HR Milner
planned RAS 185 (890L overload mitigation scheme)	Trip Unit #1 from Cascade (P2032)
Planned RAS 186 (T1 and T2 - 39S Bickerdike Overload Mitigation)	Trip Unit #1 from Cascade (P2032)
Planned RAS 188 (740L (Bickerdike to Edson) overload mitigation scheme)	Trip Unit #1 from Cascade (P2032)
Planned RAS 189 (202L overload mitigation scheme)	Trip Unit #1 from Cascade (P2032)
Planned RAS 190 (720L overload mitigation scheme)	Trip Unit #1 from Cascade (P2032)

Table E-2: Constraints Summary Table – Performance Violations and Potential Mitigation

Options for Alternative 2

Triggering Events	Type of System Constraint	Details of Constraint							Assumed System Condition	Mitigation Approach 27 MAR cap bank plus RAS and RTOP	
		Thermal								Automatic (RAS) OR Real Time Operating Practice	Post RAS Action
		Nominal rating (MVA)	Short-term rating (MVA)	*Pre-Project*		*Post-Project (Alternative 2)*					% of MVA continuous Rating
				Load Flow (MVA)	*%I of MVA continuous ratings*	*Load Flow* (MVA)	*%I of MVA continuous ratings*	*Difference (Post-Pre)*			*Post-Mitigation*
									Scenario 3		
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*99*	*109*	*149*	*150*	*143*	*144*	-6.0	2025 SP	RAS 188: Trip Unit #1 from Cascade (P2032)	*82*
39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*301*	*112*	*315*	*117*	5.0	2025 SP	RAS 186: Trip Unit #1 from Cascade (P2032)	*81*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*301*	*112*	*323*	*120*	8.0	2025 SP	RAS 186: Trip Unit #1 from Cascade (P2032)	*83*
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*126*	*117*	*126*	*117*	0.0	2025 SP	RAS 171 (Send "thermal trip" to HR Milner)	*81*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*126*	*117*	*126*	*117*	0.0	2025 SP	RAS 171 (Send "thermal trip" to HR Milner)	*81*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (Kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*138*	*129*	*138*	*129*	0.0	2025 SP	RAS 171 (Send "thermal trip" to HR Milner)	*93*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*138*	*129*	*138*	*129*	0.0	2025 SP	RAS 171 (Send "thermal trip" to HR Milner)	*93*
	202L (Edson 58S to Cynthia 178S)	*85.1*	*94*	*90*	*106*	*87*	*102*	-4.0	2025 SP	RTOP	

973L (Sundance 310P to Bickerdike 39S)	*740L (Bickerdike 39S to Edson 58S)*	*96*	*106*	*108*	*112*	*104*	*108*	-4.0	2025 SP	RTOP	
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*	*74*	*98*	-4.0	2025 SP	RTOP	
974L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*85.1*	*94*	*90*	*106*	*86*	*101*	-5.0	2025 SP	RTOP	
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*108*	*112*	*104*	*108*	-4.0	2025 SP	RTOP	
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*77*	*102*	*74*	*98*	-4.0	2025 SP	RTOP	
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*107.3*	*118.8*	*111*	*103*	*111*	*103*	0.0	2025 SP	*RAS 171 (Send "thermal trip" to HR Milner)*	*68*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*107.3*	*118.8*	*111*	*103*	*111*	*103*	0.0	2025 SP	*RAS 171 (Send "thermal trip" to HR Milner)*	*68*
1012ST1 (Deer Hill 1012S transformer)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*	*89*	*104*	67.0	2025 SP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 88%	*88%*
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*32*	*37*	*89*	*104*	67	2025 SP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 84%	*84%*
854L (Deer Hill 1012S to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*37*	*43*	*101*	*118*	75.0	2025 SP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 96%	*96%*
C5-973L-974L (Sundance 310P to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*86*	*95*	*200*	*233*	*185*	*215*	-18.0	2025 SP	RAS 190: Trip Unit #1 from Cascade (P2032)	*58%*
	202L (Edson 58S to Cynthia 178S)	*85.1*	*94*	*197*	*231*	*190*	*223*	-8.0	2025 SP	RAS 189: Trip Unit #1 from Cascade (P2032)	*74%*
	740L (Bickerdike 39S to Edson 58S)	*96*	*106*	*221*	*230*	*214*	*223*	-7.0	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from	*87%*

										Cascade (P2032)	
	671L (Bickerdike 39S to Edson 58S)	*172*	*189*	*179*	*104*	*172*	*100*	-4.0	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	*39%*
	890L (Edson 58S to Pindale 207S)	*75.1*	*83*	*171*	*228*	*166*	*221*	-7.0	2025 SP	RAS 185: Trip Unit #1 from Cascade (P2032)	*80%*
	Bickerdike 39S T1	*269*	*269*	*366*	*136*	*374*	*139*	3.0	2025 SP	RAS 186: Trip Unit #1 from Cascade (P2032)	*66%*
	Bickerdike 39S T2	*269*	*269*	*358*	*133*	*358*	*133*	0.0	2025 SP	RAS 186: Trip Unit #1 from Cascade (P2032)	*66%*
	744L (Pinedale 207S to Niton 228S)	*75.1*	*83*	*161*	*215*	*156*	*208*	-7.0	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	*69%*
	744L (Niton 228S to 106S tap)	*75.1*	*83*	*157*	*208.7*	*152*	*202*	-6.7	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	*63%*
	685L (Benbow 397S to Project 2630 Tap)	*167*	*184*	*225*	*135*	*205*	*123*	-12.0	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	*44%*
	685L (Deer Hill 1012S to Project 2630 Tap)	*167*	*184*	*225*	*135*	*244*	*146*	11.0	2025 SP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	*66%*
									Scenario 4		
671L (Bickerdike 39S to Edson 58S)	*740L (Bickerdike 39S to Edson 58S)*	*133*	*146*	*169*	*129*	*166*	*125*	-4.0	2025 WP	RAS 188: Trip Unit #1 from Cascade (P2032)	*80*
890L (Edson 58S to Pinedale 207S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*101*	*112*	*97*	*108*	-4.0	2025 WP	RAS 189: Trip Unit #1 from Cascade (P2032)	*60*

39ST1 (Bickerdike transformer T1)	*39ST2 (Bickerdike transformer T2)*	*269*	*269*	*315*	*117*	*325*	*121*	4.0	2025 WP	RAS 186: Trip Unit #1 from Cascade (P2032)	*84*
39ST2 (Bickerdike transformer T2)	*39ST1 (Bickerdike transformer T1)*	*269*	*269*	*312*	*116*	*334*	*124*	8.0	2025 WP	RAS 186: Trip Unit #1 from Cascade (P2032)	*86*
744L (Pinedale 207S to Niton 228S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*	*94*	*104*	-4.0	2025WP	RAS 189: Trip Unit #1 from Cascade (P2032)	*56*
7L20 (Thornton 2091S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*238*	*167*	*238*	*167*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*31*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*238*	*167*	*238*	*167*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*31*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*217*	*140*	*217*	*140*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*16*
7L20 (H.R. Milner 740S to Dome Cutbank 810S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*257*	*180*	*257*	*180*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*40*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*257*	*180*	*257*	*180*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*40*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*234*	*151*	*234*	*151*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*23*
202L (Edson 58S to Cynthia 178S)	*890L (Edson 58S to Pindale 207S)*	*79*	*87*	*83*	*105*	*81*	*102*	-3.0	2025 WP	RTOP	
973L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*108*	*120*	*104*	*115*	-5.0	2025 WP	RAS 189: Trip Unit #1 from Cascade (P2032)	*56*
	890L (Edson 58S to Pindale 207S)	*79*	*87*	*85*	*107*	*81*	*103*	-4.0	2025 WP	RAS 185: Trip Unit #1 from Cascade (P2032)	*54*
974L (Sundance 310P to Bickerdike 39S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*108*	*120*	*104*	*115*	-5.0	2025 WP	RAS 189: Trip Unit #1 from Cascade (P2032)	*56*

	890L (Edson 58S to Pindale 207S)	*79*	*87*	*85*	*107*	*81*	*103*	-4.0	2025 WP	RAS 185: Trip Unit #1 from Cascade (P2032)	*54*
7L28 (Big Mountain 845S to Thornton 2091S)	*7L80 (kakwa Ridge 857S to H.R. Milner 740S)*	*142.8*	*162.9*	*220*	*154*	*220*	*154*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*21*
	7L80 (Kakwa Ridge 857S to Simonette 733S)	*142.8*	*162.9*	*220*	*154*	*220*	*154*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*21*
	7L40 (Simonette 733S to Little Smoky 813S)	*155.2*	*171.5*	*199*	*128*	*199*	*128*	0.0	2025 WP	*RAS 171 (Send "thermal trip" to HR Milner)*	*10*
1012ST1 (Deer Hill 1012S transformer)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*35*	*38*	*93*	102	64.0	2025 WP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 86%	*83%*
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0	2025 WP	RTOP	
854L (Deer Hill 1012S to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*40*	*44*	*100*	*110*	66	2025 WP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 95%	*95%*
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0	2025 WP	RTOP	
614L (Benbow 397S to Berland Switching station- Pine Creek 328S)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*	*90*	*100*	-6.0	2025 WP	RTOP	
685L (Deer Hill 1012S to Berland Switching station-Pine creek 328S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*35*	*38*	*93*	*102*	64.0	2025 WP	if you add a cap bank (27 MVAR) at Berland this overload will reduce to 83%	*83%*
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*96*	*106*	*94*	*104*	-2.0	2025 WP	RTOP	
207S_T1 (Pinedale 207S transformer T1)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*96*	*106*	*95*	*105*	-1.0	2025 WP	RTOP	
207S_T2 (Pinedale 207S transformer T2)	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*98*	*109*	*96*	*107*	-2.0	2025 WP	RTOP	

744L (Niton 228S to Entwistle 235S) or 228S Niton transformer T1	*202L (Edson 58S to Cynthia 178S)*	*90.1*	*99*	*97*	*108*	*94*	*104*	-4.0	2025 WP	RTOP	
C5-973L-974L (Sundance 310P to Bickerdike 39S)	*720L (Fox Creek 347S to Benbow 397S)*	*91.1*	*100*	*196*	*215*	*179*	*196*	-19.0	2025 WP	RAS 190: Trip Unit #1 from Cascade (P2032)	*48%*
	202L (Edson 58S to Cynthia 178S)	*90.1*	*99*	*213*	*236*	*204*	*226*	-10.0	2025 WP	RAS 189: Trip Unit #1 from Cascade (P2032)	*84%*
	740L (Bickerdike 39S to Edson 58S)	*131*	*144*	*233*	*178*	*224*	*171*	-7.0	2025 WP	RAS 188: Trip Unit #1 from Cascade (P2032)	*72%*
	890L (Edson 58S to Pindale 207S)	*79*	*87*	*177*	*224*	*171*	*216*	-8.0	2025 WP	RAS 185: Trip Unit #1 from Cascade (P2032)	*82%*
	Bickerdike 39S T1	*269*	*269*	*360*	*134*	*366*	*136*	2.0	2025 WP	RAS 186: Trip Unit #1 from Cascade (P2032)	*66%*
	Bickerdike 39S T2	*269*	*269*	*360*	*134*	*355*	*132*	-2.0	2025 WP	RAS 186: Trip Unit #1 from Cascade (P2032)	*66%*
	744L (Pinedale 207S to Niton 228S)	*79.1*	*87*	*163*	*206*	*157*	*198*	-8.0	2025 WP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	66%
	744L (Niton 228S to 106S tap)	*79.1*	*87*	*157*	*199*	*151*	*191*	-8.0	2025 WP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	59%
	685L (Benbow 397S to Project 2630 Tap)	*201*	*218*	*223*	*111*	*205*	*102*	-9.0	2025 WP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	35%
	685L (Deer Hill 1012S to Project 2630 Tap)	*201*	*218*	*223*	*111*	*239*	119	8.0	2025 WP	(RAS 188) (RAS 186) Trip Unit #1 from Cascade (P2032)	54%

Table E-3: Constraints Summary Table – Voltage Stability Violations and Potential Mitigation for Scenario 3 for Alternative 2

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*400*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*65*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*74*	*Yes*
685L	*Deer Hill 1012S*	Pine Creek 328S	*75*	*Yes*
39ST1	*Bickerdike transformer T1*		*288*	*yes*
614L	Benbow 397S	Pine Creek 328S	*345*	*yes*

Table E-4: Constraints Summary Table – Voltage Stability Violations and Potential Mitigation for Scenario 4 for Alternative 2

Contingency (System Element Lost)	From	To	Maximum Incremental Transfer (MW)	Meets Criteria?
N-0	*System Normal*		*410*	*Yes*
854L	*Deer Hill 1012S*	*Bickerdike 39S*	*63*	*Yes*
685L	*Deer Hill 1012S*	Pine Creek 328S	*150*	*Yes*
1012ST1	*Deer Hill 1012S transformer*		*155*	*Yes*
39ST1	*Bickerdike transformer T1*		*390*	*yes*
614L	Benbow 397S	Pine Creek 328S	*400*	*yes*

Table E-5: Constraints Summary Table – Voltage Range Violations and Potential Mitigation for Scenario 3 for Alternative 2

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Post-project Initial Voltage (kV)	Post-project Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	13	138	124	152	139.2	121.2	131
	Chevron Kaybob 551S	82	138	124	152	139.2	121.2	131
	Benbow 397S	412	138	124	152	139.2	121.2	131
	Chevron Knight 355S	411	138	124	152	139.1	121.2	131
	P2630 Berland	526302	138	124	152	131.9	109.3	127
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	678	138	124	152	140.1	117	129
	Kaybob 346S	13	138	124	152	139.2	119.7	130
	Chevron Kaybob 551S	82	138	124	152	139.1	119.7	130
	Benbow 397S	412	138	124	152	139.2	119.7	130
	Chevron Knight 355S	411	138	124	152	139.1	119.7	130
	P2630 Berland	526302	138	124	152	131.9	107.5	124
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	13	138	124	152	138.4	122.7	130.8
	Chevron Kaybob 551S	82	138	124	152	138.4	122.7	130.8
	Benbow 397S	412	138	124	152	138.4	122.7	130.8
	Chevron Knight 355S	411	138	124	152	138.4	122.7	130.8
	P2630 Berland	526302	138	124	152	131.6	113.9	127.6

Table E-6: Constraints Summary Table – Voltage Range Violations and Potential Mitigation for Scenario 4 for Alternative 2

Contingency (System Element Lost)	Substation Name and Number	Bus Number	Nominal kV	Emergency Minimum Voltage (kV)	Emergency Maximum Voltage (kV)	Initial Voltage (kV)	Steady State Voltage (kV)	Post-Mitigation Steady State (kV)
1012ST1 (Deer Hill 1012S transformer)	Kaybob 346S	13	138	124	152	139.3	119.8	130
	Chevron Kaybob 551S	82	138	124	152	139.3	119.8	130
	Benbow 397S	412	138	124	152	139.3	119.8	130
	Chevron Knight 355S	411	138	124	152	139.3	119.8	130
	P2630 Berland	526302	138	124	152	132.2	117.9	126
854L (Deer Hill 1012S to Bickerdike 39S)	Deer Hill 1012S	678	138	124	152	140.6	115.1	127
	Kaybob 346S	13	138	124	152	139.3	117.9	128
	Chevron Kaybob 551S	82	138	124	152	139.3	117.9	128
	Benbow 397S	412	138	124	152	139.3	117.9	128
	Chevron Knight 355S	411	138	124	152	139.3	117.9	128
	P2630 Berland	526302	138	124	152	132.2	105.3	124
685L (Deer Hill 1012S to Berland Switching station - Pine Creek 328S)	Kaybob 346S	13	138	124	152	138.5	121.4	138.5
	Chevron Kaybob 551S	82	138	124	152	138.5	121.4	138.5
	Benbow 397S	412	138	124	152	138.5	121.4	138.5
	Chevron Knight 355S	411	138	124	152	138.5	121.4	138.5
	Berland River 1182S	526302	138	124	152	131.7	112.5	131.7

Study Scope

P2630 Berland River Load

Nova Gas Transmission Ltd.

Date: March. 1st, 2023

Version: V1

Classification: Public

Company Name	Name and Credentials	Date	Signature
AltaLink A Berkshire Hathaway Energy Company (Study Consultant)	Joby Varghese, P. Eng.	March 1, 2023	Joby Varghese
AESO	Mahmoud Ahmed, P. Eng.	March 2, 2023	Mahmoud Ahmed
Transmission Facility Operator	Luis Correal , P.Eng [Designated Reviewer]	Mar 1, 2023	Luis Correal
Nova Gas Transmission Ltd. (Market Participant)	Ben Ho	1-March-2023	Ben Ho

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1 Introduction

This Study Scope provides an overview of the engineering studies to be completed by AltaLink A Berkshire Hathaway Energy Company (the Studies Consultant) to assess the impact of the Project (as defined in section 1.1) on the performance of the Alberta interconnected electric system (AIES). Technical criteria, assumptions and methods for performing these engineering studies are provided in this document.

1.1 Project Overview

Nova Gas Transmission Ltd. (Market Participant) has submitted a request for system access service to the Alberta Electric System Operator (AESO) to connect its proposed Berland River Compressor Station (Facility) to the AIES.

The Market Participant's request includes: a request for a new system access service in the area, with a Rate STS, *Supply Transmission Service*, contract capacity of 0 MW and a Rate DTS, *Demand Transmission Service*, contract capacity of 37 MW; and a request for transmission development (collectively, the Project).

The Project in-service date (ISD) used for the purpose of the studies is Dec 17, 2025..

Load components of the Project are listed in Table 1-1.

Table 1-1: Project Load and Generation Details

Project Component	Description
Existing Rate DTS, *Demand Transmission Service,* contract capacity	No existing contract
Requested Rate DTS	37 MW
Type	An electric motor driven (EMD) compressor unit (expansion of an existing compressor station)
Motors (number and size)	30MW (40,000HP) motor with VFD, approx. 13.8kV voltage
Power factor	0.9

1.2 Existing System Overview

1.2.1 Study Area

Geographically, the Project is located in the AESO planning area of Hinton/Edson (Area 29) .

The Study Area consists of the AESO planning areas of Hinton/Edson (Area 29), Swan Hills (Area 26), Fox Creek (Area 24), Valleyview (Area 23), and Grande Cache (Area 22) and their neighbouring ties to the rest of the AIES.

The existing transmission system in the Study Area is shown in Figure 1-1.

1.2.2 Existing Constraints

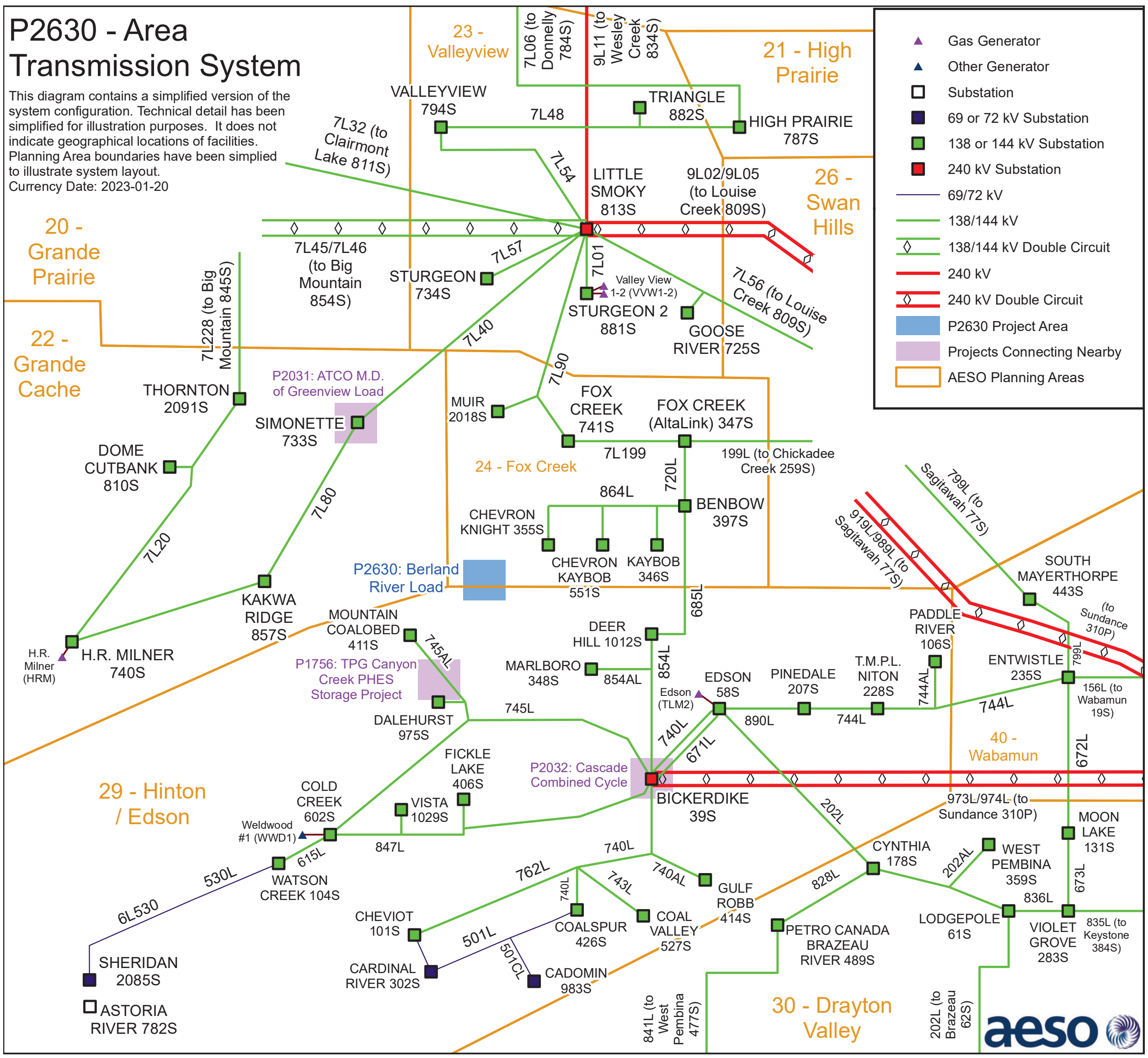
Existing constraints in the Study Area are managed in accordance with the procedures set out in Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

There are a number of constraints in the Study Area that are mitigated by existing remedial action schemes (RASs) and/or other protection schemes.

The following existing RASs and/or other protection schemes are used to manage constraints in the area:

- RAS 47 Obed Mountain Coal 411s-Load Trip Scheme
- RAS 163 Vista 1029S Under Voltage Mitigation Scheme

Figure 1-1: Transmission System in the Study Area



2 Connection Alternatives

The following alternatives will be examined:

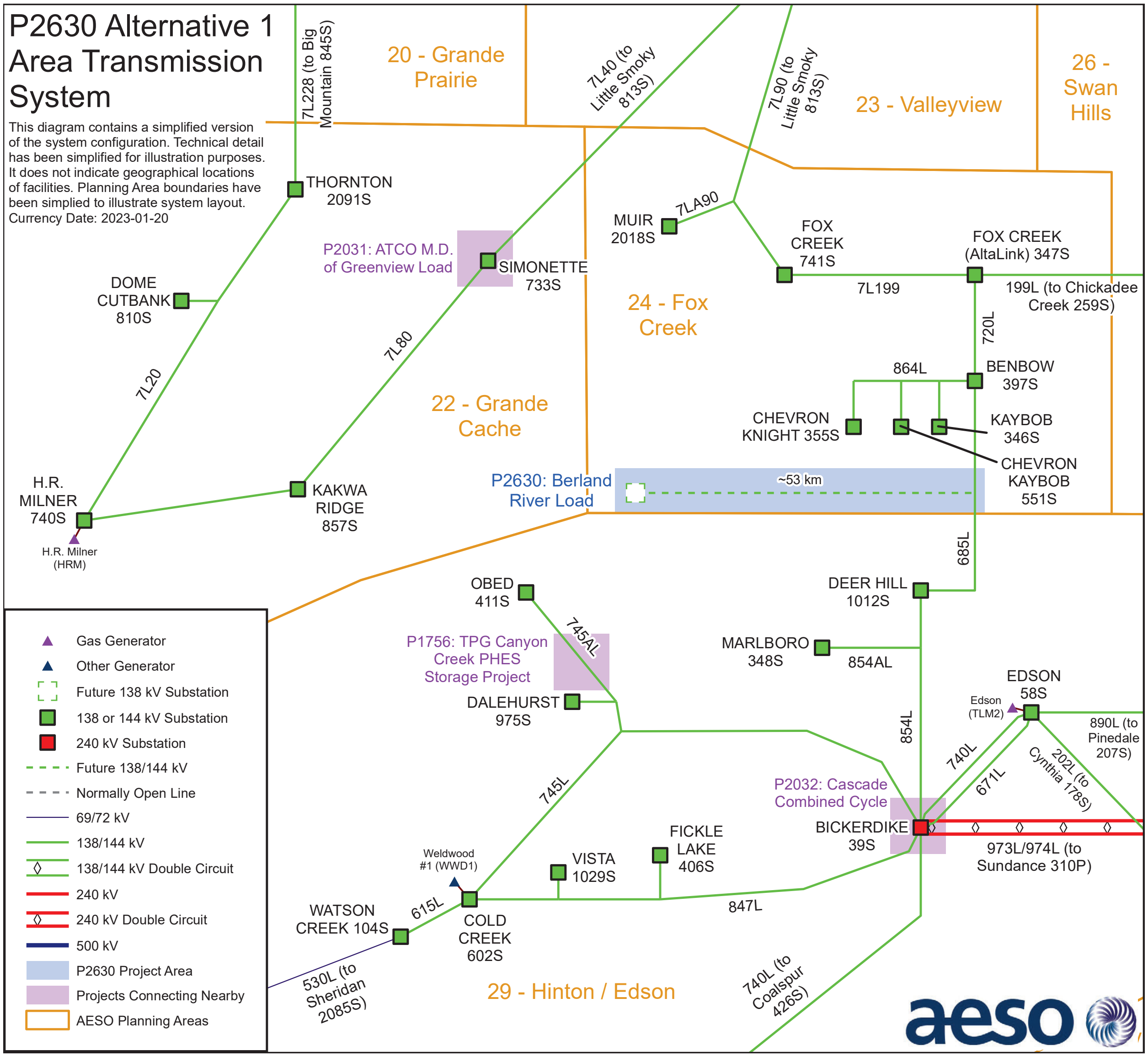
2.1 Alternative 1 – A New 138/25kV Point of Delivery connected from 685L via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 53 km in length, from the new POD to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S Substations via T Tap configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-1.

Figure 2-1: Connection Alternative 1



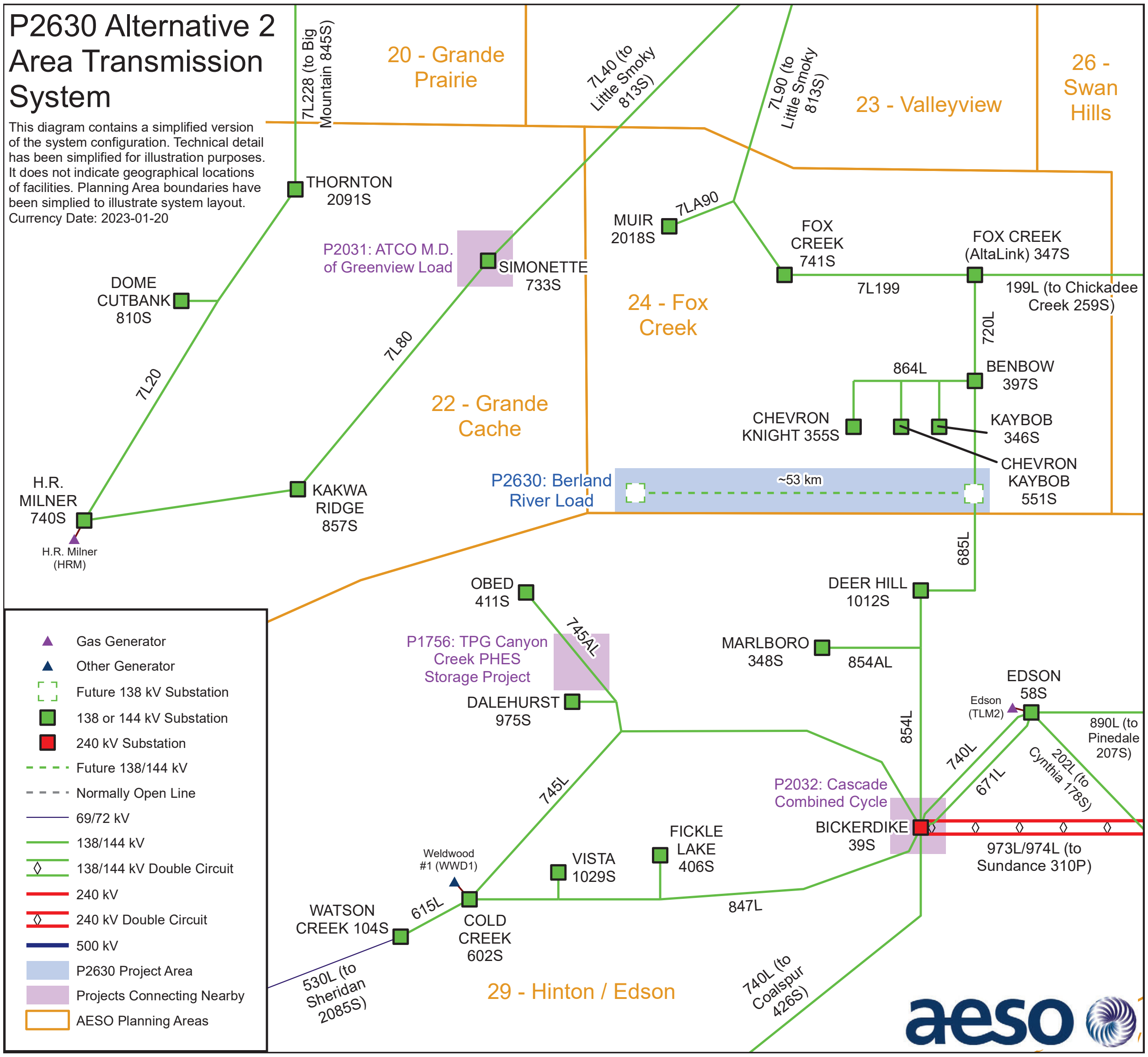
2.2 Alternative 2 – A New 138/25kV Point of Delivery connected from 685L via an an In-and-out Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 53 km in length, from the new POD to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S Substations via an In-and-out configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-2.

Figure 2-2: Connection Alternative 2



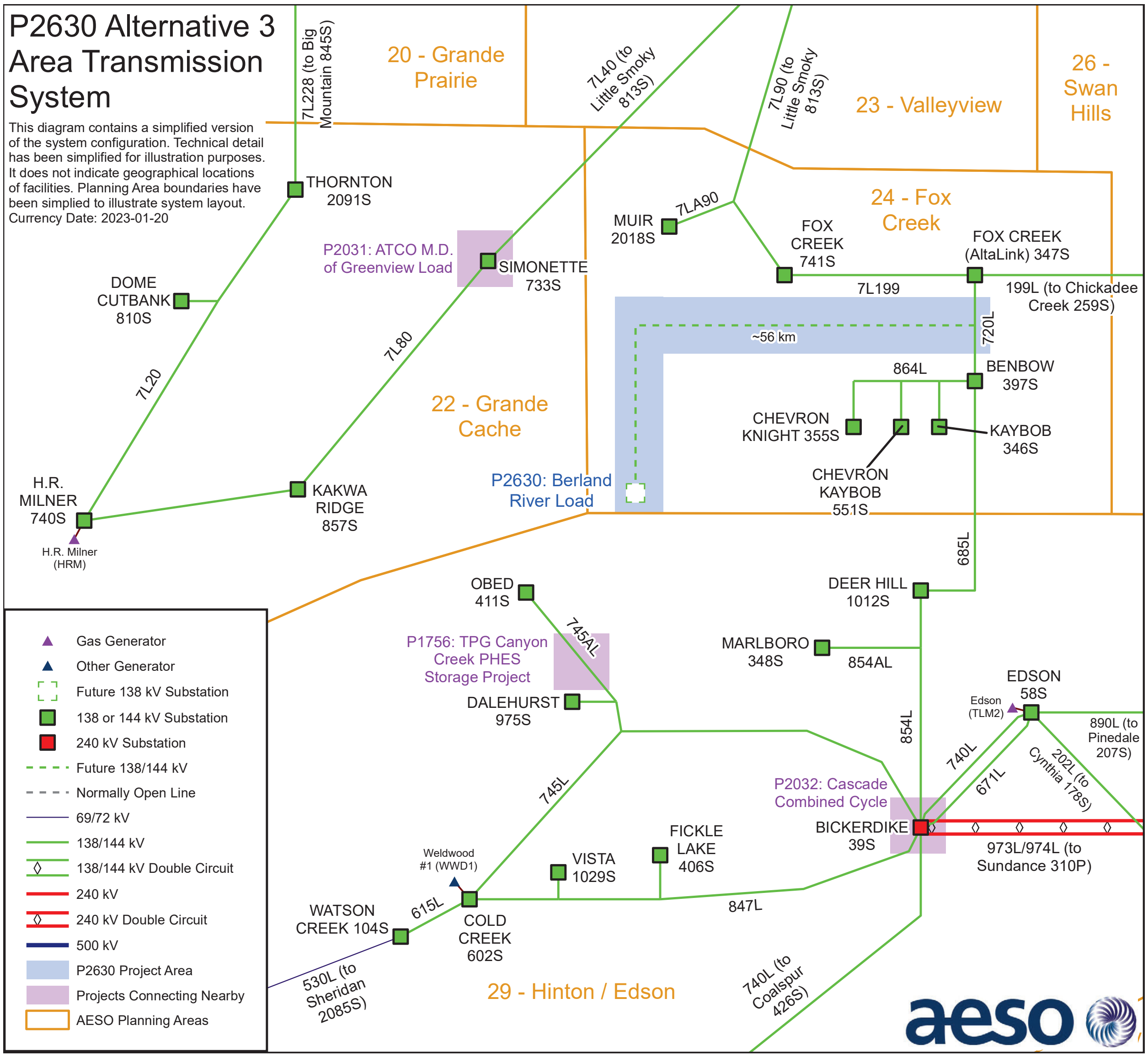
2.3 Alternative 3 – A New 138/25kV Point of Delivery connected from 720L via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing 138 kV transmission line 720L between Benbow 397S and Fox Creek 347S Substations via T Tap configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-3.

Figure 2-3: Connection Alternative 3



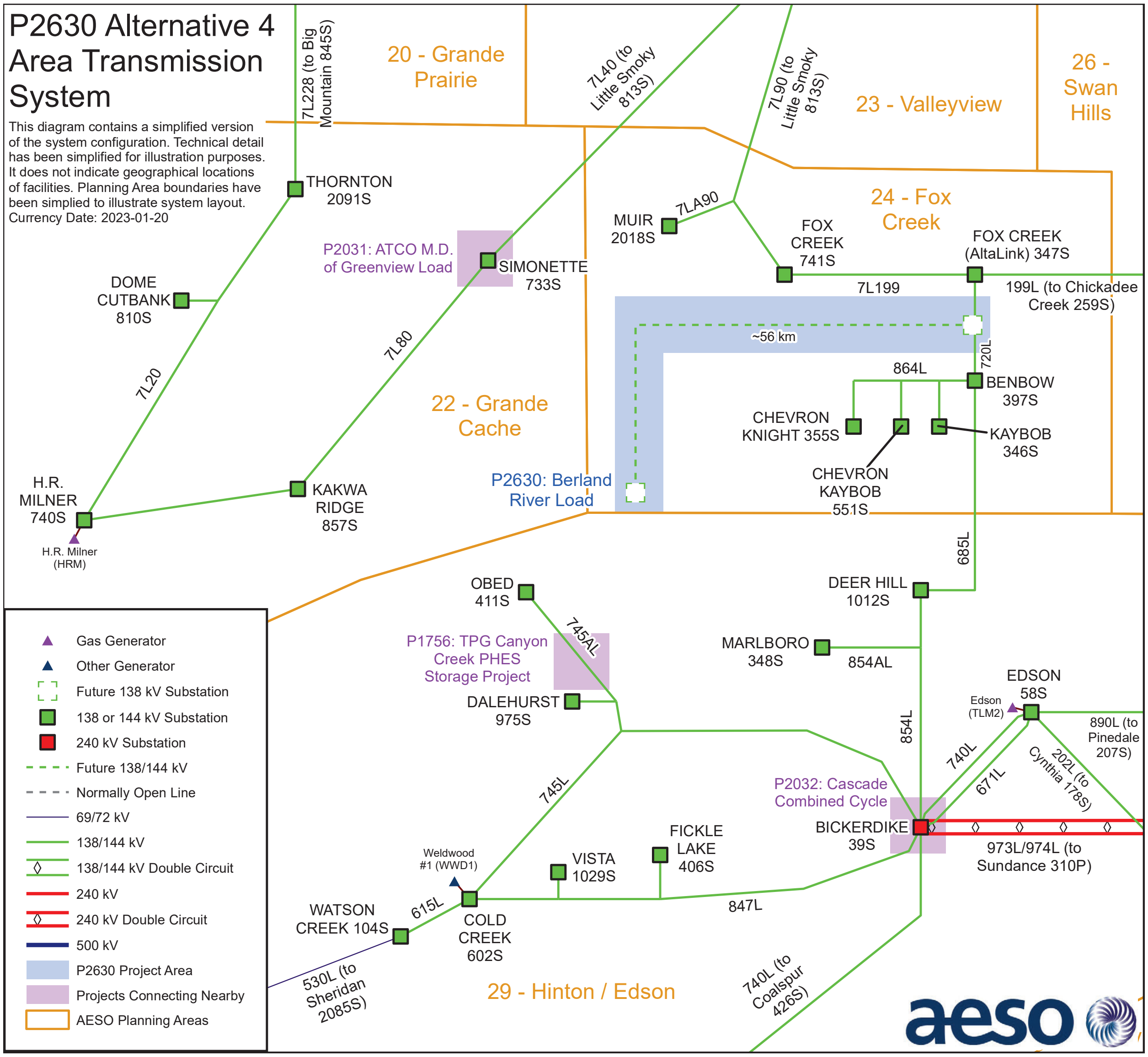
2.4 Alternative 4 – A New 138/25kV Point of Delivery connected from 720L via an In-and-out Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing 138 kV transmission line 720L between Benbow 397S and Fox Creek (AltaLink) 347S Substations via an In-and-out configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-4..

Figure 2-4: Connection Alternative 4



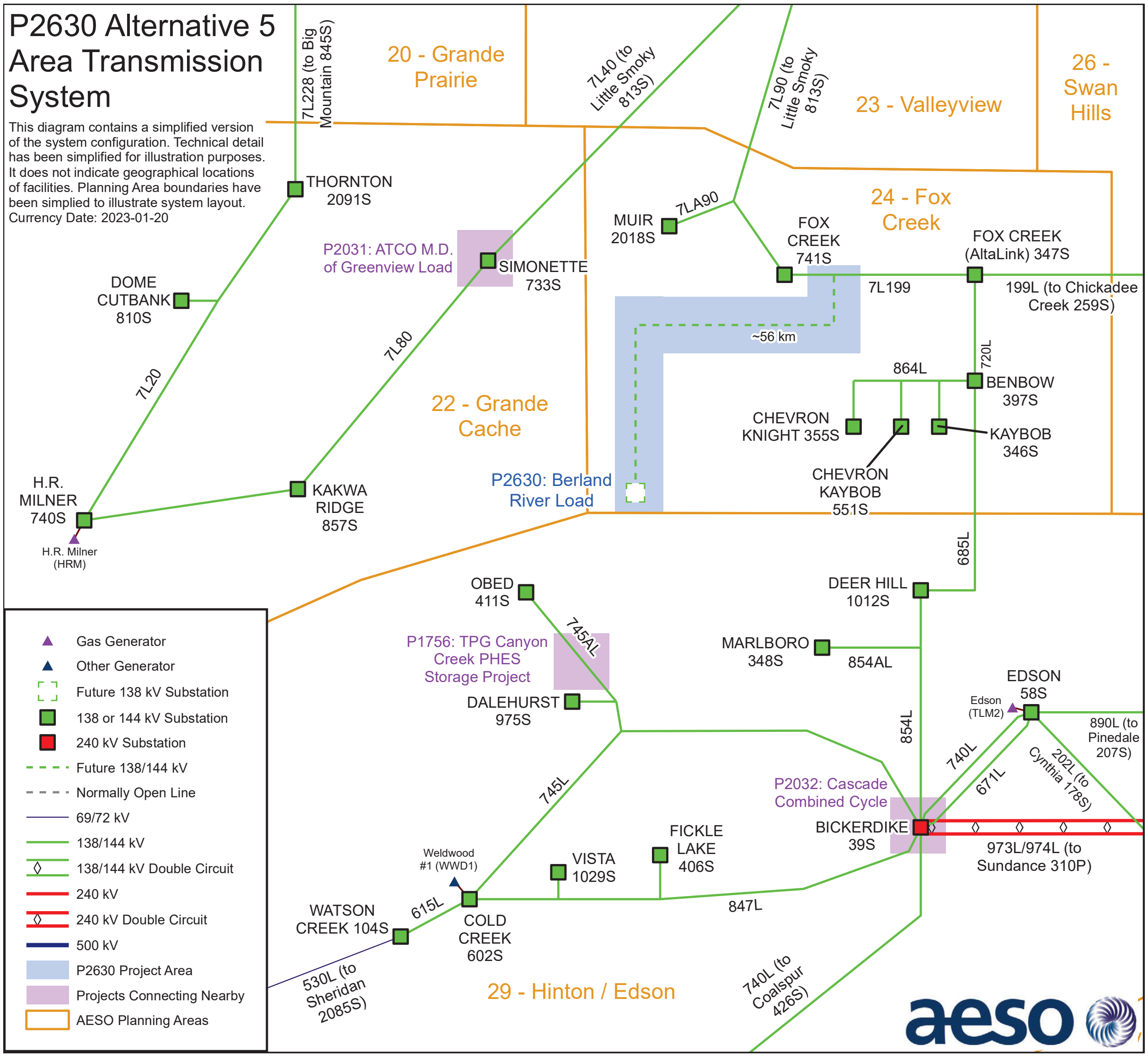
2.5 Alternative 5 – A New 138/25kV Point of Delivery connected from 7L199 via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing 138 kV transmission line 7L199 between Fox Creek (AltaLink) 347S and Fox Creek 741S Substations via T Tap configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-5.

Figure 2-5: Connection Alternative 5



2.6 Alternative 6 – A New 138/25kV Point of Delivery connected from 7L199 via an In-and-out Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing 138 kV transmission line 720L between Fox Creek (AltaLink) 347S and Fox Creek 741S Substations via an In-and-out configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-6.

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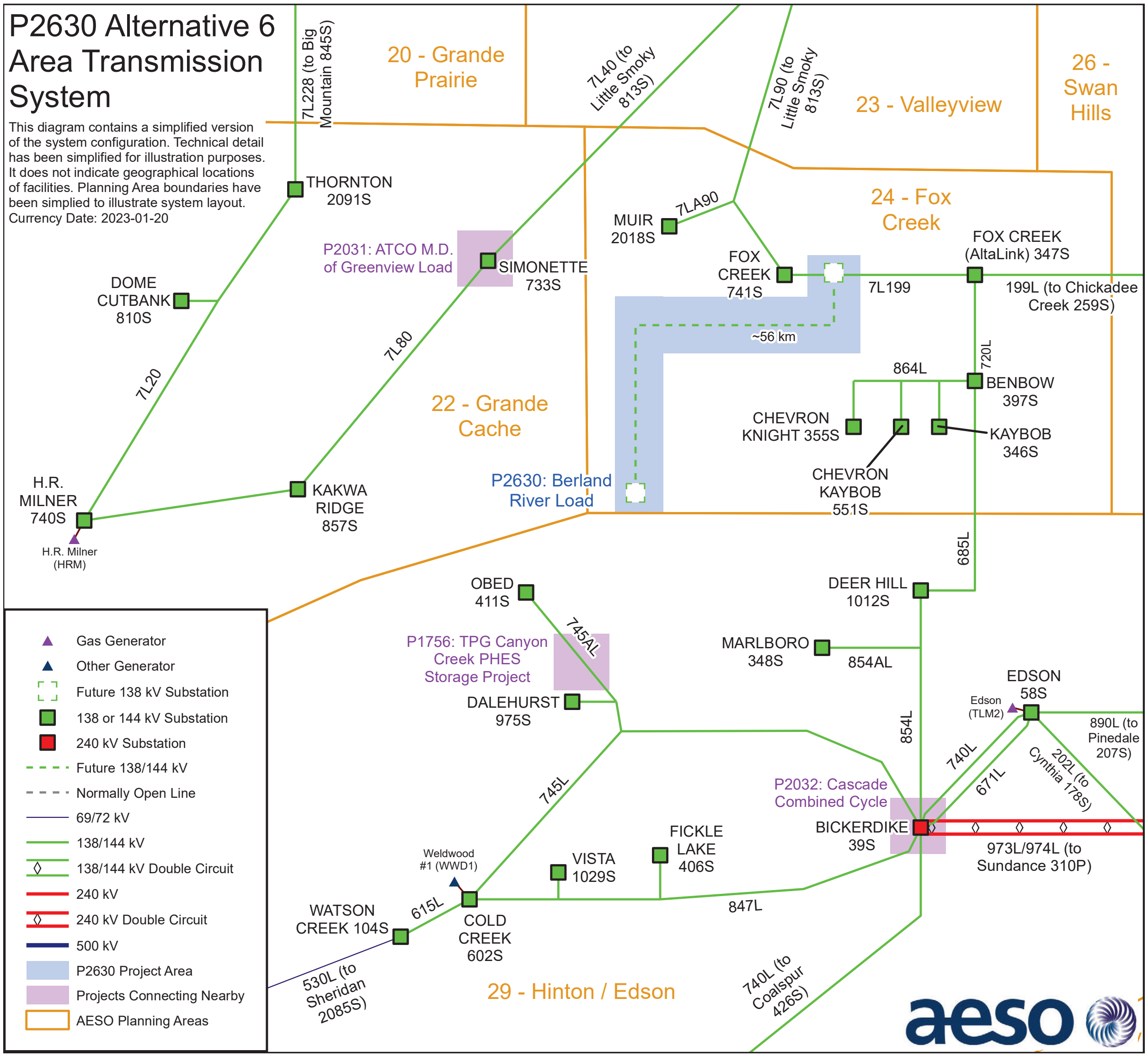
Figure 2-6: Connection Alternative 6



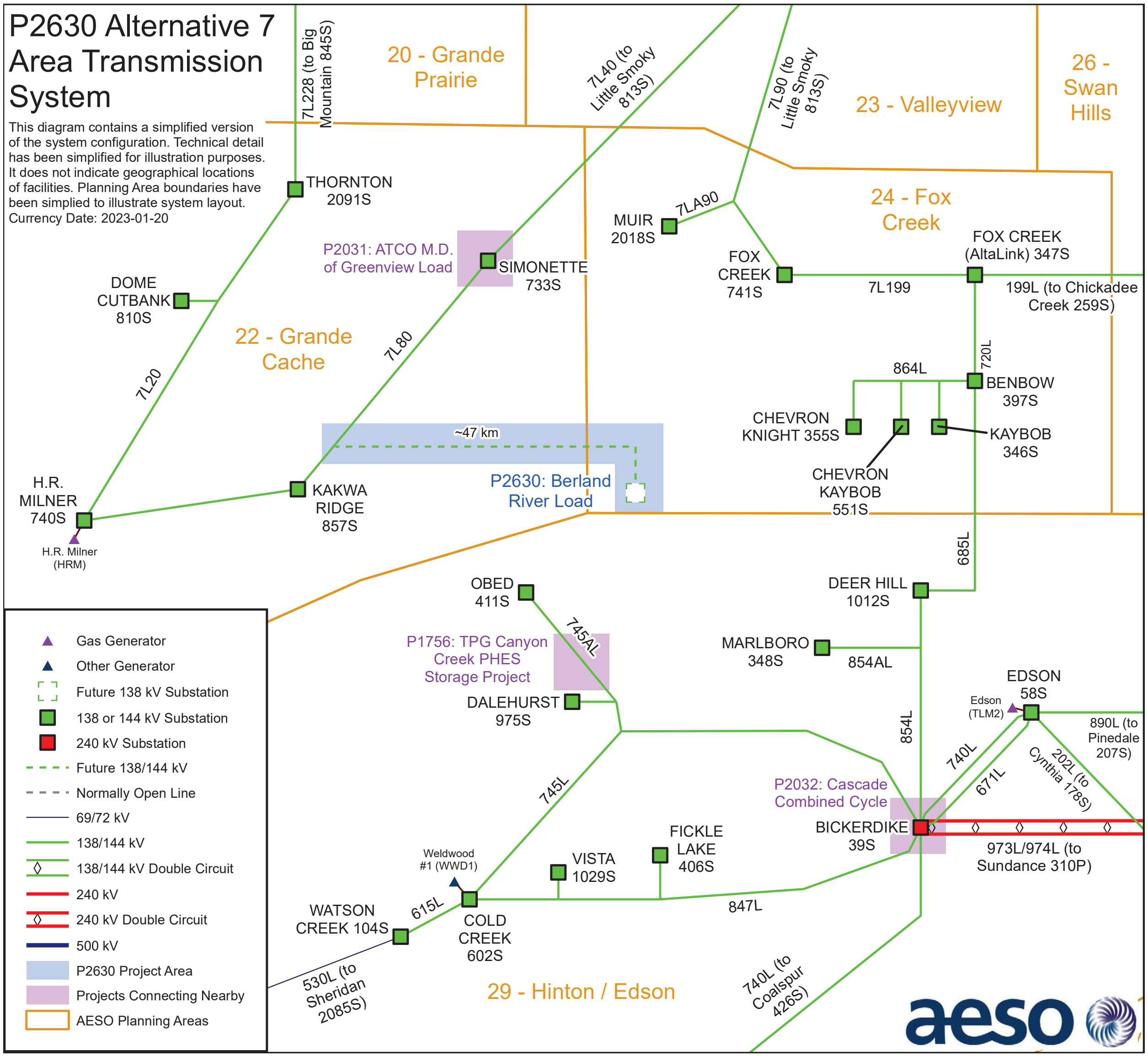
2.7 Alternative 7 – A New 138/25kV Point of Delivery connected from 7L80 via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 47 km in length, from the new POD to the existing 138 kV transmission line 7L80 between Simonette 733S and Kakwa Ridge 857S Substations via T Tap configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-7.

Figure 2-7: Connection Alternative 7



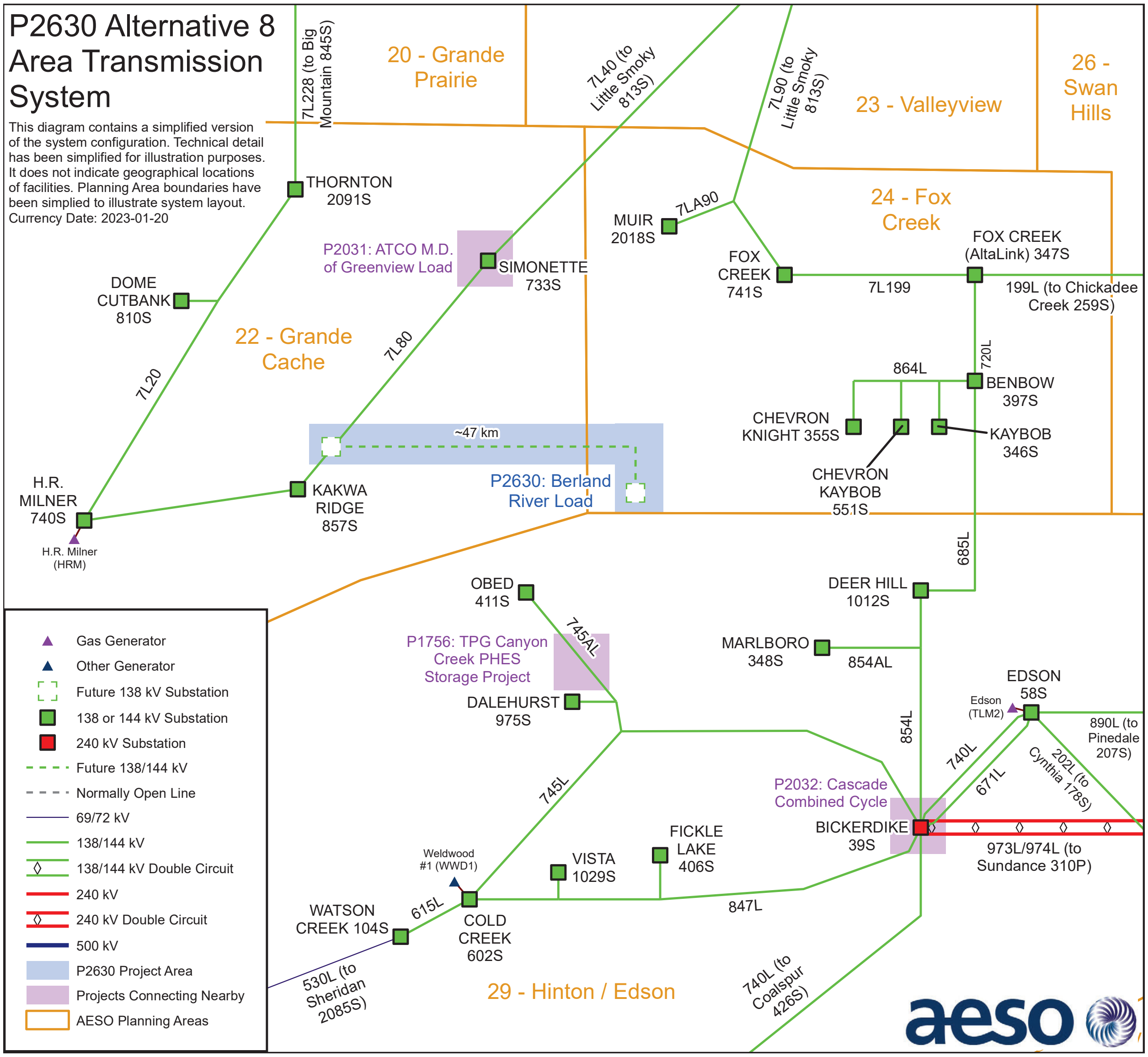
2.8 Alternative 8 – A New 138/25kV Point of Delivery connected from 7L80 via an In-and-out Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 47 km in length, from the new POD to the existing 138 kV transmission line 7L80 between Simonette 733S and Kakwa Ridge 857S Substations Substations via an In-and-out configuration.
- Add or modify associated equipment as required for the above transmission developments.

The proposed connection configuration is shown in Figure 2-8.

Figure 2-8: Connection Alternative 8



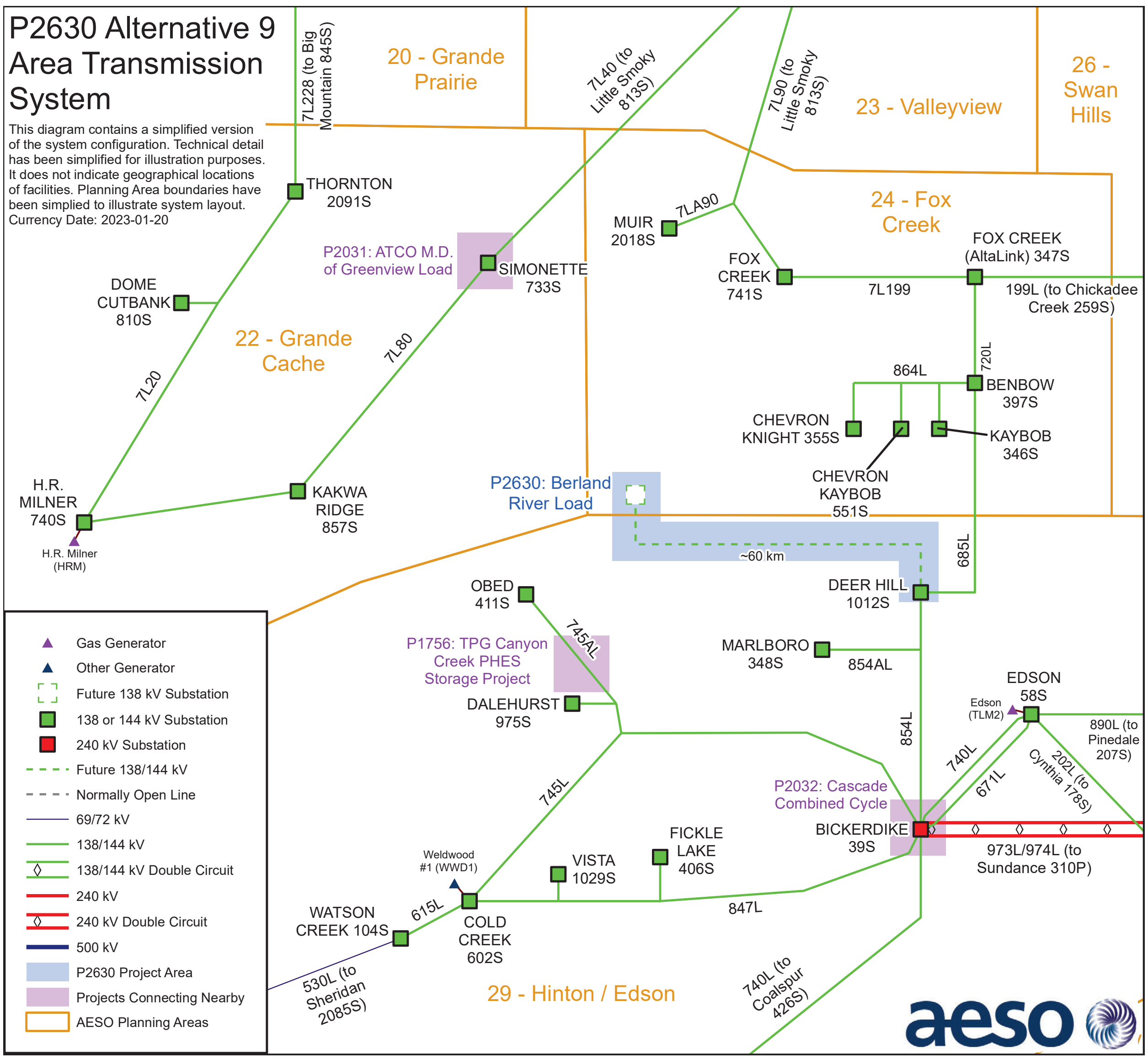
2.9 Alternative 9 – Radial Connection to the Existing Deer Hill 1012S Substation

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 60 km in length, from the new POD to the existing Deer Hill 1012S via a radial connection.

The proposed connection configuration is shown in Figure 2-9.

Figure 2-9: Connection Alternative 9



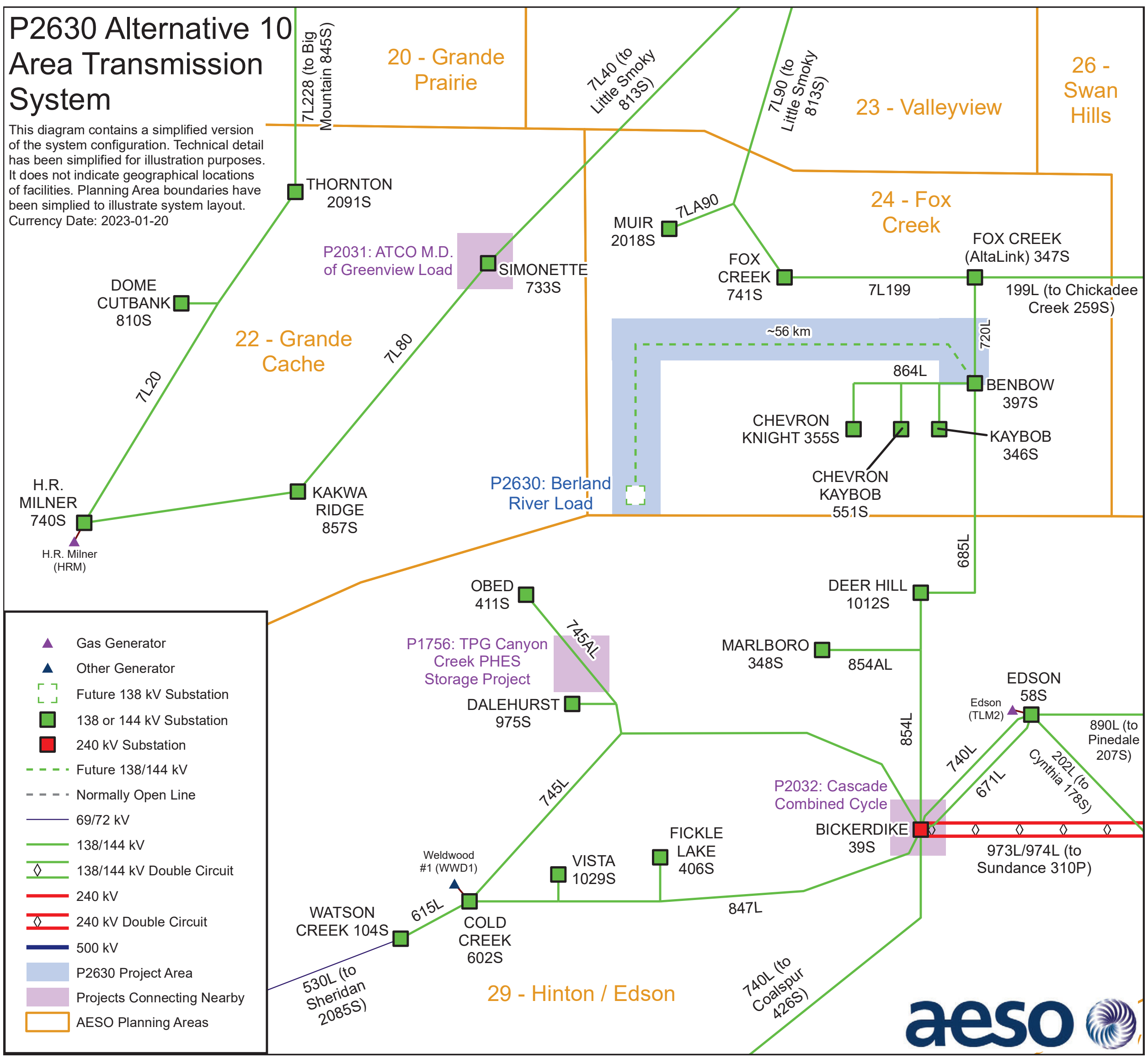
2.10 Alternative 10 – Radial Connection to the Existing Benbow 397S Substation

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing Benbow 397S substation via a radial connection.

The proposed connection configuration is shown in Figure 2-10.

Figure 2-10: Connection Alternative 10



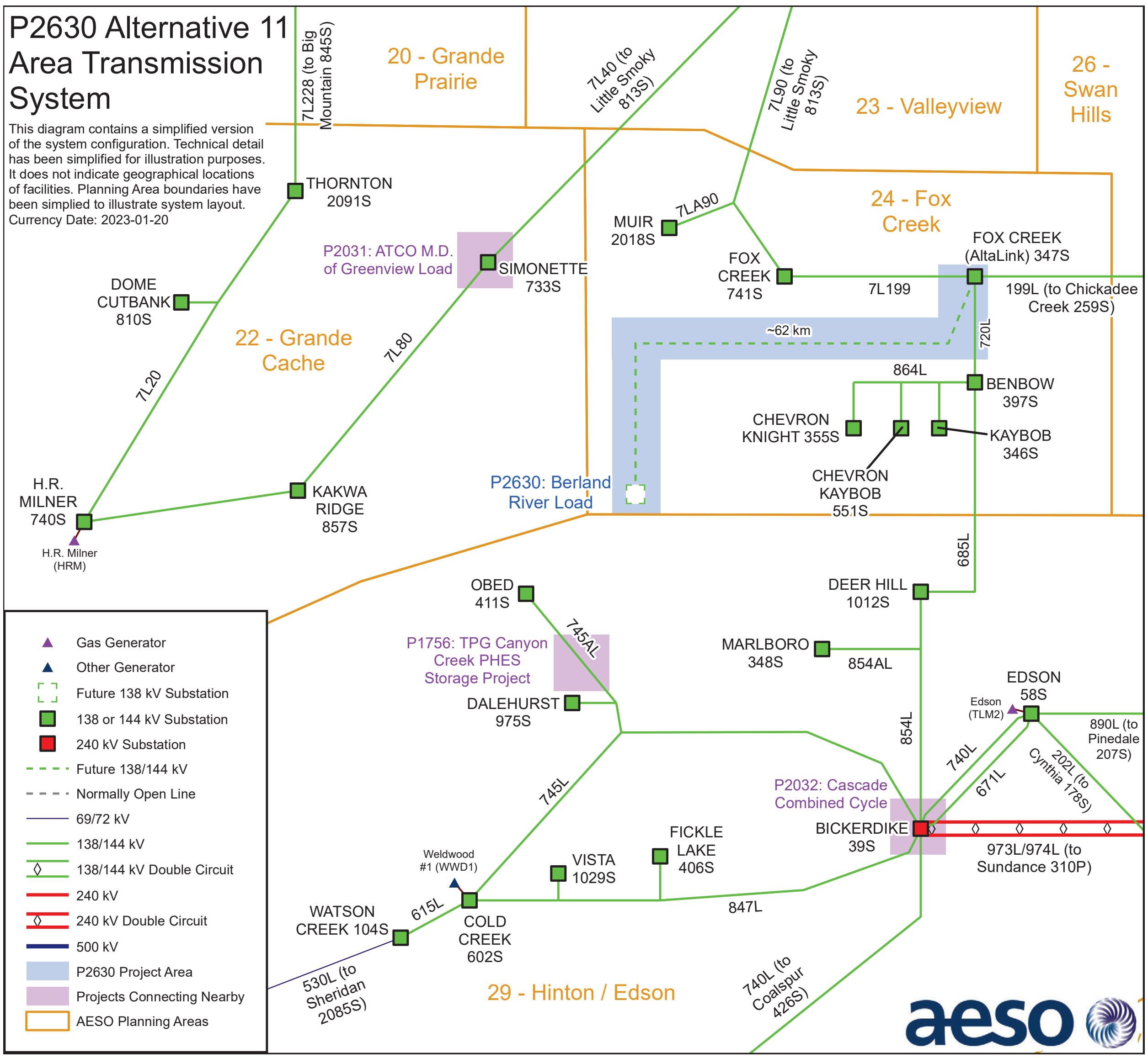
2.11 Alternative 11 – Radial Connection to the Existing Fox Creek (AltaLink) 347S Substation

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 62 km in length, from the new POD to the existing Fox Creek (AltaLink) 347S substation via a radial connection.

The proposed connection configuration is shown in Figure 2-11.

Figure 2-11: Connection Alternative 11



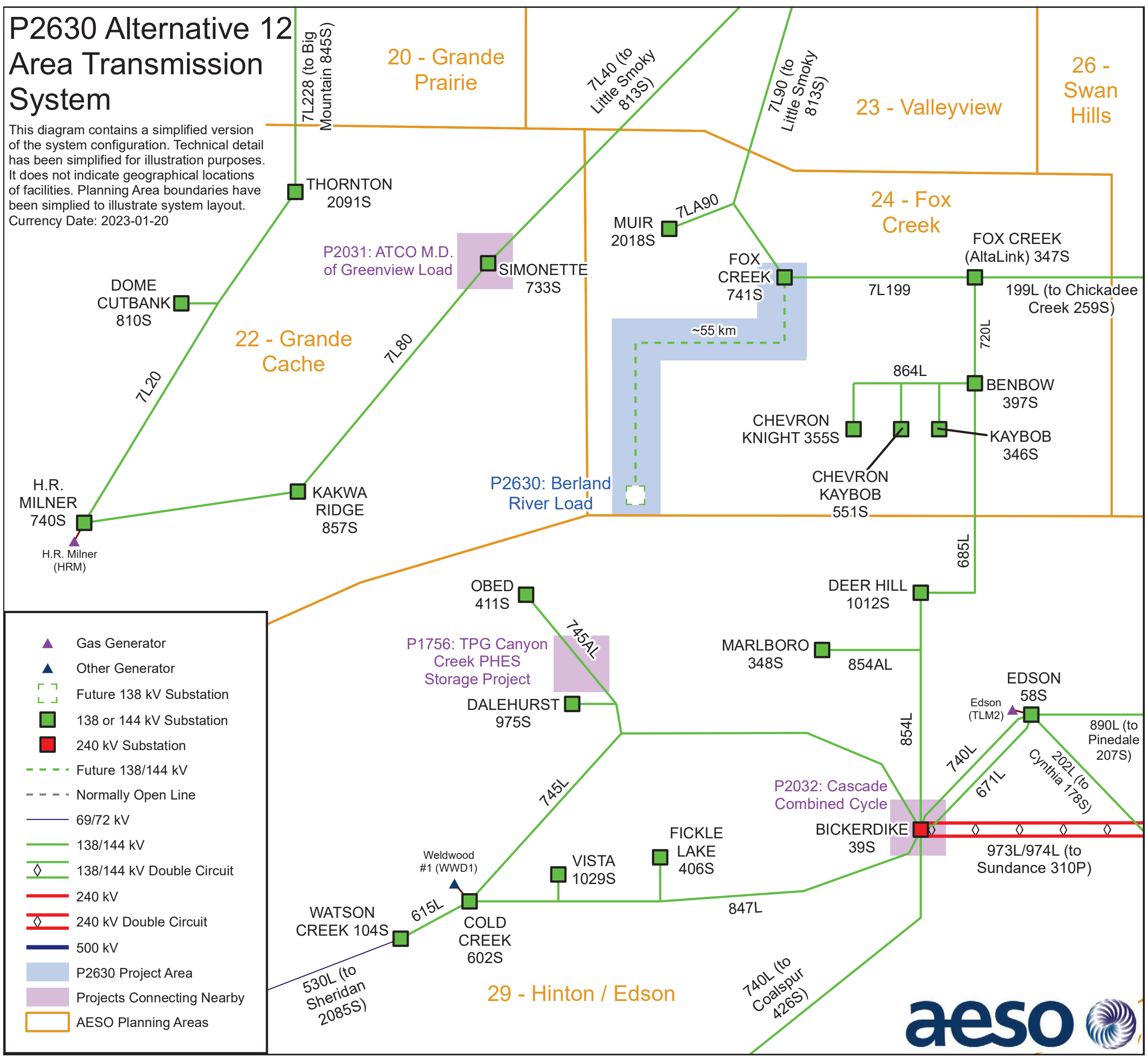
2.12 Alternative 12 – Radial Connection to the Existing Fox Creek 741S Substation

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 55 km in length, from the new POD to the existing Fox Creek 741S substation via a radial connection.

The proposed connection configuration is shown in Figure 2-12.

Figure 2-12: Connection Alternative 12



2.13 Alternative 13 – Radial Connection to the Existing Simonette 733S Substation

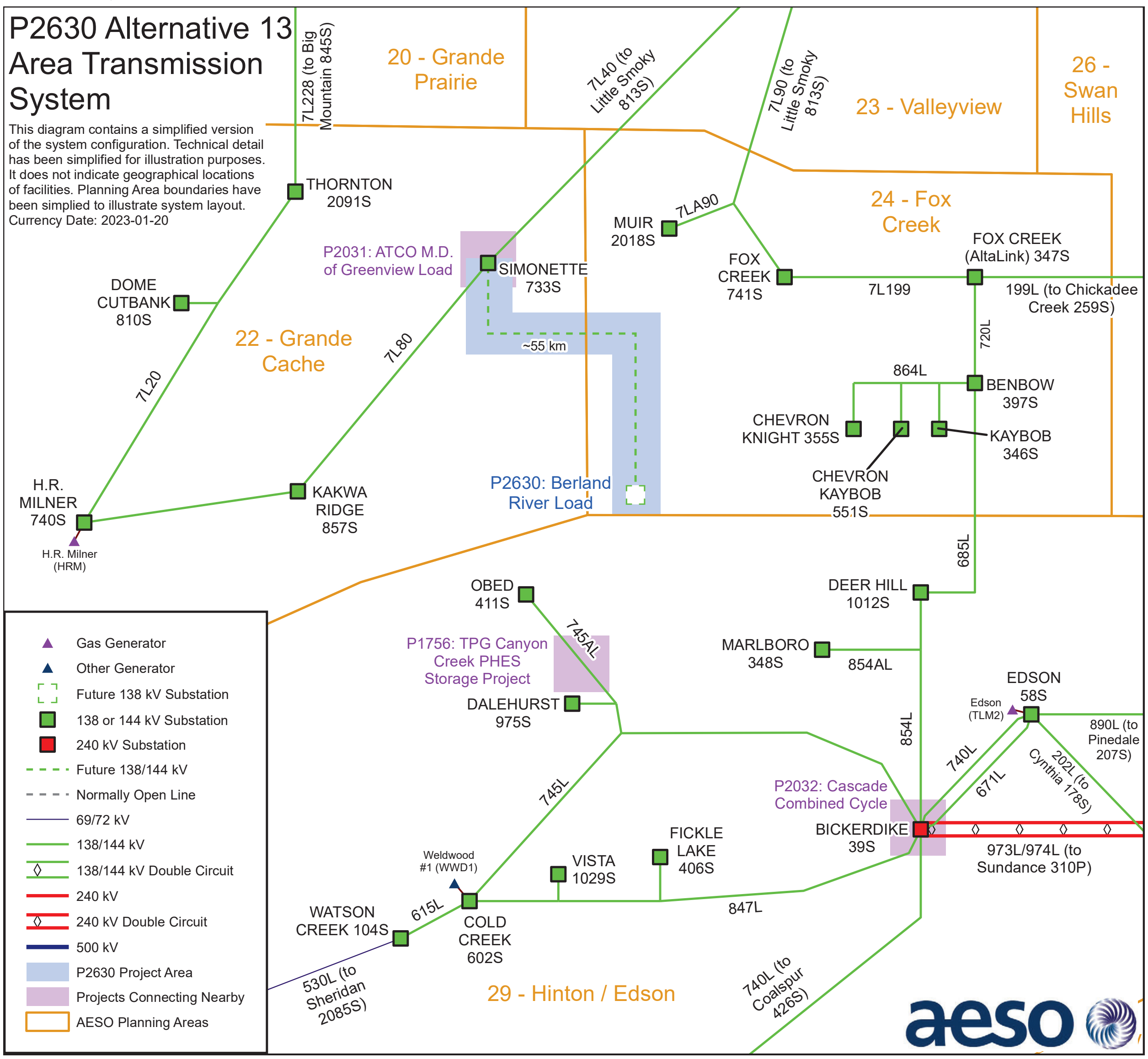
This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 55 km in length, from the new POD to the existing Simonette 733S substation via a radial connection.

The proposed connection configuration is shown in Figure 2-13.

Figure 2-13: Connection Alternative 13

Therefore,



2.14 Connection Alternatives Selected for Further Studies

Alternative 1 is selected for further studies. Alternative 2 has the same injection point into the system and the same impact as Alternative 1.

Alternative 3 and 4 have longer and more complex routes and therefore, these Alternatives will not be considered unless Alternative 1 is not technically acceptable.

Alternative 5, 6 and 12 have longer and more complex routes. Also, additional consultation with ATCO is required to determine the feasibility of these Alternatives. Therefore, these Alternatives are not selected for further consideration.

Alterntaives 7, 8, and 13 are not selected for further consideration as they may result in N-0 violations. Also, these Alternatives may limit potential future requests on higher capacity/load required.

Alternatives 9, 10, and 11 require substation fence expansion (as confirmed by AML) and therefore, additional transmission scope and associated costs. Therefore, Alternatives 9, 10, and 11 are not selected for further consideration.

3 Criteria, Standards and Requirements

3.1 AESO Reliability Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and *Transmission Planning Criteria – Basis and Assumptions (see Attachment A),* (collectively, the Reliability Criteria) will be applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

Category A, often referred to as the N-0 condition, represents a normal system with no contingencies and all facilities in service. Under this condition, the system must be able to supply all firm load and firm transfers to other areas. All equipment must operate within its applicable rating, voltages must be within their applicable range, and the system must be stable with no cascading outages.

Category B events, often referred to as an N-1 or N-G-1 with the most critical generator out of service, result in the loss of any single specified system element under specified fault conditions with normal clearing. These elements are a generator, a transmission circuit, a transformer, or a single pole of a DC transmission line. The acceptable impact on the system is the same as Category A. Planned or controlled interruptions of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) transmission service electric power transfers.

Category C5 events results in loss of two circuits of a multiple circuit tower. All equipment must operate within its applicable rating, voltages must be within their applicable range, and the system must be stable with no cascading outages. For Category C5, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted firm (non-recallable reserved) transmission service electric power transfers may be necessary to maintain the overall reliability of the interconnected transmission systems.

The TPL standards, TPL-001-AB-0, TPL-002-AB1-0, [and TPL-003-AB-0], have referenced Applicable Ratings when specifying the required system performance under Category A, Category B, [and Category C5] events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

- Normal thermal rating of the line's loading limits for each season;
- The highest specified loading limits for transformers;
- For Category A conditions: Voltage range under normal operating condition per AESO Information Document #2010-007RS, *General Operating Practices – Voltage Control* (ID #2010-007RS). For the busses not listed in ID #2010-007RS, Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions* applies;
- For Category B [and Category C5] conditions: The extreme voltage range values per Table 2-1 in the *Transmission Planning Criteria – Basis and Assumptions; and*
- Desired post-contingency voltage deviation limits for three defined post-event timeframes as provided in Table 3-1.

Table 3-1: Post-Contingency Voltage Deviation Guidelines for Low Voltage Busses

Parameter and reference point	Time Period		
	Post Transient (up to 30 sec)	Post Auto Control (30 sec to 5 min)	Post Manual Control (Steady State)
Voltage deviation from steady state at point of delivery (POD) low voltage bus.	±10%	±7%	±5%

3.2 ISO Rules and Information Documents

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for the Study Area.

The TCM Rule will be followed to set up the study scenarios and assess the impact of the Project. In addition, due regard will be given to the following:

- The AESO's *Connection Study Requirements*;
- Section 502.7 of the ISO rules, *Load Facility Technical Requirements*;

4 Scenarios and Assumptions

4.1 Scenarios

The following section describes the scenarios to be studied and the assumptions to be used in the studies.

Connection scenarios must be studied as outlined in Table 4-1.

Table 4-1: Connection Study Scenarios

Scenario No.	Year/Season	System Generation Dispatch Conditions	Scenario Name	Project Load (MW)
Pre-Project				
1	2025 Summer Peak (SP)	Low Generation	2025 SP Pre-Project	0
2	2025 Winter Peak (WP)		2025 WP Pre-Project	0
Post-Project				
3	2025 Summer Peak (SP)	Low Generation	2025 SP Post Project	37
4	2025 Winter Peak (WP)		2025 WP Post Project	37
5	2031 Winter Peak (WP)	All Generation ON	2031 WP Post-Project	37

4.2 Assumptions

4.2.1 System Project Assumptions

The pre-Project and post-Project connection assessment will not include any system transmission projects because there are no planned system transmission developments in the Study Area that are expected to be in service before the scheduled Project ISD.

4.2.2 Connection Project Assumptions

The pre-Project and post-Project connection assessment will not include any other connection projects in the Study Area.

4.2.3 Load Assumptions

The load forecast to be used for the studies is shown in Table 4-2 and is a forecast for the AESO Central Planning Region peak based on the AESO's 2021 Long-term Outlook (2021 LTO)[1] with modifications to incorporate the latest forecast intelligence. For the post-Project studies, when the Study Area loads are

[1] The [e.g., 2017 LTO] is available on the AESO website.

modified to align with the regional load forecast, the active power to reactive power ratio in the base case scenarios shall be maintained.

Table 4-2: Forecast Load (at AESO Central Planning Region Peak)

AESO Planning Area or Region Name	Forecast Peak Load by Year/Season (MW)	
	2025 SP	2025 WP
Hinton/Edson (Area 29)	168	166
Central Planning Region[1]	2013	2239
AIL without Losses	11355	11939

Note:
[1] The Central Region comprises the following AESO planning areas: Vegreville (Area 56), Lloydminster (Area 13), Wainwright (Area 32), Provost (Area 37), Alliance/Battle River (Area 36), Hanna (Area 42), Red Deer (Area 35), Didsbury (Area 39), Caroline (Area 38), Drayton Valley (Area 30), Hinton/Edson (Area 29), Abraham Lake (Area 34), Cold Lake (Area 28).

4.2.4 Generation Assumptions

The generation forecast to be used for the studies is based on the 2021 LTO with modifications to incorporate the latest forecast intelligence. The generation assumptions for the studies will assume Low Central regional generation dispatch. Additional studies may be required in the event of changes to the AESO's corporate forecast.

The existing generation (excluding wind and solar) dispatch conditions for the study scenarios are described in Table 4-3.

Whitecourt Power (EAGL) was determined to be the critical generator, and shall be modelled as being offline to simulate the N-G condition in all the study scenarios.

Table 4-3: Existing Generation (excluding Wind and Solar) Dispatch Conditions

Facility Name	Bus No.	MC (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				Low Generation	
				2025 SP	2025 WP
Whitecourt Power (EAGL)	408	25	26	25	24
NRGreen (NRG3)	2674	16	26	8	4
AB Newsprint (ANC1)	2296, 4296	63	26	58	55
Judy Creek (GEN6)	19272	15	26	10	11
Carson Creek (GEN5)	2335	15	26	10	10
House Mountain (HSM1)	19240	6	26	3	2
H.R. Milner Gas (P2158 Maxim Power Milner Change)	557147	300	22	166	286
Weldwood #1 (WWD1)	4017	50	29	27	37

Facility Name	Bus No.	MC (MW)	AESO Planning Area No.	Unit Net Generation[a] (MW) by Scenario	
				Low Generation	
				2025 SP	2025 WP
Edson (TLM2)	13020	13	29	5	5
P2032 Cascade Combined Cycle	557014, 558014	900	29	721	720
Valley View 1 (VVW1)	1171	50	23	10	13
Valley View 2 (VVW2)	1173	50	23	28	19

Notes:
[a] "Unit Net Generation" refers to gross generating unit output (MW) less unit service load.
[b] "N-G" indicates the critical generating unit that is assumed by the AESO to be offline to test the N-G contingency condition
[c] "Not in merit" means that the generating unit has operating blocks whose prices are above the system marginal price.

4.2.5 Intertie Flow Assumptions

The Alberta-British Columbia (AB-BC), Alberta-Saskatchewan (AB-SK), and Alberta-Montana (MATL) intertie points are deemed to be too far away from the Study Area to have any material impact on the connection assessment. Therefore, intertie flow values shall be set to the AESO planning base case values and will not be adjusted for the studies.

4.2.6 HVDC Power Order Assumptions

The Western Alberta Transmission Line (WATL) and the Eastern Alberta Transmission Line (EATL) are high-voltage direct current (HVDC) transmission lines. The HVDC power order assumptions for the studies will be set to minimize losses for the pre-Project and post-Project study scenarios.

The reactive power limits of the MVAr exchanges between the HVDC terminals (WATL and EATL) and the connected alternating current (AC) transmission systems are shown in Table 4-4. These limits must be maintained when performing the studies.

Table 4-4: HVDC to Adjacent AC System MVAr Exchange Limits

HVDC Facility	North Terminal Reactive Power Limit (MVAr)	South Terminal Reactive Power Limit (MVAr)
EATL	-85 to 75	-35 to 35
WATL	-75 to 75	-35 to 35

4.2.7 Transmission Facility Ratings

The legal owner(s) of transmission facilities (TFO(s)) provided the thermal ratings assumptions for the existing transmission lines in the Study Area. Table 4-5 shows the normal ratings and emergency ratings for the key transmission lines in the Study Area, which will be used to perform the engineering studies.

Table 4-5: Thermal Rating Assumptions for Key Transmission Lines in the Study Area

Line ID	From Substation	To Substation	Voltage Class (kV)	Winter Normal Rating (MVA)	Winter Emergency Rating (MVA)	Summer Normal Rating (MVA)	Summer Emergency Rating (MVA)
199L	ATCO 7L199	Fox Creek 347S	138	146	161	119	131
671L	Edson 58S	Bickerdike 39S	138	212	233	172	189
685L	Deer Hill 1012S	Benbow 397S	138	201	218	167	184
740L	Edson 58S	Bickerdike 39S	138	135	146	112	124
744L	Pinedale 207S	TMPL Niton 228S	138	79	87	75	83
744L	Entwistle 235S	TMPL Niton 228S	138	79	87	75	83
854L	Bickerdike 39S	JCT. 854AL	138	263	373	263	311
854L	JCT. 854AL	Deer Hill 1012S	138	287	373	283	311
854AL	JCT. 854L	Marlboro 348S	138	138	149	115	126
720L	Fox Creek	Benbow 397S	138	91	100	86	95
864L	Benbow 397S	JCT. 864AL	138	133	146	99	109
864L	Jct. 864AL	JCT. 864BL	138	91	100	86	95
864L	Jct. 864BL	Chevron Kaybob 355S	138	133	146	99	109
864AL	Jct. 864L	Kaybob 346S	138	133	146	99	109
864BL	Jct. 864L	Chevron Knight 355S	138	133	146	99	109
7L199	Fox Creek 741S	AML Fox Creek 347S	138	146L	157L	114L	129L

Note:
"CT" indicates that the transmission line is limited by current transformer.

"L" indicates that the transmission line rating is limited by the line

"M" indicates that the transmission line rating is limited for reasons other than protection equipment, transformer, current transformer, line, ganged switch, circuit breaker, or regulator.

The TFOs provided the details of the substation transformers in the Study Area. The key transformers in the Study Area are shown in Table 4-6.

Table 4-6: Summary of Key Transformer Ratings in the Study Area

Substation (Name and Number)	Transformer ID	Transformer Voltages (kV)	Tranformer Rating (MVA)
Bickerdike 39S	T1	240/138	269
	T2	240/138	269

The TFOs provided the details of the shunt elements in the Study Area. The key shunt elements in the Study Area are shown in Table 4-7.

Table 4-7: Summary of Key Shunt Elements in the Study Area

Substation Name and Number	Voltage Class (kV)	Capacitors		Reactors	
		Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)	Number of Switched Shunt Blocks	Total at Nominal Voltage (MVAr)
Cold Creek 602S	138	1 x 32.5	32.5		
Edson 58S	138	1 x 27	27.0		
Brazeau 62S	138	1 x 33	33.		
Cynthia 178S	138	1 x 27	27.0		
Amoco Brazeau 358S	138	1 x 21MVAr	21.0		
Violet Grove 283S	138	1 x 25 MVAr	25.0		

4.2.8 Project Dynamic Data

Dynamic data for the Project will be based on the Stage 1 Project Data Update Package (PDUP-1).

4.2.9 Voltage Profile Assumption

ID #2010-007RS will be used to establish system normal (i.e., pre-contingency) voltage profiles for key area busses prior to commencing any studies. Table 2-1 of the *Transmission Planning Criteria – Basis and Assumptions* applies for the busses not included in ID #2010-007RS. These voltages will be used to set the voltage profile for the study base cases prior to the power flow studies.

5 Study Methodology

The studies to be performed for this connection assessment are identified in Table 5-1.

Table 5-1: Summary of the Studies to be Performed

Scenario No. and Name		Power Flow			Voltage Stability			Transient Stability			Motor Starting		Short Circuit
		Category			Category			Category			Category		Category A
		A	B	C5	A	B	C5	A	B	C5	A	B	
Pre-Project													
1	2025 SP LG	X	X	X	X*	X*	X*						
2	2025 WP LG	X	X	X	X*	X*	X*						X
Post-Project													
3	2025 SP LG	X	X	X	X	X	X						
4	2025 WP LG	X	X	X	X	X	X						X
5	2031 WP All Gen ON												X

* Only required if post-Project studies show potential voltage stability issues

For the engineering studies, all transmission facilities 240 kV and 144/138 kV, within the Study Area and the transmission lines connecting these planning areas to neighbouring planning areas will be studied and monitored to assess the impact of the Project on the performance of the AIES, including any violations of the Reliability Criteria (as defined in Section 3.1).

5.1 Study Case Validation

The study will be conducted on the AIES system model using the AESO's planning base cases. The seasonal light/peak scenarios will be studied as required. The base cases will be modified by the AESO to include the corresponding load and generation forecast information. The resulting cases, or seed cases, along with the project IDEVs, will be provided by the AESO to the Studies Consultant. These cases are provided in PSS/E v34 and/or v33 format. Upon request, the AESO can provide RAW and SEQ files. Software used by the Studies Consultant must be able to read and write these file types. Manual adjustments may be required to ensure full alignment with the details outlined in this Study Scope, as described in the process outlined below. The AESO will provide guidance to the Studies Consultant with regard to the setup of the study cases should any questions arise.

The expected process for the creation of acceptable study cases is as follows:

1. The AESO provides seed cases and the appropriate incremental IDEVs to use and any other applicable information required to the Studies Consultant.
2. The Studies Consultant applies the identified IDEVs to the seed cases to create the study cases. The Studies Consultant verifies and makes adjustments as required to ensure the study cases represent the assumptions outlined within the Study Scope.
3. Upon creating the study cases, all the study cases are forwarded to the AESO for approval.

4. The Studies Consultant proceeds with the required engineering studies only after the study cases are approved by the AESO.

5.2 Power Flow Studies

Power flow studies will be performed to identify thermal and voltage criteria violations as per the Reliability Criteria, and any deviations from the limits listed in Table 3-1.

For information purposes, the Studies Consultant must also provide, as a separate file, a list of any transmission elements where the thermal loading exceeds 95% of the element's normal rating under Category A and Category B conditions.

For the Category B power flow studies, the transformer taps and switched shunt reactive compensating devices such as shunt capacitors and reactors will be locked and continuous shunt devices will be enabled.

Voltage deviations at point-of-delivery (POD) low voltage busses will also be assessed for both the pre-Project and post-Project networks by first locking all tap changers and area shunt reactive compensating devices to identify any post-transient voltage deviations above 10%. Second, tap changers will be allowed to move while shunt reactive compensating devices remained locked to determine if any voltage deviations above 7% would occur in the area. Third, all the taps and shunt reactive compensating devices will be allowed to adjust, and voltage deviations above 5% will be reported.

The scenarios to be studied are shown in Table 5-1.

5.2.1 Contingencies to be Studied

Power flow studies will be performed for the Category A and all Category B and Category C5 conditions in the Study Area.

5.3 Voltage Stability Studies

The objective of the voltage stability studies is to determine the ability of the transmission system to maintain voltage stability margin at all busses under Category A and Category B conditions. The power-voltage (PV) curve is a representation of voltage change as a result of increased power transfer between two systems. The incremental transfers will be reported at the collapse point.

Voltage stability studies will be performed for the post-Project scenarios. For load connection projects, the load level modeled in post-Project scenarios is the same as, or higher than, in pre-Project scenarios. Therefore, voltage stability studies for pre-Project scenarios will only be performed if post-Project scenarios show voltage stability criteria violations.

Voltage stability studies will be performed according to the Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria states, for load areas, post-transient voltage stability margin is required for the area modeled at a minimum of 105% of the reference load level for Category A conditions and for Category B conditions. For this standard, the reference load level is the maximum established planned load.

Typically, voltage stability studies are carried out assuming the worst case scenarios in terms of loading. In this connection assessment, the voltage stability studies will be performed by increasing load in the study area and increasing generation in the central region except the study area.

The scenarios and cases to be studied are shown in Table 5-1.

5.3.1 Contingencies to be Studied

Voltage stability studies will be performed for all Category B contingencies in the Study Area. The Category A condition and the five contingencies with the smallest stability margin will be presented in the results.

5.4 Short-Circuit Current Level Studies

A maximum fault level must be provided for the substations in the vicinity of the Project assuming normal system operation with all transmission elements in service and generation dispatched. Three-phase faults and single line-to-ground faults will be simulated. Polar coordinates and per-unit values will be used for reporting the results.

Winter peak scenarios will be used for the short-circuit studies because winter peak scenarios generally produce higher short-circuit current levels than summer peak scenarios.

Estimated maximum three-phase faults and single line-to-ground short-circuit current levels will be reported for the following substations:

- Deer Hill 1012S
- Bickerdike 39S
- Marlboro 348S
- Benbow 397S
- Foc Creek (AltaLink) 347S
- Fox Creek 741S
- The Facility POD (including in post-Project studies only)

Further sensitivity studies, in consultation with the TFO, may be required if the primary short-circuit analysis indicates a potential to exceed or approach the existing fault rating of the transmission facilities.

The scenarios to be studied are as shown in Table 5-1.

6 Mitigation Measures

6.1 Development

Mitigation measures may be required if the post-Project study results identify system performance issues. Mitigation measures for the Project may involve modifying or adding real-time operational practices and/or remedial action schemes (RASs).

The Studies Consultant must notify the AESO of any system performance issues in a timely manner, following which the AESO Studies Engineer may instruct the Studies Consultant as follows:

- Develop tables showing the constraint effective factors[2] for generation or load based on thermal criteria violations that are observed.
- Collaborate with the AESO to propose changes, if any, to the connection alternatives that could remove the requirement for a RAS.
- Collaborate with the AESO to study modifications to existing and/or planned RASs, proposed by the AESO, to ensure the coordination of existing protection schemes with the addition of any proposed protection schemes.
- Collaborate with the AESO to identify and study new RASs, if any, that may be required to ensure system reliability is maintained after connecting the Project to the AIES.

The AESO Studies Engineer will work closely with the Studies Consultant and guide the development and/or modifications of the proposed mitigation measures to ensure system reliability, security and compliance with AESO ID #2018-018T, *Provision of System Access Service and the Connection Process*.

6.2 Evaluation

6.2.1 Post-Mitigation Studies

Studies to evaluate the effectiveness of mitigation measures, if required, will be performed in accordance with the technical criteria, assumptions, and methods provided in this Study Scope and in accordance with further instructions from the AESO.

6.2.2 Constraint Effective Factor Studies

Constraint effective factor analysis are used to determine the generator- and load- constraint effective factors and to identify the most effective generators or loads to manage the thermal criteria violations, if any, that are observed under Category B conditions.

[2] Constraint effective factor studies are performed to determine the generator- and load- constraint effective factors. Constraint effective factors are used to estimate the ability of generators and loads to manage transmission constraints. A generator's or load's constraint effective factor is defined as the change in power flow over a specific transmission line following a change in the generator's energy production or in the load's energy consumption. The greater the constraint effective factor, the more effective a generator or load can be in managing a thermal criteria violation on the specific transmission line.

7 Changes to Study Assumptions

This study will utilize the AESO’s planning base cases, which are based on the AESO’s current corporate forecast (2021 LTO) with modifications to incorporate the latest forecast intelligence. Sensitivity studies or restudy may be required in the event of revisions to the AESO’s corporate forecast, forecast intelligence, or other study assumptions. Additional engineering studies may also be required to assess new connection alternatives, changes to project ISD, or delays in proposed system developments. Any additional or revised study requirements shall be captured in a signed Study Scope Amendment document.

Attachment A:
Transmission Planning Criteria – Basis and Assumptions

Study Scope Amendment

P2630 Berland River Load

Nova Gas Transmission Ltd.

Date: January 18, 2023

Version: V1

Classification: Public

Company Name	Name and Credentials	Date	Signature
AltaLink A Berkshire Hathaway Energy Company (Study Consultant)	Joby Varghese, P.Eng.	Jan 19, 2024	Joby Varghese
AESO	Nima Safari, P. Eng.	1/18/2024	Nima Safari
AltaLink (Transmission Facility Owner)	Peter Blakeman, PM	Jan 19, 2024	Peter Blakeman
Nova Gas Transmission Ltd. (Market Participant)	Ben Ho, P.Eng, PM	19-Jan-2024	Ben Ho

Contents

1 Introduction

The original Study Scope for P2630 was signed on Mar. 01, 2023. This study scope amendment is triggered due to the following:

- Change in the connection alternatives to be studied

2 Scope of Change

The following sections will be updated. All other study assumptions will be the same as the original signed Study Scope.

2.1 Connection Alternatives Selected For Further Studies

In addition to the content of the original study scope, the following sentence is added.

Alternative 2 has been selected for further study as a result of the infeasibility of Alternatives 1 and 3 as determined by the Protection and Control studies. The descriptions of Alternatives 1,2, and 3 are as follows:

2.1.1 Alternative 1 – A New 138/25kV Point of Delivery connected from 685L via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to the customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 53 km in length, from the new POD to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S Substations via T Tap configuration.
- Add or modify associated equipment as required for the above transmission developments.

2.1.2 Alternative 2 – A New 138/25kV Point of Delivery connected from 685L via an In-and-out Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to the customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 53 km in length, from the new POD to the existing 138 kV transmission line 685L between Deer Hill 1012S and Benbow 397S Substations via an In-and-out configuration.
- Add or modify associated equipment as required for the above transmission developments.

2.1.3 Alternative 3 – A New 138/25kV Point of Delivery connected from 720L via a T-Tap Configuration

This alternative included the following developments:

- Add a new 138/25kV Point of Delivery (POD) substation next to the customer site with enough capacity to serve the Project.
- Add one 138 kV circuit, approximately 56 km in length, from the new POD to the existing 138 kV transmission line 720L between Benbow 397S and Fox Creek 347S Substations via T Tap configuration.

- Add or modify associated equipment as required for the above transmission developments.