Three Year Growth Plan Strategy

Prepared for:

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Disclaimer

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1.0 Executive Summary

The Three Year Growth Plan Strategy, prepared by Electrical Consultants, Inc. (ECI) for Silicon Valley Power (SVP) presents an analysis of SVP's transmission system. The purpose of the study is to identify Near-Term and Long-Term improvements for SVP to implement in order to maintain electric service reliability with consideration of replacements of end-of-life infrastructure and significant load growth as a result of proposed data center additions, residential, and commercial growth.

The load growth projections were based on 1-in-10 peak loads as identified in the *SVP_Mini_Load_Forecast_Compilation_2021* load projections. These projections indicate the following:

- 879 MW peak system load projected in 2024
- 1125 MW peak load projected to occur in 2031

This compares with 2021 projected peak of 615 MW. Steady state load flow analysis was performed for each year between 2021 and 2031 with consideration of peak loading levels correlating with each of the respective years. The Near-Term improvements are those system upgrades that were identified between years 2021 through 2024 and the Long-Term improvements are those identified between 2025 and 2031 in an effort to keep pace with anticipated load growth. All Near-Term and Long-Term improvement projects mentioned serve as either maintenance/replacement of end-of-life equipment or to create additional capacity.

1.1 Performance Criteria

Power system reliability performance is evaluated using performance criteria established by national, regional, and local standards. These include:

- NERC Standard TPL-001-4
- NERC Standard TPL-001-5
- WECC Criterion TPL-001-WECC-CRT-3.1
- SVP local standards

The standards focus on two main parameters of the power system that define its performance. One is the voltage performance which is described by the allowable variation of the voltage at a bus around its nominal operating point. This voltage is allowed to vary between 95% and 105% of the nominal value during normal operations with all equipment operational (no equipment outages). For example, a 60 kV bus is allowed to vary from 57.0 kV to 63.0 kV during normal operation as loads change from day time maximum to night time lows. If an outage occurs, say a transformer or a line has a fault and is switched out of service, then the system voltage is allowed to operate between 90% and 110% of its nominal value. If the system is unable to operate within these limits, then there is a voltage violation, and some mitigation must be done to correct it.

The second performance metric is the level of current allowed on electrical equipment. All electrical power components that supply power to loads have current limits which could

cause thermal damage (Thermal Overload) if they are exceeded. Since current causes heating, this is often referred to as the thermal limits of the electrical components and it is expressed either in terms of current level (Amperes) or MVA (Mega-Volt-Amps which is a measure of power in the circuit). Thermal limits cannot be violated at any time under normal operating conditions with all equipment in service. An outage or contingency that removes an element from service is also not allowed to cause any thermal (or current) limits to be violated although some equipment may allow some short-term overloads. If a violation occurs, then the standards require that steps be taken to remedy the situation. In the case of a thermal overload of a line, the line may need to be rebuilt with a larger conductor. In the case of an overloaded transformer, the transformer may have to be replaced with one having a higher thermal rating.

In addition, SVP specific performance criteria was also considered as part of the evaluation of the transmission system. SVP specific criteria includes consideration that the loading on each 60 kV loop between receiving stations should not exceed 280 MVA with a target around 250 MVA and the lines can be loaded up to 80% of thermal rating. Each loop is designed for 310 MVA of loading.

1.2 Near-Term Improvements

A summary of recommended improvements and corresponding costs, year and duration for upgrades generally required between 2021 and 2024 to meet established criteria with projected peak loads is provided in *Table 1-1*. These timeframes are only conceptual and will change as the projects are developed and the actual load occurs in the system. Note that some of these improvements are already in progress as components of the South Loop Rebuild Project. In addition, there are PG&E 115 kV line upgrades that are identified as a result of not meeting planning criteria; however, costs for these items are not included in the summary and will need to be coordinated directly with PG&E. The contingencies as well as the loading levels that trigger the upgrades can be found in *Section 5* of this report.

Item	Description	Indicative Cost ($M)	Year	Estimated Duration (Design & Construction)
1	Replace the KRS breaker 662 on the KRS to Fiberglass line along with short circuit mitigation at KRS and SRS (upgrade of potentially 4 breakers plus bus tie additions)	$6.000	2021	22 months
2	Replace the Fiberglass 60 kV breakers (upgrade 4 breakers and 8 disconnect switches along with evaluation of main bus/jumpers)	$10.000	2021	22 months
3	Re-conductor 0.5 miles, 60 kV transmission line connecting Fiberglass and Walsh Substation	*Included in South Loop*	2021	In progress
4	Upgrade the NRS 115 kV tie-breaker 392	$4.250	2021	26 months
5	Re-conductor 8.59 miles, 115 kV transmission line connecting Northern Receiving Station (NRS) and Newark (D) Substations (PG&E)	*By PG&E*	2022	48 months
6	• Rebuild Scott Receiving Station (SRS) with four (4) 300 MVA, top rated 115-60 kV transformers with 115 kV and 60 kV bus arranged in breaker-and-a-half configurations (full GIS switchyard rebuild) • SRS balance of Plant including site work, foundations, steel structures, control building, wiring and design support	$63.250	2023	20 months

	• SRS cut-over including 115 kV and 60 kV riser structures, shoefly and underground cable to transition from existing SRS to new SRS facility • Current Limiting Reactor added to 60 kV breaker-and-a-half configurations to limit short circuit currents			
7	• Rebuild Kifer Receiving Station (KRS) with four (4) 300 MVA, top rated 115-60 kV transformers with 115 kV and 60 kV bus arranged in breaker-and-a-half configurations (full GIS switchyard rebuild) • KRS Balance of Plant including site work, foundations, steel structures, control building, wiring and design support • KRS cut-over including 115 kV and 60 kV riser structures, shoefly and underground cable to transition from existing KRS to new KRS facility • Current Limiting Reactors added to 60 kV breaker-and-a-half configurations to limit short circuit currents	$57.700	2023	20 months
7a	Construction of a 50 MW battery energy storage system (BESS) between Kenneth and Oak Junction	$70.000	2022	24 months
8	Construct a new 2.16-mile, 115 kV transmission line connecting NRS to KRS (combination of overhead/0.56 miles and underground/1.6 miles)	$27.100	2023	30 months
9	Re-conductor 1.64 miles of 60 kV transmission line connecting the Walsh and Uranium Substations	$2.750	2023	14 months
10	Re-conductor 2.17 miles of 115 kV transmission line between NRS and Nortech Substation (PG&E)	*By PG&E*	2023	48 months
11	NRS transformer upgrade (two 115-60 kV, 300 MVA transformers)	$15.000	2024	20 months
12	NRS spare transformer (one 230-115 kV bank and relocation of two 115 kV PG&E lines)	$17.000	2024	24 months

Table 1-1
Summary of Near-Term Improvements

The total estimated budgetary level cost for Near-Term improvements between 2021 and 2024 is $273.05M. This does not include the South Loop upgrades currently in progress as well as the PG&E system upgrades. The transmission line cost estimates do not include easement acquisitions or SVP internal costs.

1.3 Long-Term Improvements

In addition to Near-Term improvements, this report also identifies longer term anticipated upgrades. A summary of recommended improvements and corresponding costs, year and duration for upgrades required between 2025 and 2031 is summarized in *Table 1-2*.

Item	Description	Indicative Cost ($M)	Year	Estimated Duration (Design & Construction)
13	Re-conductor 0.89 miles, 60 kV transmission line connecting NRS and Agnew Substations	$2.100	2025	12 months
14	Re-conductor 1.43 miles, 60 kV transmission line connecting Central Substation and SRS	$2.600	2025	14 months
15	Reconfigure 1.88 miles, 60 kV transmission line on the Northwest and Center Loop (overhead)	$18.000	2026	60 months
16	Re-conductor 0.84 miles, 60 kV transmission line connecting Mission and NRS Substations (overhead portion)	$2.150	2026	16 months
17	Re-conductor 0.17 miles, 60 kV transmission line connecting Agnew and Freedom Junction Substations	$1.050	2030	12 months
18	Re-conductor 1.1 miles, 60 kV transmission line connecting Freedom Junction and NAJ Substations	$3.250	2030	18 months
19	Re-conductor 3.54 miles, 60 kV transmission line connecting Homestead and SRS Substations	$8.050	2030	22 months
20	Re-conductor 9.16 miles, 115 kV transmission line connecting Newark (F) to NRS (PG&E)	*By PG&E*	2030	48 months

Table 1-2
Summary of Long-Term Improvements

The total estimated budgetary level cost for Long-Term improvements between 2025 and 2031 is $37.2M. This does not include the PG&E system upgrades. These cost estimates do not include easements or SVP internal costs. A more detailed study of Long-Term upgrades will be completed at a later date and it will include projected upgrades up to 20 years beyond the 2021 base case.

1.4 Other Considerations

All of the Near-Term and Long-Term improvements identified in *Tables 1-1* and *1-2* are generally in line with improvements as identified in the *Electric Planning 2020 Report* prepared by SVP. There are many complex details such as outage coordination and cut-over of circuits that will need to be considered during the detailed design stage of the respective improvements. This is necessary to assure continuity of service to SVP's existing customers. Outage windows will be limited and will need to be identified through direct collaboration with PG&E. This is particularly applicable to the upgrades at the SRS and KRS receiving stations, projected for 2023.

Other upgrades include consideration of a 50 MW battery energy storage system (BESS) project located near KRS. Although not included in the overall cost estimates of this study, the BESS project was included in the steady state load flow analysis for years 2023 and beyond. Indicative costs for the BESS addition are estimated at $70M.

A system diagram summarizing recommended improvements is illustrated on *Figure 1-1* on the following page.

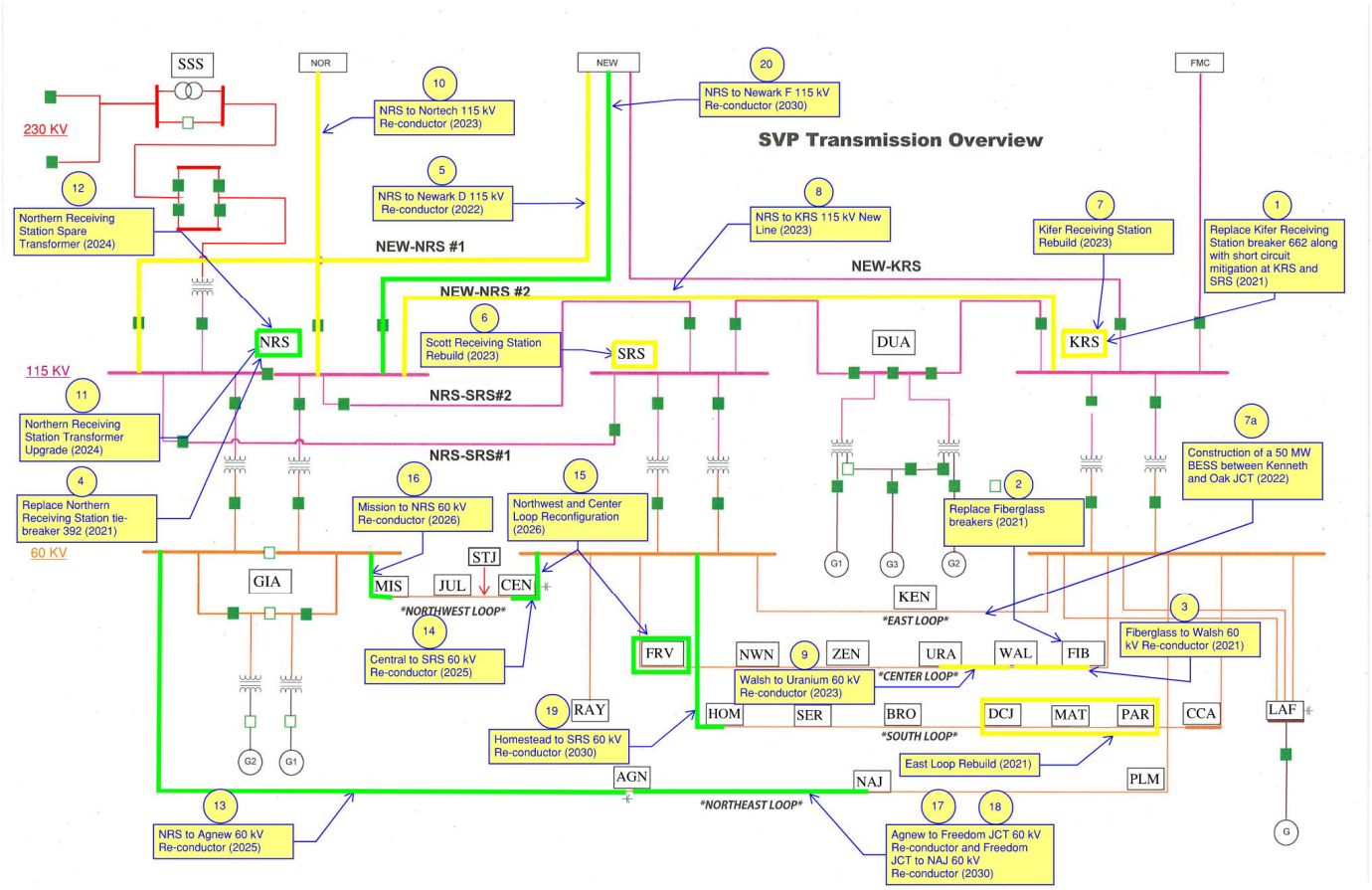


Figure 1-1: Overall Recommended Improvements

2.0 Introduction

This report presents a detailed Three Year Growth Plan Strategy of Silicon Valley Power's (SVP's) electric system expansion to service the projected load increases.

2.1 Local Transmission System

SVP provides electrical service generally within the geographical limits of the City of Santa Clara. The transmission system includes almost 60 miles of transmission line, operating at voltages of 230 kV, 115 kV, and 60 kV. The 230 kV and 115 kV systems deliver power to three receiving stations where the voltage is transformed to 60 kV and power is delivered to loads through five geographic loops. SVP 2020 peak load was 592 MW confined to a 19 square mile service territory.

Santa Clara has become a major attraction for large data centers due to its location in Silicon Valley, competitive energy cost and available redundant communication networks. SVP is committed to adding 370 MW of new load service, and developers are in the process of developing plans for more than 200 MW of new load, which could double SVP's current peak load. The load requests currently under discussion could add eight (8) 25 to 100 MVA substations and exceed interconnection capacity of SVP ties to PG&E, the transformer capacity at SVP's receiving substations and 60 kV transmission facilities.

2.2 Study Objectives

The objective of this report is to meet the SVP forecast for the TPP year 2021/2022 which provides a forecast out 10 years to 2031. This is a yearly process managed by the CAISO and which SVP participates as a Transmission Planner. The improvements are intended to upgrade the existing SVP transmission system to allow the capacity of serving up to 1090 MVA of load capacity while keeping system performance N-1 secure.

3.0 Study Methodology

3.1 Software Details

PowerWorld Simulator version 21 with a revision date of October 2020 is used for this analysis. PowerWorld Simulator is an interactive power system software package designed to simulate high voltage power system operation. The following simulation parameters were changed from their defaults for this analysis:

1) Generation lost during contingency analysis is balanced by all responsive generation in WECC.
2) The analysis utilizes PowerWorld's steady state load flow solutions for the analysis with automatic switched shunts and tap changer adjustments.
3) Performance violations in the Base Case are not re-reported during contingency analysis.
4) Generator MW limits are enforced.
5) Generator VAR limits are checked before each power flow solution.

3.2 Analysis Performed

Steady state power flow contingency analysis and incremental load analysis were performed for each scenario analyzed in this report. If switching reactive devices are recommended for a Corrective Action Plan, step changes to voltage was also analyzed. No short circuit or transient stability analysis are presented in this report. Beyond the direct connections to SVP, the PG&E Bulk Electric System was not considered in this study.

3.3 Performance Criteria

System performance is measured against the requirements of NERC Standard TPL-001-4, NERC Standard TPL-001-5, and the WECC Criterion TPL-001-WECC-CRT-3.1. In general, applicable facility continuous thermal ratings cannot be violated at any time, and bus voltages must remain between 0.95 to 1.05 pu of nominal with all lines in service and 0.9 to 1.1 pu post-contingency. Additionally, post-contingency load bus voltages cannot change by more than 8 %.

SVP has some additional system performance criteria requirements for this study. For all Bulk Electric System (BES) elements (generally defined by NERC as 100 kV and above) TPL-001-5 also applies. For the 60 kV elements, a post-contingency load bus voltage cannot change by more 5%. Each loop is designed for 310 MW of loading.

4.0 System Modeling

4.1 Study Case Used

SVP supplied the PSLF a21_R0_2020_System_TR_Issued.epc model that was used as the base case for the analysis. SVP also supplied .M files which contain yearly load updates, system upgrades, and system configuration changes. These .M files were used to create PSLF models for years 2020, 2021, 2022, 2023, 2024, and 2025 through 2031. These models where then converted to PowerWorld cases for analysis.

4.2 Study Case Assumptions

The following assumptions were considered throughout the analysis:

1) Line and equipment ratings were based on values in the existing system model provided by SVP and 2019 SVP system diagram.
2) Fault currents on 60 kV system limited to 80% of 40 kA (32 kA).
3) System upgrades are completed by the end of the calendar year as identified within the report.

4.3 Generation Dispatch and Load Growth

The SVP system has generation at Gianera Generating Station and at Duane Substation. Generation for these two locations is dispatched by the SVP_Gen_Info 2021 to 2031.M-file. The loads for SVP are dispatched for each case by SVP_Load_1in10 .M-files. These .M file loads closely match the loads in the muni load forecast excel File provided by SVP. This load forecast does not include distributed load growth or residential load growth. Based on collaboration with SVP, there is a load at San Thomas that was modified to reflect installation in 2022 instead of 2023.

4.4 Case Scenarios

Six (6) evolving study scenarios were created by adding spot loads and configuration changes to the a21_R0_2020 case. SVP's load is increasing with a 2021 addition of 11 MVA of new load, followed by an additional 77 MVA of new load in 2022, then an additional 92 MVA of new load in 2023 and additional 105 MVA load in 2024. The cumulative total new load additions studied in the 2024 scenario is 285 MVA. The 2025 case has an additional load of 78 MVA from the 2024 case.

Throughout the cases, some capacity MVA flow ratings are limited by station breaker ratings and in some instances, line ratings were changed to match the 2019 SVP system diagram. The 2000 amp breakers at KRS limit the line flow ratings to Fiberglass and to Palm. The new 2500 amp breakers at SRS moves the limiting line capacity ratings to Kenneth and to Fairview. The line from NAJ to Palm is limited by a 2000 amp breaker. There are three line ratings that were changed to match the SVP Transmission Map; the line from NRS 300 to SRS, the line from NRS 400 to SRS, and the line from Serra to Brokaw.

The following subsections are descriptions of how the cases were set up. This includes changes in load, configuration, and ratings that occur in each case. In these cases, rating

and configuration changes carry through all the successive models. If a rating changes in the 2021 case, that change carries through to the 2031 case. A configuration change is when a substation moves to a different loop. Each case has a load .M file for the case that was applied. *Table 4-1: Base Case Loading Levels* shows the base case load in each loop as well as total non-coincidental peak SVP system load calculated by summing the individual loop loads.

Location	Load Levels (MVA)
Northwest Loop	111.62
Northeast Loop	70.62
East Loop	11.56
Center Loop	213.14
South Loop	152.31
KRS / LAY	20.83
SRS	20.81
Total	**600.89**

Table 4-1
Base Case Loading Levels

4.4.1 2021 Case

Compared to the base case, there are no configuration changes or new substations in the 2021 case. This model has two rating changes. The bus tie from NRS 400 to NRS 300 was modified to have a rating of 3000 amps (598 MVA) to reflect installed rating. The 230 kV line from SSS to NRS was upgraded to have a rating of 733 MVA. The 60 kV line from Fiberglass to Walsh was upgraded from bundled 954 KCM AAC to bundled 715 KCM ACCR, which has a normal rating of 310 MVA and an emergency rating of 342 MVA. The 2000 amp KRS breaker 662 on the KRS to Fiberglass line gets replaced with a 3000 amp breaker. *Table 4-2: 2021 Case Loading Levels* shows load in each loop as well as total projected load used in the 2021 case.

Location	Load Levels (MVA)
Northwest Loop	111.84
Northeast Loop	71.06
East Loop	12.07
Center Loop	214.60
South Loop	156.92
KRS / LAY	23.98
SRS	21.42
Total	**611.89**

Table 4-2
2021 Case Loading Levels

4.4.2 2022 Case

The 2022 case has three configuration changes; DCJ, Mathew, and Parker substations were moved from the South Loop to the East Loop. This requires new lines to be built from Kenneth to Parker substation and DCJ to KRS substation. These new lines will be built with double bundled 715 KCM ACSR conductor. The

2000 amp breaker at KRS limits the line to DCJ. There are five new substations/data centers projected to come on-line in 2022. Martin JCT substation replaces the CCA substation on the South Loop. Oak JCT and Memorex substations are added to the East Loop between the Kenneth and Parker substations. San Thomas substation is added to the Northwest Loop between the Juliette and Central substations. Freedom JCT is added to the Northeast Loop between the Agnew and NAJ substations. There are no rating changes in the 2022 case. *Table 4-3: 2022 Case Loading Levels* shows load in each loop as well as total projected load used in the 2022 case.

Location	Load Levels (MVA)
Northwest Loop	120.69
Northeast Loop	78.79
East Loop	123.14
Center Loop	222.67
South Loop	96.96
KRS / LAY	24.91
SRS	22.08
Total	**689.24**

Table 4-3
2022 Case Loading Levels

4.4.3 2023 Case

There are no configuration changes in the 2023 case. There are two new substations/data centers projected to come on-line in 2023. Stender Way is added to the Central Loop between the SRS and Fairview substations. Laurelwood substation is added to the South Loop between the Martin JCT and KRS substations. There is one new 115 kV transmission line from NRS 300 to KRS with a 346 MVA rating. There are nine rating changes in the 2023 case. Both SRS and KRS are getting rebuilt this year with 3000 amp breakers and 180/240/300 MVA transformer additions. After upgrades, none of the lines leaving SRS and KRS are limited by substation breakers. The 60 kV line from Walsh to Uranium was upgraded from bundled 954 KCM AAC to bundled 715 KCM ACCR, which has a normal rating of 310 MVA and an emergency rating of 342 MVA. *Table 4-4: 2023 Case Loading Levels* shows load in each loop as well as total projected load used in the 2023 case.

Location	Load Levels (MVA)
Northwest Loop	134.95
Northeast Loop	94.83
East Loop	159.25
Center Loop	230.99
South Loop	115.07
KRS / LAY	24.52
SRS	21.81
Total	**781.42**

Table 4-4
2023 Case Loading Levels

4.4.4 2024 Case

There are no configuration changes in the 2024 case. There is one new substation/data center projected in 2024. Pacific substation is added to the East Loop between DCJ and KRS substations. There are two rating changes in the 2024 case. The NRS transformers get upgraded from 112/149/186 MVA to 180/240/300 MVA transformers. *Table 4-5: 2024 Case Loading Levels* shows load in each loop as well as total projected load used in the 2024 case.

Location	Load Levels (MVA)
Northwest Loop	154.27
Northeast Loop	99.80
East Loop	190.93
Center Loop	249.99
South Loop	135.82
KRS / LAY	25.16
NRS 500	8.07
SRS	22.26
Total	**886.30**

Table 4-5
2024 Case Loading Levels

4.4.5 2025 Case

There are no configuration changes in the 2025 case. There is one new substation/data center coming online in 2025 called Bowers located between the Uranium and Walsh substations in the Center Loop. There are three rating changes in the 2025 case. The 60 kV lines from NRS 600 to Agnew, Agnew to Freedom JCT, and Freedom JCT to NAJ are re-conductored from bundled 954 KCM AAC to bundled 715 KCM ACCR. The 715 KCM ACCR conductor has a normal rating of 310 MVA and an emergency rating of 342 MVA but these lines are limited by 2000 amp breakers so the rating of the lines are 207 MVA. This case is used to evaluate the impact of the BESS regarding 3 specific contingencies. With these contingencies the generation at DVR was increased to 149.9 MW and the generation at LECEF was increased to 320 MW. The new generation levels and contingencies were provided by SVP. With the 50 MW BESS at the proposed location between Kenneth and Oaks Junction, system performance is summarized in *Section 5.6* of this report. *Table 4-6: 2025 Case Loading Levels* shows load in each loop as well as total projected load used in the 2025 case.

Location	Load Levels (MVA)
Northwest Loop	166.75
Northeast Loop	98.78
East Loop	224.14
Center Loop	259.40
South Loop	143.18
KRS / LAY	24.73
NRS 500	25.02
SRS	21.96
Total	**963.96**

Table 4-6
2025 Case Loading Levels

4.4.6 2031 Case

There are no configuration changes or new substations in the 2031 case. There are no rating changes in the 2031 case. There are no changes in the 2026 to 2031 cases that affect the 2031 case. This case is used to ensure that upgrades and new loop configurations continue to work for in the Long-Term. *Table 4-7: 2031 Case Loading Levels* shows load in each loop as well as total projected load used in the 2031 case.

Location	Load Levels (MVA)
Northwest Loop	184.15
Northeast Loop	109.84
East Loop	254.60
Center Loop	330.00
South Loop	166.81
KRS / LAY	29.39
NRS 500	26.17
SRS	25.28
Total	**1126.24**

Table 4-7
2031 Case Loading Levels

The Near-Term and Long-Term projects recommend in this report were compared against the loading levels above in *Table 4-7: 2031 Case Loading Level.* These load levels are prior to load balancing of the Center Loop with the reconfiguration of the Center and Northwest Loop project.

5.0 Analysis

Through coordination with SVP, N-1 contingencies were evaluated for the Three Year Growth Plan Strategy. In NERC TPL-001-4 terms, N-1 contingencies (or single element outages) are known as P1 contingencies. The contingency definitions are edited and/or added to reflect changes to the system brought by configuration changes, new substations, and new lines.

5.1 Base Case (Peak Load 601 MVA)

5.1.1 Contingency Analysis

Contingency analysis of the SVP transmission base system shows thermal violations on the KRS – Fiberglass and the Fiberglass to Walsh transmission lines. The transmission line from KRS to Fiberglass is being limited by the 2000 amp breaker at KRS during loss of the SRS to Fairview 60 kV line segment.

Row Labels	MVA	% Limit
KRS_60 (36878) -> FIBERGLA (36874)		
P1 – Line Section – SRS 60-FairView	216.32	104.1
FIBERGLA (36874) -> WALSH (36890)		
P1 – Line Section – SRS 60-FairView	207.29	119.75

Table 5-1
Contingency Analysis Thermal Violation; Center Loop

Additionally, this case has voltage change (Delta V) violations based on the SVP performance criteria where voltage can not change by more than 5% from pre-contingency to post contingency conditions.

5.2 2021 Case (Peak Load 612 MVA)

5.2.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected 2021 peak loads show thermal violations on the KRS – Fiberglass and the Fiberglass to Walsh transmission lines. Similar to the Base Case, the transmission line from KRS to Fiberglass is being limited by the 2000 amp breaker at KRS during loss of the 60 kV line between SRS and Fairview.

Row Labels	MVA	% Limit
KRS_60 (36878) -> FIBERGLA (36874)		
P1 – Line Section – SRS 60-FairView	217.69	104.76
FIBERGLA (36874) -> WALSH (36890)		
P1 – Line Section – SRS 60-FairView	208.65	120.54

Table 5-2
Contingency Analysis Thermal Violation; Center Loop

Additionally, this case has some Delta V violations based on the SVP performance criteria where voltage can not change by more than 5%. The majority of these violations occur on the South loop that is mostly composed of double bundled 954

KCM AAC conductor. Duane substation experiences Delta V violations on the low side of the transformer when loss of a generator or transformer occurs at Duane.

5.2.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the increasing load with projected 2021 levels.

Replacing KRS Breaker 662

Replacing the 2000 Amp KRS breaker 662 with a 3000 Amp breaker and along with the Fiberglass breaker replacement mitigates the thermal overload on the KRS – Fiberglass 60 kV transmission line. This improvement also includes consideration of short circuit ratings mitigation at KRS and SRS. Upgrade of potentially 4 breakers (2 at KRS and 2 at SRS) along with possible addition of bus tie breakers at each facility would be the worst case requirement.

Replacing Fiberglass Breakers

Replacing the 2000 Amp Fiberglass breakers with 3000 Amp breakers. This along with the KRS breaker replacement mitigates the thermal overload on the KRS – Fiberglass 60 kV transmission line. Replacing (4) 60 kV Fiberglass breakers along with (8) disconnect switches allows the Fiberglass – Walsh 60 kV transmission line re-conductor to mitigate the thermal performance issues.

Re-conductor Fiberglass – Walsh 60 kV Line

Re-conductor the Fiberglass – Walsh 60 kV transmission line, which is approximately 0.5 miles of (2) bundled 954 KCM AAC, with (2) bundled 715 KCM ACCR mitigates all thermal performance issues found. This project is being upgraded as part of the South Loop project.

Correcting Voltage Violations

With P1 line section faults of either 60 kV Parker – CCA segment or 60 kV CCA – KRS segment, the South Loop experiences Delta V violations. At Brokaw, CCA, Mathew, DCJ, and Parker substations; Delta V is greater than 5% which violates the performance criteria set by SVP. The solution is to utilize the lightly loaded East Loop and relocate load off the South Loop. In order to transfer substations from the South Loop to the East Loop, new 60 kV transmission line will need to be constructed from Kenneth to Parker and DCJ to KRS. It is recommended to build this new transmission line with (2) bundled 715 ACCR. The new 60 kV transmission line will be approximately 3.5 miles. The upgrades are included in the South Loop rebuild program currently in the design stage and slated for completion in 2021.

NRS 392 Mitigation

SVP is adding a breaker in series with the NRS 115 kV tie-breaker in order to mitigate a P2 contingency. The tie-breaker in the 2021 model was modified to a 3000 amp rating (598 MVA) to reflect installed rating.

5.3 2022 Case (Peak Load 689 MVA)

5.3.1 Contingency Analysis

Contingency analysis of the SVP transmission system with 2022 projected peak loads shows no new thermal violations on SVP's system. The 115 kV transmission line from Newark D to NRS 400 is not part of the SVP transmission system however, it is important to note this PG&E segment of line is overloaded during loss of either the SS to NRS 230 kV line of loss or the NRS 230/115 kV transformer.

Row Labels	MVA	% Limit
KRS_60 (36878) -> FIBERGLA (36874)		
P1 – Line Section – SRS 60-FairView	226.15	207.8
FIBERGLA (36874) -> WALSH (36890)		
P1 – Line Section – SRS 60-FairView	216.07	124.82

Table 5-3
Contingency Analysis Thermal Violation; Center Loop

Row Labels	MVA	% Limit
NEWARK D (35120) -> NRS 400		
P1 – Line Section – SSS-NRS Riser 230 kV	186.02	111.32
P1 – Transformer Failure – NRS 230/115 kV	185.58	111.06

Table 5-4
Contingency Analysis; PG&E 115 kV Line

Additionally, the 2022 case has voltage change violations based on the SVP performance criteria where voltage can not change by more than 5%. Duane substation experiences Delta V violations on the low side of the transformer when loss of a generator or transformer occurs at Duane.

5.3.2 Corrective Action Plans

Other than the upgrade of the PG&E 115 kV line between Newark and NRS, there are no corrective action plans needed for the 2022 Case. There are no new violations that were not addressed in the 2021 case.

5.4 2023 Case (Peak Load 781 MVA)

5.4.1 Contingency Analysis

Contingency analysis of the SVP transmission system with 2023 projected loads show many Thermal Overload violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and receiving stations experience thermal overloads because of the large increase in load. The 115 kV line from Nortech to NRS 300 is not part of the SVP transmission system however it is important to note this PG&E segment of line is overloaded during loss of either the SSS to NRS 230 kV line or loss of the NRS 230/115 kV transformer.

Row Labels	MVA	% Limit
NRS 300 (36853) -> SRS (36852)		
P1 – Line Section – NRS 400-SRS 115 kV	367.24	132.58
NRS 400 (36851) -> SRS (36852)		
P1 – Line Section – NRS 300-SRS 115 kV	367.53	132.68

Table 5-5
Contingency Analysis Thermal Violation; NRS

Row Labels	MVA	% Limit
SRS (36852) -> SRS_60 (36886) TRANSFORMER #1		
P1 – Transformer Failure – SRS 115/60 kV #2	228.99	123.11
P1 – Line Section – Duane-KRS 115kV	198.29	106.61
P1 – Transformer Failure – NRS 300/500 115/60 kV	188.61	101.41
SRS (36852) -> SRS_60 (36886) TRANSFORMER #2		
P1 – Transformer Failure – SRS 115/60 kV #1	228.99	123.11
P1 – Line Section – Duane-KRS 115kV	198.29	106.61
P1 – Transformer Failure – NRS 300/500 115/60 kV	188.61	101.41

Table 5-6
Contingency Analysis Thermal Violation; SRS

Row Labels	MVA	% Limit
KRS (36850) -> KRS_60 (36878) TRANSFORMER #1		
P1 – Transformer Failure – KRS 115/60 kV #2	215.05	115.62
KRS (36850) -> KRS_60 (36878) TRANSFORMER #2		
P1 – Transformer Failure – KRS 115/60 kV #1	217.13	116.75

Table 5-7
Contingency Analysis Thermal Violation; KRS

Row Labels	MVA	% Limit
KRS_60 (36878) -> FIBERGLA (36874)		
P1 – Line Section – SRS 60 kV – Stender_W	235.10	113.14
P1 – Line Section – Stender_W – FairView	223.52	107.57
FIBERGLA (36874) -> WALSH (36890)		
P1 – Line Section – SRS 60 kV – Stender_W	225.07	130.02
P1 – Line Section – Stender_W – FairView	213.56	123.38
WALSH (36890) -> URANIUM (36889)		
P1 – Line Section – SRS 60 kV – Stender_W	175.21	101.22

Table 5-8
Contingency Analysis Thermal Violation; Central Loop

Row Labels	MVA	% Limit
Nortech (35659) -> NRS 300 (36853)		
P1 – Transformer Failure – NRS 230/115 kV	330.55	107.67
P1 – Line Section – SSS-NRS Riser 230 kV	328.69	107.67

Table 5-9
Contingency Analysis Thermal Violation; PG&E

Additionally, the 2023 case has Delta V violations based on the SVP performance criteria where voltage can not change by more than 5%. Duane substation experiences voltage change violations on the low side of the transformer when loss of a generator or transformer occurs at Duane.

SVP is looking at installing a 50 MW battery energy storage system (BESS) near KRS with a line tap on the 60 kV Kenneth to Oaks Junction segment. In the initial look at installing a BESS, location and size were considered. The possible installation locations are near KRS, NRS, Brokaw, Serra, and Homestead. To identify where the BESS has the greatest impact, this analysis evaluated the BESS in each of the five areas. It was also assumed for this analysis of the BESS that no upgrades on SVP's system have been implemented other than new substations being built and the South Loop reconfiguration. If the BESS is built in any of the locations, the violations decrease and the thermal violation from Nortech to NRS is corrected. However, the 50 MW BESS does not eliminate all thermal violations. To eliminate all thermal violations on any transformer in SVP's system, the BESS needs to be sized for 150 MW. Additional contingency analysis of the BESS addition was evaluated in the 2025 case with results summarized in *Section 5.6.1*.

5.4.2 Corrective Action Plans

This section covers the corrective actions needed to mitigate performance violations created by the projected 2023 load levels.

Upgrading NRS to KRS

Both the NRS 300 to SRS and the NRS 400 to SRS 115 kV lines experience thermal overloading. The proposed solution is to add a new 115 kV, 2.16 mile line from NRS 300 to KRS. It is recommended that SVP complete this project in 2023 based on the thermal overloads on these lines during contingency conditions with projected 2023 load levels. The new 115 kV line mitigates all performance issues for both of the existing 115 kV lines.

Rebuilding SRS Receiving Station

Rebuilding SRS receiving station was proposed by SVP to be completed in 2025. It is recommended that this rebuild occur earlier because in 2023 the SRS transformers are 85% loaded. This results in many thermal violations at SRS substation. Rebuilding the SRS substation with higher capacity transformers corrects the thermal overloads at SRS. A full rebuild of the facility includes a breaker-and-a-half bus arrangement on both the 115 kV and 60 kV side of the yard, as well as accommodations for four (4) 115/60 kV, 180/240/300 MVA transformers. This full rebuild of the facility requires current limiting reactors for short circuit mitigation. Due to limited space availability, the use of Gas Insulated Switchgear (GIS) is recommended for this facility upgrade. The rebuild of the SRS substation needs to occur before December 31, 2023 due to the SF6 ban in

California on January 1, 2025 and the emission report, filed by utilities, cut-off date June 1, 2024.

Rebuilding KRS Receiving Station

Rebuilding KRS receiving station was proposed by SVP to be completed in 2025. It is recommended that rebuild occur earlier because in 2023 the KRS transformers are 81% loaded. This results in a thermal violation with the loss of one transformer at KRS. Rebuilding the KRS substation with higher capacity transformers corrects the thermal overloads at KRS. A full rebuild of the facility includes a breaker-and-a-half bus arrangement on both the 115 kV and 60 kV side of the yard, as well as accommodations for four (4) 115/60 kV, 180/240/300 MVA transformers. This full rebuild of the facility requires current limiting reactors for short circuit mitigation. Due to limited space availability, the use of Gas Insulated Switchgear (GIS) is recommended for this facility upgrade. The rebuild of the KRS substation needs to occur before December 31, 2023 due to the SF6 ban in California on January 1, 2025 and the emission report, filed by utilities, cut-off date June 1, 2024.

Background on SF6 Ban Applicable to KRS and SRS Facility Upgrades

Sulfur hexafluoride (SF6) has been used world-wide by the electric utility industry for over 50 years. It is an inert, colorless, odorless, non-toxic, non-flammable, synthetic gas that has a long track record as a safe and reliable insulating gas for use in circuit breakers and in gas insulated switchgear (GIS) equipment. This is especially critical for use in GIS substations where space is limited. The total space required for a GIS substation is roughly 10% of that needed for a conventional air insulated substation. Thus, GIS is widely used in cities where load growth and urban growth have made it difficult to build new substations, or expand existing substations. Due to the growth rates of loads in many cities, the demand for GIS substations has been steadily growing.

SF6 has several properties that make it ideal as an insulating gas. It is very stable and does not break down easily. When exposed to electric arcs it can absorb large amounts of heat with minimal decomposing. SF6 also has a very high dielectric strength which makes it an excellent insulator for electrical equipment. In recent years it has become apparent that these same properties also make SF6 a potent green house gas (GHG). It is widely reported that one pound of SF6 gas has the same global warming potential as 23,900 pounds (or 11.9 tons) of carbon dioxide when compared over a 100-year period. Also, it is widely accepted that SF6 gas has a lifetime in the atmosphere of over 3,000 years. Thus, even small amounts of SF6 gas released into the atmosphere have a very long lasting effect so that any SF6 that is manufactured will essentially accumulate in the atmosphere over time unless very stringent measures are taken to contain it and decompose it before it reaches the atmosphere. SF6 gas disposal is typically done at very high temperatures and must be done by a licensed professional waste disposal service.

One source estimates that the annual global emissions of SF6 is equivalent to the CO2 emissions of about 100 million cars. Studies of SF6 leak rates indicate that

most of the leakage occurs in older GIS equipment and newer equipment has much lower leak rates. Eaton, which manufactures SF6-free switchgear says their research shows that overall life cycle studies of SF6 indicate that leaks can be as high as 15%. The global installed base of SF6 is expected to grow by 75% by 2030. At present SF6 contributes around 0.8% of CO2 equivalent modeled global warming. However, the potency of the gas and atmospheric persistence make it a prime target for climate change action. Over the course of the last 25 years the atmospheric concentration of SF6 has tripled with the largest single year increase occurring in 2017-2018.

SF6 is used in other industries including medical equipment and semiconductor manufacturing but it is estimated that the electric utility industry world-wide is responsible for 90% of the SF6 global market. Thus, eliminating SF6 is viewed as a way for utilities to deliver energy with cleaner technologies as well as a means to help comply with SF6 leak rate legal requirements and eliminate the hazardous waste costs associated with the gas.

The main hurdle preventing a rapid movement away from the use of SF6 by utilities has been the lack of proven alternatives to the gas. Most of the major GIS manufacturers have some alternatives available for at least the medium voltage (MV) range up to 36 kV and some are testing alternatives for the high voltage (HV) range up to 145 kV. The California Air Resources Board (CARB) has proposed regulations for phasing out Gas Insulated equipment in the 2025 to 2032 time frame. In addition, they have proposed a limit of 1% of SF6 annual emissions rate starting in 2020. They have also proposed an Early Action Credit for SF6 alternative equipment.

The figure below shows a CARB presentation graphic from July 2020 illustrating the proposed phase-out.

SF_6 Phase-out Starting in 2025

Voltage (kV)	Short-circuit Current (kA)	Phase-out Date
38 < kV ≤ 145	< 63	January 1, 2025
	≥ 63	January 1, 2028
145 < kV ≤ 245	< 63	January 1, 2027
	≥ 63	January 1, 2031
> 245	ALL	January 1, 2033

CARB proposed Regulation; July 21, 2020

Similar Schedule for Distribution GIE

GE has worked with 3M to develop an SF6 alternative which they call g3 (pronounced g-cubed which stands for “green gas for grid”). GE has also worked

out a licensing agreement with Hitachi 3m so that both companies can use the technology. The g3 alternative is SF6-free but has the same footprint as its SF6 based predecessor. The g3 alternative is a flouronitrile and CO2 mixture that has a reduced global warming potential (GWP) by 99% compared to SF6. GE's F35-145 kV GIS is rated for 145 kV, 40 kA fault duty, and 3,150 A continuous current. Due to the requirement to modify equipment designs for use with g3 it can not be used as a direct replacement for SF6.

Siemens has been proposing "clean air" and vacuum switching technology as replacements for SF6 in systems in the medium and high voltage range. Siemens "clean air" technology is reported to be a purified mixture of nitrogen and oxygen with zero potential for global warming. Siemens is using this technology in a gas insulated substation in Norway operating at 110 kV. The substation is scheduled for commissioning in 2022.

MEPPI (Mitsubishi Electric Power Products Inc.) has stated as recently as 2019 that there are no alternatives to SF6 that offer the same characteristics of:

- High dielectric strength
- High heat transfer capability
- Molecular stability
- Operational over a wide range of ambient temperatures

As a result, MEPPI has decided to focus on vacuum technology. They plan to expand on their line of MV vacuum breakers that currently range up to 38 kV and 5kV to 72 kV compact GIS. MEPPPI is committed to meet or beat the CARB phase-out schedule for higher rated equipment. They state that currently vacuum seems practical for interruption up to 145 kV with dry air insulation for dielectric however beyond that a new insulating gas may be required to keep equipment size and cost reasonable. MEPPI anticipates that vacuum switchgear for applications above 245 kV will require multiple breaks. This is currently a research area where the breaker design incorporates more than one pair of contacts arranged in series to interrupt fault currents.

Hitachi-ABB has in collaboration with 3M has developed what they are calling "AirPlus" insulation gas using 3M Novec 5110 gas as a key ingredient. This medium provides good insulating properties with a GWP of less than 1. For medium voltage installations the Novec gas is mixed with more than 80% dry air giving an insulation performance close to SF6. All AirPlus GIS from ABB are backwards compatible with SF6. Thus, compatible ZX2 "Ready for AirPlus" equipment can be ordered with SF6 and later refilled with AirPlus. Abb currently has AirPlus equipment in a 170/24 kV substation in Zurich Switzerland. The switchgear is rated for 170 kV, 1250 A continuous current and 49 kA short circuit current. ABB does have a few other AirPlus installations at this time mainly in Switzerland.

It appears that PG&E has been making a concerted effort to move away from SF6 for the past few years. The tables below illustrate PG&E projects using SF6-Free Dead Tank circuit breakers GIS equipment.

Dead Tank Circuit Breakers

Substation	DTCB Order Date	DTCB Delivery Date	Comment
VARIOUS 50 Dry-Air ordered (Hitachi); 72.5 kV, up to 40kA; *15 installed to date*		2017-2020	72.5 kV SF6 Breakers removed from supplier list No technological problems with installations over past 3 years
Henrietta	December 1, 2019	Dec 1, 2020	Dry-air (MEPPI) 72.5 kV, 31.5kA, 3 units
Livermore	March 1, 2020	Jan 1, 2021	Dry-air (MEPPI) 72.5 kV, 31.5kA, 1 unit
Palo Alto	July 1, 2018	June 1, 2021	Dry-air (Siemens); 145 kV, 40kA, 6 units
Santa Rosa	February 1, 2020	June 1, 2021*	Dry-air (Hitachi) 145 kV, 40kA, 3 units
To Be Identified	November 1, 2020	December 31, 2022	145kV; 63kA, 3 units RFP: September 2020

Gas Insulated Switchgear

Substation and Project ID	GIS Order Date	GIS Delivery Date	Comment
Livermore	2019	October 2022	Dry-Air (Siemens) 8VN1 115 kV, 50 kA
Hunters Point	March 1, 2020	2022	Dry-Air (Siemens) 115kV, 50kA GIS BAAH
Silicon Valley Switching Station	2022	2023	Dry-Air (TBD) 115 kV, 50 kA
Larkin	2024	2025	Dry-Air (TBD) 115 kV, 50 kA

Overall, it appears that there are not any well proven SF6-free technologies at this time for the 60 kV and 115 kV levels. However, it appears that major manufacturers including GE, Hitachi ABB and HICO are some what ahead in developing and installing their SF6 alternative technologies. These alternatives should be considered for the GIS installations proposed at SRS and KRS.

Re-conductor Walsh – Uranium 60 kV Line

Re-conductor the 1.64-mile Walsh – Uranium 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR mitigates all performance issues found on this line. An alternative to re-conductor this line would be to rerate the 954 KCM AAC line to 4ft/sec wind speeds. This increases the line rating to 230 MVA which mitigates all performance issues found on this line until 2026. With the rerate, this line will need

to be upgraded in 2026 unless the reconfiguration of the Center and Northwest Loop project is complete.

Re-conductor NRS - Nortech

The PG&E 115 kV, 2.17-mile line between NRS and Nortech will need to be rebuilt in 2023. This component is not included in overall cost estimates but will need to be coordinated with impacted parties.

Re-conductor NRS 600 – Agnew

Re-conductor the 0.89-mile NRS 600 – Agnew 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR mitigates all performance issues with peak projected loads in 2025 when the first thermal violation occurs. An alternative to re-conductor this line would be to rerate the 954 KCM AAC line to 4ft/sec wind speeds. This increases the line rating to 230 MVA however, this line is limited by a 2000 amp breaker to 208 MVA. This still mitigates all performance issues found on this line. Note that this is included with the long-term improvements and is not required in the near-term. Since this improvement was included with the 2023 .m file provided by SVP, the description is incorporated with other improvements slated for 2023.

Re-conductor Agnew – Freedom JCT

Re-conductor the 0.17-mile Agnew – Freedom JCT 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR mitigates all performance issues with projected loads in 2030 when the first thermal violation occurs. An alternative to re-conductor this line would be to rerate the 954 KCM AAC line to 4ft/sec wind speeds. This increases the line rating to 230 MVA however, this line is limited by a 2000 amp breaker to 208 MVA. This still mitigates all performance issues found on this line. Note that this is included with the long-term improvements and is not required in the near-term. Since this improvement was included with the 2023 .m file provided by SVP, the description is incorporated with other improvements slated for 2023.

Re-conductor Freedom JCT– NAJ

Re-conductor the 1.1-mile Freedom JCT– NAJ 60 kV transmission line from (2) 954 KCM AAC to (2) 715 ACCR mitigates all performance issues with projected loads in 2031 when the first thermal violation occurs. An alternative to re-conductor this line would be to rerate the 954 KCM AAC line to 4ft/sec wind speeds. This increases the line rating to 230 MVA which mitigates all performance issues found on this line. Note that this is included with the long-term improvements and is not required in the near-term. Since this improvement was included with the 2023 .m file provided by SVP, the description is incorporated with other improvements slated for 2023.

5.5 2024 Case (Peak Load 886 MVA)

5.5.1 Contingency Analysis

Contingency analysis of the SVP transmission system with 2024 loads shows no new thermal violations on SVP's system with all 2023 improvements implemented. The transmission line from Nortech to NRS 300 is not part of the SVP transmission system. It is important to note this line is overloaded during contingency conditions with projected 2024 loads.

Row Labels	MVA	% Limit
NRS 300 (36853) -> SRS (36852)		
P1 – Line Section – NRS 400-SRS 115 kV	405.69	146.46
P1 – Transformer Failure – NRS 300/500 115/60 kV	278.27	100.46
NRS 400 (36851) -> SRS (36852)		
P1 – Line Section – NRS 300-SRS 115 kV	405.92	146.54
P1 – Transformer Failure – NRS 300/500 115/60 kV	278.95	100.70

Table 5-10
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
SRS (36852) -> SRS_60 (36886) TRANSFORMER #1		
P1 – Transformer Failure – SRS 115/60 kV #2	253.40	136.23
P1 – Line Section – Duane-KRS 115kV	219.69	118.11
P1 – Transformer Failure – KRS 115/60 kV #2	212.25	114.11
SRS (36852) -> SRS_60 (36886) TRANSFORMER #2		
P1 – Transformer Failure – SRS 115/60 kV #1	253.40	136.23
P1 – Line Section – Duane-KRS 115kV	219.69	118.11
P1 – Transformer Failure – KRS 115/60 kV #2	212.25	114.11

Table 5-11
Contingency Analysis Thermal Violation; SRS

Row Labels	MVA	% Limit
KRS (36850) -> KRS_60 (36878) TRANSFORMER #1		
P1 – Transformer Failure – KRS 115/60 kV #2	249.04	133.89
P1 – Transformer Failure – SRS 115/60 kV #1	207.92	111.78
P1 – Transformer Failure – SRS 115/60 kV #2	207.92	111.78
KRS (36850) -> KRS_60 (36878) TRANSFORMER #2		
P1 – Transformer Failure – KRS 115/60 kV #1	251.47	135.20
P1 – Transformer Failure – SRS 115/60 kV #1	211.66	113.80
P1 – Transformer Failure – SRS 115/60 kV #2	211.66	113.80

Table 5-12
Contingency Analysis Thermal Violation; KRS

Row Labels	MVA	% Limit
KRS_60 (36878) -> FIBERGLA (36874)		
P1 – Line Section – SRS 60 – Stender_W	255.62	123.01
P1 – Line Section – Stender_W – FairView	228.10	109.77
FIBERGLA (36874) -> WALSH (36890)		
P1 – Line Section – SRS 60 – FairView	245.24	141.68
P1 – Line Section – Stender_W – FairView	217.90	125.88
WALSH (36890) -> Uranium (36889)		
P1 – Line Section – SRS 60 – FairView	194.16	112.16

Table 5-13
Contingency Analysis Thermal Violation; Center Loop

Row Labels	MVA	% Limit
Nortech (35659) -> NRS 300 (36853)		
P1 – Transformer Failure – NRS 230/115 kV	350.64	114.21
P1 – Line Section – SSS-NRS Riser 230kV	348.78	113.61

Table 5-14
Contingency Analysis Thermal Violation; PG&E

Additionally, this case has some voltage change violations based on the SVP performance criteria where voltage cannot change by more than 5%. Duane substation experiences voltage change violations on the low side of the transformer when the loss of a generator or transformer occurs at Duane.

5.5.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the increasing load with projected 2024 levels.

NRS Spare Transformer

The NRS T2 is identified as a P2 violation in 2023 by CAISO. This becomes a SVP load serviceability concern at 750 MW of load. Failure of the T2 transformer has an economic risk to SVP of at least $16 million/year in TAC avoidance charges. With the NRS spare transformer this risk is mitigated.

Upgrading NRS Transformers

Upgrading the NRS transformer capacity was proposed by SVP to be completed in 2023 based on *Electric Planning 2020 Report*. However, there are no violations on the NRS transformers in 2023. No thermal violation occurs on the NRS transformers until 2025. It is recommended to delay the transformer capacity upgrade at NRS until 2024. Additional transformer capacity will correct thermal overloads at NRS and on the NRS to Mission 60 kV line. In order to correct this, both NRS transformers will be upgraded from 112/149/186 MVA to 180/240/300 MVA transformers.

5.6 2025 Case (BESS)

5.6.1 Contingency Analysis

Contingency analysis of the SVP transmission system with 2025 loads and with all 2024 improvements has been studied. SVP has requested a summary of the impacts the BESS has on both the SVP and PG&E systems. SVP provided ECI with two (2) additional contingencies to help determine the impacts of the BESS on both systems. The first additional contingency is a P6 or loss of one component followed by system adjustments and then loss of a second component. The P6 contingency is the loss of SSS to NRS 230 kV line and the loss of Los Esteros to Nortech 115 kV line. The second additional contingency is a P7 or loss of any two adjacent circuits on a common structure. The P7 contingency is the loss of Los Esteros to Metcalf 230 kV and Newark to Los Esteros 230 kV. Contingency analysis was ran with the BESS on and the BESS off. Following are tables that show the result of the contingency analysis with and without the BESS.

Row Labels	MVA	% Limit
FMC JCT (35617) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	182.99	109.57
NEWARK D (35120) -> NRS 400 (36851)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	274.66	164.37
P7 – Newark - Los Esteros & Los Esteros - Metcalf	225.96	135.22
NEWARK F (35122) -> NRS 300 (36853)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	251.55	150.54
P7 – Newark - Los Esteros & Los Esteros - Metcalf	190.80	114.19
ZNKER J2 (35602) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	207.86	124.39
P7 – Newark - Los Esteros & Los Esteros - Metcalf	171.82	102.82

Table 5-15
Contingency Analysis without BESS

Row Labels	MVA	% Limit
FMC JCT (35617) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	167.61	100.37
NEWARK D (35120) -> NRS 400 (36851)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	258.21	154.52
P7 – Newark - Los Esteros & Los Esteros - Metcalf	211.44	126.53
NEWARK F (35122) -> NRS 300 (36853)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	234.37	140.26
P7 – Newark - Los Esteros & Los Esteros - Metcalf	172.70	103.35
ZNKER J2 (35602) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	194.22	116.23

Table 5-16
Contingency Analysis with BESS at KRS

Row Labels	MVA	% Limit
FMC JCT (35617) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	167.33	100.20
NEWARK D (35120) -> NRS 400 (36851)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	257.94	154.36
P7 – Newark - Los Esteros & Los Esteros - Metcalf	210.09	125.73
NEWARK F (35122) -> NRS 300 (36853)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	234.06	140.07
P7 – Newark - Los Esteros & Los Esteros - Metcalf	172.63	103.31
ZNKER J2 (35602) -> KRS (36850)		
P6 – SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	193.94	116.06

Table 5-17
Contingency Analysis with BESS between Kenneth and Oak

6.0 Conceptual Designs and Estimates

This section discusses recommended Near Term Improvements to be completed over the next three (3) years with additional details pertaining to conceptual designs and cost estimates included in *Appendix A*. The recommended projects are based specifically on their ability to mitigate thermal violations and improve voltage issues. In addition, all Near-Term Improvement projects mentioned serve as maintenance/replacement of obsolete equipment or to create additional capacity.

6.1 KRS Breaker 662 Replacement

Replace the 2000 Amp KRS breaker 662 with a 3000 Amp breaker along with short circuit mitigation. This includes upgrade of potentially 4 breakers (2 at SRS and 2 at KRS) along with possible addition of bus tie breakers at each facility.

Estimated Cost: $6,000,000

6.2 Replacing Fiberglass Breakers

Replace the 2000 Amp breakers at Fiberglass with 3000 Amp breakers. A total of (4) 60 kV breakers in addition to (8) disconnect switches will need to be replaced and main bus work/jumpers to be evaluated.

Estimated Cost: $10,000,000

6.3 Fiberglasss to Walsh 60 kV Re-conductor

Re-conductor the Fiberglass – Walsh 60 kV transmission line, which is approximately 0.5 miles of (2) bundled 954 KCM AAC, with (2) bundled 715 KCM ACC. This project is in the scope of the South Loop reconstruction project therefore no estimated cost is included.

Estimated Cost: N/A

6.4 NRS Tie-Breaker 392 Replacement

CAISO has identified a P2 violation at the NRS 115 kV bus with the failure of 115 kV bus breaker 392. The failure of breaker 392 will cause an outage on the 300 & 400 bus sections at NRS, effectively causing the loss of four (4) of six (6) SVP interties with PG&E. the lines outaged by the breaker 392 outage are; NEW-NRS #1 115 kV line, NEW-NRS #2 115 kV line, NOR-NRS 115 kV line, and the SSS-NRS 230 kV line. This event will require substantial load shedding by SVP until the contingency is resolved. The cost estimate is based on addition of a 115 kV breaker in series with breaker 392 and corresponding bus modifications.

Estimated Cost: $4,250,000

6.5 NRS to Newark 115 kV Re-conductor

This is a PG&E line that experiences thermal overloads due to the growth on SVP's system. This 8.59-mile, 115 kV line will need to be upgraded. The details of the upgrade and estimated cost will be determined by PG&E.

Estimated Cost: N/A

6.6 SRS Receiving Station Rebuild

A full rebuild of the facility includes breaker-and-a-half bus arrangement on both the 115 kV and 60 kV side of the yard as well as accommodations for four (4) 115/60 kV, 180/240/300 MVA transformers. Due to limited space availability, the use of Gas Insulated Switchgear (GIS) is recommended for this facility upgrade. This estimated cost includes the GIS supplier estimates, balance of plant estimates, and cut-over cost estimates. The SRS Rebuild includes the following specific equipment:

a) 171 kV, 3000A, 63 kA Gas-Insulated-Switchgear operated at 115 kV:

   i. Twelve 171 kV, 3000A, 63 kA Circuit Breakers – connected in four sets of breaker-and-a-half configuration with 3-position disconnect-earthing switches on each side.

   ii. Eight cable sealing ends for outgoing lines.

b) 145 kV, 3000A, 40 kA Gas-Insulated-Switchgear operated at 60 kV:

   i. Eighteen 145 kV, 3000A, 40 kA Circuit Breakers – connected in six sets of breaker-and-a-half configuration with 3-position disconnect-earthing switches on each side.

   ii. Eleven cable sealing ends for outgoing lines, with provision for a twelfth.

c) 180/240/300 MVA 115/60/13.8 kV autotransformers with De-Energized Tap Changers on the HV:

   i. Four autotransformers delivered to the pad, assembled, oil-filled, and tested.

d) Balance of plant modifications including foundations, control building, cut-over and current limiting reactors to limit 60 kV short circuit current to 32 kA:

   i. Two sets of 15 Ohm 60 kV Current limiting reactors.

Estimated Cost: $63,250,000

6.7 KRS Receiving Station Rebuild

A full rebuild of the facility includes breaker-and-a-half bus arrangement on both the 115 kV and 60 kV side of the yard as well as accommodations for four (4) 115/60 kV, 180/240/300 MVA transformer. Due to limited space availability, the use of Gas Insulated Switchgear (GIS) is recommended for this facility upgrade. This estimated cost includes the GIS supplier estimates, balance of plant estimates, and cut-over cost estimates. The KRS Rebuild includes the following specific equipment:

a) 171 kV, 3000A, 63 kA Gas-Insulated-Switchgear operated at 115 kV:

i. Twelve 171 kV, 3000A, 63 kA Circuit Breakers – connected in four sets of breaker-and-a-half configuration with 3-position disconnect-earthing switches on each side.

ii. Eight cable sealing ends for outgoing lines.

b) 145 kV, 3000A, 40 kA Gas-Insulated-Switchgear operated at 60 kV:

i. Twenty-one 145kV, 3000A, 40 kA Circuit Breakers – connected in seven sets of breaker-and-a-half configuration with 3-position disconnect-earthing switches on each side.

ii. Thirteen cable sealing ends for outgoing lines, with provision for a fourteenth.

c) 180/240/300 MVA 115/60/13.8 kV autotransformers with De-Energized Tap Changers on the HV:

i. Four autotransformers delivered to the pad, assembled, oil-filled, and tested.

d) Balance of plant modifications including foundations, control building, cut-over and current limiting reactors to limit 60 kV short circuit current to 32 kA:

ii. Two sets of 15 Ohm 60 kV Current limiting reactors.

Estimated Cost: $57,700,000

In addition to the upgrades at KRS, SVP will also be adding a 50 MW Battery Energy Storage (BESS) project that will be physically located in the northwest portion of the KRS expansion. The electrical POI for this BESS project will consist of a tap on the Kenneth to Oak Junction 60 kV transmission line.

Estimated Costs: $70,000,000

6.8 NRS to KRS 115 kV Line

The new 115 kV line from NRS to KRS is being built to alleviate thermal overloads during contingency conditions. The proposed route is to follow Wilcox Ave South to Bassett Street. The line follows Bassett Street where it crosses U.S. Highway 101 to get to KRS. The estimated cost given below is for an underground line for a majority of the route.

Conceptual Design Details

- First couple spans out of NRS will be overhead.
- 8,450ft of single ckt 115 kV underground line from NRS Substation to the corner of Bassett St and George St.

- Assuming we would be able to drill under the aqueduct that is just outside of (south and east) NRS Sub, ie., no riser structures to take the line up and over the aqueduct.
- Riser Structure at the corner of Bassett St and George St, continue overhead 2,550 ft into the KRS Sub including crossing Hwy 101.

Estimated Cost: $27,100,000

6.9 Walsh to Uranium 60 kV Re-conductor

Re-conductor the 1.64-mile Walsh – Uranium 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR.

Estimated Cost: $2,750,000

6.10 NRS 300 to Nortech 60 kV Re-conductor

This is a PG&E line that experiences thermal overloads due to the growth on SVP's system. The details of the upgrade and estimated cost will be determined by PG&E.

Estimated Cost: N/A

6.11 NRS Transformer Upgrade

Thermal overloads on neighboring lines and on the NRS transformers occur because of the increasing load. In order to alleviate overloads, two (2) 115-60 kV NRS transformers will be upgraded from 112/149/186 MVA to 180/240/300 MVA transformers.

Estimated Cost: $15,000,000

6.12 NRS Spare Transformer

Failure of the T2 transformer has an economic risk to SVP of at least $16 million/year in TAC avoidance charges. In order to alleviate this risk, a spare 230/115 kV, 180/240/300 MVA transformer will be installed at NRS. This installation includes bus work and protection modifications and will require coordination with PG&E for relocation of two (2) 115 kV lines to new bays at NRS.

Estimated Cost: $17,000,000

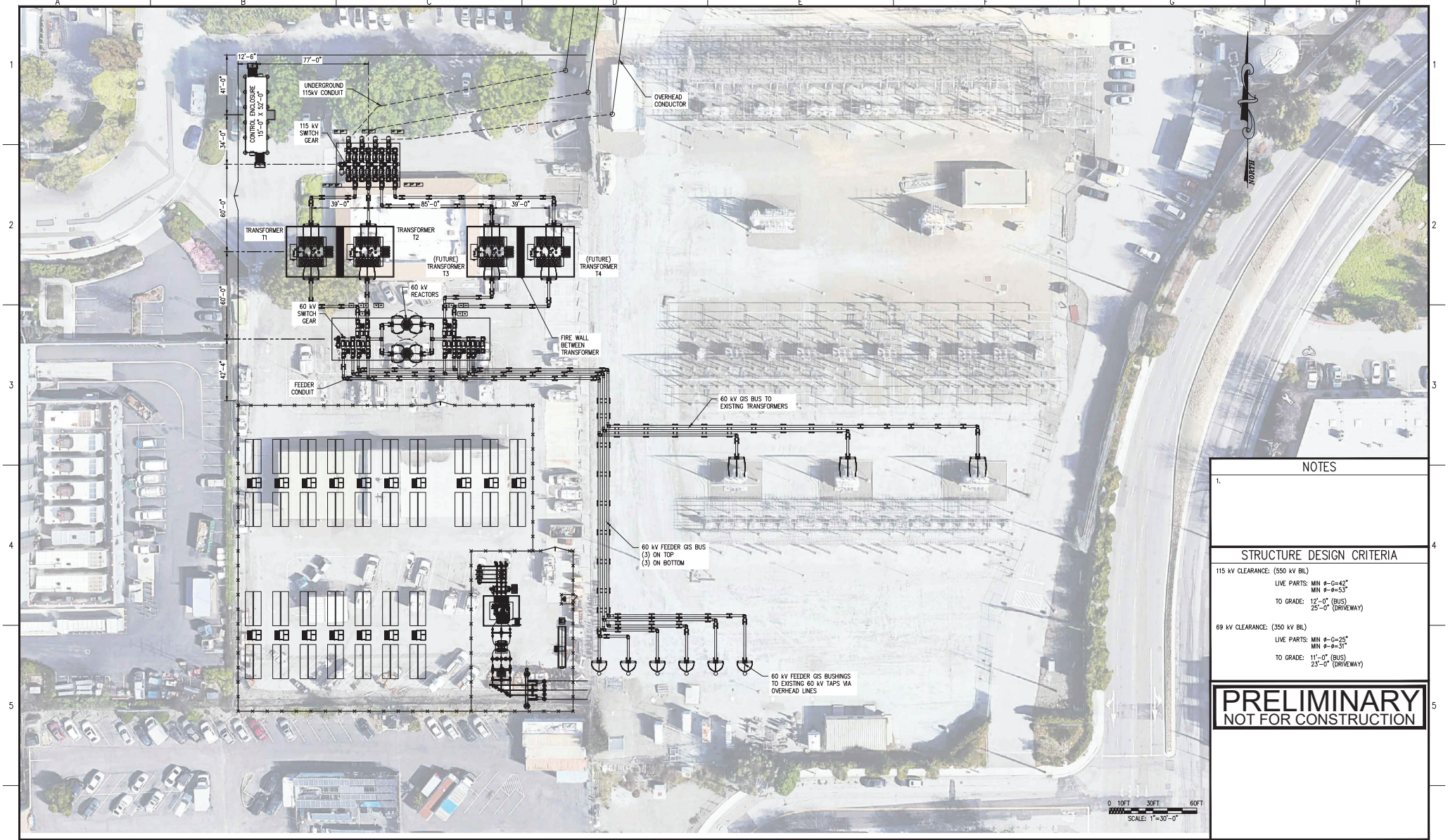
Additional details pertaining to conceptual designs and estimates for the Near-Term Improvements are provided in *Appendix A*.

Appendix A
Detailed Cost Estimates & Conceptual Designs

KRS Conceptual Designs

Notes for KRS:

1) Three (3) conceptual options were considered.
2) Cost estimate is based on Option 3.
3) Cost estimate does not include BESS yard.



NOTES

1.

STRUCTURE DESIGN CRITERIA

115 kV CLEARANCE: (550 kV BIL)

LIVE PARTS: MIN ϕ-G=42"
MIN ϕ-ϕ=53"

TO GRADE: 12'-0" (BUS)
25'-0" (DRIVEWAY)

69 kV CLEARANCE: (350 kV BIL)

LIVE PARTS: MIN ϕ-G=25"
MIN ϕ-ϕ=31"

TO GRADE: 11'-0" (BUS)
23'-0" (DRIVEWAY)

PRELIMINARY
NOT FOR CONSTRUCTION

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BILLINGS, MONTANA

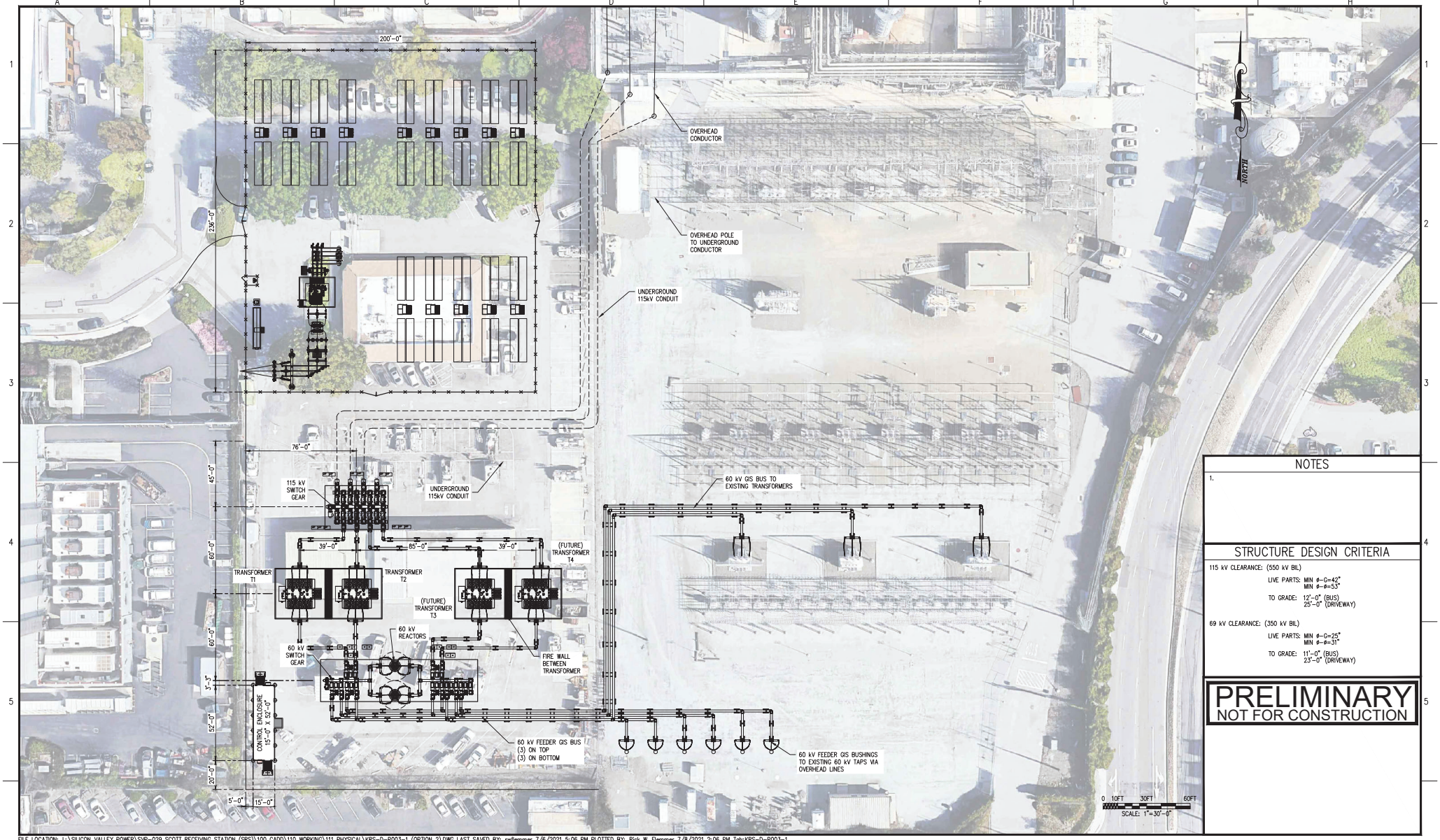
NO	REVISION	DATE	BY	APR
B	MODIFIED GIS BUS AND CLR LOCATION	06/11/21	RWF	DRM
A	PRELIMINARY	04/15/21	RWF	DRM

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	FLEMMER	4/21
DESIGNED	MAEHL	4/21
CHECKED		
APPROVED		
DWG SCALE: 1"=30'-0"	PLT SCALE: 1:1	

KIFER RECEIVING STATION
115 – 60 kV SWITCHYARD & BESS
GENERAL ARRANGEMENT (OPTION 1)

DWG. NAME: KRS-D-P003-1 OPTION 1 | REVISION NO : B



NOTES

1.

STRUCTURE DESIGN CRITERIA

115 kV CLEARANCE: (550 kV BIL)

LIVE PARTS: MIN Φ-G=42"
MIN Φ-Φ=53"

TO GRADE: 12'-0" (BUS)
25'-0" (DRIVEWAY)

69 kV CLEARANCE: (350 kV BIL)

LIVE PARTS: MIN Φ-G=25"
MIN Φ-Φ=31"

TO GRADE: 11'-0" (BUS)
23'-0" (DRIVEWAY)

PRELIMINARY
NOT FOR CONSTRUCTION

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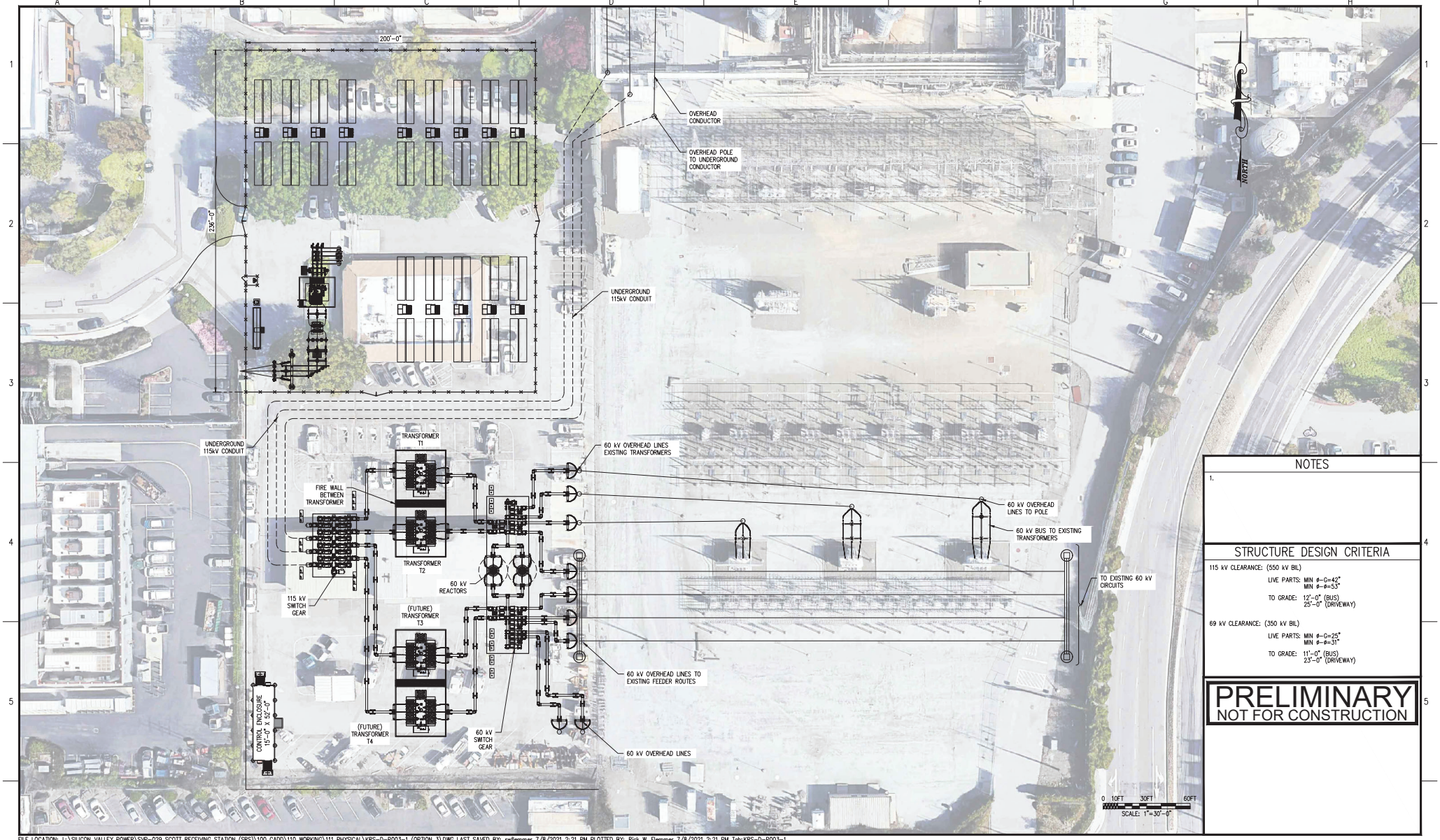
NO	REVISION	DATE	BY	APR
C	SWAP BESS YARD & GIS FACILITIES	06/23/21	RWF	DRM
B	MODIFIED GIS BUS AND CLR LOCATION	06/11/21	RWF	DRM
A	PRELIMINARY	04/15/21	RWF	DRM

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	FLEMMER	4/21
DESIGNED	MAEHL	4/21
CHECKED		
APPROVED		
DWG SCALE: 1"=30'-0"	PLT SCALE: 1:1	

KIFER RECEIVING STATION
115 – 60 kV SWITCHYARD & BESS
GENERAL ARRANGEMENT (OPTION 2)

DWG. NAME: KRS-D-P003-1 OPTION 2
REVISION NO : C



NOTES

1.

STRUCTURE DESIGN CRITERIA

115 kV CLEARANCE: (550 kV BIL)

LIVE PARTS: MIN ϕ-G=42"
MIN ϕ-ϕ=53"

TO GRADE: 12'-0" (BUS)
25'-0" (DRIVEWAY)

69 kV CLEARANCE: (350 kV BIL)

LIVE PARTS: MIN ϕ-G=25"
MIN ϕ-ϕ=31"

TO GRADE: 11'-0" (BUS)
23'-0" (DRIVEWAY)

PRELIMINARY
NOT FOR CONSTRUCTION

FILE LOCATION: L:\SILICON VALLEY POWER\SVP-029 SCOTT RECEIVING STATION (SRS)\100 CADD\110 WORKING\111 PHYSICAL\KRS-D-P003-1 (OPTION 3).DWG LAST SAVED BY: rwflemmer 7/8/2021 2:21 PM PLOTTED BY: Rick W. Flemmer 7/8/2021 2:21 PM Tab:KRS-D-P003-1

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NO	REVISION	DATE	BY	APR
D	GANTRY ADDITION FOR 60kV CIRCUITS	07/08/21	RWF	DRM
C	SWAP BESS YARD & GIS FACILITIES	06/23/21	RWF	DRM
B	MODIFIED GIS BUS AND CLR LOCATION	06/11/21	RWF	DRM
A	PRELIMINARY	04/15/21	RWF	DRM

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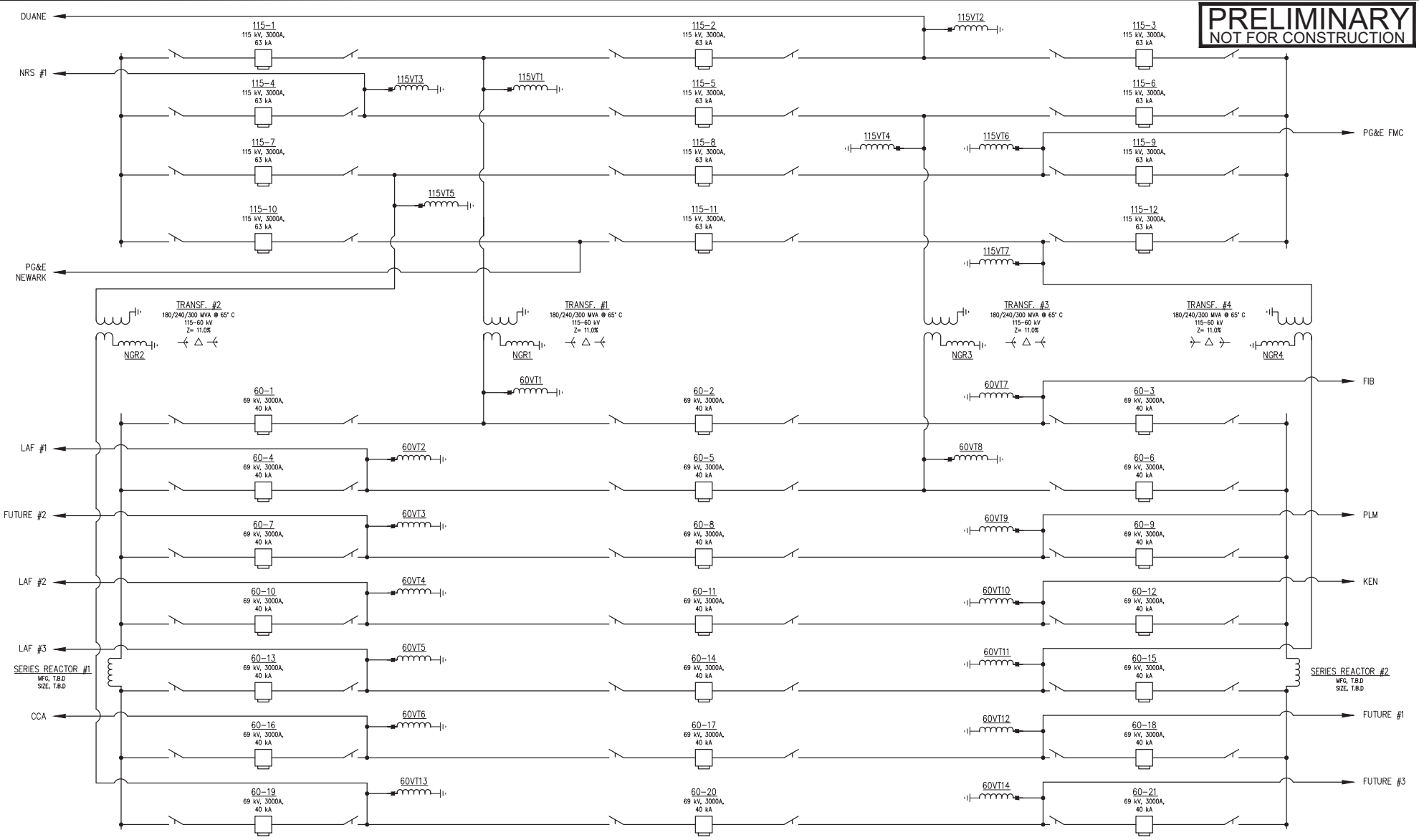
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	*FLEMMER*	4/21
DESIGNED	*MAEHL*	4/21
CHECKED		
APPROVED		
DWG SCALE: 1"=30'-0"	PLT SCALE: 1:1	

KIFER RECEIVING STATION
115 – 60 kV SWITCHYARD & BESS
GENERAL ARRANGEMENT (OPTION 3)

DWG. NAME: KRS-D-P003-1 OPTION 3 | REVISION NO : D

PRELIMINARY
NOT FOR CONSTRUCTION



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NO	REVISION	DATE	BY	APR
B	MODIFIED CLR LOCATION	07/27/21	RWF	DRM
A	ULTIMATE BUILDOUT; FOR OUTDOOR GIS EVALUATION	01/14/21	CDM	DRM

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	FLEMMER	05/21
DESIGNED	MAEHL	05/21
CHECKED		
APPROVED		
DWG SCALE: NONE	PLT SCALE: 1:1	

KIFER RECEIVING STATION
115 – 60 kV SWITCHYARD & BESS
CONCEPTUAL SWITCHING DIAGRAM

DWG. NAME: KRS-D-S001-1 | REVISION NO : B

GIS Supplier Estimates; Kifer Receiving Station			
115 kV - 60 kV, 4x 300 MVA			
Item	Description	Item Cost	
1	115 kV & 60 kV GIS, spare parts, special tools, supervision, SF6 gas, and transportation to jobsite	$	11,088,000
2	Installation and Testing of GIS Equipment above	$	2,317,000
3	Optional GIS Camera System	$	732,000
4	(4) 180/240/300MVA 115-60-13.8 kV YYD Autotransformers w/ DETC on HV	$	7,340,000
	Total	**$**	**21,477,000**
	With Escalation Cost & Margin for multiple bids	**$**	**25,772,400**

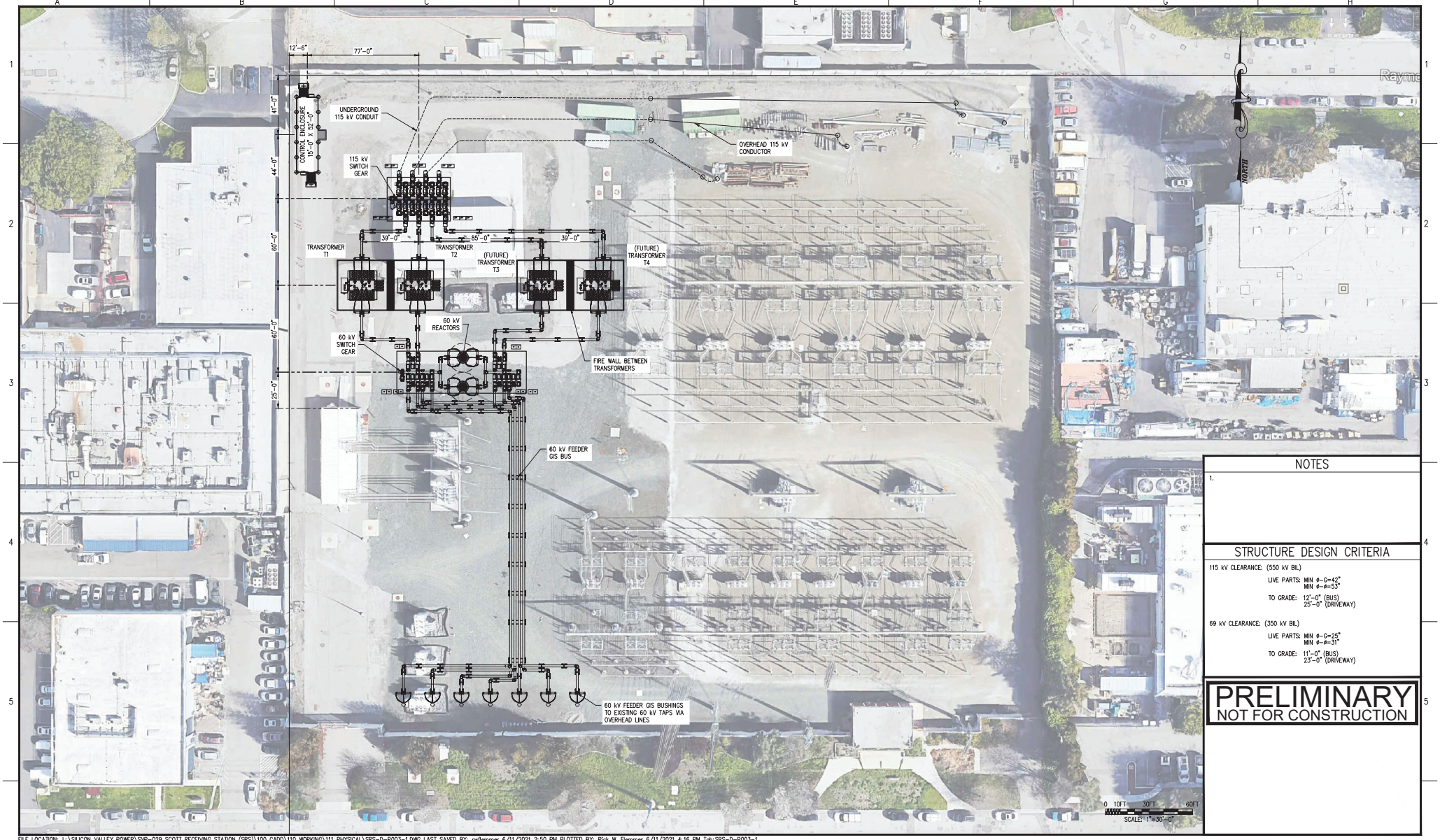
Balance of Plant Estimates; Kifer Receiving Station			
Item	**Description**	**Item Cost**	
1	Engineering & Design	$	818,125
2	Project & Construction Management, Scheduling, Accounting	$	447,095
3	Regulatory/Environmental/Site Permitting	N/A	
4	Mobilization (includes all costs associated with delivery of equipment, materials, and trailers to site)	$	158,385
5	De-comissioning, Maintenance, & Restoration (labor and material)	$	613,800
6	Site Clearing & Civil Pad Construction (labor and equipment)	$	316,210
7	Final Rock Surfacing	$	136,416
8	Concrete / Foundations (MPT, GIS, Firewall)	$	427,900
9	Fencing	$	152,361
10	Below Grade Electrical (Conduit, Grounding, Control Cable and Trench Duct)	$	217,800
11	Steel Structures	$	568,453
12	Insulators, Bus and Jumpers	$	293,957
13	Station Service (Including Transformers, Generators, Xfr Switches, Etc.)	$	29,890
14	Control Building	$	925,111
15	Above Grade Electrical (Grounding, Conduit, Cabling, Lighting, Static)	$	174,641
16	Current Limiting Reactor 60 kV 15 Ohms (quantity of 2)	$	1,960,000
17	Other Items (G&A, Contingency, Bond, Taxes)	$	935,000
18	Testing & Commissioning	$	209,972
19	Physical Security	$	2,400,000
	Total Balance of Plant Cost	**$**	**10,785,116**

Cut-over Cost Estimates; Kifer Receiving Station			
Item	**Description**	**Item Cost**	
1	115 kV Riser Structures (located adjacent to Existing DE Structures; Quantity of 3)	$	600,000
2	115 kV Shoefly (Existing DE to 115 kV Risers)	$	150,000
3	115 kV Underground Cable (from GIS to riser Structures; Bundled Cable Quantity of 3 Circuits)	$	1,500,000
4	60 kV Riser Structures & Gantry Structures for routing multiple overhead exits (located adjacent to Existing DE Structures; Quantity of 6)	$	2,400,000
5	Expansion of Test Bays at KRS (115 kV Bay and 60 kV Bay to tie into GIS during transition of loads)	$	1,500,000
6	Control Cable and Fiber (Between KRS Control Building and GIS new building	$	250,000
7	Remote Panel Upgrades (Duane, PG&E Newark and PG&E Station B for cut-over of protection schemes)	$	285,000
8	Project Management and Coordination of Outages	$	290,000
	Total Cut-over Cost	**$**	**6,975,000**

Contingencies & SVP Costs; Kifer Receiving Station			
Item	**Description**	**Item Cost**	
1	Construction Costs	$	2,577,240
2	Design	$	3,865,860
3	Administration and Permittting	$	2,577,240
4	Construction Management	$	2,577,240
5	Inspection	$	2,577,240
	Total Contingencies and SVP Cost	**$**	**14,174,820**

	Total KRS Cost	***$***	***57,700,000***

SRS Conceptual Design



NOTES

1.

STRUCTURE DESIGN CRITERIA

115 kV CLEARANCE: (550 kV BIL)

LIVE PARTS: MIN ϕ-G=42"
MIN ϕ-ϕ=53"

TO GRADE: 12'-0" (BUS)
25'-0" (DRIVEWAY)

69 kV CLEARANCE: (350 kV BIL)

LIVE PARTS: MIN ϕ-G=25"
MIN ϕ-ϕ=31"

TO GRADE: 11'-0" (BUS)
23'-0" (DRIVEWAY)

PRELIMINARY
NOT FOR CONSTRUCTION

FILE LOCATION: L:\SILICON VALLEY POWER\SVP-029 SCOTT RECEIVING STATION (SRS)\100 CADD\110 WORKING\111 PHYSICAL\SRS-D-P003-1.DWG LAST SAVED BY: rwflemmer 6/11/2021 2:50 PM PLOTTED BY: Rick W. Flemmer 6/11/2021 4:16 PM Tab:SRS-D-P003-1

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BILLINGS, MONTANA

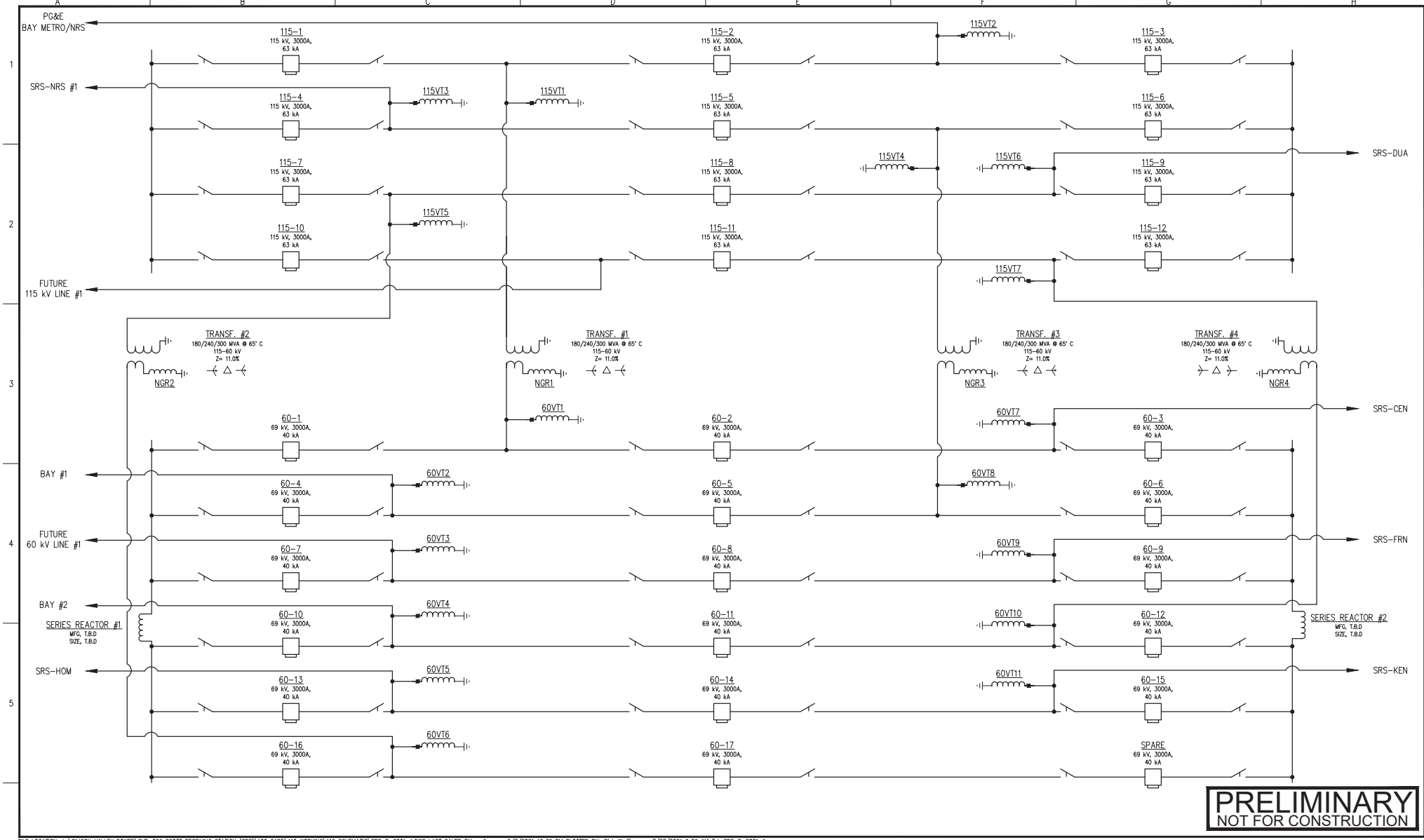
NO	REVISION	DATE	BY	APR
B	MODIFIED GIS BUS AND CLR LOCATION	06/11/21	RWF	DRM
A	PRELIMINARY	04/15/21	RWF	DRM

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	*FLEMMER*	4/21
DESIGNED	*MAEHL*	4/21
CHECKED		
APPROVED		
DWG SCALE: 1"=30'-0"	PLT SCALE: 1:1	

SCOTT RECEIVING STATION
115 – 60 kV SWITCHYARD
GENERAL ARRANGEMENT

DWG. NAME: SRS-D-P003-1 | REVISION NO : B



PRELIMINARY
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BILLINGS, MONTANA

NO	REVISION	DATE	BY	APR
B	MODIFIED CLR LOCATION	07/27/21	RWF	DRM
A	ULTIMATE BUILDOUT; FOR OUTDOOR GIS EVALUATION	01/14/21	CDM	DRM

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	MYERS	01/13/21
DESIGNED	MAEHL	01/12/21
CHECKED		
APPROVED		
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SCOTT RECEIVING STATION
115 – 60 kV SWITCHYARD
CONCEPTUAL SWITCHING DIAGRAM

DWG. NAME: SRS-D-S001-1 | REVISION NO : B

GIS Supplier Estimates; Scott Receiving Station			
115 kV - 60 kV, 4x 300 MVA			
Item	**Description**	**Item Cost**	
1	115 kV & 60 kV GIS, spare parts, special tools, supervision, SF6 gas, and transportation to jobsite	$	10,303,000
2	Installation and Testing of GIS Equipment above	$	2,162,000
3	Optional GIS Camera System	$	672,000
4	(4) 180/240/300MVA 115-60-13.8 kV YYD Autotransformers w/ DETC on HV	$	7,340,000
	Total Supplier Estimate	**$**	**20,477,000**
	With Escalation Cost & Margin for multiple bids	**$**	**24,981,940**

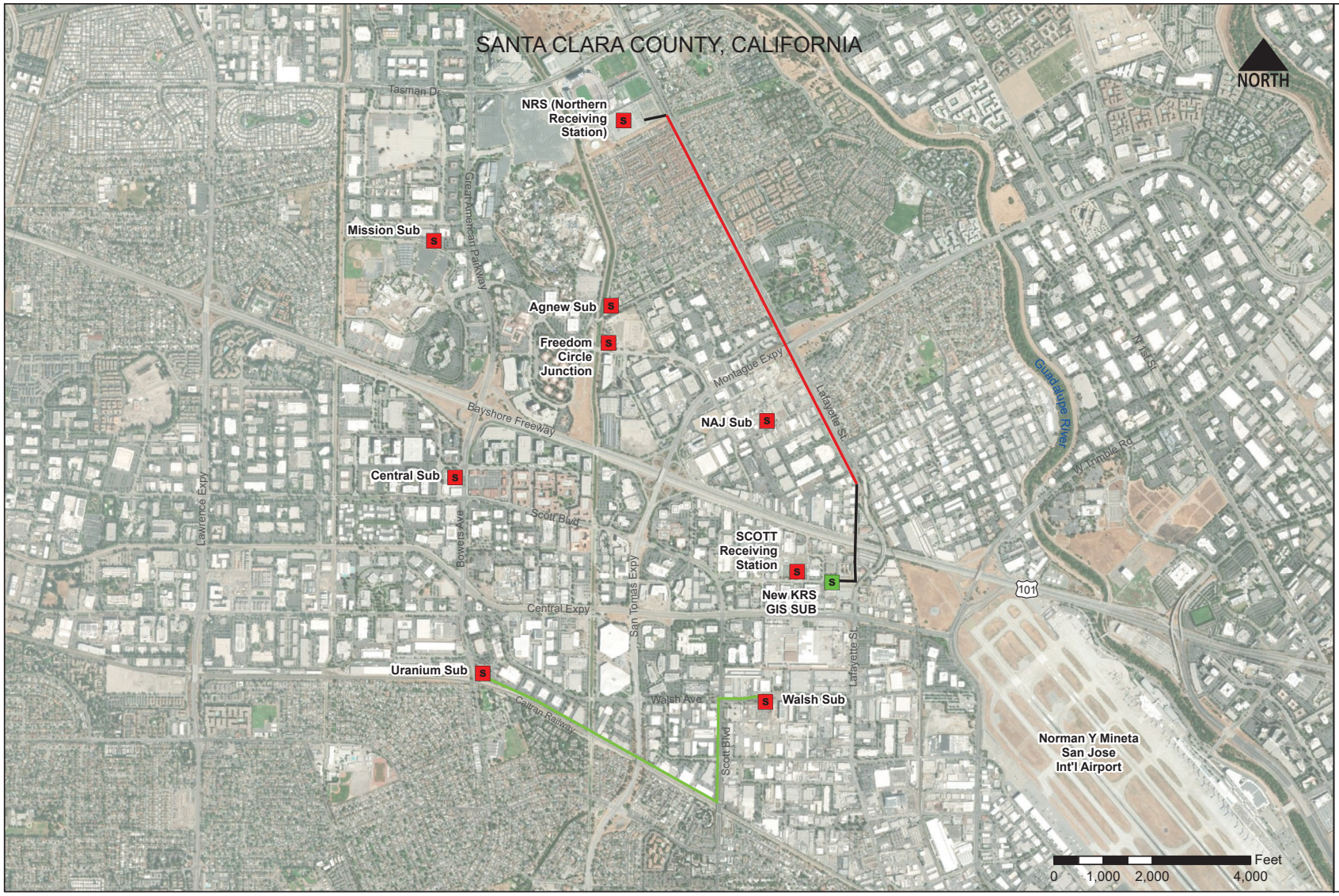
Balance of Plant Estimates; Scott Receiving Station			
Item	**Description**	**Item Cost**	
1	Engineering & Design	$	743,750
2	Project & Construction Management, Scheduling, Accounting	$	406,450
3	Regulatory/Environmental/Site Permitting	N/A	
4	Mobilization (includes all costs associated with delivery of equipment, materials, and trailers to site)	$	143,986
5	De-comissioning, Maintenance, & Restoration (labor and material)	$	558,000
6	Site Clearing & Civil Pad Construction (labor and equipment)	$	287,464
7	Final Rock Surfacing	$	124,015
8	Concrete / Foundations (MPT, GIS, Firewall)	$	389,000
9	Fencing	$	138,510
10	Below Grade Electrical (Conduit, Grounding, Control Cable and Trench Duct)	$	198,000
11	Steel Structures	$	516,775
12	Insulators, Bus and Jumpers	$	267,234
13	Station Service (Including Transformers, Generators, Xfr Switches, Etc.)	$	29,890
14	Control Building	$	841,010
15	Above Grade Electrical (Grounding, Conduit, Cabling, Lighting, Static)	$	158,764
16	Current Limiting Reactor 60 kV 15 Ohms (quantity of 2)	$	1,960,000
17	Other Items (G&A, Bond, Taxes)	$	850,000
18	Testing & Commissioning	$	190,884
19	Physical Security	$	2,400,000
	Total Balance of Plant Cost	**$**	**10,203,732**

Cut-over Cost Estimates; Scott Receiving Station			
Item	**Description**	**Item Cost**	
1	115 kV Riser Structures (located adjacent to Existing DE Structures; Quantity of 3)	$	600,000
2	115 kV Shoefly (Existing DE to 115 kV Risers)	$	150,000
3	115 kV Underground Cable (from GIS to riser Structures; Bundled Cable Quantity of 3 Circuits)	$	1,500,000
4	60 kV Riser Structures & Gantry Structures for routing multiple overhead exits (located adjacent to Existing DE Structures; Quantity of 6)	$	2,400,000
5	Expansion of Test Bays at SRS (115 kV Bay and 60 kV Bay to tie into GIS during transition of loads)	$	1,500,000
6	Control Cable and Fiber (Between SRS Control Building and GIS new building	$	250,000
7	Remote Panel Upgrades (NRS and PG&E Newark for cut-over of protection schemes)	$	190,000
8	Project Management and Coordination of Outages	$	250,000
	Total Cut-over Cost	**$**	**6,840,000**

Contingencies & SVP Costs; Scott Receiving Station			
Item	**Description**	**Item Cost**	
1	Construction Costs	$	4,996,388
2	Design	$	6,245,485
3	Administration and Permittting	$	3,747,291
4	Construction Management	$	2,498,194
5	Inspection	$	3,747,291
	Total Contingencies and SVP Cost	**$**	**21,234,649**

	Total SRS Cost	***$***	***63,250,000***

Transmission Routing & Estimates

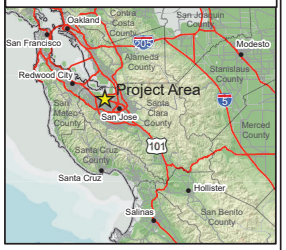


LEGEND

- Existing Substation
- Proposed Substation
- New 115 kV - Overhead
- New 115 kV - Underground
- Rebuild 60 KV - Walsh to Uranium

PRELIMINARY
NOT FOR CONSTRUCTION

VICINITY MAP



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BILLINGS, MONTANA

NO	REVISION	DATE	BY	APR
A	CONCEPTUAL TRANMISSION LINE ROUTING	05/03/21	JIH	BMS

Silicon Valley Power
CITY OF SANTA CLARA

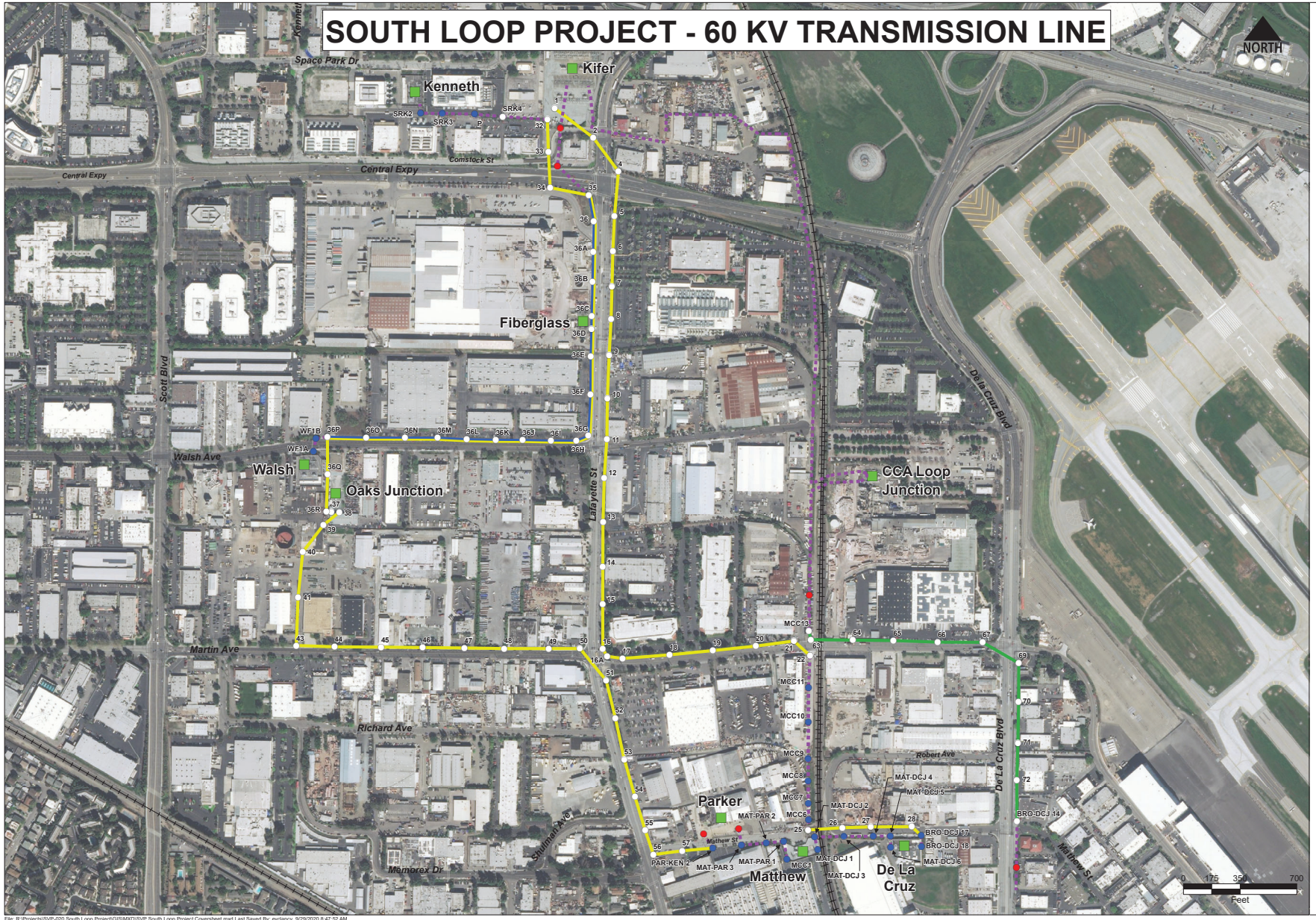
ENGINEERING RECORD		DATE
DRAWN	J. HANSON	04/30/21
DESIGNED	B. STRINGHAM	04/30/21
CHECKED	MAEHL	04/30/21
APPROVED		
DWG SCALE:	PLT SCALE: 1:1	

SVP-3 YEAR STUDY
OVERVIEW OF TRANSMISSION UPGRADES
SVP NEAR TERM; EXCLUDING SOUTH LOOP

DWG NAME: SVP-B-D001 REVISION NO: A

Maxar\USGS, ECI, ESRI, BLM Service Layer

SOUTH LOOP PROJECT - 60 KV TRANSMISSION LINE



LEGEND

- Existing Substation
- New Structure Location
- Existing Structure to Remain
- Existing Structure to be Modified and/or Reconductored
- New East Loop T–Line Construction
- New South Loop T–Line Construction
- New Double Circuit East and Central Loop Construction
- Existing 60 kV T–Line
- Railway

NOTE: ALL NEW TRANSMISSION STRUCTURES AND EXISTING STRUCTURES TO BE MODIFIED OR RECONDUCTORED ARE SHOWN. HOWEVER, STRUCTURES BEING TOPPED, EXISTING STRUCTURES BEING REPLACED, AND DISTRIBUTION STRUCTURES ARE NOT SHOWN.

ISSUED FOR BID
NOT FOR CONSTRUCTION

VICINITY MAP

File: R:\Projects\SVP-020 South Loop Project\GIS\MXD\SVP South Loop Project Coversheet.mxd Last Saved By: evclancy 9/29/2020 8:47:52 AM

"Engineering with Distinction"
ELECTRICAL CONSULTANTS, INC.
490 W. MAGEE ROAD
TUCSON, ARIZONA 85704
(520)219-9933 FAX: (520)219-9949

NO	REVISION	DATE	BY	APR
B	ISSUED FOR BID	30Sep2020	ALP	BMS
A	ISSUED FOR REVIEW	20Feb2020	ALP	BMS

Silicon Valley Power
CITY OF SANTA CLARA

ENGINEERING RECORD		DATE
DRAWN	EVC	18May2020
DESIGNED	MRF	18May2020
CHECKED	ALP	18May2020
APPROVED	BMS	18May2020
DWG SCALE: 1 in = 270 feet	PLT SCALE:	

SOUTH LOOP PROJECT
60 KV TRANSMISSION LINE
COVER SHEET

DWG NAME: SLP–B–T001–SH1 REVISION NO: B

Assumptions used for Transmission Cost Estimates

For the Lines being re-conductored

- 20% of the existing tangent poles will need to be replaced, using the same type of pole (wood vs. steel) that is being used in the existing line.
- No Geotechnical work will be completed for the few direct embed poles that will be replaced.
- All existing materials (other than the pole) will be replaced with new materials for the ACCR conductor
- No Right-of-Way services or easement purchases should be needed since these are existing lines.
- The existing 60 kV lines can be taken out of service for an extended period of time while the construction work is being done.

For the New 115 kV Line from NRS to KRS

- Single Circuit 115 kV
- The Line starts from NRS and ends at the new GIS substation that will be built adjacent to Kifer Receiving Station. Then the existing Line between KRS – Duane – SRS will extend this new line to SRS
- The first couple spans out of NRS will be overhead construction, and then transition to an underground 115 kV line to about the corner of Bassett St and George St. From that point it will be overhead for the remaining ½ mile into KRS.
- Does not include cost to purchase easements.

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 9, Rebuild 60 kV from Walsh to Uranium Subs

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$800,029	
		$800,029
2 Subcontractor Costs		
T-Line Contractor	$531,890	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$531,890
3 Project Management		
Sr. Project Manager	$12,779	
Project Manager	$9,612	
Assistant Project Manager	$4,481	
Construction Manager	$50,760	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$32,099	
Mobilization & Site Costs (for P. M.)	$8,574	
		$127,280
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$19,000	
Traffic Control	$110,000	
ROW Restoration, clearing & crubbing	$70,000	
		$377,800

5	**Engineering**			
	Engineering and Survey		$176,100	
				$176,100
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$642,949.70	
				$642,950
	SUBTOTAL:			**$2,656,049**
7	**Bonding (With Engineering)**	**1.09%**	$29,697.05	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$72,003	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$101,700**
	GRAND TOTAL			**$2,750,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 13, Rebuild 60 kV from Northern Receiving Station to Agnew Sub

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$444,833	
		$444,833
2 Subcontractor Costs		
T-Line Contractor	$311,240	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$311,240
3 Project Management		
Sr. Project Manager	$9,584	
Project Manager	$7,209	
Assistant Project Manager	$3,361	
Construction Manager	$38,070	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$23,682	
Mobilization & Site Costs (for P. M.)	$6,570	
		$97,452
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$15,000	
Traffic Control	$40,000	
ROW Restoration, clearing & crubbing	$45,000	
		$278,800

5	**Engineering**			
	Engineering and Survey		$139,500	
				$139,500
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$396,313.70	
				$396,314
	SUBTOTAL:			**$1,668,139**
7	**Bonding (With Engineering)**	**1.17%**	$20,060.92	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$40,035	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$60,096**
	GRAND TOTAL (2021 ESTIMATE)			**$1,728,234**
10	**Total (with escalation of 5% per year for 2025 estimate)**			**$2,100,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 14, Rebuild 60 kV from Central Sub to Scott Receiving Station

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$544,925	
		$544,925
2 Subcontractor Costs		
T-Line Contractor	$355,581	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$355,581
3 Project Management		
Sr. Project Manager	$11,714	
Project Manager	$8,811	
Assistant Project Manager	$4,108	
Construction Manager	$46,530	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$29,417	
Mobilization & Site Costs (for P. M.)	$7,950	
		$117,505
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$19,000	
Traffic Control	$120,000	
ROW Restoration, clearing & crubbing	$70,000	
		$387,800

5	**Engineering**			
	Engineering and Survey		$164,700	
				$164,700
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$492,034.06	
				$492,034
	SUBTOTAL:			**$2,062,546**
7	**Bonding (With Engineering)**	**1.14%**	$24,054.73	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$49,043	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$73,098**
	GRAND TOTAL (2021 ESTIMATE)			**$2,135,644**
10	**Total (with escalation of 5% per year for 2025 estimate)**			**$2,600,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 16, Rebuild 60 kV from Mission Sub to Northern Receiving Station

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$420,817	
		$420,817
2 Subcontractor Costs		
T-Line Contractor	$294,699	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$294,699
3 Project Management		
Sr. Project Manager	$9,584	
Project Manager	$7,209	
Assistant Project Manager	$3,361	
Construction Manager	$38,070	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$23,682	
Mobilization & Site Costs (for P. M.)	$6,570	
		$97,452
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$15,000	
Traffic Control	$40,000	
ROW Restoration, clearing & crubbing	$45,000	
		$278,800

5	**Engineering**			
	Engineering and Survey		$139,500	
				$139,500
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$382,118.71	
				$382,119
	SUBTOTAL:			**$1,613,386**
7	**Bonding (With Engineering)**	**1.18%**	$19,497.47	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$37,874	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$57,371**
	GRAND TOTAL (2021 ESTIMATE)			**$1,670,757**
10	**Total (with escalation of 5% per year for 2026 estimate)**			**$2,150,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 17, Rebuild 60 kV from Agnew to Freedom JCT Subs

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$94,682	
		$94,682
2 Subcontractor Costs		
T-Line Contractor	$77,681	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$77,681
3 Project Management		
Sr. Project Manager	$5,325	
Project Manager	$4,005	
Assistant Project Manager	$1,867	
Construction Manager	$21,150	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$11,091	
Mobilization & Site Costs (for P. M.)	$3,285	
		$55,699
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$60,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$5,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$11,000	
Traffic Control	$25,000	
ROW Restoration, clearing & crubbing	$20,000	
		$191,800

5	**Engineering**			
	Engineering and Survey		$104,000	
				$104,000
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$146,951.56	
				$146,952
	SUBTOTAL:			**$670,813**
7	**Bonding (With Engineering)**	**1.45%**	$9,875.41	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$8,521	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$18,397**
	GRAND TOTAL (2021 ESTIMATE)			**$689,210**
10	**Total (with escalation of 5% per year for 2030 estimate)**			**$1,050,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 18, Rebuild 60 kV from Freedom JCT and NAJ Subs

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$549,230	
		$549,230
2 Subcontractor Costs		
T-Line Contractor	$379,160	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$379,160
3 Project Management		
Sr. Project Manager	$10,649	
Project Manager	$8,010	
Assistant Project Manager	$3,734	
Construction Manager	$42,300	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$25,429	
Mobilization & Site Costs (for P. M.)	$6,997	
		$106,095
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$17,000	
Traffic Control	$100,000	
ROW Restoration, clearing & crubbing	$60,000	
		$355,800

5	**Engineering**			
	Engineering and Survey		$147,300	
				$147,300
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$486,599.93	
				$486,600
	SUBTOTAL:			**$2,024,185**
7	**Bonding (With Engineering)**	**1.14%**	$23,678.80	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$49,431	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$73,110**
	GRAND TOTAL (2021 ESTIMATE)			**$2,097,295**
10	**Total (with escalation of 5% per year for 2030 estimate)**			**$3,250,000**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item 19, Rebuild 60 kV from Homestead Sub to Scott Receiving Station

DESCRIPTION	ITEM COST	SUBTOTAL
1 Materials		
Material Cost	$1,706,185	
		$1,706,185
2 Subcontractor Costs		
T-Line Contractor	$1,141,065	
T-Line Foundations - N/A	$0	
Access Roads - N/A	$0	
Geotechnical - N/A	$0	
		$1,141,065
3 Project Management		
Sr. Project Manager	$19,168	
Project Manager	$14,418	
Assistant Project Manager	$6,722	
Construction Manager	$76,140	
Project Manager Travel Costs	$8,976	
Project Site Coordinator Travel Cost	$53,363	
Mobilization & Site Costs (for P. M.)	$13,140	
		$191,927
4 Other		
Special Insurance Coverage	$2,800	
Contractor Mobilization/Demobilization	$50,000	
Contractor Project Management Costs (If Separated)	$0	
Miscellaneous	$100,000	
Environmental Subcontractor - Biologist	$0	
Environmental Subcontractor - Other	$0	
Permits	$8,000	
Site Safety (Subcontracted Only)	$18,000	
Material Testing (Subcontracted)	$0	
Geotech	$0	
Survey	$23,000	
Traffic Control	$150,000	
ROW Restoration, clearing & crubbing	$95,000	
		$446,800

5	**Engineering**			
	Engineering and Survey		$291,900	
				$291,900
6	**Contingency and G&A (On Items 1 - 4)**	**35.00%**	$1,220,092.16	
				$1,220,092
	SUBTOTAL:			**$4,997,970**
7	**Bonding (With Engineering)**	**0.95%**	$48,690.99	
8	**Taxes (on Materials) San Jose, Ca**	**9.00%**	$153,557	
9	**Taxes (Gross Receipts 65% of 7.2%)**	**0.00%**	$0	**N/A**
	www.taxrates.com/state-rates			**$202,248**
	GRAND TOTAL (2021 ESTIMATE)			**$5,200,217**
10	**Total (with escalation of 5% per year for 2030 estimate)**			**$8,050,000**

Appendix B
Load Growth Projections

					2021	2022	2023	2024	2025	2031
2021					615	687	784	879	964	1125
DivBus Name	Zone Bus	Load ID	Unique name	Power Factor	2021 1in10 MW	2022 1in10 MW	2023 1in10 MW	2024 1in10 MW	2025 1in10 MW	2031 1in10 MW
Agnew	36870	1	368701	0.990	0.104	0.108	0.106	0.108	0.107	0.123
Agnew	36870	2	368702	0.990	27.044	27.876	27.534	28.099	27.715	31.879
Brokaw	36871	1	368711	0.990	13.574	13.992	13.820	14.104	13.911	16.001
Brokaw	36871	2	368712	0.990	14.827	15.283	15.096	15.406	15.195	17.478
Central	36873	1	368731	0.990	11.695	12.054	11.907	12.151	11.985	13.786
Central	36873	2	368732	0.990	17.751	18.297	18.073	18.444	18.191	20.925
DCJ	38904	3	389043	0.990	19.317	19.911	19.667	20.071	19.796	22.771
DCJ	38904	2	389042	0.990	0.522	0.538	0.532	0.542	0.535	0.615
DCJ	38904	1	389041	0.990	19.317	19.911	19.667	20.071	19.796	22.771
FairView	36896	2	368962	0.990	25.164	25.939	25.621	26.147	25.789	29.664
FairView	36896	1	368961	0.990	26.731	27.553	27.215	27.774	27.394	31.510
Fibergla	36874	3	368743	0.990	0.104	0.108	0.106	0.108	0.107	0.123
Fibergla	36874	1	368741	0.990	9.084	9.364	9.249	9.439	9.310	10.708
Fibergla	36874	2	368742	0.990	0.104	0.108	0.106	0.108	0.107	0.123
Homestea	36876	1	368761	0.990	23.911	24.647	24.345	24.845	24.505	28.187
Homestea	36876	2	368762	0.990	26.104	26.907	26.577	27.123	26.752	30.772
Juliette	36877	1	368771	0.990	9.920	10.225	10.099	10.307	10.166	11.693
Juliette	36877	2	368772	0.990	13.887	14.315	14.139	14.429	14.232	16.370
Kenneth	38905	1	389051	0.990	4.908	5.059	4.997	5.099	5.029	5.785
Kenneth	38905	2	389052	0.990	7.100	7.319	7.229	7.377	7.277	8.370
Laf T1	36879	1	368791	0.990	11.799	12.162	12.013	12.260	12.092	13.909
Laf T2	36880	1	368801	0.990	7.831	8.072	7.973	8.137	8.026	9.231
Laf T3	36881	1	368811	0.990	10.337	10.655	10.525	10.741	10.594	12.186
Mission	36857	3	368573	0.990	21.197	21.849	21.581	22.024	21.723	24.986
Mission	36857	2	368572	0.990	21.928	22.602	22.325	22.783	22.472	25.848
Mission	36857	1	368571	0.990	15.454	15.929	15.734	16.057	15.837	18.217
NAJ	36883	1	368831	0.990	6.474	6.673	6.591	6.727	6.634	7.631
Northwes	36869	1	368691	0.990	18.586	19.158	18.923	19.312	19.047	21.909

2021					2021 615	2022 687	2023 784	2024 879	2025 964	2031 1125
DivBus Name	Zone Bus	Load ID	Unique name	Power Factor	2021 1in10 MW	2022 1in10 MW	2023 1in10 MW	2024 1in10 MW	2025 1in10 MW	2031 1in10 MW
Northwes	36869	2	368692	0.990	23.389	24.109	23.813	24.302	23.970	27.571
Palm	36860	1	368601	0.990	20.361	20.988	20.730	21.156	20.867	24.002
Palm	36860	2	368602	0.990	17.229	17.759	17.541	17.901	17.656	20.309
Serra	36887	1	368871	0.990	14.305	14.745	14.564	14.863	14.660	16.863
SRS_60	36886	1	368861	0.990	12.321	12.700	12.545	12.802	12.627	14.524
SRS_60	36886	2	368862	0.990	9.084	9.364	9.249	9.439	9.310	10.708
Uranium	36889	1	368891	0.990	8.353	8.610	8.505	8.679	8.561	9.847
Uranium	36889	2	368892	0.990	7.936	8.180	8.080	8.245	8.133	9.355
Uranium	36889	3	368893	0.990	14.932	15.391	15.202	15.514	15.302	17.601
Walsh	36890	1	368901	0.990	25.791	26.584	26.258	26.798	26.431	30.402
Walsh	36890	2	368902	0.990	22.241	22.925	22.644	23.109	22.793	26.217
Zeno	36891	1	368911	0.990	9.606	9.902	9.780	9.981	9.845	11.324
Zeno	36891	2	368912	0.990	7.936	8.180	8.080	8.245	8.133	9.355
Parker	38906	1	389061	0.990	16.380	33.174	49.969	51.317	51.317	51.317
Mathew	36882	1	368821	0.990	12.181	24.362	24.362	24.362	24.362	24.362
Fairview Bank 3	36896	3	368963	0.990	7.983	15.551	15.551	15.551	15.551	15.551
Oak JCT	38908	1	389081	0.990	0.000	12.181	13.995	13.995	13.995	13.995
Freedom_JCT	38907	1	389071	0.990	0.000	5.184	21.978	25.399	25.399	25.399
San Thomas	38909	1	389091	0.990	0.000	0.000	20.578	37.373	51.317	51.317
Memorex	38911	1	389111	0.990	0.000	0.000	17.779	34.574	51.368	51.317
Martin Ave Jct (CCA existing)	36872	1	368721	0.990	1.037	1.037	12.181	13.995	13.995	13.995
Stender_W	38913	1	389131	0.990	0.000	0.000	10.782	25.399	25.399	25.399
Laurelwood	38912	1	389121	0.990	0.000	0.000	7.983	24.777	25.399	25.399
Pacific	38914	1	389141	0.990	0.000	0.000	0.000	12.181	28.976	51.317
NRS 500	36862	1	368621	0.990	0.000	0.000	0.000	7.983	24.777	25.918
Martin JCT	36872	1	368721	0.990	0.000	0.000	0.000	5.184	21.978	31.101
Bowers	38915	1	389151	0.990	0.000	0.000	0.000	0.000	12.181	51.317
Laf T2	36880	G2	36880G2	0.980	-3.000	-3.000	-3.000	-3.000	-3.000	-3.000
Laf T2	36880	G1	36880G1	0.980	-3.000	-3.000	-3.000	-3.000	-3.000	-3.000
DVRbload	36866	ss	36866ss	0.980	5.000	5.000	5.000	5.000	5.000	5.000
Gia100	36858	ss	36858ss	0.980	0.300	0.300	0.300	0.300	0.300	0.300
Gia200	36895	ss	36895ss	0.980	0.300	0.300	0.300	0.300	0.300	0.300

Appendix C
List of Contingencies

Label	Category	Year
Normal System	P0	2020 - 2031
GEN: DVRaST3	P1.1	2020 - 2031
GEN: DVRbGt2	P1.1	2020 - 2031
GEN: DVTaGT1	P1.1	2020 - 2031
GEN: Gia100	P1.1	2020 - 2031
GEN: Gia200	P1.1	2020 - 2031
LINE: SSS - NRS Riser 230kV	P1.2	2020 - 2031
LINE: NRS 300 - SRS 115kV	P1.2	2020 - 2031
LINE: NRS 400 - SRS 115kV	P1.2	2020 - 2031
LINE: SRS - Duane 115kV	P1.2	2020 - 2031
LINE: Duane - KRS 115kV	P1.2	2020 - 2031
LINE: NRS 500 - Gia12	P1.2	2020 - 2031
LINE: NRS 600 - Gia32	P1.2	2020 - 2031
LINE: Lafayette T1 - KRS 60 kV	P1.2	2020 - 2031
LINE: Lafayette T2 - KRS 60 kV	P1.2	2020 - 2031
LINE: Lafayette T3 - KRS 60 kV	P1.2	2020 - 2031
LINE: NRS 500 - Mission	P1.2	2020 - 2031
LINE: Mission - Juliette	P1.2	2020 - 2031
LINE: Juiliette - Central	P1.2	2020 - 2021
LINE: Juiliette - San Thomas	P1.2	2022 - 2031
LINE: San Thomas - Central	P1.2	2022 - 2031
LINE: Central - SRS_60	P1.2	2020 - 2031
LINE: NRS 600 - Agnew	P1.2	2020 - 2031
LINE: Agnew - Norman Ave 60 kV	P1.2	2020 - 2021
LINE: Agnew - Freedom JCT	P1.2	2022 - 2031
LINE: Freedom JCT - Norman Ave	P1.2	2022 - 2031
LINE: Norman Ave. - Palm	P1.2	2020 - 2031
LINE: Palm - KRS 60	P1.2	2020 - 2031
LINE: SRS 60 - Kenneth	P1.2	2020 - 2031
LINE: Kenneth - KRS 60	P1.2	2020 - 2021

Label	Category	Year
LINE: Kenneth - Oak JCT	P1.2	2022 - 2031
LINE: Oak JCT - Memorex	P1.2	2022 - 2031
LINE: Memorex - Parker	P1.2	2022 - 2031
LINE: Mathew - Parker	P1.2	2020 - 2031
LINE: DCJ - Mathew	P1.2	2020 - 2031
LINE: DCJ - KRS 60 kV	P1.2	2022 - 2024
LINE: DCJ - Pacific	P1.2	2024 - 2031
LINE: Pacific - KRS 60 kV	P1.2	2024 - 2031
LINE: SRS 60 kV - Stender_W	P1.2	2023 - 2031
LINE: Stender_W - FairView	P1.2	2023 - 2031
LINE: SRS 60 - FairView	P1.2	2020 -2023
LINE: FairView - Northwestern	P1.2	2020 - 2031
LINE: Northwestern - Zeno	P1.2	2020 - 2031
LINE: Zeno - Uranium	P1.2	2020 - 2031
LINE: Uranium - Walsh	P1.2	2020 -2025
LINE: Walsh - Fibergla	P1.2	2020 - 2031
LINE: Fibergla - KRS 60	P1.2	2020 - 2031
LINE: SRS 60 - Homestead	P1.2	2020 - 2031
LINE: Homestead - Serra	P1.2	2020 - 2031
LINE: Serra - Brokaw	P1.2	2020 - 2031
LINE: Brokaw - DCJ	P1.2	2020 - 2021
LINE : Brokaw - Martin JCT	P1.2	2022 - 2031
LINE: Parker - CCA	P1.2	2020 - 2021
LINE: CCA - KRS 60	P1.2	2020 - 2021
LINE: Martin JCT - KRS 60 kV	P1.2	2022
LINE: Martin JCT - Laurelwood	P1.2	2023 - 2031
LINE: Laurelwood - KRS 60 kV	P1.2	2023 - 2031
LINE: NRS 400 - NEWARK D 115kV	P1.2	2020 - 2031
LINE: NRS 300 - NEWARK F 115kV	P1.2	2020 - 2031
LINE: NEWARK F - ZNKER J1 115kV	P1.2	2020 - 2031
LINE: NEWARK F - ZNKer J2 115kV	P1.2	2020 - 2031
LINE: ZNKER J1 - TRIMBLE 115kV	P1.2	2020 - 2031
LINE: ZNKER J1 - ZANKER 115kV	P1.2	2020 - 2031
LINE: ZNKER J2 - KRS 115kV	P1.2	2020 - 2031
LINE: ZNKER J2 - ZANKER 115kV	P1.2	2020 - 2031
LINE: KRS 115 kV - FMC JCT	P1.2	2020 - 2031
XFMR: Duane 115/13.8 kV #1	P1.3	2020 - 2031
XFMR: Duane 115/13.8 kV #2	P1.3	2020 - 2031
XFMR: Gia12 60/13.8 kV	P1.3	2020 - 2031
XFMR: Gia32 60/13.8 kV	P1.3	2020 - 2031

Label	Category	Year
XFMR: KRS 115/60 kV #1	P1.3	2020 - 2031
XFMR: KRS 115/60 kV #2	P1.3	2020 - 2031
XFMR: NRS 230/115 kV	P1.3	2020 - 2031
XFMR: NRS 300/500 115/60 kV	P1.3	2020 - 2031
XFMR: NRS 400/600 115/60 kV	P1.3	2020 - 2031
XFMR: SRS 115/60 kV #1	P1.3	2020 - 2031
XFMR: SRS 115/60 kV #2	P1.3	2020 - 2031
SHUNT: Agnew #1	P1.4	2020 - 2031
SHUNT: Agnew #2	P1.4	2020 - 2031
SHUNT: Agnew #3	P1.4	2020 - 2031
SHUNT: Agnew #4	P1.4	2020 - 2031
SHUNT: Central #1	P1.4	2020 - 2031
SHUNT: Central #2	P1.4	2020 - 2031
SHUNT: Central #3	P1.4	2020 - 2031
SHUNT: Central #4	P1.4	2020 - 2031
SHUNT: Lafayette #2	P1.4	2020 - 2031
SHUNT: Lafayette #3	P1.4	2020 - 2031
SHUNT: Uranium #1	P1.4	2020 - 2031
SHUNT: Uranium #2	P1.4	2020 - 2031
SHUNT: Uranium #3	P1.4	2020 - 2031
SHUNT: Uranium #4	P1.4	2020 - 2031
SSS – NRS 230 kV & Los Esteros – Nortech 115 kV	P6.1.1	2025
Newark – Los Esteros & Los Esteros – Metcalf	P7.1	2025