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NORTHERN CALIFORNIA POWER AGENCY

Wildfire Risk Mitigation Project

Wildfire Mitigation Report and Recommendations

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Wildfire Mitigation Report and Recommendations

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EXECUTIVE SUMMARY

Northern California Power Agency (NCPA) contracted POWER Engineers Inc. (POWER) to prepare a wildfire mitigation report with an objective of reducing the risk of wildfires that could be ignited or propagated by NCPA electrical equipment and/or facilities. The analysis and recommendations of this report are based on a previous wildfire gap assessment report that POWER delivered to NCPA on August 5, 2019: "Gap Observation and Assessment Report." The previous report identified and assessed gaps in NCPA's system, processes, and documentation based on the design, configuration, operations, maintenance, and condition of NCPA facilities in relation to their potential to initiate a wildfire event. The analysis and recommendations included in this report will form the basis for development of a Wildfire Mitigation Plan (WMP) that will meet the requirements of California State Senate Bill 901 (SB 901). The WMP will provide action items for NCPA to correct, remediate, or employ new or better methods to be prepared for, reduce, and eliminate the risk of wildfires in and around NCPA facilities.

This report has prioritized the elements that create a wildfire event: 1) fuel, or geographic conditions represented by the California Department of Forestry and Fire Protection (CAL FIRE) and California Public Utilities Commission (CPUC) risk maps, and 2) ignition, represented by facilities subject to creating a fire. The facility types of highest interest are open wire power lines (transmission and distribution) that are near heavy vegetation or forest. This analysis is consistent with the recent history of utility-caused wildfires, all power line-related. As such, the recommended actions of this report focus on power line maintenance, vegetation management, inspection, and design review with priority on high fire risk areas.

The analysis conducted for the "Gap Observation and Assessment Report" established the following high-level findings:

- The high priority risks for NCPA are the Collierville-Bellota 230 kV transmission line (CB 230 kV line) and the Geysers 21 kV distribution lines.
- Transmission and distribution line inspections are adequate but can be improved to identify and repair facility concerns and reduce overhead line wildfire risk.
- Overhead line management processes are inconsistent between the various lines.
- Vegetation management processes are adequate but can be improved in execution and documentation.

POWER's recommendations for NCPA include:

Hydro Facilities Recommendations

- Perform the planned Collierville-Bellota insulator replacement and maintenance project. In addition to the insulator replacements, undertake guy tightening, missing damper replacement, clearance increase at the Collierville station to the powerhouse, change out of suspension clamps at towers 2 and 6, and addition of shackles in specific tangent towers at risk of hardware binding under high winds.
- Review and perform vegetation clearing to the ground in the immediate vicinity of Collierville-Bellota transmission line structures. Review and perform vegetation clearing on sidehill or other locations where conductors may blow out and impinge on required clearances.

Geothermal Facilities Recommendations

- Review the Geysers 21 kV line and add bird guard protection to the line.
- Review and clear vegetation in the immediate vicinity of Geysers 21 kV distribution structures.
- Establish emergency operating guidelines for the geothermal 230 kV transmission lines and distribution lines, similar to line shut down processes documented in Hydro guideline NCPA-PM-201.

All NCPA Facilities Recommendations

- Vegetation management improvements:
    - Include clearing to the ground around all transmission and distribution line structures and guy anchors.
    - Perform lidar survey and vegetation clearance analysis every three years for both transmission lines and Geysers 21 kV line.
    - Periodic review and tracking of CPUC and CAL FIRE maps and update to NCPA plans.
- Improve documentation of the design basis for the transmission and distribution line facilities. Establish design criteria for the line facilities such that these can be easily referenced for understanding facility operations and/or replacement activities. Establish criteria for the CB 230 kV line, Geysers 230 kV line, and Geysers distribution line.
- Similar to the design criteria for the line facilities, document and make available the latest facility information as part of the maintenance process. Document transmission and distribution facilities current plan/profile and structure drawings, manufacturer fabrication drawings, structure list, and current PLS-CADD line model.

These and other recommendations are summarized in Table 1 and discussed more fully in the report.

TABLE 1. SUMMARY OF ISSUES AND RECOMMENDATIONS

HYDRO FACILITIES		
ISSUE	RECOMMENDATION	TIME FRAME
CB Clearance Violations	Fix known and potential ground clearance violations as determined from PLS-CADD lidar analysis.	< 12 months
CB Hardware Limits	Fix Tower 2 and 6 suspension clamp departure angle violations determined from PLS-CADD.	< 12 months
CB Insulator Condition	Perform CB Insulation and Maintenance Project.	< 12 months
Conductor or OHGW Damage on CB Line	Perform conductor tension and damping analysis, recommend damping replacements as needed.	< 12 months
Vegetation Clearance on CB Line	Perform lidar survey and vegetation analysis every three years.	12-24 months
Slack Guys on CB Line	Tighten guys.	< 12 months
Avian Nests on CB Towers	Install bird diversion attachments to deadend structures.	12 to 24 months
Avian Nests on CB Structure Non-deadends	Remove bird nests from structures.	24 to 36 months

Guy Damage on CB Line	Install guy markers and repair/install cattle guy guards where missing.	12 to 24 months
McKay's Point OH Distribution Tree Branches	Harden three span section of line with tree wire or other covered conductor.	< 12 months
McKay's Point OH Distribution	Harden three span section of line - steel poles.	12 to 24 months
New Spicer Transformer	Ensure containment and provide sufficient vegetation clearing from potential fire.	12 to 24 months
Facility List	Create a list of facilities with risk of wildfire ignition: powerhouse stations, transmission lines, distribution lines, unmanned communication facilities, unmanned monitoring stations.	< 12 months
Vegetation Management	Create 10-foot clearance of vegetation around distribution poles and 20 feet around transmission poles and towers is recommended to reduce the chance of ignition. Also, highly combustible vegetation should be removed when identified after an inspection or whenever encountered. Create list of facilities that will be addressed in vegetation management program.	< 12 months
Transmission Line Inspection	Perform twice yearly line patrol/inspections—ground-based in the spring, aerial in the fall. Perform detailed aerial inspection every 5 years.	12 to 24 months
Design Basis	Establish design criteria document for CB line.	< 12 months
Design Documents	Establish current line design documents for CB line—plan/profile, structure configuration, structure fabrication drawings, structure list, PLS-CADD model.	< 12 months
Vehicle Approach	Formalize and document vehicle approach procedures for inspection and maintenance in both fire hazard and non-fire hazard areas.	< 12 months
Public Education	Continue to educate the public and Federal agencies in good forest management and fuel reduction techniques where NCPA has facilities in Wildland Urban Interface (WUI) areas.	< 12 months
Removal of Hazard Trees[1]	Formalize and document a procedure for securing permission from private landowners to remove danger trees and other vegetation on private property that pose a hazard or fire risk adjacent to NCPA facilities. The document would provide a record of the landowner contact and NCPA's attempt to rectify the issue as well as communication to CAL FIRE in the event that permission is not granted.	12 to 24 months

[1] Hazard or danger trees are those representing potential tree fall risks to power lines. These include a range of possible tree defects: dead or dying trees, dead tree tops or branches, rotted trunks or roots, exposed or damaged roots, and other factors that compromise a tree's physical integrity.

GEOTHERMAL FACILITIES		
ISSUE	RECOMMENDATION	RECOMMENDED TIME FRAME
Avian Activity on Geo Distribution Line	Add bird guard to all structure attachments.	< 12 months
Avian Nests on Geo 230 kV Line	Remove bird nests from structures.	12 to 24 months
Trees Near Geo Distribution Line	Remove hazard trees within fall zone of line.	< 12 months
Vegetation Clearance	Conduct lidar survey and clearance analysis on Geysers 230 kV and 21 kV lines every three years.	12 to 24 months
Vegetation Clearance on Geo Lines	Purchase true pulse range finder for Geo transmission and distribution line use.	12 to 24 months
Facility List	Create a list of facilities with risk of wildfire ignition: powerhouse stations, transmission lines, distribution lines, unmanned communication facilities, unmanned monitoring stations.	< 12 months
Vegetation Management	Create 10-foot clearance of vegetation around distribution poles and 20 feet around transmission poles and towers is recommended to reduce the chance of ignition. Also, highly combustible vegetation should be removed when identified after an inspection or whenever encountered. Create list of facilities that will be addressed in vegetation management program.	< 12 months
Emergency Operations Procedures	Document operating guidelines for Geysers 230 kV and Geysers distribution lines for shutdown in case of wildfire.	< 12 months
Transmission Line Inspection	Perform twice yearly line patrol/inspections—ground-based in the spring, aerial in the fall. Perform detailed aerial inspection every 5 years.	12 to 24 months
Design Basis	Establish design criteria document for Geysers 230 kV and 21 kV lines.	< 12 months
Design Documents	Establish current line design documents for 230 kV and 21 kV lines—plan/profile, structure configuration, structure fabrication drawings, structure list, PLS-CADD model.	< 12 months
Vehicle Approach	Formalize and document vehicle approach procedures for inspection and maintenance in both fire hazard and non-fire hazard areas.	< 12 months
Tower Stub Angles	Protect tower stub angles and piers on the Geysers 230 kV line above normal grade to prevent soil from accumulating around the stub angle.	24 to 36 months
Public Education	Continue to educate the public and Federal agencies in good forest management and fuel reduction techniques where NCPA has facilities in Wildland Urban Interface (WUI) areas.	< 12 months
Removal of Hazard Trees	Formalize and document a procedure for securing permission from private landowners to remove danger trees and other vegetation on private property that pose a hazard or fire risk adjacent to NCPA facilities. The document would provide a record of the landowner contact and NCPA's attempt to rectify the issue as well as communication to CAL FIRE in the event that permission is not granted.	12 to 24 months

Avian Documentation	Implement a tracking and monitoring plan for avian-related outages to help identify locations where avian protection is necessary. Develop a plan to relocate nests from poles. Consistent avian protection is necessary to prevent faults on distribution lines and to mitigate wildfire ignition from birds and other wildlife.	12 to 24 months
Distribution Line Inspection	Document plan for yearly inspections and detailed inspections every 5 years.	12 to 24 months
Bear Canyon Pump Station Vegetation Management	Include vegetation management for pump stations.	< 12 months

1. INTRODUCTION

Wildfires have caused damage and devastation to communities across California in recent years. Many of these wildfires were ignited by utility facilities, primarily transmission and distribution lines. The courts and CPUC have found those utilities financially responsible for damages caused by those events [1]. As one CPUC commissioner noted during a hearing regarding a 2007 utility wildfire, *"The burden of proof is on the utility to show they acted as a prudent manager, and based on a careful review, the decision concludes they did not meet that burden.*"

The goal of this report is to improve the management of NCPA facilities for wildfire mitigation. In most of the wildfires triggered by utility facilities, official records have shown a history of unaddressed maintenance issues by those utilities. For example, before one of the 2007 wildfire events, the utility had observed a tree that it identified as posing risks three months before the event. The tree was never removed, and it fell across a line during 90 mph winds and triggered a major wildfire.

Similarly, the CPUC opened a penalty case this year against PG&E for 2017 wildfires [2]. One commissioner described PG&E's violations during the 2017 fire siege as "extensive and disturbing." Rulings from this case are expected to provide clarity regarding California utilities' financial responsibility for wildfires.

There can be many causes of wildfire ignition—improper design, lack of inspection, lack of maintenance activities, lack of proper procedures, failure to implement modern technology, and more. This report will attempt to identify key areas of improvement for NCPA to be a "prudent manager" of its facilities.

The objective of this report is to provide NCPA with recommended actions to mitigate wildfire risks that could be ignited or propagated by NCPA electrical equipment and/or facilities. The conclusions of this report as well as the previous gap assessment report are based on review of the design, configuration, maintenance, operations, and condition of NCPA's system. The analysis includes consideration of NCPA system descriptions, record design/construction documents, typical facilities layouts, basic fire protection system features, data sheets, inspection practices and procedures, baseline vegetation conditions, potential climate change effects, vegetation management practices, fire threat and hazard maps, and other documentation. The assessment of facility conditions is largely based on inspection reports, photographs, and reports of facilities. POWER also conducted limited on-site surveys to better understand the general design, configuration, and condition of NCPA equipment and the surrounding environment for identification of associated risks.

The NCPA system consists of generation and power delivery systems, separated into two distinct geographic areas, to deliver generation to market (see Appendix A for location of facilities):

1. The Stanislaus Hydro System (Hydro) consisting of:
    - Collierville dam, powerhouse, and substation
    - McKay's Point Diversion Dam
    - McKay's Point Service Line (approximately 600 feet—3 spans of 17 kV overhead line—and 12 miles of underground line).
    - New Spicer Meadow powerhouse and substation
    - Collierville-Bellota (CB) 230 kV transmission lines (approximately 40 miles of double circuit 230 kV transmission line facilities)

- Spicer Meadow 21 kV interconnection line (12 miles of underground from Cabbage Patch Substation)
- Various communication and monitoring sites

2. The Geysers Geothermal System (Geothermal) consisting of:
   - Geysers units 1 and 2 geothermal power plants and substations
   - Approximately 2.5 miles of double circuit 230 kV transmission line
   - Approximately 6 miles of 21 kV distribution line with about 4 miles of this line in shared ownership with Calpine.
   - Four effluent pumping stations including the effluent transfer pump station at the settling ponds location.
   - Approximately 8 miles of geothermal steam pipe and associated low voltage (110-480 V) power facilities
   - Photovoltaic solar generating station

2. REVIEW OF CURRENT NCPA PROCEDURES AND PRACTICES

Since 2009, NCPA has retained POWER as a consultant to analyze reoccurring issues and concerns and to assist with NCPA's 230 kV overhead transmission lines planning. Prior to this date, POWER was a subconsultant for the design of the 39.6-mile Collierville to Bellota (CB) 230 kV double circuit steel pole transmission line that serves as a generation tie line for NCPA's Collierville hydroelectric system. POWER has also provided design services for various distribution and facility projects for NCPA. Our review is based on the knowledge gained over a 10-year partnership with NCPA, extensive documentation provided by NCPA, and recent on-site surveys.

2.1 Overhead Transmission

2.1.1 Background

Design and construction of the first circuit of the CB 230 kV line was completed around 1988. The second circuit was added around 1991. During normal operations, each circuit carries a maximum of 140.5 (MVA). Each line uses a single 1113 kcmil ACSR "Bluejay" conductor as well as 7#8 AW overhead ground wire per circuit. The conductor is designed to a maximum working tension (MWT) of about 40% of rated tensile strength (RTS). The conductor was sized to accommodate maximum generation loading of 281 MVA on one circuit for planned and unplanned line outage conditions. Additionally, the two circuits allow for flexibility of generation maintenance activities. NCPA operates the CB 230 kV line and has a contract with Western Area Power Administration (WAPA) for both emergency and routine maintenance activities. The CB 230 kV line partially exists in a Tier 2 fire risk zone (see Appendix A). Prevention and protection of the line from fire threat is of paramount importance to NCPA, and NCPA has worked hard to develop and implement a WMP focused on increased inspection and maintenance activities.

In addition to the CB 230 kV line, NCPA owns and maintains a 2-mile double circuit 230 kV lattice tower line at the 110 MW Geysers geothermal plant 1 and 2 facilities. NCPA's 11-tower 230 kV double circuit line (tower structures TT-1 to TT-9 and T-1 to T-2 are all deadend towers) taps to PG&E's 230 kV line at the TT-9 switch. The two circuits were reported to be built to PG&E specifications and were completed in 1985. Existing conductor is 1113 kcmil 61 str AAC "Marigold." The conductor is designed to a MWT of 50% of RTS. The static wire size is 3/8" EHS, but wire tensions are unknown and have not been determined from facility records. Review of transmission line records indicate that the Geysers and CB 230 kV lines were likely sagged differently. The CB 230 kV line appears to have been sagged with two ruling spans that were either 1,400 feet (ft) or 2,700 ft regardless of the actual ruling span. Tensions found on the CB 230 kV line appear to generally be tighter than the design condition and routinely exceed 40% of RTS under the CAL Medium condition of 6 psf wind, 1/4" ice at 0 deg F and 30% of RTS under GO-95 Light conditions of 8 psf at 25 deg F. No facility data exists to be able to evaluate field tensions on the Geysers line as compared to its design condition. The use of deadend towers at every location on the Geysers line provides a high degree of failure containment and greater potential for reliability.

Both the CB 230 kV line and the Geysers 230 kV line are located in and around CPUC and CAL FIRE fire threat and tree mortality high hazard zones. The Geysers 230 kV line is in a Tier 3 (extreme fire risk) zone. The CB 230 kV line partially exists in a Tier 2 (elevated fire risk) zone. Prevention and protection of these lines from fire threat is of paramount importance to NCPA.

2.1.2 Reoccurring Issues and Maintenance

The CB 230 kV line has been a reliable generation tie line for NCPA for almost 30 years. The COR-TEN steel monopole structures were considered innovative at the time of installation, as many lines at the time were constructed of wood or lattice steel. These self-weathering steel poles blend in with the environment and are currently the "go to" standard construction material for utilities such as PG&E and SDG&E when fire hardening overhead transmission and distribution systems. However, the CB 230 kV line has suffered failures due to two main issues:

- Ablation and corona cutting of the organic compounds and crimp seals on the line's EPDM polymer insulators
- Inadequate or loss of vibration damping devices

The 230 kV line at the Geysers has only suffered from one known failure:

- Shield wire static line break and line trip during a heavy snowstorm event

Table 2 summarizes these failure events.

TABLE 2. SUMMARY OF FAILURE EVENTS

COLLIERVILLE TO BELLOTA 230 KV TRANSMISSION LINE			
FAILURE EVENT	DATE	CAUSE	COMMENT
Bluejay conductor broke at Tower 140	March 2001	Inadequate vibration damping	Conductor broke near insulator support. Alcoa revised recommendation required increased damping; public safety and wildfire concern.
Line #2 middle insulator rod separated at Tower 82	April 2009	Corona cutting/ablation of seal allowed moisture ingress to rot fiberglass rod	Conductor fell to ground level and line tripped; public safety and wildfire concern; line current 293.1 A; Hubbell root cause failure analysis confirmed failure cause.
Line #2 middle insulator rod separated at Tower 50A	February 2019	Insulator y-clevis fitting bearing on tower vang during reported 70+ mph wind gusts	Insulator fiberglass rod broke in bending at tower end fitting at uplift suspension tower location. Two 50 lb wts per phase observed. Hubbell root cause failure report confirmed failure cause.
GEYSERS 230 KV TRANSMISSION LINE TO PLANT 1 AND 2			
FAILURE EVENT	DATE	CAUSE	COMMENT
Static wire broke	2001	Unknown	Heavy snowstorm event at time of break.

In 2015, NCPA (NDC and GS) coordinated with PG&E, GCC, CAL FIRE, WAPA maintenance crews, and local authorities to plan for a worst-case event in which the CB 230 kV line #2 drops across the PG&E Frogtown 17 kV line at Parrots Ferry Road at structure 25. NCPA studied the response mechanisms and time involved in restoring the line.

When the CB 230 kV line was put into service around 1991, manufacturers did not typically recommend corona rings on 230 kV lines, as this was a practice normally reserved for extra high voltage (345 kV and above). Since then, operational experience, EPRI testing, and advanced

manufacturing product research laboratory testing has indicated a need for corona rings (typically 8-inch) at the line end of 230 kV polymer insulators. NCPA has undertaken a program to replace the original EPDM polymer-type insulators with new silicon polymer insulators with 8-inch minimum corona rings. Silicon polymer compounds have been shown to provide more effective service than EPDM types with respect to hydrophobicity. To prioritize insulator replacement, NCPA has used Paul Lyons and a DayCor Solar Blind Corona Inspection Camera to scan the CB 230 kV line and detect corona hot spots. NCPA has replaced both deadend and suspension insulators on the line based on the criticality rating found in the scans. NCPA has also implemented a yearly program to perform corona scans on the CB 230 kV line. While this is a proactive approach to mitigating the risk associated with insulator failure from corona cutting, it may not catch rapid corona cutting failures that occur between observation cycles. Figure 1 shows an example of a failed polymer insulator. These corona observations provide a snapshot in time. Atmospheric and system load conditions may affect corona inception differently which wouldn't necessarily be detected at the time of scan.

Figure 1: Brittle Fracture Failure of Polymer Insulator

A second inspection program on the CB 230 kV line is performed by Hot Shot Infrared Inspections. This company employs a helicopter with infrared thermography equipment to assess the condition of the conductor compressive attachments (splices, deadend, and jumpers) for damage as may be evidenced through hot spots on the thermal scans.

NCPA understands the limitations associated with corona inspection and is resolved to implement a complete line maintenance program that includes insulator change-out, the latest vibration damping recommendations, and a review of hardware, structure grounding, and conductor/shield wire splice sleeve conditions.

Ospreys constructed a nest on top of NCPA deadend D type tower 69L. During a high wind event in February 2019 that resulted in a failure of the insulator at tower 50A, hay baling twine from the osprey nest at tower 69L had fallen into the top phase wire jumper and prevented line reclosing until the twine was removed. NCPA has removed the nest from the tower and intends to install anti-perching and nesting cones at tower 69 and on top of all D type deadend towers within 2 miles in either direction of tower 69. The larger pole top diameters and additional surface area due to horizontal shield wire pull off vangs at these D towers provides sufficient surface area to support osprey nesting. Osprey nests have not been observed on the smaller pole tops on tangent S type

towers. Smaller bird nesting has been observed at the interface of pole and davit arm at S type tower locations but is not believed to be an imminent threat for wildfire or line tripping.

Figure 2: Osprey Nest on D Structure

2.1.3 Transmission Line Relay Protection

CB 230 kV line 1 and line 2 employ a communication-assisted protection scheme referred to as a Permissive Overreaching Transfer Trip (POTT) scheme. This scheme can nearly instantaneously identify and isolate line equipment failure by allowing each end of the transmission line to send a signal to the remote end if a line fault is identified. A typical POTT scheme results in the clearing of a faulted line in less than 4 cycles (0.067 seconds) depending on the circuit breakers and line communication medium. POTT schemes allow for the activation of back-up distance relay elements if the communication path is broken. Specifically, the CB 230 kV lines utilize GE-D60 and SEL-311L line protective relays on an Ametek Pulsar UPLC-3 power line carrier.

The CB 230 kV line protection is typical of modern protection schemes and adequately reduces the risk of a line fault causing excessive arcing which could ignite wildfires.

2.1.4 Gaps in Process

The following findings are areas of NCPA transmission line processes and operations that are missing and/or could use improvement to mitigate wildfire risk:

- **CB 230 kV insulation change-out**—NCPA's insulator replacement project is planned to be performed prior to the summer of 2020. As part of this project, other maintenance activities will be completed including damper installation, hardware tightening, and upgraded/remediated shield wire grounding installations.
- **Brush growth around towers**—Careful attention must be given to brush growth to ensure that it does not contact structure or tower guy wires. Title 14 Section 1255 of the California

Code of Regulations (CCR) exempts transmission lines from the 10-foot clearance provisions stated in Public Resource Code (PRC) 4292. However, it is good practice to maintain a minimum clearance around line facilities to prevent energized wildlife or debris from falling into vegetation as well as protecting poles and guys from vegetation corrosion. Attention should be given to ensure that brush clearing does not allow for undue soil erosion.

- **Vegetation clearances**—Clearances defined in the Vegetation Management Plan (GS-305) should be verified for the maximum span applicable with respect to the adders used on the base clearance requirement for sag difference. Similar definition for span wire blowout should also be documented. NCPA's commitment to and use of the QSI lidar survey may be considered as part of the GS-305 plan to address clearance requirements.
- **Maintenance records**—Process for maintenance of current transmission line facility records with line maintenance improvements.
- **Line inspection**— POWER has reviewed NCPA's 2019 CB 230 kV line inspection logs for adequate attention to guying, grounding, insulators, static wire dampers, and brush out operations around towers and guys. A range-detecting device is used on the CB 230 kV line, but its use was not apparent to inspection crews for the Geysers 230 kV line for clearance checks.
- **Inspection procedures**—Geysers Inspection Procedure (GO-646) should be issued final and vegetation clearance requirements coordinated with the CB 230 kV line.
- **Line Design Basis Documentation**—The design basis for both transmission lines is not readily available although various forms of original design criteria for the CB 230 kV line as submitted to FERC by NCPA and also obtained through POWER records is available.
- **Lidar Vegetation Clearance Review**—The CB 230 kV line is aerially inspected on a consistent basis with lidar, but the Geysers 230kV line is not.
- **Line monitoring**—Additional risk mitigation can be accomplished by programming transmission lines to alarm based on current unbalance, which may be indicative of an open or broken conductor. Tripping transmission lines on negative sequence is not typical utility practice. However, alarming with increased sensitivity can be accomplished either by directly measuring sequence components (zero or negative sequence) in the relays or by monitoring currents provided to the SCADA system via meters. Proper operating procedures must accompany alarms to identify the source and react appropriately considering fire risk level.
- **Emergency operating guidelines**—Geysers 230 kV transmission line does not have an Emergency Operating Guidelines document similar to NCPA-PM-201.

2.2 Distribution

In addition to its history with NCPA transmission line facilities, POWER designed the original Bear Canyon 21 kV line, also referenced as the Geysers 21 kV line. NCPA owns and operates four distribution lines, all in high-risk wildfire areas:

- The Geysers 21 kV overhead line is about 6 miles long.
- The New Spicer Dam-Cabbage Patch 21 kV feeder has 12 miles of underground.
- The McKay's Point 17 kV interconnection with PG&E has three spans of overhead as well as approximately 12 miles of underground.
- Collierville powerhouse PG&E interconnection—three spans

2.2.1 Gaps in Process

The following findings are areas of NCPA distribution line processes and operations that are missing and/or could use improvement to mitigate wildfire risk:

- **Avian protection**—During POWER's on-site visit of the Geysers distribution facilities, some poles were observed that did not have avian protection, while other poles had avian protection on only one side of the crossarm. These inconsistent bird guard installation practices are shown in Figure 3. Consistent avian protection is necessary to prevent avian deaths and possible ignition of vegetation.

Figure 3: Inconsistent Bird Guard Installation

- **Overhead and underground line inspections**—Routine inspections of NCPA's overhead and underground distribution systems are required per CPUC GO 165. Since NCPA is in a high-risk area for wildfire, the distribution system should be inspected annually for vegetation and visual inspection of line components from the ground. Detailed inspections of all crossarms, line hardware and conductor should be completed every five years using qualified lineman normally engaged in this practice. Yearly inspections are included in CMMS work management procedures.
- **Vegetation control**— Enhanced vegetation management procedures may be necessary to achieve required clearances, including clearing vegetation above and around the distribution facilities. This should be documented in current vegetation management procedures. PRC Section 4296 exempts lines of 750V or less from the vegetation clearances required in PRC Section 4293 but CAL FIRE recognizes that uninsulated lines of this voltage and less have caused fires so prudent clearing around low voltage lines (both insulated and non-insulated is appropriate).
- **Operations**:
    - Line protection— Protective device installation and coordination should be documented.
- **Distribution design documentation**—Design documentation should cover foreign attachment wires. Also, it is not apparent to what standards the distribution line facilities were designed and constructed.

- **Maintenance records**—There should be a process for aligning line maintenance improvements with distribution line facility records.
- **Line monitoring**—Additional risk mitigation can be accomplished by programming distribution lines to alarm or trip based on current unbalance, which may be indicative of an open or broken conductor. Tripping distribution lines on negative sequence is not typical utility practice. However, tripping distribution lines on neutral current and/or zero-sequence current in excess of normal operating unbalance is common. Additional alarming with increased sensitivity can be accomplished either by directly measuring sequence components (zero sequence or negative sequence) in the relays or by monitoring currents provided to the SCADA system via meters. Proper operating procedures must accompany alarms to identify the source and react appropriately considering fire risk level.
- **Emergency operating guidelines**—Distribution lines do not have an Emergency Operating Guidelines document similar to NCPA-PM-201.

2.3 Generation

NCPA's generation assets have a total capacity of over 600 MW and include hydroelectric, geothermal, and natural gas-fired facilities. There are also two small 1 MW photovoltaic solar arrays used to power water transfer pumps to support the geothermal facilities. The facilities, capacity, and locations are as follows:

- NCPA Geothermal Plant 1 (Geo 1), 110 MW, at The Geysers (Lake County)
- NCPA Geothermal Plant 2 (Geo 2), 110 MW, at The Geysers (Lake County)
- Collierville Hydroelectric Powerhouse, 253 MW, on the Stanislaus River
- New Spicer Meadow Powerhouse, 6 MW, near the Spicer Meadow Reservoir
- Lodi Energy Center, 300 MW, near the city of Lodi
- NCPA CT 1, two 25 MW units in the City of Alameda and one 25 MW unit in the city of Lodi
- NCPA CT 2, 49.9 MW, in the city of Lodi

The geothermal and hydroelectric facilities are the primary focus of the analysis conducted for this report, particularly within Tier 3 (extreme fire threat) areas of the 2018 CPUC Fire-Threat Map and Very High Fire Hazard Severity Zones of the 2007 CAL FIRE fire hazard severity zone county maps that cover NCPA's territory. The remaining facilities are not located within elevated or extreme threat areas (see Appendix A).

2.3.1 Geothermal Generation

NCPA Geothermal Plant 1

Geo 1 is comprised of two 55 MW steam turbines (Unit 1 and Unit 2). The plant is shown in Figure 4. Geo 1 is supplied with a fire water system designed to contain and extinguish any fires that occur within the plant boundary. A fire water loop supplies hydrants located around the perimeter of the plant, the cooling tower deluge system, and individual risers to protected areas. These areas include hydrogen storage, turbine generator ground floor, turbine generator mezzanine floor, turbine generator operating floor, fire house main, and the lube oil deluge system. Fire water system pressure is maintained during normal operation via a small jockey pump. In the event of a fire, an electric firewater pump will maintain system pressure, and an emergency diesel pump will be used if power is lost. All three pumps are in the Geo 1 fire house. The electric and diesel pumps take suction from the

cooling tower basin, while the jockey pump takes suction from an onsite potable water storage tank. The potable water storage tank is also capable of providing makeup to the cooling tower basin.

In addition to a fire water system, Geo 1 is equipped with a pressurized CO_2 fire protection system that is used to smother fires in areas where water is not an ideal solution. The CO_2 fire protection areas include the electrical switchgear room, the motor control center (MCC), the battery room, and the steam turbine generator bearings. A Halon fire suppression system is used to protect the control room and relay room.

Figure 4: NCPA Geothermal Plant 1

NCPA Geothermal Plant 2

Geo 2 is comprised of two 55 MW steam turbines (Unit 3 and Unit 4). Unit 3 is currently not operational. The plant is shown in Figure 5. Similar to Geo 1, the Geo 2 fire water loop supplies hydrants located around the perimeter of the plant, the cooling tower deluge system, and individual risers to protected areas. These protected areas include hydrogen storage, turbine generator ground floor, turbine generator mezzanine floor, turbine generator operating floor, fire house main, and the lube oil deluge system. Fire water system pressure is maintained during normal operation via a small jockey pump. Unlike Geo 1, Geo 2 has two diesel fire pumps—one acting as primary and the second as backup. Geo 1 has an above ground diesel storage tank, while Geo 2 has an underground diesel storage tank outside of the fire house. The diesel storage tanks at each plant have the capacity to supply their respective fire pumps for more than 24 hours. The fire pumps are located in the Geo 2 fire house and take suction from a 300,000-gallon raw water storage tank; 280,000 gallons in the storage tank are dedicated to fire water.

Similar to Geo 1, Geo 2 uses a Halon fire suppression system in its control room and relay room where water may damage equipment.

Portable CO_2 and dry chemical-type fire extinguishing are located throughout both plants along with fire detection equipment, including pneumatic heat activated detectors, electric heat actuated detectors, and ionization smoke detectors.

Figure 5: NCPA Geothermal Plant 2, (Raw Water Storage Tank, not shown)

2.3.2 Geothermal Wildfire Risks

Both geothermal plants meet or exceed the specifications of National Fire Protection Association (NFPA) 850: Recommended Practice for Fire Protection for Electric Generation Plants and High Voltage Direct Current Converter Stations. Minimal risk for igniting wildfires is seen within the fence line of the plants. Apart from the administration building, all other buildings and equipment are located 50 feet or greater from the fence line, and the fence is maintained to be relatively clear of vegetation.

The highest risk areas observed are the unmanned pumping stations, Bear Canyon pump stations #0, #1, #2 and #3. The pump stations are not inspected with the same frequency as the geothermal plant, and vegetation was found growing very close to equipment and the junction box, as shown in Figure 6 and 7. Nearby 21 kV lines are inspected annually per GO-646, Geothermal Facilities Maintenance Procedure. It is recommended that BC pumping station inspection and vegetation management be included in the maintenance procedure. It should be noted NCPA was made aware of the overgrowth, and the vegetation was scheduled to be removed at Bear Canyon Pump Station #1 on August 19, 2019.

Figure 6: Bear Canyon Pump Station #1

Figure 7: Bear Canyon Pump Station #1 junction box near surge tank

2.3.3 Hydroelectric Generation

Collierville Powerhouse

The powerhouse, shown in Figure 8, contains a dual-purpose service water / fire water system designed to contain and extinguish any fires that occur within the powerhouse. Service water pumps supply river water from the tailrace to the service water system through the cooling water sump. They also serve as fire water pumps by supplying water to fire hose stations, makeup to the main transformer deluge system, and water to the service water storage tank that supplies the fire protection

system. Fire hose stations are located near the transformer deluge station, outside (north and south stairwells), on the generator floor (north and south stairwells), and on the turbine floor (north and south stairwells). The transformer deluge is provided by a “dry” piping system with a 3,013-gallon pneumatic tank for storage capacity.

In addition to the fire water system, a pressurized CO_2 fire protection system is used to protect the generator housing from electrical fires.

Portable CO_2 and dry chemical type fire extinguishing are located throughout the powerhouse along with fire detection equipment, including pneumatic heat activated detectors, electric heat actuated detectors, and ionization smoke detectors. The Collierville powerhouse is also equipped with a POK educator siphon nozzle and a 5-gallon AFFF foam concentrate cartridge to suppress any local fires.

Figure 8: Collierville Powerhouse

New Spicer Meadows Powerhouse

Similar to the Collierville Powerhouse, the New Spicer Meadow Powerhouse, shown in Figure 9, has a dual-purpose service water / fire water system. The service water system provides pressurized water to the fire water hose stations and service water storage tank. Static head from the penstock pressurizes the system, with a service water pump provided as backup if the pressure drops below a set level. The facility is supplied with two fire hose stations, one located at each (north) corner near the diesel generator and one located on the side of the powerhouse (southwest). Portable fire extinguishers are also located throughout the facility. Currently, the transformer has a fire wall located on the north side, but no fire protection (deluge system) is installed.

Figure 9: New Spicer Meadows Powerhouse

2.3.4 McKay's Point Diversion Dam

The McKay's Point diversion dam is the start of an 18-foot diameter, 8.5-mile tunnel that directs water from the McKay's Point reservoir to the Collierville powerhouse. Although McKay's Point does not contain any power generation equipment, the diversion dam houses an emergency generator, an electrical room, and a communications shelter. Two portable fire extinguishers are located in both the operations container and the stand-by generation room. One portable fire extinguisher is located in the electrical room, and one is located in the communications shelter.

2.3.5 Hydroelectric Wildfire Risks

While the Collierville and New Spicer Meadow powerhouses share much of the same equipment as the geothermal generation plants, their risk of causing a wildfire is much less. This is primarily due to the large quantity of available firewater and the inherent design of the powerhouse. Being located indoors and away from vegetation, any fire within the powerhouse will be extinguished quickly or contained within the powerhouse itself. The highest risk area for the hydroelectric generation stations are the oil-filled transformers outside. The transformers at Collierville include online monitoring for transformer health, deluge systems, and pits containing small rocks to aid in fire suppression.

2.3.6 Gaps in Process

- **Inspection process**—Unmanned Bear Canyon Pump Stations (BC0, BC1, BC2, and BC3) are monitored internally by camera, but vegetation management and inspection processes are undefined or defined within CMMS work management procedures.
- **Fire protection**—New Spicer Powerhouse generator transformer does not have any means of extinguishing or containing fire.

2.4 Other Facilities

In addition to the transmission, distribution, and generation facilities, NCPA owns several facilities within high risk fire zones. These facilities include:

2.4.1 Hydro

- Liberty Hill communication facility consisting of communication towers and antennae, exterior solar panels, enclosed shelter with digital communication equipment, battery with power connected to the solar panels, and fire suppression system.
- Communication enclosures similar to above without the solar panels—e.g. Collierville microwave building.
- U.S. Geological Survey (USGS) gauging stations with exterior solar panels, enclosed shelters with solar/battery charge controllers and electronic communications equipment. Many of these are located in Tier 2 and 3 fire hazard areas.
- Campground generator and propane tank

2.4.2 Geothermal

- Monitoring stations
- Solar farm

The Liberty Hill and Collierville microwave shelters have automatic clean agent fire suppression systems within their enclosures. The clean agent fire suppression system installed utilizes Chemori HFC-227/N2 propellant designed to flood the enclosure in less than 10 seconds. Although the threat of ignition of these sites is small, the locations for some of these sites has high risk. Appropriate processes to ensure proper operation of the fire suppression should be in place.

The gauging stations do not have fire suppression systems similar to the communications facilities. It is unknown whether any fire suppression equipment other than fire extinguishers are available.

The campground generator is within a protected shelter. Appropriate inspection and direction for campground operations should be in place.

Geothermal monitoring stations should be treated similar to Hydro gauging stations if the batteries installed have an electrolyte capacity greater than 50 gallons for lead-acid or more than 1,000 lbs of Li-ion within an enclosed shelter.

Solar power panels have had very few fire incidents. The risk of ignition is minor from the panel. The fire concern regards the potential damage of the interior battery and fire working within the building and outside through the cabling to the exterior power source.

2.4.3 Gaps in Process

- The number, name, and location of the unmanned facilities is not part of existing plans.
- At the time of this report, a thorough accounting of fire suppression methods for unmanned communication, gauging, and monitoring stations was unavailable.

2.5 Environmental

For this report, POWER reviewed written policies and procedures related to environmental issues, and POWER's team discussed NCPA operations applicable to these environmental items during our meetings with NCPA staff. Environmental topics included vegetation management and clearing as well as avian hazards.

POWER's initial wildfire risk field review included visiting both NCPA geographic (Hydro and Geothermal) facilities. During these field reconnaissance surveys, POWER's team met with and interacted with NCPA staff familiar with these facilities. Our observations associated with environmental issues are summarized below for both Hydro and Geothermal facilities. Vegetation management plans for Geothermal are under preparation and were not available for review at the time of this assessment.

2.5.1 Vegetation Management

Vegetation management plans are one of the primary tools for managing wildfire risks. These wildfire-related risks include two components:

- Potential for facilities to start a fire
- Risk of impacts to facilities from a wildfire

The conductor and insulator failures that NCPA experienced on the CB 230 kV line in the early- and mid-2000s was a major driver in the agency developing a formal transmission vegetation management program (TVMP). NERC FAC-003-3 and 4 also required that utilities have a TVMP in place and that they conduct adequate surveys of their conductors to understand the space they occupy in relation to vegetation along the ROW. NERC also required that utilities maintain adequate clearance to that vegetation.

NCPA retained POWER in January 2012 to help evaluate the existing plan and profile drawings and sag tension of the CB 230 kV line conductor for blowout and sag factors related to transmission line blowout and horizontal and vertical vegetation clearance components. POWER assisted NCPA in determining an appropriate clearance of 19 feet to vegetation based on a yearly vegetation management cycle and 3-foot growth rate and a sag factor of 6 feet. A controlling phase-to-ground clearance of 10 feet per CAL FIRE Power Line Fire Prevention Field Guide 2008 was also used. NCPA employed Quantum Spatial to perform lidar survey of ground and vegetation canopy for the line in 2016.

Quantum Spatial prepared a PLS-CADD model of the line to confirm that vegetation management inspection activities have been properly considering vegetation inspection with relation to span blow out charts and the 19-foot radial clearance buffer. NCPA is committed to re-flying the line every three years to confirm that adequate clearance is maintained to vegetation. NCPA does not allow any vegetation overhang of facilities, and though they are able to clear-cut their ROW to the full extent, their practices preclude the need to do so. NCPA has stated that they allow walnut orchards to grow to a maximum height of 15 feet under the transmission line in areas where excess clearance is available. POWER is aware that NCPA determined phase-to-ground clearance to be inadequate in the span between towers 70 and 71. NCPA has mitigated the clearance issue by removing ground under the lines to achieve proper clearances.

POWER has reviewed the document titled NCPA-GS-305 Transmission Vegetation Management Program and found it to be a comprehensive plan to assist with annual line vegetation inspections on the CB 230 kV line. POWER is not aware whether this document is utilized at NCPA Geo 1 and Geo 2 or at other facilities. POWER is aware that a drone survey was recently conducted by NCPA on the Geysers 230 kV line for the purpose of identifying problem vegetation and for tower hardware inspection.

2.5.2 Landslides

Landslides are present at both Hydro and Geothermal facilities. Existing and possible future landslides represent a potential risk to overhead and underground power lines if present.

NCPA is conducting active monitoring and dewatering activities at an existing landslide near the McKay's Point dam (underground 480 VAC cable in road, no overhead lines). A separate future landslide hazard assessment may be warranted, especially at the Geysers Geothermal Area.

2.5.3 Wildlife

There are a number of potential environmental risks associated with wildlife, including impacts to power line conductors, structures, and supports. Avian risks—including from large birds (raptors) and nests—are generally addressed through deterrents designed to limit or restrict nesting or perching on structures. Raptor and large bird problems occur when nests or perch sites are directly above energized conductors. Debris from nests or bird "streamers" upon take-off can cause flashovers. Generally, smaller bird nests in lattice steel towers, located away from conductors, represent low risks. However, it is considered good practice to remove all nests from towers.

In some instances, rodents can access facilities and damage wires, causing ignition. Also, during POWER's field review, it was noted that a bear damaged a NCPA distribution pole.

2.5.4 Gaps in Process

Overall, NCPA environmental-related policies and procedures are strong. NCPA could enhance the existing vegetation management plan for Hydro transmission by adding technical details in relevant appendices: growth rates (average, low, and high for different tree species present) and the CMS work order process for other facilities. These additional details would provide the technical information to support vegetation management adjustments based on different conditions.

Hydro and Associated Facility Observations

- Vegetation management plan is in place for transmission lines
- Clearing and vegetation management at critical facilities (substations and generating facilities) goes beyond minimum regulatory limits (see Figure 10)

Figure 10: Clearing Beyond Minimum Regulatory Requirements

- Potential issues
  - Vegetation management:
    - No vegetation management plan for critical facilities, such as substations and generating facilities
    - No vegetation management plan for distribution or only defined within CMMS work management.
    - Possible risk to distribution lines from tall trees adjacent to ROW—falling branches or deadfall, especially during major wind events (see Figure 11)

Figure 11: Possible Risk to Distribution Lines from Tall Trees Adjacent to ROW—Falling Branches or Deadfall

  - Wildlife:
    - Osprey nest on top of transmission structure 69L. Nest has been removed and a plan is in place to install pole top anti-perch cones on the two pole structures as well as at a distance of 2 miles ahead and back from structure 69 at all D tower locations. The D towers have larger pole top diameters that are believed to facilitate nesting materials.

        - Wooden distribution pole damaged by bear. Recommend bear proof cover be installed around the pole to a height of 8 feet to discourage using the pole as a scraping post. Any other distribution poles in remote hydro locations, particularly those with risers, should be bear proofed. Bears can develop an affinity for chewing on jackets of riser cable if they find it exposed or if they have exposed the cable themselves.
    - Landslides—Active landslide near McKay's Point dam, not assessed during site visit for potential impacts to vegetation

Geothermal and Associated Facility Observations

- Vegetation management plan is under development for transmission lines
- Vegetation management plan under development for facilities
- Clearing and vegetation management at facilities go beyond minimum regulatory limits
- Re-establishing old fire breaks throughout the facility area (Figure 12)

Figure 12: Establishing Fire Breaks

- Ongoing clearing and vegetation management along pipelines, where accessible (Figure 13)

Figure 13: Clearing Along Pipelines

- Potential issues
    - Vegetation management:
        - Vegetation management plan for transmission lines pending

- Vegetation management plan for facilities pending
- No vegetation management plan for distribution
- Possible risk to distribution lines from tall trees adjacent to ROW—falling branches or deadfall, especially during major wind events
- Some areas not cleared due to environmental restriction
- Vegetation growing within one of the facilities
- Cleared, dry vegetation debris piled-up on existing vegetation, representing a concentrated fuel source (Figure 14)

Figure 14: Debris Piled on Existing Vegetation

- Wildlife
  - Possible risk to distribution lines from raptor contact with conductors
  - Small bird nests observed in lattice steel transmission towers generally represent a minor potential risk
- Landslides—Landslides common throughout the Geysers Geothermal Area, affecting vegetation health (i.e., dead or stressed trees) and road access

Vegetation Inspection

Documentation of a detailed inspection program would enhance the Vegetation Management Plan. This program would identify and document the methods and types of observations, thus ensuring consistency during the periodic inspections that may be conducted by different individuals over time. Vegetation inspections are focused on ROWs, parallel zones adjacent to ROWs, and areas surrounding critical facilities, such as substations and generating facilities. Inspection frequency may vary dependent on physical conditions (i.e., drought, weather conditions, forest health, etc.).

- Observations and training
  - Vegetation height and vertical clearances within ROWs
  - Vegetation height and horizontal clearances adjacent to ROWs and critical facilities
  - Vegetation health and defects within and adjacent to ROWs, and near critical facilities
    - Dead, dying, rot, disease, damage, deformities, leaning trees
    - Inspect tree roots for exposure (e.g., undermined by erosion), disease (e.g., root rot) or damage, such as severing (i.e., grading or excavation, landslides)

    - Provide inspection staff with basic training to utilize tools and recognize potential issues that would require further evaluation by appropriate subject matter experts
- Observation methods
    - Visual ground inspection, data recording and tree flagging
    - Use of visual aids, such as binoculars, measuring devices, cameras, video recording devices, and location tracking (GPS)
    - Drone surveys
    - Aerial surveys (helicopter or fixed-wing)
    - Satellite imagery, when applicable

2.6 Operations

POWER reviewed NCPA-PM-201, Emergency Operating Guidelines 230 kV Lines, and found that the procedure meets the purpose set by NCPA to promote public safety and mitigate risk of wildfires. This guideline adequately describes procedures for de-energizing the CB 230 kV line under the direction of CAL FIRE during active fire situations. NCPA is currently able to de-energize both circuits of the CB 230 kV line via SCADA and PM-201 procedures within 20 minutes. CAL FIRE's Columbia Air Attack Base is also located within 5 minutes from NCPA's Murphy office. Procedures are also described in NCPA-PM-201 to address transmission line trips during normal and fire scenarios that significantly reduce fire risk, including requiring patrols prior to restoring the transmission line. Requiring patrols like this during high fire risk scenarios is typical (and recommended) of California utilities.

NCPA does not employ automatic reclosing on its 230 kV lines. This is a typical approach for utility operations in rugged and remote terrain, for both personnel and fire hazard safety reasons. In the event of a planned or emergency line trip, close coordination with NCPA generation services and dispatch as well as with PG&E grid control center is mandatory, and the line is only re-energized after extensive line patrol visual confirmation. If the lines are tripped due to a forecasted or imminent wildfire or if a wildfire is believed to be caused by downed lines, close coordination with CAL FIRE's onsite representative and control center are required before generation services attempts to reclose the line.

2.6.1 Gaps in Process

- Relay maintenance procedures—Documentation of relay maintenance procedures conforming to maintenance intervals prescribed in NERC standard PRC-005 is good utility practice. This practice is maintained within NCPA, although not visible in overall plans.

3. FIRE ZONE REVIEWS

A key concern for NCPA is the historical risk of wildfires in the vicinity of the agency's facilities, particularly within potential fire hazard zones. Both CAL FIRE and the CPUC have developed maps to identify potential fire hazard zones, published in 2007 and 2018, respectively. Current CAL FIRE hazard severity zone and CPUC fire-threat maps were reviewed with respect to NCPA facilities, as shown in Appendix 1.

NCPA reviewed facilities and determined the hazard zones where these facilities are located. Information provided by NCPA in the RFP is presented in Figure 15. This information illustrates the difference between currently published CAL FIRE and CPUC hazard zone maps. The table prepared by NCPA does not include a column for CPUC's Tier 1 HHZ category.

NCPA Project	NCPA Facility	Cal Fire Hazard Severity Zone (2009)			CPUC Fire Threat Zone (2018)	
		Moderate	High	Very High	Tier 2	Tier 3
Hydroelectric	Collierville Powerhouse 11523 Camp 9 Rd., Murphys, CA 38.144944, -120.380022	-	-	X	X	-
	New Spicer Meadows Powerhouse 38.393735, -119.999489	-	-	X	-	-
	McKay's Point Diversion Dam 38°14'3.70"N, 120°17'31.70"W	-	-	X	-	X
	McKay's 17kV Service Line	-	-	600 ft.	-	600 ft.
	Beaver Creek 38°14'02.94" N 120°16'43.50" W	-	-	X	-	X
	Collierville-Bellota 230kV Gen-Tie Line	10 miles	11 miles	15 miles	25 miles	-
Geothermal	Plant 1, Middletown, CA 38.751915, -122.719932	-	-	X	-	X
	Plant 2, Middletown, CA 38.748348, -122.710913	-	-	X	-	X
	230kV Gen-Tie Line	-	-	2.5 miles	-	2.5 miles
	Effluent Pump System and 21kV Service Line	-	-	3 miles	-	3 miles

Figure 15. NCPA Hazard Zone Facility summary

CAL FIRE also published an updated version of its Power Line Fire Prevention Field Guide in 2008 [3]. This document provides substantial guidance regarding vegetation clearances, field inspections, and recognizing a wide range of potential vegetation hazards. This comprehensive field guide is incorporated by reference, and the information presented in the field guide is not reproduced in our report.

3.1 Baseline Vegetation Conditions and Risks

During the July 2019 on-site field review, POWER's team noted two dramatically different vegetation conditions. Live vegetation appears very healthy, which may be a direct result of a very wet winter during the 2018-2019 rainy season. In contrast, some areas exhibit a substantial number of dead trees. In the Sierra Nevada foothills, these dead trees may be related to bark beetle infestation, though no specific investigation was conducted to determine the cause. Areas exhibiting high concentrations of dead trees represent additional fire hazard risks.

Generally, healthy trees resulting from a wet season represent a lower wildfire risk than diseased or dead trees. But as tree health changes from year to year or from spring to fall, the associated wildfire risk also fluctuates. In addition, heavy rains encourage extensive underbrush growth. As this underbrush dries during the summer and fall, wildfire risks increase.

3.2 Map Comparisons and Updates

Currently published wildfire hazard maps from CAL FIRE and the CPUC show different boundaries for the risk areas delineated. They also use different terminology for hazard zones. Several factors could account for these boundary differences between agency maps: publication dates, study methodology, vegetation changes over time, recent wildfires, and potential climate change effects. The zones delineated by the CAL FIRE and CPUC maps are discussed below and are shown in Appendix 1.

3.2.1 CAL FIRE California Fire Hazard Severity Zone Map

CAL FIRE generated and published Fire Hazard Severity Zone Maps for the entire state of California in 2007, including separate maps for each county. These maps delineate three hazard zone levels: moderate, high and very high. The figures in Appendix 1 illustrate these fire hazard severity zones.

CAL FIRE is currently updating these maps. It is not known if the zones in these maps will correspond more closely to the 2018 CPUC Fire Threat Zone map boundaries. The agency will release draft versions of these updated maps for public review, though it may be worth noting that a draft updated Hazard Severity Zone map for Los Angeles County was released in 2018. NCPA should also be aware that other entities, including other California utilities, have produced updated maps that are intended to help with evaluation of fire risks.

3.2.2 CPUC Fire-Threat Maps

The CPUC has developed and published Fire-Threat Maps. These 2018 maps include Tier 2 (elevated fire risk) and Tier 3 (extreme fire risk) zones. Additionally, the CPUC uses a Tier 1 (zero to moderate fire risk) category, which includes a High Hazard Zone (HHZ) designation based on a 2018 U.S. Forest Service-CAL FIRE joint map of tree mortality HHZs. This Tier 1 information addresses the hazard areas with large expanses of dead trees and associated fire risks.

3.3 Potential Climate Change Effects

Climate change has affected vegetation in many ways. Droughts are longer and more severe. Large storm events are more common and intense. Summers are hotter and may include more thunderstorms. These climate change factors affect vegetation and the associated wildfire risks:

- Vegetation adapts, with plant migration into different areas
- Vegetation dries out during droughts, presenting increased fire danger
- Stressed vegetation is more susceptible to insect infestations, damaging trees or accelerating mortality
- Thunderstorms present lighting strike risks along with strong wind events

Extended periods of intense rainfall also typically increase landslide risks. In turn, landslides could damage or topple structures, limit access or create safety hazards by damaging roads, or cause

localized tree mortality by severing root systems. Note that heavy rainfall is not the only landslide trigger mechanism, but it is the one most closely associated with climate change.

3.4 Potential Climate Change Risk Management Impacts

Climate change has affected the risks associated with wildfires, especially in fire hazard zones. Shifting weather patterns result in impacts to vegetation and increased wildfire risks. Some of the specific climate change impacts that affect wildfire risks include:

- Tree and underbrush growth rates
- Vegetation type changes
- Vegetation migration from existing habitats
- Stress and disease contributing to higher tree mortality

As potential impacts shift over time, fire hazard management practices should evolve and adapt to changing risk management requirements.

3.5 CAL FIRE Tree Mortality Task Force and Tree Mortality Viewer Tool

It is estimated that over 100 million trees in California died from drought-related stress between 2012 and 2017. The extended drought period left millions of acres of forestland highly susceptible to insect attacks. Drought stress is aggravated in forests with too many trees competing for limited water resources.

In 2015, California established the Tree Mortality Task Force (https://frap.fire.ca.gov/frap-projects/tree-mortality/). This task force was established to identify and map tree mortality areas with the greatest potential for causing harm to people and property. The High Hazard Zones were prioritized for tree removal.

Information from CAL FIRE's assessment is displayed in the Mortality Viewer Tool (https://egis.fire.ca.gov/TreeMortalityViewer/). Data presented, for years 2012 through 2017, corresponds directly with tree mortality identified by the US Forest Service Aerial Detection Survey. This year-to-year data illustrates tree mortality migration, especially moving upslope in the Sierra Foothill region. Although this study does not specifically address climate chance, the tree mortality migration trend illustrates its value as a useful assessment and planning tool.

Dead, rotten and diseased trees represent two potential wildfire risks for NCPA. Tall trees adjacent to power line ROWs represent a hazard from falling branches or toppling into power lines. This threat increases substantially with tall dead trees or tall trees with dead tops. Dead or highly stressed trees are also an easily ignitable fuel source. They ignite quicker and generally burn faster than healthy trees.

3.6 Fire Zone Review Process

The existing fire zone review process, set forth by regulatory agencies such as CAL FIRE and CPUC, is an important tool for reducing wildfire risks and hazards. Preparing and executing adequate vegetation management plans is a critical component of this process. The current fire zone process

incorporates lessons learned from past major wildfire events, with each new occurrence adding knowledge and forming the basis for improving the process.

3.6.1 Gaps in Process

POWER believes that the long-term fire zone review process will evolve over time as more information becomes available. And with this evolution, requirements for vegetation management and facility protection may change periodically as new hazard maps or guides are issued. Tracking proposed legislation and CPUC rulings would identify pending modifications to the current fire zone review process.

Since differences exist between currently published CAL FIRE and CPUC wildfire hazard zone maps, the fire zone review process should address these discrepancies. POWER recommends that NCPA use the most conservative approach to vegetation management and asset protection, assuming the highest risk factor from the combined datasets. Alternatively, NCPA could update the fire hazard maps, for regions surrounding NCPA facilities, based on available data and field surveys.

4. RECOMMENDED ACTIONS

The interconnected transmission line system in the western United States has been called the largest machine in the world. Any particular line has structures located with varying geologic, vegetative, and weather conditions. Couple this with mechanically connected components within the structure subject to varying temperature, weather, and other outside influences including birds, wildlife and intentional and unintentional human caused issues. Transmission and distribution lines are typically constructed with life spans of 30-40 years but are often kept in place for double that time.

Power line-caused wildfire events are typically not the result of glaring failures in design, construction, or process but rather a series of small items that are missed, overlooked, or not understood that converge to cause a big problem.

Given the abundance of facilities with multiple components and variable terrain and conditions, an emphasis on detailed processes is necessary to ensure NCPA is a "prudent manager" of its facilities. The initial recommendations regard existing processes that NCPA has in place.

- Create a list of facilities with risk of wildfire ignition: powerhouse stations, transmission lines, distribution lines, unmanned communication facilities, unmanned monitoring stations.
- Vegetation management:
    - The vegetation program requires a schedule that will mitigate vegetation fuel sources surrounding the poles, towers, and guys. A 10-foot clearance of vegetation around distribution poles and 20 feet around transmission poles and towers is recommended to reduce the chance of ignition. Also, highly combustible vegetation should be removed when identified after an inspection or whenever encountered. A 10-foot clearance around transmission guys is recommended to protect against corrosion.
    - Create a list of all facilities that will be addressed regularly with vegetation management including frequency and description of vegetation management activities.
    - Define species and growth rates expected on the CB and Geysers transmission lines.
    - Identify tree defects (hazard or danger trees), as described in Section 3.5.4 *Vegetation Inspection*, that represent potential tree fall hazards to power lines and remove or trim trees, if feasible.
    - List agreements with agencies regarding vegetation management.
    - List agreements with private property owners regarding vegetation management.
- Create Emergency Operating Guidelines similar to PM 201 for the Geysers 230 kV line and Geysers distribution line including operations recommendations.
- Describe the frequency of inspection procedures for transmission and distribution line facilities. It is recommended that a detailed aerial inspection be added to the inspection plans on a 5-year basis. This inspection would include a detailed aerial review of both 230 kV lines and the Geysers distribution line
- Improve documentation of the design basis for the transmission and distribution line facilities. Establish design criteria for the line facilities such that these can be easily referenced for understanding facility operations and/or replacement activities. Establish criteria for the CB 230 kV line, Geysers 230 kV line, and Geysers distribution line.
- Similar to the design criteria for the line facilities, document and make available the latest facility information as part of the maintenance process. Document transmission and

distribution facilities current plan/profile and structure drawings, manufacturer fabrication drawings, structure list, and current PLS-CADD line model.

Based on a review of the gaps identified above and a careful assessment of risks, POWER also recommends the following actions for each of the technical areas analyzed in this report.

Transmission

- **CB Insulator Replacement Project**—NCPA plans to replace insulators and other maintenance on the CB 230 kV line in 2020.
- **CB Ground Clearance Issues**—Mitigate clearance-to-ground issues on the CB line for span between Collierville switchyard deadend structure and powerhouse terminal deadend structure. This location has been identified by POWER using NCPA's PLS-CADD lidar model as part of the insulator replacement project design review.
- **Suspension Clamp Changes**—Change suspension clamps at Tower 2 and 6 on the CB line as the vertical wire departure angle limit of the existing clamps are exceeded and could result in conductor damage around the clamping area. Inspection of the conductor for fatigue or damaged strands is recommended.
- **Anchor Shackle Addition at CB TS-1 Structures**—Depending on the nature of terrain in wind spans on Towers 15, 23, 41, 49, 50A, 70, 71 and 108 of the Collierville to Bellota line, the addition of anchor shackles at the suspension insulator Y-Clevis end should be performed to mitigate potential for binding under extreme wind events. Additional swing angle studies should be performed to determine whether insulator strut braces or hold down weights are required to prevent insulator swing if conductor flashover prevention under extreme wind conditions is desired by NCPA. Tower 50A may be considered as a critical tower for swing prevention due to its negligible weight span as the possibility for flashover under several different weather conditions, including a 6 psf wind, is possible.
- **Range detection**—Purchase a second "true pulse" or equivalent range-detecting device for use at NCPA's Geysers facility.
- **Aerial lidar survey**—Conduct aerial lidar survey on all overhead facilities that span greater than 1 mile in length on a 5-year minimum return period, dependent on vegetation growth return periods, as a way of checking that vegetation is being maintained to a proper height per NCPA Transmission Vegetation Management Program (GS-305) and Geysers Inspection Procedure (GO-646). Ensure that the lidar survey checks conductor clearance at rest and blown out. This survey can also be used to verify some basic design conditions are being met including ground clearance and design tensions. This information is also useful to help check conductor vibration conditions. The lidar information can also form a basis for a formal record of design as encouraged for North American Electric Reliability Corporation (NERC) compliance.
- **Inspections**—Visually inspect the 230 kV overhead facility from the ground semi-annually. NCPA currently performs a ground inspection in the spring as ground conditions allow. A second aerial patrol in the fall is recommended. This patrol would involve a visual review of each structure with focus on the aerial attachments. In addition, a detailed inspection on insulators, arms, and hardware to the cotter key level is recommended every 5 years. The 5-year cycle would include infrared inspection of conductors and connectors. The detailed inspection is recommended to be carried out by Haverfield or other qualified aerial inspection services. It may be advantageous that the aerial inspector be qualified and ready to make fixes on the spot as defects are captured in the field. Haverfield normally has this capability.

- **Corona rings**—Replace all 230 kV polymer insulators that lack corona rings with new insulators that include manufacturer-recommended rings.
- **Vibration analysis and damping**—Obtain updated damper manufacturer recommendations for vibration analysis on the CB 230 kV line, as 2019 inspection logs noted that static grounds were broken in numerous locations, with the majority occurring in the final 80 towers toward Bellota Substation. The two locations where dampers were noted to be missing are scheduled for replacement in September of 2019. Assemble a table of damping design conditions as part of inspection logs to document damping conditions for conductor and static wires.

  In addition, perform vibration and conductor protective device study to determine if a revised dampering schedule is warranted on the CB line or if additional conductor clamping protection would benefit the conductor lifespan. Recommendation is made upon observation of higher tensions in the lidar model than the original design condition and due to the past conductor failure event described earlier in this report.
- **Guy guards**—Replace all guy guards with high visibility yellow or orange guards as they become deteriorated.
- **Guy wire tensioning**—Include measurement of individual guy wire tensions where guy wires are used on line structures in visual inspections. Loose guy wires should be considered as high priority and re-tensioned to a minimum of 3% of its rated strength by qualified linemen. Where guy wires are sufficiently slack, there is a danger of tower failure occurring during a dynamic loading event that could load the tower suddenly. Loose guys may also allow the tower to lean, which can affect line conductor tensions due to slack wire introduced into a span. Failures can occur at adjacent tower locations.
- **Cattle guy guards**—Evaluate towers in appropriate areas for proper cattle guy guards to prevent cattle from walking and rubbing around the guy wires.
- **Avian roosting locations**— Prioritize clearing to the ground around towers that are utilized/identified as avian roosting locations, such as near CB tower 99. Recommended clearing distance is 20 feet from the structure. To maintain clearing, apply herbicides as allowed by property owners or jurisdictions. Clearing can help prevent avian streamers, which can become glowing hot due to phase wire contact, from falling to the ground and starting a fire. Tower 99 is in a CPUC Tier 2 (elevated fire risk) and CAL FIRE high fire hazard severity zone, though vegetation was found to be very sparse grass/rangeland in this area.
- **Vehicle approach procedures**—Formalize and document vehicle approach procedures for inspection and maintenance in both fire hazard and non-fire hazard areas, as defined by CPUC and CAL FIRE, including referencing USFS procedures and requirements related to use of diesel trucks, equipment, and hand tools.
- **Tower stub angles**—Protect tower stub angles and piers on the Geysers 230 kV line sufficiently above normal grade to prevent soil from accumulating around the stub angle. Moist soil in an active zone in the presence of air is a potential corrosion issue when directed onto the stub angles. POWER did not note any adverse corrosion on the towers that were inspected, though tower 7 is an example of one location where stub angles are buried by sloughed soils.
- **Public education**—Continue to educate the public and Federal agencies in good forest management and fuel reduction techniques where NCPA has facilities in Wildland Urban Interface (WUI) areas, as defined by the CPUC and CAL FIRE. Seek grant money where available.

- **Removal of trees on private land**—Formalize and document a procedure for securing permission from private landowners to remove danger trees and other vegetation on private property that pose a hazard or fire risk adjacent to NCPA facilities. The document would provide a record of the landowner contact and NCPA's attempt to rectify the issue as well as communication to CAL FIRE in the event that permission is not granted. This is a requirement of California Public Resource Code (PRC) Section 4295.

Distribution

Routine inspections of NCPA's overhead and underground distribution systems are required per CPUC General Order 165 (GO 165). Table 1 in GO 165 provides the type and frequency of inspections for the overhead and underground distribution systems. Since NCPA is in a high-risk area for wildfire, the distribution system should be inspected annually with detailed inspections completed every five years.

The climate where the NCPA's distribution facilities are located supports optimal vegetation growth. Vegetation growth around distribution facilities has the potential to ignite a wildfire if vegetation management procedures are not in place. Enhanced vegetation management procedures may be necessary to achieve the required clearances and include clearing vegetation above and around the distribution facilities.

Distribution system operations is also a key element in wildfire mitigation. Distribution line emergency switching plans, distribution system protection devices and coordination, and line construction and maintenance standards allows the distribution system to operate optimally and will help mitigate the ignition of wildfires.

- **Avian protection—**Implement a tracking and monitoring plan for avian-related outages to help identify locations where avian protection is necessary. Develop a plan to relocate nests from poles. Consistent avian protection is necessary to prevent faults on distribution lines and to mitigate wildfire ignition from birds and other wildlife.
- **Distribution line inspection**—Complete and document general inspection of the distribution system annually. Conduct a more detailed inspection every five years. Routine inspections of the distribution system are required per CPUC General Order 165. These inspections should have a process that is documented by NCPA, and each annual inspection and 5-year inspection should be documented and stored. The annual distribution inspection should include, but not necessarily be limited to, the following inspection points:
    - Ground-level inspections (noting poles with any of the following problems):
        - Poles and crossarms
            - Leaning poles
            - Cracks, woodpecker holes, and pole degradation by insects
            - Pole rot at the base
            - Cracked or rotted crossarms
            - Copper theft
        - Conductors, insulators, and devices
            - Broken or cracked insulators
            - Excessive bird droppings on insulators
            - Device rust or leaking
            - Any signs of burning or charring

        - Underground locations with equipment – switches, transformers, etc.
        - Vegetation
            - Excessive vegetation within 10 feet of the pole
            - Trees growing directly under the line
            - Leaning trees or rotted trees
            - Tree branches that could touch the line during a high wind event
            - High tree branches that could fall onto power lines
    - The five-year distribution inspection should include, but not necessarily be limited to, the following points:
        - The annual ground level inspections
        - Detailed pole inspection by climbing the pole or flying in a bucket
        - Pole "sounding" test with a hammer to detect internal decay
        - Pole bore test on the pole where the sound test fails
        - Excavation at pole base to a depth of 18 inches to determine the extent of any ground-line rot
        - Apply wood pole preservative where needed
        - Underground locations (splice vaults, no equipment contained)
            - Inspect underground cabinets for rust/rot
            - Look for damaged hinges that could cause the lid to contact live components
            - Leaning cabinets/vaults and erosion
            - Damaged conductors and devices within cabinets and vaults
            - Copper theft
- **Vegetation control**— Revise GS-305 to implement a documented vegetation removal program for distribution facilities to reduce risk of fire ignition. NCPA's territory is in a high wind area, and trees need to be trimmed so that during a high wind event the branches will not be able to touch the distribution lines. Arcing and ignition of vegetation can occur during a high wind event if trees are not properly trimmed.
- **Operations and maintenance**—Fix and replace flagged problems from documented inspections as part of a maintenance program— as soon as possible depending on the severity of the problem. Maintenance of the distribution system is critical to keep the system reliable and to prevent ignition of wildfires.
- **Storm hardening**:
    - Storm harden the distribution system, especially at the three spans of overhead conductor at the McKay's Point 17 kV line connection with PG&E and the Collierville powerhouse 17 kV connection with PG&E. These areas of overhead conductor can be reconductored to a covered conductor to reduce the risk of a fault and fire ignition from tree branches contacting a conductor during a storm. It is also recommended that these wood poles be replaced with steel poles.
    - The 6-mile Geysers 21 kV overhead line has several risks, including potential bird contact as well as tree hazards. The following is recommended for this line:
        - Prioritize proper bird protection of this line. Install conductor coverings at all locations on the line.
        - Prioritize vegetation removal around each structure.
        - Prioritize danger tree removal.
    - Consider other storm hardening and mitigation options:
        - Re-design the line to place poles on the downhill side of the road to reduce tree fall in risks.

- Consider covered conductor for the line to eliminate concerns with tree contacts.
- Use piercing connectors on the covered conductor instead of the standard connectors that require the covering to be stripped back to make a connection.
- Use flex brackets for a Hendrix Spacer Cable reconductored line to help prevent pole tops from breaking under the load of a falling tree onto the line.
- Review distribution pole loading calculations to make sure the poles are designed to withstand the load of a tree falling onto the line.
- Replace wood poles with steel poles to enable the distribution system to survive a wildfire.
- Replace standard fuses with current limiting fuses to reduce the risk of fire ignition. Current limiting fuses don't explode with hot material when they clear a fault.

Generation

- **Inspection process**—Define vegetation management and inspection processes for unmanned Bear Canyon Pump Stations (BC #0, #1, #2, and #3), which are monitored internally by camera.
- **Fire protection**—Install means of extinguishing or containing fire for the New Spicer Powerhouse generator transformer. Vegetation removal from potential fire location is acceptable means of containment.

Environmental

Hydro and Associated Facilities

- **Avian deterrents**—Install avian deterrents on transmission structures to prevent nesting by osprey and other large birds.
- **Tall trees**—Monitor tall trees adjacent to ROWs for encroachment and tree fall hazards.
- **Vegetation Management Plan (GS-305)**—add technical appendices:
  - CMMS work orders for inspection of overhead and underground lines
  - Guidelines for inspection consistency between facilities
  - Tree species growth information
  - Tree health inspection guidelines
- **Pole damage**—Evaluate structural integrity of wooden distribution pole damaged by bear and replace if warranted; consider steel pole for replacement structure.

Geothermal and Associated Facilities

- **Bird nests**—Inspect small bird nests in lattice steel transmission towers to assess:
  - Risk based on nest size and location
  - Falling materials that contact conductors
  - If removal is warranted
- **Restricted areas**—Areas not cleared due to environmental restrictions:
  - Acquire technical background information for areas with environmental exclusions.
  - Develop a mitigation plan that addresses environmental concerns.
- **Vegetation Management Plan (GS-305):**
  - Include transmission line vegetation management within GS-305.

- Include facilities vegetation management within GS-305.
- Add technical appendices:
  - CMMS work orders for inspection of overhead and underground lines
  - Guidelines for inspection consistency between facilities
  - Tree species growth information
  - Tree health inspection guidelines

Other Considerations

The following are items that are noted as "good housekeeping" items to consider in future activities. Their value in support of wildfire mitigation are indirect and longer term.

- **Other unmanned facilities**—Verify fire hazards and potential hazards related to communication enclosures, USGS gauging stations, a campground generator and propone tank, and a solar farm. The current analysis indicates a low risk of fire hazards.
- **Landslide area near Mackay Point**—Conduct evaluation to determine potential impacts to existing vegetation, such as distressed or dead trees.
- **Landslides near Geothermal Site**—Delineate documented landslides and assess potential risk to NCPA facilities, including power lines, access roads and generating facilities.

Tree Mortality

- **Tree removal**:
  - Where feasible (with private property owner approval), remove hazardous dead trees or dead tree tops adjacent to power line ROWs, especially trees located upslope.
  - Remove dead trees located immediately downslope from critical facilities, including substations and generating facilities.
- **Historic tree mortality expansion rates**—Use existing data (2012 through 2017 from CAL FIRE Tree Mortality Tool website) to establish historic tree mortality expansion rates for areas in and around NCPA assets.
- **Satellite data**—Obtain additional data (satellite imagery) for years 2018 and 2019 to update the publicly available data from the CAL FIRE Tree Mortality Tool website.
- **Current tree mortality expansion**—Apply 2018 and 2019 data to delineate tree mortality expansion for areas in and around NCPA assets, including power lines, substations, and generating facilities.
- **Field inspection**—Establish annual field inspection programs for areas where high tree mortality is migrating toward critical facilities, including substations and generating facilities.

Fire Zone Reviews

- **Boundary updates**—Update boundaries presented by CAL FIRE on the Hazard Severity Zone maps for regions surrounding NCPA facilities applying available data.
- **Facility reassessment**—Reassess NCPA facilities located in the published CAL FIRE Hazard Severity Zone maps presented above in Figure 15 based on NCPA's updated Fire Severity Zone assessment.
- **Vegetation management**—Apply vegetation management based on the updated assessment.
- **Tracking process**—Establish and maintain an internal NCPA tracking process for documenting proposed changes to the Hazard Zone review process.

- **Periodic review and update**—Establish a formal process to periodically review and update wildfire management processes and procedures based on new regulations, requirements, and new data.

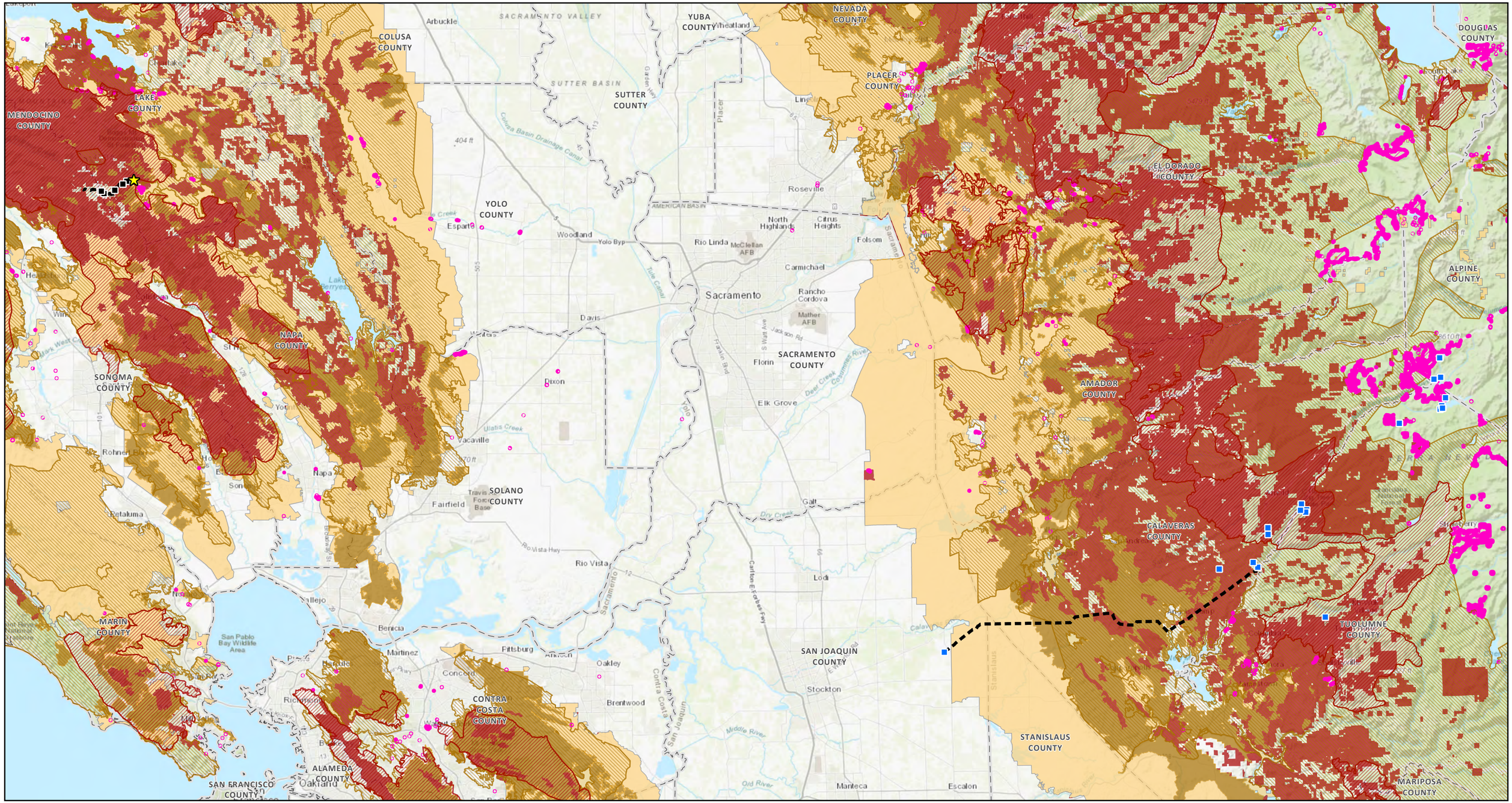
5. REFERENCES

[1] R. Nikolewski, “CPUC rules against SDG&E in 2007 wildfire case, *The San Diego Union-Tribune*, Nov. 30, 2017.

[2] California Public Utilities Commission (CPUC), “CPUC opens penalty case against PG&E for 2017 wildfire,” *YubaNet.com*, June 27, 2019.

[3] California Department of Forestry & Fire Protection (CAL FIRE), “Power Line Prevention Field Guide,” November 2008.

APPENDIX 1: FIRE ZONE MAPS



- Hydro Facility
- Geothermal Facility
- Solar Array
- Transmission Line
- County Boundary

Fire Hazard Severity Zone (CPUC) 2018
- Tree Mortality, High Hazard Zone
- Fire-Threat, Tier 2-Elevated
- Fire-Threat, Tier 3-Extreme

Fire Hazard Severity Zone (CAL FIRE) 2017
- Moderate
- High
- Very High

N W E S

NAD 1983 StatePlane California II FIPS 0402 Feet
Foot US
Lambert Conformal Conic
North American 1983

State of California

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Miles

Date: 8/2/2019
Author: CTK (POWER)

Overview

Fire Risk Assessment Map

California Department of Forestry and Fire Protection (Cal Fire) and the California Public Utilities Commission (CPUC)

Northern California Power Authority (NCPA)

POWER ENGINEERS

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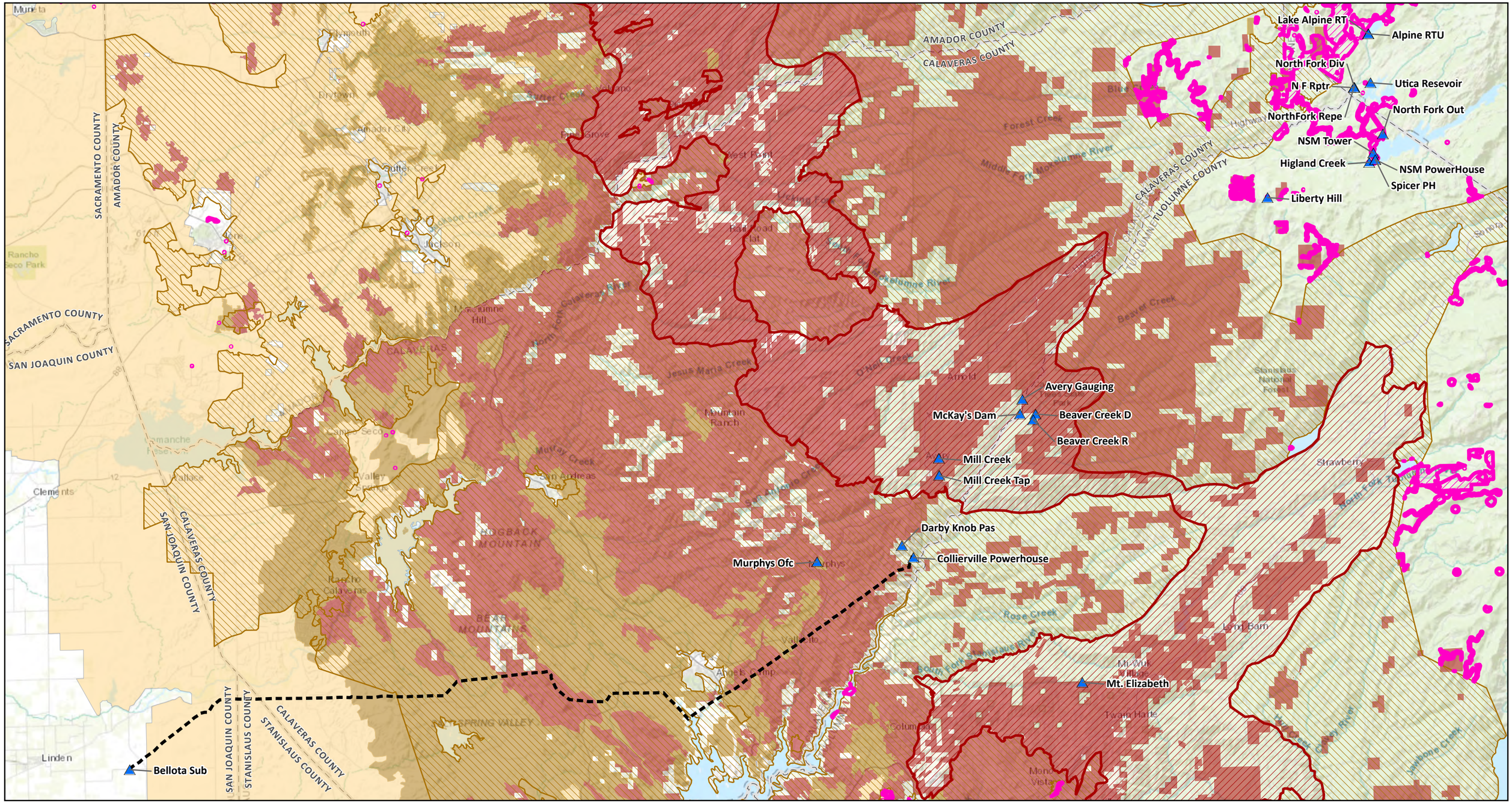

Hydro Facility
Transmission Line
County Boundary

Fire Hazard Severity Zone (CPUC) 2018
Tree Mortality, High Hazard Zone
Fire-Threat, Tier 2-Elevated
Fire-Threat, Tier 3-Extreme

Fire Hazard Severity Zone (CAL FIRE) 2017
Moderate
High
Very High

N W E S

NAD 1983 StatePlane California II FIPS 0402 Feet
Foot US
Lambert Conformal Conic
North American 1983

State of California

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Miles

Date: 8/2/2019
Author: CTK (POWER)

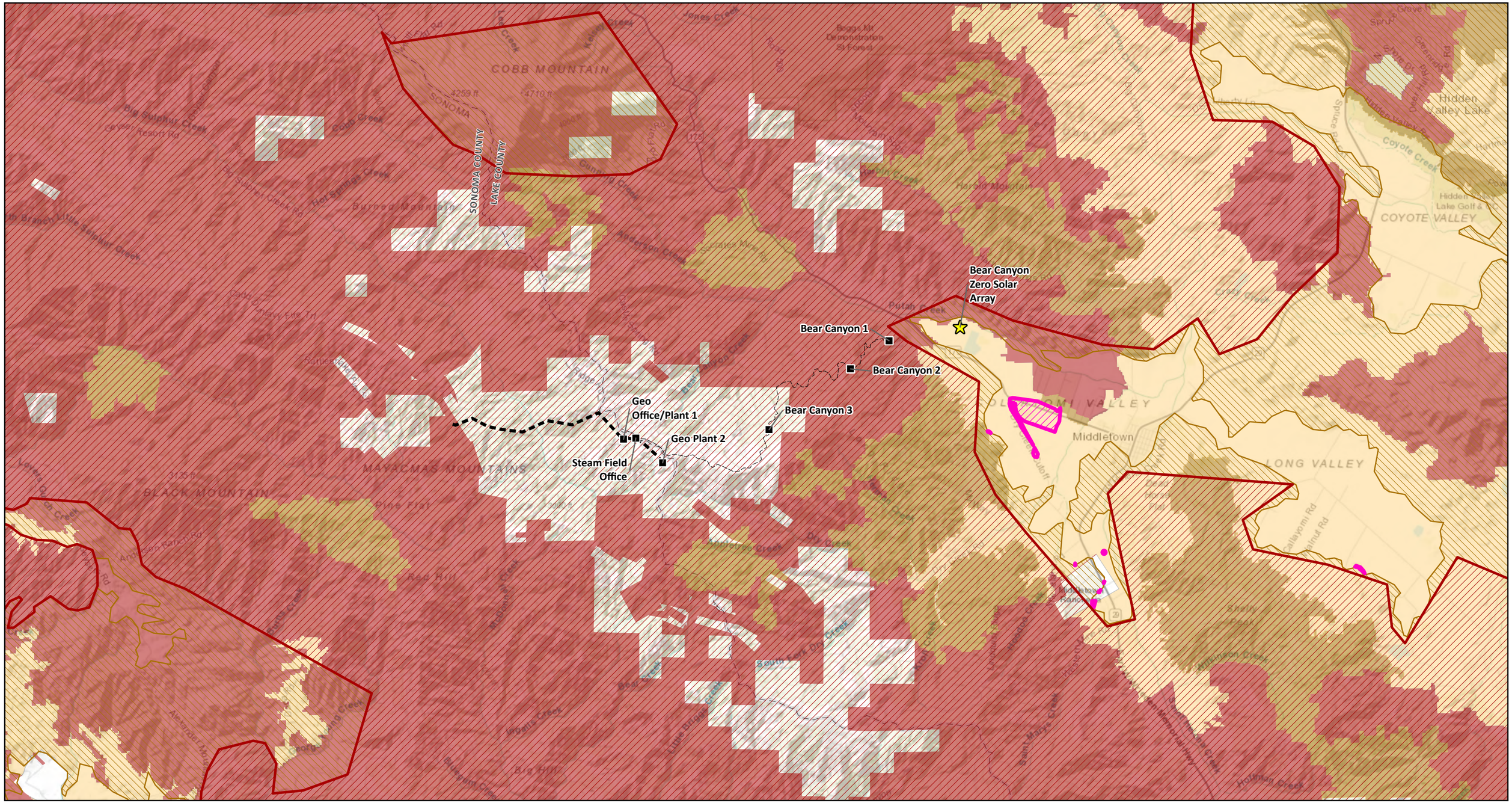
Map 1 of 2

Fire Risk Assessment Map

California Department of Forestry and Fire Protection (Cal Fire) and the California Public Utilities Commission (CPUC)

Northern California Power Authority (NCPA)

POWER ENGINEERS



- Geothermal Facility
- Solar Array
- Distribution Line
- Transmission Line
- County Boundary

Fire Hazard Severity Zone (CPUC) 2018
- Tree Mortality, High Hazard Zone
- Fire-Threat, Tier 2-Elevated
- Fire-Threat, Tier 3-Extreme

Fire Hazard Severity Zone (CAL FIRE) 2017
- Moderate
- High
- Very High

N W E S

NAD 1983 StatePlane California II FIPS 0402 Feet
Foot US
Lambert Conformal Conic
North American 1983

State of California

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Date: 8/2/2019
Author: CTK (POWER)

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Map 2 of 2

Fire Risk Assessment Map

California Department of Forestry and Fire Protection (Cal Fire) and the California Public Utilities Commission (CPUC)

Northern California Power Authority (NCPA)

POWER ENGINEERS

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