Data request for Liberty
Date sent 3/13/2020
Response requested by 3/18/2020

Should you need clarification on this data request, please contact Ryan Arba (ryan.arba@cpuc.ca.gov)

This data request shall be completed according to the process outlined in Resolution WSD 001. In particular:

1. Any discovery or data requests and responses shall be posted on the responding electrical corporation's website in an easy to follow format that identifies what the discovery was about, what the responses were about, and links to any documents produced. The electrical corporations shall update the website weekly, with an e-mail to the service list of R.18-10-007 with the relevant link and discussion of what is new on the website. The website (or portion of webpage) shall be labeled "2020 Wildfire Mitigation Plan Discovery/Data requests" for each electrical corporation.

2. Electrical corporations must copy any data requests received from or responses to Commission staff to the e-mail address wildfiresafetydivision@cpuc.ca.gov. Requests from staff to the electrical corporations may also come from this address or from individual e-mail addresses.

3. Each electrical corporation shall send to wildfiresafetydivision@cpuc.ca.gov the name of their single point of contact for all data requests and response matters for Commission staff use.

4. Electrical corporations must respond to all data and discovery requests within 3 business days of the request. Both requests and responses shall be sent by e-mail. Exceptions to the 3-business-day requirement will require a letter to the Division Director and a strong showing of the specific reason for the delay.
In your response to each data request please specify the relevant item index being responded to, found here in column B.

5. Parties conducting discovery must first analyze the significant data that will be submitted with 2020 WMPs along with the Supplemental Data Request.2 Entities submitting data requests should avoid submissions where such information is contained in the electrical corporations' WMP filings.

6. All documents the electrical corporation references in its WMP plans shall be collected on the above website in an easy to follow format, with notice to the service list of the location of such documents. This will be in addition to the posting of WMPs on the Commission's website as

A. Item Index [For CPUC tracking purposes. Please reference this item index with the response provided.]	C. Relevant section of WMP (if applicable)	D. Relevant question in Maturity Survey (if applicable)	E. Relevant meeting or call (if applicable)	F. Specific Data request	G. Format in which the data is to be provided	Response
LU-43900-Z -643	6.4: Current baseline state of service territory and utility equipment	NA	NA	Regarding request LU-43879-Z -228, provide a timeframe for when critical facility GIS data will become available.	GIS file	Liberty CalPeco anticipates having all critical facilities mapped by the end of 2020 by working with cities, counties and other agencies to obtain the data and create layers in the GIS. A new Emergency Manager position has been created and will be responsible for gathering this information.
LU-43900-Z -644	NA	NA	NA	Submit data for circuit risk levels for all transmission lines and distribution lines.	GIS file	Liberty CalPeco does not currently have any risk mapping in the GIS and is unable to provide the data requested.
LU-43900-Z -645	5.3.7.4	NA	NA	Submit locations for near misses (areas where damage and/or faults nearly caused a fire).	GIS file	Liberty CalPeco does not currently track these events in the GIS but has provided a GIS file from an export of the system that does. Please see the shapefile and attached tabular data for near misses and asset faults. Liberty CalPeco is working on linking the two sources of information which should be completed in 2020. See attachment LU_DR_20200312-43900-Z-645.
LU-43900-Z -646	Various	NA	NA	Submit locations of asset faults.	GIS file	Liberty CalPeco does not currently track these events in the GIS but has provided a GIS file from an export of the system that does. Please see the shapefile and attached tabular data for near misses and asset faults. Liberty CalPeco is working on linking the two sources of information which should be completed in 2020. See attachment LU_DR_20200312-43900-Z-646.
LU-43900-Z -647	5.3.5	NA	NA	Submit locations of vegetation projects (completed in the last 5 years and planned for the future).	GIS file	Liberty CalPeco does not have this information in shapefile format. A GIS shapefile can be created to meet this request by COB March 20, 2020.
LU-43900-Z -648	5.3.5	NA	NA	Submit vegetation risk index data as attributes associated with transmission and distribution lines.	GIS file	Liberty CalPeco does not have vegetation risk index data.
LU-43900-Z -649	6.4: Current baseline state of service territory and utility equipment	NA	NA	Submit line data showing the current locations of covered conductors.	GIS file	See attachment LU_DR_20200312-43900-Z-649.
LU-43900-Z -650	6.4: Current baseline state of service territory and utility equipment	NA	NA	Submit any remaining data (not previously submitted) for circuit risk levels (including vegetation risk index data) for all transmission lines and distribution lines	GIS file	Liberty CalPeco does not have any risk mapping or risk analysis data in the GIS and is unable to provide the requested information at this time.
LU-43900-I-726	5.3.5	NA	NA	Provide the environmental asessment or EIS for the Water Infrastructure Improvement for the Nation Act of 2016, as described on pg 88 in section 5.3.5.	Narrative	Attached is the Categorical Exclusion (CE) that grants us exemption from conducting further environmental documentation under NEPA, such as an Environmental Assessment (EA) or Environmental Impact Statement (EIS). The CE is a National Environmental Policy Act (NEPA) document that says that the work we are proposing to do has a minimal impact on the environment and therefore we do not have to conduct an EA or EIS. So there is no EA or EIS to provide because the CE exempts us from that process. See attachment LU_DR_20200312-43900-I-726.
LU-43900-I-727	5.3.5	NA	NA	Provide a list of all local and state agencies Liberty has working groups with, as described on pg 89 of section 5.3.5.	List	Liberty CalPeco's 2020 WMP explains our intent host working groups with SME's, local and state agencies to understand the greatest needs in improving fuel reduction practices. The groups that have been identified are: o US Forest Service – LTBMU o California Tahoe Conservancy o Tahoe Regional Planning Agency o Tahoe Fire and Fuels Team o Cal Fire
LU-43900-I-728	5.3.5	NA	NA	Is Liberty intending to move towards annual VM inspections for Tier 2 areas? If not, describe why.	Narrative	Liberty CalPeco is considering annual vegetation management inspections for tier 2 areas and plans to accomplish this through a phased approach. Beginning in 2020, Liberty CalPeco will conduct annual inspections in Tier 3 areas which amounts to approximately 50 miles of power line. The Tier 3 annual inspections will provide valuable information for planning the expansion into Tier 2 areas by providing estimated timing of inspection (how long it takes to inspect) and the resulting tree workload (how much work results from the inspection). After compiling the information from Tier 3 annual inspections, Liberty CalPeco will consider expanding annual inspections to include the entire circuit span for all circuits that originate in Tier 3 (approximately 130 miles of power line). The next phase would involve a transition to annual inspections in all tier 2 areas. Tier 2 and Tier 3 makes up nearly all of Liberty CalPeco's power lines (approximately 700 miles). Throughout the phased process, Liberty CalPeco will consider cost of implementation, resource needs, other existing inspection programs, and seasonality constraints that will determine the feasibility of annual inspections for the high fire threat district.
LU-43900-I-729	5.3.5	NA	NA	What third-party contractor is Liberty using for QA/QC audits?	Narrative	Liberty CalPeco is in the process of acquiring a third party contractor for QA/QC audits and expects to begin third party implementation of QA/QC by the end of June.

LU-43900-I-730	5.3.5	NA	NA	Provide all procedures relating to consideration of clearance at time of trim, as described in section 5.3.5 on pg 91.	Narrative	Liberty CalPeco performs Routine Vegetation Maintenance inspections of entire circuits to prescribe trimming and removal of vegetation as a safeguard against grow-ins or fall-ins and to conform to required laws and regulations. In prescribing trimming or removal the following factors are considered: 1) the potential for vegetation to grow and/or encroach within the minimum allowed distances to the facilities within the cycle. 2) The potential for vegetation to structurally fail into the facilities within the cycle. Additional site conditions and factors are considered in prescribing tree work such as length of span, line sag, planned maintenance cycles, location of vegetation within the span, species type, species characteristics, vegetation growth rate, arboricultural practices, environmental characteristics of the site, local climate, and elevation.
LU-43900-I-731	5.3.5	NA	NA	Provide all procedures Liberty uses to determine whether or not a tree has "strike potential".	Narrative	Trees with "strike potential" are trees or parts of trees that have the potential to contact the electrical facilities if they were to fail. Assessing strike potential begins with determining if the tree is tall enough to reach the electrical facilities. Tree height is measured using forestry devices such as a line tape and clinometer, or laser rangefinder/hypsometer. If a tree, or part of a tree, is tall enough to reach an electrical facility, it must also have a path to the target. Direction of fall (slope, lean, etc.) and protection (trees or other objects blocking the path) are also considered when determining the strike potential of a tree.
LU-43900-I-732	5.3.5	NA	NA	Provide Liberty's list of tree species' growth rates, and provide the number of each species Liberty has in its inventory.	Narrative	The third party assessment of Liberty's vegetation management program estimated a total of 32,600 trees on the system and 24 unique tree species were identified. The growth rates, frequency, and estimated number of each species in the inventory are detailed in the table included in the LU_DR_20200313-43900-I-732 file attachment.
LU-43900-I-733	5.3.5	NA	NA	When does Liberty intend to complete its "tree failure database" as described in section 5.3.5 on pg 92, and what data will be used as inputs to explore such opportunities?	Narrative	Liberty CalPeco is developing a tree failure database that will use tree related outage data to explore other opportunities for targeting reliability/at-risk species and how to treat them. Data used as inputs to explore such opportunities will include tree species, tree health, failure mode, size of part that failed, location in relation to utility assets, and defects that may have contributed to failure. Other relevant information gathered at the time of inspection may be added to the database. Liberty anticipates the development of this database to be completed by end of summer 2020.
LU-43900-I-734	5.3.5	NA	NA	Provide the "resource protection measures" within Liberty's VM plan, as described in section 5.3.5 on pg 92.	Narrative	Vegetation management activities are necessary to protect the environment by ensuring that fires are not ignited by vegetation coming into contact with electrical equipment. Liberty CalPeco is committed to carrying out vegetation management in an environmentally responsible manner, while supporting the principles of ecologically sustainable development. Power Line Vegetation Management Activities shall adhere to all regulations and policies as adopted by State, Federal, and Local Government agencies. See attached file LU_DR_20200313-43900-I-734 for detailed description of each measure.
LU-43900-I-735	5.3.5	NA	NA	Why has Liberty "not developed an initiative around additional efforts to manage community and environmental impacts"? Does Liberty intend to develop one moving forward? If not, why does Liberty not find such necessary?	Narrative	Liberty CalPeco identified and included in its WMP the Forest Resiliency Corridor Project as an additional effort to manage community and environmental impacts in Section 5.3.5.1. The sentence that reads 'Liberty CalPeco has not developed an initiative around additional efforts to manage community and environmental impacts' at the end of the first paragraph of this section should be deleted since the Forest Resilience Project is the WMP initiative that best fits this category. Please see the discussion in Liberty CalPeco's WMP Section 5.3.5 for a detailed description of Liberty CalPeco's overall strategy for the vegetation mitigation efforts currently planned. In addition, see DR response LU-43900-I-734, where vegetation management resource protection measures are provided.
LU-43900-I-736	5.3.5	NA	NA	Regarding Liberty's Vegetation Treatment Zones, as discussed in section 5.3.5.1 on pg 92 to 93: a. How many circuit miles has Liberty performed the Resilience Corridor Project for? b. How many circuit miles does Liberty have scheduled to enforce the Resilience Corridor Project? c. How is Liberty measuring and tracking the effectiveness of the Resilience Corridor Project?	Narrative	(a) 0 (b) 14 © The total proposed project area is on 7,600 acres of forest lands and spans about 55 miles of Liberty CalPeco's power lines. Liberty CalPeco will measure and track the effectiveness of the Resiliency Corridor Project by monitoring the number of acres treated for each zone. There are three vegetation treatment zones. Zone 1 (approximately 200 acres) includes clearance of all vegetation up to 15' on each side of the power line and vegetation greater than 18" high to be removed. Zone 2 includes removing trees with structural defects up to 175' along the power lines and represents approximately 2,200 acres. Zone 3 includes reducing fuel loads and thinning the forest for up to 1000' on each side of the power lines and represents 5,200 acres. Treatments in Zone 1 and Zone 2 will be designed to meet three objectives: (1) Remove vegetation that can grow into or fall onto utility infrastructure. (2) Improve forest health adjacent to utility infrastructure – Forest will be thinned to improve resiliency to insect attack, drought and climate change. (3) Reduce hazardous fuels under and adjacent to utility infrastructure – treatments will be designed to modify fire behavior, where anticipated flame lengths are less than 4' in height and likelihood of passive or active crown fire is reduced. Prescriptions will mimic treatments in the wildland urban interface that are designed to protect communities. Treatments in Zone 3 will meet the last two objectives. Treatment prescriptions are informed by research related to fire behavior and forest growth models that provide evidence of effectiveness.
LU-43900-I-737	5.3.5	NA	NA	What are the "upcoming projects" Liberty intends to complete within the next 3 years for section 5.3.5.1, seen on pg 94?	Narrative	The map illustrates the Forest Resilience Corridor project areas. Projects will be performed at the circuit level. A long term schedule for Forest Resilience Corridor projects will be developed after the implementation of the first project (625 Line). In order to create a more accurate schedule, it is important to incorporate lessons learned from existing experience (i.e. resource requirements, pace, timing, resource protection measures, etc.). See attachment LU_DR_20200312-43900-I-737.
LU-43900-I-738	5.3.5	NA	NA	If Liberty identifies a high priority vegetation management emergency, does personnel remain on-site until the emergency is abated? Provide all procedures supporting such.	Narrative	In the event Liberty CalPeco's personnel identifies a high priority vegetation management emergency, all efforts will be made to remediate the affected area. Liberty CalPeco's Vegetation Management Plan describes emergency work as any work required to resolve a situation that has seriously compromised the electrical facilities, electric system reliability, and/or forest resources. These situations represent immediate threats to life, public safety, or property. Emergency situations generally result from high winds, storms, wildfires, other natural disasters, or other accidents that damage the electrical lines. Emergency repairs may include replacement of downed poles, re-conductoring segments of line, or pulling new line. Emergency work will start immediately to correct unsafe conditions and return the electrical facilities to service. Examples of emergency operations include, but are not limited to, Electrical Outage (Loss of Service) to electrical customers resulting from natural or man-made causes resulting in: Distribution or Transmission Conductor Failure, Distribution or Transmission Pole Failure, Underground equipment Failure, Transformer or Transformer Switch Failure, Vegetation in direct contact or that has the ability to make direct contact in wind or with snow loading with electrical equipment or conductors resulting in electrical faults, arcing, or smoldering vegetation. Telecommunications failures resulting in the loss of data collection from smart meter installations. Vegetation which has failed or is in the process of failure that will impact and come into direct contact with the electrical equipment. Radio communication failures resulting in loss of communications to field operations personnel. Hazardous materials releases associated with electrical equipment (i.e. transformers) requiring immediate containment and mitigation. Broken or damaged structures and equipment that could result in electrical outage, telecommunications failure, radio communication failure, or hazardous materials releases.

LU-43900-I-739	5.3.5	NA	NA	Regarding Liberty's workforce: a. How many inspectors and tree crew personnel did Liberty employ or contract respectively in 2019? b. Howmany inspectors and tree crew personnel does Liberty currently employ or contract respectively? C. What qualifications and certifications does Liberty require of inspectors and tree crew personnel?	Narrative	(a). 8 inspectors were contracted in 2019. Approximately 200 tree crew personnel were contracted in 2019. Tree crew personnel staffing levels varied based on availability. (b). Inspectors = 6 and Tree Crew Personnel = 16 (c). Liberty CalPeco contracts tree work with private tree companies who certify their employees as qualified line clearance arborists and trainees. A qualified line-clearance arborist is defined as an individual who, through related training and on the job experience, is familiar with the equipment and hazards in line clearance and has demonstrated the ability to perform the special techniques involved. Qualifications of Utility Forester staff require one of the following: An International Society of Arboriculture (ISA) Certified Arborist with a minimum of one year experience working on a utility vegetation management project, An ISA Certified Arborist with an ISA Utility Specialist Certification, A California licensed, A qualified individual having a minimum of five years' experience in forestry, arboriculture, horticulture, or any field as determined by Liberty CalPeco to show adequate knowledge and experience to be qualified for the project Registered Professional Forester,
LU-43900-I-740	5.3.5	NA	NA	Who performs the third party assessment of Liberty's vegetation management program, as described on pg 98 in section 5.3.5.6?	Narrative	The third party assessment of Liberty's vegetation management program was completed by Western Environmental Consultants, LLC.
LU-43900-I-741	5.3.5	NA	NA	What are all of the changes Liberty made in its VM program between the last third party assessment and the assessment that will be completed in 2020?	Narrative	Liberty has implemented several changes after the completion of the last third-party assessment to enhance its VM program. These changes include: Increased vegetation maintenance funding to approximately $4M annually (based on calculated system workload) to move Liberty CalPeco closer to a 3-year cycle; Updated the Liberty CalPeco Vegetation Management Plan document; Worked with the local US Forest Service (USFS) to develop the Liberty CalPeco Resilience Corridors Project; Added additional staff (2 positions) to the Vegetation Management Department; Is in the process of developing a tree failure database; and Is developing an annual and long-range program plan to prioritize work and determine program funding requirements and resource needs.
LU-43900-I-742	5.3.5	NA	NA	Provide the last third party assessment completed on Liberty's VM program.	Narrative	See attachment LU_DR_20200313-43900-I-742.
LU-43900-I-743	5.3.5	NA	NA	How does Liberty prioritize tree work prescribed (i.e. prioritization scoring similar to Rule 18, risk ranking, etc.)?	Narrative	Liberty prioritizes tree work by classifying it into four categories: 1. EMERGENCY WORK Emergency work is required to resolve a situation that has seriously compromised the electrical facilities, electric system reliability, and/or forest resources. These situations represent immediate threats to life, public safety, or property. 2. IMMEDIATE WORK Immediate work is required to resolve a situation that, if not corrected, could cause an outage or the threat to life and property at any time and needs to be immediately rectified. 3. ACCELERATED WORK Accelerated work requires the timely corrective action to mitigate an existing condition that, at the time of identification, represents a potential hazard to life public safety, or property. Corrective action is required within 30 days from the date the condition is identified. 4. ROUTINE VEGETATION MAINTENANCE Routine maintenance involves preventative inspection, pruning, and removal of vegetation as a safeguard against grow-ins or fall-ins and is performed on entire circuits.
LU-43900-I-744	5.3.5	NA	NA	Regarding sections 5.3.5.11 and 5.3.5.12: a. Does Liberty currently perform "an accelerated inspection" under CEMA? b. If so, provide the percentage of Liberty's system in which such inspection occurs, and the frequency of such inspection. Additionally, provide all procedures for such inspections, and describe how they differ from the routine VM inspections. c. If not, when does Liberty intend to implement such inspections, and identify which areas need to undergo acceleratied inspection? d. Does Liberty perform any Level 2 inspections? If so, what percentage of inspections completed are Level 2, and what criteria would prompt such an inspection? If not, why does Liberty Provide all supporting procedures.	Narrative	Each year Liberty performs Accelerated Vegetation Inspections under CEMA, and every circuit in the system gets scheduled for such inspections. Since instituting this program, Liberty has completed inspecting 100% of its system and will repeat inspection of each circuit on a regular basis. The accelerated vegetation inspection begins with surveying a circuit and performing a Level 1 inspection. The Level 1 inspections involves a basic visual ground inspection of trees or populations of trees to identify dead and dying trees. If the inspector identifies a tree warranting a more thorough inspection during the course of the Level 1 inspections, then a Level 2 inspection of that tree will be performed. The Level 2 assessment is a 360-degree visual evaluation of a tree where the crown, trunk, trunk flare, above-ground roots, and site conditions are evaluated. Liberty does not quantify what percentage of inspections completed are Level 2; however, criteria that would prompt a Level 2 inspection may include leaning trees, trees with codominant stems, weak branch unions, fungal fruiting bodies, cracks, cankers, or other visible defects that could lead to an increased likelihood of failure or a decline in tree health.
LU-43900-I-745	5.3.5	NA	NA	On page 100, Liberty states that it "will have completed the first cycle inspection of the Tier 3 Inspections and will have data to report on." If Liberty was not performing such inspections before, how did the previous inspections differ (such as frequency, content, etc.)?	Narrative	Liberty CalPeco is planning to annually inspect all Lines in Tier 3 zones. Previous inspections for routine maintenance were based on a three-year cycle. Three-year cycle inspections aim to achieve compliance until the next maintenance cycle (three years), which generally results in a higher volume of work. Clearances must be greater in order to hold compliance, and trees must be evaluated for their potential to grow into the minimum clearance requirements within three years. This results in a higher volume of trees identified for pruning. When evaluating hazard trees, the arborist must determine if a tree defect would be likely to fail before the next evaluation (three years).
LU-43900-I-746	5.3.5	NA	NA	How does Liberty audit work that is not on local, federal, and state agency land?	Narrative	In the Lake Tahoe basin, all trees being removed that are greater than 30" diameter at breast height (DBH) are reviewed by Liberty CalPeco arborists and reported to the Tahoe Regional Planning Agency (TRPA) and reviewed by a TRPA forester for consent to proceed. Remaining work performed on private property is reviewed by the contractor. Liberty CalPeco is in the process of formalizing its audit process by engaging a third party contractor to perform QA/QC audits.
LU-43900-I-747	5.3.5	NA	NA	How many trees are currently within Liberty's inventory system?	Narrative	There are approximately 72,000 trees.
LU-43900-D-770	5.3.2	NA	NA	How many weather stations does Liberty intend to deploy in 2020 and 2021, respectively?	Narrative	Liberty CalPeco intends to install 20 stations in 2020 and 20 stations in 2021.
LU-43900-D-771	5.3.2	NA	NA	How did Liberty determine the locations for new weather stations?	Narrative	Liberty CalPeco assesses a variety of factors when determining the locations of weather stations. First, Liberty CalPeco worked with the local National Weather Service (NWS) office to identify locations where forecasting could be improved by additional stations. Next, in order to improve decision making for potential PSPS events, stations are planned to be installed within PSPS zones to improve forecasts and real-time data specific to each zone. Finally, site specific locations are made to ensure that the weather stations have adequate solar exposure to function properly.

LU-43900-D-772	5.3.2	NA	NA	In section 5.3.2.1 on page 58, Liberty states that it has "contracted Reax Engineering to develop a weather monitoring and notification tool to warn of potential elevated risk." a.When does Liberty anticipate completion of such model? b.How is Liberty benchmarking with other utilities in the development of this model? c.What are all of the functions Liberty intends this model to perform? d.What data will feed into this model and how was this data collected?	Narrative	(a).The Reax Engineering weather monitoring and notification tool was completed in July of 2019. It will be refined in 2020 to assimilate data from recently-installed weather stations in and adjacent to the service territory and ingest data from version 4 of NOAA's High-Resolution Rapid Refresh (HRRR) forecast product which is currently planned for release in June 2020. (b).Other utilities' published PSPS methodologies were assessed and used as a starting point for developing a customized PSPS protocol and weather monitoring/analytics that is more appropriate for the fuel, weather, and topography conditions unique to Liberty's service territory (c). The Reax Engineering weather monitoring and notification tool performs several functions. The map-based tool allows for several forecasting metrics to be overlaid on Liberty's service territory, including temperature, relative humidity, wind speed and gust, wind direction, Energy Release Component (ERC) and Fosberg Fire Weather Index (FFWI). This data visualization allows forecasting of specific impacts to Liberty's PSPS zones. The webtool also generates email and text notifications to internal stakeholders to allow for planning up to 168 hours in advance for potential PSPS events. (d). The PSPS tool is driven by gridded operational weather model forecasts generated by NOAA (HRRR v3/v4, NAM CONUS nest, and GFS-FV3) and fire danger ratings generated by the US Forest Service's Wildland Fire Assessment System (WFAS) including Energy Release Component (ERC) and Burning Index (BI). Data obtained from or derived from these gridded products is supplemented by in-situ fuel moisture sampling conducted on a weekly basis in and adjacent to Liberty's service territory
LU-43900-D-773	5.3.2	NA	NA	In Figure 2 on page 60 in section 5.3.2.1, the legend labels the blue areas as "future station locations where not already existing". Will all 40 of the weather stations set for deployment be within these blue areas? If not, provide a map of where weather stations will be located.	Narrative	Yes, all 40 of the weather stations will be located within the blue areas.
LU-43900-D-774	5.3.2	NA	NA	In section 5.3.2.2a on page 61, Liberty states that it will "Make provisions for deployment of DFA" in the next year, and will "Deploy DFA n 10 feeders" in the next 3 years. a.What "provisions" need to be made in order to deploy DFA? b.Why does Liberty anticipate deployment will take 3 years? c.When does Liberty anticipate the pilot will be complete? d.Has Liberty determined which 10 feeders will be piloted for DFA? If so, include a list of such feeders and discuss how these feeders were determined. If not, provide an estimate time in which such will be determined.	Narrative	(a).Liberty CalPeco is also still negotiating contractual terms with the provider of DFA technology. Additionally, site specific provisions within substations must be made to accommodate DFA technology. Site specific provisions include modifying substation control houses and circuitry to accommodate DFA hardware. (b).The possibility of starting the DFA project in Q3 2020 rather than 2021 is currently being evaluated. Deployment ideally starts in Q3 2020 with all hardware installed by the end of 2020. In 2021 and 2022, Liberty will continue collaborative development of DFA technology alongside the provider, integrate DFA technology into existing work practices, and continue to evaluate options for expanding DFA to include more than 10 circuits. (c). Liberty CalPeco anticipates the DFA pilot project will be complete in 2022.(d).The table attached in LU-43900-D-774 contains the 10 feeders that will be piloted for DFA and methodology on why they were selected.
LU-43900-D-775	5.3.2	NA	NA	In section 5.3.2.2b on page 62, relating to ALERTWildfire Cameras: a.How many cameras are currently within the ALERTTahoe wildfire camera network? b.What percentage of Liberty's service territory do the cameras currently cover? c.Does Liberty intend to install additional cameras? If so, how has Liberty evaluated the placement of such cameras? d.How many times in the 2018 and 2019 wildfire season did Liberty use the ALERTTahoe camera network? e.Has Liberty partnered with ALERTWildfire before the filing of the 2020 WMP? If so, described the extent of such partnership.	Narrative	(a).There are currently 49 cameras in the ALERTTahoe wildfire camera network. (b). Close to 100% of Liberty CalPeco's service territory is covered by the ALERTTahoe wildfire camera network. (c).Liberty CalPeco does not intend to install additional cameras. In discussion with ALERTWildfire, they do not see the need to add cameras to the ALRERTTahoe network as coverage is already excellent. However, ALERTWIldfire did stress the need for maintenance of the existing cameras. Therefore, Liberty CalPeco intends to partner with ALERTWildfire in 2020 to maintain the existing ALERTTahoe network and be able to control the cameras. This project will be considered an O&M expense and not seek rate recovery. (d).Liberty CalPeco did not use the ALERTTahoe camera network during the 2018 or 2019 wildfire seasons since a partnership with ALERTWildfire was not in place at that time. However, Liberty CalPeco acknowledges that the camera network is a critical tool to support firefighters and first responders during a wildfire. (e). No. See response to part d.
LU-43900-D-776	5.3.2	NA	NA	In section 5.3.2.3 on page 63, relating to Fault Indicators: a.Why does Liberty not currently plan on using or expanding the use of fault indicators? b.What line monitoring technologies is Liberty currently conducting research for, as indicated under "Before the next annual update" for the Program Timeline.	Narrative	(a).Liberty CalPeco already uses fault indicators to help identify outage locations. There are no plans to expand future use of fault indicators as they are a reactive approach to wildfire mitigation (if the fault indicator is flashing the near-miss or ignition may have already occurred). Liberty CalPeco views proactive wildfire mitigation programs, such as continuous monitoring, weather forecasting, and system hardening, as programs with higher risk spend efficiencies. (b).Liberty CalPeco already uses line monitoring technologies such as Aclara medium voltage sensors. Line monitoring sensors are fundamentally different from a traditional fault indicator since line monitors are able to provide advanced notification of a potential near miss event such as contact from foreign objects or potentially faulty hardware. Liberty CalPeco will focus on refining and identifying areas to expand the use of line monitoring sensors and provide updates in the 2021 WMP filing. Distribution Fault Anticipation (DFA) technology can also be considered a line monitoring technology and is discussed in Section 5.3.2.2a "Continuous monitoring sensors."
LU-43900-D-777	5.3.2	NA	NA	Provide the projected completion dates for the listed FPI initiatives under section 5.3.2.4 on page 63.	Narrative	The FPI development is scheduled for completion on May 1, 2020.
LU-43900-D-778	5.3.2	NA	NA	Provide all of the "new working procedures for elevated fire risk conditions" discussed in section 5.3.2.5 on page 65.	Narrative	See attached Fire Prevention Plan in LU_DR_20200313-43900-D-778. Operating procedures begin on page 7 of the document.
LU-43900-D-779	5.3.2	NA	NA	In section 5.3.2.6 on page 66 under "Before the next annual update" for the Program Timeline, Liberty states that it intends for "Continued use of existing weather forecasting tools." a.What tools does Liberty currently use? b.What tools will be replaced by the Reax model?	Narrative	(a). Liberty CalPeco currently uses the Reax model. (b). Prior to the introduction of the Reax model, Liberty CalPeco used weather forecasts provided by the local National Weather Service (NWS) office.
LU-43900-E-782	5.3.9 Emergency Planning and Preparedness	NA	NA	Explain why Table 29 only has only one initiative of the seven requested in the WMP template.	Narrative	Please see Liberty CalPeco's responses to LU-43879-E-199 and LU-43895-E-401. In its revised 2020 WMP submitted February 28, narrative was included for the six initiatives specifically outlined in Section 5.3.9 as programs to reduce ignition probability and wildfire consequence. Narrative was not included for the seventh "Other" initiative because each program was properly classified within the other six initiatives. The table only includes initiatives that forecast spend and/or applicable data. Thus, only one initiative was included in Table 29.
LU-43900-E-791	5.3.9 Emergency Planning and Preparedness	NA	NA	Explain why Table 29 only has only one initiative of the seven requested in the WMP template.	Narrative	See response to LU-43900-E-782.

LU-43903-Y-7	6.6: Planned 2020 WMP initiative activity per year	NA	NA	Provide planned initiative data at the most granular level possible for each initiative activity (e.g., each asset location for each activity under an initiative). The exact schema for the spatial data can be found in the attaced excel file, "20200311_Initiative_schema", in the sheet "Initiative schema for utilities". The priority for each field is listed in the "priority" column. An example of the table is provided in the sheet "Initiative Template". Table should be organized as shown in "Initiative Template" sheet with the column names matching "Field Name Shapefile" column in the "Schema" sheet. Each field is explained in the "Field description" column, and type of data for each field is in the "Field Type". Attached to this dataset should be lat/lon points corresponding to each row in the data	GIS File with same schema as attached (see specfic data request)	Liberty CalPeco does not currently track this type of information in the GIS and is unable to provide the data as requested. There are initiatives in place that will allow this type of reporting to be generated by the GIS for future requests.
LU-43903-Y-8	5.3.4 Asset management and inspections	NA	NA	Provide asset spatial data at the individual asset level for each of the asset categories listed (substations, weather stations, capacitor banks, conductors, poles, transmission lines and distribution lines). The exact schema for the spatial data can be found in the attaced excel file, "20200311_Asset_schema", in the sheets "Asset schema for utils - points" and "Asset schema for utils - lines". The priority for each field is listed in the "priority" column. An example of the table is provided in the "Asset Template" sheets. Table should be organized as shown in "Asset Template" sheets with the column names matching "Field Name Shapefile" column in the "Schema" sheet. Each field is explained in the "Field description" column, and type of data for each field is in the "Field Type". Attached should be two spatial files, one for points data and one for lines data, where each dataset should have its respective shape features (lat/lon points or lines) corresponding to each row in the data	GIS Files with same schema as attached (see specfic data request) - one for lines and one for points	Liberty CalPeco has provided as much information as it can but some fields are not able to be populated. There are initiatives in place that will allow this type of reporting to be generated by the GIS for future requests. See attachment LU_DR_20200312-43903-Y-8.
LU-43903-Y-17	6.1 Recent weather patterns and use of PSPS	NA	NA	Provide PSPS event data at the circuit level (i.e., each circuit shut-off in an event should have its own row in the shapefile dataset). The exact schema for the spatial data can be found in the attaced excel file, "20200303_PSPS_schema", in the sheet "PSPS Schema for utilities". "Risk drivers" should be the same across circuits in an event, but all other values should be unique to each circuit. The priority for each field is listed in the "priority" column. An example of the table is provided in the sheet "PSPS Event Template". Table should be organized as shown in "Example onlyPSPS Event Template" sheet with the column names matching "Field Name Shapefile" column in the "Schema" sheet. Each field is explained in the "Field description" column, and type of data for each field is in the "Field Type", and priority of data being received by CPUC is in the "Priority" column	GIS File with same schema as attached (see attached excel file - 20200202_PSPS_schema).	See attachment LU_DR_20200313-43903-Y-17.
LU-43903-Y-18	6.4: Current baseline state of service territory and utility equipment	NA	From WMP: Summarized risk map: Operation wildfire risk reduction model used to prioritize long-term hardening efforts. Referred to on page 5—43, section 5.3.1.1. From the section: "PG&E has leveraged the FMEA that was used to inform its 2019 accelerated and enhanced inspections to develop." 1. "ignition probabilities for each of the various electric overhead equipment types for electric distribution, transmission and substation facilities" 2. "Likelihood of failure: Relative risk of a circuit causing an outage and ensuing ignition" 3. "Likelihood of wildfire spread and consequence score: Relative ability ignition spread and quantity of homes or timber affected if ignition occurs"	Provide the most recent map of overhead distribution, transmission, and substation facilities (as was provided earlier) in high-fire threat regions with additional fields for… 1. Ignition probability – projected likelihood of target asset causing an ignition in the next year (0.0 – 1.0) 2. Failure probability – projected likelihood of target asset failing in the next year (0.0 – 1.0) 3. Wildfire spread and consequence score (normalized from 0.0 – 1.0) – relative ability ignition spread and quantity of homes or timber affected if ignition occurs 4. Prioritization ranking of assets for maintenance – calculated ranking of assets for prioritizing asset maintenance, upgrades, and equipment replacement. This is a percentile ranking with 99th percentile being highest priority and 0th percentile being lowest priority for asset maintenance	GIS File	Liberty CalPeco does not currently have any risk mapping in the GIS and is unable to provide the mapping data requested.

Liberty Utilities Resilience Corridors Project

Decision Memo

USDA Forest Service
Lake Tahoe Basin Management Unit
&
Tahoe National Forest
El Dorado and Placer, CA, and Washoe, NV Counties

Decision

I am authorizing the implementation of this project, with the following terms and conditions.

Background

The proposed project area is on approximately (~) 7,600 acres of lands managed by the Lake Tahoe Basin Management Unit (LTBMU) and the Tahoe National Forest (Tahoe NF). The project comprises roughly 55 miles of Liberty Utilities (Liberty) power lines, with ~54 miles on the LTBMU and one mile on the Tahoe NF (**Figure 1**).

The USDA Forest Service (FS) and Liberty have long partnered to manage hazard tree threats along power lines in the basin. This project will build on that partnership towards our long-term shared commitment of reducing threats to critical infrastructure and increasing landscape resilience. It will also help give additional guidance to Liberty for future active hazard maintenance. There is a present need to reduce the risk of wildland fires that ignite from vegetation contacting utility infrastructure or failures in that infrastructure. Recent destructive fires within California have demonstrated the need to also improve forest health and resilience by reducing fuels and stand density within the forests surrounding the power line corridors.

The project record includes supporting documentation not found in this memo.

Forest Thinning

There are three treatments zones around the power lines (**Figure 2**):

- Zone 1 (up to 15' each side of power line, ~200 acres): vegetation, including shrubs ≥ 18" high, with potential to grow into utility infrastructure will be removed, along with defect trees.

- Zone 2 (up to 175' each side of power line, ~2,200 acres): trees with structural defects with the potential to strike utility infrastructure will be removed; fuels will be reduced to improve forest resilience to fire, insect, disease, and drought; and, thinning to desired conditions will improve forest health and resilience. The target average stand density is 60 BAF (basal area factor) with a range of 40-80 BAF. For trees less than 10" in diameter in the understory, a minimum of 10 tree per acre will be retained.

- Zone 3 (up to ~1000' each side of power line, ~5,200 acres): reducing fuel loads and thinning the forest to desired conditions will improve forest health and resilience to disturbance. The target average stand density is 100 BAF, with a range of 80-120 BAF. For trees less than 10" in diameter in the understory, a minimum of 10 trees per acre will be retained.

Riparian fuels, including mature aspen trees, will be removed only if they have the potential to grow into the utility infrastructure. Trees showing signs of insect infestation, diseases, or symptoms of poor health would be selected for removal first. Intermediate (crowns are generally narrow or one-sided and below the general level of the canopy) and co-dominant (crown extends into canopy and receives direct sunlight from above but limited sunlight from the sides) trees would also be removed first.

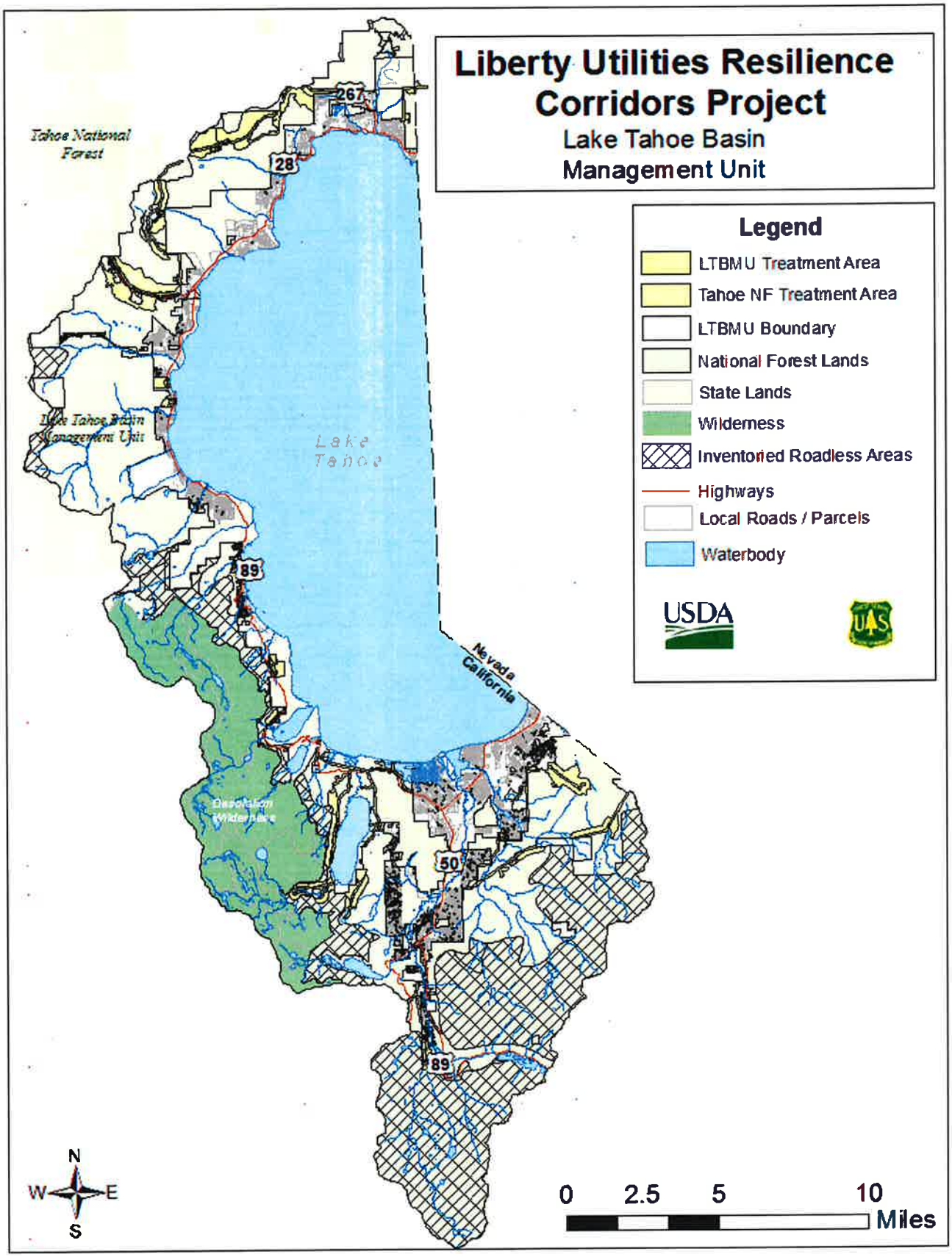

Figure 1. Liberty Utilities Resilience Corridors Project Overview Map

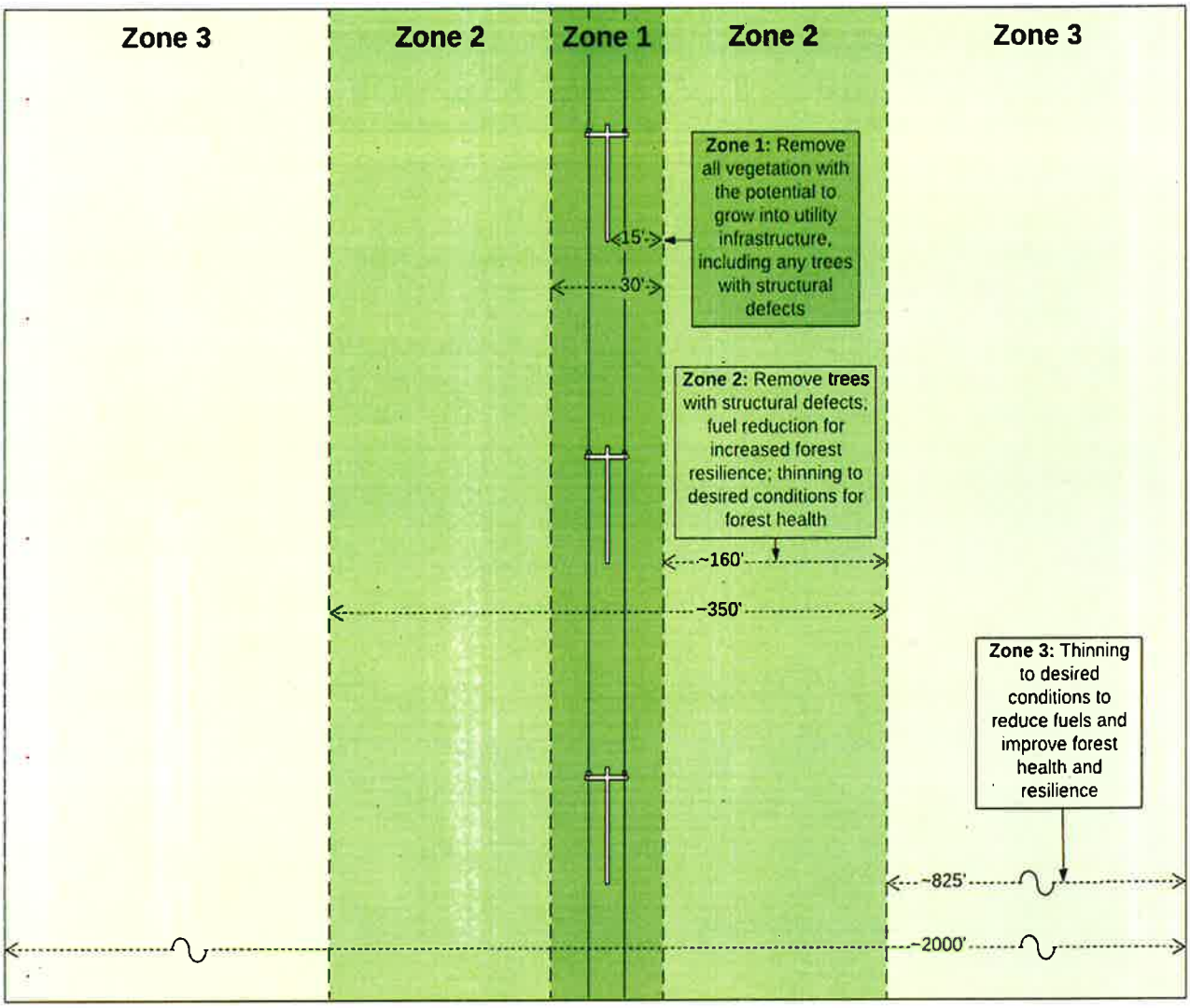

Figure 2. Treatments up to ~1,000' on both sides of power line in three Zones.

The general prescription for thinning treatments would be to remove trees up to 30 inches diameter-at-breast-height (DBH) to meet desired conditions for stand density. Trees larger than 30 inches DBH may be removed if reviewed by a FS wildlife biologist and if the tree presents a safety hazard, prevents equipment operability, or is infested by insects or disease with potential to spread to adjacent trees. In hand treatments, where material would be piled or scattered and not removed, thinning would generally be limited to trees under 20 inches DBH. Sugar pine, Jeffrey pine, and incense cedar would be favored for retention at mid elevations and whitebark pine, Jeffrey pine, western white pine, incense cedar, and red fir for retention at higher elevations.

Treatments may create openings to restore forest structure, ranging in size from less than one acre to three acres. Openings may retain trees and clumps to produce spatial and structural variability, increasing forest resiliency. The location of openings would be influenced by, but not limited to: 1) areas of heavy tree mortality, insect infestation, or disease; 2) proximity to Protected Activity Centers (PACs) and Home Range Core Areas and detections of late- and mid-seral associated species; 3) existing connectivity of habitat for species within or adjacent to project area; 4) proximity to developed recreation sites, scenic resources, and cultural resources; 5) proximity to open water and Stream Environment Zones (SEZs); 6) proximity to communities; 7) surrounding seral stages; and, 8) spread of invasive species.

California spotted owl and Northern goshawk PACs overlapping power line corridors would be carefully managed to prevent potentially catastrophic fire in these sensitive areas. Because PACs are increasingly destroyed by high severity fires throughout the Sierra Nevada, treatments in them will mimic low to moderate natural disturbances to facilitate tree growth. Where power line corridors overlap PACs, Zone 1 would be treated similarly to areas outside PACs to protect power lines. Treatments in Zones 2 and 3 would emphasize optimal forest structure for owls and goshawks. Large diameter tall trees in the Wildland Urban Interface (WUI) may be retained in clumps with limited tree cutting, while clumps of small diameter, short (less than 50 feet tall) trees may be removed, creating a mosaic of stand structures.

The type of thinning operation selected would be based on soil type and slope of treatment stands. Hand thinning would occur where slopes are generally greater than 30% and ground-based mechanical thinning on slopes less than 30%. Cable yarding or helicopter systems for biomass removal could take place on slopes greater than 30% or in areas where soils are too sensitive for ground-based mechanized equipment. Cable yarding generally has a limitation of ~1500' from roads.

In mechanical units, treatment may be completed by whole tree skidding or low impact methods such as cut-to-length forwarding. Follow up treatments to reduce or redistribute residual fuel could include lop and scatter, mastication, chipping or grapple piling, and pile burning. Public fuelwood collection may also be used where accessibility to roads and treatment areas exist.

Existing downed logs and fuels may be reduced by removal through ground-based mechanical methods. Material not removed could be chipped or masticated, piled and burned within the units or at landings, or consumed during planned understory burning.

Conifers would be thinned from SEZs, including riparian areas, meadows, and aspen stands. All conifers that are competing with riparian vegetation, overtopping aspen, or encroaching upon meadows would be considered for removal.

Landings would primarily be in areas previously used as landings and in other existing openings, though may need some construction. They would be strategically placed to create openings to restore forest heterogeneity. Landings would be large enough to safely facilitate the handling and removal of biomass material and would range from less than one acre to three acres to meet forest structure objectives.

Temporary stream crossings may occur in ephemeral, intermittent, and perennial drainages. The Forest sale administrator, hydrologist, and aquatic biologist will agree on temporary locations and designs prior to construction. Equipment used in SEZs will follow appropriate best management practices (BMPs) and resource protection measures (RPMs) found in the project record. When constructed, reconstructed, or permanently removed, crossings will provide for aquatic organism passage as described in the RPMs. The number of crossings will be kept to the minimum required for access and will be as perpendicular to stream course as possible.

Within 300 feet of developed areas (homes and other infrastructure), brush, snags, and down logs may be removed to meet defensible space objectives.

Seeds or plugs will be planted in areas where increased size, age, and species diversity are desired. Reforestation may be used as a post-thinning treatment to increase the diversity of seral stage, species, and size class in forest stands, and prescriptions would incorporate species mix, stocking density, and the use of white pine blister rust resistant seedlings. Examples of where reforestation may be used include, but are not limited to, areas that are cleared for landings and openings from thinning dead or dying trees. Areas would be chosen based on the need for diversity in species and size composition in that area.

Prescribed Fire

Prescribed fire is used to remove slash piles and to reduce surface and ladder fuels. Prescribed fire may also be used to promote pockets of tree mortality where it is not feasible for thinning treatments to meet these objectives (e.g., too many trees that are too large for hand piling, or current stand densities would result in too many piles) and to increase available snags and down woody debris for wildlife habitat.

Prescribed fire could occur within Zones 2 and 3 but would not be conducted in Zone 1. The creation of snags and coarse woody debris using prescribed fire would only occur more than 300 feet from private property. Fuel treatments using prescribed fire may occur as the primary treatment, or within two to five years following hand or mechanical treatment. Prescribed fire would be the only treatment allowed in PACs outside the WUI. Existing roads and trails would be utilized as fire lines to minimize new ground disturbance, though additional fire lines may be constructed with hand tools. All constructed fire lines would be restored after implementation following the most current FS and Tahoe Regional Planning Agency (TRPA) BMPs and RPMs.

Roads

Temporary road construction would be required to facilitate thinning treatments. Where possible, temporary roads would be constructed on top of a non-historic, relic road prism (i.e. previously decommissioned), consistent with the FS Region 5 Programmatic Agreement with the California State Historic Preservation Office (SHPO) and the Advisory Council for Historic Preservation (ACHP). Construction needs may include installation of drainage structures to prevent surface water runoff, road widening for vehicle access (including removal of trees and brush), and road surface stabilization. All temporary roads would meet FS and TRPA standards for BMPs to minimize erosion risk and stabilize the surface. The proximity and crossing of recreation corridors such as trails will be considered during the planning of the temporary road system and avoided whenever possible.

Roads would be maintained commensurate with use. Native surface roads would be watered to abate dust during project implementation. Upgrades to roads would not be undertaken to accomplish substantial improvements in road standard to raise the maintenance level. Damage to any bituminous, chip seal, or asphaltic surfaced type would be repaired.

When operations have been completed, temporary roads used for the project would be decommissioned in their entirety and closed with entry barriers to prevent access, and water bars or other drainage structures would be installed to provide proper drainage. Other rehabilitation, including ground cover, would be implemented as described in the RPMs.

Exclusion Categories

Based on information in this document and the project record, I have determined this project may be categorically excluded from documentation in an Environmental Assessment or Environmental Impact Statement. It meets the criteria outlined in the Water Infrastructure Improvement for the Nation Act of 2016:

> *A forest management activity conducted in the Lake Tahoe Basin Management Unit for the purpose of reducing forest fuels is categorically excluded from the requirements of the National Environmental Policy Act, if the forest management activity:*
> *(A) does not exceed 10,000 acres, including not more than 3,000 acres of mechanical thinning;*
> *(B) is developed in coordination with impacted parties, specifically including representatives of local governments, such as county supervisors or county commissioners and in consultation with other interested parties; and,*
> *(C) is consistent with the Lake Tahoe Basin Management Unit land and resource management plan.*

Because a portion of the project (approximately 40 acres) is located on the Tahoe National Forest, the following additional category (36 CFR 220.6(e)(6)) has been utilized to authorize those treatments:

> *Timber stand and/or wildlife habitat improvement activities that do not include the use of herbicides or do not require more than one mile of low standard road construction.*

The Delegation of Authority letter from the Regional Forester, Randy Moore dated 10/7/2019 is in the project record.

Finding of No Extraordinary Circumstances

I have determined no extraordinary circumstances affecting resource conditions exist (36 CFR 220.6). The rationale for my decision is based on: 1) project meeting Categorical Exclusion criteria; 2) proposed action meeting the need for the project; 3) findings related to extraordinary circumstances, discussed below; 4) project's consistency with laws and regulations, including the Forest Plan; 5) on-the-ground reviews and discussions with Forest resource specialists; and, 6) my reviews of other agencies' concurrences or specialists' written determinations.

1. **Federally listed threatened or endangered species or designated critical habitat, species proposed for Federal listing or proposed critical habitat, or Forest Service sensitive species.**

There are no threatened or endangered plant species in the project area. Whitebark pine is a candidate species under the Endangered Species Act, and the proposed action may affect, but is not likely to adversely affect, the species.

Determinations for FS sensitive plant species are as follows. The proposed action will have no effect on the following species for the Tahoe National Forest, occurring at elevations below the proposed project area: Lemmon's milkvetch, valley elderberry longhorn beetle, Webber's ivesia, Layne's butterweed, Modoc Plateau milkvetch, Webber's milkvetch, clustered lady's slipper, mountain lady's slipper, Butte County frittilary, Sierra Valley ivesia, Dog Valley ivesia, Santa Lucia dwarf-rush, Cantelow's lewisia, saw-toothed lewisia, elongate copper-moss, Follett's monardella, closed-throated beardtongue, Stebbins phacelia, Sierra bluegrass, and sticky pyrrocoma. The proposed action may affect, but is not likely to result in a trend toward Federal listing or loss of viability for the starved daisy, goldencarpet buckwheat, Donner Pass buckwheat, Kellogg's lewisia, upswept moonwort, scalloped moonwort, slender moonwort, common moonwort, Mingan moonwort, western goblin, Bolander's candle moss, Blandow's bog-moss, Plumas ivesia, broad-nerved hump-moss, Ortho-trichum moss, Goward's water fan, Tahoe yellow cress, Galena Creek rock cress, Tiehm's rock cress, Tulare rockcress, Cup Lake draba, Tahoe draba, Mineral King draba , long-petaled lewisia, whitebark pine, Howell's tauschia, large cudonia, branched collybia, olive phaeocollybia, stalked orange peel-fungus, and short-leaved hulsea.

There are no threatened or endangered terrestrial wildlife species in the project area. Determinations for FS sensitive species are as follows. The proposed action will have no effect on great gray owl or North American wolverine. The proposed action may affect, but is not likely to result in, a trend toward Federal listing or loss of viability for the northern goshawk, willow flycatcher, bald eagle, California spotted owl, Pacific marten, pallid bat, Townsend's big-eared bat, fringed myotis, and western bumble bee.

There is suitable habitat and designated critical habitat in the project area for the Sierra Nevada yellow-legged frog (*Rana sierrae*). The proposed action may affect, but is not likely to adversely affect, the species and the designated critical habitat.

There are seven Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) occupied or potentially occupied waterbodies adjacent to proposed treatment units. Based on the proposed project description, RPMs, and species occurrence, the proposed action may affect, but is not likely to adversely affect, this species.

2. Flood plains, wetlands, or municipal watersheds

The project area includes floodplains and wetlands. Floodplains will receive both mechanical and hand thinning treatments. Due to soil moisture restrictions, mechanical treatments would not occur within wetlands. Hand thinning treatments would improve wetland conditions by removing encroaching conifers with material piled for later burning or removal by cable yarding or helicopter systems. The project will have no effect on municipal watersheds.

3. Congressionally designated areas

These are no congressionally designated areas within the project area.

4. Inventoried roadless areas or potential wilderness areas

Inventoried roadless areas (IRAs) are located within the project area, though no roads would be constructed within them. Some trees may be harvested for commercial purposes but would be accessed from outside the IRA. The Roadless Rule allows the cutting, sale, or removal of timber if needed "to maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period" (36 CFR 294.13(b)). The FS Region 5 office determined this project is consistent with the 2001 Roadless Rule, does not require a Washington Office briefing, and will protect roadless area characteristics.

5. Research Natural Areas

There are no research natural areas within the project area.

6. American Indians and Alaska Native religious or cultural sites

No American Indian religious or cultural sites will be affected.

7. Archaeological sites, or historic properties or areas

In consultation with the State Historic Preservation Office (SHPO) and the Washoe Tribe of Nevada and California, compliance with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. 306108) and implementing regulations at 36 CFR 800 will be met through a phased identification and evaluation approach that utilizes the Region 5 Programmatic Agreement. Please see supporting documents and project record for consultation documents.

Public Involvement

On April 19th, 2019, the project was posted for a 30-day scoping period on the LTBMU Forest Projects webpage, on the Schedule of Proposed Actions (SOPA), in press releases to surrounding media outlets, and in a Legal Notice in the newspaper of record. On the same date, the proposed action and cover letter were emailed to multiple State, County, local entities, and other interested parties. Comment letters are contained within the project record and have been addressed within this document, by Interdisciplinary Team (IDT) specialists' analyses, or by other information in the project record. Coordination occurred with Eldorado County Supervisor Sue Novasel, Placer County Supervisor Cindy Gustafson, and the office of California Congressional Representative Tom McClintock.

Findings Required by Other Laws

The proposed action is consistent with the standards and guidelines contained in the LTBMU Land and Resource Management Plan, 2016. The project will implement RMPs and BMPs compliant with the Lahontan Regional Water Quality Control Board Timber Waiver (Timber Waiver). LTBMU staff will coordinate closely with TRPA during project planning to ensure that the project is consistent with Tahoe Regional Planning Agency environmental thresholds. This project falls under the Memorandum of Understanding (2009) between TRPA and the FS regarding Fuels Reduction and Forest Health Projects. Coordination would include completing a TRPA environmental checklist and environmental threshold findings.

Implementation

Implementation may occur in the 2019 calendar year where survey requirements have been met. Additional survey work and unit layout may begin as early as summer, with a majority of project implementation beginning in the 2020 calendar year. The project would be completed within the next 10 years because of piling and prescribed burning.

Interdisciplinary coordination during project development, design, and implementation is mandated in the Forest Plan and is based on the FS's multiple use land management mandate. The project Interdisciplinary Team (IDT) will continue to work as a group through the implementation of this project. The IDT consists of resource specialists from planning, timber, silviculture, terrestrial and aquatic wildlife, botany, hydrology, fuels, recreation, and engineering. Treatments for this project will be fitted to on-the-ground assessments and current resource information at the time of implementation. The IDT will continue to gather information throughout implementation to ensure appropriate RPMs are applied while the needs of this project are met.

Administrative Review

This decision is not subject to appeal or objection, pursuant to Section 431 of the Consolidated Appropriations Act of 2014.

Contact Person

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JEFF MARSOLAIS
Forest Supervisor

10/7/19
Date

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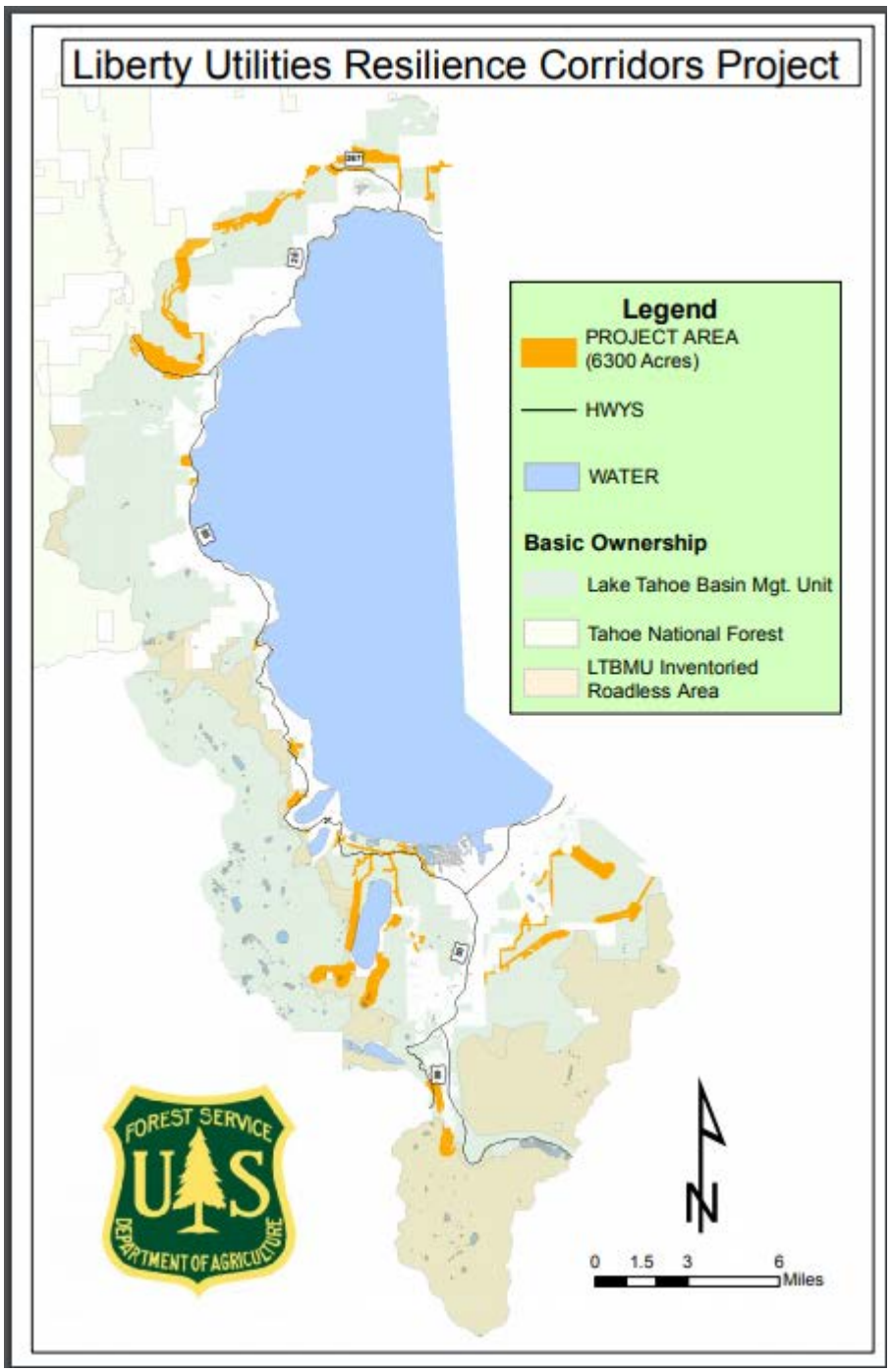
LU-43900-I-737

What are the "upcoming projects" Liberty intends to complete within the next 3 years for section 5.3.5.1, seen on pg 94?

The map below illustrates the Forest Resilience Corridor project areas. Projects will be performed at the circuit level. A long-term schedule for Forest Resilience Corridor projects will be developed after the implementation of the first project (625 Line). In order to create a more accurate schedule, it is important to incorporate lessons learned from existing experience (i.e. resource requirements, pace, timing, resource protection measures, etc.).



LU-43900-D-774

Feeder Name	Selection Methodology
Northstar 8400	Tier 2 HFTD, provisions were made for this feeder as part of a relay upgrade project
Northstar 8500	Tier 2 HFTD, provisions were made for this feeder as part of a relay upgrade project
Northstar 8600	Tier 2 HFTD, provisions were made for this feeder as part of a relay upgrade project
Stateline 2200	Tier 2 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Stateline 2300	Tier 2 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Stateline 3501	Tier 2 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Meyers 3200	Tier 3 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Meyers 3300	Tier 3 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Meyers 3400	Tier 3 HFTD, provisions to be made for this feeder as part of a relay upgrade project
Meyers 3500	Tier 3 HFTD, provisions to be made for this feeder as part of a relay upgrade project

Fire Prevention Plan for Overhead Electric Facilities

REVISION HISTORY

The Liberty Utilities (CalPeco Electric), LLC (U 933-E) (Liberty CalPeco) Wildfire Prevention Department (Department) updated the Fire Prevention Plan (FPP or Plan) October 2019.[1] The Department will oversee the execution of required training for Liberty CalPeco personnel and contractors prior to the 2020 fire season.

PURPOSE

In 2017 and 2018, California experienced some of the most destructive wildfires in its history. The combination of drought, extreme winds and build-up of dry vegetation contributed to increased wildland fires. The wildfire season and associated forest fire risk factors have increased due to warmer spring and summer temperatures, reduced snowpack, and earlier spring snowmelt, leading to higher levels of dry fuels. Liberty CalPeco recognizes that the operations, maintenance and construction on the electric grid, and characteristics of associated equipment may present an ignition risk. Our goal is to develop reasonable and actionable plans to mitigate ignition risks, be prepared to suppress small fires, keep our employees safe while working in wildland areas and provide general fire safety precautions for field operations.

Liberty CalPeco developed this Plan in compliance with Ordering Paragraph 3 of California Public Utilities Commission (CPUC) Decision (D.) 12-01-032 and the revisions of D.17-12-024 pursuant to General Order (GO) 166 Standard 11 and information specified in GO 166 Standard 1, Part E as applicable to Liberty CalPeco's service territory (See Attachment 1). The FPP identifies operational protocols for Liberty CalPeco overhead facilities that lie within Tiers 2 and 3 of the High Fire-Threat District (HFTD) Map adopted by the CPUC on January 19, 2018. The Plan delineates operational pathways in working with electrical assets and overhead facilities that may pose a fire ignition threat under notification of rated fire watch conditions.

The FPP establishes procedures to be followed by the utility for facilities in Tier 2 or 3 of the HFTD or during the Fire Precautionary Period, which is considered to be sustained by the Department of Forestry and Fire Protection (CAL FIRE). Due to the high alpine climate of Liberty CalPeco's electric service territory, late fall and winter months present a seasonal swing of reduced risk due to snow conditions as compared to spring and summer months. Liberty CalPeco personnel operate with consideration of stringent fire safety requirements for high risk areas and conditions. Currently, a combination of Red Flag Warning (RFW) notifications, interpretations from the Reax predictive tool, and information gathered from Liberty CalPeco weather stations will help determine avenues and countermeasures to mitigate the threat of utility-caused fire ignitions during

[1] Navigant Consulting, Inc., a Guidehouse company (Navigant) assisted Liberty CalPeco in preparing this report for filing, based on the information the utility provided. The information presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared with Liberty CalPeco's overall decision-making. Navigant is not responsible for the reader's use of, or reliance upon, the Plan, or any decisions based on the Plan. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of this Plan are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the Plan, or the data, information, recommendations, and opinions contained in the report.

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periods of "Normal," "Elevated," and "Extreme" fire ratings. (*See* Fire Potential Index.) These procedures include practices for field operations and maintenance (O&M) activities in applicable areas and conditions.

The FPP establishes procedures and routine operational practices that:

1) Provide employees and contractors an understanding of the enacted processes and procedures that will improve reliable and safe operation of overhead electric facilities in high-risk areas or under fire weather conditions;
2) Establish Liberty CalPeco standards of equipment and vehicle use and operations during fire risk seasons and work near potential ignition sources;
3) Determine work restrictions during cautionary periods issued by internal meteorological and predictive tools and RFWs, as designated by the National Weather Service (NWS);
4) Outline the operational and communication procedures when working adjacent to or immediately after a fire ignition within the service territory;
5) Present the future use of the Fire Potential Index (FPI) as it relates to additional risk measurements that may be warranted and discerning the appropriate operational procedures for field activities; and
6) Introduce general fire safety considerations and precautions for performing work in high risk areas and/or during high risk weather periods.

DEFINITIONS

Activity: Specific operation of a piece of equipment, such as a chainsaw or tractor.

Baseline Fire Tools: Items available to field personnel to prevent and quickly suppress small ignitions for a designated worksite. These tools include but are not limited to:

Fire Box: Container available at the worksite containing fire suppression equipment and additional as deemed appropriate for the performed activity.
Indian Can: Canister containing fire suppressant material.
Shovel: Rounded tip with a length of approximately 48 inches.
Wildland McLeod tool: Fire hand tool used for raking and scraping.

Fire Potential Index: Ranking system that aligns predetermined operational practices with elevated risks restrictions due to the threat of potential ignition. Liberty CalPeco has identified three tiers of risk: normal fire risk, elevated fire risk, and extreme fire risk. The Fire Potential Index tool is currently being developed and will be updated in the next revision cycle of the FPP.

Fire Safety Leader: Designated field supervisor or crew member who has a dedicated role for fire safety requirement oversight during extreme fire risk working conditions.

Fire Safety Monitor: Designated field supervisor or crew member responsible for fire safety requirement oversight during Elevated Fire Risk working conditions.

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Manager in Charge: Non-represented employee designated by Liberty CalPeco to implement this policy during normal hours of operation.

Mechanical Operations: Any activity that requires the use of motorized power equipment.

On-call Supervisor: Employee designated by Liberty CalPeco to implement this policy in the absence of the Manager in Charge.

Operating Area: Property on which active operations, including transportation, are to be conducted. The area within 100 feet of the traveled surface of roads is generally considered part of the Operating Area, whether or not it is included in the rights-of-way or easements.

Red Flag Warning (RFW): The National Weather Service will typically declare a RFW within a zone when wind gusts exceed 30 miles per hour (mph), and the relative humidity is less than 20 percent for more than three hours. Other factors considered include timber conditions and forecasts for weather elements, such as dry lightning. Typically, the RFW is issued for a specified period.

ASSESSMENT METHODOLOGY

Liberty CalPeco pursued a structured approach to determining whether an FPP was required for Liberty CalPeco facilities under the Rulemaking (R.) 08-11-005, as described in the final decision. The approach utilized the information collected to identify specific facilities that meet the Plan criteria for inclusion in the FPP. This Plan is sufficient for most routine work activities. In the event a project-specific fire plan is deemed necessary, the Project Manager, or Project Manager's designee, will coordinate with field crew to frame additional criteria. The assessment methodology for the FPP is described below.

1) Liberty/Reax Fire Forecast: Reax is a predictive tool that captures three main methods of fire weather condition measurement: Energy Release Component (ERC), wind gusts, and the Fosberg Fire Weather Index (FFWI). Liberty CalPeco will issue proactive patrols and inspection procedures during applicable work if a triggered scenario is revealed through the predictive software tool. When the Reax tool predicts potential fire weather conditions, the Manager in Charge or designee will refer to the tiered risk categories in this Plan and initiate operational protocols based on the determined rating.

2) Red Flag Warnings: Fire Weather Zone Boundaries were compared to Liberty CalPeco's service territory, and it was identified that the territory spans portions of three different zones. Liberty CalPeco will monitor the applicable zones 271, Zone 272, and Zone 273. Historical data for the past 10 years' RFWs within each of these zones was collected for each occurrence, so that wind data could be collected and evaluated for each identified RFW.[2]

[2] Alerts may be monitored using the links below and Liberty CalPeco will make best efforts to subscribe to automatic alert notifications: http://inws.wrh.noaa.gov/page/faq and https://inws.wrh.noaa.gov/alerts.

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During Red Flag Events, Liberty CalPeco will monitor wind gusts at the peak elevation located at Bliss State Park using the link below or other available data.[3]

Liberty CalPeco has identified 46 Public Safety Power Shut-off (PSPS) zones that are based on isolation points within certain circuits or areas. If Reax forecasts for these zones that the ERC, wind, and FFWI will come within 80%, 90%, or 100% of the thresholds for de-energization, Liberty CalPeco will enact a PSPS upon or just before reaching 100%. During a PSPS event, Liberty CalPeco will suspend noncritical operational work to focus efforts on current conditions and proactive patrols after de-energizing and when restoring power. Liberty CalPeco adheres to the guidelines provided in R. 18-12-005, an open proceeding that prescribes utilities' PSPS processes, among other issues. Liberty CalPeco will provide updated protocols for internal PSPS practices in the 2020 version of its Wildfire Mitigation Plan.

3) Liberty CalPeco Design Standards: An engineer examined the Liberty CalPeco facilities design standards to evaluate the minimum standard for wind loading design. The design standard utilizes the criteria specified in GO 95 Section IV. However, this is a minimum design standard, and facilities are often oversized for a variety of reasons. Liberty CalPeco will review applicable wind loading design standards, monitor regulatory changes to standard design requirements, and update standards for minimum wind loading design criteria as deemed prudent.

4) Wind Data: NWS Remote Automatic Weather Stations were mapped for the area within 25 miles of the Liberty CalPeco service territory. Wind gust data from the NWS site is monitored for each RFQ. The station automatically records the maximum instantaneous gust over the past hour, while wind speed averages are recorded by the stations over 10-minute periods. Because it is not possible to discern if gusts lasted three seconds or more, it is assumed that all maximum gusts meet the three-second criteria to guard against underestimating a fire threat.

   In addition to fire weather and fuels data from the NWS and United States Department of Agriculture National Fire Danger Rating System, Liberty CalPeco tracks instantaneous meteorological conditions received from the 10 weather stations in the service territory. Liberty CalPeco also proposes to install 20 additional weather stations during 2020. The server data capturing meteorological conditions will serve as a principle variable underlying the development of the FPI. Until the FPI is developed and adopted by Liberty CalPeco, operational designations for fire ratings will be derived from the meteorological data expressed above.

5) Mapping: Tiers 2 and 3 of the HFTD are overlaid on the Liberty CalPeco service territory map. All Liberty CalPeco facilities are mapped without underground facilities, which are not subject to the Plan requirements. Operational work within Tier 2 and 3 of the HFTD or in response to issued RFWs are subject to more stringent fire safety requirements, as described in this Plan. The

[3] Bliss State Park: https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?caCDLB

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attached map complies with GO 95 Rule 21.2-D.

6) Fire Potential Index (FPI): The FPI is used as means to develop guidelines for utility and contractor operations and maintenance crews to follow under Liberty CalPeco's defined categories of wildfire risk. The Wildfire Prevention Department is responsible for determining and communicating the FPI on a daily basis. The current status of the FPI will be posted on the Liberty CalPeco intranet and will communicate the status to the Manager in Charge. The FPI rating framework is currently in development.

FIRE POTENTIAL INDEX

Liberty CalPeco is currently developing a FPI methodology that comprehensively assesses the fire risk utilizing several data points to influence operation and maintenance decisions related field work. The FPI forecasting application is anticipated to capture data from situational awareness tools and seven-day projections and will then present a fire ranking that aligns with a "Normal," "Elevated," and "Extreme" fire potential. The FPI is scheduled for completion in 2020 and will be included in the FPP for the next filing cycle.

The three FPI Risk conditions are defined as follows:

Extreme Fire Risk: As determined by the Wildfire Prevention Department, Extreme Fire Risk is defined as periods of significant risk of wildfires and the associated ignition risks within Tier 2 or 3 of the HFTD. All O&M activities have stipulations, and significant fire mitigation activities are required. The Extreme Fire Risk status is indicated as "red."

Elevated Fire Risk: As determined by the Wildfire Prevention Department, High Fire Risk is defined as periods of increasing risk of wildfires and associated ignition risks within Tier 2 or 3 of the HFTD. Many O&M activities have stipulations and additional fire mitigation activities are required. The Elevated Fire Risk status is indicated as "yellow."

Normal Fire Risk: As determined by the Wildfire Prevention Department, Normal Fire Risk is defined as periods where the potential for wildfires and associated ignition risks are not elevated but still exist within Tier 2 or 3 of the HFTD. Some O&M activities may have stipulations and additional fire mitigation activities may be required. The Normal Fire Risk status is the default operational state and the FPI is indicated as "green."

PROCEDURE

General Safety Instructions for Utility and Contractor Crews

- **General Fire Awareness:** During the execution of work activities and use of company equipment and

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vehicles, all operating personnel must be actively aware and consider actions that may reduce fire risks and personal exposure.

- Activities such as idling a vehicle near brush, grassland, or at-risk vegetation is prohibited, and drivers should always perform a perimeter check after exiting the vehicle and inspect underneath for potential fuel risk.
- The Fire Safety Monitor/Leader should remain alert of crew vehicles traveling over low vegetation or brush.
- Smoking is only permitted in site-specific designated areas or within a 10' clearance of any vegetation or grass.
- When possible during days with high temperatures and low humidity, wet down adjacent vegetation when performing work with equipment that may spark or has an exposed exhaust system.
- Consider the need to disable reclosers on potentially impacted equipment or de-energize circuits within the operating area to prevent potential sparks.

- **Safety Briefings:** When assigned to work within wildland areas, the tailboard safety briefing shall include review of the following:
  - 1. The current daily FPI Rating;
  - 2. Job site-specific fire risks;
  - 3. Elimination of tasks that pose an elevated fire risk;
  - 4. Actions to reduce personal exposure; and
  - 5. Any other possible fire risk mitigation actions.
- **Fire Safety Tools Responsibility:** The crew leader must check the availability and condition of the baseline fire tools during the daily truck safety inspection and make fire suppression equipment readily accessible near operating areas.
- **Tailboard Fire Briefings**: If, during the execution of work, the job site-specific fire risks are elevated, the crew leader shall stop work and hold a tailboard meeting to discuss revised actions. If warranted by elevated jobsite risk conditions, the crew leader may elect to declare the next highest level of Fire Potential Index Rating for the job site.
- **Fire Reporting and Actions:**
  - All fires must be reported to dispatch and follow appropriate incident reporting requirements to the CPUC Safety Enforcement Division (SED).
  - If the work crew cannot quickly extinguish a minor fire or rapidly accelerating fire conditions are encountered, the crew leader shall immediately report the situation to dispatch and relocate the crew, equipment, and materials to a safe location.

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Safety Instructions for Working Under Extreme Risk Index Conditions

When working under Extreme Risk Index conditions, the crew leader shall designate a crew member as a Fire Safety Leader. The Fire Safety Leader will not be assigned any job site tasks and will be assigned the specific duties of fire risk awareness and prevention, detecting and extinguishing minor fires, and placing the baseline fire tools in a location that is easily accessible by the work crew. Liberty CalPeco will utilize alerts from Reax to determine if a proactive patrol of electrical equipment and vegetation clearances is warranted. Liberty CalPeco will activate proactive fire patrols if it receives a 90% or 100% alert from Reax.

Operating Procedures – Extreme Risk Index Conditions

As a general rule, all work should be suspended during Extreme Risk Index conditions		
Activity	**Description**	**Stipulations**
Travel with Company Trucks and Vehicles	**Paved roads or bare improved roads**	**Allowed**
	Off-road and unimproved roads	**Permitted for performance of only those activities that reduce wildfire risks and/or restore customer outages**
Facility Inspections and Patrols	**Driving and climbing inspections of poles, equipment, vegetation and security**	**Assign a Fire Safety Leader**
Overhead Line Corrective Maintenance and Repairs	**Replacement and/or installation of splices, fuses, lightning arrestors, and insulators**	**Perform only those activities that reduce wildfire risks and/or restore customer outages; assign a Fire Safety Leader**
Pole Setting and Removal	**Paved roads or bare improved roads**	**Not allowed**
	Off-road and unimproved roads	**Not allowed**
Replacing and Stringing Conductor	**Paved roads or bare improved roads**	**Not allowed**
	Off-road and unimproved roads	**Not allowed**
Vegetation Management Near Poles and Towers	**Use of powered hand tools (chainsaws and weed eaters) to clear low-lying vegetation and noxious and invasive plant control**	**Not allowed**
T&D Overhead Line Vegetation Management	**Minor maintenance tree trimming and associated branch removals using buckets and/or hand tools to maintain company clearance standards**	**Perform only those activities that reduce wildfire risks and/or restore Customer outages; assign a Fire Safety Leader**
	Cycle trimming using buckets and/or hand tools to maintain company clearance standards	**Not allowed**
Reciprocating Construction Equipment	**Truck mounted compressors and/or generators**	**Assign a Fire Safety Leader**
	Non-truck mounted compressors and/or generators	**Not allowed**
	Welders and grinders	**Not allowed**
Blasting	**Blasting of rock with explosives**	**Not allowed**

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Safety Instructions for Working Under Elevated Risk Index Conditions

When working under Elevated Risk Index conditions, the crew leader shall designate a crew member as a Fire Safety Monitor. In addition to the assigned work duties at the job site, the Fire Safety Monitor is responsible for fire risk awareness and prevention, detecting and extinguishing minor fires, and placing the baseline fire tools in a location that is easily accessible by the work crew.

Operating Procedures - Elevated Risk Index Conditions

As a general rule, work may be limited during Elevated Risk Index conditions		
Activity	**Description**	**Stipulations**
Travel with Company Trucks and Vehicles	**Paved roads or bare improved roads**	**Allowed**
	Off-road and unimproved roads	**Permitted for performance of only those activities allowed under High Risk Conditions**
Facility Inspections and Patrols	**Driving and climbing inspections of poles, equipment, vegetation and security**	**Assign a Fire Safety Monitor**
Overhead Line Corrective Maintenance and Repairs	**Replacement and/or installation of splices, fuses, lightning arrestors and insulators**	**Perform only those activities which reduce wildfire risks and/or restore Customer outages; assign a Fire Safety Monitor**
Pole Setting and Removal	**Paved roads or bare improved roads**	**Assign a Fire Safety Monitor**
	Off-road and unimproved roads	**Not allowed**
Replacing and Stringing Conductor	**Paved roads or bare improved roads**	**Assign a Fire Safety Monitor**
	Off-road and unimproved roads	**Not allowed**
Vegetation Management Near Poles and Towers	**Use of powered hand tools (chainsaws and weed eaters) to clear low-lying vegetation and noxious and invasive plant control**	**Not allowed**
T&D Overhead Line Vegetation Management	**Minor maintenance tree trimming using buckets and/or hand tools to maintain company clearance standards**	**Perform only those activities which reduce wildfire risks and/or restore Customer outages; assign a Fire Safety Monitor**
	Cycle trimming and associated tree/branch removals using buckets and/or hand tools to maintain company clearance standards	**Not allowed**
Reciprocating Construction Equip.	**Truck-mounted compressors and/or generators**	**Assign a Fire Safety Monitor**
	Non-truck-mounted compressors and/or generators	**Not allowed**
	Welders and grinders	**Not allowed**
Blasting	**Blasting of rock with explosives**	**Not allowed**

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Safety Instructions for Working Under Normal Risk Index Conditions

When working under Normal Risk Fire Index conditions, workers should still maintain high awareness of the fire risk and safety hazards within the operating area.

Operating Procedures - Normal Risk Index Rating

As a general rule, work can proceed during Normal Risk Index conditions following General Safety Instructions		
Activity	**Description**	**Stipulations**
Travel with Company Trucks and Vehicles	**Paved roads or bare improved roads**	**No restrictions**
	Off-road and unimproved roads	**No restrictions**
Facility Inspections and Patrols	**Driving and climbing inspections of poles, equipment, vegetation and security**	**No restrictions**
Overhead Line Corrective Maintenance and Repairs	**Replacement and/or installation of splices, fuses, lightning arrestors and insulators**	**No restrictions**
Pole Setting and Removal	**Paved roads or bare improved roads**	**No restrictions**
	Off-road and unimproved roads	**No restrictions**
Replacing and Stringing Conductor	**Paved roads or bare improved roads**	**No restrictions**
	Off-road and unimproved roads	**No restrictions**
Vegetation Management Near Poles and Towers	**Use of powered hand tools (chainsaws and weed eaters) to clear low-lying vegetation and noxious and invasive plant control**	**Follow safety instructions for working under High Risk Index conditions**
T&D Overhead Line Vegetation Management	**Minor maintenance tree trimming using buckets and/or hand tools to maintain company clearance standards**	**No restrictions**
	Cycle trimming and associated tree/branch removals using buckets and/or hand tools to maintain company clearance standards	**No restrictions**
Reciprocating Construction Equipment	**Truck mounted compressors and/or generators**	**No restrictions**
	Non-truck mounted compressors and/or generators	**Assign a Fire Safety Monitor**
	Welders and grinders	**Assign a Fire Safety Monitor**
Blasting	**Blasting of rock with explosives**	**Truck must have permit with restrictions; assign a Fire Safety Monitor**

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ACTIVE FIRE SAFETY PRECAUTIONS

Liberty CalPeco values safety as a core competency of field and hot work performed in high risk areas. For all contractors and utility personnel, these precautions exist for critical work performed within Tiers 2 and 3 of the HTFD under threat of wildland fire. If a small fire ignites and rapid suppression is not achieved by field personnel, field crew are directed to stop work, retreat to a safe area adjacent to the work site, immediately call upon dispatch services, and alert nearby fire and impacted agencies and entities.

All contractors and utility personnel working adjacent to active wildland fires should consider the following:

- Use Personal Protective Equipment (P.P.E.) when working within or adjacent to and uncontrolled fire perimeter if required at the determination of the Fire Safety Leader or designee.
- Maintain communication lines through operational protocols when a fire ignites,. This includes correspondence made with office and dispatch centers, local law and fire agencies, customers, and impacted jurisdictions, if any.[4] The Incident Commander (IC), once designated, should coordinate and effectuate these activities.
- Take increased precaution when driving near flames or in smoky conditions. Road obstructions may pose a risk, and drivers and crew should have a general awareness of nearby access and evacuation routes.
- Determine if de-energizing any potentially impacted electrical assets or those that pose a risk to spreading the active wildland fire is necessary. Field crew should adhere to Liberty CalPeco PSPS procedures where applicable.
- Designate an Emergency Operations Center and adhere to the Incident Command Structure led by an IC to oversee response, fire exhaustion, and recovery efforts.
- Perform any routine investigations after fire suppression. Report incident data to SED and execute necessary reporting procedures as part of Liberty CalPeco business practices.

ATTACHMENTS

1) Attachment 1- Liberty CalPeco service territory map
2) Attachment 2- Liberty CalPeco service territory overlaid with the HFTD

[4] Notifications to customers during and post-fire suppression should occur in English and Spanish.

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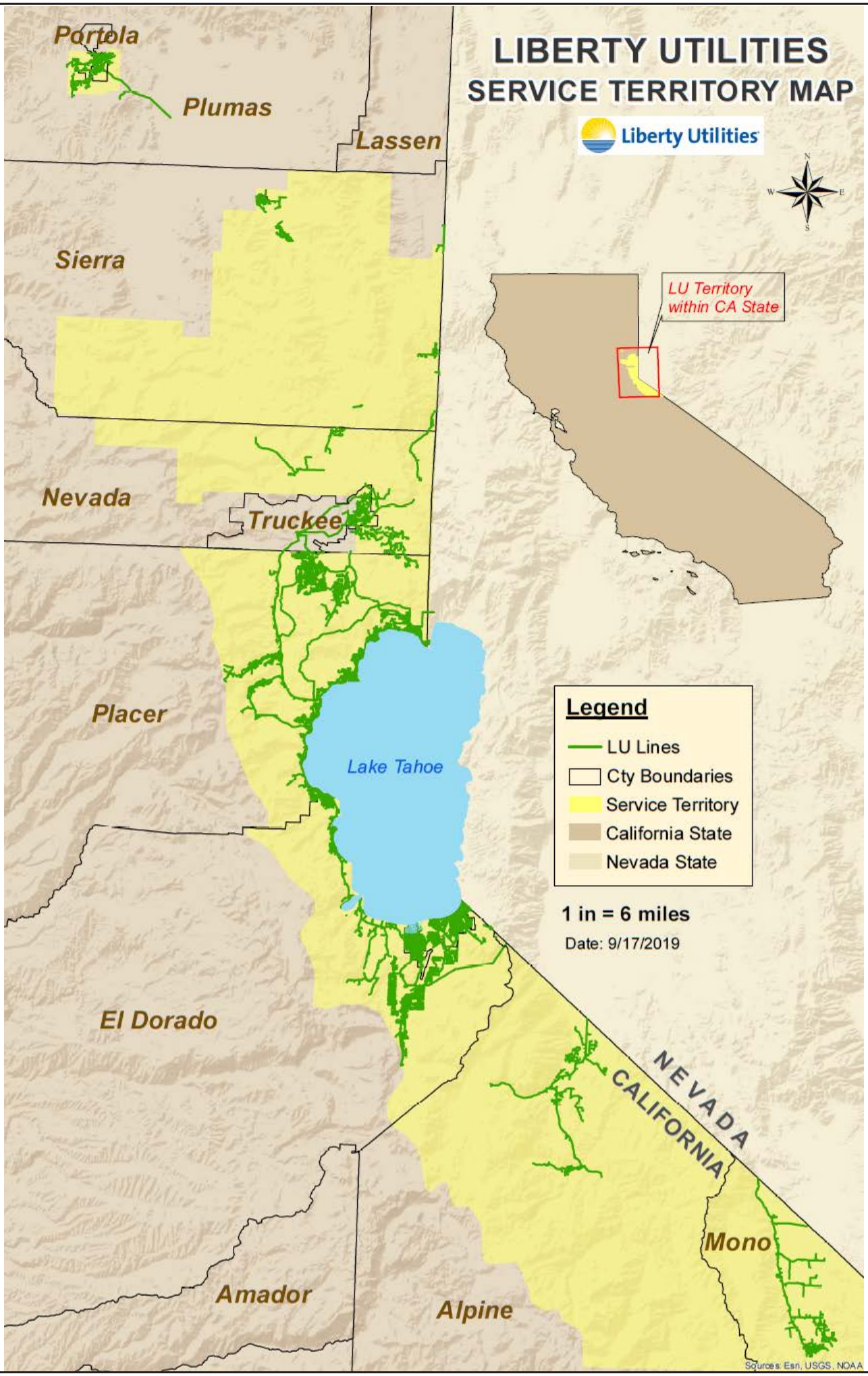
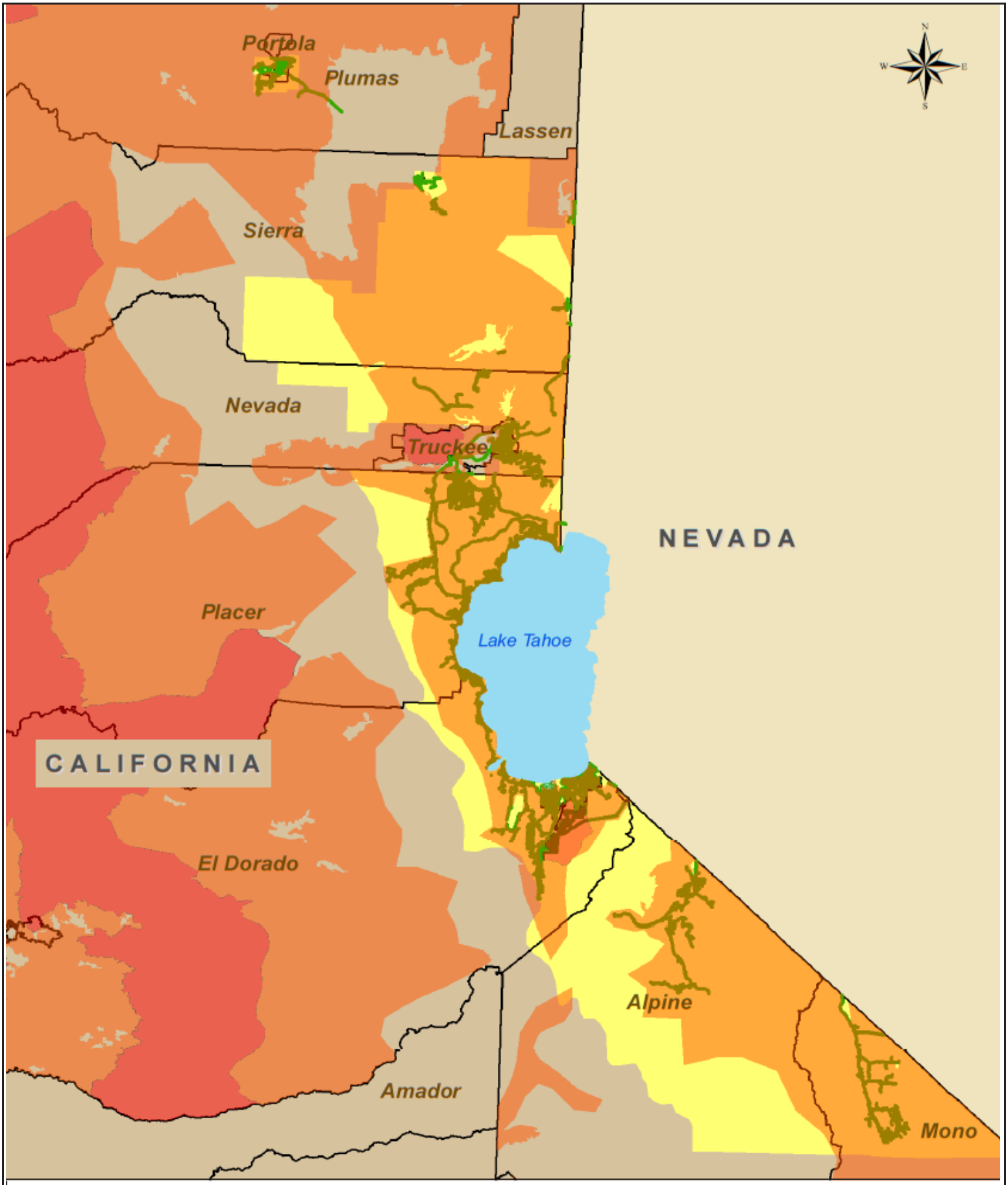

LIBERTY UTILITIES
SERVICE TERRITORY MAP
Liberty Utilities
Portola
Plumas
Lassen
Sierra
Nevada
Truckee
Placer
Lake Tahoe
El Dorado
Amador
Alpine
Mono
NEVADA
CALIFORNIA
LU Territory within CA State
Legend
LU Lines
Cty Boundaries
Service Territory
California State
Nevada State
1 in = 6 miles
Date: 9/17/2019
Sources: Esri, USGS, NOAA



Legend

- LU Lines
- California
- Nevada
- Service Territory
- Tier 2 Fire Threat
- Tier 3 Fire Threat

HIGH FIRE THREAT WITHIN LIBERTY UTILITIES SERVICE TERRITORY

Date: 6/27/2019

1 in = 11 miles

Liberty Utilities
701 National Ave
Tahoe Vista, CA 96148

LU-43900-I-732

Common Name	Regrowth Rate	Frequency	Estimated Number
Alder, thinleaf	Fast	0.5%	163
Apple	Medium	0.5%	163
Sequoia	Slow	0.1%	33
Ash, green	Fast	0.1%	33
Aspen, quaking	Fast	8.7%	2,836
Birch, paper (white)	Fast	0.2%	65
Cedar, incense	Slow	1.7%	554
Cherry, ornamental	Medium	0.4%	130
Crabapple	Medium	0.2%	65
Elm, American	Fast	0.1%	33
Elm, Siberian	Fast	1.3%	424
Fir, red	Slow	1.5%	489
Fir, white	Slow	22.6%	7,368
Juniper	Slow	0.4%	130
Locust, black	Fast	0.1%	33
Maple, silver	Fast	0.5%	163
Pine, Jeffrey	Medium	49.0%	15,974
Pine, lodgepole	Medium	9.0%	2,934
Pine, ponderosa	Medium	0.4%	130
Pine, sugar	Medium	0.3%	98
Poplar, Lombardy	Fast	0.1%	33
Poplar, white	Fast	0.2%	65
Spruce, blue (Colorado)	Slow	1.1%	359
Willow	Fast	1.0%	326

LU-43900-I-734

1. WATER QUALITY

Power line vegetation management activities shall adhere to all requirements and laws as set forth by the California Environmental Protection Agency, Lahontan Regional Water Quality Control Board (LRWQCB), Tahoe Regional Planning Agency (TRPA), and the California Department of Fish and Wildlife (CDFW). Vegetation management activities necessary for forest fire prevention under PRC 4293 and 4292 are, in most cases, categorically exempt from notification, application, and monitoring by these agencies, however, there are numerous water bodies located within Liberty Utilities' service territory. Tree and vegetation removal operations necessary for compliance with applicable laws located within Water Body Buffer Zones as defined by the LRWQCB shall be mitigated appropriately to ensure compliance with water quality ordinances.

Liberty Utilities will use the following Best Management Practices (BMP's) when performing vegetation management within Water Body Buffer Zones:

- Avoid removal of any vegetation within 15 feet of the high water mark of perennial streams
- Avoid the use of mechanical equipment within designated Water Body Buffer Zones
- Directional felling of trees within the Water Body Buffer Zone away from the watercourse or lake
- Avoid the use of herbicides for controlling vegetation growth within designated Water body Buffer Zones.
- Removal all wood, debris, slash, and chips that are produced as a result of vegetation management activities which occur within 15 feet of the high water mark of all perennial, intermittent, and ephemeral streams.
- Retain all stumps and low growing vegetation
- Use of only pre-existing roads as access to facilities and trees.

Should trees require removals that exist in SEZ areas, Liberty Utilities will document the trees and locations and submit the information to TRPA for review.

2. TERRESTRIAL WILDLIFE

Vegetation Management activities shall be conducted as to comply with the United States Migratory Bird Treaty Act of 1918 the Endangered Species Act. Limited Operating Periods (LOPs) may be applied when working near or within known nesting or denning areas. These include, but are not limited to the following:

- Northern Goshawk - February 15 through September 15
- Bald Eagle - January 1 through August 31
- California Spotted Owl - March 1 through August 15
- Great Gray Owl – March 1 through August 15
- Willow Flycatcher – June 1 through August 15
- American Marten – May 1 through July 31

Liberty Utilities' employees and vegetation management contractors are required to report the following conditions observed in the field prior to proceeding with vegetation management operations to the appropriate Liberty Utilities department:

- Evidence of nests greater than 12 inches diameter occurring on power company equipment (poles, cross arms, transformers)
- Evidence of nests occurring on or in trees requiring removal for compliance with PRC 4293 or GO 95, Rule 35

- Evidence of any and all dead or injured birds and their location if found in the vicinity of the facilities

When hazard trees are identified for removal in areas containing suitable habitat the above listed protected species, trees may be topped if they are safe to climb. Bole wood may be left in place in order to increase the number of downed logs, if needed. If trees are selected for topping to increase the number of habitat snags, they shall be larger than 15" diameter.

3. SENSITIVE AND RARE PLANTS

In order to reduce potential damage to sensitive plant species, the following actions should be taken:

- Sensitive plant occurrences and sensitive habitat are most often protected by identification and avoidance. Known occurrences should be flagged with appropriate buffers so that direct and indirect impacts to those areas can be avoided.
- When Sensitive or Watch list plant species occurs within the road surface and cannot be avoided, maintenance activities may need to be planned when roads are dry and plants have completed the flowering stage.
- Assume sensitive plants are present in fens and avoid activities that may disturb or accelerate drainage of fens such as those.
- Establishment of motor vehicle access routes off of authorized roads will be avoided and ground disturbance in areas without road access will be minimized.

4. NON-NATIVE INVASIVE PLANT MANAGEMENT

The following measures will be standard operating procedures to be adopted by Liberty Utilities and its subcontractors upon entering the project area:

1. Provide prevention training to staff and contractors prior to starting work.
2. Scout for invasive plants and evaluate risks before activities begin.
3. Schedule activities to minimize potential for introduction and spread of invasive plants.
4. Designate specific areas for cleaning tools, vehicles, equipment, clothing and gear.
5. Designate waste disposal areas for invasive plant materials, and contain invasive plant material during transport.
6. Plan travel routes to avoid areas infested with invasive plants.
7. Clean tools, equipment, vehicles and animals before transporting materials and before entering and leaving worksites.
8. Clean clothing, footwear and gear before leaving infested areas.
9. Prepare worksites to limit the introduction and spread of invasive plants.
10. Minimize soil and vegetation disturbance.
11. After activities, monitor worksites for invasive plants.
12. Adopt official project or maintenance activity policy to prevent invasive plant spread.
13. Include invasive plant risk evaluation as a component of initial project planning and environmental analysis.
14. Integrate invasive plant prevention BMPs into design, construction, vegetation management and maintenance planning activities.
15. Integrate invasive plant prevention BMPs and monitoring methods into environmental awareness training for staff, contractors and volunteers.
16. Coordinate invasive plant prevention efforts with adjacent property owners, regional weed management groups, and local agencies.
17. In the initial stage of planning, conduct site assessment for invasive plant infestations and incorporate findings into a GIS database and project drawings or maps.
18. Develop monitoring plans to evaluate effectiveness of BMP implementation.

19. Use a weed-free source for project materials.
20. Prevent invasive plant contamination of project materials when stockpiling and during transport.
21. Schedule vegetation management activities to maximize the effectiveness of control efforts and minimize introduction and spread of invasive plants.
22. Retain existing desirable vegetation and canopy where possible.
23. Render invasive plant material nonviable when disposing of materials on-site.
24. Minimize soil disturbance and transport during project implementation.
25. Implement erosion control practices.
26. Manage existing topsoil and duff material.
27. Re-vegetate and/or mulch disturbed soils as soon as possible.
28. Identify prevention priorities with resource, facility, or corridor managers prior to starting work.
29. Document invasive plant findings and communicate to resource, facility or corridor managers.
30. Identify travel direction and cleaning locations prior to starting work.
31. Designate lay-down and staging areas outside of infested areas prior to starting work.
32. Carry portable cleaning tools that can be used without water.
33. Develop brush control policy along access roads to minimize the introduction and spread of invasive plants.
34. Minimize soil disturbance when maintaining access roads.
35. Maintain facility site to limit the introduction and spread of invasive plants.

5. HAZARDOUS SPILL CONTROL AND NOTIFICATION

Regardless of the perceived or potential environmental impact that an oil spill may present, electrical hazards and safety issues must take precedence over the spill response. The safety of Liberty Utilities' employees and contractors, local emergency responders, spill responders, and the Public is of primary importance. The routine response for Liberty Utilities Employees and contractors is to:

1) Address all safety and electrical hazards present and secure the location;
2) As the situation permits, contain the spill-create berms or dikes to prevent further migration of oil into:
    a) Drop inlets, waterways, wetlands, creeks, or rivers;
    b) Uncontaminated soils; or
    c) Reduce the spread of the oil over man-made surfaces;
3) Notify Environmental Services Contractor by calling: H20 (775)351-2237. Notification of the release should be made no later than 2 hours after the discovery of the spill. The following information regarding the spill should be provided:
    a) Name of the person reporting the spill;
    b) Phone number where the individual reporting the spill can be reached;
    c) Location or address of the spill;
    d) Time of spill discovery;
    e) Equipment information: Company number, serial number, size, quantity of oil, is the equipment labeled Non-PCB? (Not containing Polychlorinated biphenyls), etc.;
    f) A description of the area contaminated (dirt, ground covering, lawn, asphalt, sidewalks, etc.)
    g) Report any potential impacts to surface water.

The routine response for the Environmental Services Contracted responder is to:

1) Review and verify information obtained by the individual reporting the spill;
2) Upon arrival to the release site:
    a) Coordinate the spill response.
    b) Assess the situation and determine the best management practices (BMPs) to be used to contain, control, and clean the site.

c) Clean up and remediate the spill

3) Notification: Depending upon the size, PCB concentration, and location of the release the following agencies may be contacted:

- The National Response Center
- County Environmental Health Departments
- State and/or Federal Forest Management Agencies

Western Environmental Consultants

Liberty Utilities (CalPeco Electric) LLC Distribution Vegetation Management Program Assessment and Workload Projections

Prepared for
Liberty Utilities (CalPeco Electric) LLC
Tahoe Vista, CA

May 11, 2018

Prepared by
Western Environmental Consultants, LLC
Auburn, CA

Liberty Utilities (CalPeco Electric)

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LIBERTY UTILITIES

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Liberty Utilities

1.0 Executive Summary

1.1 Introduction

Western Environmental Consultants, LLC (WECI) has completed a comprehensive study to evaluate the Liberty Utilities (CalPeco Electric) LLC (hereby referred to as Liberty Utilities) distribution and sub-transmission vegetation management (VM) program. The study includes an examination of the vegetation management practices, policies, operating procedures and current work techniques on the Liberty Utilities electrical system.

The Liberty Utilities electric system includes approximately 623 pole miles of primary overhead distribution and 21 miles of sub-transmission (24.9kV and 60kV) serving approximately 49,000 electric customers over a service territory of 1,482 square miles. WECI performed a random sample survey of the distribution and sub-transmission vegetation workload to document the amount of vegetation present on the Liberty Utilities system. WECI examined Liberty Utilities' tree-caused interruption data, fire risk, and local tree species with estimated regrowth rates to formulate an appropriate distribution and sub-transmission maintenance strategy option and recommendations.

This document presents the results of the WECI study. It includes methodologies, projections, analysis, and recommendations designed to assist Liberty Utilities in optimizing the management of vegetation for the distribution and sub-transmission systems.

This section contains a brief synopsis of the findings and recommendations resulting from this study. A detailed discussion of these vegetation management program recommendations can be found in Section 4.

1.2 Key Findings

Based on this evaluation, WECI's experience in analyzing numerous other utility programs, and by performing a comparative analysis with other utilities and benchmark groups, it is evident that Liberty Utilities has taken steps to establish some important elements of a sound vegetation management program. Several observations brought us to this conclusion, including but not limited to: a centralized vegetation management program; standard operating procedures and practices; technically correct pruning practices; and low tree-wire contact.

Despite having many aspects of a sound program, examination of Liberty Utilities' data in comparison to industry benchmarks reveals several opportunities for improvement to maximize shareholder value. The key findings leading to the recommendations for improvements as listed in **Section 1.4** are as follows:

- Man-hours and cost per tree are higher than the averages from the benchmarked group (due to higher than average local labor rates).
- In an effort to meet the current cyclical goal of three-years, funding since 2016 has increased to $2.523M per CPUC allowable limits; however, annual miles completed suggest that current funding is inadequate (approximately 7.3-year cycle).

- Current staffing levels at the time of this study are inadequate to drive a best-in-class program.
- Performance targets do not currently exist and are needed to measure contractor production metrics and program goal performance.
- High tree-caused customers interrupted (CI) and customer minutes interrupted (CMI)
- Outage reporting lacks sufficient cause codes for vegetation, preventing detailed analysis of tree-caused interruptions and development of appropriate preventative strategies.
- Long-range circuit maintenance plans do not currently exist. These plans are necessary to drive budget requirements instead of budgets driving program targets.

1.3 Best Management Practice Gap Analysis

Best management practices for vegetation management include those practices that are designed to improve cost, efficiency, effectiveness, and work quality. Best management practices are the foundation for top-quartile programs. **Table 1-1** presents a gap analysis of industry best management practices for the Liberty Utilities vegetation management program.

Table 1-1. Distribution and Sub-Transmission Best Management Practice Gap Analysis.

DISTRIBUTION & SUB-TRANSMISSION		
Best Management Practice	**Current Liberty Utilities Program**	**Gaps/Clarification**
COST		
Consistent and levelized funding. A consistent plan needs consistent funding. Budget changes causes workforce disruptions that increase future costs.	Budgeted expenditures have been consistent at $2.523 million since 2016.	Levelize expenditure and resource requirements by providing budget requests that reflect workload requirements to meet three-year annual cycle targets.
Workload and cycles drive budget requirements. Bottom up budgets maximize resources and production and ensure annual cycle targets can be met.	Liberty Utilities historically has lacked the appropriate workload data to estimate future budget requirements.	Funding of vegetation maintenance should be directly tied to estimated resource requirements and workload to meet cycle mileage targets and other performance metrics. Currently limited by CPUC authorized spending limits.

DISTRIBUTION & SUB-TRANSMISSION		
Best Management Practice	**Current Liberty Utilities Program**	**Gaps/Clarification**
Stump treatment of all removed deciduous trees (where applicable). The treatment of stumps with approved herbicides prevents re-sprouting and reduces future maintenance costs.	Requires contractors to treat the exposed stumps of removed deciduous trees and a anti-fungal treatment of removed conifers.	Conifers are routinely treated; however, deciduous trees and brush are not currently treated with an appropriate herbicide. Begin treating stumps of removed deciduous trees.
Appropriate contract strategy. Contracts that put the burden of production on the contractor can help drive production improvements and reduce costs.	Liberty Utilities utilizes both unit price and T&M contracts for vegetation maintenance appropriately. Mainly T&M in the winter months due to accessibility issues.	Continue with current unit price and T&M strategy and work toward adding performance metrics and incentives for production improvement to drive down costs.
Detailed budget level breakouts. Categorizing expenditures into appropriate work types is important to identify discretionary versus non-discretionary dollars. Budget dollars allocated to the completion of annual target miles should be considered non-discretionary.	Budgets are allocated to allow for work type analysis of annual spend. However, expenditure information in current reporting mechanism does not match system totals.	Need better accuracy of detailed cost reporting.
Reactive spend <= 10 of total budget. Reactive work (Tags) can cost two to five times more per unit than scheduled work. Many utilities strive to restrict reactive maintenance to 10 percent of the total reactive and planned maintenance budget	Reactive work (Tags) averaged 13 percent between 2012 and 2017, but have steadily increased since 2015. Reactive work accounted for 19 percent of the VM spend in 2017.	Much of the increase can be attributed to the deferred maintenance work (7.3-year cycle) namely, as a result of previous ownership (CalPeco). Proper annual funding should reduce this amount in future years.
EFFECTIVENESS		
Integrated Vegetation Management (IVM). Utilizing the principles of IVM to maximize herbicide use and reduce future costs.	There is limited opportunity for foliar spraying of brush on the Liberty Utilities system.	☑ Good

DISTRIBUTION & SUB-TRANSMISSION		
Best Management Practice	**Current Liberty Utilities Program**	**Gaps/Clarification**
Hazard tree program. Seventy percent of tree related outages occur from off-ROW trees on well-maintained systems. Additional reliability improvements often result from focusing on hazard tree mitigation, particularly from outside of the ROW.	Significant resources have been expended in controlling hazard tree issues. However, overall fire risk and areas impacted by bark beetles are still being identified.	Consider a geospatially robust remote sensing solution for assisting in the identification and mitigation of hazard trees in bark beetle kill areas and high fire risk areas to allow for better planning and budget estimation for mitigating potential outage and wildfire ignition threats.
Reliability Centered Maintenance (RCM). Utilizing the principles of RCM to prioritize circuit work and select trees to be removed and pruned based on available data and understanding of tree failure modes.	Circuit prioritization is based on: 1. Years since last worked 2. Perceived wildfire ignition risk 3. Circuit outage investigation reports 4. Circuit outage history 5. Budget thresholds	☑ Good
Tree outages per 100 miles of OH Line <= 10. Best managed utilities strive to keep tree-related outages at a minimum.	Reported an average of 3.2 tree-related outages per 100 miles for the years 2013 through 2017. However, this increased to 5.3 in 2017.	☑ Good
Tree SAIFI <= 0.1. A tree SAIFI of 0.1 or less is considered best practice.	Reported an average tree SAIFI of 0.25 for the years 2013 through 2017.	It is unlikely that Liberty Utilities will ever achieve this goal due to the high percentage (90 percent) of multi-phase line miles with high customer counts that drive CI. The average utility has approximately 33 percent multi-phase. Liberty Utilities would need to have no more than 8 tree interruptions for a total of 4,875 CI to meet goal, which is not reasonable.

DISTRIBUTION & SUB-TRANSMISSION		
Best Management Practice	**Current Liberty Utilities Program**	**Gaps/Clarification**
EFFICIENCY / COMPLIANCE		
Centralized VM program. A centralized organization drives standardized processes and procedures to ensure uniformity and compliance.	Vegetation management program is centralized.	☑ Good
Clearly documented specification for vegetation work. The success of any vegetation management program is dependent upon a clear scope and defined expectations.	The Liberty Utilities Vegetation Management Plan (Revised March 2015) appropriately addresses work scope and procedures.	Need to update references in Section 5.5 to include new ANSI Z133.1 2017 updates. Minimum approach distances have changed.
Appropriate clearance standards. Clearance standard must be adequate to support the desired cycle length based on species regrowth.	The Liberty Utilities Vegetation Management Plan appropriately addresses clearances in terms of minimum clearance.	☑ Good
Record keeping. Best managed utilities have clear report processes and procedure along with appropriate data retention. This includes customer information, costs, production, and reliability.	Liberty Utilities budget reports are standardized making cost tracking acceptable. Centralized databases for completed work are used. Liberty Utilities lacks a reporting mechanism to effectively monitor crew production.	☑ Good Work towards developing production metrics for the available data.
Annual and long-range maintenance planning. Best managed utilities possess annual and long-range management plans to ensure cycle target completion and appropriate funding and resource allocation to meet these goals.	Not to be confused with the Vegetation Management Plan currently in use which is the specifications and guidelines document. Liberty Utilities lacks a long-range, multi-year management plan for scheduling work and budgets.	With known workload and resource requirements gained through the workload study, develop long-range, multi-year circuit plans and budgets with ties to risk mitigation.

DISTRIBUTION & SUB-TRANSMISSION		
Best Management Practice	**Current Liberty Utilities Program**	**Gaps/Clarification**
Appropriate supervision to tree crew ratio (utility staffing). T&M contract in particular, require a higher level of crew oversight to ensure cost effective management through production monitoring.	Organization is currently under-staffed to drive production improvements.	Utility staffing should include a total of two System Arborists (add one additional) to assist the Program Manager of VM and drive production improvements, adherence to contract specifications, and ensure work quality.
Customer notification process. An appropriate customer notification process is required to ensure customer satisfaction in regard to scheduled maintenance activities.	Customers are notified on an as needed basis for excessive pruning or tree removal. Customers are notified by personal contact or by door hanger.	Many utilities find it beneficial to include a scripted, auto-generated outbound call (e.g., reverse 911), email, post-card or letter notification at least three to six weeks in advance of issuing routine circuit work as part of the customer notification process.
QUALITY		
ANSI A300 compliance. Technically correct pruning in compliance with ANSI A300 pruning standards helps to reduce future workload by minimizing sucker growth. Improper pruning produces weak branch attachments which can lead to increased outages.	Enforces compliance with ANSI A300 (Part 1) pruning standards.	☑ Good
Formal QA/QC process. Documenting the inspection of planned and completed work. It is important to identify work that does not meet standards early so that corrections can be made before more deficient work is completed.	Work is inspected informally and deficiencies are not documented but verbally communicated to the tree contract(s).	A formal inspection process should be developed to track deficient work, to hold contractor accountable for completing work in accordance with expectations and to measure overall contractor value.

1.4 Key Recommendations

In recognition of the best management practices identified above, WECI's assessment of the Liberty Utilities distribution and sub-transmission VM program offers the following key recommendations in order of importance:

1. Increase vegetation maintenance funding to $3.98M annually (based on calculated system workload) to move Liberty Utilities from a 7.3-year cycle to a 3-year cycle. The improvement in reliability may be marginal, but the shorter cycle will mitigate potential fire risk by reducing clearance issues.
2. Edit the current *Liberty Utilities Vegetation Management Plan* (Revised March 2015) document to bring it into compliance with the new 2017 ANSI Z133.1 standard, particularly for minimum approach distances.
3. Develop a detailed annual and long-range program plan to prioritize work and determine program funding requirements and resource needs. These plans are essential in measuring program efficiencies and effectiveness in meeting Liberty Utilities long-term goals. It also provides Liberty Utilities the necessary framework to assist with financial decisions that may impact system reliability.
4. Work with the local US Forest Service (USFS) to develop a Memorandum of Understanding (MOU) to eliminate individual site permitting requirements for tree maintenance. This will reduce internal resource time requirements for planning and executing routine maintenance work.
5. Develop program and tree contractor Key Performance Indicators (KPI) to drive improvements in crew production. These targets are crucial, particularly with time and material contracts to avoid price creep and to demonstrate fiscal responsibility to upper management and regulators.
6. Add one additional staff position to assist the Manager, Vegetation Control and Regulatory Compliance and help drive program success in meeting goals and objectives. Liberty Utilities arborist to tree crew staffing ratios are slightly lower than accepted industry norms, however, exceptional permitting requirements drive the need for one additional System Arborist. Additional staffing will provide resources for additional data collection and analysis as well as to help drive production improvements through the implementation of new formal processes (e.g., QA/QC).
7. Budget separately for unscheduled reactive work to prevent the use of non-discretionary schedule work dollars that will affect the ability to meet annual mileage targets.
8. Establish an ongoing work acceptance process (QA/QC) designed to formally document and confirm work quality and work completion to established standards, such as: compliance with clearance standards; appropriate and targeted tree removals and effective application of herbicides.
9. Utilize the publicly available High Hazard Zone and Fire-Threat GIS layers to help identify and quantify funding and resource requirements to effectively mitigate the threat of bark beetle-killed trees and reduce fire risk. Incorporate this data into the circuit prioritization schedules and long-range plans.

10. Enhance existing customer notification process to inform customers of impending routine maintenance work utilizing scripted, auto-generated outbound calls (e.g., reverse 911), emails, post-cards, or mail notifications.
11. Begin to evaluate tree-related interruptions (post-outage autopsies) to increase Liberty Utilities understanding of the specific conditions that are most common among trees that fail and cause outages in order to optimize program effectiveness.
12. Institute a formal tracking procedure/process to effectively manage customer refusals or locations where specified clearances cannot be achieved. This can be as simple as an Excel spreadsheet that is updated along with monthly reports regarding the current status of the refusal/inadequate clearance locations.
13. Standardize vegetation cause codes in Responder OMS system. Currently there are seven tree cause codes with 89 percent of the outages coded to one cause code ("Trees"). WECI recommends eliminating the current cause codes in favor of more descriptive cause codes. Doing so will bring more granularity to vegetation issues and provide better information for circuit prioritization decisions. Consider the following:

    - Tree Cause Codes:
        - Tree - Grow In
        - Tree - Overhang Limb Failure
        - Tree - Trunk Failure
        - Tree - Root Failure
        - Tree - Snow Loading
        - Tree – Private Contractor

    Secure buy-in/accountability with first-responders to accurately and consistently report the cause codes and ensure that other critical fields are being recorded. Accurate data is crucial to better target the VM maintenance program toward that portion of the tree population that is most prone to fail and cause outages.

1.5 Estimated Costs

One of the primary purposes of this study was to determine the optimal schedule and associated budgets necessary to maintain a desired level of service reliability and fire risk mitigation. Based on the vegetation workload survey, known regrowth rates for the common tree species, and Liberty Utilities production cost generated from contractor supplied unit and man-hour data, numerous program alternatives and program funding scenarios were reviewed by WECI.

The WECI recommended option provides the greatest opportunity to improve reliability and mitigate fire risk. It is evident that Liberty Utilities has invested a great deal of resources in reclaiming distribution and sub-transmission rights-of-way over the last three-years and these efforts should result in substantial cost savings in future cycles (after 2nd cycle) due to total workload reductions accomplished through tree removals. WECI believes that Liberty Utilities should adopt the WECI recommended funding strategy to reduce cycle length and to provide for additional reductions in fire risk and the mitigation of bark beetle-killed trees. WECI considered four key system attributes in determining the recommended cycle strategy:

1. Historically, low tree-caused outages at Liberty Utilities.
2. Potential reductions in total tree density due to right-of-way reclamation.

3. Potential fire risk from grow-ins and hazard trees.
4. The potential for significant bark beetle kill which may impact fire risk for fallen trees.

Table 1-2 provides projected vegetation maintenance program costs for three program options beginning in 2018. WECI's recommended option (Option 1) estimates that an annual budget of approximately $3.98M would be required to meet the optimum cycle goal (exclusive of CEMA dollars) and provide minimum tree-wire contact to control fire risk. Once the results from post-outage autopsies becomes available, it is likely that routine cycles of maintenance can be further optimized at a circuit or area level.

Table 1-2. First Cycle Estimated Liberty Utilities Vegetation Program Cost for Program Strategy Scenarios.

			WECI Recommended		
VM Activity	*Average 12' – '17*	*Current 2017*	***Option 1:*** *3 YR Cycle*	***Option 2:*** *4 YR Cycle w/ Hazard Tree Patrol*	***Option 3:*** *2 YR Cycle*
Planned Maintenance Total:	**$1,387,000**	**$1,120,000**	**$2,069,000**	**$1,706,500**	**$3,103,000**
Circuit Maintenance:	**$1,381,000**	**$1,114,000**	**$2,063,000**	**$1,547,000**	**$3,094,000**
Accessible:	$946,000	$763,000	$1,413,000	$1,059,000	$2,119,000
Inaccessible:	$435,000	$351,000	$650,000	$488,000	$975,000
Hazard Tree:				**$155,000**	
Brush Control:	**$6,000**	**$6,000**	**$6,000**	**$4,500**	**$9,000**
Reactive Maintenance Total:	**$290,000**	**$434,000**	**$289,000**	**$340,000**	**$248,000**
Other VM Maintenance:	**$702,000**	**$969,000**	**$1,626,100**	**$1,353,000**	**$1,754,000**
Debris Disposal/ Traffic Control:	$53,000	$115,000	$211,700	$172,500	$230,000
Preinspection:	$308,000	$364,000	$669,900	$546,000	$728,000
Permits/Environmental/ Cultural/Legal	$41,000	$52,000	$95,700	$78,000	$104,000
Pole Clearing	$108,000	$167,000	$150,000	$150,000	$150,000
Misc.	$26,000	$51,000	$93,900	$76,500	$102,000
Labor	$166,000	$220,000	$404,900	$330,000	$440,000
TOTAL VM PROGRAM:	**$2,379,000**	**$2,523,000**	**$3,984,100**	**$3,399,500**	**$5,105,000**
Incremental $ Over 2017 Actuals:		**$0**	**$1,461,100**	**$876,500**	**$2,582,000**
Contract Crew Requirements:					
Equivalent 3 Man Lifts:	3.0	3.0	4.6	4.0	6.6

Table 1-3 presents projected second-cycle stabilized annual costs. Estimated gains in production efficiencies and reductions in workload from the first two cycles support these projections.

Table 1-3. Second-Cycle Estimated Liberty Utilities Vegetation Program Cost for Program Strategy Scenarios.

	WECI Recommended		
VM Activity	***Option 1:*** ***3 YR Cycle***	***Option 2:*** ***4 YR Cycle w/ Hazard Tree Patrol***	***Option 3:*** ***2 YR Cycle***
Planned Maintenance Total:	**$1,876,000**	**$1,586,500**	**$2,742,000**
Circuit Maintenance:	**$1,870,000**	**$1,427,000**	**$2,733,000**
Accessible:	$1,281,000	$977,000	$1,872,000
Inaccessible:	$589,000	$450,000	$861,000
Hazard Tree:		**$155,000**	
Brush Control:	**$6,000**	**$4,500**	**$9,000**
Reactive Maintenance Total:	**$262,000**	**$314,000**	**$219,000**
Other VM Maintenance:	**$1,488,800**	**$1,261,600**	**$1,566,300**
Debris Disposal/ Traffic Control:	$192,000	$159,400	$203,100
Preinspection:	$607,600	$504,500	$642,800
Permits/Environmental/ Cultural/Legal	$86,800	$72,100	$91,800
Pole Clearing	$150,000	$150,000	$150,000
Misc.	$85,200	$70,700	$90,100
Labor	$367,200	$304,900	$388,500
TOTAL VM PROGRAM:	**$3,626,800**	**$3,162,100**	**$4,527,300**
Contract Crew Requirements:			
Equivalent 3 Man Lifts:	4.2	3.7	5.8

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Liberty Utilities

2.0 Introduction

Liberty Utilities (CalPeco Electric) LLC (Liberty Utilities), a subsidiary of Algonquin Power and Utilities Corporation, provides electric service to approximately 49,000 customers within its 1,482-square mile service territory around the Lake Tahoe basin. The utility is comprised of approximately 623 pole miles of primary overhead distribution and 21 miles of sub-transmission (24.9kV and 60kV) lines.

Liberty Utilities engaged WECI to complete a comprehensive review of the distribution and sub-transmission vegetation management program with the goal of identifying an optimum vegetation maintenance cycle strategy and identifying opportunities for improvement. WECI has completed similar studies for numerous electric utilities around the world. WECI's study involved an in-depth evaluation of Liberty Utilities operating procedures, work practices and vegetation workload.

Cycle recommendations are based on fire risk, species frequency and regrowth information, and an evaluation of reliability data to determine optimum cycle(s). WECI's evaluation includes a review of current vegetation maintenance clearance specifications (*Liberty Utilities Vegetation Management Plan*, Revised March 2015) and recommendations for enhancements to improve efficiencies in the vegetation management programs for both distribution and sub-transmission.

2.1 Project Purpose

WECI conducted this comprehensive study of the Liberty Utilities program between January 2018 and March 2018. The results of this study and the recommendations for enhancing the line clearance program, with an emphasis on optimal vegetation management cycle lengths and corresponding distribution and sub-transmission budget requirements, are presented in this report.

The following vegetation management program elements have been evaluated:

- Program management
- Vegetation workload
- Scheduling practices
- Field procedures
- Fire risk
- Public relations
- Budgeting
- Record keeping

Field surveys conducted by WECI provided the required data for projections of the existing vegetation workload on the Liberty Utilities system, how various factors within the utility's service territory may influence tree work production, as well as the tree contractors' resources and budgets required for its management. Analysis of Liberty Utilities' tree-caused interruption data and a review of tree regrowth rates were completed to aid in development of

the appropriate distribution and sub-transmission cycle length(s) and cost options for the program recommendations.

2.2 Report Organization

This report has been divided into six main sections.

- **Section 1: Executive Summary** – Includes recommendations for improvement designed to encourage the continued development of a long-term, cost effective distribution and sub-transmission vegetation management program.
- **Section 2: Introduction** – Provides the project purpose, report organization and methodology.
- **Section 3: System Analysis** – Describes the current state of the Liberty Utilities distribution and sub-transmission system. Includes the vegetation workload estimates for the Liberty Utilities system, species frequency, reliability data, and program expenditure histories.
- **Section 4: Recommendations** – Management-oriented section that presents specific recommendations designed to enhance the long-term cost effectiveness of the Liberty Utilities distribution and sub-transmission vegetation management program.
- **Section 5**: **Bibliography** – Contains bibliographic references for sources cited in this report.
- **Appendices** – Supplemental material to further clarify items referred to in this report.

2.3 Study Methodology

WECI's study of the Liberty Utilities vegetation management program included a review of existing workload data, collection and evaluation of tree species frequency data, analysis of maintenance frequency options, crew production analysis, specifications, and program processes and procedures.

2.3.1 Office Data

Liberty Utilities supplied the historical data required for the program evaluation. The requested documentation was discussed between WECI's project management team and Liberty Utilities management staff. Additional information, including staff recommendations and suggestions for improvement, were obtained during interview sessions with the Liberty Utilities staff responsible for vegetation management oversight.

WECI's extensive library and resource base of practical experiences in the vegetation management industry were utilized, in conjunction with the information provided by Liberty Utilities, in the analysis of the current vegetation management program. Comparisons were made with other utility vegetation management programs to assess the efficiency and effectiveness of the existing program.

2.3.2 Vegetation Workload Survey

Vegetation conditions at points randomly located throughout Liberty Utilities service territory were documented as part of the distribution and sub-transmission survey. Data was collected in January and February of 2018. The survey team consisted of a WECI employee and an assigned driver from Liberty Utilities.

The survey was designed to estimate the existing vegetation workload on Liberty Utilities primary overhead distribution and sub-transmission system. Data was collected to ensure an overall, system-level tree workload projection accuracy of ±10 percent error at the 90-percent confidence level.

2.3.3 Species Frequency and Regrowth Data

During the workload survey, additional sample points were taken within each of the workload sample points to collect species data and proximity to the conductors. This data provides a relative species frequency that helps paint a picture for future maintenance requirements. The species diversity on the Liberty Utilities system along with its relative frequency and estimated regrowth rates, can be used to determine future regrowth into the conductors and determine estimated percent tree-line contact at varying cycle lengths.

2.3.4 Cycle Optimization

Tree regrowth rates, together with vegetation workload characteristics and interruption data, were utilized to model the impact of various pruning cycle options. Contractor unit cost production rates were calculated through the use of production data provided by Liberty Utilities. Production data was analyzed from 2011 through 2017 and was used in the development of cost projects for various modeled options.

LIBERTY UTILITIES

Liberty Utilities

3.0 System Analysis

This section contains four components: (1) a brief overview of the organization and operation of the Vegetation Management (VM) program, (2) detailed information on the quantity and condition of the vegetation workload, (3) an examination of Liberty Utilities' tree-related outage data, and (4) a review of program expenditures over recent years.

3.1 Program Organization and Operation

3.1.1 Organizational Structure

At the time of this study, the responsibility for vegetation management oversight at Liberty Utilities rests with the Manager, Vegetation Control and Regulatory Compliance. The Manager reports directly to the Vice President of Operations. One System Arborist, reporting to the Manager, Vegetation Control and Regulatory Compliance, is responsible for day to day activities of the field operations. **Appendix F** provides a complete vegetation organizational chart for the Liberty Utilities system.

Responsibilities for the Manager, Vegetation Control and Regulatory Compliance include:

- Directing all aspects of the overall Vegetation Management Program along distribution and sub-transmission lines at Liberty Utilities (CalPeco Electric).
- Developing corporate policies for Integrated Vegetation Management.
- Budgeting, allocation, and management of the annual VM expenditures.
- Leading, developing, executing & monitoring various special projects related to vegetation management.
- Negotiation of master service agreements for Liberty Utilities' contracted tree crews.
- Organizing large scale storm restoration.
- Owner of project management efficiencies among contracted crews with continuous improvement projects, communicating and monitoring safety policies, auditing vendor's work and confirming trimming standards are met.
- Establishes working relationships and presents information to numerous internal and external groups including: senior management, Federal and State Agencies such as U.S. Forest Service, and U.S. Bureau of Land Management, professional councils, city mayors, directors of public work, and homeowner associations.
- Fosters a productive and respectful relationship with direct reports and with management of contractors.

The Manager, Vegetation Control and Regulatory Compliance receives field assistance from one full-time equivalent. This System Arborist covers the entire Liberty Utilities service territory while directing the day-to-day activities of the contract tree crews.

The System Arborist's responsibilities include:

- Providing direct oversight, monitoring performance, and implementing control measures of external vegetation contractor(s).
- Scheduling of work for external contractors while balancing priorities of safety, timeliness, and critical nature of some tasks.
- Responding to internal and external customer requests to ensure proper clearances required in Liberty Utilities' standards are achieved.
- Developing and maintaining a strong professional relationship with county, city, state, and federal organizations as well as landowners impacted by vegetation management work.
- Ensuring compliance with federal, state, and local standards and fire codes. Applying and obtaining permits with these agencies for vegetation management work.
- Inspecting contract work to ensure compliance with Liberty Utilities specifications.
- Supporting System Operations during after hour outage restoration and emergencies.
- Investigating vegetation-related outages and developing plans to minimize outages.
- Identifying opportunities to improve vegetation management practices.
- Identifying opportunities to reduce cost of vegetation management work while maintaining a high degree of quality and productivity.

3.1.2 Vegetation Management Goals

The Vegetation Management program at Liberty Utilities is a key strategic initiative focused to help ensure safe and reliable electric service to its customers. In addition, the Liberty Utilities Vegetation Management program is driven to do its part in assisting Liberty Utilities to become a best-operated top quartile company in terms of efficiency and effectiveness in program expenditures, production, system reliability, customer satisfaction, and safety. The reduction in fire risk due to trees in contact with energized facilities is a key primary program initiative.

3.1.3 Current Vegetation Management Budget

Accurate and consistent tracking of historical vegetation management expenditures has been a challenge at Liberty Utilities. The lack of accurate detailed budget and actual expenditures by work category prohibit balancing the budget at year end. Based on the available data for 2012 through 2017, Liberty Utilities vegetation management budget for distribution and sub-transmission work has been relatively steady since 2013 (see **Figure 3-1**). Actual expenditures have varied significantly from year to year.

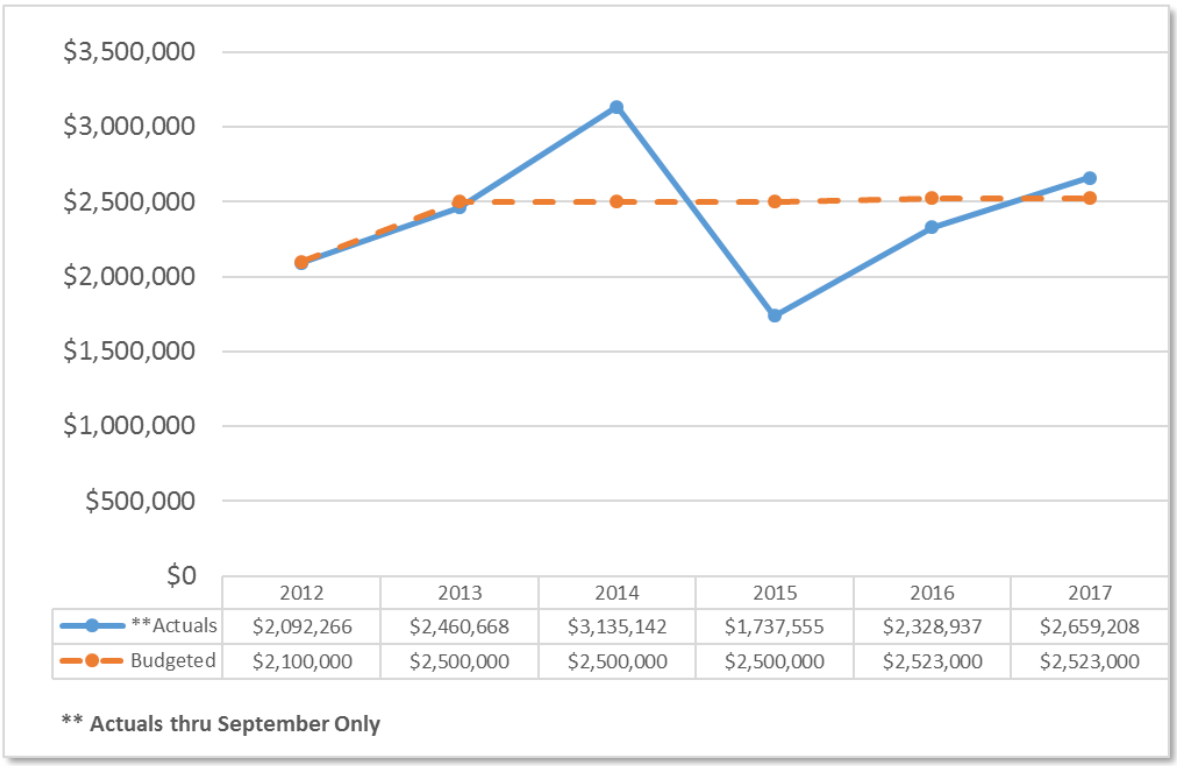

Figure 3-1. Historical Vegetation Management Budget and Actuals for O&M at Liberty Utilities (per Expenditure Info.xlsx).

Budgets at Liberty Utilities were authorized by the CPUC for three-year periods totaling $7.5 million from 2013 through 2015 and $7.569 million from 2016 through 2018. Actual expenditures vary by year, however, Liberty Utilities strives to meet the overall three-year budget target.

Expenditures, work units completed, and production data were provided by Liberty Utilities. **Table 3-1** presents a combination of data from the varying sources (*CalpecoVM All Trees.xlsx*, *LU Distribution Circuit Status.xlsx*, and *Expenditure Info.xlsx*), which is used as the basis for this report. Note that the data presented reflects the best available data as calculated by WECI. Liberty Utilities does not currently possess a means to accurately track budget versus actual spend at the work type level. Additionally, expenditures and miles completed tracked at the circuit level by year appear to be inaccurate as demonstrated in **Table 3-1** for year 2015 where miles and cost are missing.

Accurate circuit costs, miles completed, and units completed provide a means to assess lump sum bids for future work. Accurate budget and actual expenditures are crucial to monitor progress throughout the year and ensure annual mileage targets are met. These items are considered best management practices and provide important metrics for program success.

Table 3-1. Historical Liberty Utilities Expenditure and Other Information by Operating Company.

	2012	2013	2014	2015	2016	2017	Averaage 2012-2017
Unit Maintenance	$1,113,584	$1,048,492	$1,061,855	$784,454	$645,756	$683,102	$889,541
T&M Maintenance	$233,895	$513,885	$971,938	$346,668	$454,507	$546,779	$511,279
Tags - Customer Requ.	$327,115	$197,421	$227,674	$184,990	$368,597	$507,202	$302,166
Emergency/Storm	$928	-	-	$12,750	$0	$0	$6,839
***Capital**	$32,455	$203,350	$72,518	$449,724	$374,172	$153,382	$214,267
Debris Disposal/Traffic Control	$20,189	$0	$40,586	$49,507	$80,283	$76,788	$53,471
Preinspection	$413,530	$387,134	$295,925	$162,260	$265,138	$369,353	$315,557
Permits/Environmental/ Cultural/Legal	$75,276	$10,404	$131,393	$12,253	$2,140	$13,949	$40,903
Pole Clearing (PRC 4292)	$81,691	$125,211	$93,510	$103,059	$116,664	$128,673	$108,135
Misc.	$43,848	$32,525	$18,776	$36,517	$8,373	$13,745	$25,631
Labor	$74,762	$116,437	$226,638	$186,898	$208,865	$253,573	$177,862
****Actuals**	$2,092,266	$2,460,668	$3,135,142	$1,737,555	$2,328,937	$2,659,208	$2,402,296
Budgeted	$2,100,000	$2,500,000	$2,500,000	$2,500,000	$2,523,000	$2,523,000	$2,441,000
Other Info:							
Tags as % of Total VM	16%	8%	7%	11%	16%	19%	13%
Miles Completed YE:	94	107	68	0	56	118	74
Cost Per Mile:	$7,091	$12,302	$26,393	$0	$30,205	$13,602	$14,932
# of Trees:	9,964	7,250	7,595	2,726	2,545	2,432	5,419
Trees Per Mile:	106	67	112	0	45	21	59

*Capital is excluded from VM Budget

**Actuals thru Sept

Bark Beetle Considerations

Thriving in the abundant even-aged, high density ponderosa pine stands, which are continuous across much of the Liberty Utilities service territory, the MPB attacks green host trees in late summer, boring under the bark and spreading a blue-stain fungus, both of which can eventually lead to tree mortality if the mass attack was successful.

A Forest Service aerial survey conducted in 2016 found more than 62 million trees in California died that year alone, a more than 100 percent increase over the number that died in 2015. From 2010 to November 2016, the Forest Service estimates that more than 102 million trees have died statewide, with the majority of those in counties along the southern and central Sierra (Rhoades, 2017). The spread of MPB has been exacerbated by previous year's drought conditions and will continue to deplete the pine forests for several years to come.

The total number of dead trees between 2010-2016 is estimated at 774,000 in Placer County, according to an April report from the Tree Mortality Task Force, which was created in 2015 by Gov. Jerry Brown to address tree mortality. About 557,000 of those trees died in Placer County in 2016, alone (Rhoades, 2017).

Liberty Utilities has experienced some tree mortality due to the MPB and other bark beetles where the infested trees posed a risk to its distribution and sub-transmission systems. As of this report, Liberty Utilities has begun CEMA (Catastrophic Event Memorandum Account)

patrols to identify hazard trees, which includes those trees infested by bark beetle. The CEMA budgeted expenditure at Liberty Utilities in 2018 is estimated to be approximately $300,000 for the patrols alone.

3.1.4 Contract Crews

Liberty Utilities currently employs the services of one primary tree contractor to perform vegetation management work on both its distribution and sub-transmission system. These crews operate namely on a time and material (T&M) contract during the winter months (January through March) and unit price for the remainder of the year when performing routine maintenance work. Tags, hot spot, and other non-routine work, or in cases where the routine work is out of normal scope, T&M is also used. The number of crews may also vary during those time frames from two crews in the winter months to three crews thereafter (see **Table 3-2**).

Table 3-2. Liberty Utilities Tree Crew Resources.

	Number of Crews
January – March:	
Supervisor w/ PU	1
Pre-Inspector w/ PU	2
3 - man 75' Bucket w/ chipper	1
4 - man 100' Bucket w/ chipper	1
April – December:	
Supervisor w/ PU	1
Pre-Inspector w/ PU	2
3 - man 75' Bucket w/ chipper	1
4 - man 100' Bucket w/ chipper	1
3 -man Split-dump Manual w/ chipper	1

These crews perform cyclic distribution and sub-transmission maintenance, capital/work order work, reliability enhancement pruning, customer ticket requests (Tags), hot-spot requests, and storm response. The contractor provides one full-time Supervisor for crew supervision and interface with the Liberty Utilities system arborists. The supervisor is billable under the current time and material contract during the winter months.

Currently there are no contractor productivity targets in terms of man-hours per tree or cost per mile although it is tracked. Work packets (i.e., circuit maps) are assigned to the contractor on a job-specific basis. Tree crew timesheets are processed weekly based on the crew cost and hours worked.

3.1.5 Work Scheduling

From 2012 to YE 2017, approximately 69 percent (average of 74 miles per year) of the distribution and sub-transmission cycle miles have been completed which equates to an 8.72-year cycle. Between the years of 2016 and 2017 that cycle is reduced to 7.3 years. **Table 3-3** presents the cycle mileage information.

Table 3-3. Liberty Utilities Distribution/Sub-Transmission Miles to be Maintained and Current Status.

	Total Miles	*Current Cycle Length (yrs.)*	*Completed Miles 2016 & 2017*	*Remaining*	*Estimated Current Cycle Complete Date*
Liberty	644	7.3	174	470	2022

Liberty Utilities utilizes several metrics to select circuits for the annual maintenance plan. These include:

1. Years since last trim
2. Perceived fire risk
3. Circuit outage investigation reports
4. Circuit outage history
5. Budget thresholds

The circuit priority list is created and maintained by the Manager, Vegetation Control and Regulatory Compliance. A multi-year master schedule by circuit has not been established. The annual work plan is loosely developed during the preceding year's fourth quarter with the work load varying based on the budget and the time devoted to non-preventative or reactive work. The annual plan is fluid and changes as additional work is selected for the contract tree crews. Liberty Utilities uses a process for circuit selection that appears to be effectively minimizing tree-caused outages based on the reliability data provided.

3.1.6 Customer Interface

Liberty Utilities notifies customers of pruning or herbicide application in advance of the work utilizing the pre-inspectors for routine work. Customer trim/removal requests are examined by Liberty Utilities staff, contract pre-inspector, or tree crew. The majority of these service or customer requests (Tags) relate to customer concerns over trees in close proximity to primary wires that they believe poses a threat to service reliability or fire risk. Service trim requests are frequently deferred or scheduled during planned maintenance in the area. Trees that pose an immediate threat are removed or pruned. Clearance is not provided for secondaries and service drops unless there is heavy contact or weight on the conductors. Removal of large trees for customers does not occur unless that tree is considered a future reliability or safety risk.

3.1.7 Record Keeping

Vegetation Management

It is WECI's opinion that data collection, standardization of data, and data retention processes represent the biggest current challenge and need at Liberty Utilities. The centralization and standardization of system asset data, production data, reliability, and budget information is a vital component in moving Liberty Utilities into the top quartile of best-operated companies. System asset information (e.g. circuit and mileage data) for instance, seems to vary between reports primarily between the historical trim information and completed circuit list. Merging asset information with production, budgets, actual expenditures, and reliability information is currently a difficult if not impossible task. A single corporate source for this data should be identified and serve as the basis for any future reporting.

The Manager, Vegetation Control and Regulatory Compliance is responsible for tracking all vegetation maintenance work including VM production and cost data. Production is tracked through the use of the pre-inspector planning database tool (e.g. *CalpecoVM All Trees* as an output). However, production metrics and production targets are not currently utilized.

The largest single identifiable gap exists in identifying budgeted dollars versus actual expenditures from year to year or within the budget year. Breakouts between maintenance work types are not easily obtainable and prevents accurate accounting. Going forward, it will be important to both budget and track actual expenditures monthly by work type to ensure cycle dollars are properly executed to meet annual cycle miles targets.

The timesheets and payment system used by Liberty Utilities appear to be sufficient in appropriately capturing work type. Dashboard reports with associated production targets are currently not available at Liberty Utilities to measure progress in meeting mileage or crew production goals. System goals and clear targets are crucial paths to continual improvement.

System Interruption Data

Out-of-service trouble tickets are initiated through contact with the Liberty Utilities Customer Care/Phone Board. Out-of-service tickets are referred to the Liberty Utilities Dispatch Center when immediate response is needed for out-of-service situations. Based on the information received from the trouble shooter, the dispatchers assign a cause code to the outage. Currently, Liberty Utilities classifies all vegetation outages into seven cause-codes:

1. Trees
2. TreesCutout
3. Trees Snow
4. TreesSnow Unloading
5. Trees Structure Down
6. Tree Trimming
7. Trees Wire Down

Approximately 89 percent of the non-storm excluded tree outages and 96 percent of the customers interrupted (CI) were charged to the "Trees" cause code, between 2013 and 2017. The cause codes currently in use by Liberty Utilities do not provide sufficient information to

determine the specific number of outages that result from tree growth, falling limbs, etc. The lack of use of more descriptive OMS tree cause-codes limits the ability for Liberty Utilities to analyze root cause and incorporate that information into the prioritization of circuits. Outages occurring from within the current pruning zone (i.e., grow-ins) require a different management strategy than those trees falling from outside of the normal pruning zone.

3.2 System Workload

The tree and brush workload on the Liberty Utilities distribution and sub-transmission system was estimated statistically based on random sample surveys conducted across the company's 644-mile system. Brush was measured in quarter span increments. For the purposes of this study, brush was defined as any woody vegetation less than four (4) inches dbh (diameter at breast height) determined by Owner to be a threat to the safe and reliable operation of the line or circuit or hinder accessibility to the line or circuit (see **Appendix A**).

3.2.1 Tree Workload

WECI projects that there are approximately 50.6 trees per mile or 32,600 total trees on the 644 miles of line that comprise the Liberty Utilities primary distribution and sub-transmission system. These are the trees under and along the Liberty Utilities overhead electric system that require maintenance now or will require maintenance within the next five years. This includes trees within and outside of the designated rights-of-way. **Table 3-4** summarizes the current vegetation workload on the Liberty Utilities distribution and sub-transmission system.

Table 3-4. Projected Vegetation Workload on the Liberty Utilities Primary Distribution and Sub-Transmission System.

	System Miles	*Tree Pruning*	*Tree Removal[1]*	*Total Trees*	*Brush[2] Acres*	*Trees per Mile*	*Error Rate[3]*
Distribution & Sub-Transmission	644	17,300	15,300	32,600	15	50.6	±8.8

Detail

It was noted that the historical unit data yielded a similar estimated tree density and maintenance requirements as compared to the current workload survey. In careful review of the historical data, it was determined that while the high removal rates on completed work have had some impact on reducing tree density, the extended cycle has prevented any

[1] In general, good candidates for removal were defined as small diameter trees in rural areas. Fast-growing trees in urban or rural areas may also be good candidates for removal regardless of diameter, especially if they would require top pruning.
[2] A woody plant less than four-inches diameter (d.b.h) that may reach the conductor at maturity.
[3] Sample Error Rate (±) based on 90 percent confidence level.

significant reduction in overall tree density. **Table 3-5** presents a detailed workload breakout by work type on the Liberty Utilities system.

Table 3-5. Detailed Estimated Workload by Work Type.

	Accessible	Inaccessible	Total
Total Trees	**22,330**	**10,270**	**32,600**
Trims	**11,840**	**5,460**	**17,300**
Top	1,140	530	1,670
Side	9,680	4,460	14,140
V-Trim	20	10	30
Overhang	1,000	460	1,460
Removals	**10,490**	**4,810**	**15,300**
Removals_4_11.9	5,030	2,310	7,340
Removals_12_23.9	3,250	1,490	4,740
Removals_24_35.9	1,890	870	2,760
Removals_>36	310	140	450
Removals_SVC/SEC	10	0	10
Compliance Trees	**1,030**	**480**	**1,510**
Hazard Trees	**1,690**	**780**	**2,470**
Brush Acres	**10**	**5**	**15**
Mow&Treat	0	0	0
Cut&Spray	0	0	0
Spray_Only	0	0	0
Trim_Only	0	0	0
Hand Cut_Only	10	5	15

*Hazard tree count and Compliance Trees are included in trim and removal count.

Figure 3-2 provides a comparison of tree densities with a selected benchmark group of 17 other utilities. Of the 200+ utility vegetation workload studies conducted by WECI and ECI, the average tree density is 90-99 trees per mile, indicating Liberty Utilities average tree density (50.6 per mile) is well below the norm for the industry. Utilities with the highest tree densities are located primarily in the northeastern United States.

Based on the results of WECI's system survey the trimming characteristics are: 43 percent side-trim; 5 percent top-trim; 5 percent other trims; and 47 percent removals. Of the total trees listed above, approximately 12 percent are currently considered hazard or compliance trees. **Appendix A** provides a detail breakout of the workload and other associated workload characteristics.

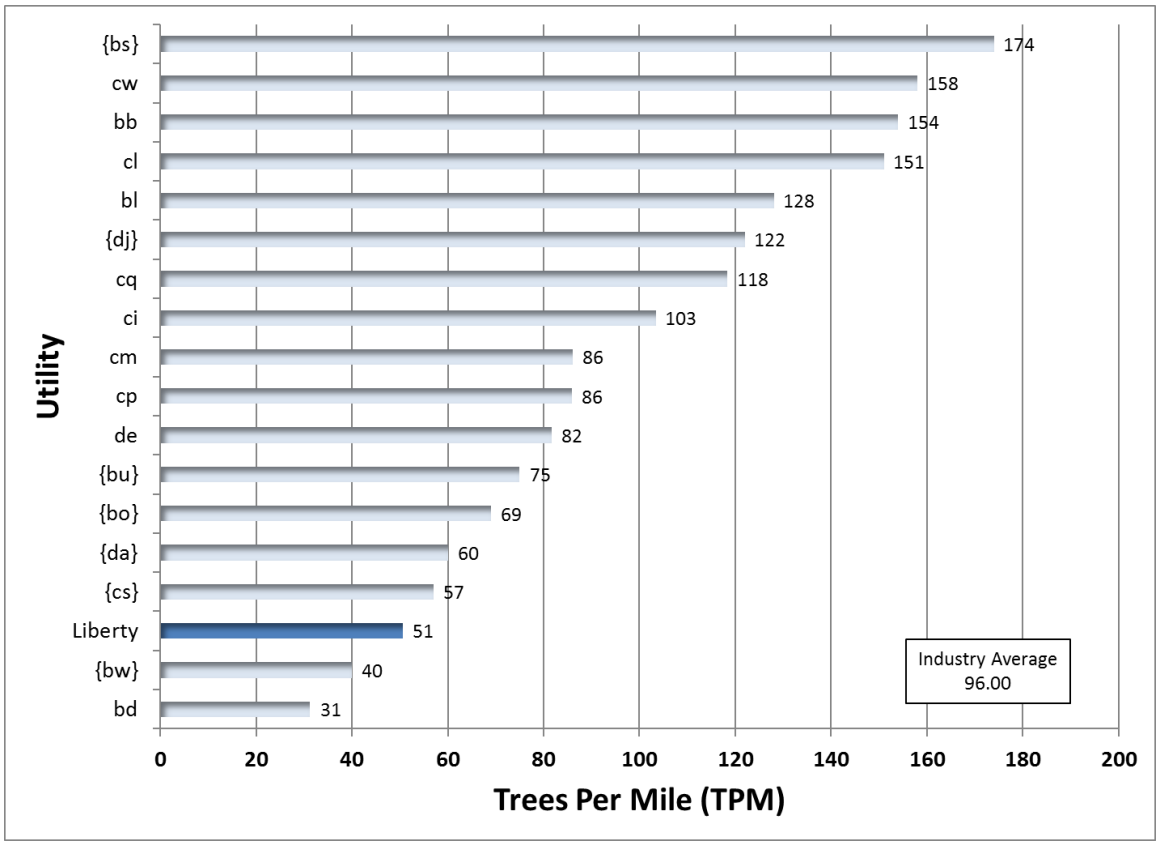

Figure 3-2. Comparison of Liberty Utilities tree density with a Benchmark Group of 17 Other Utilities.

Line construction, growth rate, pruning type, species composition and clearance characteristics shape the approach to vegetation maintenance. By understanding the system make-up or characteristics, a strategy can be developed to maximize the vegetation management effort and provided a more directed approach to improving system reliability and/or maximize cost benefit. Liberty Utilities overhead distribution and sub-transmission system consists of 10 percent single-phase construction and 90 percent multi-phase construction.

3.2.2 Species Composition

Liberty Utilities has a limited number of tall-growing tree species that make up the maintenance workload. Of the 24 unique tree species identified, the most common tree species comprised of Jeffery pine, white fir, lodgepole pine, and quaking aspen represent approximately 90 percent of the trees on the Liberty Utilities system. The total tree species population on the Liberty Utilities distribution and sub-transmission system are listed in **Table 3-6** in order of relative frequency.

Table 3-6. Relative Frequency of Tree Species Found on the Liberty Utilities Distribution and Sub-Transmission System in Order of Frequency.

		Frequency	
Common Name	***Scientific Name***	***North***	***South***
Pine, Jeffrey	*Pinus jeffreyi*	42.1%	59.30%
Fir, white	*Abies concolor*	25.2%	18.79%
Aspen, quaking	*Populus tremuloides*	10.2%	6.46%
Pine, lodgepole	*Pinus contorta*	8.5%	9.78%
Fir, red	*Abies magnifica*	2.5%	
Cedar, incense	*Calocedrus decurrens*	2.0%	1.37%
Elm, Siberian	*Ulmus pumila*	1.8%	0.39%
Spruce, blue (Colorado)	*Picea pungens*	1.6%	0.39%
Maple, silver	*Acer saccharinum*	0.9%	
Apple	*Malus spp.*	0.8%	0.20%
Willow	*Salix spp.*	0.7%	1.57%
Juniper	*Juniperus spp.*	0.7%	
Alder, thinleaf	*Alnus tenuifolia*	0.5%	0.59%
Pine, ponderosa	*Pinus ponderosa*	0.5%	0.20%
Crabapple	*Malus spp.*	0.4%	
Pine, sugar	*Pinus lambertiana*	0.4%	0.20%
Cherry, ornamental	*Prunus spp.*	0.3%	0.59%
Poplar, white	*Populus alba*	0.3%	
Birch, paper (white)	*Betula papyrifera*	0.3%	
Poplar, Lombardy	*Populus nigra*		0.20%
Locust, black	*Robinia pseudoacacia*	0.1%	
Elm, American	*Ulmus americana*	0.1%	
Ash, green	*Fraxinus pennsylvanica*	0.1%	
Arborvitae	*Thuja spp.*	0.1%	

3.2.3 Tree Removal

Trees can be managed by pruning or complete removal. Removal candidates typically included volunteer trees (brush that has been allowed to mature) and trees that were obviously dead, dying, or otherwise structurally unsound (hazard trees/fire risk). In general, trees in landscaped areas and other ornamentals were not usually listed for removal unless the tree was located directly underneath the conductors, or it was determined that removal would be especially beneficial (e.g., trees that have been improperly pruned in the past, fast-growing trees with minimal clearance, trees with major structural defects, or immature trees that, when mature, will require repeated pruning to maintain an acceptable clearance).

Based upon historical work planning data, the average removal rate for Liberty Utilities was 50.2 percent (as compared to the 47 percent removals identified in the workload survey for remaining work). The high removal percentage is a result of concerted efforts by Liberty Utilities to reclaim the distribution and sub-transmission rights-of-way. **Figure 3-3** represents data obtained from a typical utility (on a four-year cycle) and provides a comparison of the cost to remove a tree compared to that of pruning. For most utilities, it costs no more to remove smaller trees than it does to prune them. In fact, many small trees

can be removed for less than it would cost to prune them, resulting in reduced short-term expenditures.

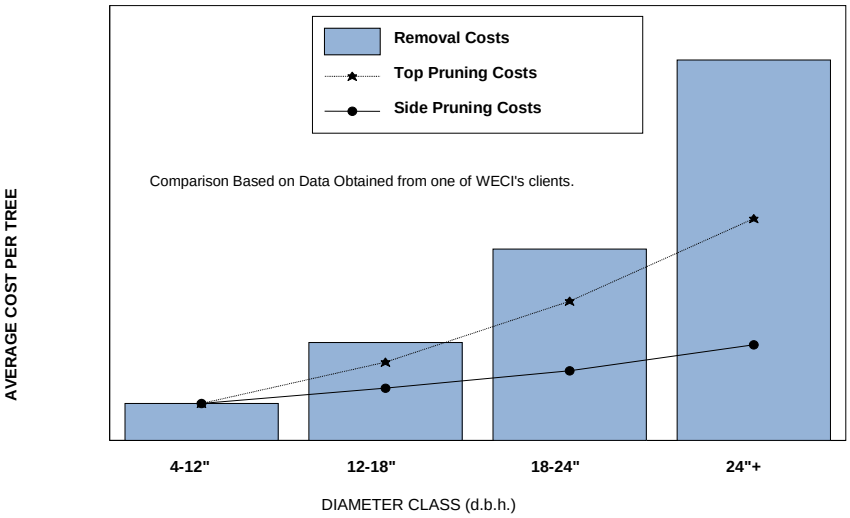

Figure 3-3. Comparison of Relative Pruning and Removal Costs.

WECI examined the historic production data from Liberty Utilities to compare removal cost to prune cost. The average cost for 2017, is presented in **Figure 3-4**. This data indicates that while Liberty Utilities has spent significantly more (approximately 458 percent more) for removals on a cost per tree basis, the mature nature of the forest stand does not allow for many younger trees on the Liberty Utilities system. With the aging forest, many of the larger and older trees are in decline and require removal.

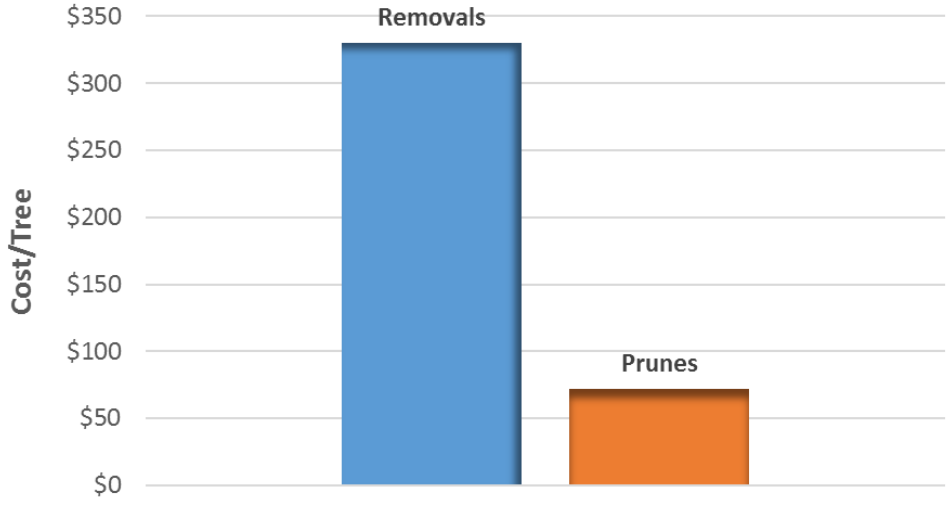

Figure 3-4. Comparison of Average Cost per Unit to Remove versus Trim.

Guidelines for tree removal selection help assure cost effective. However, since removal and stump treatment of trees will reduce the future workload and provide for long-term cost reductions, many utilities are often willing to remove some larger trees.

3.2.4 Tree Pruning

Pruning is a temporary measure, but the use of proper techniques can reduce and direct growth away from the conductors, providing adequate clearance for a longer time. Improper pruning techniques can stimulate regrowth, thus providing only short-term results. Studies have shown that properly pruned trees encroach on the conductors at a rate that is 25 percent to 50 percent slower than improperly pruned trees. WECI observed that Liberty Utilities contract line clearance crews are following proper arboricultural standards on manually pruned trees.

3.2.5 Clearance

Table 3-7 shows the current Liberty Utilities guideline for minimum specified clearance distances between trees and conductors for distribution and sub-transmission facilities (per Section 6.2 of the *Liberty Utilities Vegetation Management Plan* – Revised March 2015).

Table 3-7. Liberty Utilities Distribution and Sub-Transmission Clearance Guidelines at Time of Pruining.

Line Type	*Voltage*	*Minimum Clearance*	*Notes*
Open Wire Secondary	<2.4 kV	4 feet	
Coated Aerial Cable	<2.4 kV	4 feet	Only prune for strain or for abrasion
Guy and Support Wires	<2.4 kV	2 feet	Only prune for strain or for abrasion
Distribution Primary – Slow/Medium	>2.4 kV to 25 kV	10 feet	Tree species with growth rate of < 2 ft./year. Removal of overhang.
Distribution Primary – Fast Growers	>2.4 kV to 25 kV	15 feet	Tree species with growth rate of ≥ 2 ft./year. Removal of overhang.
Sub-Transmission – Slow/Medium Growers	60 kV / 120 kV	10 feet / 20 feet	Tree species with growth rate of < 2 ft./year. Remove all overhang and remove all trees within wire zone. Remove defective, dead, decayed or suppressed trees within border zone.
Sub-Transmission – Fast Growers	60 kV / 120 kV	15 feet / 25 feet	Tree species with growth rate of ≥ 2 ft./year. Remove all overhang and remove all trees within wire zone. Remove defective, dead, decayed or suppressed trees within border zone.

While the above minimum clearances serve as the basic guideline for clearances at the time of pruning, Liberty Utilities is also bound by the minimum clearances as set forth by the California Public Service Commission (CPUC), General Order 95, Rule 35 which provides

the minimum clearances for all trees on the Liberty Utilities electric system during all times of the year. Additionally, Public Resource Code (PRC) 4293 mandates minimum tree-to-conductor clearances for all trees within State Responsibility Areas (SRA's) on the Liberty Utilities system during fire season.

Clearance at time of pruning is a key factor in determining the optimal cycle strategy. More importantly, the tree contractor's ability to consistently clear to the established standards will determine if established cycles can be maintained. From the frequency study and analysis, WECI estimates that the average system clearance at time of pruning is approximately 7.9 to 11.1 feet (see **Table 3-8**).

Table 3-8. Summary of Average Weighted Clearances at Time of Pruning for All Species.

	Liberty Utilities	
	Avg. Side (Ft.)	***Avg. Top (Ft.)***
System	7.9	11.1
Two-Phase	7.5	9.5
Three-Phase	8.2	12.0
Rural	8.5	10.2
Suburban	6.3	11.3
Urban	7.6	11.3

When high numbers of trees are capable of contact with the conductors, they may present a threat to the integrity of the distribution and sub-transmission system. The National Electric Safety Code (NESC – C2-2007) Section 218[4] states, "Vegetation that may damage ungrounded supply conductors should be pruned or removed. Vegetation management should be performed as experience has shown to be necessary." Section 218 does not specifically state that clearance between vegetation and energized lines should be maintained. Moreover, the industry has not interpreted this rule to mean that mandatory clearances between vegetation and energized conductors be maintained at all times.

Many utilities in North America where wildfires are not a major threat consider 10 percent tree contact with the conductors to be a reasonable goal for their distribution line clearance program to minimize the potential threat of interference with conductors. Many utilities exceed this level of tree-line contact. It is important to note that the specific conditions associated with trees in contact with conductors are key determinants of the impact of those contacts on system performance. WECI research has documented the importance of voltage stress gradient, stem diameter and tree species as they relate to a tree branch becoming a fault pathway leading to a sustained interruption. However, incidental contact between small tree branches and conductors normally remain low-current high-impedance faults. WECI observed negligible incidents of tree and line contact on the Liberty Utilities system.

The field review of vegetation conditions on the Liberty Utilities distribution and sub-transmission system found the system to be generally adequate based on minimal contact

[4] Appendix D contains the full text of the modified Section 218.

between trees and conductors. However, fire risk is a major concern in the Liberty Utilities service territory and any contact can be an issue. **Table 3-9** presents the amount of system contact noted from the field survey (includes trees within one-foot of the energized conductors). **Figure A.8** in **Appendix A** provides additional detail related to current tree clearance.

Table 3-9. Percent of Trees Surveyed Within One-Foot of the Energized Conductors.

	Two-Phase	Three-Phase	Rural	Suburban	Urban	Total
Liberty Utilities	1.2%	2.1%	0.2%	0.2%	2.9%	3.3%

At this point, it is important to note that trees are dynamic and the proximal relationship between the total tree workload and overhead distribution and sub-transmission facilities is influenced by several factors. The rate of growth of individual tree species, the amount of clearance achieved at the time of pruning, and work scheduling practices all result in a tree population with varying amounts of clearance at any given time.

3.2.6 Brush Workload

Liberty Utilities utilizes herbicides as part of its overall Integrated Vegetation Management (IVM) program to prevent fungi spread on manually removed coniferous trees. No other herbicides are used at this time. Rights-of-way floors were noted to be generally devoid of brush.

Of the projected 15 total acres of brush on the Liberty Utilities system, WECI found no significant opportunity for controlling brush with foliar herbicides. **Table 3-10** presents the brush characteristics of the current brush acres on the Liberty Utilities system along with the percentage of acres by recommended treatment type.

Table 3-10. Brush Characteristics on the Liberty Utilities System.

	Liberty Utilities
Brush Height:	
Low (0'-6')	3%
Medium (6'-12')	52%
High (12'-18')	41%
Priority (>18')	4%
Density:	
Sparse (0%-5%)	4%
Light (5%-35%)	12%
Medium (35%-70%)	26%
High (70%-100%)	58%
Treatment Type:	
Mow/Treat	0%
Mow Only	0%
Cut/Spray	0%
Spray Only	0%
Trim Only	0%
Hand Cut Only	100%

3.3 Tree-Related Interruptions

Trees are often a leading cause of service interruptions at most utilities and a measure of potential fire risk. In the proceeding figures, the reported number of vegetation outages calculated by WECI is presented for comparison alongside benchmarking data collected by WECI.

One useful means of comparing the effectiveness of vegetation management programs is based on primary tree-caused outages per 100 miles. **Figure 3-5** compares Liberty Utilities' primary tree-caused outage frequency to 17 other utilities. Liberty Utilities reported an average of 3.2 tree-related outages per 100 miles for the years 2013 through 2017. **Figure 3-5** also provides a normalized look at tree-caused interruptions by looking at tree-caused interruptions per 1,000 trees. The primary tree-caused interruptions per 1,000 trees metric relates more directly to outage exposure than does the outages per 100 miles metric. Liberty Utilities' tree-caused interruptions per 1,000 trees are lower than many others in the industry at 0.63 outages per 1,000 trees. Liberty Utilities, falls within the first quartile in both metrics. Best in class utilities, as benchmarked through previous national surveys, are shown to have outages per 100 miles between 1.5 and 2.0. However, Liberty Utilities is well within the average ranges based upon the 58 utility averages per the national survey (10 tree outages per 100 miles).

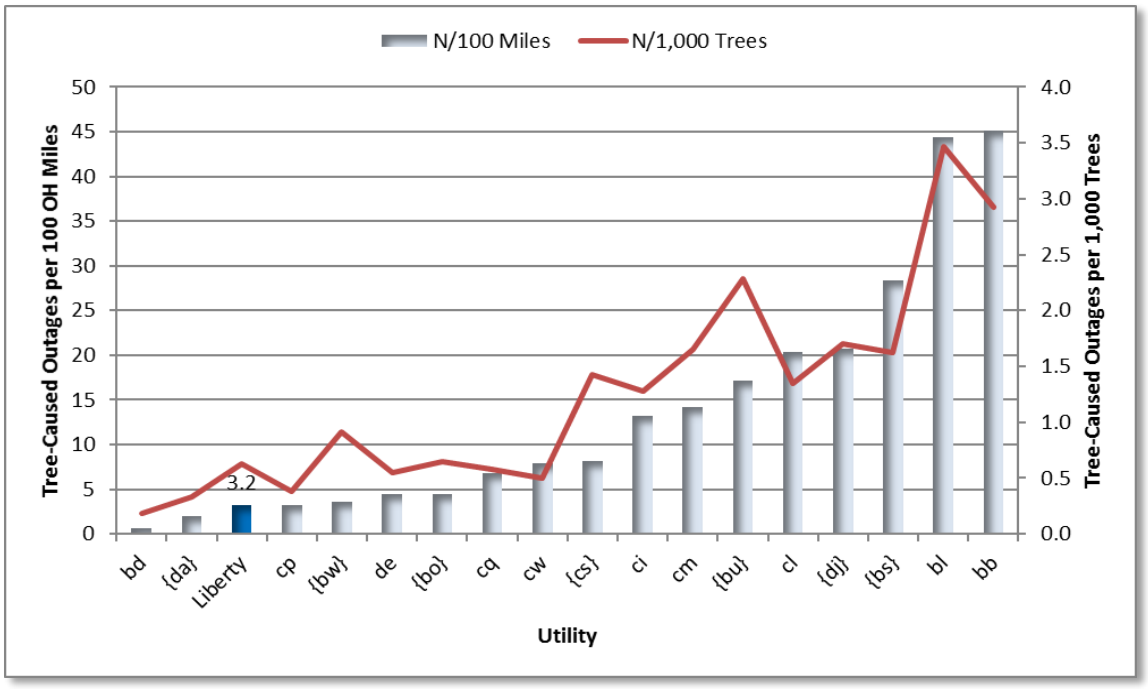

Figure 3-5. Average Annnual Number of Tree-Related Outages per 100 Miles and per 1,000 trees for Liberty Utilities for Years 2013 through 2017, as Compared to a Benchmark Group.

Figure 3-6 and **Figure 3-7** provides a benchmark comparison for customers interrupted (CI) and customer minutes interrupted (CMI) per 100 miles and per 1,000 trees.

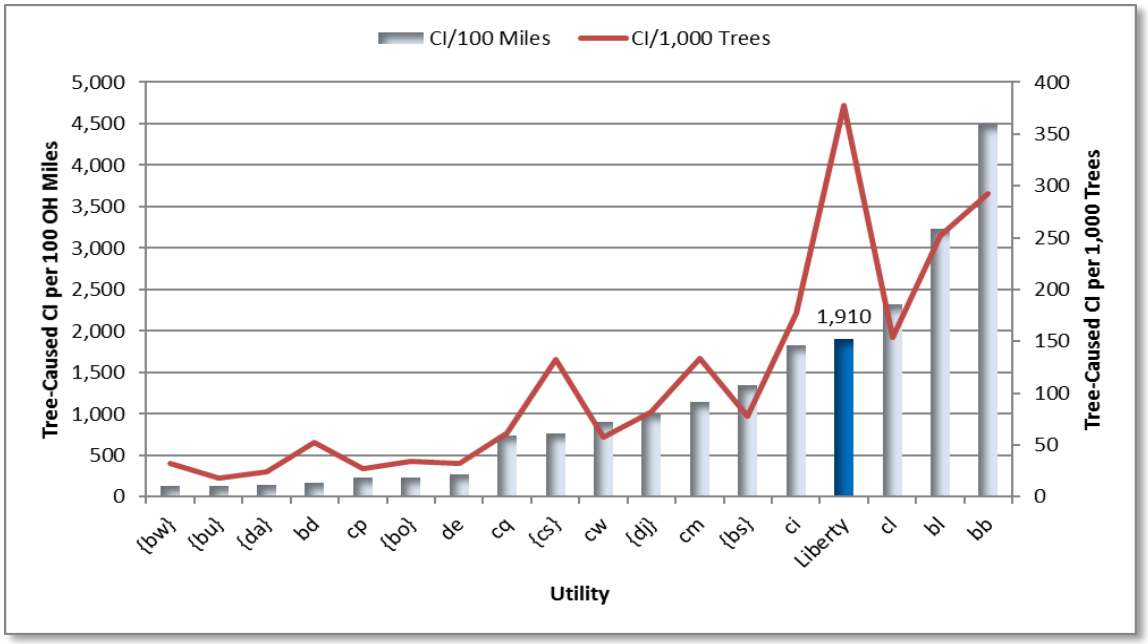

Figure 3-6. Customers Interrupted per 100 Miles and per 1,000 trees for Liberty Utilities for Years 2013 through 2017, as Compared to a Benchmark Group.

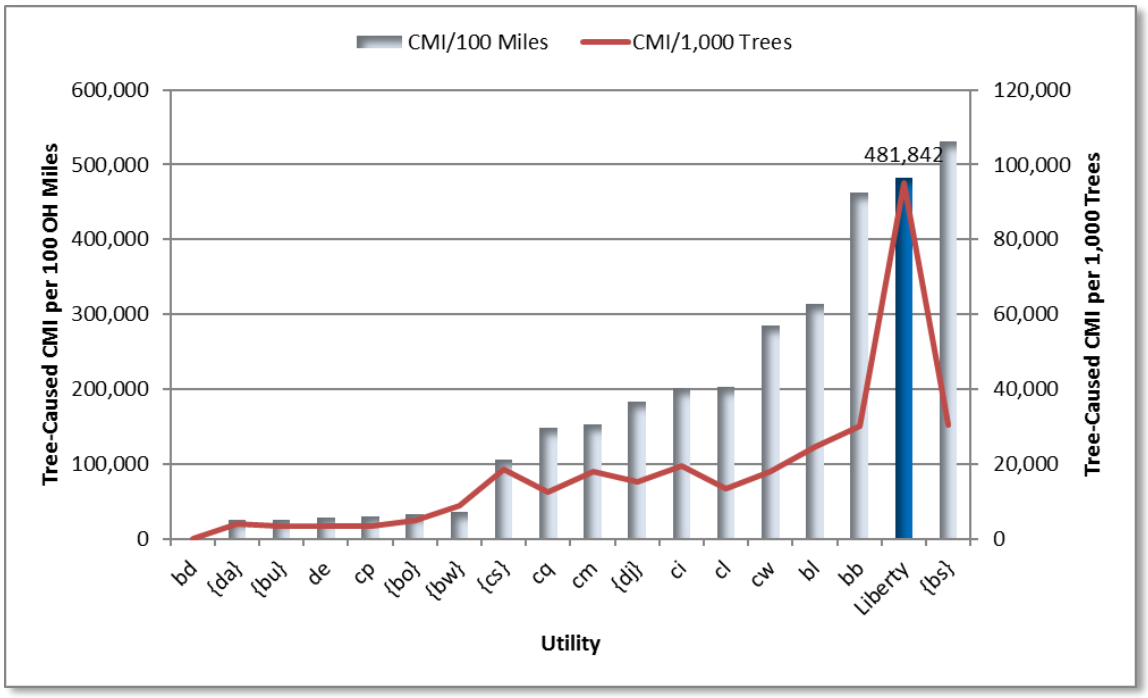

Figure 3-7. Customers Minutes Interrupted per 100 Miles and per 1,000 trees for Liberty Utilities for Years 2013 through 2017, as Compared to a Benchmark Group.

Customer Interrupted (CI) and Customer Minutes Interrupted (CMI) are driven by the high percentage of multi-phase lines on the Liberty Utilities system. High average customers per device will preclude Liberty Utilities from becoming top-quartile in these metrics unless a concerted effort is made to further sectionalize the multi-phase system through the addition of auto-reclosers or fuses.

Figure 3-8 summarizes Tree SAIFI for Liberty Utilities as compared to the benchmarked utilities. Tree SAIDI and CAIDI are presented in **Figure 3-9** and **Figure 3-10**. Crew response and repair time (duration) significantly impact SAIDI and CAIDI. It should be noted however, that duration is often outside the control of the vegetation management program and care should be used in placing too much emphasis on these two indicators. SAIFI associated with tree only outages are below the benchmarked average.

The multi-phase portion of the Liberty Utilities system are more prone to tree-caused interruption events per mile than the single-phase portion of the system. However, less than 10 percent of the Liberty Utilities circuit mileage is classified as single-phase. Analysis of the multi-phase versus single-phase outages did not yield any potential benefits of a split cycle between backbones and laterals to further drive reliability improvements.

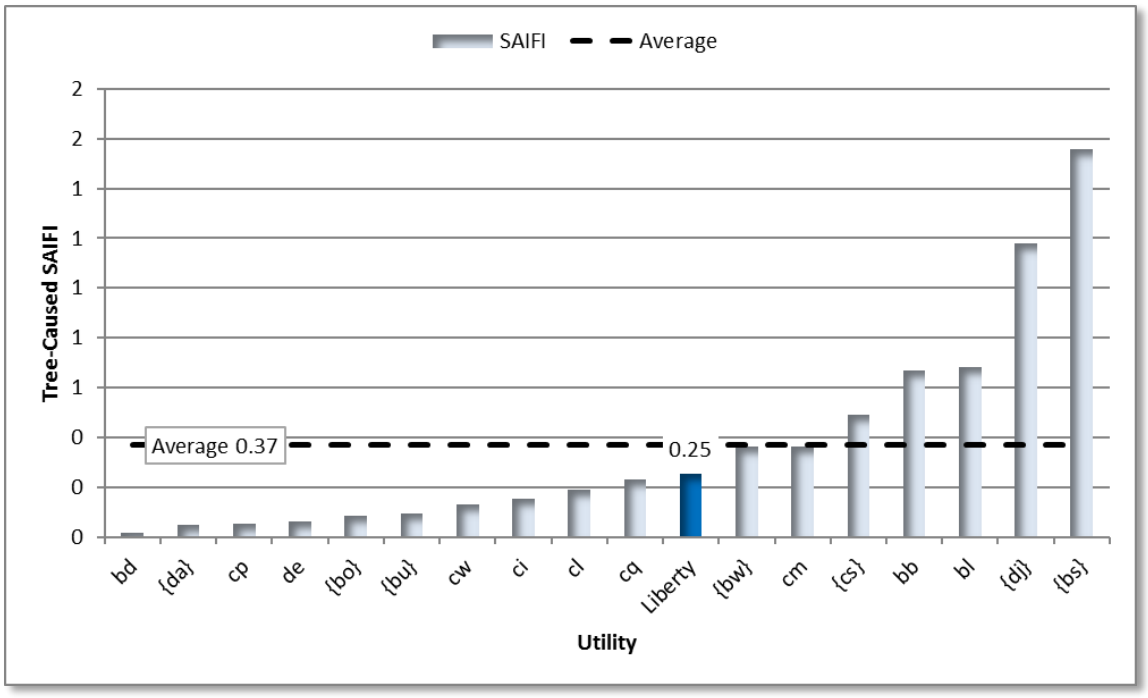

Figure 3-8. Liberty Utilities – Average 2013 through 2017 Tree-Related SAIFI, as Compared to a Benchmarked Group..

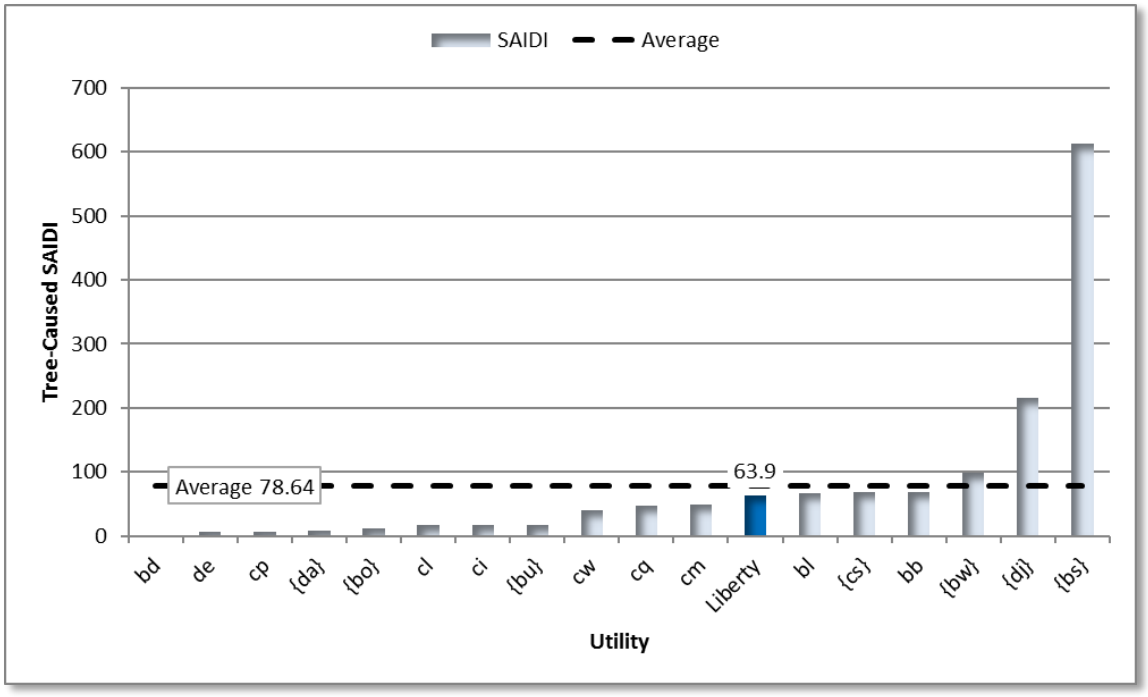

Figure 3-9. Liberty Utilities – Average 2013 through 2017 Tree-Related SAIDI, as Compared to a Benchmarked Group.

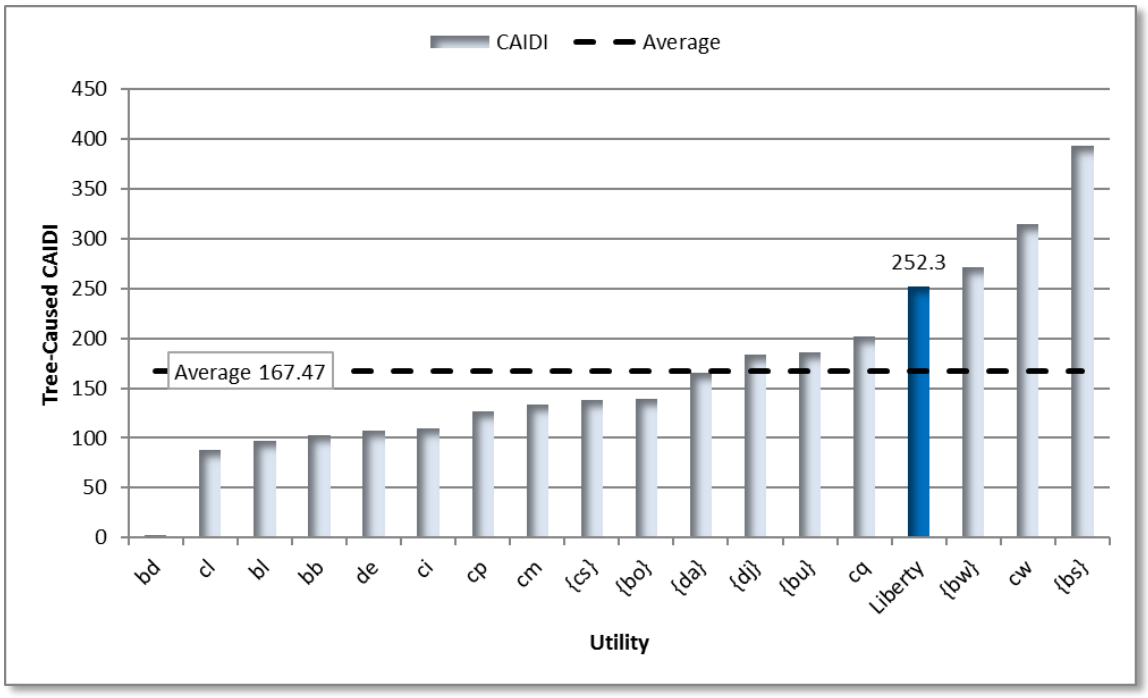

Figure 3-10. Liberty Utilities – Average 2013 through 2017 Tree-Related CAIDI, as Compared to a Benchmarked Group.

3.4 Expenditure History and Production

3.4.1 Program Expenditures

Scheduled work is far more efficient than non-scheduled reactive, Tags, or "hot spot" work in terms of cost versus benefit. Non-scheduled reactive maintenance often has minimal impact on reliability and frequently costs two to five times more per unit than does scheduled work. However, a certain base level of reactive maintenance is necessary. Many utilities strive to restrict reactive maintenance to 10 percent of the total reactive and planned maintenance budget; however, Liberty Utilities averaged 13 percent between 2012 and 2017 with a high of 19 percent in 2017 alone. Refer to **Table 3-1** and **Figure 3-1** in Section 3.1.3 for the historical Liberty Utilities vegetation maintenance total expenditures by work type.

The high removal rates between 2013 and 2017, which averaged 53 percent, was a major cost driver for Liberty Utilities. As a result (**Figure 3-11**), the historical unit production at Liberty Utilities is higher than the average of the benchmarked utilities at 1.68 man-hours per tree. In comparison, a typical utility removes between 15 to 20 percent. Therefore, the slightly higher than average rate for Liberty Utilities is commendable.

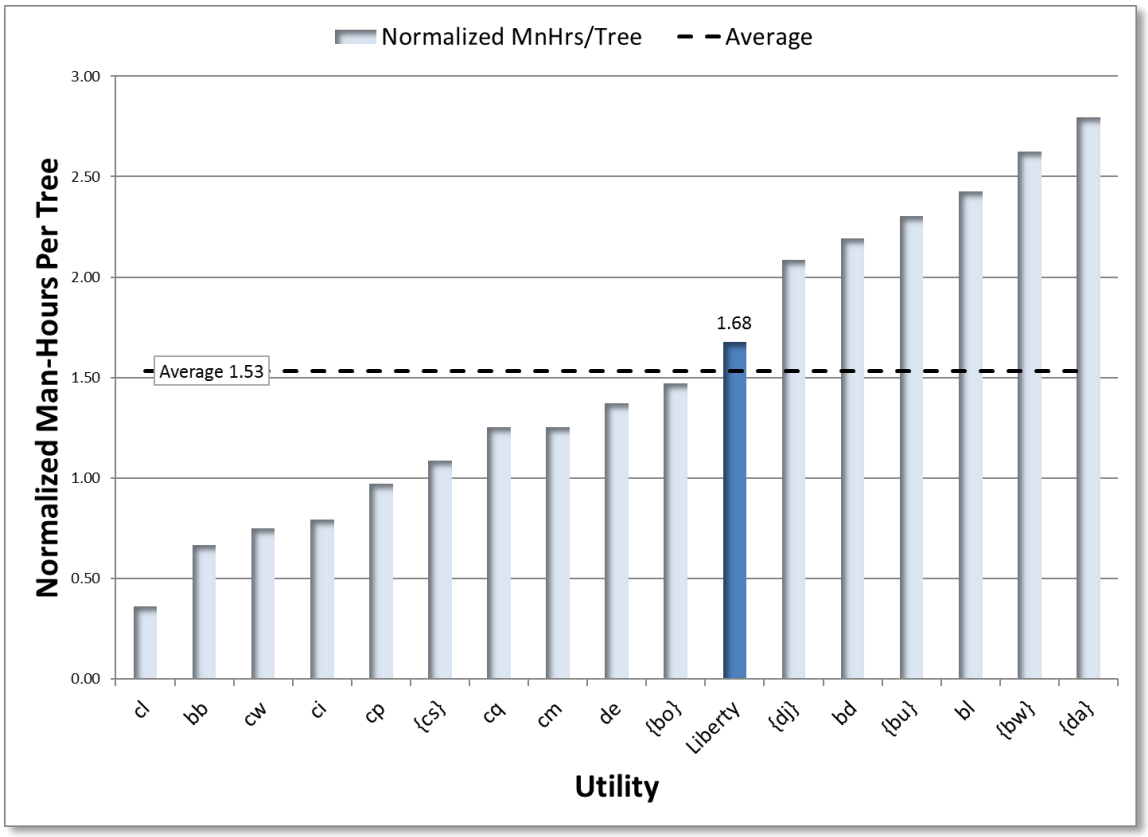

Figure 3-11. Average 2013 through 2017 Man-Hour Per Tree Trimmed (Including Supervision and Planner Hours), Liberty Utilities Compared to Benchmark Utility Group.[5]

Cost per tree at Liberty Utilities during that same time frame was also high in comparison to the benchmarked group (**Figure 3-12**). Normally, a cost per tree over $50 is considered high. Again, considering the high percentage of removals obtained by Liberty Utilities and with 71 percent of those removals coming from larger more costly removals (≥ 12" d.b.h.), $82 per tree is respectable.

[5] Normalized for on-road vs. off-road and urban vs. rural.

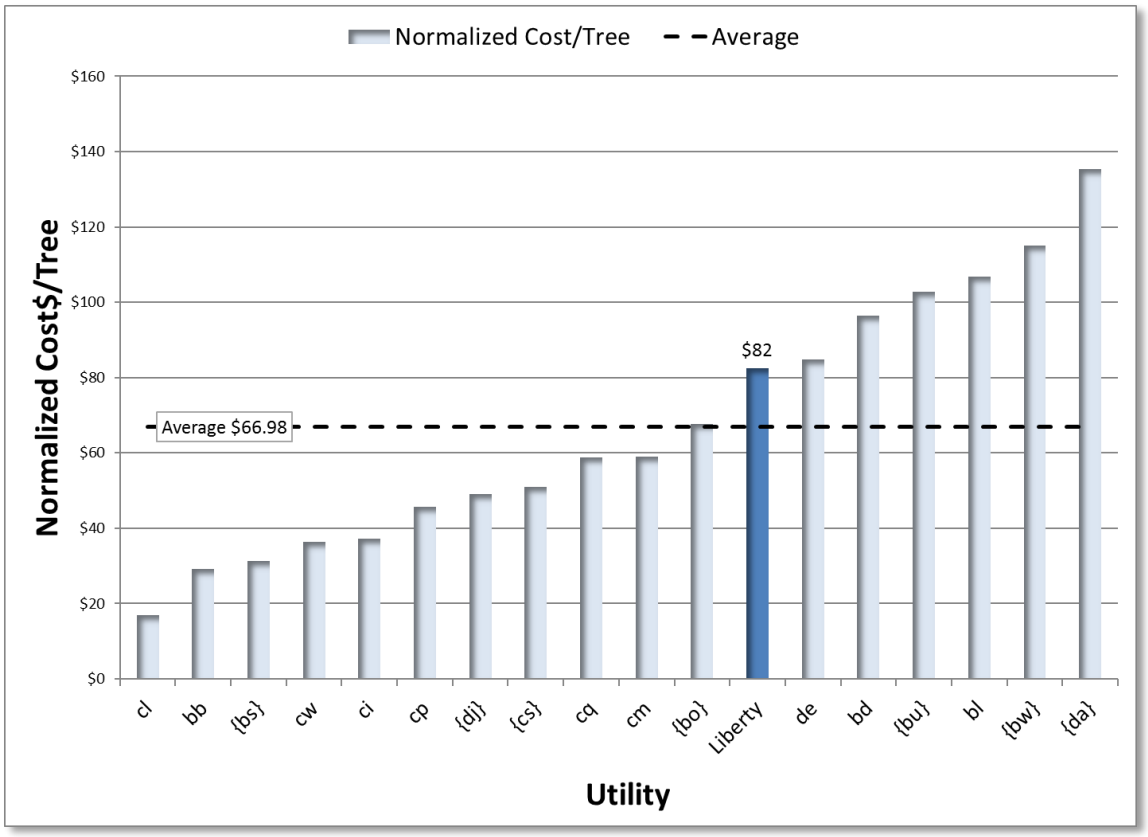

Figure 3-12. Average 2013 through 2017 Cost Per Tree Maintained, Liberty Utilities Compared to Benchmark Utility Group.[6]

Analysis of crew rates offers an explanation for the higher than normal cost per tree rates. **Figure 3-13** shows that average crew rate for a 2-man bucket crew on the Liberty Utilities System is $213 per crew hour which is more than double the crew rate in the benchmark group. The reasons for the high cost per tree unit, therefore, rests namely on high local labor rates for the crews on the Liberty Utilities system.

[6] Normalized for crew rates, on-road versus off-road, and urban versus rural.

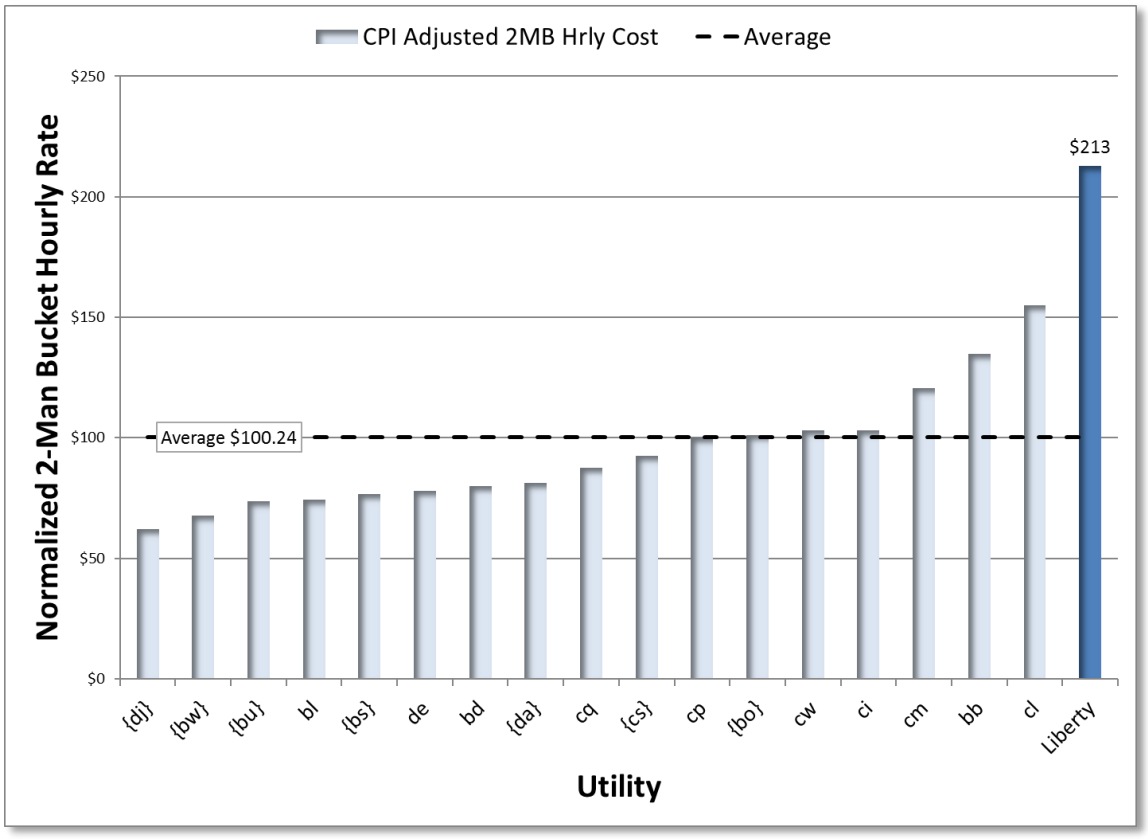

Figure 3-13. Average Crew Rates for a 2-Man Bucket on the Liberty Utilities System versus the Benchmarked Group.

3.4.2 Annual Maintenance Cost Comparison

Figure 3-14 illustrates the relative cost of vegetation maintenance operations at Liberty Utilities compared to the benchmark group. Cost is normalized for differences in tree density, local tree crew billing rates, accessibility of vegetation to aerial lift equipment, and the percentage of urban versus rural miles. Liberty Utilities' average non-normalized cost per mile is $19,443 for the years of 2016 and 2017. However, the normalized cost per mile while higher than the average for the benchmarked utility group is $16,872. The higher removal rates along with the high hourly crew rates are a significant contributor to the high cost per mile. However, even when considering the higher than average man-hours per tree and cost per tree, along with the much higher cost per crew hour, the opportunity for improvement is limited due to the low number of tree crews on the Liberty Utilities system.

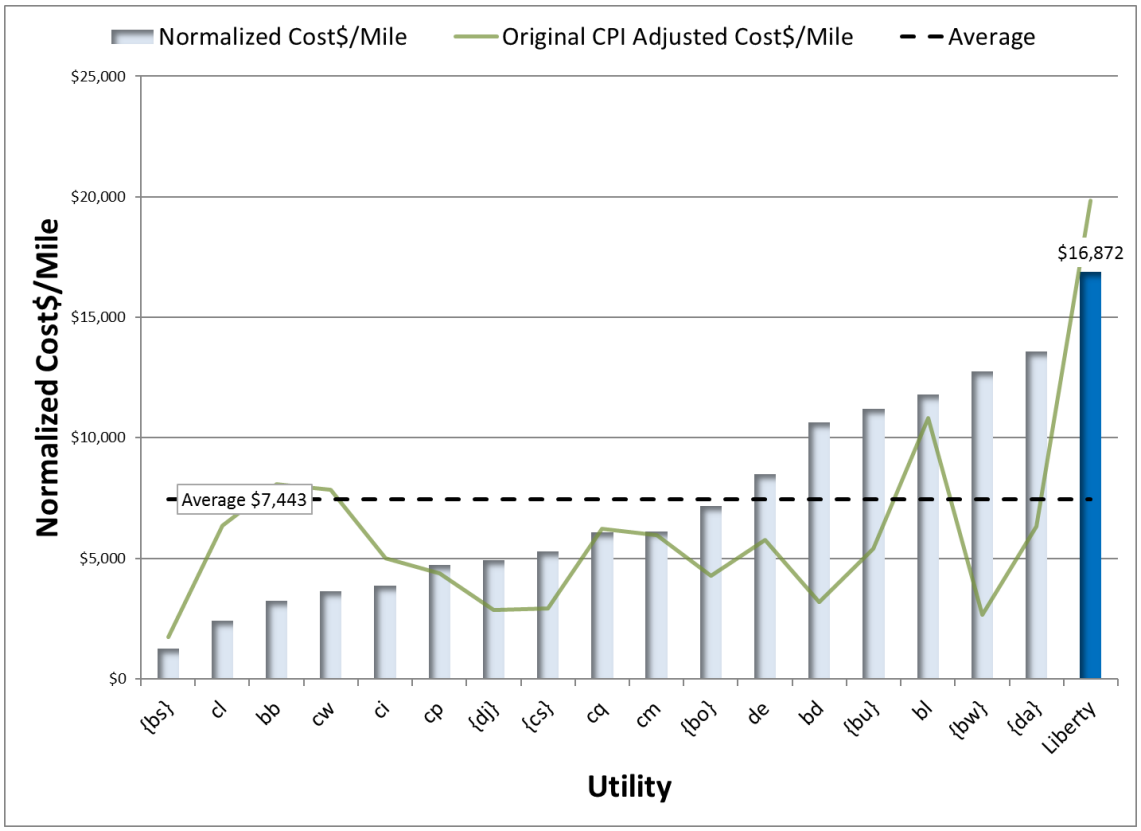

Figure 3-14. Normalized cost per mile comparison normalized for tree density, labor & equipment cost, urban/rural, and the site accessibility – CPI adjusted for 2017.

The normalized average annual asset cost per mile, **Figure 3-15**, consists of all program costs divided by the total OH line miles. Programs with extended cycles (i.e., seven-year cycles) will tend to be lower. A program that spends zero dollars would be to the far left, however, you would expect their reliability to be excessive. It is important therefore, to consider reliability as part of the asset cost per mile analysis.

One of the advantages of the asset cost per mile metric is that it measures all extraneous costs such as contract management or specialized programs (i.e., spray) that all contribute to the mileage being completed. It also removes the biases of reactive/corrective maintenance work being used to perform planned maintenance work to avoid those dollars from being incorporated into the cost per mile. Liberty Utilities' normalized annual average asset cost per mile of $3,362 is well above the average benchmark group. However, interruptions per 100 miles are well below average indicating Liberty Utilities is receiving great reliability benefits (and thereby, fire risk reduction benefits) to offset the additional maintenance expenditures.

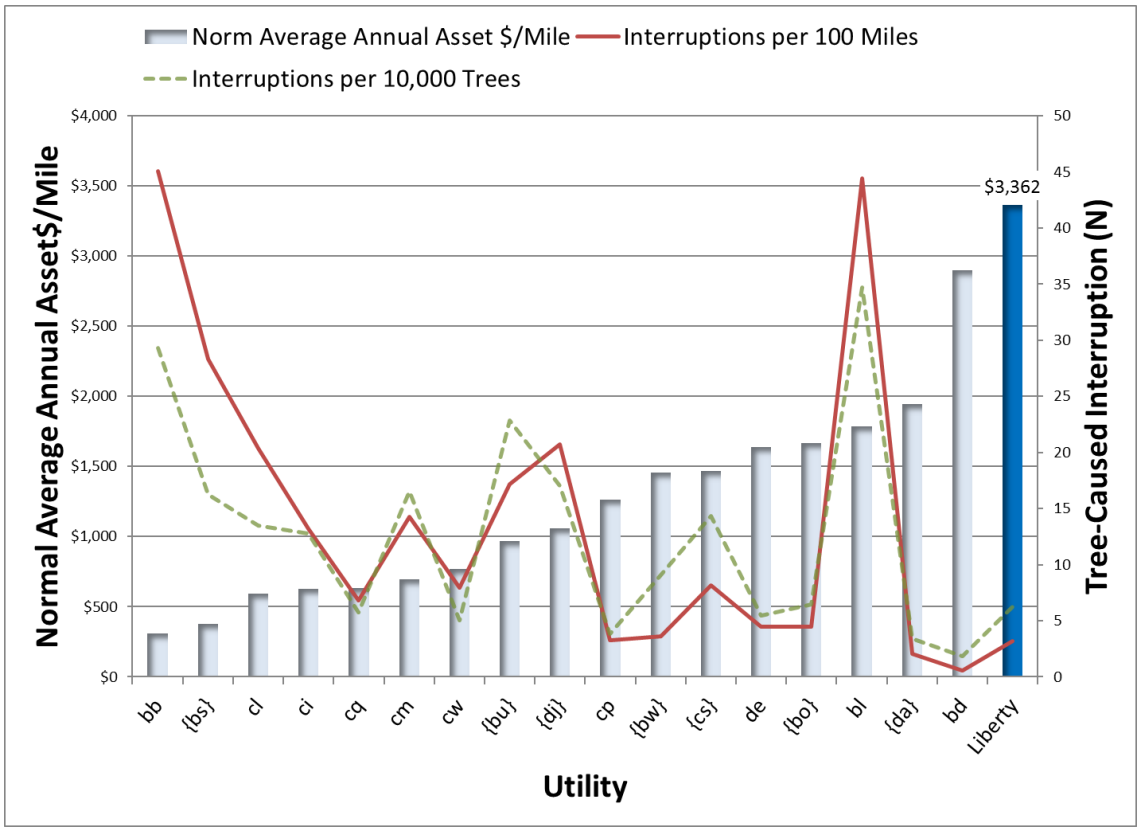

Figure 3-15. Normalized Asset cost per Mile Comparison. Normalized for tree density, labor & equipment cost, urban/rural, and site accessibility – CPI adjusted to 2017 dollars.

LIBERTY UTILITIES

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Liberty Utilities

4.0 Recommendations

4.1 Overview

4.1.1 General Assessment

The Liberty Utilities vegetation management program was evaluated between January and March 2018 to assess current field conditions, operating procedures and work practices. Based on this evaluation, WECI's experience in analyzing numerous vegetation programs, and in comparing Liberty Utilities with a nationwide utility benchmark group, WECI offers the following observations concerning Liberty Utilities current program:

- Tree-caused outages are low even when normalized against tree density.
- Customers Interrupted (CI) and Customer Minutes Interrupted (CMI) are relatively high when normalized against system mileage and tree density.
- Rights-of-way are well maintained and floors are generally devoid of brush.
- Tree-wire contact is minimal due to exceptional clearing to maintain current fire code regulations.
- Man-hours and cost per tree are higher than the averages from the benchmarked group (due to higher than average local labor rates).
- In an effort to meet the current cyclical goal of three-years, funding since 2016 has increased to $2.523M per CPUC allowable limits; however, annual miles completed suggest that current funding is inadequate (approximately 7.3-year cycle).
- Current staffing levels are inadequate to drive a best-in-class program.
- Liberty Utilities does not currently possess the means to easily track historical production and cost data.
- Performance targets to measure contractor production metrics and program goal performance currently do not exist.
- Outage reporting lacks sufficient cause codes for vegetation, preventing detailed analysis of tree-caused interruptions and development of appropriate preventative strategies.
- Long-range circuit maintenance plans do not currently exist. These plans are necessary to drive budget requirements instead of budgets driving program targets.
- Expenditures are difficult to track by work type, making it difficult to analyze program efficiency.

4.1.2 Scope of Recommendations

The assessment covered a wide range of subjects relative to the vegetation management program. The results of the assessment segregate the program elements into the following categories, each appropriately treated in this section.

A. Elements of Liberty Utilities program that were found to be consistent with those of best practice utilities. Little or no further discussion of these items is required in this section. Elements in this category include:

   - Crew headquarters and dispatch
   - Debris disposal
   - Tree removal and pruning

B. Elements of the program where minor comment is appropriate. These elements all fall under the general category of Work Practices (Section 4.2) and are as follows:

   - Tree pruning and removal (Sections 4.2.2 and 4.2.3)
   - Customer relations/notifications (Section 4.3.4)

C. Elements of the program which receive considerable discussion, and which require significant recommendations for change. These elements include:

   - Contract specifications and work standards (Section 4.2.1)
   - Brush control and the consistent use of herbicides (Section 4.2.4)
   - Risk trees (Section 4.2.5)
   - Implementation of a formal QA/QC program (Section 4.2.6)
   - Additional categories for vegetation outage reporting (Section 4.2.7)
   - Contracting for Production Improvement (Section 4.2.10)
   - Program management, supervision and work planning (Section 4.3)
   - Level of vegetation management staffing (Section 4.3)
   - Federal Lands Strategy (Section 4.5)
   - Production data collection and reporting, record keeping (Section 4.6)
   - Maintenance strategies and cost projection, including scheduling alternatives, benefits and cost (Section 4.7)
   - Program funding projections (Section 4.7.2)

4.2 Work Practices

4.2.1 Specifications and Standards

From a distribution and sub-transmission perspective, the *Liberty Utilities Vegetation Management Plan* (Revised March 2015) establishes technical expectations for tree pruning, clearances, tree removal, the treatment of cut stumps to prevent resprouting or the spread of fungi, proper site cleanup, and reduction of fire risk. Reference to American National Standards Institute (ANSI) A-300 standards for tree pruning, OSHA 1910.269, and ANSI Z133.1 are adequately addressed. Overall, the Management Plan is very comprehensive and contains all the vital elements normally found in a best-in-class program document.

Tree Pruning Specifications

Tree pruning specifications at Liberty Utilities are governed by three primary principles: 1) adherence to General Order 95, Rule 35 which dictates minimum tree-to-conductor clearances for all trees on the Liberty Utilities system at all times of the year; 2) adherence to Public Resource Code 4293 which dictates minimum tree-to-conductor clearance during fire season; and 3) adherence to Liberty Utilities standards for tree clearance at time of pruning which are designed to allow for clearances that maintain or exceed the standards for GO 95, Rule 35 and PRC 4293 over a three-year period. The guidelines allow for tree clearances less than the specification where the main trunk of the established tree is closer than the specified minimum or as defined by clearance exemptions in GO 95, Rule 35 and PRC 4293.

Tree Removal Specifications

Liberty Utilities specifications adequately address the guidelines for the types of trees to be considered for removal when they are within the public or private easement or within the maintenance zone (on- and off-ROW).

Other Specifications

Liberty Utilities specifications provide additional information that is often missing in many utility specifications and guidelines. Namely, complete references to the orders and codes mentioned above, as well as pertinent information for minimum approach distances, safety and reporting, as well as facility identification guides.

WECI noted that the current plan is in need of some updates, particularly in reference to the minimum approach distances which recently changed in the new release of ANSI Z133.1 (2017). In addition, updates are required to address recent changes to GO 95 Rule 35 on Tables 13 and 14.

Risk Trees (a.k.a., danger trees, hazard trees)

The specification currently addresses hazard trees as those meeting the definition in the Power Line Fire Prevention Field Guide. Liberty Utilities should also include language contained in the newest ANSI standard, ANSI A300 (Part 9): Tree Risk Assessment. This new standard establishes three levels of risk tree assessment and defines each in detail. This document focuses on the level of risk a tree may pose and establishes guidelines for the tree risk manager (the controlling authority), tree risk assessor and the arborist to follow (as defined in the scope of work).

Liberty Utilities should also specify, per ANSI guidelines, the appropriate level of inspection during scheduled work. A level one visual inspection is recommended.

4.2.2 Tree Pruning

In total, the pruning practices observed throughout Liberty Utilities service territory meets the accepted arboricultural standards for utility line clearance, as described in the American National Standards Institute ANSI A300 (Part 1) tree pruning standard.

Whether overhanging limbs are removed when trees are pruned can have a significant impact on reliability, fire risk, and vegetation maintenance cost. The industry has found that branches overhanging the conductors can be one of the most significant threats to service reliability. This is particularly true for weak wooded species with excessive overhang. WECI is generally not a proponent for the removal of all overhang, without regard for species, but, WECI does recommend Liberty Utilities continue to remove all overhang to mitigate fire risk (as currently identified in the clearance specification). Normally a wholesale approach to removing all overhanging limbs to reduce the risk of broken limbs falling on or across conductors will prove extremely expensive, cause unnecessary resistance from utility customers, and only provide marginal improvement in system reliability. However, since Liberty Utilities has been successful in the past in removing most of the overhang, the need for the removal of large diameter limbs to meet the overhang criteria should be minimal.

Minimum Clearance

There are three key factors that determine the appropriate pruning cycle for a given area: (1) the characteristics of the tree workload (primarily species composition), (2) local regrowth rates, and (3) the clearance achieved at the time of pruning. Utilities can encourage removal of fast-growing species and trees directly under the lines and can enforce the use of natural pruning techniques to slow the regrowth. Otherwise, they have little control over the first two factors. On the other hand, a utility can significantly influence the clearance obtained at the time of pruning.

Specific standards in feet of clearance to be achieved at the time of maintenance are included in the *Liberty Utilities Vegetation Management Plan* (Revised March 2015). These clearances are within the range that many effective line clearance programs can achieve. Liberty Utilities distribution and sub-transmission clearance specifications are listed in **Table 4-1**. In addition to the Liberty Utilities specific clearance standards, Liberty Utilities must adhere to the clearances defined in General Order 95, Rule 35 and Public Resource Code 4293 which dictate clearances of trees from energized facilities to reduce fire risk.

WECI observed that Liberty Utilities has been successful in obtaining clearances as mandated and found little to no encroachment on the energized facilities. Crews performing initial clearing are diligent in removing those trees that either show signs of defect or cannot be effectively pruned.

Table 4-1. Liberty Utilities Recommended Minimum Distribution and Sub-Transmission Clearance Guidelines.

Line Type	*Voltage*	*Minimum Clearance*	*Notes*
Open Wire Secondary	<2.4 kV	4 feet	
Coated Aerial Cable	<2.4 kV	4 feet	Only prune for strain or for abrasion
Guy and Support Wires	<2.4 kV	2 feet	Only prune for strain or for abrasion
Distribution Primary – Slow/Medium	>2.4 kV to 25 kV	10 feet	Tree species with growth rate of < 2 ft./year. Removal of overhang.
Distribution Primary – Fast Growers	>2.4 kV to 25 kV	15 feet	Tree species with growth rate of ≥ 2 ft./year. Removal of overhang.
Sub-Transmission – Slow/Medium Growers	60 kV / 120 kV	10 feet / 20 feet	Tree species with growth rate of < 2 ft./year. Remove all overhang and remove all trees within wire zone. Remove defective, dead, decayed or suppressed trees within border zone.
Sub-Transmission – Fast Growers	60 kV / 120 kV	15 feet / 25 feet	Tree species with growth rate of ≥ 2 ft./year. Remove all overhang and remove all trees within wire zone. Remove defective, dead, decayed or suppressed trees within border zone.

These Liberty Utilities clearance specifications are considered minimums. During WECI survey data collection, WECI noted that Liberty Utilities has been successful in obtaining minimum clearances on average when considering clearance exemptions. Approximately 88 percent of the side pruned slow and medium growth trees on the Liberty Utilities system are trimmed to less than the 10 feet suggested (see **Table 4-2**). Additionally, approximately 96 percent of the fast-growing trees were pruned to clearances of less than 15 feet. However, it should be noted that a majority of the slow and medium growth trees that comprise the less than 10 feet, are conifers and meet the definition of clearance exemptions. Most of the trees noted with less than minimum clearance was due to the bole of the tree being within the minimum clearance specification. Quaking aspen make up most of the fast-growing trees and nearly all of them (98 percent) were pruned to less than 15 feet (average six-feet at time of pruning). Liberty utilities should re-examine clearances on quaking aspen which comprise approximately 8.7 percent of the total tree population.

Table 4-2. Compares the Percentage of Trees With Clearances at the Time of Pruning of Less Than Liberty Utilities Recommended Minimum Clearances.

			Clearance at Time of Pruning			
Common Name	**Regrowth Rate**	**Frequency**	**<10 Ft.**	**>=10 Ft.**	**<15 Ft.**	**>=15 Ft.**
Alder, thinleaf	Fast	0.5%			100%	0%
Apple	Medium	0.5%	100%	0%		
Sequoia	Slow	0.1%	100%	0%		
Ash, green	Fast	0.1%			100%	0%
Aspen, quaking	Fast	8.7%			98%	2%
Birch, paper (white)	Fast	0.2%			100%	0%
Cedar, incense	Slow	1.7%	100%	0%		
Cherry, ornamental	Medium	0.4%	100%	0%		
Crabapple	Medium	0.2%	100%	0%		
Elm, American	Fast	0.1%			100%	0%
Elm, Siberian	Fast	1.3%			100%	0%
Fir, red	Slow	1.5%	89%	11%		
Fir, white	Slow	22.6%	80%	20%		
Juniper	Slow	0.4%	100%	0%		
Locust, black	Fast	0.1%			100%	0%
Maple, silver	Fast	0.5%			100%	0%
Pine, Jeffrey	Medium	49.0%	93%	7%		
Pine, lodgepole	Medium	9.0%	78%	22%		
Pine, ponderosa	Medium	0.4%	75%	25%		
Pine, sugar	Medium	0.3%	100%	0%		
Poplar, Lombardy	Fast	0.1%			100%	0%
Poplar, white	Fast	0.2%			100%	0%
Spruce, blue (Colorado)	Slow	1.1%	100%	0%		
Willow	Fast	1.0%			69%	31%
Average:			**88%**	**12%**	**96%**	**4%**

It is also recommended that Liberty Utilities continue the practice of overhang removal as specified in the clearance guidelines. Liberty Utilities has been extremely successful in removing overhang of both the three-phase and single-phase portions of its system.

A coordinated approach of good public relations, property owner permission/notification, and proper pruning has allowed many utilities to achieve and, in many cases, exceed minimum clearance guidelines. The existence of a professional certified arborist has shown to be beneficial in talking with customers and municipalities regarding utility pruning requirements. Knowledgeable utility arborists have been effective in negotiating additional clearances despite easement provisions that do not provide explicit rights to maintain trees outside of easement boundaries. Good communication with property owners regarding the need for tree maintenance often allows utilities to avoid customer conflicts over easement provisions. WECI's recommended clearances and cycle length recommendations, combined with a sound, professionally managed line clearance program, have been accepted by utilities, property owners, and public service commissions.

The Liberty Utilities Manager, Vegetation Control and regulatory Compliance has had great success at achieving a high rate of removals. Direct contact with property owners when performing enhanced maintenance (e.g., high percentage of removals) has helped Liberty Utilities in the past, and should continue as part of the process to address trees located outside prescribed easement widths and for permissioning tree removals.

4.2.3 Tree Removal

Based upon the historical data provided by Liberty Utilities (CalpecoVM All Trees.xlsx), removals accounted for approximately 53 percent of the total tree workload between 2013 and 2017. The historical high removal percentage rate was a result of the need to remove defective trees and/or trees identified as hazards. Future workloads as estimated by the WECI field survey suggests that while these efforts have reduced the overall hazard tree workload substantially, the number of potential removals going forward will remain relatively high, at least through the first two cycles.

Trees growing close to the conductors must be pruned or removed to prevent interference with line reliability. Proper pruning techniques can inhibit and redirect growth to extend the time between maintenance cycles. However, pruning is still only a temporary measure. On the other hand, tree removal can provide permanent clearance and eliminate future trunk or limb failures. Removal of trees in conjunction with a selective cut surface herbicide treatment program to inhibit sprouting of deciduous species will provide both short and long-term benefits (see discussion on herbicide use). Liberty Utilities' practice has been to cut trees and treat the stumps of coniferous trees to prevent fungi spread, however, the treatment of deciduous stumps to prevent resprouting is rarely done.

The critical element of cost-effective tree removal is proper tree selection. It is almost always cost-effective to remove small trees (4"-12" diameter), but the economics of removal change quickly as tree size increases (see **Section 3.2.3**, **Figure 3-3**). It is common for utilities that do not target large trees for removal to have high numbers of small trees, and, to report average removal costs that are about equal to their average pruning costs. This comparison is dependent on the maintenance cycle length. While beneficial to maintain a low cost per tree removed, there is economic justification on a net present value basis to removing some larger trees, even if the cost of removal is somewhat greater than the cost of pruning. Liberty Utilities should continue to monitor and document information regarding trees removed to assess the extent of this opportunity versus the cost in achieving desirable reliability. As stated previously, many of the trees removed on the Liberty Utilities system are larger trees that show visible signs of defects. These trees will continue to be removed to mitigate fire risk.

4.2.4 Brush Control

Brush Control

Liberty Utilities incorporates limited aspects of Integrated Vegetation Management (IVM) in respect to the management of brush on the distribution and sub-transmission system. IVM is the process of using biological, chemical, manual or mechanical maintenance techniques to control undesirable vegetation. The selection of control options is based on effectiveness, site

characteristics, environmental impacts, safety and economics. In relation to herbicide applications, the key components of IVM include the proper prescription, herbicide selection, and timing of herbicide applications in the appropriate areas based on individual site conditions. Herbicide application opportunities are extremely limited on the Liberty Utilities system. WECI estimates that are no more than 15 total acres of brush to be maintained. Therefore, there is currently limited opportunity for savings utilizing chemical control.

It should be noted however, that hand cutting or mowing brush without applying a follow-up herbicide application to the stump surface will permit the vegetation to re-sprout, thus requiring future maintenance. Pruning brush and/or allowing it to mature results in it becoming a more expensive, and often permanent, part of the future workload. Field review of the Liberty Utilities distribution and sub-transmission system demonstrated that the right-of-way floors are being effectively cleared (**Figure 4-1**).

WECI recommends that Liberty Utilities continue to aggressively ground-line cut/mow brush, and begin to stump treat with appropriate herbicides whenever possible. This will prevent future expansion of the distribution and sub-transmission workload and future line clearance cost increases.

Figure 4-1. Example of Cleared Right-of-Way Floor on the Liberty Utilities Distribution System.

Herbicide Use

The use of cut/stump herbicides is essential if Liberty Utilities is to maximize the benefits of its distribution and sub-transmission tree and brush removal programs. Herbicide use is an

important component of an IVM strategy. The effectiveness of selective herbicide applications has been well documented through long-term studies on utility rights-of-way in the central and northeastern United States. Results from treatment simulation models developed through these studies project that sites dominated by deciduous species would nearly double in stem density by the end of two cycles if simply cut without a follow-up herbicide application (**Figure 4-2**). These same sites would be expected to exhibit about a 50 percent reduction in stem density over the same time period if treated with a selective herbicide application.

An important consideration is that the use of herbicides must be environmentally safe and professionally applied and supervised to maintain public acceptance. Line clearance crews performing herbicide applications should receive proper training in species identification and herbicide application methods. The Manager, Vegetation Control and Regulatory Compliance should be responsible for the implementation of a comprehensive herbicide use policy and for selecting approved herbicides. Professional supervision by the line clearance contractor's foreman is essential to ensure safe, effective application on appropriate species and sites. Herbicide application contractors are currently required to be licensed by the states in which they apply herbicides. Liberty Utilities must require contractors to demonstrate compliance with regulatory rules and frequently inspect operations to assure that contractors are operating safely and professionally.

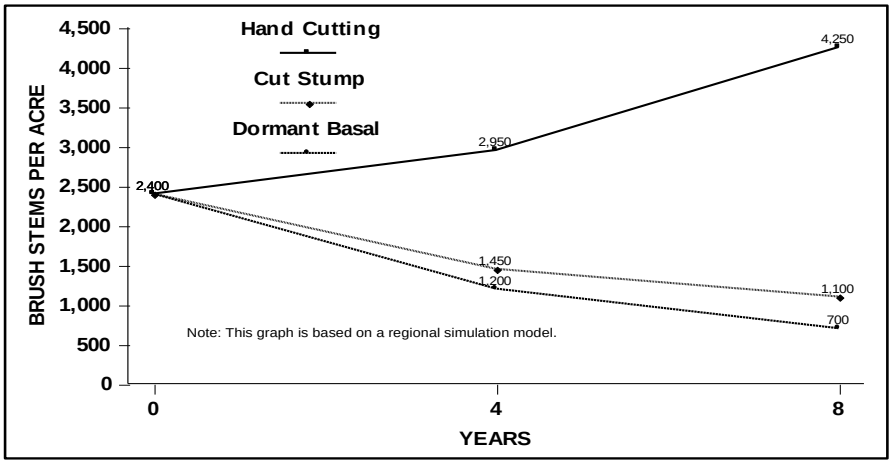

Figure 4-2. Effectiveness of Herbicides for Control of Brush Over Time.

Herbicide Safety and Risk Assessments

Today's herbicides control resprouting by blocking chemicals needed by plants to convert water, sunlight and nutrients into food for growth. Since these same chemicals are not present in animals and humans, the herbicides are very low in toxicity to people or animals. Without any food, the treated weed trees on the ROW wither and decompose. Treated stumps dry out and don't re-sprout.

Herbicides commonly used for stump treatments are U.S. EPA-registered general use products that are commonly available at local garden centers and hardware stores. No special license is required to purchase these products. Prior to registration by the EPA for use, herbicides undergo rigorous testing to assure the public that proper use of these products will not result in adverse risk to human health, wildlife or the environment.

Registered herbicides are safe for humans and the environment and do not cause adverse effects that are unacceptable. In this context, risk assessment is the process by which the likelihood of unacceptable adverse effects from the use of various methods of vegetation management can be determined.

An extensive report prepared by WECI provided the technical basis for and a summary of the risk to human health, wildlife and the environment from the use of 10 herbicides by a New York utility. These herbicide uses included broadcast foliar, selective foliar, basal bark and cut stump applications. This assessment concluded that the margins of safety for herbicide use by the utility that commissioned the assessment were "adequate to assure protection of human health of workers and the general public."

WECI also completed an environmental impact statement resulting in the authorization of herbicides to control ROW vegetation in the Allegheny National Forest in Pennsylvania. Subsequent evaluation of herbicide use in the National Forest confirmed safe and effective use of foliar herbicides to control brush on utility ROW.

The human health risk assessment methodology used in these reports was the one generally recognized by the scientific community (National Research Council) as necessary to characterize the potential adverse human health effects of chemicals in the environment. It is the same process used in judging the human health risk from cosmetics, food additives, pharmaceuticals, various household chemicals and many other materials.

Herbicide Acceptance by Wildlife Groups

Cut surface herbicides are not only used by electric utilities, but also by the U.S. Forest Service on areas such as the Midewin National Tallgrass Prairie in Illinois and by Nature Conservancy on projects designed to limit the spread of invasive and non-native trees and shrubs. Groups such as the National Wild Turkey Federation, Buckmasters, Butterfly Lovers International, Pollinator Partnership of north America and Quail Unlimited have joined together to encourage utilities to implement an "Integrated Vegetation Management" approach to maintaining utility ROW that appropriately utilizes herbicides as a component in the control of ROW vegetation. They have recognized that environmental benefits of herbicides, when properly used, outweigh any adverse risk and are far more desirable than the alternatives to herbicide use, such as frequent mowing or hand cutting of undesirable trees.

Significant research has been undertaken over the past 40 years to document the impact of ROW herbicide use on the environment, wildlife and management costs. Much of this research has been conducted by WECI and its university research associates. Stems per acre decrease over time through the use of herbicides, as does associated maintenance costs.

4.2.5 Risk Trees (a.k.a. Hazard Trees)

Liberty Utilities' interruption data does not distinguish between trees that cause outages through growth across conductors, or because of mechanical failure of tree limbs or trunks. Following detailed root-cause analysis of tree-related outages, utilities that have implemented a systematic preventative maintenance program find that 80 percent or more of tree-caused outages are a result of trees that fail structurally. A portion of these trees are often either dead or structurally unsound and often outside the normal maintenance corridor. These trees, termed hazard trees ("risk trees" under the new ANSI A300 (Part 9)), represent a particular risk to system integrity because of their location and/or condition. However, previous studies involving multiple utilities have reported about 60 percent of these failures to be from limbs of trees that are healthy and without noticeable defects. This, of course, leaves the other 40 percent that did contain failure predisposition factors that could be addressed through an intensive risk tree mitigation program. These same studies also indicated that over 40 percent of all trees that failed and caused interruptions were within five feet of conductors – primarily to the side of conductors, while another 40 percent were over 20 feet away. Consequently, it is important to identify which trees are predisposed to failure on the Liberty Utilities system, target those high-risk trees, and reduce the total number of trees that are close to conductors. This will include trees within 10 feet from conductors but can include any trees that are close enough that if they fell could strike the line.

Cyclic vegetation maintenance on utility systems primarily addresses tree growth issues. Developing a storm hardened electrical system, one that is more resilient under the impacts of high wind, should also be taken into account when developing a vegetation management strategy. Development of a prioritization plan to address hazard tree removals funded over several years can help address risk trees at a manageable cost. Some utilities have improved system reliability through hazard or risk tree reduction efforts. In some cases, the costs of these mitigations have been capitalized or in the case of California, allowed to be charged through CEMA. Eliminating those trees prone to failure will help reduce system damage (broken poles/downed wire), mitigate fire risk, and improve system average interruption durations (SAIDI) and customer average interruption duration (CAIDI). These types of outages (limb/tree failures) often result in significant equipment failure (downed wire, broken cross-arms and poles) thus are longer in duration and have higher restoration costs than simply replacing line fuses.

Equally important risks include those posed by codominant stems and leaning trees. Those defects in tree structure can pose a significant risk to the Liberty Utilities distribution and sub-transmission facilities due to snow and ice loading that may lead to structural failure. The mitigation of those risks should be included in all risk tree assessments.

In California, Public Resource Code (PRC) 4293 dictates hazard tree requirements in State Responsibility Areas (SRA's). The identification of hazard (or risk) trees is clearly defined in the CAL FIRE *Power Line Fire Prevention Field Guide* (2008 Edition).

Bark Beetle (e.g., mountain pine beetle, IPS, and other bark beetles)

Liberty Utilities has invested a great deal of time and effort to date in the removal of hazard trees and bark beetle infested trees that pose a risk to its distribution and sub-transmission systems. Liberty Utilities will invest approximately $300,000 in hazard tree surveys in 2018

as part of the CEMA project. Over the next several years, Liberty Utilities will continue to remove those identified trees to mitigate potential tree failures resulting from mountain pine beetle and other bark beetles as well as other hazard trees.

Bark beetle is a major risk within the Liberty Utilities system. Beetle kills should be carefully tracked and monitored to determine the overall risk and mitigation frequency. One nearby utility utilizes GIS, aerial, and satellite imagery to identify beetle kill areas to determine the potential risk to adjacent electrical facilities. There has been a great deal of research in the Colorado area and at neighboring utilities that can be useful in terms of determining and justifying the frequency of risk tree patrols to legislators and the general public. This research indicates that a two-year risk tree patrol on primary and secondary voltages is appropriate. Liberty Utilities should align themselves with neighboring utilities in their best practices regarding risk tree mitigation to reduce potential liability. Developing a targeted strategy to prevent interruptions caused by beetle kill trees can be expensive as well as challenging.

Fortunately for Liberty Utilities, the State of California has great resources available through CAL FIRE to identify areas of high tree mortality due to drought and bark beetle, as well as fire risk.

High Hazard Zone 2018 GIS Data: http://www.fire.ca.gov/treetaskforce/reports#Maps-Data

Tier 2 CPUC Fire-Threat Map: ftp://ftp.cpuc.ca.gov/safety/fire-threat_map/2018/CPUC_Fire-Threat_Map_GIS/ESRI_Shapefiles/Tier_2_Fire-Threat_Areas/

Tier 3 CPUC Fire-Threat Map: ftp://ftp.cpuc.ca.gov/safety/fire-threat_map/2018/CPUC_Fire-Threat_Map_GIS/ESRI_Shapefiles/Tier_3_Fire-Threat_Areas/

WECI recommends that Liberty Utilities utilize the available GIS layers to help identify beetle kill areas and fire-threat areas on the Liberty Utilities system. The GIS layers should be incorporated to identify those areas with known beetle kill so that targeted and more frequent observation of those areas can be performed. See **Appendix K** for a detailed circuit priority list with the assigned risks.

4.2.6 QA/QC Process

Liberty Utilities or their designated representative(s) perform informal quality control audits on contractor's work per Section 8 of the Liberty Utilities *Vegetation Management Plan* (revised March 2015). The quality audits include the inspection of a minimum of 15 percent of the work performed by Utility Foresters (work planners), vegetation contractor completed tree, and completed work performed by the pole clearing contract crews. Utility Foresters are audited based on the number of locations which were inspected. Utility Forester inventories are audited for location accuracy, correct tree prescriptions, routing, and proper crew type designation. Tree work contractors completed work is audited based on the adherence ISA tree pruning standard, clearance distances obtained, adherence to Utility Forester tree work prescriptions, and the quality of the disposal of debris. Pole Clearing contractors are audited based on the radial circumference of the cleared area around the pole, vertical height of flammable vegetation or debris, disposal of debris, and the quality of the data entry.

While the current Liberty Utilities QA/QC process is adequate, there is a need to formalize the process and reduce the number of required random samples. Resource limitation often make it difficult for Liberty Utilities to meet the 15 percent sample target. By formalizing the

process to utilize a Six-Sigma approach, Liberty Utilities can ensure quality controls with fewer resources.

QA/QC is the single most important process to ensure that services purchased meet the contractual obligations of the contractors and the expectations of the utility. Quality assurance (QA) and quality control (QC) are activities used to prevent and identify product defects to ensure the delivery of high quality products. QA is a set of activities for ensuring quality in the processes by which products are developed. In the management of vegetation on rights-of-way, a quality assurance program entails performing crew evaluations to measure crew safety, productivity, efficient use of equipment, adherence to work specifications, etc. (see **Appendix H** form example). Statistical process control (SPC) is a category for analytical tools used to measure the stability and capability of processes being performed. An advantage of SPC over other methods of quality control, such as "inspection", is that it emphasizes early detection and prevention of problems, rather than the correction of problems after they have occurred. Stability analytics are used to measure consistency in the process (i.e., proper equipment setup to avoid wasted time between trimming trees) and over time can be used to detect deviations in the process. Capability analytics are used to determine if a specific process can meet the target values required by a customer(s) and if the process results in a product that falls within lower and upper spec limits. The Taguchi Loss Function, developed by the Japanese business statistician Genichi Taguchi, is another tool used for QA analytics to determine the value of products produced by a company. If the process performed by a company begins to shift from spec, the Taguchi Loss Function graphically depicts the incurred cost to the customer.

QC is a set of activities used to identify (and correct) defects in the finished product. Quality control, therefore, is a reactive process. Auditing work completed by tree contractors is an example of a quality control program (see **Appendix H** form example). Statistical quality control (SQC) is the term used to describe the statistical methods used for measuring product quality or the quality of work performed. SQC encompass three categories of statistics: SPC, descriptive statistics and acceptance sampling. SPC is generally used for the QA process. Acceptance sampling is the process of randomly selecting the number of items to inspect to determine whether to accept or reject the entire batch (i.e., distribution circuit or line segment). Acceptance sampling is different from SPC because sampling is done after the process has been completed instead of sampling during the process. The keys to acceptance sampling is determining the size of the lot, size of the sample, number of defects that will result in rejecting the batch and the level of confidence in the sample results.

After the tree contractors have completed vegetation line clearance work, utilities may audit 100 percent of the work or only audit a random sample. Both methods have their strengths and weakness even when used correctly. A 100 percent audit allows a utility to report all discrepancies back to the tree contractor to remedy in a timely manner. After the discrepancies have been remedied, an additional audit should be performed to confirm that the identified discrepancies have been rectified before paying the tree contractor. This type of audit requires additional time in the field and if performed as a driving audit, may result in a significant number of missed discrepancies. When auditing a random sample of the work completed, the time required is less but the audit is performed by walking with more attention to detail, decreasing the chance that a discrepancy could be missed. The starting point is randomly chosen for the sample and the length of the random sample is based upon the line segment or circuit length. An audit of a random sample is not designed to identify all discrepancies to be remedied but is used to determine if work performed by tree contractors

meets a determined acceptance level. The acceptance level is a threshold written into the contract language defined by a set number of discrepancies per 100 trees. The threshold can be set differently for discrepancies that are critical (i.e., inadequate side clearance) versus those that are non-critical (i.e., improper cuts). If the work performed by the tree contractor is below the threshold, then the utility accepts the work as complete and pays for the work. However, if the number of discrepancies is above the threshold then the tree contractor is required to re-patrol the entire work unit and remedy any discrepancies. Then a second random sample is chosen and audited. This process continues until the number of discrepancies identified is less than the threshold. The tree contractor agrees to reimburse the utility for the cost required to perform any additional audits if work fails after the second audit.

The report titled "Utility Line Inspections and Audits" (EPRI, 1012443) states that an audit of only five to ten percent of the work completed by tree contractors will provide an accurate representation of overall quality and compliance. While the EPRI report provides support for only auditing a portion of the work completed, the report does not go into the details needed for such a program and that is why WECI recommends a Six-Sigma approach as a guide for developing a random sampling audit program. Six-Sigma procedures use ANSI/ASQ Z1.4 – Sampling for Attributes, for determining sample size and accept/reject rates on work output. While this normally applies to a product being produced from an assembly line in a factory, it can also be applied to the number of trees being pruned to a specific standard. Acceptance sampling is used by industries worldwide for assuring the quality of incoming and outgoing goods. Acceptance sampling plans determine the sample size and criteria for accepting or rejecting a batch (i.e., line segment or entire circuit) based on the quality of a sample, using statistical principles.

Using a random sample methodology enables the utility to decrease sample size and increase the intensity of the audit. Theoretically, the length of time to perform a random sample audit would be shortened because of the large reduction the in the number of miles audited for each circuit.

When performing random sample audits, WECI suggests that discrepancies be split into critical and non-critical discrepancies. The threshold for accepting or rejecting completed work (a.k.a. Acceptable Quality Limits or AQL) should be set differently for deficiencies that are critical or likely to result in tree outages (i.e., inadequate clearance) versus non-critical deficiencies (i.e., improper cuts). WECI further recommends that the acceptance or rejection of work be based on the number of trees that do not meet specification. Discrepancies per 100 trees are a good measure of contractor performance and focuses on critical discrepancies for risk reduction. This unit of measure allows for a more normalized comparison between contractors by eliminating circuit density variations. Refer to **Appendix H** for more detailed information regarding the proposed ANSI/ASQ Z1.4 audit process.

4.2.7 Outage Reporting

Liberty Utilities currently utilizes seven primary outage codes for all tree-related outages:

1. Trees
2. TreesCutout
3. Trees Snow
4. TreesSnow Unloading

5. Trees Structure Down
6. Tree Trimming
7. Trees Wire Down

Approximately 89 percent of the tree-caused outages between 2013 and 2017 were coded to only one cause-code ("Trees"). Utilizing meaningful tree-outage codes is important to understanding the root cause of tree failures as well as in the development of an effective reliability centered maintenance program. The lack of sufficient OMS tree cause-codes and/or their ineffective use limits the ability for Liberty Utilities to analyze fault locations and incorporate that information into the prioritization of circuits. Outages occurring from within the current pruning zone (i.e., grow-ins) require a different management strategy than those trees falling from outside of the normal pruning zone.

An understanding of the vegetation-caused interruption data, coupled with an understanding of Liberty Utilities current clearance specifications and management practices, can lead to more aggressive targeted enhancements to Liberty Utilities current vegetation program and specific types of vegetation-caused interruptions.

Modifying the existing interruption reporting system by editing the codes related to tree interruptions and ensuring their proper use, will provide a more formal reporting format for understanding how trees are causing outages. The following are suggestions for cause codes that will help to classify the interruption reporting data:

- Tree - Grow In
- Tree - Overhang Limb Failure
- Tree - Trunk Failure
- Tree - Root Failure
- Tree - Snow Loading
- Tree – Private Contractor

In addition to accurate/enhanced cause code reporting on trouble tickets, many utilities routinely require further detailed tree interruption information following tree-related interruptions. Liberty Utilities does not currently conduct post-outage investigations. Post-outage vegetation interruption investigations collect such attributes as tree species, tree or limb distance from the conductor, tree height and diameter, length of limb that failed (if applicable), voltage and number of conductors as well as observations on the condition of the tree (internal decay, up-rooted, broken limb vs. broken trunk, growth caused interruption vs. broken limb or up-rooted tree). These are critical factors in determining the effectiveness of a vegetation maintenance program and they provide key information to the vegetation manager that can be used for strategic planning. However, simply collecting the data is not enough. Liberty Utilities should develop a centralized database to collect and analyze this data to determine common modes of failure. This data can be mined to not only optimize work methodologies but can be extremely helpful in communicating to regulatory entities the modes of failure related to vegetation and the utilities ability, or lack thereof, to prevent these failures. WECI has provided an example data collection form (see example form in **Appendix E**).

System Protection Strategies

In **Section 3** of this report, it was noted that while the number of tree-caused outages per 100 miles of overhead line are low at Liberty Utilities, the normalized number of customers interrupted (CI) and customer minutes interrupted (CMI) are high when compared to the benchmark group. The issue involves the nature of the Liberty Utilities system whereas 90 percent of the system is multi-phase line construction with a relatively high number of customers per protective device. WECI recommends that Liberty Utilities consider construction solutions to lower the impact of tree-caused outages by breaking up line sections through additional fusing or breakers.

4.2.8 Reactive Maintenance

Overall reactive or corrective maintenance (or "Tags") needs should be limited to only that which is necessary to address imminent threats to safety, reliability, and the reduction of fire risks. Historically, reactive/corrective maintenance as a percent of the total Liberty Utilities vegetation management budget has averaged approximately 13 percent between 2012 and 2017 but increased to 19 percent in 2017. WECI recognizes that the increases in reactive/corrective maintenance in 2017 are due primarily in part to deferred maintenance work, extended maintenance cycles, and increases in tree mortality prior to the start of the CEMA program. The latter accounting for a large portion of the increase in 2017. It should be noted that when crews are assigned to prune trees to eliminate incidental contact with primary conductors, this "hot spot" pruning does not normally provide improvements in reliability. Liberty Utilities should continue to focus on reducing these expenditures, in favor of investing program dollars into planned maintenance cycles and risk tree programs. Research has shown that for every tree mitigated reactively, five to seven trees in the same condition can be mitigated proactively when scheduled as part of planned maintenance.

4.2.9 Scheduling

Planned maintenance work units on the Liberty Utilities distribution and sub-transmission system are by circuit. Liberty Utilities' selection process is based upon last maintenance date, annual trimming capacity, safety, fire risk, and empirical data (i.e., reliability data).

The proper scheduling and forecasting of maintenance work is crucial to meeting cycle targets and to maximizing reliability benefits. The maximization of reliability benefits is dependent largely upon the ability of the utility to tie outage data to the work units (i.e. circuits) to be issued. Annual work unit selection should strive to address those work units with the worst reliability issues (e.g., Reliability Centered Maintenance, refer to **Appendix B**). Effective scheduling offers the ability to measure the effectiveness of the vegetation maintenance work performed on that individual circuit. Scheduling at the circuit level offers:

- Ease of scheduling.
- Circuit integrity provided as a result of completing the entire circuit. This allows for the measurement of the effectiveness of the vegetation maintenance work performed on that individual circuit.

- The ability to track the cost of completing a circuit, which can easily be converted to cost per mile for benchmarking.
- The ability for the crews to work more linearly. Following a line from the beginning to the end and working within a compact geographic area makes it easier for tree crews to schedule and track completion progress.

Liberty Utilities currently does not produce a multi-year, long-range maintenance plan (e.g. for the entire cycle). Circuits are selected per annum on an as needed basis during the course of the year. It is considered a best management practice to utilize an annual plan and long-range plan to set mileage targets, production targets, budget targets, and program goals and objectives. WECI strongly recommends the Liberty Utilities utilize the benefits of these plans going forward.

Feeder backbone and associated laterals are trimmed concurrently. Scheduled maintenance work is performed through non-union unit price and time and material (T&M) contracts; however, Liberty Utilities should consider transitioning to target price contract strategy. Target price identifies historical trends and utilizes that data to set production goals for the tree contractors. **Appendix C** provides additional information regarding contract strategy types.

New construction and capital work should be closely monitored. Concerns may arise when little or no lead time is given for these requests. This causes inefficiencies in crew scheduling and may affect maintenance costs when dedicated maintenance crews are reassigned mid-day to support construction. Capital and new construction work is not a budgeted VM item.

4.2.10 Contracting for Production Improvements

Driving out waste in the production system ensures that program dollars are maximized. Time and Material (T&M) contracts are inherently risky. The risk of production falls solely on the utility for which the tree contractor works. However, the freedom of T&M contracts cannot be overlooked. The optimal solution is to develop T&M contracts that operate much like lump-sum or firm price contracts that place the burden of ensuring optimal production, back on the tree contractor.

Some utilities have found it very beneficial to include production targets, incentives, and in some cases, penalties into their T&M contracts for routine maintenance work. Utilities with good historical man-hours and cost data for completed circuits, use this information to set production goals for the tree contractor(s). The historical data can be used to develop "should take" times and cost for each tree unit, much the same as unit price contracts set the cost for each unit.

In the case of Liberty Utilities, where unit price contracts are already in place, the same unit cost rates can be applied to T&M circuits as initial targets. When T&M circuits are issued to the tree contractor, the unit rates can be multiplied by the units inventoried on the work plan to estimate the cost of completion for that circuit (target price). Contractors invoice based on actual hours to complete the circuit and their actual total costs when complete is compared to the estimated target costs from the work plan. Quarterly or annually, the actuals and estimates are tallied up to calculate the delta and determine if the contractor shall receive an incentive payment or be required to pay a remedy. The calculation methodology for determining incentive/remedy percentages should be mutually agreed upon by both the utility as well as

the tree contractor in advance, and set in the contract language. Refer to the following example using one circuit (Circuit XYZ).

Target Pricing Incentive/Remedy Example:

TIER PERCENTAGE SCHEDULE:

Per the incentive/remedy tier schedule agreed to by both parties and set in the contract:

Qualified Bonus Tier Percentage Schedule	
Tier Percentage	**Percent**
± 5%	0%
> 5% to 10%	± 15%
> 10% to 25%	± 25%
> 25%	± 50%

CALCULATED TARGET PRICE FOR CIRCUIT XYZ BASED ON WORK PLAN:

Units	* Unit Price	Quantity Per Work Plan	Target Cost
BR – Brush Removal	$37.09	21	$779
BT -Brush Trim	$54.19	1	$54
CT - Trim – Coated Lines	$39.47	11	$434
F1A – Removal A (4.0” < 11.9” dbh)	$44.25	18	$797
F1B – Removal B (4.0” < 11.9” dbh)	$83.36	6	$500
F2A – Removal A (12.0” < 23.9” dbh)	$143.97	11	$1,584
F2B – Removal B (12.0” < 23.9” dbh)	$245.28	15	$3,679
F3A – Removal A (24” < 35.9” dbh)	$271.24	19	$5,154
F3B – Removal B (24” < 35.9” dbh)	$503.71	3	$1,511
F4A – Removal A (>36” dbh)	$653.44	19	$12,415
F4B – Removal B (>36” dbh)	$1,352.80	25	$33,820
FOA – Facility Protect Overhang A	$83.82	25	$2,095
FOB – Facility Protect Overhang B	$209.27	23	$4,813
FTAA – Facility Protect Trim Minor A	$79.11	25	$1,978
FTAB – Facility Protect Trim Minor B	$115.45	13	$1,501
FTBA – Facility Protect Trim Major A	$223.87	10	$2,239
FTBB – Facility Protect Trim Major B	$381.50	14	$5,341
OV - Overhang Trim	$41.41	2	$83
R1A – Removal A (4.0” < 11.9” dbh)	$40.31	11	$443
R1B – Removal B (4.0” < 11.9” dbh)	$60.55	15	$908
R2A – Removal A (12.0” < 23.9” dbh)	$95.39	12	$1,145
R2B – Removal B (12.0” < 23.9” dbh)	$129.91	5	$650
R3A – Removal A (24” < 35.9” dbh)	$303.09	5	$1,515
R3B – Removal B (24” < 35.9” dbh)	$300.71	2	$601
R4A – Removal A (>36” dbh)	$422.92	5	$2,115
R4B – Removal B (>36” dbh)	$586.61	23	$13,492
SD - Side Trim	$56.29	10	$563
TD - Top Trim	$49.82	13	$648
VT - V Trim	$42.70	10	$427
Total Target Price for Circuit XYZ:			**$101,284**

* Unit prices used are for example only and not reflective of actual unit prices on the Liberty Utilities system to protect contractor.

INCENTIVE EXAMPLE - WHEN CONTRACTOR BEATS TARGET PRICE:

Unit Description	Quantity x Unit Price
Target Cost for Circuit XYZ	$101,284
Actual Hours Billed Cost for Circuit XYZ	$87,543
Amount Actual Lower than Target Cost	$13,741
Percent Actual Below Target Cost	13.6%
Tier Incentive Percentage	25%
Incentive Amount	**$3,435**

The contractor will be paid $3,435 in incentives for improving efficiencies.

REMEDY EXAMPLE - WHEN CONTRACTOR EXCEEDS TARGET PRICE:

Unit Description	Quantity x Unit Price
Target Cost for Circuit XYZ	$101,284
Actual Hours Billed Cost for Circuit XYZ	$110,323
Amount Actual Higher than Target Cost	$9,039
Percent Actual Above Target Cost	8.9%
Tier Remedy Percentage	15%
Remedy Amount	**$1,356**

In this case, the contractor would owe the utility $1,356 as a remedy for not controlling costs (shared risk).

The idea here is to incent and empower the contractor to make good business decisions regarding improving production. This may be done through a combination of monitoring their own production through increased supervision, providing unique solutions in the form of specialized equipment, or other means. The savings to the utility can be re-invested in completing more line miles which should drive down future cycle costs. It will also be important to specify how incentives are distributed. Both the contractor and its employees must share any incentives to gain the buy-in from employees in driving out inefficiencies.

Target unit prices used to calculate the target costs for circuits should be reviewed and adjusted each contract term.

4.2.11 Conclusions about Work Practices

Recommendations relative to the work practices can be summarized as follows:

- Edit the current Liberty Utilities Vegetation Management Plan (Revised March 2015) document to bring it into compliance with the new 2017 ANSI Z133.1 standard, particularly for minimum approach distances.
- Re-examine actual clearances on quaking aspen which comprise approximately 8.7 percent of the total tree population and validate they meet initial clearing exceptions. This is best accomplished through a formal QA/QC program.
- Continue to treat stumps of all coniferous trees and begin treating stumps of deciduous trees and brush as a routine part of the tree removal and brush cutting operation on the distribution and sub-transmission system.
- Remove codominant stems where necessary to prevent future outages resulting from trunk failures.
- Reduce reactive/corrective maintenance expenditures (or "Tags") to no more than 10 percent of the total expenditures. This should become a natural occurrence once Liberty Utilities achieves a three-year cycle.
- Budget separately for unscheduled reactive work (or "Tags") to prevent the use of non-discretionary schedule work dollars that will affect the ability to meet annual mileage targets. Develop expenditure reports that accurately capture expenditures by work type.
- Develop program and tree contractor Key Performance Indicators (KPI) to drive improvements in crew production. These targets are crucial, particularly with time and material contracts to avoid price creep and to demonstrate fiscal responsibility to upper management and regulators. Revise the current T&M contract to include target pricing metrics to incent the contractor to improve production and lower costs.
- Utilize the publicly available High Hazard Zone and Fire-Threat GIS layers to help identify and quantify funding and resource requirements to effectively mitigate the threat of bark beetle-killed trees and reduce fire risk. Incorporate this data into the circuit prioritization schedules and long-range plans.
- Develop a formal QA/QC program to audit in-progress and completed work to ensure work meets contractual specifications for clearance and work quality.
- Begin to evaluate tree-related interruptions (post-outage autopsies) to increase Liberty Utilities' understanding of, and the ability to communicate, the specific conditions that are most common among trees that fail and cause outages. Create a centralize database.
- Replace the existing OMS tree-cause codes with appropriate codes that may be effective in management decisions modeling and circuit prioritization.
- Develop a detailed annual and long-range program plan to prioritize work and determine program funding requirements and resource needs. These plans are essential in measuring program efficiencies and effectiveness in meeting Liberty Utilities long-term goals. It also provides Liberty Utilities the necessary framework to assist with financial decisions that may impact system reliability.

4.3 Program Management and Supervision

4.3.1 Management

Sound program management forms the basis for an effective line clearance program. WECI's experience with other electric utilities throughout North America, together with best practices benchmarking studies, have pointed toward centralized management of a vegetation management program as the most effective approach. One knowledgeable individual who establishes standards for cost-effective work practices and then enforces them in a uniform manner is credited to the success of these programs. Liberty Utilities follows industry best management practice in this regard.

Productivity and reliability target goals are considered best management practices for sound program management; however, these sometime opposing targets need to work in conjunction with each other. Once the utility determines the circuit schedule for the tree contractors, both reliability metrics and tree density should be considered when balancing out crewing by geographic area. Other targets, such as cost per mile, should be incorporated to balance these metrics.

Of particular concern, is Liberty Utilities' need for annual and long-range maintenance plans. These plans are useful in determining future budget requirements, mileage goals, and resource requirements. WECI strongly recommends Liberty Utilities implement these plans as soon as practical.

4.3.2 Organizational Structure

To drive efficiencies and ensure effective work flows, every organization should have a strategic business configuration that clarifies reporting relationships, roles, and responsibilities as well as define good communications processes. While choosing the appropriate organizational structure for Liberty Utilities, WECI considered the seven fundamental organizational structure types as they relate to Liberty Utilities overall organizational structure and the appropriateness of each structure based upon the needs of the evolving vegetation management program. The seven organizational structure types considered were:

1. Functional
2. Divisional: Product-Based
3. Divisional: Market-Based
4. Divisional: Geographical
5. Process-Based
6. Matrix
7. Circular

Based on WECI's cursory review of Liberty Utilities vegetation management program, future goals and objectives, along with WECI's knowledge of effective vegetation management programs from across the country, two structure types were identified as the most appropriate; functional and geographical.

Functional organizational structures are one of the most common business organizational structure types (Devaney, 2014). Liberty Utilities as an organization is functionalized by core

activities or departments that share common skills and expertise. For instance, human resources, customer service, external affairs, accounting, purchasing, operations, vegetation management, meter reading etc. are functional alignments that maximize the effectiveness of each group. While there is or can be a geographical component to the functional organization, what sets functional organizational structures apart from pure geographical organizational structures is that in geographical structures, each geographical area (e.g. division, region, service center) operates independently from one another and possess a repetitive or duplicate functional structure within each area. In the case of vegetation management, a geographical organizational structure would include a supervisor or manager for each geographic region. Each of these supervisors or managers would be responsible for all of the vegetation activities occurring within their respective geographic areas including: work planning; execution of planned and reactive maintenance; quality control and assurance; and project management. Geographical organizational structures work well where a company needs to focus on localized strategies or when customer expectations vary significantly between areas (Suttle, 2015).

Liberty Utilities Vegetation Management program shares a common customer satisfaction goal and execution expectations within its service area. Consistency in vegetation management processes across the Liberty Utilities service area is crucial. The small geographic area lends itself to the need for a functional organizational structure.

Roles

Within functional organizations, there a several work functions that are common to many larger utility vegetation management programs. Those functions include:

1. Contract administration
2. Budgeting
3. Annual and Long-Term Scheduling
4. Work planning
5. Auditing
6. Planned maintenance work execution
7. Reactive maintenance work execution
8. Customer communications and education

Project Management

Generally, the first three functions can be combined under Project Management. Project Management is defined by the Project Management Institute (PMI®) as “the application of knowledge, skills, tools and techniques to meet project objectives. Project Management is accomplished through application and integration of the project management processes of initiating, planning, executing, monitoring and controlling, and closing” (Hollenbaugh & Ostrander, 2006). Project Management typically includes:

1. Developing and maintaining standardized clearance specifications and guidelines.
2. Setting system and regional performance goals and objectives for the vegetation management program.

3. Developing and monitoring program metrics to measure compliance with program goals and objectives.
4. Defining and standardizing system processes and procedures.
5. Managing vendor contracts, including contract specs, bid documents, and contract incentive programs.
6. Developing short and long-term budget requirements.
7. Monitoring and tracking of vegetation management expenditures and ensuring expenditures are within approved budgets.
8. Developing short and long-term annual plans and overall schedule based on system performance goals.
9. Drive new technologies to better enhance performance tracking.
10. Internal and external stakeholder communications/reports regarding budget and target compliance.
11. Regulatory compliance support.

A strong leader or manager with a thorough understanding of Liberty Utilities' overall Vegetation Management program and strong analytical skills is required to ensure the success of this function. Additional analytical support reporting to this manager will be required to manage the magnitude of data and reports that will be required.

The remaining functions will be distributed to the regional arborists in charge of contract compliance or their subordinates.

Work Planning

Work planning (pre-inspection) involves the identification of the work scope to be provided to the contract tree crews for execution. Work Planning is essential to control program costs by preventing over-execution whereby tree crews misidentify vegetation requiring maintenance that will have little or no impact in outage reliability or in the attainment of program goals and objectives. Conversely, it will also prevent misidentification leading to under-execution of work that may lead to increased tree-caused outages. Work planning differs from resource planning commonly done by the tree contractors to determine which crews should be applied to various pieces of the work scope. Work planning functions include:

1. Ensuring that tree crews are adequately supplied with scheduled work to maintain high levels of production.
2. Identifying and recording individual work units to be maintained that meet the goals and objectives of the vegetation management program.
3. Removing customer barriers or other obstacles to allow tree crews to focus on production.
4. Obtaining customer permissions for removal and/or obtaining permits.
5. Ensuring customer satisfaction by clearly defining the scope of work.
6. Preparing work packets for tree crews.

7. Act as a liaison between the tree contractor(s), Liberty Utilities, and customers.
8. Address and escalate customer issues to Liberty Utilities management.

This function is often performed by third-party contractors. Third-party work planners should report to a Liberty Utilities arborist responsible for that geographic region. Liberty Utilities currently work plans (pre-inspection) effectively.

Auditing

The inspection of work, both in-progress as well as completed work, is essential for cost control and to ensure that work is being performed to contractual standards. In-progress work or quality control (QC) is the auditing that takes place while the work is being performed that will lead to a consistent and desirable end product. QA audits are performed at work completion to ensure that the work meets contractual specifications prior to the release of contractor payments. The auditing function includes:

1. Random inspection of in-progress tree work to identify defects prior to work completion. This allows the tree contractor to remedy the defects before crews leave the site.
2. Inspection of all completed tree work for contractual compliance.
3. Issuing defects back to the tree contractor for remedy and tracking that remedies are completed timely.
4. Tracking defect metrics that can be utilized in performance measures and incentives.

The auditing function at Liberty Utilities may be performed by vegetation management consulting foresters that perform both the QA and QC audits of the contract tree crews and completed work. In addition, the consulting foresters can also perform random QC audits on work planning to ensure that work planners are consistent and identifying work. WECI recommends a Liberty Utilities arborist manage the oversight of these contract auditors if used.

Planned Maintenance Work

The Planned Maintenance Work function involves the direct oversight of field tree crews in the performance of planned maintenance work. This function includes:

1. Direct customer communication regarding planned maintenance work activities.
2. Monitoring customer notification process and procedures for planned maintenance work.
3. Customer complaint resolution and ensuring complaints are resolved in a timely manner.
4. Managing customer expectations through face-to-face meetings and customer education.
5. Determining and managing resource requirements.
6. Work scheduling and assignment of work packets to contract tree crews and tracking progress.

7. Monitoring in-progress and completed work regarding contract compliance.
8. Ensuring planned maintenance work activities are completed within budget parameters.
9. Monitoring contractor performance to maximize productivity.
10. Ensuring program maintenance targets (i.e. miles complete) are met.
11. Managing internal and external obstacles that may hinder work unit completion.
12. Ensuring that crews stay focused on planned maintenance work and prevent the unnecessary pulling of crews that may impact target completion.

Planned maintenance work execution has the highest customer visibility and potential to impact customer satisfaction. WECI recommends therefore, that Liberty Utilities provide well-trained regional personnel to manage this function with direct oversight by a system arborist.

Reactive Maintenance Work

The Reactive Maintenance Work function, like its Planned Maintenance counterpart, involves the direct management of execution crews and has to a lesser degree, high customer visibility. However, much of the reactive work function is geared toward managing internal and external requests for maintenance that fall outside of the planned maintenance work scope. Customer requests for tree maintenance, hot-spot request from operations or other internal Liberty Utilities groups, and restoration support fall within this function. Reactive maintenance may include:

1. Managing customer and other reactive requests and accurately track work progress and completion.
2. Inspecting reactive requests prior to issuing to tree crews to manage workload and prevent the unnecessary waste of program dollars.
3. Managing internal reactive maintenance requests by proactively working with operations groups to maximize impact of limited funding.
4. Managing customer expectations through personal contact and education.
5. Ensuring valid reactive requests are completed per accepted service level agreements.
6. Managing resource requirements and ensuring adequate resource coverage is maintained to support restoration needs.
7. Working with Planned Maintenance functional group to acquire resources when workload exceeds current resources and in emergency situations.
8. Monitoring contractor performance to maximize productivity.
9. Monitoring in-progress and completed work regarding contract compliance.
10. Performing tree-outage autopsies for root cause analysis.

Customer Communication and Education

This function plays an integral role in the success of the Liberty Utilities vegetation management program. As the Liberty Utilities Vegetation Management program or maintenance strategy changes, customer perceptions and expectations will require close management. This functional role includes:

1. Integration and alignment of corporate messages throughout various communication tools.
2. Assisting in the creation and dissemination of messages related to corporate direction, policy matters, and other relevant topics.
3. Translate services and product strategy into effective marketing plans and communications materials.
4. Developing technical articles, brochures, and advertisements and the development of on-line content for corporate website.
5. Direct interface with customer service to ensure consistent messages through the development of standardized call scripts for vegetation management services.
6. Interfacing with corporate communications as needed to develop communications and educational strategies.
7. Interfacing with Liberty Utilities regulatory group as needed.

4.3.3 Staffing Requirements

The vegetation maintenance program at Liberty Utilities is not sufficiently staffed to affect the administration of the current line clearance contracts and tree contractor staffing at the time of this review. Based on the responsibilities outlined for the functional roles as listed above, the roles that support the Manager, Vegetation Control and Regulatory Compliance do not have the bandwidth to help drive program goals and objectives. The Manager, Vegetation Control and Regulatory Compliance has one direct report (System Arborist) that assist with the day-to-day field operations. This individual is responsible for both distribution and sub-transmission vegetation management activities.

For Liberty Utilities' vegetation management program to move toward best-in-class, it will be important to have arborists supporting the Manager, Vegetation Control and Regulatory Compliance that can provide analytical skills and support the managerial and administrative functions of the program. In addition, those arborists positions may require additional assistance to manage field operations, particularly once tree crew resources are added to meet the new cycle recommendations.

Figure 4-3 shows data from two benchmarking studies that evaluated the average number of line clearance crews supervised by utility arborists. In the Pennsylvania Electric Association (PEA) and Edison Electric Institute (EEI) studies, the average ratio of line clearance crews to each utility arborist was respectively 8 and 11 (**Figure 4-3**). However, in both studies 75 percent of the reporting utilities average 10 crews or less per supervising arborist. **Figure 4-3** also shows that in a recent benchmarking study of over 20 utilities, the two-overall best-in-

class utilities have a ratio of approximately one utility arborist (including the system arborist and managers) for every six-line clearance crews.

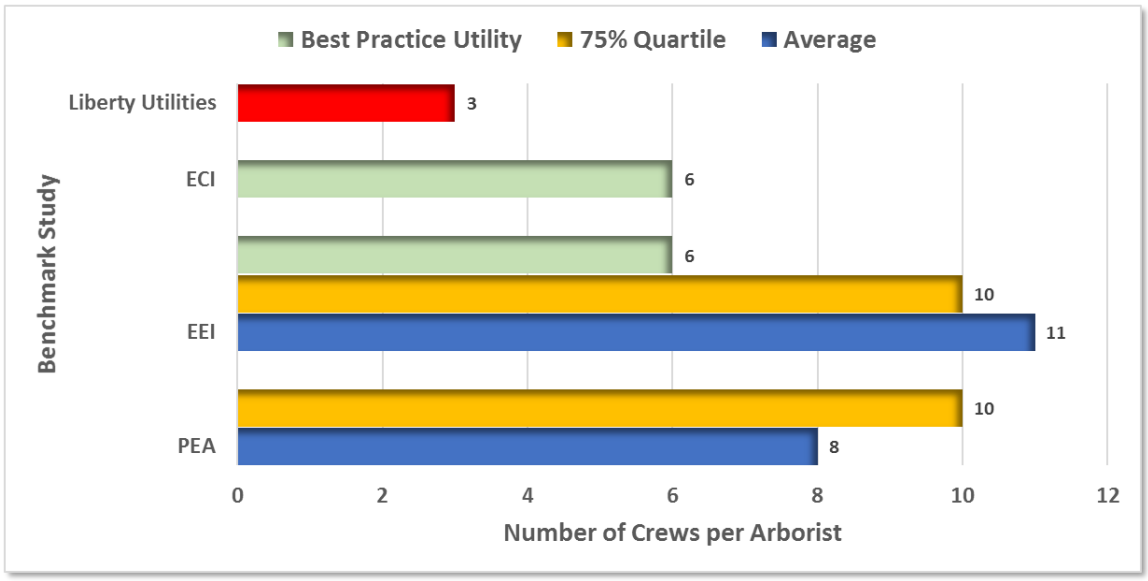

Figure 4-3. Comparative Data on the Average Number of Line Clearance Crews Overseen by Utility Personnel[3].

Figure 4-3 shows that Liberty Utilities is currently well within suggested arborist to tree crew ratios. However, Liberty Utilities is unique as compared to many utilities across the country in that the arborist spend a great deal of time with governmental and local permitting. Therefore, based on the estimated increase in contractor tree crew staffing as defined in the WECI budget recommendations in **Section 4.7**, and the anticipated increase in governmental and local permitting requirements, WECI recommends that Liberty Utilities establish a total of two in-house System Arborists (supervisors) to assist the Manager, Vegetation Control and Regulatory Compliance in the day to day management of the program. This will provide a ratio consistent with current levels.

These individuals (System Arborists) should primarily be responsible for field implementation of the line clearance program and the evaluation of the line clearance crews and contractors within their area of responsibility. These positions should report directly to the Manager, Vegetation Control and Regulatory Compliance. This will provide a measure of control over individual interpretation of company guidelines and will ensure consistent implementation of appropriate work practices and operating procedures across the system.

The System Arborist will coordinate the planning and execution of all Liberty Utilities vegetation management activities within their respective regions. This includes permitting, the preparation of tree crew work packets, post-outage investigations, customer refusal follow-up, quality control on contractor work to ensure adherence to clearance specifications,

[3] PEA = Data from a 7-utility survey conducted by the Pennsylvania Electric Association.
EEI = Data from the Edison Electric Institute benchmark study of 29 utilities.
WECI = Data from a benchmarking study of 22 North American utilities.

work quality, monitor contractor productivity and prepare monthly summaries for senior Liberty Utilities management. These system summaries should include: production against goals, contractor productivity, budget status, tracking of customer complaints, tracking and work-down of customer refusals and other duties as assigned by Liberty Utilities senior management.

The System Arborist will aid in promoting the image of Liberty Utilities as a best-in-class utility. Involvement in local community organizations will exemplify Liberty Utilities' public interest and civic commitment. Participation in trade associations and organizations involved in vegetation control activities should be encouraged. This will enable the System Arborists to keep abreast of research and development in the industry, while exchanging information with other utility professionals. The goal should be to remain informed on current topics in the industry and incorporate appropriate technological advances into the program. This individual should act as liaisons with local and municipal officials and university, college, and extension personnel. Consequently, the System Arborist must have public relations skills to gain acceptance within and outside the company.

The System Arborist should have a minimum of three years of experience in utility vegetation management and, preferably, a Bachelor's Degree in Forestry or a related field. International Society of Arboriculture (ISA) certification is also recommended for these individuals. Sufficient technical expertise is critical if these individuals are going to effectively evaluate and manage line clearance activities in their area of responsibility.

Proposed Organization and Future Considerations

WECI recommends a functional organizational structure for Liberty Utilities that will allow for personnel specialization within the respective service territories. This alignment will drive program efficiencies by allowing individuals to manage all aspects of the vegetation management program within their respective regional boundaries. The main goal for this organizational structure will be continual process improvement. **Figure 4-4** presents the WECI recommended organizational structure.

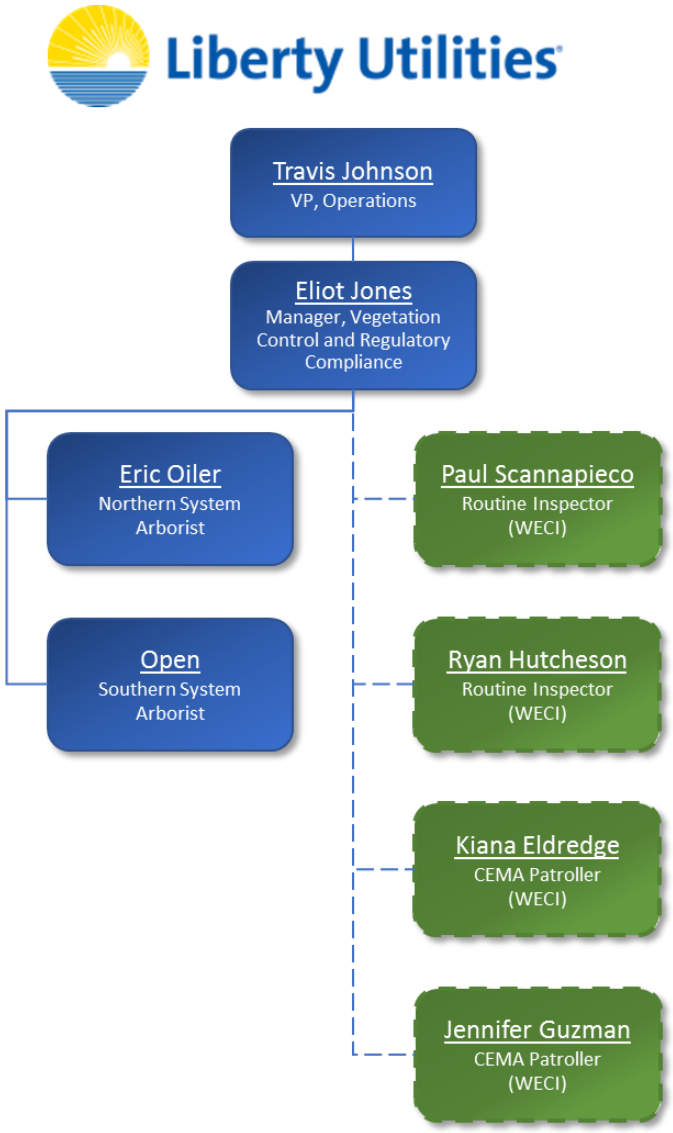

Figure 4-4. Proposed Liberty Utilities Functional Organizational Structure.

4.3.4 Customer Notification and Work Planning

Customer Notification

Customer notification of pending work is performed using door hangers and/or personal contact performed by the contract work planners (Pre-Inspectors). Contact attempts and contact method are recorded in the planning software. Work planning is performed four to six weeks ahead of issuance of the maintenance unit to the tree crews. This falls within industry best management for customer notification of impending routine maintenance. However, many utilities have, and is considered a best practice, to notify customers by mail at least three to six weeks in advance. This allows for the customer to contact the utility if they have

a specific concerns or questions before a work planner shows up at their door. Mail notifications utilizing utility customer account information also allows for notification to absentee owners. WECI recommends that Liberty Utilities consider using mail notification to supplement the current notification process. One added advantage of a mail notification system is that customer accounts can also be noted as having been sent notification to validate and verify customer notification.

Professional management and a coordinated approach to public concerns helps to ensure the success of the vegetation maintenance program. Liberty Utilities should continue to convey to the public that the utility has a responsibility to maintain vegetation that can have an impact on the safety and reliability of the electrical system in a cost-effective manner. Liberty Utilities maintenance program and practices should reflect this attitude.

Liberty Utilities should also consider utilizing the current customer information system or a centralized database to house customer refusals, inadequate clearances, damage complaints, or other customer issues. Tracking of these issues along with their resolutions can be very beneficial in ensuring issues are resolved timely which provides for increased customer satisfaction. It also allows for a means to validate insufficient clearances when they are noted during the QA audits.

Additional Programs

An effective public relations program should include the distribution of materials that guide the public in the selection of tree species that are compatible for planting around electric lines. Other information brochures include a discussion on the policies and procedures of the line clearance program and information about special programs such as a tree replacement programs, etc.

Additional programs that have been successful at other utilities and which Liberty Utilities may consider include the following:

- Involvement in public and civic organizations by the arborists to reflect Liberty Utilities' concern for the communities it serves.
- Affiliation with area universities extension personnel to enhance Liberty Utilities' public relations efforts with respect to proper pruning techniques and herbicide use.
- Inclusion of pamphlets with customer's bill describing the benefits and availability of wood chips and how/where to obtain them.
- Sponsorship of local tree planting efforts on earth Day, Arbor Day or other similar environmental awareness occasions.
- Greater utilization of the Liberty Utilities website for vegetation management related information (which circuits are currently scheduled for work, educational materials, FAQ section, etc.).

4.3.5 Conclusions about Management and Organization

Recommendations relative to the program management and supervision can be summarized as follows:

- Increase the current Liberty Utilities in-house staffing by one additional full-time System Arborist to assist with increased permitting requirements, help drive crew production, and manage program goals and objectives.
- Consider increasing the level of communication with customers by adding a customer mailer or IVR system to notify customers of impending vegetation maintenance on their circuit.
- Consider developing a tree planting and compatible species selection guide for customers to aid them in planting trees that are appropriate near power lines.
- Institute a formal tracking procedure/process to capture customer refusals or locations where specified clearance cannot be achieved. This can be as simple as an Excel spreadsheet that is updated along with monthly reports regarding the current status of the refusal/inadequate trim locations, or the utilization of an enterprise work management system.

4.4 Contracting for Line Clearance

Three different approaches are commonly used by electric utilities to contract line clearance work. These include "time and material/equipment" (T&M), "unit price" and "firm price" or "lump sum" pricing strategies, and are more fully described in **Appendix C**. Each has advantages and disadvantages that are important to understand, and there are multiple variations possible within each pricing family. Each carries a different risk profile for the contractor and the utility. Unit price and firm price contracts are inherently performance-based contracts. However, T&M with incentive pricing can also be a performance-based contracting strategy. WECI recommends that Liberty Utilities continue with the unit price contract strategy as their primary contract methodology for routine maintenance work and the T&M strategy as their secondary contract methodology for routine maintenance, however, consider adding production targets and incentives to the T&M contract as discussed in **Section 4.2.10**. Performance-based T&M contracting provides an incentive for the contractors to become more efficient, especially if they get to share in the increased savings to Liberty Utilities.

4.5 Federal Lands Strategy

Historically many electric and gas utilities have struggled to consistently execute accepted industry best-practice for utility vegetation management (UVM) on federal lands (e.g., integrated vegetation management or IVM). A complex web of sometimes conflicting federal policies and laws can hamper the ability of utilities and federal land managers to meet the expectations of the American people (e.g., FERC/NERC electric reliability standard FAC-003 and National Environmental Policy Act or NEPA requirements)

More specifically, utilities are facing increasingly complex challenges related to the permitting of new facilities, renewing expired permits for existing facilities and managing vegetation in existing rights of way (ROW), including emergency response. In addition, specific requirements related to threatened & endangered species, species of concern, avian protection, and preservation of archaeological & historical sites must be satisfied.

Electric utilities have the obligation to provide safe, reliable electric service and to maintain their facilities to the highest degrees of care. Electric transmission and distribution and gas infrastructure are considered critical infrastructure and are foundational to national security, health and welfare.

Federal land management organizations have the duty to care for the land and serve the people. These agencies are decentralized organizationally, which by design allow and encourage great autonomy at the field level (e.g., USFS forests and districts). This is understandable as vegetation and forest management are very site-specific activities. Although this model enables effective vegetation prescriptions to be formulated considering local requirements, in many cases these plans are missing higher-level components critical to both utilities and federal agencies to best ensure all the nation's expectations are met in a cost-effective manner.

Declining forest health throughout the West has increased the risk to both utilities and federal lands managers over the last decade. The prevention and protection of assets from wildfire has become a priority of both stakeholders. The frequency and severity of wildfire is predicted to increase. For example, prior to 2000, rarely were more than 3 million acres of land impacted by wildfire annually; today that number has climbed to approximately 9-10 million acres.

There are some excellent localized examples of utilities, federal land managers, special interest groups and other stakeholders working together to develop sustainable, environmentally sound land management practices on and adjacent to electric utility corridors. However, previous attempts at holistic solutions or governance at the national level (e.g., 2006 Memorandum of Understanding, or MOU, between the utility industry and federal land managers) have been largely ineffective.

WECI believes a paradigm shift is long overdue that will change the perception of utility facilities on federal lands from a liability to a beneficial asset (e.g., wildfire break, biodiversity, invasive species control, enhanced wildlife and pollinator habitat, emergency access, etc.). We believe great opportunity exists to improve efficiencies, reduce frustration and cost, better ensure compliance and improve the stewardship of public lands across the national landscape.

WECI has experience helping to foster collaborative partnerships and memorandums of understanding between utilities and federal land agencies, developing mutually beneficial outcomes. Our leadership has decades of experience working with western US utilities and federal land agencies. Our executive leadership have testified in US Congressional hearings and have actively participated in other national meetings related to UVM matters on federal lands. Liberty Utilities should consider assistance with developing MOU's with the U.S Forest Service to reduce the permitting time currently required.

4.6 Record Keeping

A comprehensive recordkeeping and reporting system is an essential component of an effective line clearance program. Record keeping systems can provide management with the following information:

- Data for use in making sound vegetation management program decisions.
- Providing accurate annual program cost.
- Building circuit workload history to better predict budget requirements in the future.
- Determination of the most cost-effective crew type for various locations and work types.
- Relating tree-caused outages at the circuit level to circuit pruning history.
- Detailed monitoring of crew productivity.
- Establishing tracking process for customer refusals and hazard trees.

A comprehensive line clearance record keeping system depends on recording four key components for field activities:

1. work location
2. description of work completed
3. time required to complete the activity
4. required materials

Time report verification, evaluation of crew productivity and accumulation of cost and production data all depend on these elements of activity reporting.

Recording crew time by specific work units and work-related activities provide the means to (1) examine detailed costs, (2) evaluate productivity, and (3) initiate appropriate changes to maximize the efficiency of the program. All record keeping needs to be adjusted to conform to the type of contract in place and the system metrics Liberty Utilities desires.

Liberty Utilities currently tracks work units completed through the contractor timesheets which match up to the pre-planned work units.

Time Utilization

Time utilization measures can be used to evaluate crew time and production figures: time utilization, performance, and effectiveness.

Time utilization calculations allow a utility to determine what each crew does with the time it controls on a daily basis. For example, if time utilization is low, it indicates that the crew has excessive nonproductive time.

Performance

Performance is a measure that compares the actual time required to prune or remove a tree to the expected or standard time. Standards are developed from actual local data and are periodically evaluated for accuracy. The performance rating provides a good means for evaluating the production rates of each crew relative to an established set of standards. If performance is too high, it may suggest that a crew is inaccurately reporting work, obtaining inadequate clearance, or pruning brush (rather than removing brush). If performance is too low, it may suggest that the need for increased supervision and/or training. Liberty Utilities should begin to monitor crew productivity through measures of trees maintained per FTE and incorporate production goals into the existing contract and incentives.

Effectiveness

Effectiveness is calculated as a product of time utilization and performance (time utilization X performance/100). It provides a relative measure of what the return on expenditures is for each contract crew. Effectiveness ratings can be used to compare individual crews.

Liberty Utilities uses several metrics that are necessary to effectively and efficiently manage the program. Data is collected from contractor timesheets, and invoices include circuit number, work/equipment codes, billing codes, and maintenance units (prunes, removals, and brush) completed.

Reporting and Record Keeping Requirements

In reviewing the available reports and data provided by Liberty Utilities, WECI noted an area of opportunity in improving the available metrics, targets, reports, and centralized databases. The Manager, Vegetation Control and Regulatory Compliance has done well with the resources he has been provided, however, there are many missing components that will prevent Liberty Utilities from becoming best-in-class if they are not addressed.

Fundamentally, the types of data and reports that can be beneficial in managing the VM program can be broken down into seven categories:

1. Production
    a. Costs per unit versus target price (T&M only)
    b. Miles complete actual versus target
2. Costs
    a. Cost per mile actual versus target
    b. Actual total expenditures by work type versus target (e.g., planned maintenance, reactive maintenance, herbicide, etc.)
3. Quality
    a. Contractor QA/QC audit discrepancies
4. Reliability
    a. Number of tree outages versus last 12 month ending average
    b. Number of customers interrupted versus last 12 month ending average
5. Customer Satisfaction
    a. Number of customer complaints received
    b. Number of executive complaints received
6. Man Power
    a. Number of contract personnel versus target
7. Safety
    a. Number of OSHA recordables for contract tree crews
    b. Number of QA safety violations noted

Aside from their obvious benefits and use in managing the day-to-day activities in the VM program, these reports can be generated and rolled into monthly dashboard reports for upper management. The generation of these reports, however, requires steadfast commitment to capturing and entering the data in a timely manner. It also requires the appropriate software

or databases for retention. There are many off-the-shelf software programs that can assist with some of these collections, however, there is no one individual software to solve every issue. However, Liberty Utilities currently has or can obtain all the necessary inputs to develop useful reports. WECI will be happy to assist Liberty Utilities in developing the appropriate metrics and with finding compatible software that will best fit the needs of Liberty Utilities.

4.7 Maintenance Strategies and Cost Projections

4.7.1 Preventive Maintenance Strategy Alternatives

One of the primary purposes of this study was to determine the optimal schedule and associated budgets necessary to maintain a desired level of service reliability and fire risk.

Maintenance strategies are often thought of in terms of cycle lengths or planned years between maintenance. However, not all circuits or system components have the same risk or the same impact on overall system performance. The potential for a tree branch to become a pathway for a sustained interruption is higher for multi-phase lines than for single-phase lines, and higher for a 14.4 kV line than for a 4.8 kV line. Construction types, as well as voltage, carry varying degrees of tree-related risk to system integrity, and the cycle lengths of different system components have varying impacts on Liberty Utilities' customers. However, Liberty Utilities' reliability data does not currently include circuit outage at discernable device level (i.e., substation, feeder, lateral) that would allow WECI to draw additional inferences. Without this additional information, and considering that Liberty Utilities overall system tree-caused outages are generally low, WECI's initial recommendation is to continue with the current whole circuit maintenance strategy.

Table 4-3 summarizes the current and alternate program strategies, as well as WECI's recommended program strategy for adoption on the Liberty Utilities system. Cost projections for these recommendations are provided in detail in **Section 4.7.2** of this report. There are numerous program cycle options and combinations that were considered; however, WECI's recommended funding option provides the greatest opportunity to maintain reliability and reduce fire risk. Liberty Utilities has invested a great deal in reclaiming distribution and sub-transmission rights-of-way over the last six-years but still falls short of an acceptable cycle frequency. WECI believes that Liberty Utilities should reduce cycle length from the current 7.3 year-cycle to three-years to provide for additional reductions in fire risk and the removal of beetle kill trees. WECI considered four key system attributes in determining the recommended cycle strategy:

1. Historical Liberty Utilities low tree-outages.
2. Increases in hazard trees due to beetle kill and drought.
3. Potential fire risk.
4. A suggested tree contact level of less than five percent (related to fire risk).

Table 4-3. WECI Program Strategy Options at the Liberty Utilities Corporate Level.

Options	*Program Description*
Liberty Utilities (Current 2018)	• **Planned Maintenance**: planned maintenance 7.3-year circuit cycle. • No mid-cycle pruning. • Aggressive tree removal. • **Risk Tree Removal**: for beetle kill trees and other hazard trees (through proposed CEMA funding). • **Brush Maintenance:** hand cutting and stump spraying only. • **Unscheduled Reactive Work**: customer tickets, restoration support, and repetitive outage/hot-spot work request account for approximately 19 percent[4] of total distribution and sub-transmission expenditures • **Current Staffing**: Program Manager and one full-time equivalent (System Arborist).
Option 1: *3-Year Cycle* **WECI Preferred Option**	• **Planned Maintenance**: planned maintenance 3-year circuit cycle. • No Mid-cycle pruning. • Continue aggressive tree removal. • **Risk Tree Removal**: for beetle kill trees and other hazard trees (through proposed CEMA funding). • **Brush Maintenance:** hand cutting and stump spraying only. • **Unscheduled Reactive Work**: reduce customer tickets, restoration support, and repetitive outage/hot-spot work request to 14 percent with further reductions in second cycle. • **Current Staffing**: Amend staff to include one additional System Arborist positions to manage the increase in tree crew resources and associated increase in governmental permitting.

[4] Unscheduled reactive work percentage of total vegetation maintenance expenditures based upon the dollar amount in 2017.

Option 2: *4 Year Cycle* w/ Hazard Tree Patrol	• **Planned Maintenance**: planned maintenance 3-year circuit cycle. • No Mid-cycle pruning. • Continue aggressive tree removal. • **Risk Tree Removal**: for beetle kill trees and other hazard trees (through proposed CEMA funding and additional funding). • **Brush Maintenance:** hand cutting and stump spraying only. • **Unscheduled Reactive Work**: customer tickets, restoration support, and repetitive outage/hot-spot work request remains at current level. • **Current Staffing**: Amend staff to include one additional System Arborist positions to manage the increase in tree crew resources and associated increase in governmental permitting.
Option 3: *2 Year Cycle*	• **Planned Maintenance**: planned maintenance 2-year circuit cycle. • No Mid-cycle pruning. • Continue aggressive tree removal. • **Risk Tree Removal**: for beetle kill trees and other hazard trees (through proposed CEMA funding only). • **Brush Maintenance:** hand cutting and stump spraying only. • **Unscheduled Reactive Work**: reduce customer tickets, restoration support, and repetitive outage/hot-spot work request to eight percent of the total budget. • **Current Staffing**: Amend staff to include one additional System Arborist positions to manage doubling of tree crew resources and associated increase in governmental permitting.

4.7.2 Estimated Costs

Cost of Cycle Options

Based on the vegetation workload survey, species frequency, estimate regrowth rates, and estimated Liberty Utilities production cost generated from contractor supplied unit cost data, numerous program alternatives, cycles, and program funding scenarios were reviewed by WECI (see **Table 4-3** above).

Table 4-4 provides projected vegetation maintenance program costs (distribution and sub-transmission) for three program options for the next cycle beginning in 2019. WECI's recommended option (Option 1) estimates that an annual budget of approximate $3.98M would be required to meet the optimum cycle goal and provide minimum tree-wire contact of less than five percent to control fire risk and mitigate hazard trees.

It should be noted that the term "cycle" is a planning term reflecting the average circuit maintenance frequency. Cycle cost projections assume completion of all miles on the system within the specified cycle length. However, specific conditions will necessitate circuit-specific variances around this average cycle length. Reliability metrics and field observations should be used to modify the preventive maintenance strategy to complete highest risk circuits first during a scheduling quarter or year, or push individual circuits forward or backward by one year. Outage restoration is a significant cost for Liberty Utilities and reductions in repetitive tree-caused interruptions will result in a reduction in these restoration costs.

Table 4-4 presents projected first cycle annual cost utilizing current estimated average cost per tree unit against WECI estimated workload. Circuit pruning cycle length for the WECI recommendation is three-years for both multi-phase and single-phase lines.

Table 4-4. Estimated Liberty Utilities Vegetation Program First-Cycle Cost for **P**rogram Strategy Scenarios.

VM Activity	*Average 12' – '17*	*Current 2017*	WECI Recommended *Option 1: 3 YR Cycle*	*Option 2: 4 YR Cycle w/ Hazard Tree Patrol*	*Option 3: 2 YR Cycle*
Planned Maintenance Total:	**$1,387,000**	**$1,120,000**	**$2,069,000**	**$1,706,500**	**$3,103,000**
Circuit Maintenance:	**$1,381,000**	**$1,114,000**	**$2,063,000**	**$1,547,000**	**$3,094,000**
Accessible:	$946,000	$763,000	$1,413,000	$1,059,000	$2,119,000
Inaccessible:	$435,000	$351,000	$650,000	$488,000	$975,000
Hazard Tree:				**$155,000**	
Brush Control:	**$6,000**	**$6,000**	**$6,000**	**$4,500**	**$9,000**
Reactive Maintenance Total:	**$290,000**	**$434,000**	**$289,000**	**$340,000**	**$248,000**
Other VM Maintenance:	**$702,000**	**$969,000**	**$1,626,100**	**$1,353,000**	**$1,754,000**
Debris Disposal/ Traffic Control:	$53,000	$115,000	$211,700	$172,500	$230,000
Preinspection:	$308,000	$364,000	$669,900	$546,000	$728,000
Permits/Environmental/ Cultural/Legal	$41,000	$52,000	$95,700	$78,000	$104,000
Pole Clearing	$108,000	$167,000	$150,000	$150,000	$150,000
Misc.	$26,000	$51,000	$93,900	$76,500	$102,000
Labor	$166,000	$220,000	$404,900	$330,000	$440,000
TOTAL VM PROGRAM:	**$2,379,000**	**$2,523,000**	**$3,984,100**	**$3,399,500**	**$5,105,000**
Incremental $ Over 2017 Actuals:		**$0**	**$1,461,100**	**$876,500**	**$2,582,000**
Contract Crew Requirements:					
Equivalent 3 Man Lifts:	3.0	3.0	4.6	4.0	6.6

Table 4-5 presents projected second-cycle annual costs to be expected due to minimal gains in workload reduction (from removals) from the first cycle. During the second cycle, tree-wire contact should remain minimal, allowing the contractor to remain productive.

Table 4-5. Second-Cycle Estimated Liberty Utilities Vegetation Program Cost for Program Strategy Scenarios.

VM Activity	WECI Recommended ***Option 1:*** ***3 YR Cycle***	***Option 2:*** ***4 YR Cycle w/ Hazard Tree Patrol***	***Option 3:*** ***2 YR Cycle***
Planned Maintenance Total:	**$1,876,000**	**$1,586,500**	**$2,742,000**
Circuit Maintenance:	**$1,870,000**	**$1,427,000**	**$2,733,000**
Accessible:	$1,281,000	$977,000	$1,872,000
Inaccessible:	$589,000	$450,000	$861,000
Hazard Tree:		**$155,000**	
Brush Control:	**$6,000**	**$4,500**	**$9,000**
Reactive Maintenance Total:	**$262,000**	**$314,000**	**$219,000**
Other VM Maintenance:	**$1,488,800**	**$1,261,600**	**$1,566,300**
Debris Disposal/ Traffic Control:	$192,000	$159,400	$203,100
Preinspection:	$607,600	$504,500	$642,800
Permits/Environmental/ Cultural/Legal	$86,800	$72,100	$91,800
Pole Clearing	$150,000	$150,000	$150,000
Misc.	$85,200	$70,700	$90,100
Labor	$367,200	$304,900	$388,500
TOTAL VM PROGRAM:	**$3,626,800**	**$3,162,100**	**$4,527,300**
Contract Crew Requirements:			
Equivalent 3 Man Lifts:	4.2	3.7	5.8

4.7.3 Unscheduled Reactive Work

Best practice vegetation management programs commonly have been able to limit unscheduled or reactive work (or "Tags") to 10 percent or less of total production costs. Historically, Liberty Utilities has averaged approximately 13 percent (between 2013 and 2017) increasing to 19 percent in 2017. Of the 461 Tags completed in 2017, 167 (36 percent) were from dead trees requiring removal (350 trees). Liberty Utilities has seen a rise over the last few years, namely due to deferred maintenance work and increases in tree mortality prior to the CEMA program.

4.7.4 Tree-Line Contact Impacts

Clearance at time of pruning is a key factor in determining the optimal cycle strategy. More importantly, the tree contractor's ability to consistently clear to the established standards will determine if established cycles can be maintained.

Many utilities in North America where wildfires are not a major threat consider 10 percent tree contact with the conductors to be a reasonable goal for their distribution and sub-transmission line clearance program to minimize the potential threat of interference with conductors. However, there is no hard-set rule and many utilities exceed this level of tree-line contact to varying degrees. It is important to note that the specific conditions associated with trees in contact with conductors are key determinants of the impact of those contacts on system performance and fire risk. WECI research has documented the importance voltage stress gradient, stem diameter and tree species as they relate to a tree branch becoming a fault pathway leading to a sustained interruption. These conditions may justify higher allowable tree contact percentages. However, due to the potential fire risk on the Liberty Utilities system, WECI has recommended five percent or less as the nominal contact percentage for Liberty Utilities. This justification was used in the recommendation for three-year cycle.

Other Opportunities

This study has focused on tree maintenance solutions for sustained reliability and fire risk reduction. While improved tree maintenance is part of the solution, it may not be the entire solution. Some utilities have found that changes to the overcurrent protection strategy, correction of inappropriate fuse coordination, use of additional fuses or reclosers, arrestor replacement or even reconductoring leads to a reduction in interruptions previously associated with trees, or reductions in the customer impact of tree-related outages that do occur. **Appendix B** includes a white paper on prescriptive reliability, which addresses some of these issues.

4.7.5 Consistency of Funding

The recommendations provided will allow Liberty Utilities to maintain sustained control of the vegetation growing near the distribution and sub-transmission system. It is dependent upon consistent funding at the appropriate level, with adjustment for inflation and supervisory costs. Consistent funding is the single most important recommendation provided in this report.

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Appendix A – Liberty Utilities System Workload Attributes

Table A.1 Liberty Utilities System Workload Estimates.

Total Overhead System Miles = 644
Average Tree Density Per Mile = 50.6

	Accessible	Inaccessible	Total
Total Trees	**22,330**	**10,270**	**32,600**
Trims	**11,840**	**5,460**	**17,300**
Top	1,140	530	1,670
Side	9,680	4,460	14,140
V-Trim	20	10	30
Service_Secondary	0	0	0
Overhang	1,000	460	1,460
Removals	**10,490**	**4,810**	**15,300**
Removals_4_11.9	5,030	2,310	7,340
Removals_12_23.9	3,250	1,490	4,740
Removals_24_35.9	1,890	870	2,760
Removals_>36	310	140	450
Removals_SVC/SEC	10	0	10
Compliance Trees	**1,030**	**480**	**1,510**
Hazard Trees	**1,690**	**780**	**2,470**
Brush Acres	**10**	**5**	**15**
Mow&Treat	0	0	0
Cut&Spray	0	0	0
Spray_Only	0	0	0
Trim_Only	0	0	0
Hand Cut_Only	10	5	15

*Hazard tree count and Compliance Trees are included in trim and removal count.

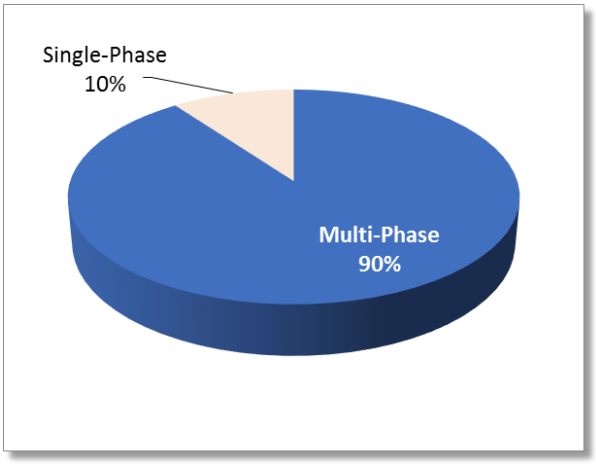


Figure A.1 Workload by Single/Multi-Phase.

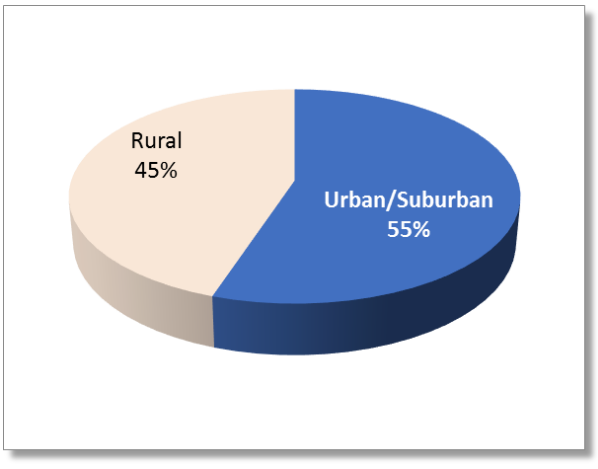


Figure A.2 Workload by Rural/Suburban/Urban.

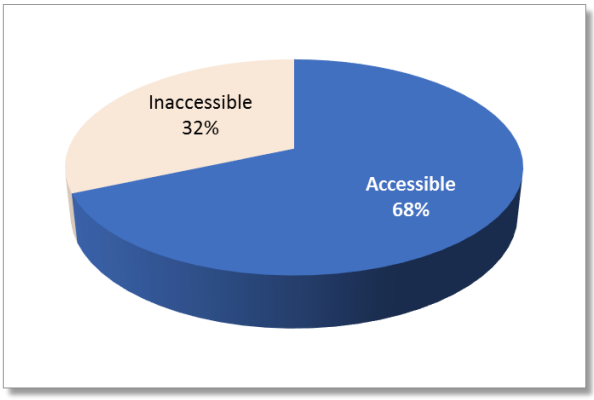


Figure A.3 Workload by Accessibility.

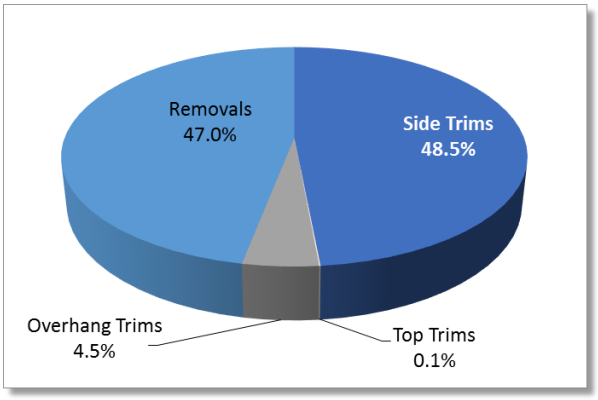


Figure A.4 Workload by Work Type.

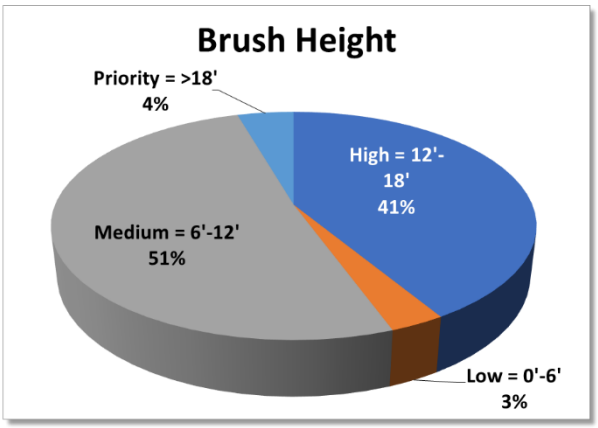


Figure A.5 Brush Workload by Average Height.

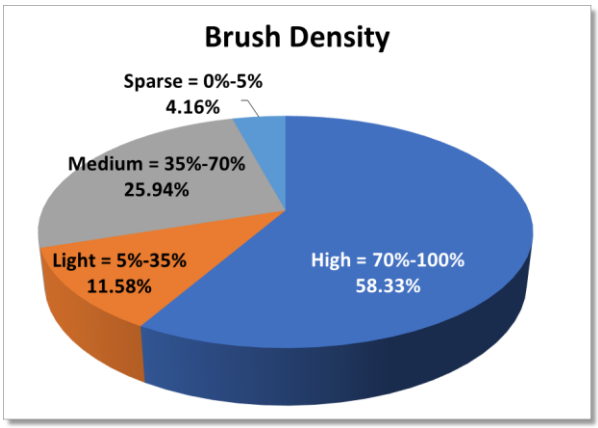


Figure A.6 Brush Workload by Average Density.

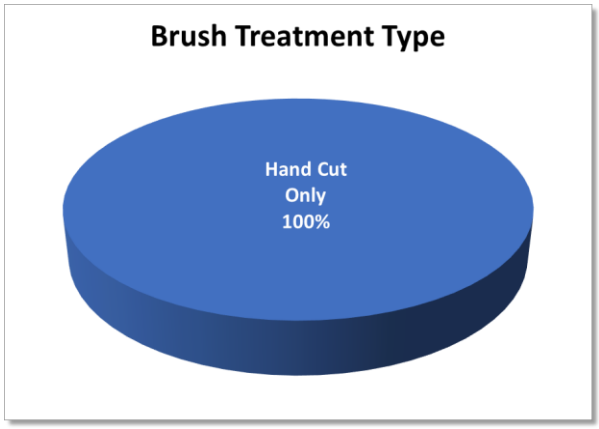


Figure A.7 Brush Workload by Treatment Type.

Current Tree Clearance at Time of Survey

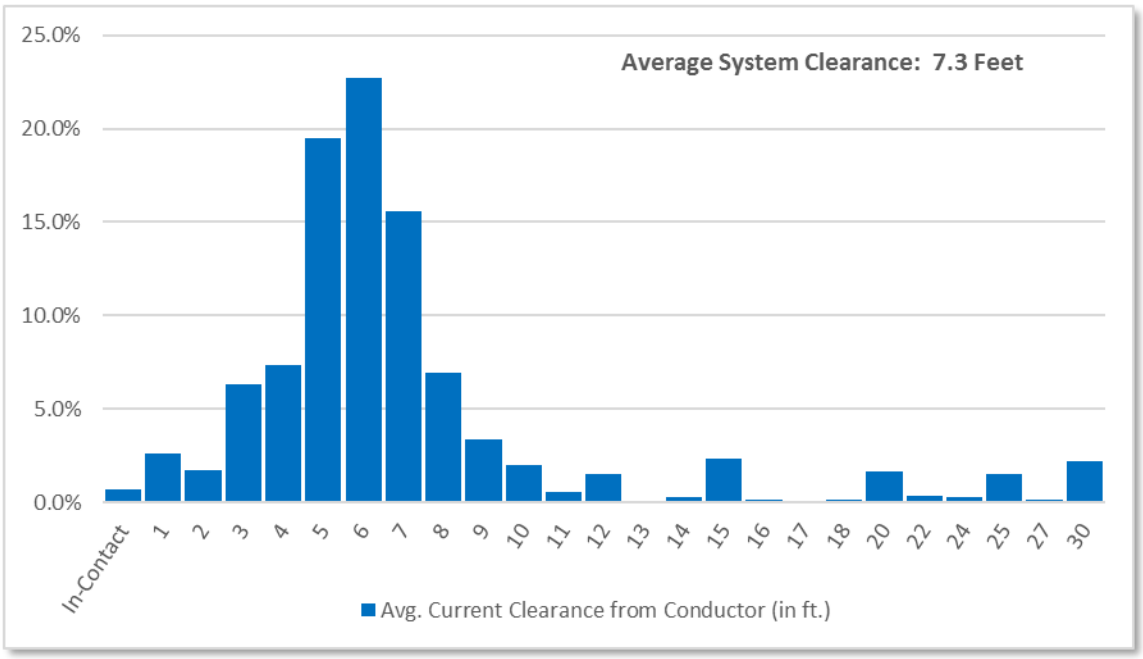


Figure A.8 Percentage of Trees by Clearance from Conductor.

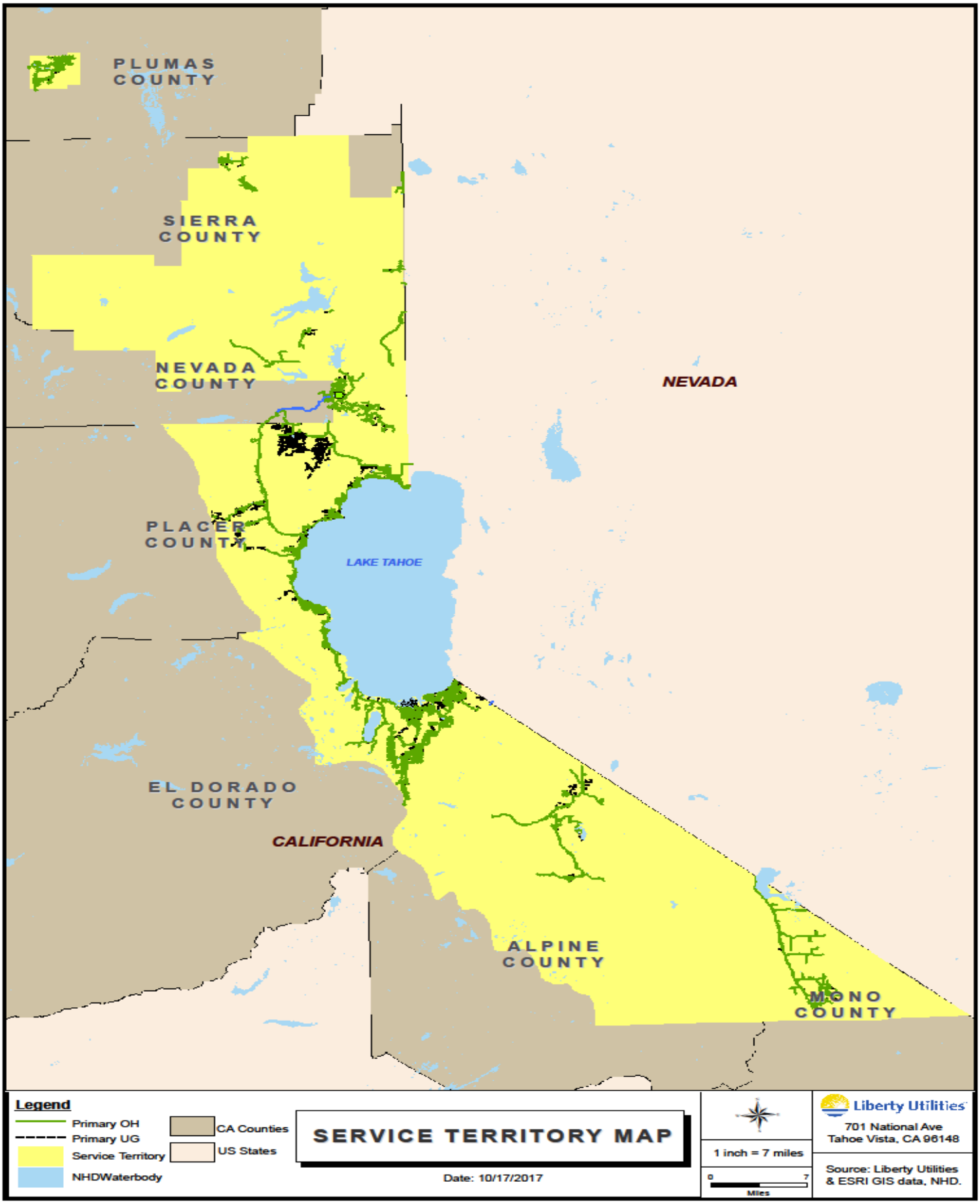


Figure A.9. Liberty Utilities Service Territory.

Appendix B – Prescriptive Reliability

Prescriptive Reliability

An Alternative to Traditional Vegetation Maintenance

Traditional Vegetation Management Programs

It has long been recognized that trees pose a significant threat to the reliable operation of overhead electric distribution lines. It is estimated that the industry spends in excess of 2 billion dollars annually maintaining vegetation growing in close association with conductors. Contemporary vegetation management programs emphasize the completion of preventive maintenance on a scheduled cycle in an effort to mitigate this threat. The focus of preventive maintenance work is to create and maintain clearance between conductors and trees. This is accomplished by establishing and applying uniform clearance specifications. Vegetation maintenance is typically conducted as a discrete program, with an emphasis on achieving efficiency in completing line clearance work.

Application Of RCM To Distribution System Maintenance and Vegetation Management

Recent work in applying Reliability Centered Maintenance (RCM) to a traditional distribution vegetation management program has led ECI to the belief that there is a significant opportunity for improvement in reliability and cost efficiency.

Development of a RCM-based approach to overhead distribution maintenance has led to the realization that while it has been useful to manage traditional preventive maintenance efforts as discrete programs for the efficiency's sake, they need to be coordinated so that their composite effect is to optimize the performance of the system.

RCM focuses the allocation of available maintenance resources on the preservation of system function. The analysis process starts by identifying the important systems and the function to be preserved, which is reliable electric service. The process then moves to the identification of the important modes and causes of failure. With a clear understanding of the way interruptions occur, RCM uses a logical decision hierarchy to select preventive maintenance tasks that will be most effective in mitigating the identified risks to system function.

Understanding The Mode & Cause of Tree-Related System Failures

There are two basic ways trees cause distribution system interruptions. Trees fail structurally and mechanically damage the overhead utility infrastructure (mechanical mode), or trees provide a fault current pathway between conductors and /or ground, resulting in a short circuit fault (electrical mode).

The mechanical mode of failure is intuitively obvious and is a major cause of interruptions. Recent research in the area of electrical mode of failure has led to new insight as to what kinds of tree contact pose the greatest threat to reliability. Most tree contact with conductors begins as a high-impedance, low-current fault. Only under certain conditions will this fault evolve from high to low impedance and result

in high levels of fault current, operation of overcurrent equipment and, subsequently, an interruption.
Some important points emerge from an understanding of the mode and cause of tree-initiated interruptions. First, the majority of incidental tree contact with energized conductors is of relatively low risk to reliability. Secondly, the structural failure of trees and branches is typically a major cause of both mechanical and electrical failures on a distribution system. Finally, that the overcurrent protection system plays a major role in determining if and how a tree-initiated fault is manifested as an interruption.
It should also be understood that more work needs to be done regarding incidental tree contact with conductors in order to fully understand issues such as the risk to safety by touch potential, risk of initiating wildfires, the economic significance of line loss, and the potential for conductor damage.

The New Maintenance Paradigm - Prescriptive Reliability
Applying a RCM focus of preserving system function to distribution vegetation management leads to a new way of thinking about preventive maintenance. Specifically the new approach places greater emphasis on assessing field conditions and determining the need for maintenance. Once the need is established, a specific reliability prescription is developed to effectively mitigate risk. The maintenance prescription is an integrated solution including both traditional elements and potentially non-traditional tasks as alternatives to tree pruning and removal.

This maintenance philosophy is consistent with an emerging industry business model that separates asset management and services responsibilities. By practicing prescriptive reliability, the asset represented as overhead distribution infrastructure is actively managed with a focus on preserving system function. This is achieved through an interactive process of resource allocation based on the effectiveness of results, which in this case is reliability. Individual maintenance services, such as the work done by tree crews, are managed for efficiency. This is typically accomplished through existing maintenance contractors. Rather than managing for efficient vegetation work (the service provider's focus) through a prescriptive reliability approach, the maintenance program is managed for optimal reliability by those assigned the responsibility for management of the asset. This avoids the potential for the maintenance program to become focused on the work of maintenance rather than the reason for maintenance.

Changes in the traditional approach to vegetation management. It's not about trimming more trees!
As has been discussed, the traditional cyclical approach to consistent scheduling and completion of preventive maintenance work is a management convenience. However, this philosophy often leads to less than optimal results. The reality is that various elements of the distribution system are not alike in terms of infrastructure, site, and the risk to reliability and consequence of failure. An emphasis on the

performance of specific preventative maintenance based on condition assessment is a more intensive form of program management. However, this approach is justifiable given the opportunity for improvements in the effectiveness of resource allocation and reliability.

The second major change to the traditional vegetation management approach is driven by the knowledge that the greatest risk to reliability is caused by the structural failure of trees. This risk can be due to whole tree failure, branch failure within the tree's crown, and the deflection of branches. Loss of tree-conductor clearance is of lesser risk. The concept of clearance remains important, but it should not be as important as it has become. In fact, for much of a distribution system, clearance per se is one step removed from the true risk.

There are three areas where refinement needs to be made to the traditional program, which are as follows:

- Clearance specification,
- Hazard trees maintenance
- Corrective maintenance.

Preventive maintenance clearance specifications should place much greater emphasis on the elimination of potential causes of tree and branch failure. This also includes an important emphasis on proper arboricultural practices. This emphasis is driven by the goal to reduce the risk of structural failure. Trees respond favorably to proper pruning. Improper trimming causes stress, decay, and mortality, which effectively increases the risk of structural failure.

Secondly, because the risk of tree failure is predictable, regular hazard tree inspection and mitigation needs to be included as an important element of the vegetation management program.

Finally, armed with a new understanding of the mode and cause of tree-related interruptions, refinements can be made in the way corrective maintenance tree work (a.k.a. hot spotting) is managed.

Out-Of- The- Box Preventive Maintenance Alternatives

RCM begins with an initial assumption that reliability is an inherent design characteristic of the system. Within this frame of reference, structured decision logic is used to select optimal preventive maintenance tasks. This decision hierarchy defines the preferred approach to preventative maintenance as follows:

- Performing maintenance based on-condition
- Performing maintenance based on a fixed time interval
- Not performing preventive maintenance but repairing after failure
- Redesigning the system.

Redesign is recognized as the least preferred preventive maintenance alternative because it is often expensive. Nevertheless, it has a place in the maintenance program. The reality is that traditional vegetation maintenance tasks will not provide adequate risk mitigation for all sites and for all elements of the distribution system. In some small percentage of sites, adequate risk mitigation by traditional tree work is neither practical nor possible. In these cases, redesign alternatives deserve consideration.

Because RCM focuses attention on preserving system function, a number of strategies not traditionally considered to be maintenance items could be included in the maintenance prescription. Examples would include changes to the overcurrent protection system, corrective repair to existing infrastructure, and changes in the infrastructure. While the majority of resources will be allocated to preventive maintenance, (e.g. tree pruning and removal work), these other options will be considered and prescribed based on information acquired during field condition assessment.

Changes in Overcurrent Protection

Tree contact with overhead conductors initiates a fault. Under certain circumstances, the fault evolves from high to low impedance, with a corresponding increase in fault current levels. It is through the operation of the overcurrent protection system that the fault results in an interruption of some duration and size. There are a number of things that should be considered as means of mitigating the risk posed by trees.

Distribution systems are dynamic, and overcurrent protection coordination must keep pace. This is not always the case. A strong argument can be made to include a high level review of overcurrent protection coordination as part of the scheduled preventive vegetation maintenance of a circuit. The combined effect of tree maintenance together with overcurrent protection coordination would yield a return greater than either one done independently.

In addition to finding problems with overcurrent coordination, one will likely find missing, bypassed and/or disabled protection equipment. An example would be the occurrence of un-fused single-phase lateral taps. In this case, the argument can be made that a more effective means of mitigating risk than through tree pruning alone would be shifting part of the tree maintenance expenditures toward fuse installation. This is not to suggest that tree maintenance along single-phase lines isn't important. But with proper overcurrent protection, the intensity of that effort could be reduced, as compared to that required for multi-phase lines.

Finally, there is the issue of overcurrent protection philosophy. An understanding of tree-related fault mode and cause suggests that a review of some basic system protection practices may be in order. The practice of feeder selective relaying, (preserving fuses by recloser operation), is commonly practiced in the industry. One reason for this approach is the belief that most faults on the overhead system are

transient in nature. As pointed out, if a tree-initiated short circuit is the cause of the recloser operation, it is because it has provided a low impedance fault pathway. If the tree/branch with fully developed fault pathway remains in contact with the conductor(s), the reclosing operation will close back into a low impedance fault pathway. Based on an understanding of mode and cause, there is reason to question an assumption that the majority of tree-initiated faults would in fact be transient. ECI acknowledges that the overcurrent protection system must be effective in addressing faults of all causes. However, for circuits where trees pose the dominant threat to reliability, a fuse-sacrifice protection scheme should be considered.

Assessing Opportunities for Changes to Infrastructure

The most intuitively logical element of infrastructure to include in the overhead preventative maintenance program is inspection and correction of obvious defects. As has been discussed, an argument can be made for condition assessment and the development of a specific maintenance prescription. Assessment of the elements of the overhead infrastructure can be easily included in the inspection and maintenance prescription writing process.

On the basis of a generic economic assessment, it would be unlikely that the investment necessary to alter existing infrastructure is justifiable. However, conventional preventive maintenance tree work will not provide cost-effective risk mitigation on all sites and circuits. This is the same basic argument for redesign that supports consideration of change to overcurrent protection.

Here too, a RCM philosophy is useful in assessing where changes in infrastructure may be the preferred alternative. A system-based rather than site-based assessment of preventive maintenance costs is warranted. With an on-condition approach, the cost savings related to future maintenance may come from both a reduction in maintenance intensity and frequency.

The assessment involves comparing the present value of future maintenance costs on the old system to the cost of conversion plus the present value cost of maintaining a new system. Benefits such as potential improvements in reliability between systems should also be considered. The specific approach to economic analysis is beyond the scope of this paper. Conceptually speaking, however, when the cost to change a small portion of infrastructure provides a greater return in terms of cost savings and reliability than repetitive pruning and removal work, it should be included as part of the maintenance prescription. Finally, it is important not to imply high precision in the analysis if it cannot be supported by available data and assessment tools.

Changes To Conductor Orientation and Alignment.

Research into the electrical mode of failure points to the importance of considering the voltage gradient in assessing the risk presented by tree-conductor contact. A

second factor is conductor orientation as it relates to branch capture, which is the likelihood of a branch intercepting and remaining in contact with two conductors and or a conductor and the neutral wire. Compact phase configurations create higher voltage gradients and increased potential for faults developing due to branch capture. Horizontal phase orientation can present a high risk of branch capture that could result in phase-to-phase faults. Opening up phase spacing and vertical construction presents lower risk. Both need to be considered when designing new lines, as well as a means to harden the existing system to tree-caused faults.
The other alternative strategy involving conductor position is their physical location. This alternative is intuitive. Realignment or rerouting of conductors to separate them from trees can reduce tree-related risk on some sites. Options include the use of offset arms (a.k.a. wing arm or alley arm), increasing pole height, and the physical relocation (and possible elimination) of the line. The important point is that while some of these options are quite expensive, they deserve consideration on a relatively small percentage of the system.

Changes To Overhead Conductors

The voltage stress gradient impressed upon a branch that falls between two or more conductors may also be reduced by the use of various coated conductor systems, which are collectively known as "tree wire". The options include the use of coated overhead primary, where the coating provides some insulating characteristics, while not being technically rated as insulation. Spacer cable and true aerial cable systems provide increased resistance to tree-initiated faults since the coating serves increasingly as insulation. Getting creative, it is conceivable that adequate reduction in voltage gradient may be achieved with only one phase being replaced with a coated conductor. Finally, it is possible that a field-applied coating system can be developed, reducing the cost of this maintenance alternative by eliminating the need to re-conductor a section of infrastructure.

Tree wire can be applied with excellent results for those portions of circuits where the risk due to trees cannot be effectively mitigated by pruning and tree removal. The point once again is that by including these methods as options, the benefit of an integrated approach to prescriptive reliability can be achieved.

Conversion from Overhead To Underground

The final alternative to traditional tree pruning and removal is converting overhead infrastructure to underground. This is the most effective alternative in reducing the risk of tree-related service interruption. In fact, the risk due to trees is effectively eliminated. Undergrounding overhead lines can be prohibitively expensive. That said, it is important to state again the underlying philosophy; traditional vegetation maintenance will not provide adequate risk mitigation on all sites and for all elements of the distribution system. In some small percentage of sites, where tree pruning and removal is neither practical nor possible, undergrounding deserves consideration.

The cost of underground conversion is highly variable. Factors such as the complexity and function of the overhead infrastructure affect cost of conversion. The construction methods required also influence cost as does the site location and the need for restoration following construction. Likewise, there are locations where cost can be relatively low and where the risk faced by overhead lines is very high. The point once again is that by assessing risk these sites will be identified. Underground conversion applied on a generic basis makes little sense. However, including undergrounding as a specific treatment for a specific high-risk situation can be very effective in improving the reliability of a distribution system.

A final note on underground conversion

Underground construction has greater potential to adversely affect the health of trees than do most overhead maintenance practices, because underground construction has the potential to destroy a tree's root system. Conversion work should include work practices intended to reduce the potential for adversely affecting trees. Useful information in this area can be found in the
National Arbor Day Foundation's booklet: "*Trenching & Tunneling Near Trees*".

Summary:

There is room for improvement with respect to traditional vegetation management programs. Too often, traditional vegetation maintenance focuses on just achieving clearance, and not on the ultimate goal, which should be reliability. Prescriptive reliability represents an opportunity to refocus maintenance resources on what counts; improved reliability. This philosophy relies on condition assessment and the development of a specific maintenance prescription. A much wider range of maintenance alternatives are available than are typically found in the traditional program. The resulting integrated maintenance solution provides for a more effective allocation of resources and improvement in reliability.

Reference: Utility Vegetation Management: Use of Reliability Centered Maintenance Concepts to Improve Performance. EPRI. Palo Alto, CA. 2009. 1019417.

Appendix C – Contracting Strategies

C.1 Introduction to Contracting Strategies

Three different approaches are commonly used by electric utilities to contract line clearance work. These include "time and material/equipment" (T&M), "unit price" and "firm price" or "lump sum" pricing strategies. Each has advantages and disadvantages that are important to understand, and there are multiple variations possible within each pricing family. Each carries a different risk profile for the contractor and the utility. Unit price and firm price contacts are inherently performance-based contracts. However, T&M with incentive pricing can also be a performance-based contracting strategy.

Performance-based contract strategies generally offer the lowest production risk for the utility by placing the burden to monitor crew productivity on the tree contractor and "incentivizing" the contractor to control costs. This applies to firm price, lump sum, unit price, and T&M with incentive type contracts. However, it should be understood that in order for these contract strategies to be effective, the utility and contractor should have a thorough understanding of the work scope, historical man-hours and costs for the work units to be maintained within the contract period. While it is possible to utilize these specific contract types for all work (i.e. ticket type work as well as preventative maintenance work), they are the most effective in situations where the scope of work is better defined such as on preventative maintenance. Ticket work such as Customer Trim Requests and Restoration are often too variable and can lead to higher "unit" prices due to the "contingency" contractors may build into their bid to account for this uncertainty.

Where historical data is not available, some utilities are successful in developing performance-based contracts by clearly defining the project scope prior to bidding through the development of detailed work plans. Pre-planning to define clearances, clearance exceptions, and removals has proven to be a very effective strategy in receiving least cost competitive bids. Contractors provide pricing on the defined work scope that the utility has pre-designated, thus eliminating guess work on the part of the contractor and eliminating the "contingency" cost that contractors build into bids. However, this does require additional effort on the part of the utility to employ knowledgeable personnel to perform the pre-work planning as well as post work acceptance. This strategy generally works well when the utility is developing firm price contracts in the form of a guaranteed cost per mile or a guaranteed cost per circuit.

Utilizing a T&M with incentives type contract is a viable alternative for preventative maintenance work, but does require an extensive knowledge of historical man-hours in order to develop "should take times" in order to set contractor valid targets or thresholds for each work unit. In this contract type, the utility agrees to pay the contractor for their total actual man-hours incurred to complete the work unit. The contractor in turn, agrees to meet the established target and "share" with the utility any cost savings achieved by completing the work unit with less man-hours than allotted. Some contracts also include a shared "penalty" where the contractor agrees to also share the cost of any work units exceeding the threshold man-hours thus, this provides the contractor with an incentive to find cost savings while minimizing their perceived risk in relation to their skepticism to utility provided targets.

Another variation to this contract type includes a T&M not to exceed. In this contract type, the contractor and utility agree that any cost savings will be shared; however, the contractor bears the entire burden for any cost over-runs above the man-hour threshold set by the utility. The advantage to this contract strategy is that the utility can have 100 percent confidence in their maximum expenditure which they can then use to better plan and budget. The disadvantage is that the contractor may include higher pricing due to the "contingency" variable and therefore, it may not offer the same cost savings as could be expected through the shared incentive/penalty contract.

Utilizing multiple contract strategies for vegetation management is generally the most cost effective. Performance based contracts are preferred for preventative maintenance type work but should be utilized in combination with other contract strategies to ensure overall program cost effectiveness. Firm price or unit price contracts are most effective for brush maintenance or herbicide treatment programs where the contractor can easily inspect and quantify the work volume. Competitive bidding of these work types ensures the contractor will provide the lowest unit price based on their estimated cost to complete the defined work scope and their known material costs (i.e. herbicide costs). T&M contracts (without incentives) offer the greatest level of flexibility to the utility in terms of being able to easily add or remove work scope and therefore are recommended for ticket type work. For the contractor, T&M minimizes their risk where work scope is variable or undefined as in Customer Trim Requests and Restoration type work. This allows the contractor to provide better pricing but shifts the burden to the utility to ensure that crews remain productive. Even so, T&M is generally considered the preferred method for these work types. A combination of all the contract strategies tailored toward specific work types, will offer the greatest potential for cost savings to the utility while minimizing the resources required to monitor contractor performance.

Well-documented inspection of completed work and establishment of clear standards are critical to achieving value from firm price or unit price contracts. Where clearance requirements may be variable due to customer concerns or in situations where work scope is not clearly defined (as with ticket work), T&M normally can provide a better value.

In recent years, the impacts of fuel price fluctuations have become a major concern for contractors as well for the utilities they work for. Concerns arise when contract rates are set at a time when fuel prices are at the extremes and then change dramatically over the life of the contract. This either leaves the contractor with a windfall profit if fuel prices decrease (and the utility with higher costs) or can result in significant loss of profits for the contractor if fuel prices increase. Shorter contract periods (i.e. one-year) can minimize potential risk, but can be costly in terms of the cost to develop new contracts every year, and in terms of higher rates from contractors due to increased risk from shorter contract periods. Many utilities have elected to incorporate fuel escalators into their contracts to offset this concern.

The following are brief descriptions of the common contracting strategies:

Time and Materials (T&M)

T&M is normally the least risky for the contractor since most of the production-related risk is born by the utility. T&M contracts with performance measures and incentives tend to move some of the production risk back to the contractor. T&M often results in the highest work quality. Poor performance may subject a contractor to contract termination or result in assignment of "penalty points" as part of future bid evaluations. For work that is highly variable in nature, difficult to quantify in advance and where quality and customer relations are significant concerns, T&M may be the most desirable method.

Unit Price

Unit price work shifts production risk to the contractor but requires preplanning by the utility to designate which units the contractor should complete. Units are normally a tree trimmed, a square area of brush removed, footage cleared, or a tree removed by diameter classes. There is a natural incentive for the contractor to provide only the level of quality enforced by the utility. Consequently, quality control inspection by the utility is an important administrative requirement for this pricing strategy as well as work completion inspection. Administration of unit price contracts can become burdensome for utilities with high tree densities.

Firm Price

Firm price work also shifts production to the contractor but also shifts work unit selection to the contractor. The natural incentive in this pricing strategy is for the contractor to select the minimum acceptable units and provide the minimum acceptable quality. Post-work inspection by the utility is critical to assuring that all work was completed in compliance with the established specification. Tree removal is often an issue in a firm price contract since costs for tree removal can be highly variable. Consequently, trees to be removed are sometimes identified in advance as part of the bid package preparation. Alternatively, unit prices by size class for tree removal can be established or tree removal can be completed on a T&M basis for trees specifically authorized by the utility. Firm price is best suited to situations where the work can be clearly defined and understood by the bidders. It should also be limited to locations where there will be good competition by a number of bidders. Awarding of concurrent firm price contracts to multiple contractors is desirable. Small firm price contracts bid to companies that do not have a local presence frequently results in higher pricing to cover the cost of per diems or personnel relocations necessary to establish a labor force.

Turnkey and Incentive Based Contracts

Turnkey pricing shifts the maximum risk from the utility to the turnkey service provider. This pricing strategy normally is accomplished by establishing incentives tied to accomplishment of specific objectives such as cost control, tree-related reliability targets, and customer relations. Because most of the program management responsibility is that of the contractor, it is critical that the utility closely monitor the performance objects through periodic review of key performance indicators. A variation of turnkey pricing is a management services contract with a third-party management firm that administers contracts on behalf of the utility. The contracts for craft labor and equipment may continue to be with the utility or through the management company. The management services company may utilize any or all of the other pricing methods. This pricing strategy should be utilized if the utility has limited management resources or desires to totally overhaul existing systems, methods and practices.

Appendix D – National Electric Safety Code (NESC) Section 218

National Electrical Safety Code (NESC)
Part 2: Safety Rules for Overhead Lines

Section 218 Vegetation management

A. General

1. Vegetation that may damage ungrounded supply conductors should be pruned or removed. Vegetation management should be performed as experience has shown to be necessary.

   NOTE 1: Factors to consider in determining the extent of vegetation management required include, but are not limited to: line voltage class, species growth rates and failure characteristics, right-of-way limitations, the vegetation's location in relation to the conductors, the potential combined movement of vegetation and conductors during routine winds, and sagging of conductors due to elevated temperatures of icing.

   NOTE 2: It is not practical to prevent all tree-conductor contacts on overhead lines.

2. Where pruning or removal is not practical, the conductor should be separated from the tree with suitable materials or devices to avoid conductor damage by abrasion and grounding of the circuit through the tree.

B. At line crossings, railroad crossings and limited-access highway crossings, or navigable waterways requiring crossing permits.

   The crossing span and the adjoining span on each side of the crossing should be kept free from over-hanging or decayed trees or limbs that otherwise might fall into the line.

NESC Section 218 Interpretations

Prepared by **ECI**

In the context of electric utility vegetation management, use of the tern "interfere" means to impede or hinder the safe and reliable operation of a power delivery system. Interference with power lines by trees is not synonymous with contact between trees and power lines.

The NESC[1] addresses tree trimming and "interference" in section 218 as follows:

A. General

1. Trees that may interfere with ungrounded supply conductors should be trimmed or removed.

   NOTE: Norma/tree growth, the combined movement of trees and conductors under adverse weather conditions, voltage, and sagging of conductors at elevated temperatures are among the factors to be considered in determining the extent of trimming required.

2. Where trimming or removal is not practical, the conductor should be separated from the tree with suitable materials or devices to avoid conductor damage by abrasion and rounding of the circuit through the tree.

B. At line Crossings, Railroad Crossings, and Limited-Access Highway Crossings

The crossing span and the adjoining span on each side of the crossing should be kept free from overhanging or decayed trees or limbs that otherwise might fall into the line.

Clearly, trees that interfere should be trimmed or removed as described in NESC 218 A1. Section 218 A2 describes an alternative to trimming that achieves the avoidance of interference, that is, avoiding "conductor damage by abrasion and grounding of the circuit through the tree". Grounding of a circuit is not the same as current leakage, since minor amounts of current leaks through even the best insulators. Rather, grounding of a circuit results from a high-current fault and would normally cause operation of protective devices. Incidental contact between tree branch tips does not result in high-current faults or "grounding" through a tree. Therefore, incidental contact between trees and distribution primary or secondary conductors does not constitute "interference" as used within the NESC section on tree trimming.

Ongoing contact with conductors, depending on voltage and conductor type, can result in abrasion or mechanical damage to conductors. Mechanically damaged conductors have been known to fail, resulting in economic loss, system failure and unsafe conditions upon failure. Therefore, caution to avoid this condition is appropriately included in the NESC.

[1] Institute of Electrical and Electronic Engineers, Inc. National Electric Safety Code. 2002. p. 63. IEEE. New York, New York.

Defining interference as hindering safe and reliable operation of the electric system is also consistent with the historic use of the phrase "interference" in relation to line clearance tree trimming. For over 50 years, adequate clearance between trees and overhead power lines has been defined as a class of clearance that permits efficient operation of overhead lines. Adequate clearance has been understood to safeguard against interference from new growth and should be measured by effectiveness in terms of reliability (Blair[2]).

Creation of new definitions or understandings of the term "interfere", outside of the NESC use of the term creates an arbitrary use without benefit of the expert industry input that has been critical to the development of national standards like the NESC.

[2] Blair, G. D. Line Clearance for Overhead Lines. 1951. p. 95. Electrical Publications, Inc. Chicago, Illinois.

Appendix E – Liberty Utilities Outage Investigation

Tree Outage Report

OAS NUMBER | **District** | **Feeder** | **Previous Trim Date**

Location | **Contractor**

Date Checked | **Checked By**

Order Type
- ☐ Feeder outage
- ☐ Device outage
- ☐ Transformer outage

Condition
- ☐ Appeared healthy
- ☐ Construction damage
- ☐ Dead
- ☐ Declining
- ☐ Girdling roots
- ☐ Hollow
- ☐ Included bark
- ☐ Root rot
- ☐ Soil compaction
- ☐ Soil saturation
- ☐ Topped/improper pruning
- ☐ Visible fungi

Horizontal Distance From Wire
- ☐ 0-10'
- ☐ 10-20'
- ☐ 20-30'
- ☐ Over 30'

Species
- ☐ Ash Species
- ☐ Black Cherry
- ☐ Black Walnut
- ☐ Boxelder
- ☐ Bradford Pear
- ☐ Cedar
- ☐ Conifer (other)
- ☐ Cottonwood
- ☐ Elm (American)
- ☐ Elm (Siberian)
- ☐ Hackberry
- ☐ Hickory (other)
- ☐ Hickory (Shagbark)
- ☐ Hickory (Shellbark)
- ☐ Locust (Black)
- ☐ Locust (Honey)
- ☐ Mulberry
- ☐ Oak (Black)
- ☐ Oak (other)
- ☐ Oak (Pin)
- ☐ Oak (Red)
- ☐ Oak (Shingle)
- ☐ Oak (White)
- ☐ Other
- ☐ Pine Species
- ☐ Poplar Species
- ☐ River Birch
- ☐ Silver Maple
- ☐ Sugarberry
- ☐ Sweetgum
- ☐ Sycamore
- ☐ Tree of Heaven
- ☐ Willow Species

Line Type
- ☐ Single phase
- ☐ Two phase
- ☐ Three phase
- ☐ Subtransmission

Cause
- ☐ Broke at base
- ☐ Broke in crown
- ☐ Broke in trunk
- ☐ Close overhang
- ☐ Growth
- ☐ Homeowner/Tree service
- ☐ Mistake in reporting
- ☐ Previous storm damage
- ☐ Split
- ☐ Uproot
- ☐ Washout

Preventable
- ☐ Yes ☐ No

Overhang
- ☐ Yes ☐ No

Relation to ROW
- ☐ Off ROW East side
- ☐ Off ROW North side
- ☐ Off ROW South side
- ☐ Off ROW West side
- ☐ On ROW

Weather
- ☐ Calm
- ☐ Flood
- ☐ Ice
- ☐ Major Storm
- ☐ Rain
- ☐ Snow
- ☐ Thunderstorm
- ☐ Wind

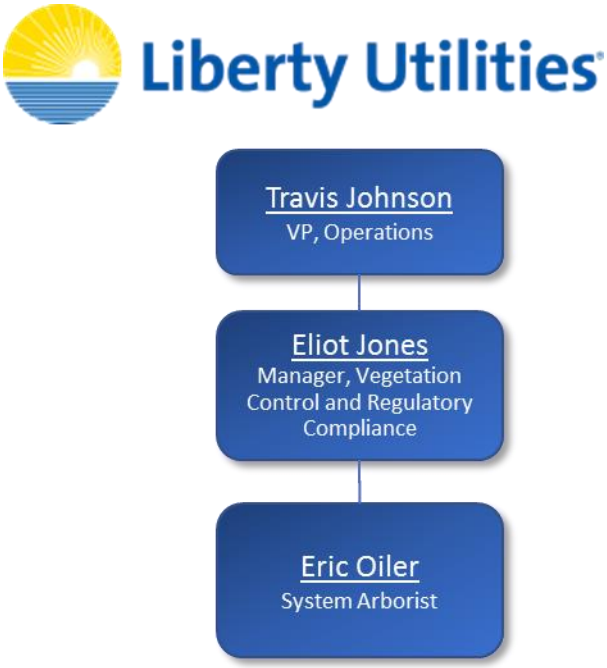
Tree Density
- ☐ < 10 trees per span
- ☐ 10-20 trees per span
- ☐ > 20 trees per span

Distance Above Line
- ☐ 0-10'
- ☐ 10-20'
- ☐ 20-30'
- ☐ Over 30'

Notes:

Appendix F – Liberty Utilities Organizational Structure

Current Vegetation Management Organization Chart



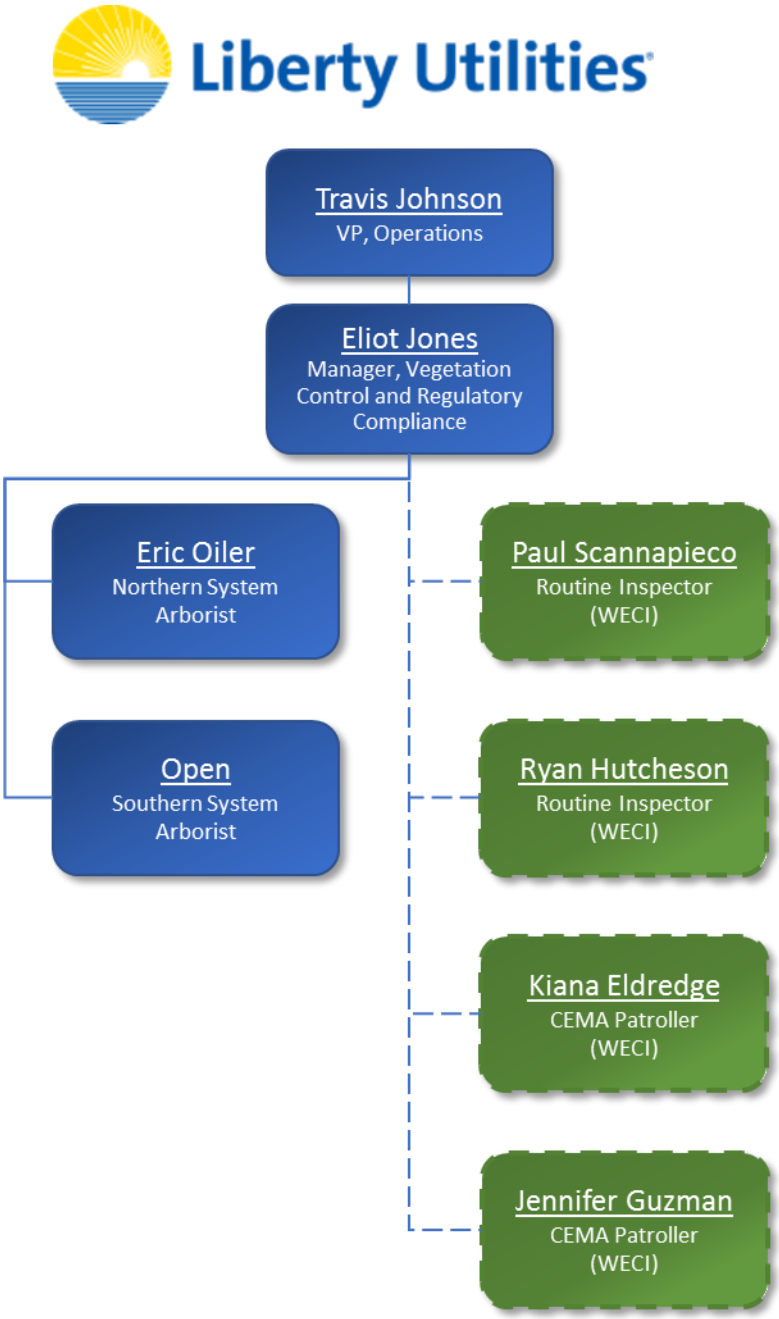
Eliot Jones – Manager, Vegetation Control and Regulatory Compliance

- Directs all aspects of the overall Vegetation Management Program along sub-transmission and distribution lines at Liberty Utilities (CalPeco Electric).
- Develops corporate policies for Integrated Vegetation Management.
- Budgets, allocates, and manage annual VM expenditures.
- Leads, develops, executes & monitors various special projects related to vegetation management.
- Negotiator of master service agreements for Liberty Utilities contracted tree crews.
- Organizes large scale storm restoration.
- Owner of project management efficiencies among contracted crews with continuous improvement projects, communicating and monitoring safety policies, auditing vendor's work and confirming trimming standards are met.
- Establishes working relationships and presents information to numerous internal and external groups including: senior management, Federal and State Agencies such as U.S. Forest Service, and U.S. Bureau of Land Management, professional councils, city mayors, directors of public work, and homeowner associations.
- Fosters a productive and respectful relationships with direct reports and with management of contractors.

Eric Oiler – System Arborist

- Provides direct oversight, monitor performance, and implement control measures of external vegetation contractor(s).
- Schedules work of external contractors while balancing priorities of safety, timeliness, and critical nature of some tasks.
- Responds to internal and external customer requests to ensure proper clearances required in Liberty Utilities standards are achieved.
- Develops and maintains a strong professional relationship with county, city, state, and federal organizations as well as landowners impacted by vegetation management work.
- Ensures compliance with federal, state and local standards. Applies and obtains permits with these agencies for vegetation management work.
- Inspects contract work to ensure compliance with Liberty Utilities specifications.
- Supports System Operations during after hour outage restoration and emergencies.
- Investigates vegetation-related outages and develop plans to minimize outages.
- Identifies opportunities to improve vegetation management practices.
- Identifies opportunities to reduce cost of vegetation management work while maintaining a high degree of quality and productivity.

Proposed Vegetation Management Organization Chart



Appendix G – Effects of Deferred Maintenance and Inadequate Clearance

Deferred Maintenance, Inadequate Clearance, and Normal Pruning Cycles

Deferred maintenance is a process in which tree growth is allowed beyond the limits prescribed by a regular maintenance cycle. This happens when the time between pruning is too long for the clearances obtained.

Inadequate clearance is the result of not pruning the branches far enough from the conductors to allow for the growth of the trees.

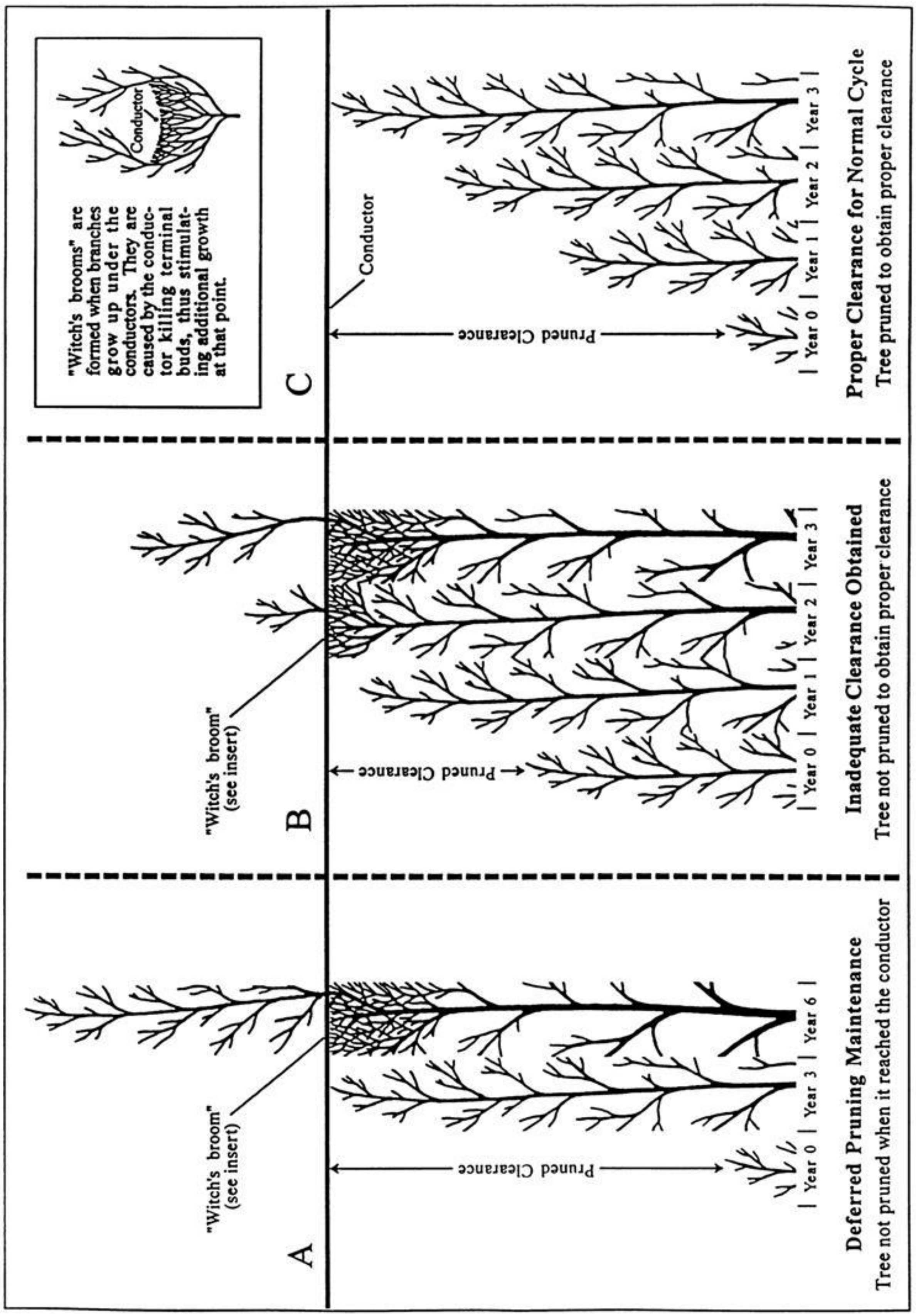
Deferred maintenance and inadequate clearance generally result in increases in the number of tree-related service outages and in the overall costs of the line clearance operations. Clearances and pruning cycles recommended in this report should be maintained to avoid these problems.

Figure A illustrates the typical results of three different top pruning situations for trees, based on a 3-year maintenance cycle. (Similar effects would occur for side pruning and other recommended cycle lengths.)

Situation 1: Sketch "A" illustrates the effect of deferred maintenance. The maintenance cycle should be such that when the tree limbs reach the conductor, the tree should be pruned. If maintenance is deferred, these limbs will grow around and between the conductors, producing a much more difficult and expensive pruning job. Branches will have to first be trimmed to the conductors to remove growth in close proximity to them. The branches will then have to be pruned again below the conductors to obtain proper clearance.

Situation 2: Trimming that does not provide adequate clearance around the conductors can produce the same situation created by deferred maintenance. Sketch "B" illustrates how inadequate clearance created a difficult and expensive pruning job, because branches grew around the conductors before the line was scheduled for the next pruning cycle. The clearances recommended in this report are the minimum necessary for the recommended cycles.

Situation 3: If normal pruning cycles are maintained (as shown in Sketch "C") and proper pruning techniques and clearances are used, pruning costs will be reduced and stabilized over the long run. However, cost increases will occur if stability is lost due to budget cutbacks or reduction in clearance obtained.



Appendix H – QA/QC Process

Appendix H – QA/QC Process

Example In-Progress Field Crew Audit (QA)

Contractor:	CREW FOREMAN									
Reviewer:										
Week ending:										
GF:										
Mark 1 if the crew complied										
Mark 0 if the crew did not comply										
Leave blank if no observation can be made										
Date►										
Work Type										
SAFETY										
Cones										
Signs										
Flagger										
PPE (hardhat; chaps; eye & ear protection)										
General Safe Working Practices										
Safety Comments										
QUALITY										
Clearance										
Vines										
Clean Up										
Dead/hazardous Wood Removed										
Stump Treatment Applied										
Proper Cuts										
Timesheet accuracy										
Quality Comments										
PRODUCTIVITY										
Crew at reported location										
Crew Productively Working										
Equipment in Good Repair										
Appropriate Start and Stop Times										
Productivity Comments										
PERMISSION										
Permission Understandable										
Permission Complete										
Permission Comments										
SCORING										
Safety score[1]										
Quality score[1]										
Productivity score[1]										
Permission score[1]										
Total score[2]										

[1] category score = #1's / (#1's + # 0's)

[2] Total Score = categories totaled by 25% weighting each

Appendix H – QA/QC Process

Example QC Audit Form

Division: _____ Work Type: _____ Circuit: _____ Miles: _____

Assessor: _____ Date: _____ Time: _____ Town: _____

Span #	Pole#	Total Tree Count in Span	NUMBER OF DISCREPANCIES													# Critical	# Non-Critical	Photo #	Remarks
			Critical						Non-Critical										
			Inadequate Clearance Under	Inadequate Clearance side	Inadequate Clearance Over	Main Stem Clearance	Deadwood	Danger Tree (!)	Should be Removed	Brush Topped / Not Removed	Herbicide Application	Improper Cut	Improper Crown Ratio	One-Third Rule	Clean-Up / Hinges				
Subtotals:																			

Appendix H – QA/QC Process

ANSI/ASQ Z1.4 2008 – Sampling for Attributes

Six-Sigma suggests the use of ANSI/ASQ Z1.4 for determining sample size and accept/reject rates on work output. While this normally applies to a product being produced (i.e. the number of widgets coming off the assembly line in a factory), it can also be applied to the number of trees being pruned to a specific standard. Acceptance sampling is used by industries worldwide for assuring the quality of incoming and outgoing goods. Acceptance sampling plans determine the sample size and criteria for accepting or rejecting a batch based on the quality of a sample, using statistical principles. Many organizations require the use of ISO standards (or their ISO/ANSI/ASQC/BS/Military Standards or other counterparts) for purposes of certification.

Table I—Sample size code letters

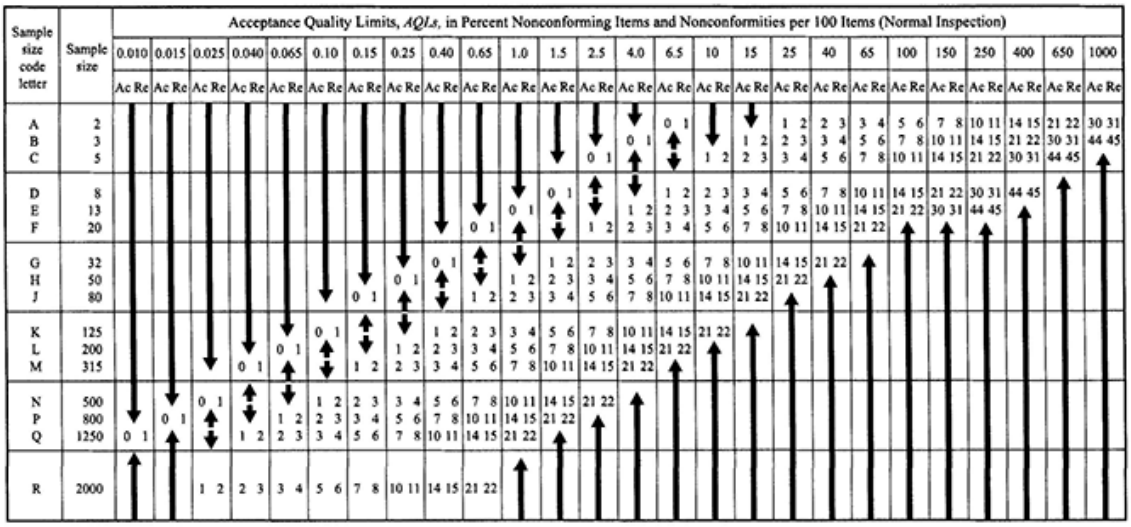
(See 9.2 and 9.3)

Lot or batch size	Special inspection levels				General inspection levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
500001 and over	D	E	H	K	N	Q	R

Appendix H – QA/QC Process

Table II-A—Single sampling plans for normal inspection (Master table)

(See 9.4 and 9.5)



Sample size code letter	Sample size	Acceptance Quality Limits, *AQLs*, in Percent Nonconforming Items and Nonconformities per 100 Items (Normal Inspection)																														
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000						
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re						
A	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	0 1	0 1	↓	1 2	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31						
B	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	1 2	2 3	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45						
C	5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↑	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑						
D	8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↕	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑							
E	13	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑								
F	20	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↑	↕	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑									
G	32	↓	↓	↓	↓	↓	↓	↓	↓	0 1	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑													
H	50	↓	↓	↓	↓	↓	↓	↓	↓	↕	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑													
J	80	↓	↓	↓	↓	↓	↓	↓	↓	↑	↕	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑													
K	125	↓	↓	↓	↓	↓	0 1	↓	↓	1 2	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑														
L	200	↓	↓	↓	↓	↓	↑	↓	↓	1 2	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑														
M	315	↓	↓	↓	↓	0 1	↑	↓	↓	1 2	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑														
N	500	↓	↓	↓	0 1	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑																		
P	800	↓	↓	↓	↕	↓	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑																			
Q	1250	0 1	↑	↕	1 2	↓	3 4	5 6	7 8	10 11	14 15	21 22	↑																				
R	2000	↑		1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	↑																					

↓ = Use the first sampling plan below the arrow. If sample size equals, or exceeds, lot size, carry out 100 percent inspection.

↑ = Use the first sampling plan above the arrow.

Ac = Acceptance number.

Re = Rejection number.

If the Switching Rules are not specified, then this QA policy criterion will be used:

Normal (II)→ Tightened (III) – When 2 Lots are found nonconforming out of the past 5 or fewer lots, switch from normal to tightened inspection.

Tightened (III) → Normal (II) – When 5 consecutive conforming lots are found, switch from tightened to normal inspection.

Normal (II) → Reduced (I) – When 10 consecutive conforming lots are found, switch from normal to reduced inspection.

Reduced (I) → Normal (II) – When 1 lot is found nonconforming during reduced inspection, switch from reduced to normal inspection.

Appendix H – QA/QC Process

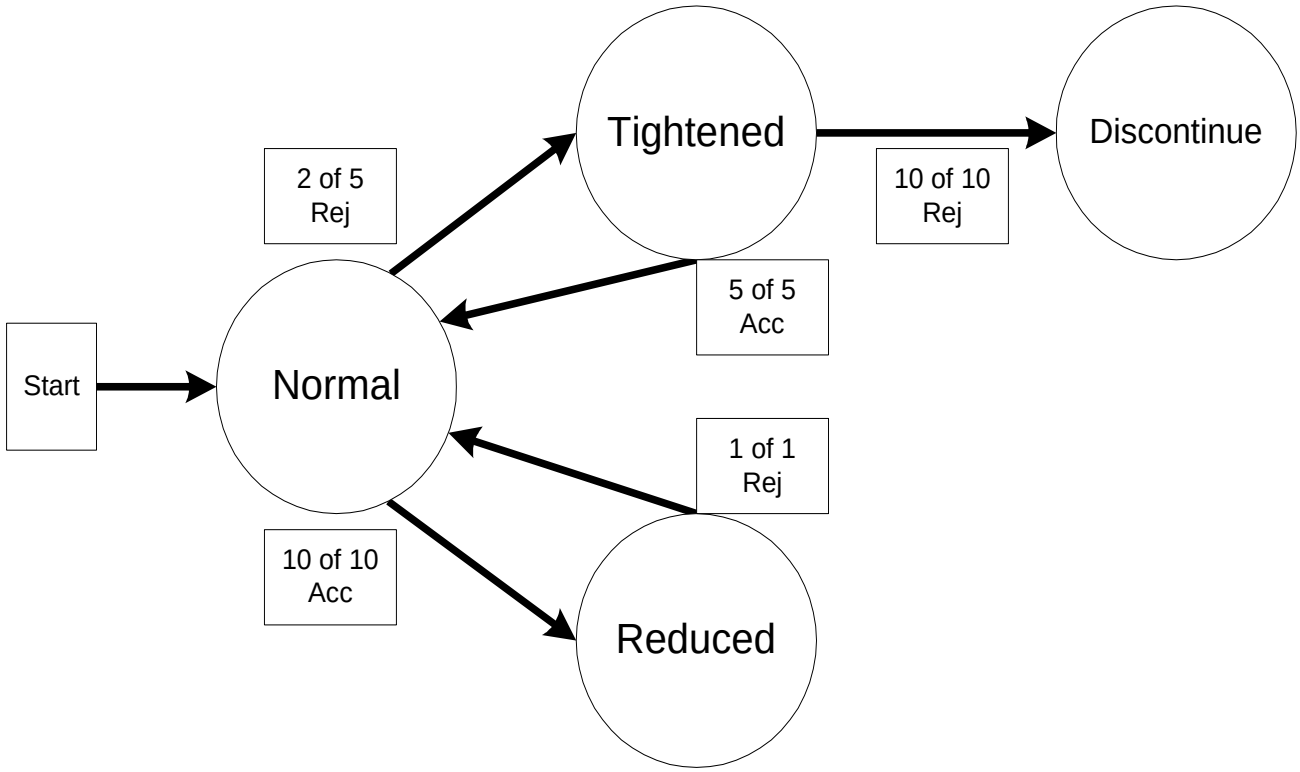


Figure H-1. ANSI/ASQ Z1.4 Switching Rules. To Be Used to Determine Audit Intensity.

Goals:

1. To decrease sample size and increase inspection intensity within limits of a statistically valid random sample.
2. To distinguish between critical and non-critical discrepancies.
3. To hold the tree contractor accountable for developing and administering a comprehensive quality assurance (QA) program.
4. Base the accept/reject of entire circuit or segment on the number of discrepancies per 100 trees (not number of deficient spans per mile). This is a better measure of overall contractor performance and focuses on critical discrepancies for risk reduction.
5. Set threshold for circuit or line segment acceptance. On reject, require contractor to re-inspect line and correct all discrepancies. Repeat audit after reworks complete.

Determining Acceptable Quality Limits:

Determine the AQL (Acceptable Quality Limits) per 100 trees for the critical and non-critical discrepancies. This is the number of discrepancies the utility is willing to accept and still pay the contractor for the work unit completed. It is suggested that different AQL's be used for critical versus non-critical discrepancies. This will prevent the rejection of a work unit for minor infractions that have little or no bearing on reliability. This is a one-time process and will apply to all circuits or work units being inspected.

Normally, the AQL for critical discrepancies is set to zero. However, critical discrepancies are generally considered defects that may lead to severe injury or death, such as with a defective part in an automobile braking system. Manufacturers cannot tolerate any defects in brake components and would therefore, set their critical discrepancy tolerance to zero percent. Tolerance allowances on the maintenance of vegetation while still important, is less critical than automobile braking systems. So the term "critical" as used here for vegetation maintenance discrepancies is much looser than the traditional definition.

Critical discrepancies in vegetation maintenance work should be defined as insufficient clearance issues or issues involving the failure to remove defective live or dead wood that pose a direct risk to service reliability. Some critical discrepancies may be tolerated in the interest of efficiencies and cost effectiveness. A zero tolerance while ideal in a perfect world, may come at an additional cost that is not easily justifiable. Therefore, the utility should consider an AQL of between 2.5 and 4.0 percent as a good starting point for critical discrepancies. These values can be adjusted at any time by the utility to meet the risk tolerance as conditions change.

Non-critical discrepancies (e.g., improper cuts, poor cleanup, etc.) which reflect poor quality of work more than a specific safety or reliability risk, allow for greater tolerances. These discrepancies are still important because they reflect directly upon the tree vendor's attitudes and abilities. Further, poor quality work can lead to higher future maintenance costs. However, here again, setting the bar too high can result in excessive costs. A starting AQL of ten percent or higher should be considered as a starting point for non-critical discrepancies.

Steps:

1. Note the critical and non-critical AQL's that will be used to determine pass/fail.
2. Determine the number of miles completed in the circuit or line segment to be audited.
3. Convert miles to number of spans. This is your batch/lot size.
4. Use Table I to determine letter code. Always start with level II (Normal) unless switching rules indicate another level of inspection is required.
5. Use letter code to determine number of spans to sample using Table II. This is your sample size.
6. Select a random starting point on the circuit or line segment using a circuit map (i.e. close your eyes and pick a point or use a random number generator to select specific pole numbers).
7. Field QC:
    a. Start audit at random start location as selected on map or random pole selection.
    b. Begin span to span audit looking at all trees/brush that was and/or should have been maintained.
    c. Use QC form that splits critical vs. non-critical discrepancies (see example below):

Appendix H – QA/QC Process

Division: _____ Work Type: _____ Circuit: _____ Miles: _____

Assessor: _____ Date: _____ Time:_____ Town: _____

Span #	Pole#	TotalTree Count in Span	NUMBER OF DISCREPANCIES													# Critical	# Non-Critical	Photo #	Remarks
			Critical						Non-Critical										
			Inadequate Clearance Under	Inadequate Clearance side	Inadequate Clearance Over	Main Stem Clearance	Dead wood	Danger Tree(s)	Should be Removed	Brush Topped / Not Removed	Herbicide Application	Improper Cut	Improper Crown Ratio	One-Third Rule	Clean-Up / Hregers				
Subtotals:																			

d. Record total number of trees that were or should have been maintained within each span in the column "Total Tree Count in Span". Brush within a span is counted as a total of one tree regardless of the amount of brush.
e. Record the number of discrepancies in the appropriate column. Continue through all spans.
f. Sum the total discrepancies by critical vs. non-critical.
g. Once all the spans within the sample have been completed total up the total tree count and the critical vs. non-critical discrepancies.
h. Divide the total critical discrepancies by the total tree count and multiply by 100. This is your total critical discrepancies per 100 trees. Repeat the process for the non-critical discrepancies.
i. If the ratio of critical and the ratio of non-critical discrepancies is less than or equal to their respective AQL's, the circuit or line segment is accepted and payable. If either the ratio of critical or the ratio of non-critical discrepancies is higher than their respective AQL's, the circuit or line segment is rejected and that circuit or line segment must be re-patrolled by the tree contractor and all discrepancies remedied.
j. On rejected circuits or line segments that have been remedied, the tree contractor re-submits the circuit to the utility for re-inspection.

k. The utility repeats step (a) through (j) to determine if the remedied circuit or line section can be accepted. Follow the switching rules to determine the new inspection level.
l. If a circuit or line section fails a second time, the work unit is returned to the tree contractor for further remedies AND the tree contractor agrees to reimburse the utility the full cost of the third and subsequent QC audits.

8. With any random sampling process and specifically the ANSI/ASQ 1.4 Acceptance Sample process, there will be a perceived level of discrepancies that will be accepted due to the selected AQL or due to deficient areas that were not selected in the random sample (i.e. skipped line sections not selected in the random sample). It is important therefore, for the VM Arborists to frequently visit work in progress and track work completion over the entirety of the circuit.

9. The contractor scorecard should be amended to use the critical and non-critical scores for measuring tree contractor performance.

Example:

Completed Circuit: AA1234

Circuit Miles Completed: 8.45 OH miles

Critical AQL: 4.0% (as set by utility)

Non-Critical AQL: 10% (as set by utility)

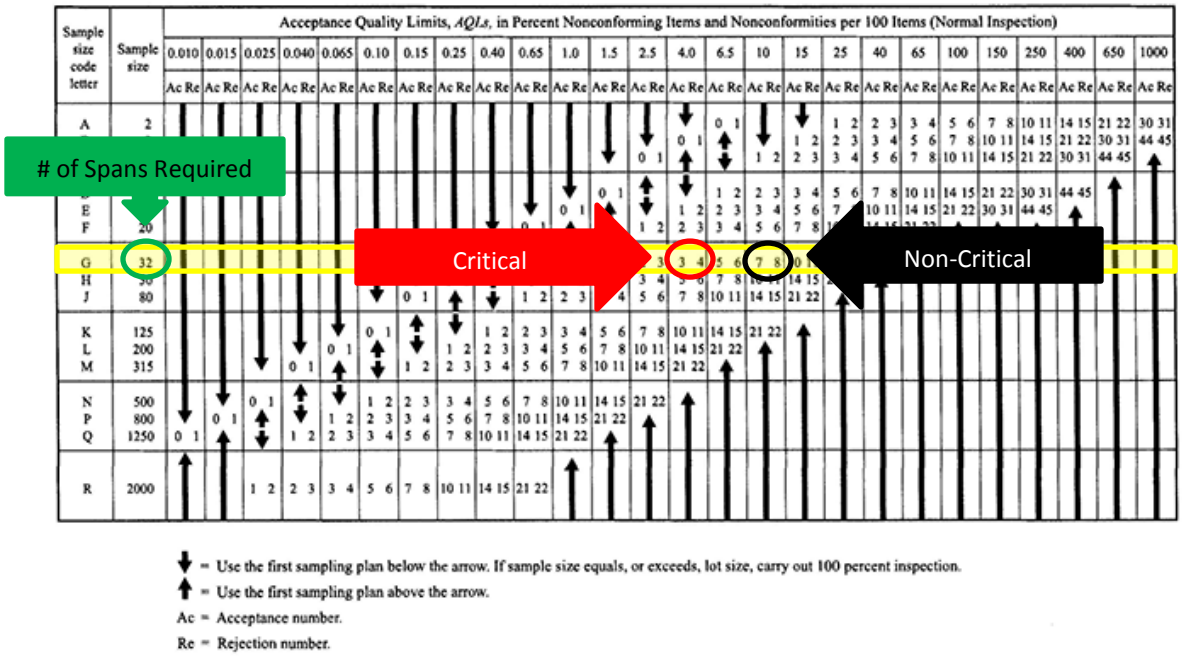
1. **Determining Number of Samples Needed**
   a) Convert the completed circuit miles (8.45 miles) to a number of spans. If the number of spans is known, use that number, if not, calculate the number of spans based on average span distance or number of spans per mile. In this case, the average number of spans per mile used is 26. Therefore, the total number of spans completed is 26 x 8.45 miles or 220 spans.
   b) Using Table I above, locate the lot or batch size range in the left column which corresponds to 220 spans. Per Table I, the number 220 falls in the range of 151 and 280 (seven rows down).
   c) Assuming a Normal Inspection (II), read across that seventh row to the General Inspection Levels column under II. Note that the sample size code letter is "G".
   d) Using Table II, note the number just to the right of the Sample Size Code Letter column for "G". The number "32" is the number of samples that should be taken. Therefore, the table suggests that 32 spans of the total 220 spans be inspected for discrepancies. See Table II example below.

2. **Determining Accept/Reject Thresholds**
   Use Table II again, to determine the number of allowable discrepancies for both critical and non-critical discrepancies. Reading across row "G", find the numbers under the column for 4.0% AQL. This will be the threshold for critical discrepancies for this circuit. The numbers are "3" (AC-accept) and "4" (RE-reject). Therefore, if the number of discrepancies per 100 trees is three or less, then the work unit is approved. If the

number of discrepancies is four or more, then the work unit fails. Find the thresholds for the non-critical discrepancies using the same manner. In this case, those numbers for a 10% AQL are "7" (AC) and "8" (RE). Record these thresholds for later use.

Table II-A—Single sampling plans for normal inspection (Master table)

(See 9.4 and 9.5)



Sample size code letter	Sample size	Acceptance Quality Limits, *AQLs*, in Percent Nonconforming Items and Nonconformities per 100 Items (Normal Inspection)																													
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2													↓	0 1	↑	↓	1 2	1 2 2 3	2 3 3 4	3 4 5 6	5 6 7 8	7 8 10 11	10 11 14 15	14 15 21 22	21 22 30 31	30 31 44 45	↓
B	3												↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓	
C	5											↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓		
D	8										↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓			
E	13									↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓				
F	20								↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓					
G	32							↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓						
H	50						↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓							
J	80					↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓								
K	125				↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓									
L	200			↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓										
M	315		↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓											
N	500	↓	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓												
P	800	0 1	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓													
Q	1250	↑	↓	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓														
R	2000		1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↓															

↓ = Use the first sampling plan below the arrow. If sample size equals, or exceeds, lot size, carry out 100 percent inspection.

↑ = Use the first sampling plan above the arrow.

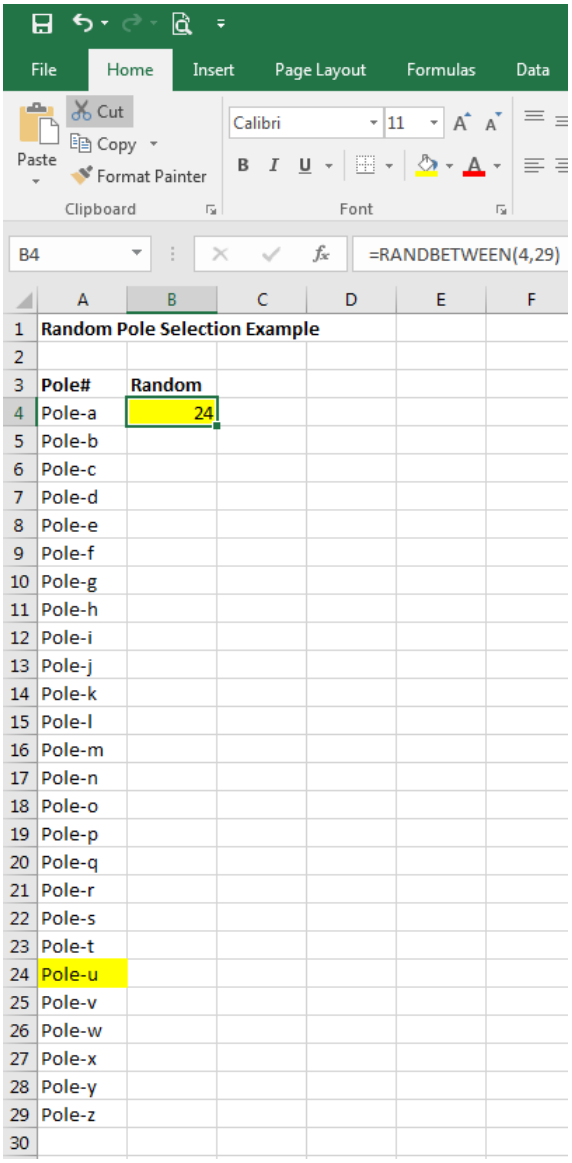
Ac = Acceptance number.

Re = Rejection number.

3. Performing Field Audit

a) Select a random starting point to begin the audit of the 32 required spans as determined above. This can be done by closing your eyes and randomly picking a place on the map, or better yet, using a list of pole numbers or pole locations. We will assume that we have an Excel list of every pole (with pole number and/or GPS location) on circuit AA1234. Since we are looking for only one location, determine the Excel row number for the first pole on the list and also for the last pole on the list. Using Excel formula in any cell, type in "=RandBetween(top row, bottom row)" where "top row" is the cell row of the first pole occurrence and "bottom row" is the last row. See the simplified example below. In this example, "Pole-u' was selected by the random formula inserted in cell b4. "Pole-u" on row 24 therefore, would be our random starting location.

Appendix H – QA/QC Process



	A	B	C	D	E	F
1	**Random Pole Selection Example**					
2						
3	**Pole#**	**Random**				
4	Pole-a	24				
5	Pole-b					
6	Pole-c					
7	Pole-d					
8	Pole-e					
9	Pole-f					
10	Pole-g					
11	Pole-h					
12	Pole-i					
13	Pole-j					
14	Pole-k					
15	Pole-l					
16	Pole-m					
17	Pole-n					
18	Pole-o					
19	Pole-p					
20	Pole-q					
21	Pole-r					
22	Pole-s					
23	Pole-t					
24	Pole-u					
25	Pole-v					
26	Pole-w					
27	Pole-x					
28	Pole-y					
29	Pole-z					
30						

b) After locating "Pole-u" in the field, a contiguous audit of 32 spans is conducted to record discrepancies per the audit form as shown in the **Steps** section above. Each span should be recorded on a separate line on the inspection form. This means that once the form for this audit is completed, it will show 32 lines of data.

c) Contiguous is a relative term. More often than not, you will be required to break-up the inspection line due to hitting a terminal point. When this happens, return to the beginning of that line section that terminated and proceed from that point.

d) Randomness is important, therefore, when beginning the audit, use a coin to determine which direction you will proceed (e.g., left or right).

e) While auditing spans, should you encounter an any line intersection (e.g., where a feeder "T's" off, lateral pulls-off the feeder, a secondary lateral pulls-

off the main lateral, etc.) use a coin to determine which direction you should proceed. Do not let ease of access or other factors influence your decision.

f) Record the number of critical and non-critical discrepancies on the audit form. Don't forget to count the total number of trees maintained (or that should have been maintained per the plan) for each span. Note that an individual tree can have multiple discrepancies.

4. Determining Pass/Fail

a) After completing the 32 spans as required in this example, tally up the total discrepancies for critical versus non-critical discrepancies and divide by the total number of trees counted in the 32 spans (note that some spans may have no trees). Let's assume for this example that the auditor found 2 critical discrepancies and 8 non-critical discrepancies in the 32 spans audited. The total number of trees maintained or to be maintained within the 32 spans was determined to be 97 trees. Therefore, the critical discrepancies per 100 trees is calculated to be 2/97=0.021 or 2.1. Likewise, the non-critical discrepancies can be calculated as 8/97=0.082 or 8.2.

b) The critical discrepancies calculated of 2.1 is less than the 4 (RE) critical discrepancy threshold however, the non-critical discrepancies calculated as 8.2 is higher than the reject value of 8 (RE) as determined in Table II (and as originally noted in item 2 above). Therefore, in terms of non-critical discrepancies, the work unit fails. Since the work unit passed in terms of critical discrepancies but failed in non-critical discrepancies, the work unit would fail and be sent back to the vendor to remedy. The vendor should be provided the list of the discrepancies encountered but would be made clear that the "entire" circuit should be rechecked to ensure the types of discrepancies identified are rectified.

Once the tree vendor has notified the utility that the circuit has been remedied (not just the specific spans audited), the utility will begin the audit process all over again by selecting a new random auditing start point and repeating steps 3 and 4 above. The process will continue until the circuit receives a pass on both critical and non-critical discrepancies.

Appendix I – Recommended Industry Best Management Practices

RECOMMENDED INDUSTRY BEST PRACTICES STRATEGIES

Transmission owners need to develop practices that fulfill the requirements of the vegetation standard in a cost effective manner. These practices or strategies must be documented and consistently implemented. Over time, certain practices have been shown to be successful in preventing outages due to vegetation. Many of these practices were incorporated into the NERC Standard FAC-003 since the group that developed and approved the standard included experienced transmission vegetation managers. The American National Standards Institute (ANSI) has established standards for vegetation maintenance on transmission ROW[1]. In addition, the International Society of Arboriculture (ISA) has issued a companion publication to ANSI A300 Part 7, Best Management Practices, Integrated Vegetation Management.[2]

WORK MANAGEMENT

ECI proposes the following best practice work management recommendations as part of any successful transmission vegetation management program. The utilization of some or all of these work management tools and methods may already be in use at BHP, CLFP, and BHCOE and therefore, these recommendations in no way imply the current lack of appropriate procedures. The original scope of this workload study did not include a review of the transmission program procedures or strategies. The recommendations presented here should be considered for implementation by BHP, CLFP, and BHCOE if not already integrated into the existing management program.

- **Develop and keep current a policy document for FAC-003 compliance.** The current NERC standard FAC-003 no longer explicitly requires a vegetation management plan document (TVMP). However, ECI recommends implementing a "Policy Document" as outlined in draft form (Appendix J). This policy document can be used to complete the required Reliability Standard Audit Worksheets (RSAW) document for audit purposes. The policy document references the applicable components of the VM program as expressed in the suggested Guidelines document (Appendix K). This policy document becomes a compliance "road map" to guide auditors in understanding how the company meets both the spirit and intent of the FAC-003 standard.
- **Develop and keep a current work schedule.** The work schedule would include both a master schedule for all transmission facilities as well as an annual plan for work (routine maintenance and inspections) scheduled for a particular year. The annual work plan requires periodic (at least monthly) updating of work progress.
- **Implement a system of inspecting planned work.** Documenting the inspection of completed work is also necessary to properly approve payment and ensure work reported as complete by the contractor meets BHP's, CLFP's, and BHCOE's expectations. Spot checks of completed work are commonly used with inspections of additional completed work when deficiencies are found. It is important to identify work that does not meet the standard early so that corrections can be made before

[1] ANSI. 2006. The American National Standard for Tree Care Operations - *Tree, Shrub, and Other Woody Plant Maintenance- Standard practices (Integrated Vegetation Management a. Electric Utility Rights-of-way).* A 300 Part 7. American National Standards Institute, NY.

[2] Miller, R.H. 2007. Best Management Practices- Integrated Vegetation Management. International Society of Arboriculture, Champaign, Il.

more deficient work is completed. This will save time for both the utility and the contractor performing the work. Formal documentation of the work inspection is recommended.

- **Provide for consistent budgeting.** A consistent plan needs consistent funding. Budget reductions mid-year can cause workforce disruptions that increase future costs. Any changes to the established annual plan require documentation.
- **Establish and enforce work specifications.** The personnel performing the work must know exactly what is expected of them. The work inspector must know the specifications to properly enforce them. If future contract strategies are being considered, a clear, concise specification is required to communicate BHP, CLFP, and BHCOE vegetation maintenance goals to perspective contractors. The clearer the contract specification, the better the pricing from a perspective new contractor.
- **Develop action thresholds.** Develop a "clearance at time of maintenance" (clearance 1) distance and establish a minimum clearance threshold (clearance 2) that vegetation should never exceed. This threshold clearance will provide an additional margin of error to allow for vegetation growth, line sag and variations in maintenance cycles. Best practice utilities have developed an action threshold clearance value between Clearance 1 and Clearance 2 in order have an intermediate point to take appropriate action to avoid violating the vegetation standard. Another type of action threshold relates to the maximum height that brush[3] is allowed to attain to provide efficient and cost effective foliar application of herbicides. Since herbicide application is frequently less costly than mechanical clearing, it is important that brush is not allowed to grow taller than the maximum height 8-12 feet for effective herbicide use.
- **Develop a mitigation plan for exceptions/non-standard maintenance.** Keeping a record of locations where exceptions to standard practices exist is important to prevent outages or violations of s minimum acceptable clearance (between vegetation and conductors). An example would be where pruning is the only vegetation maintenance option allowed by the easement. The record should be specific as to the nature of the situation and regular inspection should be scheduled. Use of an automatic reminder system is recommended. Renegotiating or acquiring easements to eliminate clearance restrictions, payment for tree removal or replacing tall growing trees with compatible vegetation should be considered to eliminate the situation.
- **Develop standardized processes.** A uniform vegetation management plan for the entire BHP, CLFP, BHCOE system that coincides with BHP's, CLFP's, and BHCOE's current specification is key.
- **Implement an Integrated Vegetation Management program (IVM).** IVM is the art of controlling plant populations based on scientific principles from such fields as ecology, zoology and biology. Vegetation is managed to produce desired conditions (plant community density, structure and composition) and associated values consistent with stakeholder objectives on a sustainable basis. Stakeholders include both easement or fee holders, and all stakeholders and interested parties who may be influenced by IVM activities.
- **Manage the ROW by zones.** Managing the ROW in the zone immediately beneath the conductors differently from the rest of the ROW, known as the wire zone-border

[3] Brush is normally defined as immature (less than 10.2 cm or 4 inches in diameter), tall-growing tree species that would grow tall enough to interfere with conductors

zone concept, is a successful approach to prevent outages in a cost effective manner (**Figure L--1**), where sufficient ROW width is present. Different management techniques can be applied to these two zones and result in the many economic, operational and environmental benefits associated with the use of IVM techniques.

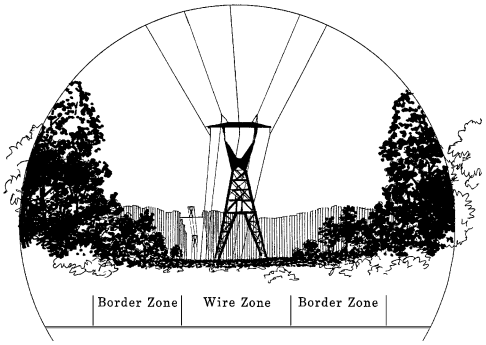


Figure L-1. Wire Zone / Border Zone Vegetation Management.

- **Maintain the ROW edge**. Side pruning consists of pruning trees on the edge of the ROW. This work can be accomplished through the use of truck-mounted aerial lift equipment (bucket trucks), by manual climbing, or through the use of mechanical pruning equipment, such as a Jarraff, Aerial Saw, or similar tools.
- **Coordinate transmission work with related distribution work**. Occasionally distribution lines are found on the same ROW and even the same structures as a transmission line. Managing the vegetation simultaneously on both facilities can be cost effective. Problems can arise when different departments within the same company manage facilities with varying cycles, maintenance methods and budgets. The transmission maintenance organization should take the lead in coordinating and ensuring that the work is completed because a transmission outage has greater consequences than a distribution outage.

INTEGRATED VEGETATION MANAGEMENT

In Integrated Vegetation Management (IVM), the selection of control options is based on effectiveness, site characteristics, environmental impacts, safety, and economics. Good vegetation management is based on an understanding of plants and their environment. A holistic approach considers the inter-relationship of plants, site, and species composition and growth rates.

IVM is recognized as an industry best practice, and it is therefore recommended that BHP, CLFP, and BHCOE adopt this strategy for the maintenance of undesirable brush on its transmission system. In general, this would be a combination of brushing, mechanical clearing (hydro-axe), and the use of herbicides to manage trees and bush on the BHP, CLFP, and BHCOE systems.

Cutting deciduous brush without applying a follow-up herbicide application to the stump surface will permit the vegetation to re-sprout, thus requiring future maintenance. Trimming brush and/or allowing it to mature results in its becoming a more expensive and often permanent part of the workload. Trimming brush and the failure to use herbicides on cut stumps are not cost effective long-term brush management techniques.

ECI recommends that BHP, CLFP, and BHCOE continue to remove trees with the ROW and ROW edge and treat the deciduous cut-stumps of trees and brush with appropriate herbicides whenever possible. BHP, CLFP, and BHCOE should continue to enforce the existing specifications for removal and stump treatment. This will prevent future expansion of the system vegetation workload and future line clearance cost increases.

On most of the BHP, CLFP, and BHCOE transmission system, there is little opportunity to treat standing brush less than 8 feet tall with either foliar or basal herbicide applications, avoiding hand cutting. Taller standing dead brush can become a source of complaints, and taller brush can be difficult to control with foliar applications without risking exposure to off-target plants. This use of a basal bark-applied herbicide would be a particularly valuable tool in the removal of tall-growing tree species growing in sensitive areas or where there is concern for off-target damage.

Use of herbicides is essential if BHP, CLFP, and BHCOE is to maximize the benefits of mechanical clearing and brushing. Herbicide use is an important component of an IVM strategy. BHP, CLFP, and BHCOE should continue to enforce the specifications that require use of herbicides to treat stumps. The effectiveness of selective herbicide applications has been well documented through long-term studies on utility rights-of-way in the central and northeastern United States. Results from treatment simulation models developed through these studies project that sites dominated by deciduous species would nearly double in stem density by the end of two cycles if simply cut without a follow-up herbicide application (**Figure L-22**). These same sites would be expected to exhibit about a 50 percent reduction in stem density over the same time period if treated with a selective herbicide application.

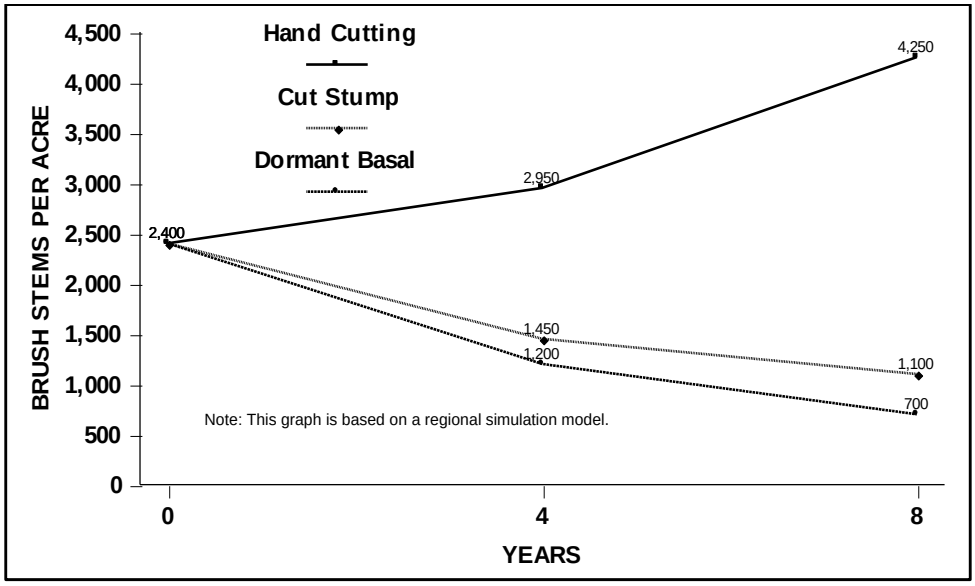


Figure L-2. Effectiveness of Herbicides for Control of Brush Over Time. Results of long term study of brush management on utility rights-of-way in the northeast United States.

Currently, herbicides are effectively used in the control of ROW vegetation. This is an integral part of any IVM program. An important consideration is that a herbicide program must be environmentally safe and professionally supervised to maintain public acceptance. Line clearance crews performing herbicide applications should receive proper training in species identification and herbicide application methods that are approved and deemed acceptable by the public and land owners.

It is recommended that BHP, CLFP, and BHCOE continue to pursue the selective use of herbicides (e.g., foliar and basal) for the management of communities of deciduous brush species as a part of IVM program. Utilizing contractors trained and experienced in the use of herbicides will ensure the continued success of the BHP, CLFP, and BHCOE vegetation management program.

HERBICIDE SAFETY AND RISK ASSESSMENTS

Today's herbicides control tree/brush re-sprouting by blocking chemicals needed by plants to convert water, sunlight and nutrients into food for growth. Since these same chemicals are not present in animals and humans, the herbicides are very low in toxicity to people or animals. Without any food, the treated weed trees on the right-of-way wither and decompose. Treated stumps dry out and don't re-sprout.

Safety for humans and the environment includes not causing adverse effects that are unacceptable. In this context, risk assessment is the process by which the likelihood of unacceptable adverse effects from the use of various methods of vegetation management can be determined.

An extensive report prepared by ECI provided the technical basis for and a summary of the risk to human health, wildlife and the environment from the use of 10 herbicides by a utility owner in the US. These herbicide uses included broadcast foliar, selective foliar, basal bark and cut stump applications. This assessment concluded that the margins of safety for herbicide use by the utility that commissioned the assessment were "adequate to assure protection of human health of workers and the general public."

ECI also completed an environmental impact statement resulting in the authorization of herbicides to control right-of-way vegetation in the LG&E and KU National Forest in Pennsylvania (US). Subsequent evaluation of herbicide use in the National Forest confirmed safe and effective use of foliar herbicides to control brush on utility right-of-way.

The human health risk assessment methodology used in these reports was the one generally recognized by the scientific community as necessary to characterize the potential adverse human health effects of chemicals in the environment. It is the same process used in judging the human health risk from cosmetics, food additives, pharmaceuticals, various household chemicals, and many other materials.

HERBICIDE ACCEPTANCE BY WILDLIFE GROUPS IN THE UNITED STATES

In the US, stump control herbicides are used not only by electric utilities, but also by numerous private and governmental wildlife habitat improvement organizations. Examples include:

- The Nature Conservancy on projects designed to limit the spread of invasive and non-native trees and shrubs. This would be similar to the efforts in the UK to eradicate the invasive plants Japanese Knotweed and Himalayan Balsam.
- Under the banner of a former organization called Project Habitat®, groups such as the National Wild Turkey Federation, Buckmasters, Butterfly Lovers International and Quail Unlimited have joined together to encourage utilities to implement an "Integrated Vegetation Management" (IVM) approach to maintaining utility

easements that appropriately utilizes herbicides as a component in the control of right-of-way vegetation. They have recognized that environmental benefits of herbicides, when properly used, outweigh any adverse risk and are far more desirable than the alternatives to herbicide use, such as frequent mowing or hand cutting of undesirable trees.

Significant research has been undertaken over the past 30 years in the United States to document the impact of right-of-way herbicide use on the environment, wildlife and management costs. Much of this research has been conducted by ECI and its university research associates. Stems per acre decrease over time through the use of herbicides, as does associated maintenance costs.

Brush control through the use of herbicides is an extremely cost effective maintenance tool. **Figure L-3** illustrates the successful use of herbicides and provides cost effective, environmentally acceptable and long-term brush control.

Figure L-3. Example of good brush control through the use of herbicides.

Appendix J – Process for Developing a Remote Sensing Program

REMOTE SENSING PROGRAM DEVELOPMENT

As a result of the WECI Distribution and Sub-Transmission Program Review, WECI believes that Liberty Utilities (CalPeco Electric) stands to gain significant benefit through the design and implementation of a well architected cross-functional Remote Sensing (RS) program. The expanding universe of remote sensing technologies, capture platforms, data analytics and visualization tools can be applied to reduce operating costs, improve safety, reliability and customer satisfaction while maintaining regulatory compliance.

WECI believes that a structured approach to remote sensing technology evaluation is required to determine where remote sensing technology can or should be applied. This analysis is achieved by taking a holistic view of Distribution and Sub-Transmission programs aimed at optimizing program effectiveness, finding new synergies, identifying improvements to key metrics and improving Return on Investment.

Background

The rapid growth in 2-D & 3-D remote sensing technologies such as Light Detection & Ranging (Lidar), Photogrammetric Detection & Ranging (Phodar), Radiometric Detection & Ranging (Radar), and high resolution imagery such as Orthographic, Oblique, Multi-spectral, Thermal and UV Corona, Radio Frequency (RF) combined with the explosion in capture platforms from low altitude Satellite, High & Low Altitude Fixed Wing, Unmanned Aerial Systems (UAS - beyond-line-of-sight & within-line-of-sight), Helicopters, Ground based and Mobile platforms, is simultaneously breathtaking and confounding.

Significant developments in multi-sensor data fusion combined with Artificial Intelligence (AI), including machine learning and pattern recognition for feature extraction and advanced analytics have the potential to provide massive reductions in the cost of data processing while improving the accuracy and automation of anomaly detection and analysis.

Furthermore, massive investments in consumer 3-D gaming technology is morphing into opportunities to leverage this capability along with high definition data to create a whole new class of Virtual Reality (VR) work products, potentially improving safety and productivity while reducing operating costs.

Perhaps most important, formatting and delivering this data in such a way that it can be integrated with back-office systems including geographic information systems (GIS), payment systems, work management (WMS) and outage management systems (OMS) can help other utility business verticals gain efficiencies while further enhancing ROI. There is also a need for the data to be spatially accurate and mobile, working in both connected and disconnected states. Combine these requirements with data hosting, storage and delivery concerns (e.g. cloud vs on premise) and an entirely new set of challenges must be included within the decision matrix.

Paradoxically, the complexity and multitude of technologies, platforms and approaches also present tremendous risk of sub-optimal or even wasteful spending due to lack of full understanding of the "art-of-the-possible" in leveraging the synergistic effects of a well architected cross-functional remote sensing and software integration program.

SOS Approach

To address the multitude of challenges, WECI believes that a fresh perspective is needed in what can best be described as a "system-of-systems" (SOS) approach to remote sensing, analytics and software system integration. SOS begins by elevating the analysis to look across both Sub-Transmission and Distribution and within and across as many internal verticals as practicable including Asset Inspection, Vegetation Management, Right-of-Way protection, Facility Maintenance, Engineering, Compliance, Environmental, Legal etc.

This analysis should be performed in conjunction with understanding the business drivers within each group including internal and external constraints while creating use cases for each specific vertical's needs. From this set of use cases, a least-common-denominator (LCD) approach can be applied to evaluate the minimum level of frequency, timing and accuracies required for each business use case.

WECI believes that combining the SOS approach with a team of subject matter experts will result in significant gains in operational efficiencies (either better optimization of spend or direct O&M savings) while maintaining or improving safety performance, reliability and compliance.

One of the overriding themes of WECI's SOS methodology is to utilize a "collect once and leverage many times" approach wherever possible. This model makes sense on many levels, but in many cases, requires cross-functional collaboration and even a new way of thinking and working within the organization. The significant difference is that our approach focuses on meeting LCD outcomes across as many business use cases as practicable. This is a departure from traditional "silo" product specifications which in many cases preclude cross-functional participation e.g. (a vegetation specification that does not require sufficient accuracy to be of value to the engineering group, or an imagery collection that is not high enough resolution to benefit the asset inspection group). In the context of this approach, WECI uses the term "remote sensing program" to encompass data capture, analytics, storage, hosting, software and delivery of products to field users.

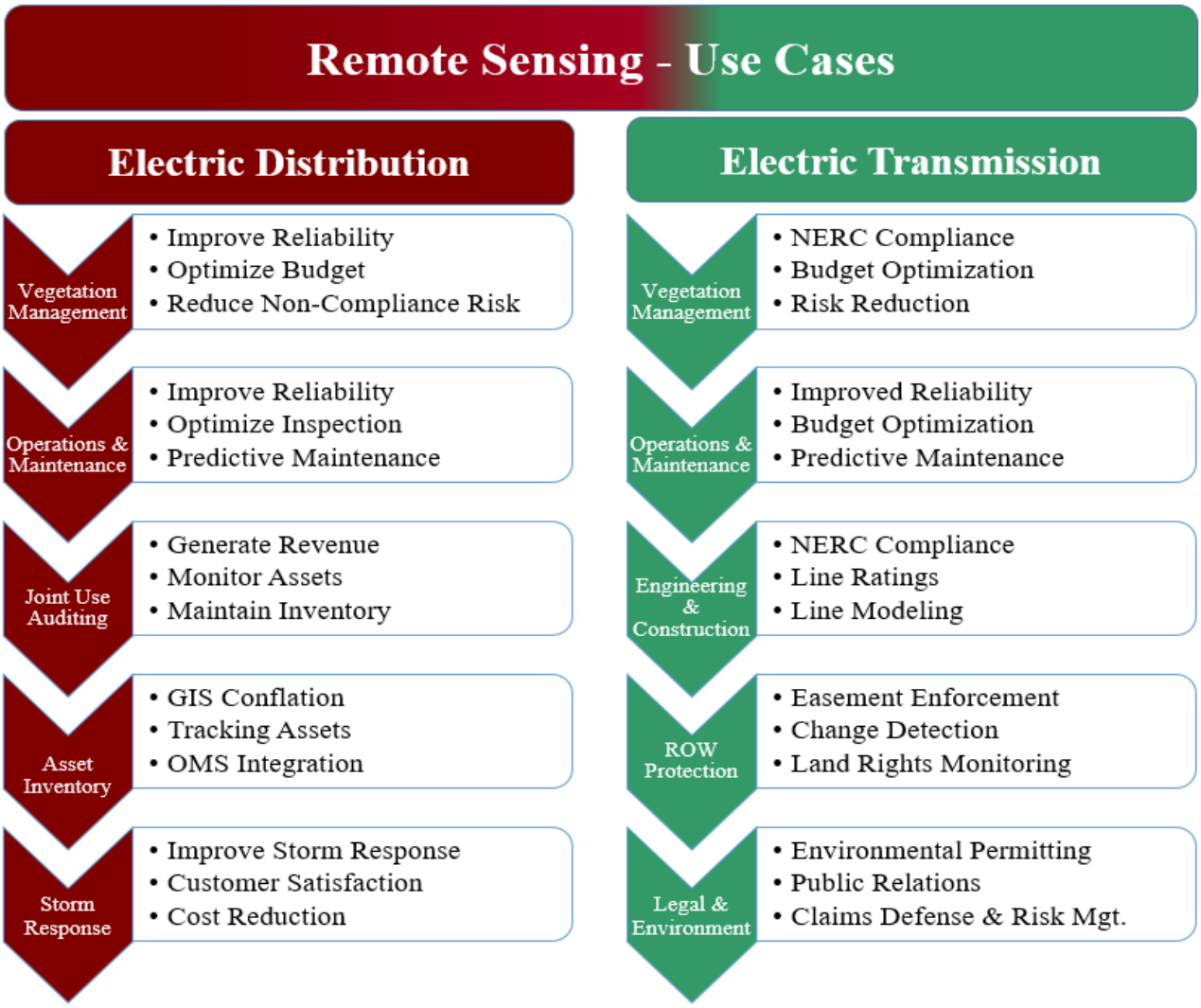


Figure O-1. Example Business Use (or Functional) Use Cases evaluated during SOS Analysis.

Project Objectives and Mutual Understanding

As with most enterprise projects, WECI recommends soliciting participation from key Liberty Utilities management and/or subject matter experts covering the following functional areas for Sub-Transmission and Distribution operations (see below):

- **Vegetation Management:** regulatory compliance and routine maintenance
- **Right-of-Way (ROW) protection:** managing ROW integrity
- **Asset Protection/Maintenance, Inspection:** routine inspection patrols and asset health
- **Joint Use:** managing joint use revenue (Primarily a Distribution function)
- **Engineering:** compliance and line-ratings and re-ratings
- **Geographic Information Systems (GIS):** managing spatial data and pole conflation efforts

- **Information Technology:** connecting remotely sensed data with GIS and Work Mgt. Software
- **Other:** for example: Legal, Finance etc.

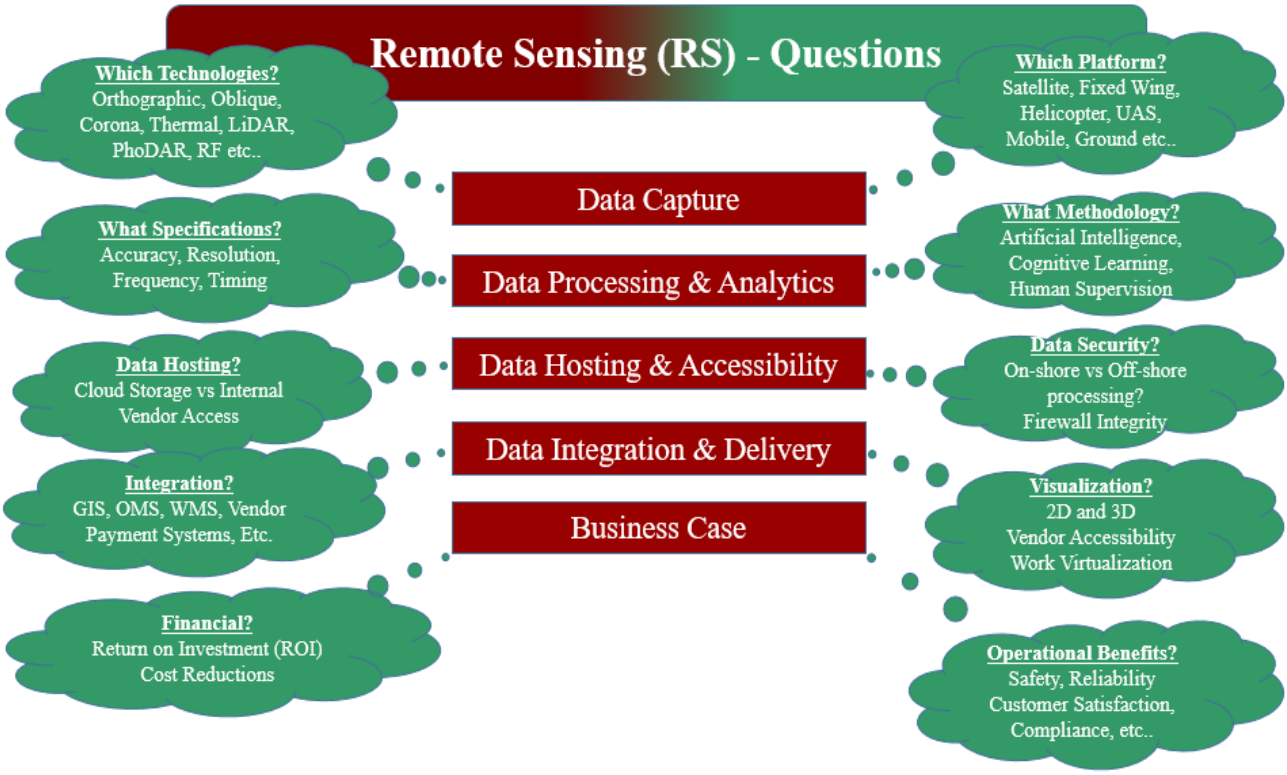


Figure O-2. Sample Questions WECI attempts to answer during an SOS Analysis

Phase 1: Business Use Case Development (SOS Analysis)

Utilities should begin this project by conducting SOS working sessions with each of the business unit (or functional) leaders in defining those use cases where technology may play a role in improving business performance. From this foundation of information, WECI will create a technology application matrix to help identify where, what, and if, technology can support achieving or improving these objectives.

From the defined, prioritized use cases, working through the technology application decision matrix process to determine which general approach (data type, fidelity, frequency, hosting, visualization and delivery format etc..) will provide the optimum benefit to your organization.

Phase 2: Request for Information (RFI) Development

WECI will apply the use cases and technology application matrix to create an RFI for approval by Liberty Utilities. The RFI would provide scenarios for Sub-Transmission and Distribution including desired deliverables and outcomes and LCD specifications. We will

then conduct a search to recommend which vendors we believe have the best potential to provide a qualified response (or partial response) to the remote sensing program requirements. Because of the complex nature of the challenge and the unlikelihood that any single vendor can provide a complete response, we recommend encouraging vendor partnering and collaboration in their responses. WECI would then lead (or support) the solicitation of vendors to respond to the RFI.

Phase 3: RFI Evaluation

After Liberty Utilities receives the RFI responses, WECI will evaluate each response and provide a quantitative assessment of each solution proposed during the RFI response. This assessment would evaluate the primary components from the technology application matrix as well as an overall score.

Deliverables

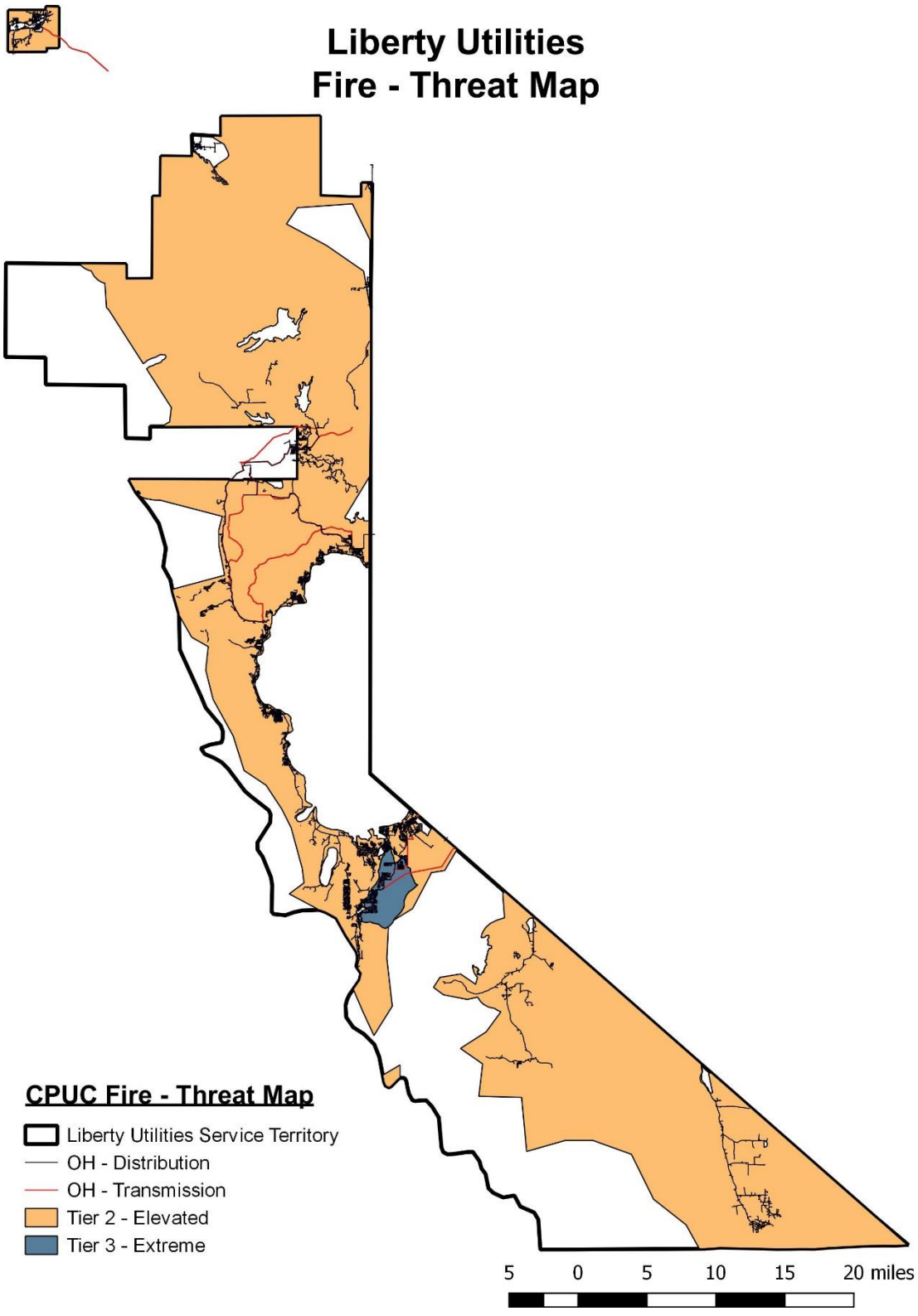
- Use cases per business or functional area as directed by Liberty Utilities.
- Technology application matrix
- List of potential vendors for invitation to RFI
- RFI management and coordination
- RFI evaluation and quantitative scoring
- Other (e.g. business case development, RFP development, etc..) as directed by Liberty Utilities

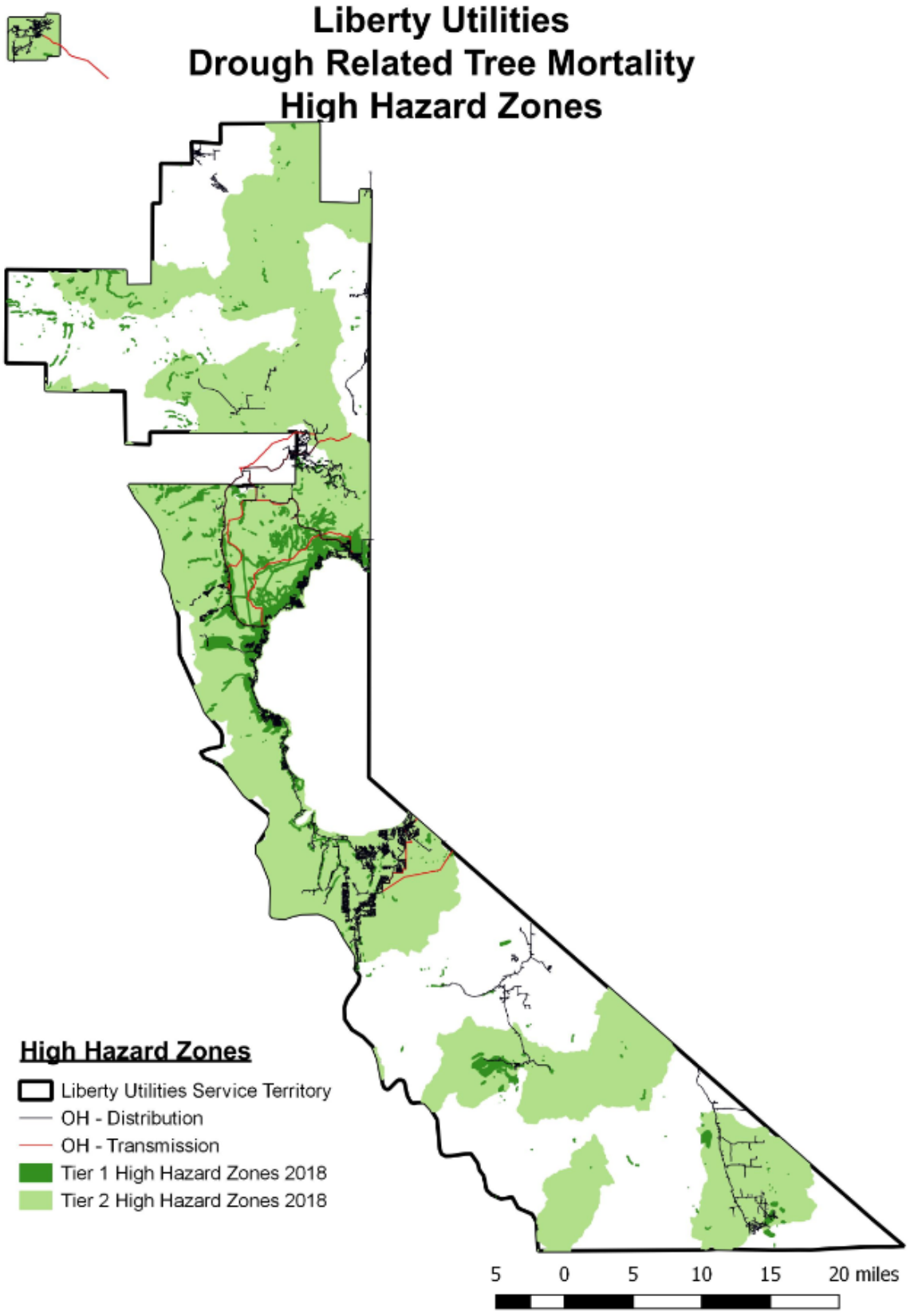
Summary

By taking a holistic view of remote sensing programs, WECI believes that Liberty Utilities stands to gain significant value in program optimization, improvements to key metrics and return on investment value.

When the time is right, WECI is well suited to support this initiative. This proposed approach is a suggested frame-work by which we believe Liberty Utilities can achieve the best long-term value.

Appendix K – Liberty Utilities Circuit Priority





Liberty Utilities Circuit Priority List (2018)

Substation	FDRID	Voltage	Total Miles	Last Trim Date (Year)	Priority	Estimated Circuit Cost	Estimated Cost (running total)
BROCKWAY	BKY4201	14.4	4.86	2012	1	$12,180	$12,180
MEYERS	MEY3200	14.4	21.75	2010	2	$341,479	$353,659
MEYERS	MEY3500	14.4	27.71	2009	3	$434,950	$788,609
TRUCKEE	TRK7203	14.4	6.47	0	4	$101,615	$890,224
SQUAW VALLEY	SQV8200	14.4	5.11	2014	5	$23,700	$913,924
BROCKWAY	BKY4202	14.4	9.18	2012	6	$4,772	$918,696
KINGS BEACH-TAHOE CITY	KINGS BEACH-TAHOE CITY 625	60	15.40	2012	7	$2,085	$920,781
BROCKWAY	BKY5200	14.4	23.22	2013	8	$15,201	$935,982
TAHOE CITY	TAH7200	14.4	5.03	0	9	$78,991	$1,014,973
TRUCKEE SWITCH STATION-DONNER SUMMIT SWITCH	TRUCKEE SWITCH STATION-DONNER SUMMIT SWITCH 133	120	0.04		10	$628	$1,015,600
TAHOE CITY	TAH5201	14.4	21.44	2014	11	$19,793	$1,035,393
STAMPEDE	SMP8700	14.4	0.32		12	$5,047	$1,040,441
PORTOLA SUBSTATION	POR31	14.4	14.24	2009	13	$223,518	$1,263,959
STATELINE-MEYERS	STATELINE-MEYERS 640	60	7.90	2014	14	$30,964	$1,294,923
MEYERS	MEY3300	14.4	52.52	2013	15	$7,695	$1,302,618
STATELINE	STL3501	14.4	13.85	2013	16	$32,257	$1,334,875
RUSSELL VALLEY	RUS7900	14.4	3.29	2011	17	$3,004	$1,337,879
STATELINE-BUCKEYE	STATELINE-BUCKEYE 634	60	0.27		18	$4,238	$1,342,117
MEYERS	MEY3100	14.4	18.67	2018	19	$3,819	$1,345,936
TRUCKEE	TRK7204	14.4	6.86		20	$107,702	$1,453,638
TAHOE CITY	TAH7300	14.4	57.70	2016	21	$29,952	$1,483,590
HOBART	HOB7700	14.4	8.97	2012	22	$10,885	$1,494,474
STATELINE	STL3101	14.4	15.73	2014	23	$21,018	$1,515,493
TAHOE CITY-SQUAW VALLEY	TAHOE CITY-SQUAW VALLEY 629	60	6.30	2017	24	$32,329	$1,547,822
TRUCKEE-GLENSHIRE	TRUCKEE-GLENSHIRE 608	60	6.10	2007	25	$95,752	$1,643,574
PORTOLA SUBSTATION	POR32	12.5	21.00	2012	26	$8,260	$1,651,834
TRUCKEE	TRK7400	14.4	3.19	2017	27	$13,318	$1,665,152

STATELINE	STL2300	14.4	2.96	2014	28	$22,413	$1,687,564
TOPAZ	TPZ1261	12.5	55.08	2011	29	$864,558	$2,552,122
SQUAW VALLEY	SQV8300	14.4	1.39	2014	30	$19,139	$2,571,261
TAHOE CITY	TAH7100	14.4	13.16	2017	31	$218	$2,571,480
MEYERS-BUCKEYE	MEYERS-BUCKEYE 111	120	7.60	2017	32	$119,297	$2,690,777
SQUAW VALLEY	SQV7201	14.4	12.02	2017	33	$188,692	$2,879,469
BROCKWAY	BKY5100	14.4	2.21	2013	34	$4,678	$2,884,148
TRUCKEE	NVE	14.4	0.92		35	$14,511	$2,898,659
WASHOE	WSH201	14.4	7.26	2010	36	$113,883	$3,012,542
MEYERS	MEY3400	14.4	54.48	2017	37	$12,697	$3,025,239
STATELINE	STL2200	14.4	0.25	2014	38	$15,375	$3,040,613
TRUCKEE	TRK7202	14.4	12.17	2017	39	$5,427	$3,046,040
KINGSBURY	KNG2800	14.4	0.35		40	$5,436	$3,051,476
TRUCKEE	NVE-TRK70204	14.4	5.19		40	$81,447	$3,132,923
TRUCKEE-GLENSHIRE	TRUCKEE-GLENSHIRE 621	60	7.10	2007	40	$111,449	$3,244,372
NORTHSTAR	NST8600	14.4	16.53	2016	43	$259,520	$3,503,892
TAHOE CITY	TAH629	14.4	4.61	2017	44	$32,329	$3,536,221
SIERRA BROOKS	SRB51	14.4	6.77	2013	45	$3,822	$3,540,043
MARTIS-SQUAW VALLEY	MARTIS-SQUAW VALLEY 132	120	12.20	2014	46	$44,775	$3,584,818
TDPUD	TDPUD	14.4	6.76		47	$106,180	$3,690,998
MULLER	MULLER1296	12.5	43.51	2012	48	$7,690	$3,698,688
FRONTIER-ANACONDA MOLY	FRONTIER-ANACONDA MOLY 2307	230	0.00		49	$0	$3,698,688
LAST CHANCE-WELLS	LAST CHANCE-WELLS 660	60	0.00		49	$0	$3,698,688
SILVER LAKE	SLK257	14.4	2.97	2010	51	$46,652	$3,745,340
GLENSHIRE	GLS7600	14.4	5.19	2017	52	$16,069	$3,761,409
KINGS BEACH-TRUCKEE	KINGS BEACH-TRUCKEE 650	60	14.20	2016	53	$222,897	$3,984,307
TRUCKEE-SQUAW VALLEY	TRUCKEE-SQUAW VALLEY 609	60	9.50	2017	54	$12,254	$3,996,560
ROUNDHILL-STATELINE	ROUNDHILL-STATELINE 160	120	0.30	2017	55	$4,709	$4,001,269
GLENSHIRE	GLS7400	14.4	32.57	2017	56	$13,318	$4,014,588
CALIFORNIA	CAL204	14.4	4.93	2013	57	$17,415	$4,032,002
CEMETERY	CEM42	14.4	7.11	2013	58	$3,291	$4,035,293
CEMETERY	CEM41	14.4	2.17	2013	59	$10,217	$4,045,510
MARBLE-PORTOLA	MARBLE-PORTOLA 619	60	6.05	2016	60	$94,967	$4,140,477
LOYALTON	LOY619	14.4	0.06	2016	61	$967	$4,141,444

Appendix L – Glossary of Terms

Appendix L - Glossary of Terms

ANSI A 300 – The American national Standard for Tree Care Operations- Tree, Shrub, and Other Woody Plants maintenance – standard Practices (Pruning). American national arboricultural consensus standard.

Basal Application: The application of a herbicide and oil mixture to the lower or basal part of the stem.

Best management Practices: In the context of utility vegetation management, best management practices is the most effective, safe, economical and environmentally sound procedure (s) for maintaining electric rights-of-way

Brush: A woody plant less than 4 inches d.b.h. that may reach the conductor at maturity.

Callus: New growth made by the cambium layer around all wounds.

Cambium Layer: The actively growing tissue between the bark and sapwood of a tree that accounts for a tree's growth in diameter.

Certified Arborist: professionals dedicated to excellence in the field of arboriculture. Certified arborists are highly qualified in the care of trees and woody shrubs with knowledge of the most up to date, advance and proven age-old techniques. They have a number of years of experience, training and must pass rigorous testing before they can become a certified arborist. Term used here specifically in reference to utility arborists or those individuals with specific knowledge of utility arboriculture.

Clearance: The distance between vegetation and the conductors.

Climbable Trees: For the purposes of this report, trees with the trunk or a significant branch within 10 feet of the conductors that have sufficient limbs within 10 feet of the ground or other climbable object (shed, fence, etc.) so that they can be climbed without the use of climbing aids (ropes, spurs, etc.).

Compatible Vegetation: Vegetation that matures at a low height, so that it will never grow tall enough to interfere with the electrical conductors.

Conductor Security Zone: The area around electrical conductors into which vegetation should never be allowed to encroach. The size of this zone is determined primarily by the voltage of the conductors.

Coniferous: Any of the cone-bearing trees or shrubs, mostly evergreens. Coniferous trees usually do not sprout new growth when cut or trimmed.

Crew Foreman: Tree contractor's crew leader (man or woman) working with and supervising the line clearance crew.

Cut Stump Treatment: Removing vegetation by cutting, followed by herbicide application to the stump.

Cycle: See "Pruning Cycle."

Appendix L - Glossary of Terms

Danger Tree: Any dead, dying, weak, diseased, or leaning tree (on or off the right-of-way) that could fall onto the conductors. (See "Hazardous Trees.")

Diameter at Breast Height (d.b.h.): Diameter of trees or brush measured at a point 4.5 feet above the ground.

Deciduous: Any perennial plant that sheds its leaves annually at the end of a growing season. Deciduous species generally sprout prolifically when cut or trimmed unless treated with a herbicide.

Drop-Crotching: See "Natural Pruning."

Evergreen: Any plant that retains its leaves year-round. These leaves are replaced gradually, thus retaining the "evergreen" appearance.

Foliar Application: The application of an herbicide to the stems, leaves, or needles of a target plant.

General Foreman: Supervisory personnel (man or woman) working for the contractor who has responsibility for work performed by that particular contractor's tree crews.

Ground-Line Cutting: Completely removing trees or brush at ground level.

Hazard Trees: Trees that are dead, diseased, infested by insects, deformed, shallow-rooted, or otherwise structurally unsound and that could fall into or cause other trees to fall into electrical conductors.

Healing: The roll or callus growth around a wound area. Trees do not actually heal; they simply "wall off" the damaged area and grow around, and eventually over, the wound.

Herbicide: A chemical used to control, suppress, or kill plants, or to severely interrupt their normal growth processes.

Hot Spotting: Assigning line clearance crews in a manner that does not involve a systematic schedule.

Incompatible Vegetation: Vegetation that is undesirable or unsafe or that interferes with the intended use of the site.

Integrated Vegetation Management: (IVM) – A system of managing plant communities in which the managers set objectives; identify compatible and incompatible vegetation; consider action thresholds; and evaluate, select and implement the most appropriate control method or methods to achieve those objectives.

Line Clearance: Controlling vegetation to maintain proper clearance from conductors and to provide reliable electric service. This includes the pruning of trees to prevent limb contact, the control of brush to minimize future problems, and the removal of dead, diseased, weak, or interfering trees and branches that could fall onto the conductors. Synonymous with tree clearing, tree trimming, or vegetation management.

Appendix L - Glossary of Terms

Minimum Clearance: The required minimum distance between tree and conductor to be achieved at the time of pruning to ensure that the tree will not grow into the conductor before the end of the maintenance cycle.

Natural Pruning: A method by which branches are cut to the branch collar at a suitable parent limb back toward the center of the tree. This method of pruning is sometimes called "drop-crotching" or "lateral trimming." Natural pruning is also directional pruning, since it tends to guide tree growth away from wires.

Non-Compatible Vegetation: See "Target Vegetation."

OFF-ROAD: not accessible to bucket/ lift truck.

ON-ROAD: accessible to bucket / lift truck.

Ornamentals: Trees used for landscaping or that otherwise have aesthetic value. Ornamentals are often hybrids, varieties, or grafted species.

Pollarding: Stubbing off major limbs until the tree assumes the desired size. The result is unsightly, and a multitude of fast-growing suckers will sprout from the stubs resulting in a line clearance problem more serious than before.

Preventative Maintenance: refers to planned or scheduled maintenance work as in cyclical trimming of electrical circuits.

Pruning: The removal in a scientific manner of dead, dying, diseased, interfering, objectionable, and/or weak branches of trees or shrubs.

Pruning Cycle: The period of time that elapses between the time a tree is pruned and then pruned again.

Qualified Vegetation Manager: A professional with the proper experience, education and training to successfully establish or supervise an integrated vegetation management program.

Reactive Maintenance: Non-scheduled work including restoration, customer trim requests, and operations hot spot requests.

Reliability Enhancement Program: (REP) refers to a planned program aimed at improving reliability on a given circuit or portion of circuit. Through analysis of reliability data, investigation of types of interruptions, a planned approach is developed to resolve the reliability issue through a combination of vegetation maintenance, construction changes or both.

Removal: Completely removing an entire tree to ground level; required when a tree is described as a danger tree or when a tree should be removed for other reasons. Also, any tree that is a candidate for removal.

Residential: See "Urban."

Appendix L - Glossary of Terms

Rounding Over: The making of many small cuts so that the tree top is sheared in a uniform line. This creates an unhealthy tree condition and results in rapid regrowth directly back toward the electrical conductors.

ROW: refers to utility rights-of-way

Rural: An area that is not directly associated with a permanent or seasonal residence where vegetation is not intensively managed for aesthetic values. This includes areas of agricultural and forest land use, as well as undeveloped sites within otherwise urban or residential neighborhoods. Rural areas are commonly dominated by native species of trees, shrubs, and herbaceous vegetation.

Selective Herbicide: A herbicide that, when applied to a mixed population of plants, will control specific species without injury to others.

Shearing: See "Rounding Over."

Shrub: A woody plant normally maturing at less than 20 feet in height, presenting a generally bushy appearance because of its several erect, spreading, or prostrate stems.

Side Trim Stubbing: Stubbing off portions of limbs along the side of the tree to obtain clearance. The result is not only unsightly, but on many species a multitude of fast-growing suckers will sprout from the stubs, soon resulting in a line clearance problem more serious than before. The stubs are quite likely to fall victim to decay or disease.

Side Pruning: Cutting back or removing side branches that are threatening the conductors; required where trees are growing adjacent to conductors.

Slash: Debris resulting from a tree clearing operation.

Species: The basic category of biological classification, intended to designate a distinct group or kind of plant or animal having common attributes.

Specifications: All the terms and stipulations contained in a contract pertaining to the method and manner of performing the work or to the quantities and qualities of the material to be furnished under the contract, including amendments, revisions, deductions, or additions.

Sprout: New growth originating from adventitious buds, usually induced by removing a limb.

Target Vegetation: Woody species capable of growing tall enough to interfere with the electrical conductors and/or access to the electrical conduction system.

Top Pruning: Cutting back large portions of the upper crown of a tree; required when trees are located directly beneath a conductor. Sometimes called topping.

Translocated Herbicide: A herbicide that is moved from its point of entry throughout a plant via the vascular system.

Translocation: The transfer of substances from one location to another in the plant body.

Appendix L - Glossary of Terms

Tree: A woody plant normally maturing at 20 feet or more in height, usually with a single trunk, unbranched for several feet above ground with a definite crown. Any trunk that is over 4 inches d.b.h. can be considered a tree.

Tree Crown: Upper portion of the tree; the branches or leaf area.

Trimming: Cutting back tree branches or shrubs, not necessarily in a scientific manner, to shape or reduce the size of the tree or shrub.

Trimming Cycle: See "Pruning Cycle."

Troublesome Species: Trees that exhibit great potential to grow into contact with electrical conductors due to their growth patterns.

Under Pruning: Removing limbs beneath the tree crown to allow wires to pass below the tree.

Urban: An area in direct association with permanent or seasonal residences, commercial properties, or other developed areas, where the existing vegetation is intensively managed for aesthetic value. This includes all landscaped areas, such as business and industrial properties, golf courses, lawns, and parks. Urban areas are typically stocked with yard or street trees of high aesthetic or ornamental value.

Volunteer Trees: Trees that are established naturally, rather than being planted.

Windthrow: The uprooting of trees due to wind.

Whorl: A circle of three or more similar parts around a central point, as three or more leaves growing around a twig at one spot or node. The circular arrangement of branches about the trunk of conifers.

ACRONYMS & LIBERTY UTILITIES SPECIFIC TERMS

CAL FIRE: California Department of Forestry and Fire Protection

Caltrans: California Department of Transportation

CDFW: California Department of Fish and Wildlife

CEPA: California Environmental Protection Agency

CEMA: Catastrophic Event Memorandum Account

CEQA: California Environmental Quality Act

CPUC: California Public Utilities Commission

CTC: California Tahoe Conservancy (Landowner)

CPUC GO 95 Rule 35: Minimum vegetation clearances required at all times

- Maintain 18” of clearance between trees and primary distribution power lines and 60/70 kV, up to 10 ft. for higher voltages

- Remove facility protection trees (as defined above)
- Address trees that cause strain or abrasion on secondary conductors

LOPS: Limited Operating Periods

LRA: Liberty Utilities Responsibility Areas

LRWQCB: Lahontan Regional Water Quality Control Board

LTBMU: Lake Tahoe Basin Management Unit

MBTA: Migratory Bird Treaty Act of 1918

PRC: California Public Resource Code

PRC 4292: Pole clearing mandates in SRA areas

- Clear 10 ft. x 8 ft. cylinder around the base of subject poles and transmission
- structures
- Remove dead vegetation up through the primary conductor level

PRC 4293: Minimum tree clearances for all trees during fire season

- Maintain 4 ft. clearance from trees to 4kv-60/70 kV transmission lines
- Maintain 10 ft. clearance between trees and all transmission lines >/= 115 kV
- Remove dead, diseased, defective and dying trees that could fall into the lines (facility protection trees)

REAX: Consulting company in Berkley currently mapping fire zones

SEZ: Stream Environment Zone

SRA: State Responsibility Area

TRPA: Tahoe Regional Planning Agency

USFS: Unites States Forest Service

LU_DR_20200313-43903-Y-17

UtilityID	EventID	CircuitID	UniqueID	HFTDClass	StartDate	StartTime	PredictedDurationMinutes	ActualDurationMinutes	DurationPredictionError	TotalCustomerMinutes
Liberty	1	3400	Liberty_1_3400	Tier 2	2018-11-21	12:00	600	180	420	5400

LU_DR_20200313-43903-Y-17

TotalCustomerHours	TotalCustomers	ResidentialCustomers	MedicalBaselineCustomers	CommercialIndustrialCustomers	OtherCustomers	WindRisk	RelativeHumidityRisk
90	30	29	0	1	0	1	0

LU_DR_20200313-43903-Y-17

TemperatureRisk	VegetationRisk	AssetRisk	DeadFuelRisk	LiveFuelRisk	RedFlagWarningRisk	OtherRisk	OtherRiskReason	FPIValue	FPIPercentile	FeatureClass
0	1	1	1	0	1	0	N/A	N/A	N/A	Polygon