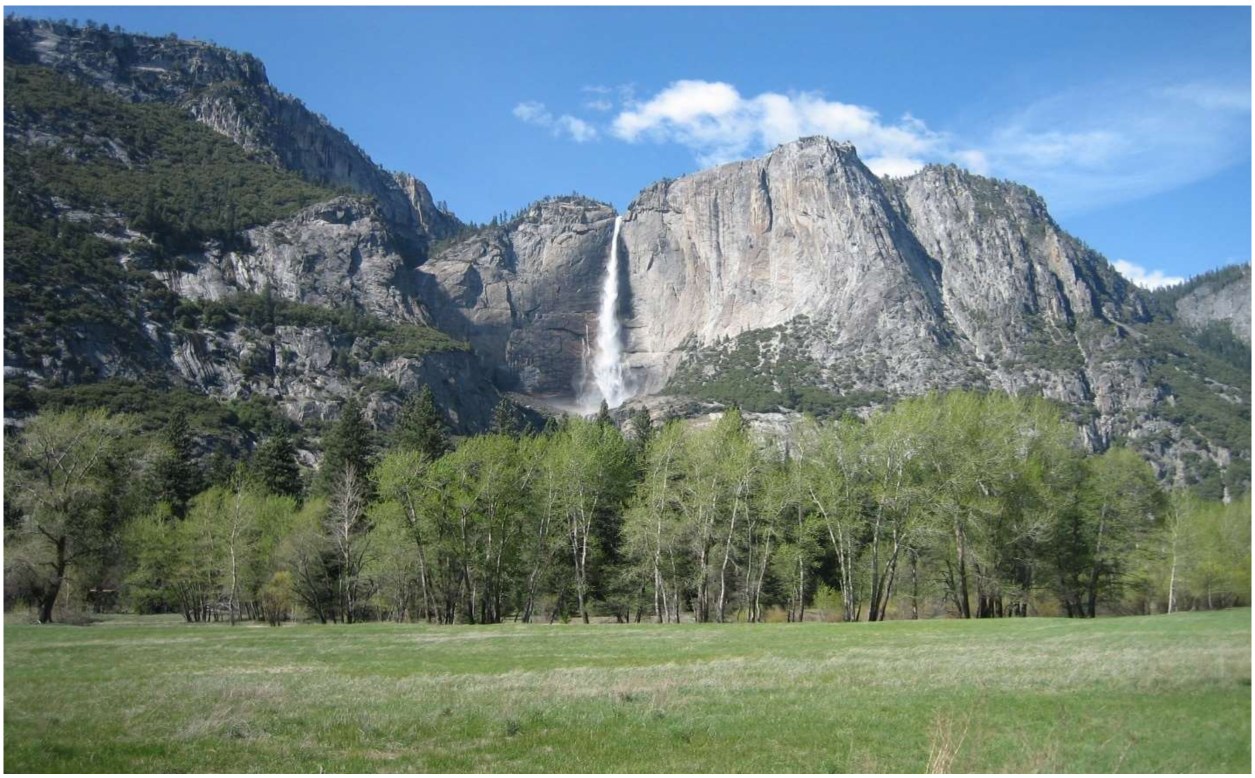
FINAL REPORT

South Central Sierra Pilot Study:

Wood Products Campus Siting and Financial Risk Analysis



Prepared by:

Wildephor Consulting Services, LLC

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WILDEPHOR

ABOUT THIS REPORT

The work presented in this report was performed for the Mariposa County Resource Conservation District under subcontract to CLERE, Inc. between July 2024 and August 2025. Inquiries may be made directly to the author:

W. David Featherman, P.E.
Wildephor Consulting Services, LLC
481 N Santa Cruz Ave #280
Los Gatos, CA 95030 USA
david.featherman@wildephor.com
+1 510 845 0016
www.wildephor.com

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LIST OF ABBREVIATIONS

BDT	bone dry ton
BF	board foot
BUFFS™	Biomass Utilization Financial Feasibility and Sensitivity
C-BREC	California Biomass Residue Emissions Characterization
CPAD	California Protected Areas Database
cy	cubic yard
DBH	diameter at breast height
DWR	Department of Water Resources (California)
ft	foot
GHG	greenhouse gas
JPA	joint powers authority
lb	pound
LCI	Office of Land Use and Climate Innovation (California)
m	meter
MBF	thousand board feet
mph	miles per hour
MTCO2	metric tons of carbon dioxide
MWe	megawatt electric
NPV	net present value
OPR	Office of Planning and Research (California)
OSM	OpenStreetMap
psf	pounds per square foot
RCD	Resource Conservation District
sf	square foot
yr	year

1.0 BACKGROUND

The work described here was performed as part of Phase 3 of the South Central Sierra feedstock aggregation pilot study funded by the California Governor's Office of Planning and Research (OPR), now the Office of Land Use and Climate Innovation (LCI). Portions of this analysis build upon work from the previously completed *Biomass Feedstock Supply Availability and Cost Analysis for the Central Sierra Region of California (2023)* and *Feasibility Study for a Value-Added Wood Products Campus Within the Central Sierra Region of California (2024)*. Although these prior reports served as a basis for some of the assumptions and modeling structures used in the analysis presented here, the author did not participate in those studies and therefore cannot explicitly confirm the validity of their results. Rather, they offer a point of comparison for the more advanced geospatial analysis employed here, and serve as the basis for a "proof of concept" methodology in the case of the financial sensitivity analysis described in this report.

1.1 Analysis Overview

A team led by Wildephor was contracted in July 2024 to develop a series of related modeling tools and analyses for the purpose of de-risking biomass utilization projects of the types contemplated by the South Central Sierra pilot study. Those analyses included the following, which are further described in the sections below:

- Siting and supply optimization
- Operating cost analysis
- Financial sensitivity analysis

1.2 Siting and Supply Optimization

This entailed using geospatial analysis to confirm feedstock quantities and thus the viability of the three candidate sites for a wood products campus identified in the prior feasibility study (referred to as the Toyon, Pioneer, and

Mariposa sites). In addition, it included supplemental analyses to optimize recovery of economically available feedstocks within a two-hour drive of the proposed campus sites. The mapping analysis also included assessments of land ownership type (e.g., federal, state, county, private), identification of biomass within recently burned areas, and determination of the required ton-miles of feedstock trucking for each candidate wood products campus site in order to estimate the annual greenhouse gas (GHG) emissions from that feedstock transportation.

1.3 Operating Cost Analysis

This analysis sought to develop quantitative models to estimate operating expenses for a wood products campus to enhance the reliability of "base case" estimates provided in the prior feasibility assessment. Results from such range estimating exercises can provide more realistic estimates of annual operating expenses and annual net revenues, given that processing equipment costs are generally well-understood. In addition, a facility sizing model and capital cost estimate were developed for onsite bulk storage of biomass feedstock for a 3.0 megawatt electric (MWe) bioenergy plant.

1.4 Financial Sensitivity Analysis

Risk-adjusted pro forma financial analysis using Monte Carlo simulation was applied to explicitly model the impacts of cost and revenue uncertainties for two proposed wood products campus businesses. This work expands upon the operating cost analysis described above, yielding more robust estimates of project financial performance (e.g., net present value) compared with the "worst case" sensitivity analysis provided in the prior wood products campus feasibility report. Further, the Monte Carlo-based sensitivity analysis—termed a Biomass Utilization Financial Feasibility and Sensitivity (BUFFS™) analysis—was able to identify and rank the highest impact drivers of project financial performance for the proposed firewood business and small-scale sawmill (it was assumed that a post and pole business is nonviable based on findings from the prior feasibility analysis). This ability to quantitatively determine the impact of specific risk drivers on project financial performance has not been previously demonstrated in the biomass industry, and therefore represents a step change in the analytical toolkit available to biomass project owners and developers as well as to their prospective financial partners.

1.5 Decision Support

Through the combined lenses of advanced geospatial modeling and novel financial risk and sensitivity analysis, the results presented below illuminate multiple key metrics that can be used to inform decisions regarding 1) which candidate wood products campus site appears best positioned to optimize regional biomass feedstock supplies, and 2) which businesses on that wood products campus are likely to be profitable based on the ability to proactively identify and manage the highest impact risk drivers to their operations. The following sections will describe the analytical processes undertaken, as well as the valuable results generated and their implications on future decisions made by the wood products campus project team.

2.0 BIOMASS FEEDSTOCK SUPPLY

The success of any biomass utilization project begins with a reliable source of feedstock. To that end, considerable effort was made to characterize not only the quantities of available biomass feedstocks, but also the economic feasibility of their recovery and transportation to a wood products campus. This entailed using high-resolution geospatial analysis based on published forest residue modeling tools, along with a separate assessment of woody biomass available from periodic orchard removals in and adjacent to the five-county study area that included Alpine, Amador, Calaveras, Mariposa, and Tuolumne counties. A detailed description of this site suitability analysis methodology and its results are provided in Figure 1 and the sections that follow, including detailed maps and tables characterizing the economically feasible biomass feedstock supplies for each of the three candidate sites.

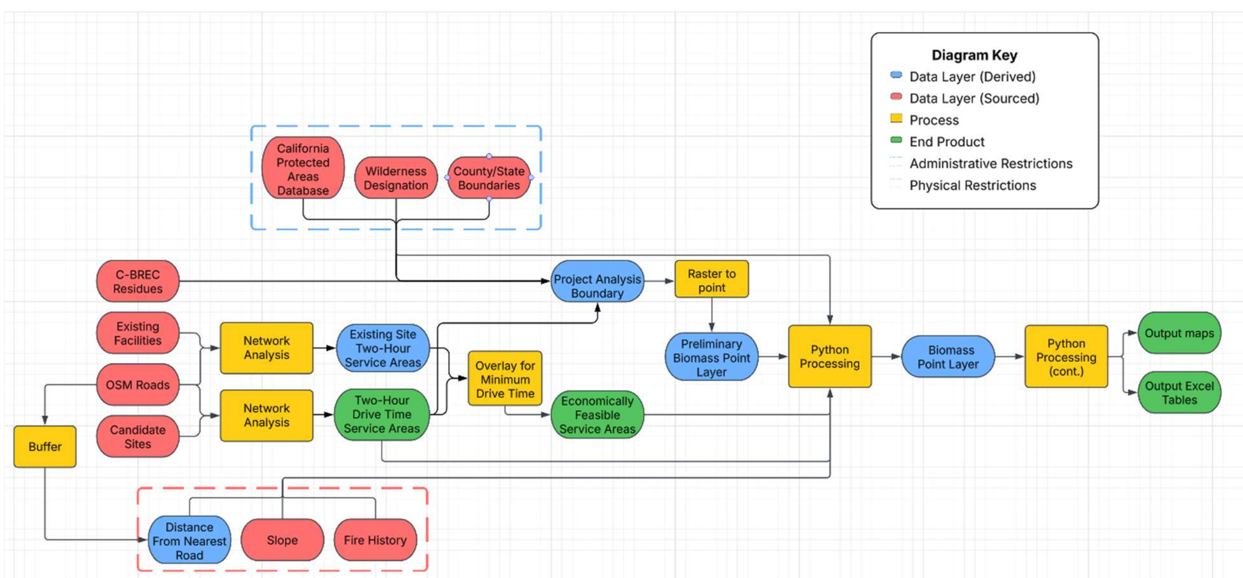

Figure 1. Site Suitability Geospatial Analysis Methodology

2.1 Step 1 – Developing Service Areas

The first modeling step was to perform a road network analysis based on existing and candidate biomass utilization site locations (as defined in the prior wood products campus feasibility study; see Table 1 below for site details) to create two-hour drive time service areas for each site. The drive time service areas were created at five-minute increments using road data sourced from the OpenStreetMap (OSM) portal. Driving speed limits were determined using a combination of OSM's built-in speed limit attributes as well as various regulation-based assumptions (e.g., a 25 mph speed limit for residential areas). Service areas were developed using the Esri Network Analyst extension.

Table 1. Biomass Utilization Site Locations

	Candidate Campus Sites	City	County	Latitude	Longitude
1	Toyon Industrial	Valley Springs	Calaveras	38.209484	-120.767843
2	P&M Cedar Sawmill *(former)*	Pioneer	Amador	38.433436	-120.560858
3	Mariposa Biomass	Mariposa	Mariposa	37.504500	-120.012940
	Existing Utilization Sites				
1	Pacific Ultrapower	Jamestown	Tuolumne	37.873684	-120.475800
2	Sierra Pacific Standard	Sonora	Tuolumne	37.967396	-120.318259
3	Rio Bravo-Fresno	Fresno	Fresno	36.687124	-119.723827
4	Rio Bravo-Rocklin	Lincoln	Placer	38.831953	-121.312213
5	DTE Stockton	Stockton	San Joaquin	37.943355	-121.328303
6	DTE Woodland	Woodland	Yolo	38.689821	-121.737569

Sites Within Central Sierra Study Area

Once service areas were created for both the existing and candidate sites, "Economically Feasible Service Areas" were created for each candidate site (see Figure 1). These constrained service areas refer to the area within the two-hour drive time from a candidate site where there is no shorter drive time to an existing facility, meaning the candidate site would be the most economically efficient location for transporting the biomass to a utilization facility. The economically feasible service areas were developed using a custom geoprocessing function written in Python that spatially compares each candidate site's two-hour service area with all the existing site service areas. Figure 2 shows examples of the two-hour service area (left) and the economically feasible service area (right) for the Mariposa candidate site. It should be noted that proximity to a utilization (or disposal) site is often the most salient—but not the only—factor in determining where biomass from forest treatments is taken. Higher offtake prices (or lower tipping fees) at sites further away from where the biomass is generated could complicate that decision, but for the purposes of this analysis it was assumed that, all else being equal, biomass would be transported to the nearest existing or new utilization site.

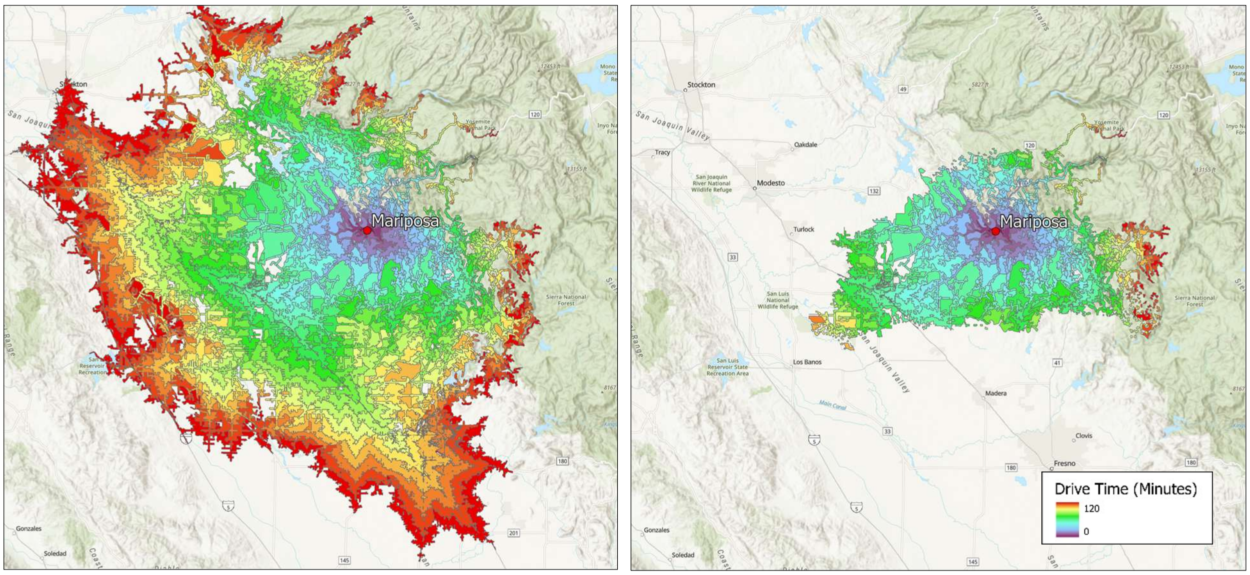

Figure 2. Two-Hour and Economically Feasible Service Areas

2.2 Step 2 – Preparing Data and Constraints

Biomass data used to produce feedstock estimates for the three candidate sites came from the California Biomass Residue Emissions Characterization (C-BREC) model. Produced by the Schatz Energy Research Center at Cal Poly Humboldt, the C-BREC model estimates the forest biomass residues available for the entire state of California at a 30-meter by 30-meter scale (i.e., pixel size). The model is flexible and can estimate residues produced from several different types of forest treatments. For this analysis, biomass quantities were based on 2025 estimates for a “thin from below by 40%” treatment type, meaning that stands are cleared of their biomass starting from the lowest diameter growth until 40% of all material has been removed.

Using the two-hour drive-time service areas for the candidate sites, along with administrative constraints (e.g., county and state boundaries), a project boundary was created for the biomass analysis. Within this boundary, the 30-meter C-BREC raster data were converted to a point feature class with points spaced 30 meters apart. Each of these roughly 23 million points were then assigned attributions to characterize their biomass residues. This is the "Preliminary Biomass Point Layer" (see Figure 1) that forms the foundation for the subsequent Python processing.

2.3 Step 3 – Processing Data and Outputs

Using a script written from the Pandas library in Python, the 23 million-point dataset created from the C-BREC model was converted into a DataFrame, a digital table similar to a spreadsheet, with a key difference being that a Pandas DataFrame allows for high-speed calculations when working with large quantities of data. For each row in the table, variables for all of the constraints (see Table 2 below) were attached for the corresponding point, which in turn corresponds to a 30 m by 30 m pixel within the analysis area. Additionally, each row was assigned a binary 'yes/no' designation indicating whether the related location falls within either of the service areas for each candidate site. The result of this processing step is the final "Biomass Point Layer" (see Figure 1), which contains each of the 23 million point features and their variables stored in the DataFrame and relating to the location of the point or one of the constraints in Table 2. This table can then be used to calculate biomass residue estimates based on a specific set of constraints. For this analysis, only the forest residues located in pixels with a less than 40% slope gradient and within 1,000 feet of an existing road were included. In addition, forest residues from areas that have burned within the past ten years (i.e., since 2014) were not included in the feedstock supply totals.

Table 2. Site Suitability Modeling Constraints

Constraint	Type	Variable Format
California Protected Areas Database (CPAD)	Administrative	Points categorized by agency level (federal, state, county, city, private).
Wilderness Designation	Administrative	Areas excluded from analysis as unsuitable.
County and State Boundaries	Administrative	Points assigned to underlying county.
Two-Hour Drive Time Service Area	Geographic	Points given binary flag for whether they fall within service area for each candidate site.
Economically Feasible Service Area	Geographic	Points given binary flag for whether they fall within service area for each candidate site.
Slope	Physical	Points assigned slope of underlying terrain in percent rise.
Distance From Nearest Road	Physical	Points assigned horizontal distance to nearest road in meters.
Fire History	Physical	Points assigned most recent burn from CAL FIRE records dating back to 1878.

2.4 Step 4 – Adding Tree Crop Residues

Separate from the forest residues analysis, potentially available agricultural residues from deciduous tree crops also were estimated. These orchards can produce thousands of tons[1] of biomass and, depending on the type of crop, need to be removed and replaced every twenty to one hundred years. Using the California Department of Water Resources (DWR) Statewide Crop Mapping Dataset, all orchards within the economically feasible service area qualifying as deciduous tree crops were identified. Based on specific tree diameters and typical replacement intervals, average bone dry tonnages available per year were determined. Separate output tables and maps were produced for this analysis and combined with the results from the analysis of C-BREC forest residue data to arrive at a total quantity of biomass available annually at each candidate wood products campus site.

[1] Unless otherwise noted in the report, "tons" is used to indicate green (or wet) short tons of biomass, as distinct from bone dry tons (BDT).

2.5 Step 5 – Estimating Feedstock Supplies

The final step of data processing utilized the Biomass Point Layer dataset to produce maps and output tables. A series of maps for each candidate site was produced displaying its 1) aerial overview; 2) density of forest biomass residues; 3) two-hour trucking service area; 4) economically feasible service area; and 5) deciduous tree crop residues. Sets of associated output tables were used to estimate the suitable biomass feedstocks for each candidate site with respect to the predetermined constraints and variables. For each set of tables, summaries were produced for both the two-hour drive time service area and economically feasible service area. Estimated feedstock supplies were categorized into small (<4”), medium (4-9”), and large (>9”) diameter (at breast height [DBH]) size ranges and reported in bone dry tons (BDT). Estimated biomass feedstock supplies for the three candidate wood products campus sites are summarized in Tables 3 through 5 below, with additional detail available in the tables in Appendix A. The associated maps for all three candidate sites are provided in Appendix B.

Table 3. Two-Hour Drive Time Forest Feedstocks (BDT)

Facility	Small DBH	Med DBH	Large DBH	Total
Toyon	6,256,167	5,266,661	8,946,235	**20,469,063**
Pioneer	5,533,575	4,684,789	7,560,604	**17,778,968**
Mariposa	2,522,501	2,075,979	3,418,729	**8,017,209**

Table 4. Economically Feasible Forest Feedstocks (BDT)

Facility	Small DBH	Med DBH	Large DBH	Total
Toyon	3,423,774	2,845,005	5,040,234	**11,309,014**
Pioneer	3,720,144	3,030,296	5,497,656	**12,248,096**
Mariposa	1,207,507	969,868	1,787,739	**3,965,113**

Table 5. Economically Feasible Annual Feedstocks (BDT/year)

Facility	Interval[1]	Forest	Orchard	Total Annual
Toyon	20 Years	565,451	16,490	**581,941**
Pioneer	20 Years	612,405	910	**613,315**
Mariposa	20 Years	198,256	79,066	**277,322**

[1] Average for all forest treatments and orchard removals other than almonds (22 years), walnuts (30 years), olives and pistachios (100 years).

2.6 Supply Optimization

Based on the economically available feedstock estimated for each site, it appears that a wood products campus at either Pioneer or Toyon would offer a much higher certainty of supply compared with the Mariposa site. The site in Pioneer offers slightly more large diameter feedstock than the Toyon site, with a greater portion of the total feedstock within the two-hour driving range being economically feasible for Pioneer (i.e., closer to the proposed campus than to any existing utilization sites). On the other hand, the Toyon site is located closer to major roadways, and it has access to significantly more orchard removals, which are negligible for the proposed Pioneer site. These tradeoffs, along with other similarities between the two site assessments (e.g., proportion of public versus private land, percentage of area burned within the last ten years) suggest that other considerations such as zoning and permitting, the capacity of existing infrastructure, and the strength of community support are likely to determine which campus site is preferable. Strictly from a supply standpoint, however, the two sites are generally comparable, with each offering about 600,000 BDT/year of woody biomass feedstock to support operations of a wood products campus.

2.7 Greenhouse Gas Impacts

One additional point of comparison is the magnitude of annual greenhouse gas emissions from trucking biomass feedstocks to the various candidate utilization sites. Using the same geospatial modeling framework developed to estimate economically feasible feedstock supplies, ton-miles of trucking (assumed to be diesel) needed to transport those supplies to each site was able to be estimated (see Table 6 below). These estimates were made for comparative purposes only, as it isn't necessarily assumed that 100% of the economically feasible feedstock would be transported to each site. These estimates do, however, highlight large differences in the carbon intensity of moving feedstocks to various campus locations. As shown in Table 7, the GHG emissions from trucking all biomass within the economically feasible zone for each candidate site vary from a low of just under 24,000 metric tons of carbon dioxide (MTCO2) to nearly 80,000 MTCO2 over an assumed 20-year utilization interval. On an annual basis, this equates to between approximately 1,200 and 4,000 MTCO2. Much of this difference is due to the greater tonnages of feedstock available to the Toyon and Pioneer sites, but the geospatial modeling also accounts for actual road distances that would be traveled to each site. Looking at just the Toyon and Pioneer sites, which share similar feedstock supply characteristics, GHG emissions for trucking wood to the Pioneer site are estimated to be nearly 20% lower than to the Toyon site. Put in terms of equivalent passenger vehicle emissions, trucking all economically feasible feedstock to Pioneer rather than to Toyon could offset the annual emissions of roughly 160 passenger vehicles in the study area. This reduced GHG impact from feedstock transportation could be used to further inform decisions regarding which site may be optimal for a wood products campus.

Table 6. Feedstock Trucking Requirements (Ton-Miles)

Facility	Small DBH	Med DBH	Large DBH	Total
Toyon	129,581,132	103,499,922	203,586,072	**436,667,125**
Pioneer	107,964,530	83,856,631	162,045,539	**353,866,699**
Mariposa	38,250,400	30,169,600	62,557,601	**130,977,601**

Table 7. GHG Emissions From Feedstock Trucking

Facility	Ton-Miles	MTCO2[1]	MTCO2/yr[2]	Vehicles[3]
Toyon	436,667,125	79,214	3,961	**861**
Pioneer	353,866,699	64,194	3,210	**698**
Mariposa	130,977,601	23,760	1,188	**258**

[1] Based on emissions factor of 0.40 lbs CO2/ton-mile of freight transportation via diesel truck (U.S. CBO).

[2] Assumes 20-year average treatment/utilization interval for woody biomass feedstocks.

[3] Assumes average annual emissions of 4.6 MTCO2 per U.S. passenger vehicle (U.S. EPA).

3.0 BIOMASS FEEDSTOCK STORAGE

Designs for wood products campuses often include a central biomass-fired boiler or gasification plant for generating heat and/or electricity to serve the various co-located businesses on the campus. In support of that concept, a biomass feedstock storage model was developed to estimate the size and capital cost of an appropriately-scaled covered storage facility (e.g., a pole barn). The covered storage facility was specifically sized to accommodate biomass feedstocks needed to fuel the 3.0 MWe gasification plant planned for the Mariposa Biomass Project, as an example of the footprint and cost requirements that could be expected for a comparable facility at any of the three candidate wood products campus sites.

3.1 Feedstock Storage Size

The wood fuel required to operate the gasification plant was conservatively estimated at 30,000 tons/year. In the event that less feedstock is needed, the storage facility will simply have marginally greater capacity and require less frequent deliveries of wood chips. The size of the pole barn is driven by two primary factors: 1) the number of months of fuel storage required; and 2) the average depth of the wood chip piles. To allow continuous operation of the bioenergy plant during prolonged periods of inclement weather or road closures, it was assumed that a minimum of two weeks of fuel would be needed in the storage facility. This equates to about 1,250 tons of stored wood chips, or approximately 6,100 cubic yards (cy) piled to an average depth of 15 feet. This volume of chips would occupy about 11,000 square feet (sf) within the enclosed pole barn. Assuming an additional 20% of open space on all sides of the chip piles for maneuvering the equipment needed to manage the fuel brings the estimated chip storage area for a 3.0 MWe bioenergy plant to nearly 20,000 sf. A summary of the biomass feedstock storage sizing model is shown in Table 8 below, with the key assumptions highlighted in blue.

Table 8. Estimated Footprint of Feedstock Storage Facility

Number of bioenergy projects served	1
Quantity of chips per project (tons/yr)[1]	30,000
Months of storage required[2]	0.5
Maximum quantity of stored chips (tons)	1,250
Bulk density of wood chips (lb/cy)[3]	410
Maximum quantity of stored chips (cy)	6,100
Average depth of stored chips (ft)	15
Total area of stored chips (sf)	11,000
Square dimension of stored chips (ft)	110
Square dimension of floor slab (ft)	140
Estimated chip storage area (sf)	**20,000**

[1] *Wood fuel estimate for 3.0 MWe biomass gasification system.*

[2] *Assumes year-round power generation; no significant snowfall.*

[3] *Wood Fuels Handbook, Bioenergy Europe (AEBIOM), 2008.*

3.2 Feedstock Storage Cost

Independent cost estimates were developed using parametric pricing tools from three pole barn suppliers: Carter Lumber, DIY Pole Barns, and Armour Metals. The estimates include both material and construction costs, and all assume a fully enclosed pole barn that is roughly 120' wide by 160' long with a 5"-thick poured concrete slab floor. The barn roof was assumed to have a 12" overhang on all four sides and 12'-wide lean-tos on two sides. Two large overhead doors to accommodate the equipment necessary for managing the fuel piles, along with two entry doors and two windows, were priced into all three estimates.

As indicated in Table 9, the average base cost for a completed 20,000 sf enclosed pole barn with a concrete floor is estimated to be $825,000 with sales tax. This estimate is composed of a $532,000 materials cost and a $293,000 construction cost that includes freight. Applying an additional 30% contingency (an appropriate figure at the conceptual design phase) brings the risk-adjusted total capital cost for the feedstock storage facility to nearly $1.1 million. Additional assumptions and sources for the three parametric cost estimates are provided in the footnotes below Table 9.

Table 9. Estimated Cost of Feedstock Storage Facility

		Carter	DIY	Armour	AVERAGE
	Materials Cost				
16	Barn[1,2]	$ 270,000	$ 315,000	$ 312,000	$ 299,000
5	Slab[3,4,5]	$ 233,000	$ 233,000	$ 234,000	$ 233,000
	Subtotal	**$ 503,000**	**$ 548,000**	**$ 546,000**	**$ 532,000**
	Construction Cost				
	Freight[6,7]	$ 39,000	$ -	$ 39,000	$ 26,000
	Labor[8]	$ 279,000	$ 279,000	$ 243,000	$ 267,000
	Subtotal	**$ 318,000**	**$ 279,000**	**$ 282,000**	**$ 293,000**
	BASE COST	**$ 821,000**	**$ 827,000**	**$ 828,000**	**$ 825,000**
	Contingency (30%)	**$ 247,000**	**$ 249,000**	**$ 249,000**	**$ 248,000**
	TOTAL COST	**$ 1,068,000**	**$ 1,076,000**	**$ 1,077,000**	**$ 1,073,000**

[1] Assumes design with maximum roof snow load of 70 psf.

[2] Estimates based on eave height indicated to the left (feet).

[3] Estimates based on slab depth indicated to the left (inches).

[4] Carter and DIY based on unit prices from Concrete Network.

[5] Armour Metals based on 3 times the cost of a 40' x 160' slab.

[6] Carter freight based on estimate from Armour Metals.

[7] DIY barn materials estimate includes free delivery.

[8] Carter labor based on estimate from DIY Pole Barns.

4.0 PROJECT FINANCIAL RISK

The project risk and sensitivity analyses described in this report were based on the static financial models developed during earlier phases of the South Central Sierra pilot study. Those prior models were not fully validated as part of this work; rather, they formed the foundation upon which more advanced stochastic analysis techniques have been applied. The process described here could be used with any similar baseline financial model, and thus is intended to serve as a proof of concept for the Biomass Utilization Financial Feasibility and Sensitivity (BUFFS™) analysis approach as it applies to other biomass utilization projects both within California and elsewhere. While the analytical approach outlined here may be somewhat novel to the biomass industry, it has been widely applied for decades in the construction industry and in manufacturing and other business settings. Its proposed adoption by the biomass industry would represent a new level of maturity in the types of financial assessments that could be used by prospective project owners, developers, and stakeholders to evaluate project feasibility and ultimately to determine whether or not to move forward with capital investments needed for various biomass utilization projects. *The BUFFS™ analysis methodology described here is based on pre-existing intellectual property developed by the author and his colleagues more than thirty years ago, which has been updated and further refined by the author over the intervening three decades for applications in the environmental remediation and aerospace industries.*

4.1 Model Assumptions

The BUFFS™ analysis methodology uses Monte Carlo simulation, a random sampling technique employing range estimates and probability distributions rather than single point estimates for variables in a capital cost estimate or pro forma financial model. These simulation models run a large number of trials (e.g., 10,000) to estimate a range of potential outcomes for a project as if it had been executed numerous times, each with a different result based on the sampled values for key model inputs. Monte Carlo simulation models are used to produce probabilistic forecasts of project financial metrics such as initial capital expense, total annual revenue, and net present value (NPV). This latter metric was the focus of the BUFFS™ analyses developed here to support further evaluation of the financial feasibility of two proposed wood products campus businesses, namely, a firewood processing operation and a small-scale sawmill.

Point estimates for roughly two dozen input variables in each prior financial model were converted into probabilistic distributions to allow use of Monte Carlo simulation techniques. Assigned probabilistic values included uniform, triangular, normal, and lognormal distributions, depending upon the nature of the specific input variable. For example, the number of cords per day of wood that could be processed by the firewood business was modeled using a uniform distribution to reflect consistent variability both above and below the single-point estimated value. Other variables such as operating days per year and unit price per cord of firewood sold were modeled using triangular distributions, which have a strong central tendency along with diminishing probabilities of values reaching thresholds above or below the base case point estimate. Input variables for various operator labor rates were modeled using normal distributions to reflect available historical cost data, while items such as utility costs and insurance premiums, which often exhibit normally distributed behavior but with very large high-end tails, were modeled using lognormal distributions.

For cases in which multiple model input variables could be expected to vary together (i.e., to be correlated) based on local market conditions or business operating practices, the models adopted a simplified approach of assigning a correlation coefficient of either 0.5 for moderately correlated variables or 1.0 for strongly correlated variables. Further details about the assumptions used to develop Monte Carlo simulation models for the two proposed wood products businesses are provided in Appendices C and D.

It is important to note that the modeling assumptions used for the BUFFS™ analyses were chosen in part to demonstrate the variety of options available and not necessarily to reflect the most accurate ranges, which would need to be determined on a case-by-case basis through interviews with subject matter experts and/or compilation of historical project data. That said, the assumptions were generally consistent with the types of cost and revenue uncertainties often seen in similar biomass utilization projects. The results described below highlight the significant impact that these uncertainties can have on the ultimate success or failure of a biomass utilization effort.

4.2 Model Forecasts

By running thousands of simulation trials of the pro forma financial model for a proposed wood products business, forecasts of various cost and revenue elements can be generated. For example, probabilistic forecasts of average feedstock cost per cord of firewood produced or thousand board feet (MBF) of lumber milled can be derived as indicators of cost efficiency for a project. These intermediate values ultimately feed into a discounted cash flow model for the project, yielding a probability distribution of its NPV over its design life (e.g., 20 years). In the case of the proposed firewood processing business, the median net present value generated by the Monte Carlo simulation was negative, meaning that the business could be expected to lose money. To be more precise, the model predicts about a 40% likelihood of the business being profitable, with worst case downside losses exceeding $500,000 (in current dollars) over the life of the firewood business (see Figure 3). On the other hand, the proposed sawmill business has an extremely high likelihood (>95%) of being profitable based on the specific input variables used in the Monte Carlo simulation. Its median NPV is forecast to be just over $1 million, with a maximum potential upside that exceeds $3 million (see Figure 4).

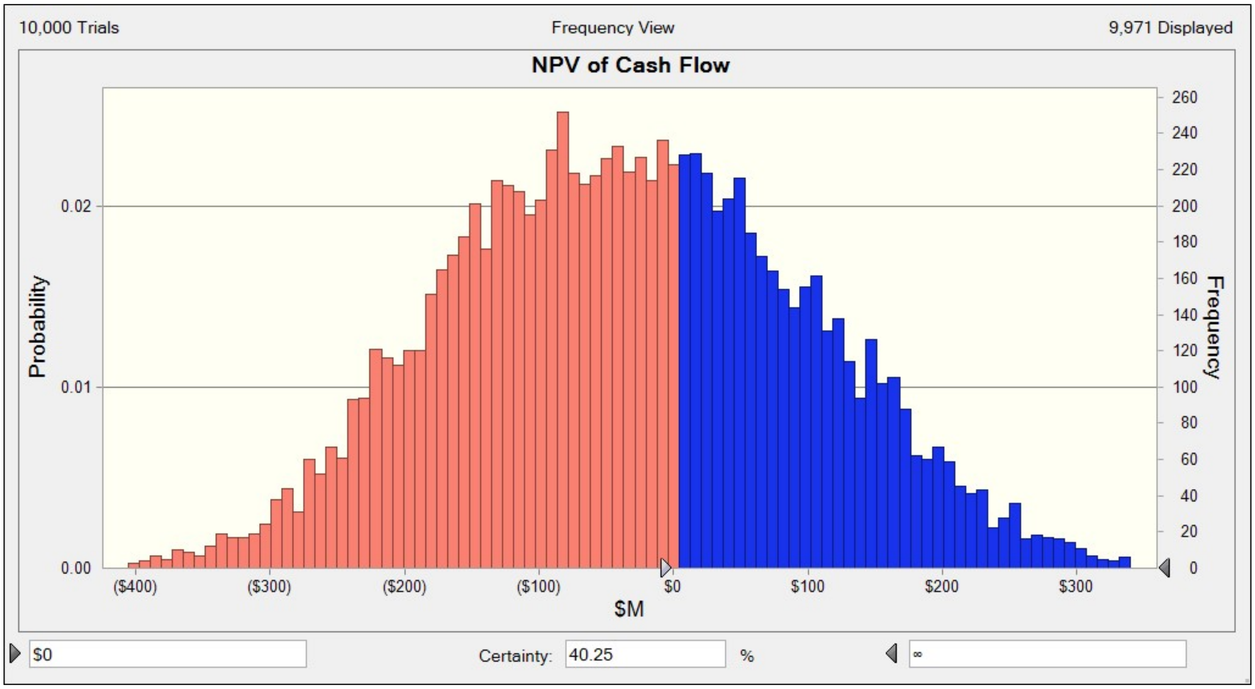

Figure 3. Forecast NPV for Firewood Processing

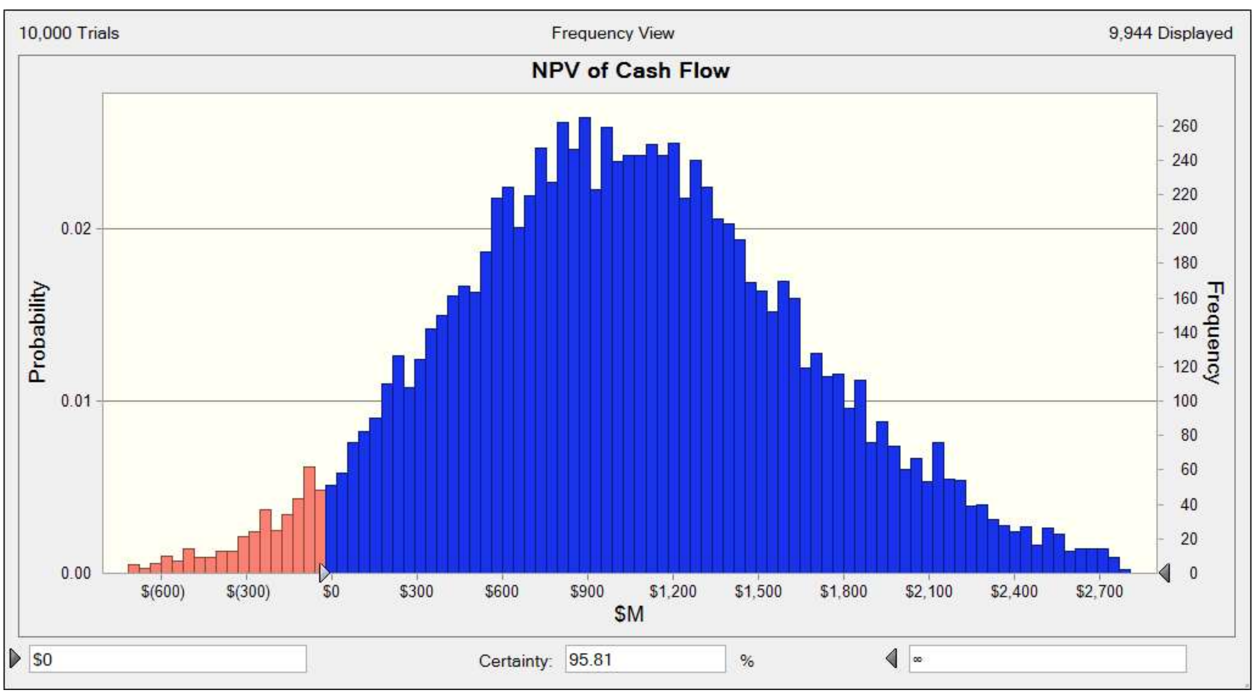

Figure 4. Forecast NPV for Small-Scale Sawmill

Both of the businesses showed positive net present values in the prior static pro forma financial models; however, by more explicitly capturing cost and revenue uncertainties in these simulation models, the BUFFS™ analysis was able to highlight very distinct differences in their anticipated profitability. This offers valuable analytical support to decision makers as they weigh various capital investment options during early phases of a wood products campus development or other biomass utilization project. Further details and outputs from the Monte Carlo simulation models for these two proposed businesses are provided in Appendices C and D.

4.3 Sensitivity Analysis

Perhaps the most powerful feature of the BUFFS™ analysis methodology is its ability to identify the highest risk drivers from among the various inputs to the project financial model. In the case of the firewood business, simulation modeling revealed that the throughput of softwood and hardwood logs (i.e., cords per day processed) accounts for fully 50% of the total variability in the project NPV. In addition, the NPV is highly sensitive to the unit sales price per cord for softwood, but much less so to the unit sales price for hardwood. Conversely, the financial model results are relatively insensitive to variations in seemingly important factors including log procurement costs, labor rates, grant funding, interest rates, and insurance premiums, demonstrating the utility of such an analytical tool versus relying on intuitive assessments. In all, just five input values to the simulation model account for roughly 75% of the variability in the forecast NPV of the proposed firewood business, allowing the project owners and developers to focus on reducing uncertainty in those key areas in order to increase the likelihood of the project's financial viability (see the Cumulative Variation values in Table 10).

A tornado diagram depicting the relative importance (i.e., sensitivity) of the model input variables in terms of their individual impacts on the NPV of the firewood business is shown in Figure 5, with bar labels identifying the test range for each input variable. Note that the Monte Carlo simulation modeling software uses "upside" to indicate higher numerical values and "downside" for lower numerical values, regardless of their net impact on NPV. Additional quantitative results in Table 10 show the rank-ordered cumulative influence on variation in the forecast project NPV contributed by various input variables in the simulation model. Again, these results are illustrative and not intended to be strictly applied without further project-specific refinements.

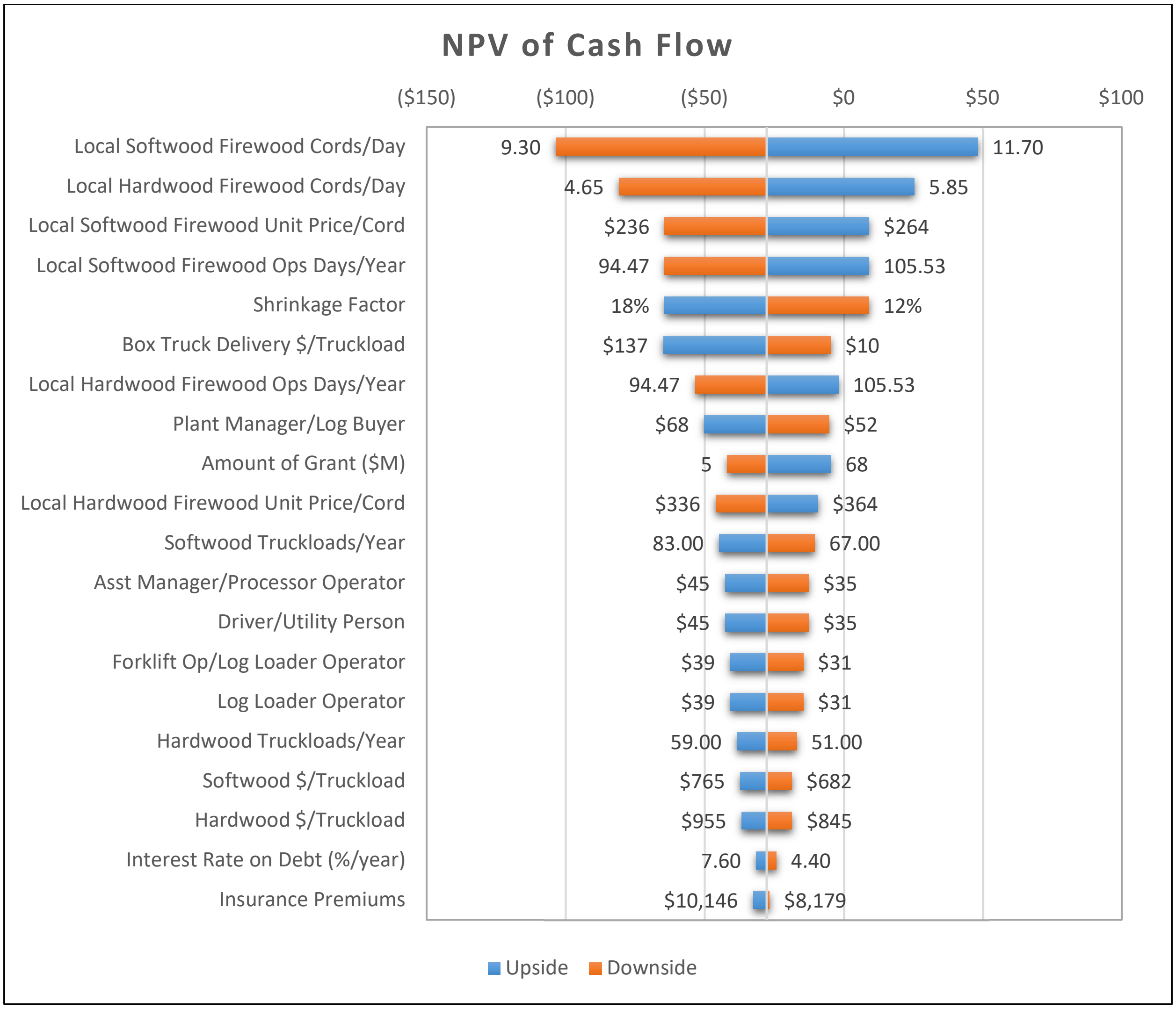

Figure 5. Tornado Diagram for Firewood Processing

Table 10. Factors Driving NPV for Firewood Processing

Input Variable	Downside NPV	Upside NPV	NPV Range	Cumulative Variation
Local Softwood Firewood Cords/Day	($103)	$48	$152	34.31%
Local Hardwood Firewood Cords/Day	($81)	$25	$106	51.12%
Local Softwood Firewood Unit Price/Cord	($64)	$9	$73	59.14%
Local Softwood Firewood Ops Days/Year	($64)	$9	$73	67.17%
Shrinkage Factor	$9	($64)	$73	75.19%
Box Truck Delivery $/Truckload	($5)	($65)	$60	80.60%
Local Hardwood Firewood Ops Days/Year	($53)	($2)	$51	84.53%
Plant Manager/Log Buyer	($5)	($50)	$45	87.53%
Amount of Grant ($M)	($42)	($5)	$37	89.60%
Local Hardwood Firewood Unit Price/Cord	($46)	($9)	$37	91.60%
Softwood Truckloads/Year	($10)	($45)	$34	93.36%
Asst Manager/Processor Operator	($13)	($43)	$30	94.70%
Driver/Utility Person	($13)	($43)	$30	96.03%
Forklift Op/Log Loader Operator	($15)	($41)	$26	97.06%
Log Loader Operator	($15)	($41)	$26	98.08%
Hardwood Truckloads/Year	($17)	($38)	$21	98.76%
Softwood $/Truckload	($19)	($37)	$19	99.27%
Hardwood $/Truckload	($19)	($37)	$18	99.76%
Interest Rate on Debt (%/year)	($24)	($31)	$7	99.84%
Insurance Premiums	($27)	($32)	$6	99.89%

NOTE: *Shaded input variables account for >75% of variation in project NPV.*

In contrast to the proposed firewood business, which shows a relatively low likelihood of financial viability, a similar sensitivity analysis for the small-scale sawmill project revealed that just four factors are likely to materially influence its projected profitability, namely, the number of board feet (BF) of incense cedar and of pine and fir produced per day, as well as the unit sales price per board foot for both types of lumber. Together these four model inputs account for more than 95% of the variability in the forecast NPV, with all the other factors contributing very little uncertainty to the financial performance of the project. The tornado diagram in Figure 6 depicts the full sensitivity analysis results for the proposed small-scale sawmill, while Table 11 lists the model input variables in order from the most to least influence on project net present value.

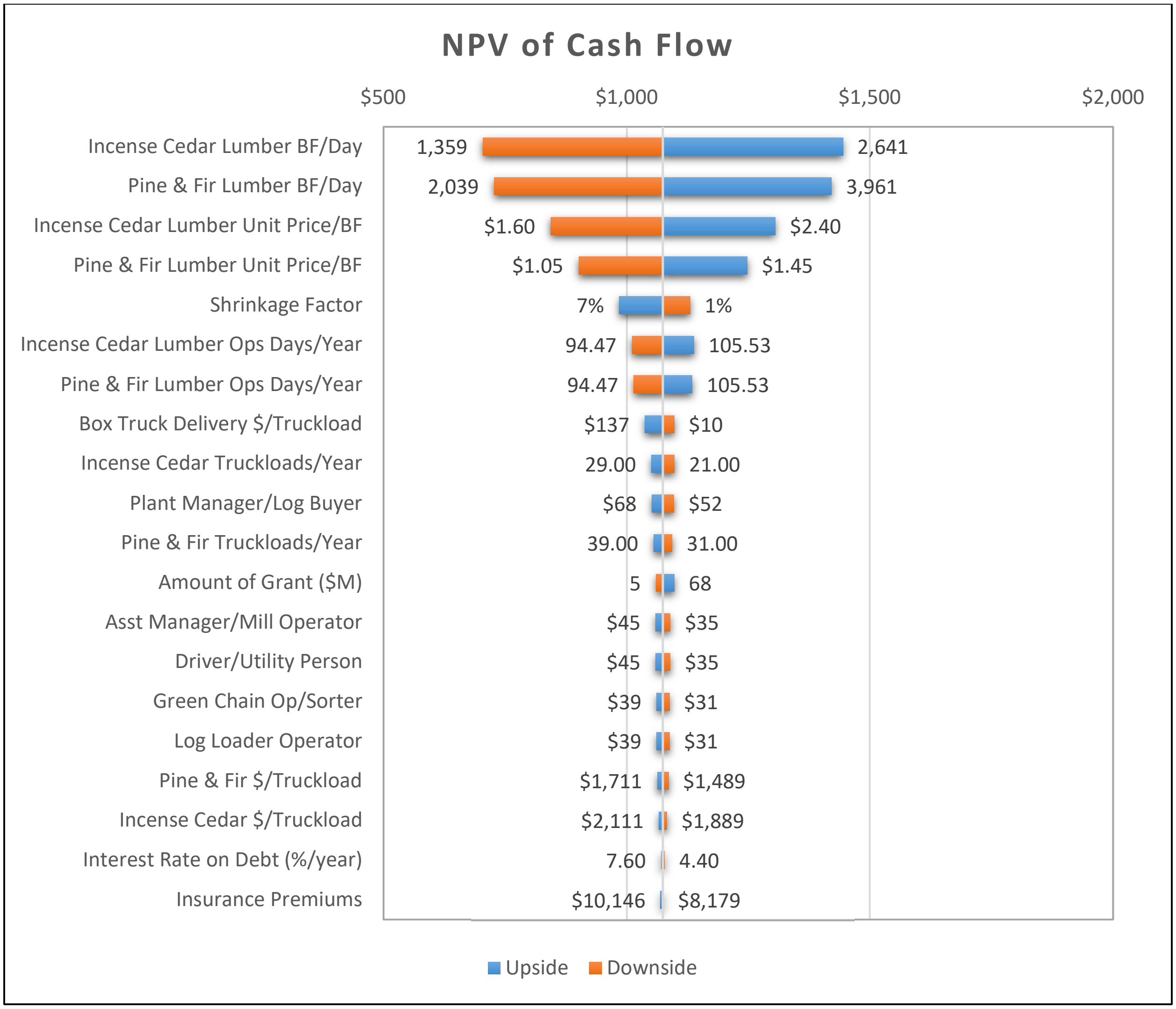

Figure 6. Tornado Diagram for Small-Scale Sawmill

Table 11. Factors Driving NPV for Small-Scale Sawmill

Input Variable	Downside NPV	Upside NPV	NPV Range	Cumulative Variation
Incense Cedar Lumber BF/Day	$704	$1,444	$740	38.32%
Pine & Fir Lumber BF/Day	$728	$1,421	$694	72.00%
Incense Cedar Lumber Unit Price/BF	$843	$1,305	$462	86.93%
Pine & Fir Lumber Unit Price/BF	$901	$1,248	$346	95.33%
Shrinkage Factor	$1,130	$984	$146	96.82%
Incense Cedar Lumber Ops Days/Year	$1,011	$1,138	$128	97.96%
Pine & Fir Lumber Ops Days/Year	$1,015	$1,134	$120	98.96%
Box Truck Delivery $/Truckload	$1,097	$1,037	$60	99.21%
Incense Cedar Truckloads/Year	$1,098	$1,051	$48	99.37%
Plant Manager/Log Buyer	$1,097	$1,052	$45	99.51%
Pine & Fir Truckloads/Year	$1,093	$1,055	$38	99.61%
Amount of Grant ($M)	$1,060	$1,097	$37	99.71%
Asst Manager/Mill Operator	$1,089	$1,059	$30	99.77%
Driver/Utility Person	$1,089	$1,059	$30	99.84%
Green Chain Op/Sorter	$1,087	$1,061	$26	99.88%
Log Loader Operator	$1,087	$1,061	$26	99.93%
Pine & Fir $/Truckload	$1,086	$1,063	$23	99.97%
Incense Cedar $/Truckload	$1,083	$1,066	$16	99.99%
Interest Rate on Debt (%/year)	$1,078	$1,071	$7	99.99%
Insurance Premiums	$1,075	$1,070	$6	99.99%

NOTE: *Shaded input variables account for >95% of variation in project NPV.*

5.0 SUMMARY OF FINDINGS

Results from these three distinct but related analysis tasks offer insights for meaningfully reducing the risk associated with implementing the proposed wood products campus. By examining key facets of a biomass utilization project including 1) economic availability of feedstocks; 2) feedstock storage requirements; and 3) sensitivity of project financial outcomes to various risk drivers, the project team is much better positioned to proactively manage and mitigate the elements most likely to impact project success. To recap, reliability of economically feasible feedstocks is projected to be much higher at the Pioneer and Toyon sites than the Mariposa site. Further, developers of a wood products campus having a central bioenergy plant requiring on the order of 30,000 tons/year of wood chips should anticipate needing 20,000 sf of covered storage at a constructed cost of around $1 million. Lastly, of the two businesses currently proposed for the campus, the small-scale sawmill has a significantly higher likelihood of being profitable as compared with the firewood business, which is more likely to experience a financial loss than a profit given the specific assumptions made in the BUFFS™ analysis. Taken together, these results offer an improved decision making framework for the proposed wood products campus as its design continues to evolve.

6.0 PROPOSED APPLICATIONS

As stated at the outset of this report, the analyses developed for the South Central Sierra pilot study were intended to be a proof of concept that could be applied to numerous other biomass utilization projects at various stages in their development. The sections below suggest the broad applicability of these methods to projects beyond the pilot study area.

6.1 Advanced Geospatial Analysis

The advanced geospatial analysis methodology described here is designed to complement more "on the ground" approaches like the one used in the prior feedstock supply study. That type of bottom-up approach to estimating practically available feedstock supply, which relies on direct interviews with existing and potential suppliers, is necessary to develop a locally accurate picture of feedstock availability that considers important constraints such as labor availability and infrastructure capacity. The more top-down approach demonstrated here can, however, serve as a valuable confirmation of such bottom-up estimates. In this case, geospatial analysis estimated available feedstocks of between 277,000 and 613,000 BDT/year, depending upon where the wood products campus is sited. The prior supply study arrived at a figure of 322,000 BDT/year of biomass feedstock in the five-county study area. Thus, the advanced geospatial analysis demonstrated here was able to confirm and refine that estimate on a more site-specific basis, but it is not intended to replace the hands-on approach relying on direct communication with local landowners and forestry professionals. The two approaches are instead meant to be complementary and to serve as a means of reducing supply risk in the early phases of project development.

6.2 Feedstock Storage Modeling

Applications for the feedstock storage model extend to any kind of biomass utilization project that relies on chipped wood fuel. This may include various types of biomass combustion, gasification, and pyrolysis plants designed to produce heat, electricity, biochar, or some combination of those products. Project owners and developers may underestimate both the size and cost required for onsite wood fuel storage, which can significantly impact facility operations. Existing community-scale bioenergy facilities in California have experienced such operational challenges due to intermittent shortages in local wood fuel supplies. By incorporating a larger chip storage element into the facility design, owners and operators can reduce the risk of plant down time, which in turn can improve the project's financial performance through increased plant availability and throughput. The sizing and parametric cost models developed for this pilot study could be readily adapted to meet the feedstock storage needs of other biomass utilization facilities of various sizes and types, including for centralized feedstock aggregation sites.

6.3 Financial Risk Reduction

The unique approach to financial risk reduction provided by the BUFFS™ analysis methodology could have wide-ranging applications for all types of biomass utilization efforts. This approach substantially enhances the more traditional means of predicting financial performance of a proposed project by directly accounting for cost, revenue, and operational uncertainties in its financial analysis methodology. By replacing point estimates with probability distributions for key model input variables, Monte Carlo simulation can be employed to analyze the full range of potential project outcomes in order to better understand both downside risk exposure and upside opportunities for improving return on investment. The BUFFS™ analyses developed for this pilot study were intended primarily to demonstrate the powerful capabilities of this modeling approach—in particular the ability of its sensitivity analysis to pinpoint the sources of greatest project financial risk—but these results also were able to further refine the findings of the prior wood products campus feasibility study by highlighting significant differences in the likelihoods of two proposed wood products businesses being profitable. This kind of analytical tool can support decision making far better than what is possible with static financial models or intuitive judgments about risk and uncertainty, which are known to be subject to a range of cognitive biases and heuristics that make them consistently unreliable.

6.4 Use Cases

As the LCI pilot study teams seek to implement enhanced operational and organizational frameworks for executing biomass utilization projects in the state (e.g., establishing new regional joint powers authorities (JPA); offering permitting support services), the tools and methods described here should be considered sufficiently flexible and mature to be immediately applicable across a wide range of projects and entities. That said, the suitability of any modeling results will be directly dependent upon the quality of the underlying input assumptions, and therefore it is recommended that these approaches be applied carefully in coordination with experienced analysts and regional subject matter experts who understand the nuances and constraints of the specific project environment. The BUFFS™ analysis approach in particular requires specialized expertise on how best to elicit and encode probabilistic judgments in order to develop accurate financial forecasts, and thus should only be implemented by analysts who are well-versed in developing those types of assessments (see publication by Diekmann and Featherman in the References section of this report for additional details). Otherwise, analysis results could be skewed to portray an overly optimistic or pessimistic view of a proposed biomass utilization project or other related business venture.

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APPENDIX A. FEEDSTOCK SUPPLY TABLES

FOREST BIOMASS SUPPLY ON PRIVATE AND PUBLIC LANDS

Economically Feasible Zone

Facility	Agency Level	Small DBH	Med DBH	Large DBH	Total	
Toyon	Private	2,220,024	1,950,958	2,901,119	**7,072,101**	63%
Toyon	Public	1,203,751	894,047	2,139,115	**4,236,913**	37%
Toyon	**TOTAL**	**3,423,775**	**2,845,005**	**5,040,234**	**11,309,014**	**100%**
Pioneer	Private	2,233,298	1,955,668	2,958,609	**7,147,575**	58%
Pioneer	Public	1,486,846	1,074,628	2,539,048	**5,100,521**	42%
Pioneer	**TOTAL**	**3,720,144**	**3,030,296**	**5,497,657**	**12,248,096**	**100%**
Mariposa	Private	461,995	380,409	459,785	**1,302,190**	33%
Mariposa	Public	745,511	589,459	1,327,953	**2,662,924**	67%
Mariposa	**TOTAL**	**1,207,506**	**969,868**	**1,787,738**	**3,965,114**	**100%**

Two-Hour Drive Time Zone

Facility	Agency Level	Small DBH	Med DBH	Large DBH	Total
Toyon	Private	3,741,999	3,326,578	4,536,270	**11,604,847**
Toyon	Public	2,514,168	1,940,083	4,409,964	**8,864,216**
Toyon	**TOTAL**	**6,256,167**	**5,266,661**	**8,946,234**	**20,469,063**
Pioneer	Private	3,576,152	3,187,656	4,340,117	**11,103,925**
Pioneer	Public	1,957,423	1,497,133	3,220,487	**6,675,043**
Pioneer	**TOTAL**	**5,533,575**	**4,684,789**	**7,560,604**	**17,778,968**
Mariposa	Private	1,261,113	1,065,701	1,258,089	**3,584,903**
Mariposa	Public	1,261,388	1,010,277	2,160,640	**4,432,306**
Mariposa	**TOTAL**	**2,522,501**	**2,075,978**	**3,418,729**	**8,017,209**

All biomass values are in bone dry imperial short tons,
and reflect the C-BREC 2025 estimates of a thin from below by 40%.
Small DBH: Foliage and <4" diameter residues.
Med DBH: 4-9" diameter residues.
Large DBH: >9" diameter residues.

'Economically Feasible Zone' refers to areas within the two-hour
drive time zone where there is not a closer competing site.

Values reflect suitable conditions:
- Less than 40% slope gradient,
- Within 1,000 feet of a road,
- Areas that have not burned in the last ten years (2014+)

FOREST BIOMASS SUPPLY BY REPORTING AGENCY

Economically Feasible Zone

Facility	Agency Level	Small DBH	Med DBH	Large DBH	Total	
Toyon	Private	2,220,024	1,950,958	2,901,119	7,072,101	63%
Toyon	Federal	1,142,109	844,832	2,046,981	4,033,922	36%
Toyon	State	54,517	41,955	85,691	182,163	2%
Toyon	County	622	671	948	2,241	0%
Toyon	City	129	116	132	377	0%
Toyon	Special District	3,883	4,048	1,914	9,845	0%
Toyon	Non Profit	2,491	2,425	3,449	8,364	0%
Toyon	**TOTAL**	**3,423,775**	**2,845,005**	**5,040,234**	**11,309,013**	**100%**
Pioneer	Private	2,233,298	1,955,668	2,958,609	7,147,575	58%
Pioneer	Federal	1,408,810	1,012,746	2,428,293	4,849,848	40%
Pioneer	State	69,226	53,084	101,224	223,534	2%
Pioneer	County	623	673	948	2,244	0%
Pioneer	City	184	155	171	510	0%
Pioneer	Special District	5,046	5,085	4,767	14,898	0%
Pioneer	Non Profit	2,957	2,886	3,644	9,486	0%
Pioneer	**TOTAL**	**3,720,144**	**3,030,297**	**5,497,656**	**12,248,095**	**100%**
Mariposa	Private	461,995	380,409	459,785	1,302,190	33%
Mariposa	Federal	740,117	585,711	1,320,981	2,646,810	67%
Mariposa	State	175	153	154	482	0%
Mariposa	County	1,063	826	1,071	2,960	0%
Mariposa	City	0	0	0	0	0%
Mariposa	Special District	2,551	1,621	2,665	6,836	0%
Mariposa	Non Profit	1,607	1,148	3,082	5,837	0%
Mariposa	**TOTAL**	**1,207,508**	**969,868**	**1,787,738**	**3,965,115**	**100%**

Two-Hour Drive Time Zone

Facility	Agency Level	Small DBH	Med DBH	Large DBH	Total
Toyon	Private	3,741,999	3,326,578	4,536,270	11,604,847
Toyon	Federal	2,428,171	1,869,449	4,292,606	8,590,227
Toyon	State	63,618	49,980	95,490	209,088
Toyon	County	3,490	3,037	3,213	9,740
Toyon	City	1,629	1,682	1,294	4,606
Toyon	Special District	8,066	7,303	7,419	22,789
Toyon	Non Profit	9,194	8,631	9,941	27,766
Toyon	**TOTAL**	**6,256,167**	**5,266,660**	**8,946,233**	**20,469,063**
Pioneer	Private	3,576,152	3,187,656	4,340,117	11,103,925
Pioneer	Federal	1,862,151	1,419,998	3,095,608	6,377,756
Pioneer	State	76,942	59,656	108,190	244,788
Pioneer	County	3,182	2,791	2,834	8,807
Pioneer	City	1,688	1,727	1,331	4,747
Pioneer	Special District	6,054	5,999	5,379	17,432
Pioneer	Non Profit	7,407	6,963	7,145	21,514
Pioneer	**TOTAL**	**5,533,576**	**4,684,790**	**7,560,604**	**17,778,969**
Mariposa	Private	1,261,113	1,065,701	1,258,089	3,584,903
Mariposa	Federal	1,243,429	995,600	2,137,923	4,376,952
Mariposa	State	4,811	4,160	6,636	15,607
Mariposa	County	3,279	2,848	3,834	9,961
Mariposa	City	58	49	44	151
Mariposa	Special District	3,966	2,706	3,893	10,565
Mariposa	Non Profit	5,845	4,915	8,310	19,070
Mariposa	**TOTAL**	**2,522,501**	**2,075,979**	**3,418,729**	**8,017,209**

All biomass values are in bone dry imperial short tons,
and reflect the C-BREC 2025 estimates of a thin from below by 40%.
Small DBH: Foliage and <4" diameter residues.
Med DBH: 4-9" diameter residues.
Large DBH: >9" diameter residues.

'Economically Feasible Zone' refers to areas within the two-hour
drive time zone where there is not a closer competing site.

Values reflect suitable conditions:
- Less than 40% slope gradient,
- Within 1,000 feet of a road,
- Areas that have not burned in the last ten years (2014+)

FOREST BIOMASS SUPPLY BY COUNTY

Economically Feasible Zone

Facility	County	Small DBH	Med DBH	Large DBH	Total	
Toyon	Alpine	56,211	36,391	82,994	175,596	2%
Toyon	Amador	773,829	675,059	953,311	2,402,199	21%
Toyon	Calaveras	1,601,355	1,329,879	2,442,924	5,374,159	48%
Toyon	El Dorado	661,222	563,534	960,102	2,184,859	19%
Toyon	Sacramento	1,279	1,271	875	3,426	0%
Toyon	San Joaquin	627	518	599	1,744	0%
Toyon	Tuolumne	329,250	238,353	599,429	1,167,032	10%
Toyon	**TOTAL**	**3,423,773**	**2,845,005**	**5,040,234**	**11,309,015**	**100%**
Pioneer	Alpine	250,271	157,233	313,474	720,978	6%
Pioneer	Amador	773,826	675,030	953,423	2,402,279	20%
Pioneer	Calaveras	1,396,031	1,146,661	2,217,512	4,760,204	39%
Pioneer	El Dorado	946,634	798,693	1,361,094	3,106,421	25%
Pioneer	Sacramento	1,282	1,274	876	3,432	0%
Pioneer	San Joaquin	64	51	61	175	0%
Pioneer	Tuolumne	352,037	251,354	651,216	1,254,607	10%
Pioneer	**TOTAL**	**3,720,145**	**3,030,296**	**5,497,656**	**12,248,096**	**100%**
Mariposa	Madera	579,298	453,153	937,127	1,969,578	50%
Mariposa	Mariposa	610,905	502,305	823,051	1,936,262	49%
Mariposa	Merced	129	80	140	348	0%
Mariposa	Tuolumne	17,174	14,330	27,420	58,925	1%
Mariposa	**TOTAL**	**1,207,506**	**969,868**	**1,787,738**	**3,965,113**	**100%**

Two-Hour Drive Time Zone

Facility	County	Small DBH	Med DBH	Large DBH	Total
Toyon	Alpine	56,218	36,394	83,007	175,620
Toyon	Amador	773,882	675,095	953,383	2,402,359
Toyon	Calaveras	1,625,109	1,353,707	2,459,270	5,438,086
Toyon	El Dorado	1,730,215	1,590,574	2,137,508	5,458,297
Toyon	Mariposa	239,467	190,479	264,671	694,617
Toyon	Merced	110	70	115	295
Toyon	Placer	84,267	73,456	46,898	204,621
Toyon	Sacramento	1,664	1,690	1,077	4,431
Toyon	San Joaquin	627	518	599	1,744
Toyon	Stanislaus	1,803	967	1,501	4,272
Toyon	Tuolumne	1,742,804	1,343,711	2,998,205	6,084,721
Toyon	**TOTAL**	**6,256,166**	**5,266,661**	**8,946,234**	**20,469,063**
Pioneer	Alpine	250,331	157,265	313,550	721,147
Pioneer	Amador	773,919	675,112	953,512	2,402,543
Pioneer	Calaveras	1,624,976	1,353,580	2,458,942	5,437,498
Pioneer	El Dorado	1,991,317	1,791,405	2,568,330	6,351,052
Pioneer	Mariposa	272	244	232	748
Pioneer	Placer	80,425	70,202	44,717	195,344
Pioneer	Sacramento	1,690	1,717	1,091	4,498
Pioneer	San Joaquin	628	518	600	1,746
Pioneer	Stanislaus	311	172	385	868
Pioneer	Tuolumne	809,707	634,574	1,219,246	2,663,526
Pioneer	**TOTAL**	**5,533,576**	**4,684,789**	**7,560,605**	**17,778,970**
Mariposa	Calaveras	167,694	161,805	131,555	461,054
Mariposa	Fresno	60,562	53,280	42,636	156,479
Mariposa	Madera	733,428	576,708	1,058,221	2,368,357
Mariposa	Mariposa	769,494	626,879	1,013,025	2,409,398
Mariposa	Merced	130	80	141	351
Mariposa	Stanislaus	1,802	967	1,502	4,272
Mariposa	Tuolumne	789,391	656,259	1,171,649	2,617,299
Mariposa	**TOTAL**	**2,522,501**	**2,075,978**	**3,418,729**	**8,017,210**

All biomass values are in bone dry imperial short tons,
and reflect the C-BREC 2025 estimates of a thin from below by 40%.
Small DBH: Foliage and <4" diameter residues.
Med DBH: 4-9" diameter residues.
Large DBH: >9" diameter residues.

'Economically Feasible Zone' refers to areas within the two-hour drive time zone where there is not a closer competing site.

Values reflect suitable conditions:
- Less than 40% slope gradient,
- Within 1,000 feet of a road,
- Areas that have not burned in the last ten years (2014+)

FOREST BIOMASS IN BURNED AREAS

Economically Feasible Zone

Facility	Burned Status	Small DBH	Med DBH	Large DBH	Total	
Toyon	Burned Since 2014	415,347	310,359	991,967	1,717,673	13%
Toyon	Not Burned Since 2014	3,423,774	2,845,005	5,040,234	11,309,014	87%
Toyon	**TOTAL**	**3,839,121**	**3,155,364**	**6,032,201**	**13,026,687**	**100%**
Pioneer	Burned Since 2014	852,558	612,257	2,005,345	3,470,160	22%
Pioneer	Not Burned Since 2014	3,720,144	3,030,296	5,497,656	12,248,096	78%
Pioneer	**TOTAL**	**4,572,702**	**3,642,553**	**7,503,001**	**15,718,256**	**100%**
Mariposa	Burned Since 2014	494,203	366,699	1,061,170	1,922,071	33%
Mariposa	Not Burned Since 2014	1,207,507	969,868	1,787,739	3,965,113	67%
Mariposa	**TOTAL**	**1,701,710**	**1,336,567**	**2,848,909**	**5,887,184**	**100%**

Two-Hour Drive Time Zone

Facility	Burned Status	Small DBH	Med DBH	Large DBH	Total
Toyon	Burned Since 2014	728,013	550,064	1,737,784	3,015,861
Toyon	Not Burned Since 2014	6,256,167	5,266,661	8,946,235	20,469,063
Toyon	**TOTAL**	**6,984,180**	**5,816,725**	**10,684,019**	**23,484,924**
Pioneer	Burned Since 2014	930,055	665,787	2,235,467	3,831,309
Pioneer	Not Burned Since 2014	5,533,575	4,684,789	7,560,604	17,778,968
Pioneer	**TOTAL**	**6,463,630**	**5,350,576**	**9,796,071**	**21,610,277**
Mariposa	Burned Since 2014	585,977	428,410	1,288,319	2,302,706
Mariposa	Not Burned Since 2014	2,522,501	2,075,979	3,418,729	8,017,209
Mariposa	**TOTAL**	**3,108,478**	**2,504,389**	**4,707,048**	**10,319,915**

All biomass values are in bone dry imperial short tons,
and reflect the C-BREC 2025 estimates of a thin from below by 40%.
Small DBH: Foliage and <4" diameter residues.
Med DBH: 4-9" diameter residues.
Large DBH: >9" diameter residues.

'Economically Feasible Zone' refers to areas within the two-hour
drive time zone where there is not a closer competing site.

Values reflect areas that have burned in the last ten years (2014+), but are otherwise suitable:
- Less than 40% slope gradient,
- Within 1,000 feet from a road

OMITTED FOREST BIOMASS SUPPLY

Economically Feasible Zone

Facility	Small DBH	Med DBH	Large DBH	Total	
Toyon	2,000,987	1,713,048	3,288,583	**7,002,618**	38%
Pioneer	2,653,698	2,135,967	5,020,901	**9,810,566**	44%
Mariposa	1,364,812	1,076,772	2,273,682	**4,715,266**	54%

Two-Hour Drive Time Zone

Facility	Small DBH	Med DBH	Large DBH	Total
Toyon	3,426,228	2,916,208	5,592,814	**11,935,250**
Pioneer	3,391,678	2,801,327	5,961,740	**12,154,745**
Mariposa	2,059,389	1,663,018	3,154,800	**6,877,207**

All biomass values are in bone dry imperial short tons,
and reflect the C-BREC 2025 estimates of a thin from below by 40%.
Small DBH: Foliage and <4" diameter residues.
Med DBH: 4-9" diameter residues.
Large DBH: >9" diameter residues.

'Economically Feasible Zone' refers to areas within the two-hour
drive time zone where there is not a closer competing site.

Values reflect areas that have at least one unsuitable condition:
- Greater than 40% slope gradient,
- More than 1,000 feet from a road,
- Areas that have burned in the last ten years (2014+)

ECONOMICALLY FEASIBLE ORCHARD BIOMASS SUPPLY

Facility	County	Crop	Acres	BDT/Year
Toyon	Amador	Pomegranates	0.6	1
Toyon	Amador	Deciduous (Misc.)	4.0	4
Toyon	Amador	Olives	32.2	5
Toyon	Amador	Walnuts	362.7	339
Toyon	Calaveras	Pistachios	22.3	6
Toyon	Calaveras	Pomegranates	2.3	2
Toyon	Calaveras	Apples	3.6	3
Toyon	Calaveras	Deciduous (Misc.)	41.4	37
Toyon	Calaveras	Almonds	229.4	297
Toyon	Calaveras	Olives	214.8	32
Toyon	Calaveras	Walnuts	839.7	784
Toyon	El Dorado	Peaches and Nectarines	2.7	2
Toyon	El Dorado	Walnuts	122.7	115
Toyon	El Dorado	Deciduous (Misc.)	3.0	3
Toyon	El Dorado	Olives	3.1	0
Toyon	San Joaquin	Peaches and Nectarines	117.6	106
Toyon	San Joaquin	Citrus and Subtropical (No Subclass)	3.2	3
Toyon	San Joaquin	Cherries	509.2	323
Toyon	San Joaquin	Pomegranates	28.1	25
Toyon	San Joaquin	Walnuts	7,383.6	6,891
Toyon	San Joaquin	Olives	392.4	59
Toyon	San Joaquin	Apples	30.6	28
Toyon	San Joaquin	Almonds	2,254.3	2,920
Toyon	San Joaquin	Pears	8.8	8
Toyon	San Joaquin	Deciduous (Misc.)	9.8	9
Toyon	Stanislaus	Walnuts	1,230.9	1,149
Toyon	Stanislaus	Almonds	2,577.7	3,339
Pioneer	Alpine	Deciduous (Misc.)	2.0	2
Pioneer	Amador	Walnuts	362.6	338
Pioneer	Amador	Olives	32.2	5
Pioneer	Amador	Pomegranates	0.6	1
Pioneer	Amador	Deciduous (Misc.)	4.0	4
Pioneer	Calaveras	Pistachios	20.7	5
Pioneer	Calaveras	Walnuts	422.9	395
Pioneer	Calaveras	Olives	7.4	1
Pioneer	Calaveras	Apples	3.6	3
Pioneer	Calaveras	Deciduous (Misc.)	27.9	25
Pioneer	El Dorado	Walnuts	128.8	120
Pioneer	El Dorado	Olives	6.0	1
Pioneer	El Dorado	Deciduous (Misc.)	3.0	3
Pioneer	El Dorado	Peaches and Nectarines	2.7	2
Pioneer	El Dorado	Apples	6.1	5
Mariposa	Mariposa	Deciduous (Misc.)	4.9	4
Mariposa	Mariposa	Apples	8.6	8
Mariposa	Mariposa	Olives	43.5	7
Mariposa	Merced	Citrus and Subtropical (No Subclass)	12.1	12
Mariposa	Merced	Peaches and Nectarines	411.5	370
Mariposa	Merced	Apricots	43.5	39
Mariposa	Merced	Pomegranates	16.5	15
Mariposa	Merced	Pistachios	8,710.0	2,178
Mariposa	Merced	Walnuts	4,722.6	4,408
Mariposa	Merced	Almonds	54,101.4	70,086
Mariposa	Merced	Deciduous (Misc.)	1,007.1	906
Mariposa	Merced	Prunes	1,131.8	1,019
Mariposa	Merced	Olives	71.1	11
Mariposa	Stanislaus	Almonds	3.2	4

Toyon Tree Crops	BDT/Year
Almonds	6,557
Apples	31
Cherries	323
Citrus and Subtropical (No Subclass)	3
Deciduous (Misc.)	52
Olives	96
Peaches and Nectarines	108
Pears	8
Pistachios	6
Pomegranates	28
Walnuts	9,277
TOTAL	**16,490**

Pioneer Tree Crops	BDT/Year
Apples	9
Deciduous (Misc.)	33
Olives	7
Peaches and Nectarines	2
Pistachios	5
Pomegranates	1
Walnuts	853
TOTAL	**910**

Mariposa Tree Crops	BDT/Year
Almonds	70,090
Apples	8
Apricots	39
Citrus and Subtropical (No Subclass)	12
Deciduous (Misc.)	911
Olives	17
Peaches and Nectarines	370
Pistachios	2,178
Pomegranates	15
Prunes	1,019
Walnuts	4,408
TOTAL	**79,066**

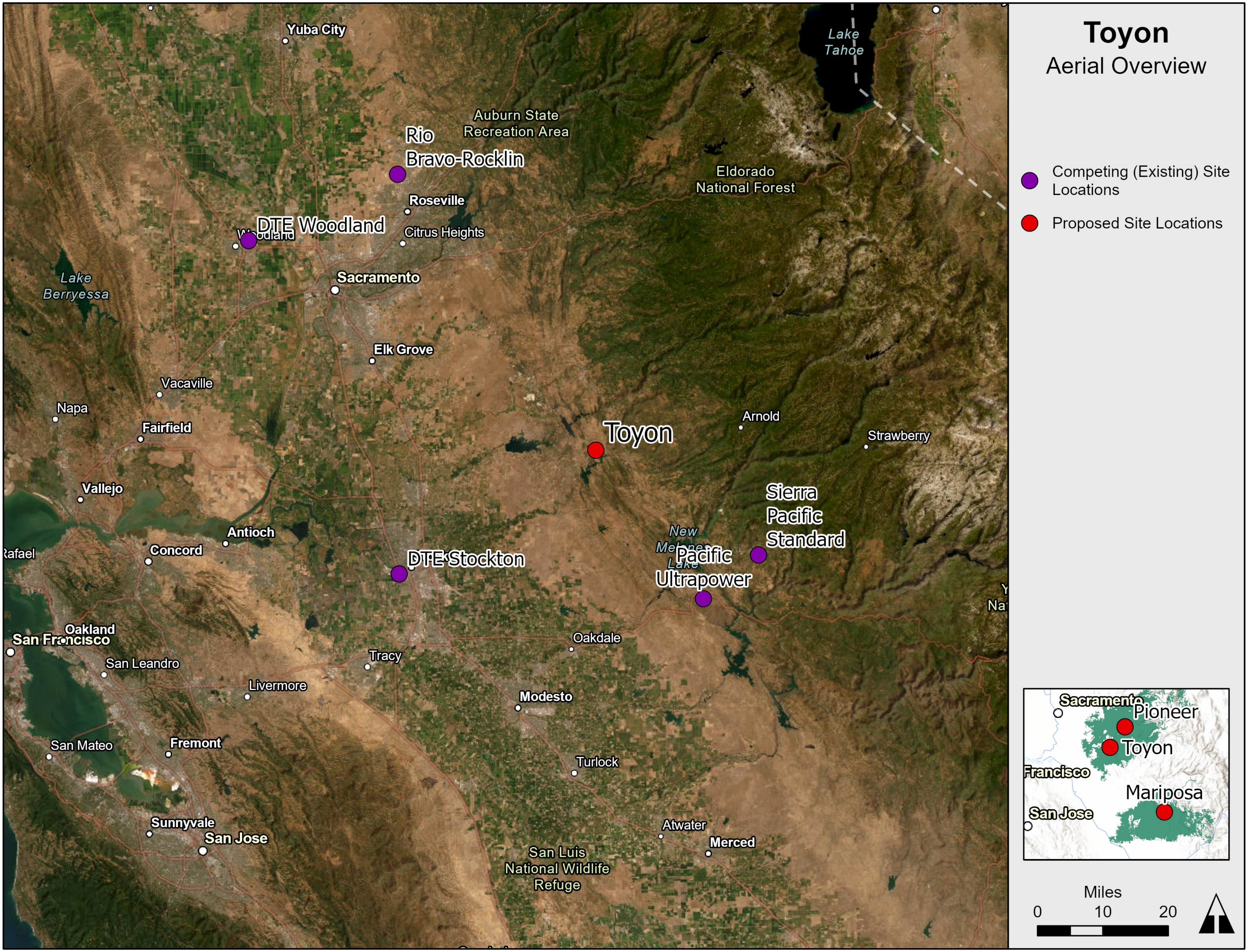
ORCHARD BIOMASS SUPPLY ASSUMPTIONS

Crop	Replacement Interval (Years)	Recovery Volume (BDT/Acre)	BDT/Acre/Year	DWR Crop Code
Almonds	22	28.5	1.295	D12
Apples	20	18.0	0.900	D1
Apricots	20	18.0	0.900	D2
Avocados*	0	0.0	0.000	C5
Cherries	20	12.7	0.635	D3
Citrus and Subtropical (No Subclass)	20	20.1	1.005	C
Dates*	0	0.0	0.000	C4
Deciduous (Misc.)	20	18.0	0.900	D10
Deciduous (Mixed)	20	18.0	0.900	D11
Eucalyptus*	0	0.0	0.000	C10
Figs	20	18.0	0.900	D9
Grapefruit	20	20.1	1.005	C1
Jojoba*	0	0.0	0.000	C9
Kiwi*	0	0.0	0.000	C8
Lemons	20	20.1	1.005	C2
Olives	100	15.0	0.150	C6
Oranges	20	20.1	1.005	C3
Peaches and Nectarines	20	18.0	0.900	D5
Pears	20	18.0	0.900	D6
Pistachios	100	25.0	0.250	D14
Plums	20	18.0	0.900	D7
Pomegranates	20	18.0	0.900	D15
Prunes	20	18.0	0.900	D8
Subtropical Fruit (Misc.)	20	20.1	1.005	C7
Subtropical Fruit (Mixed)	20	20.1	1.005	C11
Walnuts	30	28.0	0.933	D13
	AVERAGE	15.8	0.704	

*Crops that either:
- Do not produce enough biomass to be relevant
- Are shrub crops
- Do not appear in the area of interest

Data used for calculations: Statewide Crop Map, Department of Water Resources.
https://lab.data.ca.gov/dataset/statewide-crop-mapping

APPENDIX B. FEEDSTOCK SUPPLY MAPS



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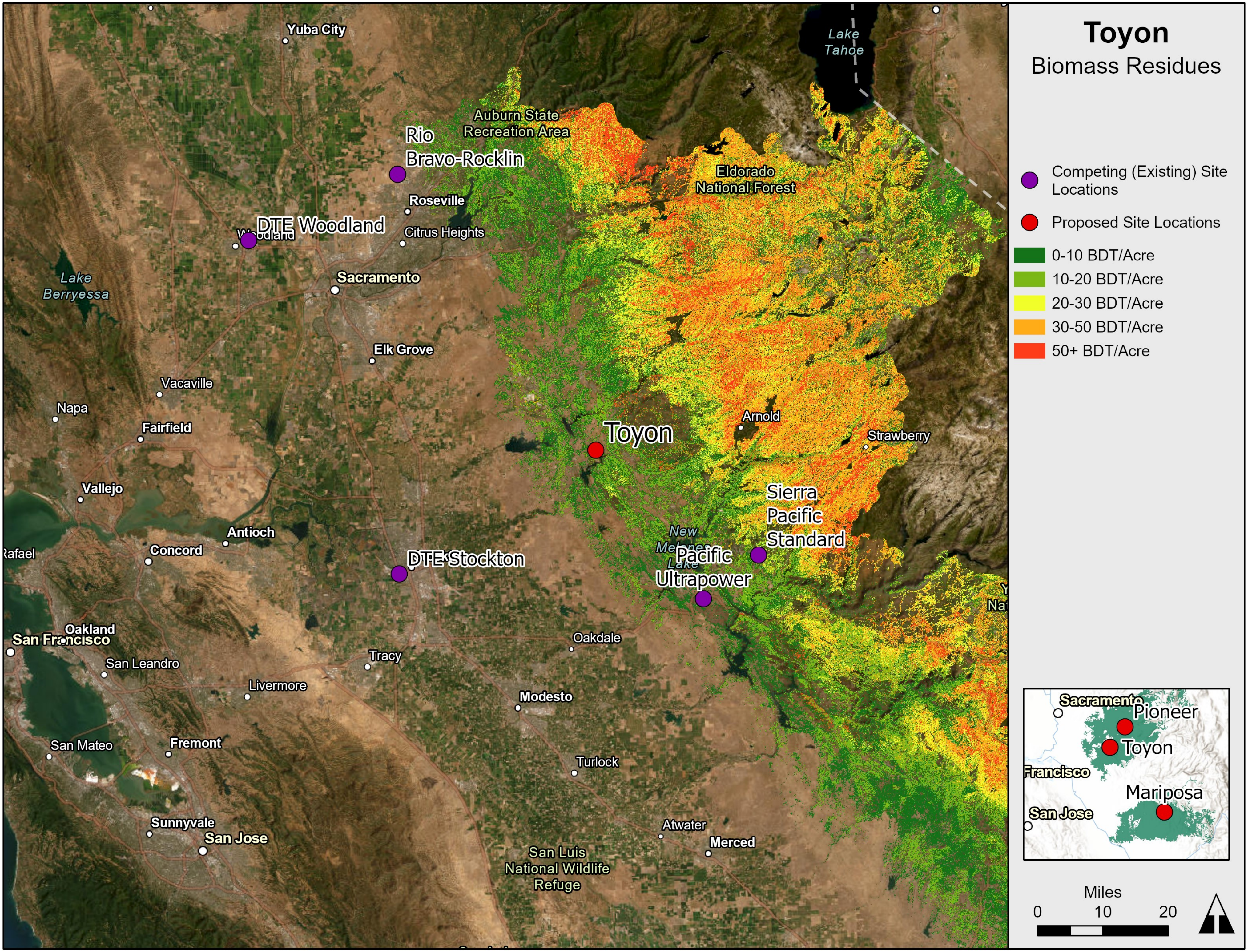

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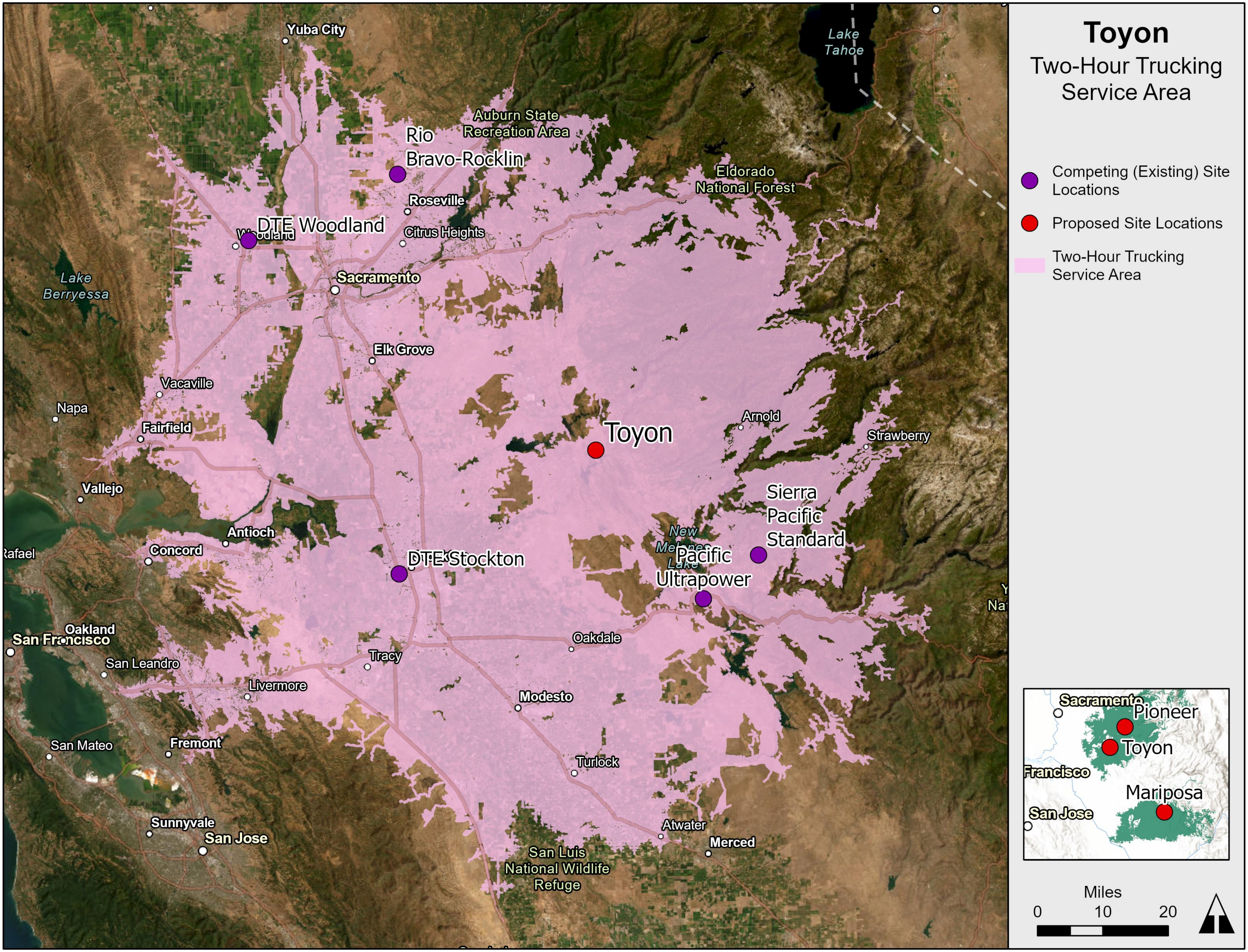

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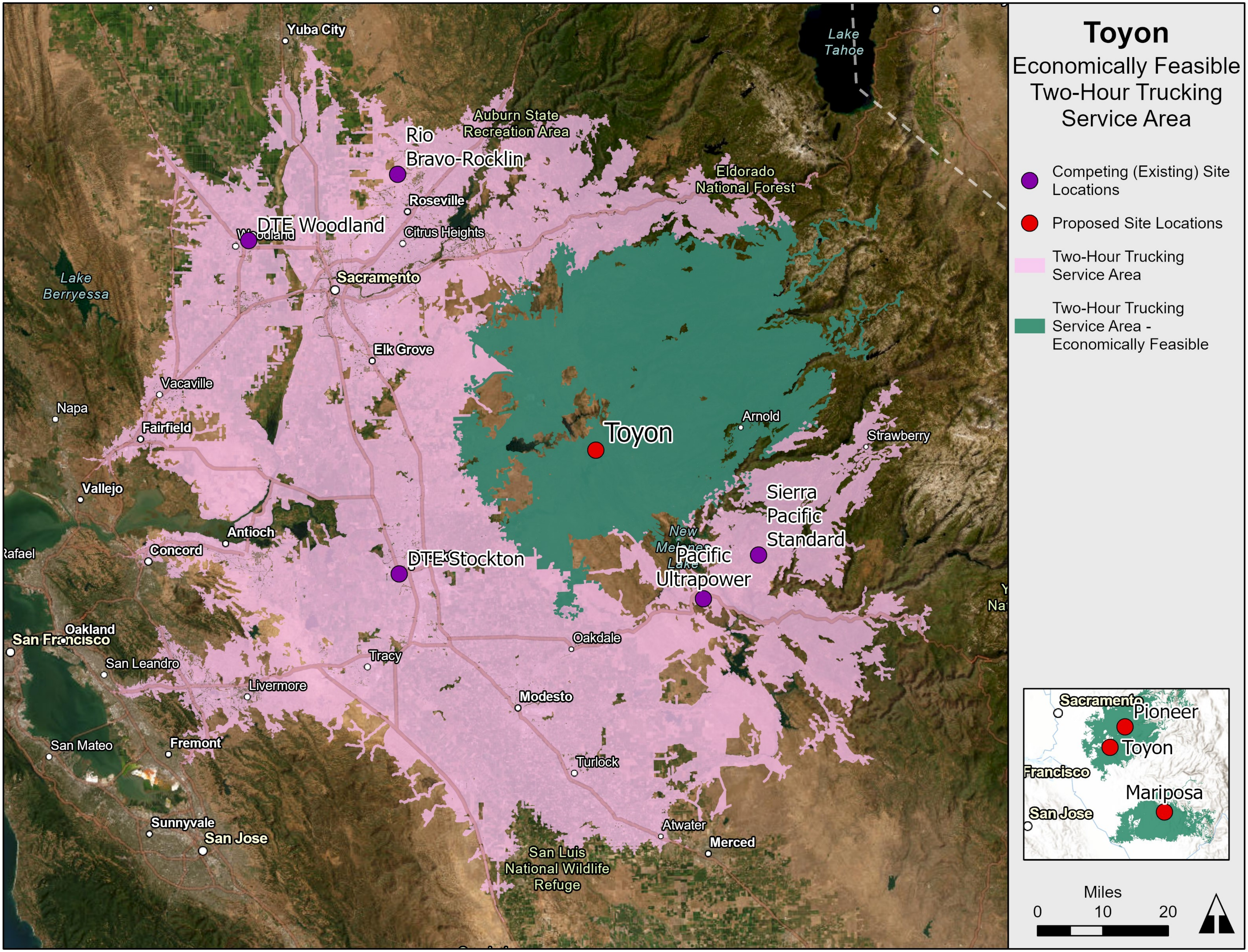

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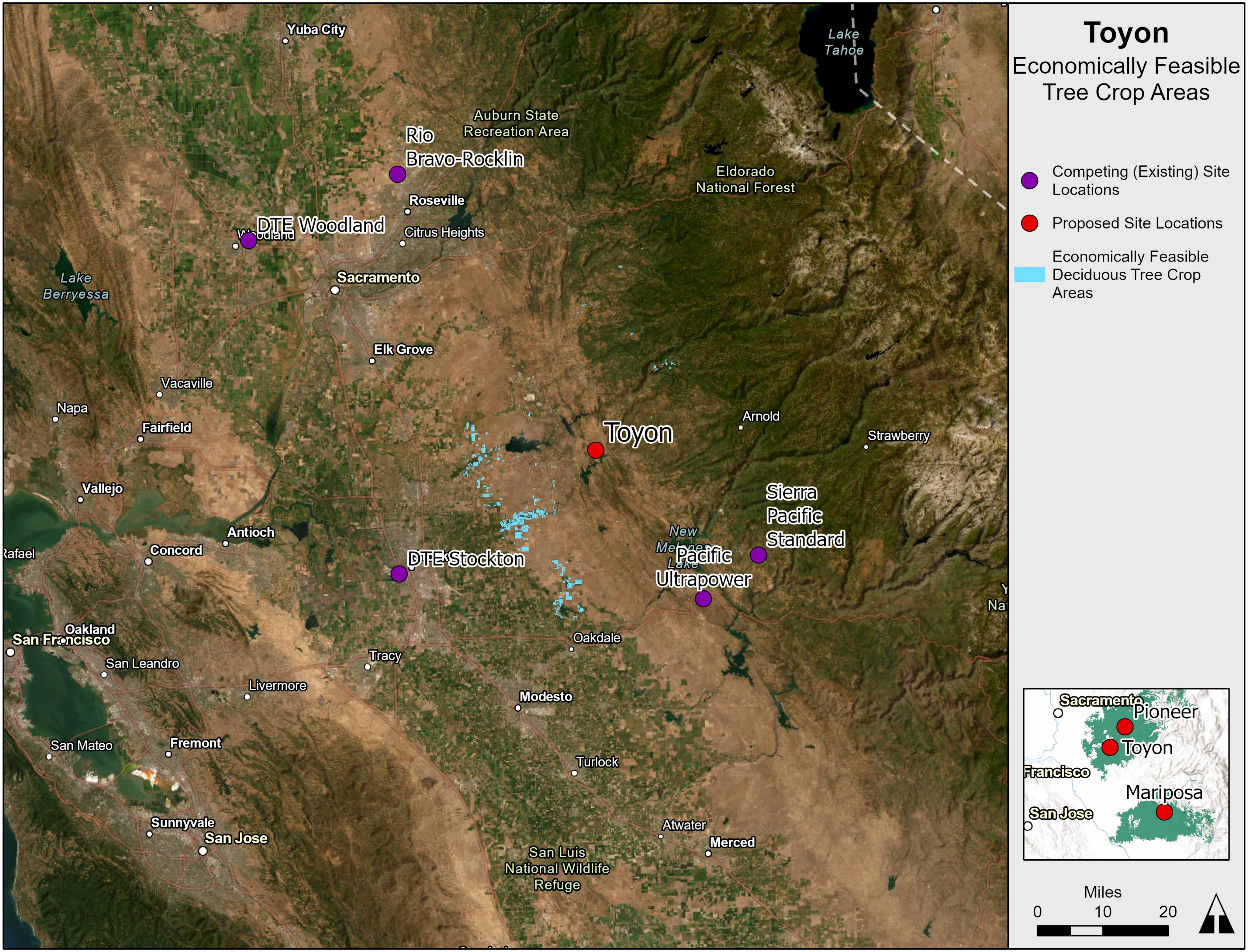

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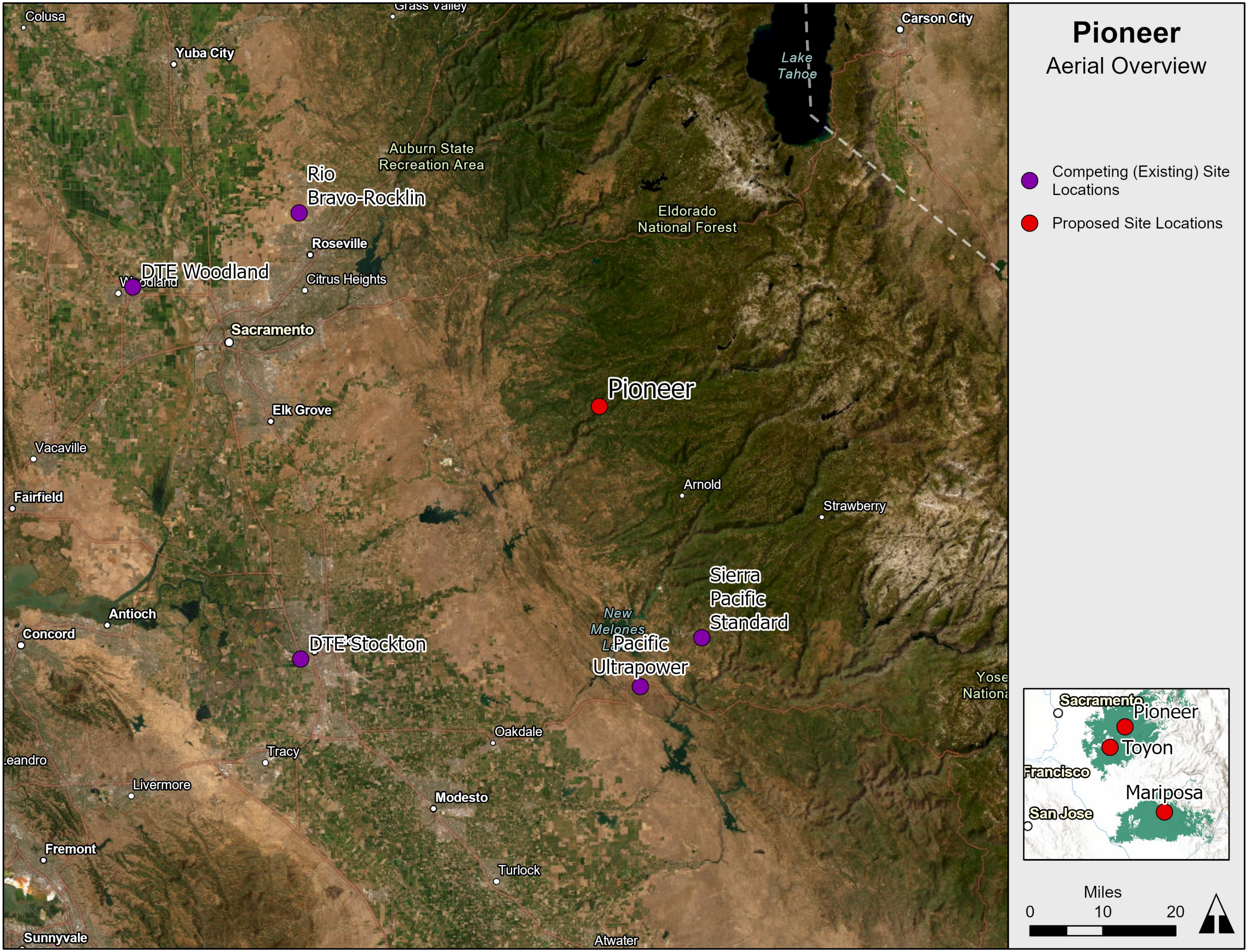

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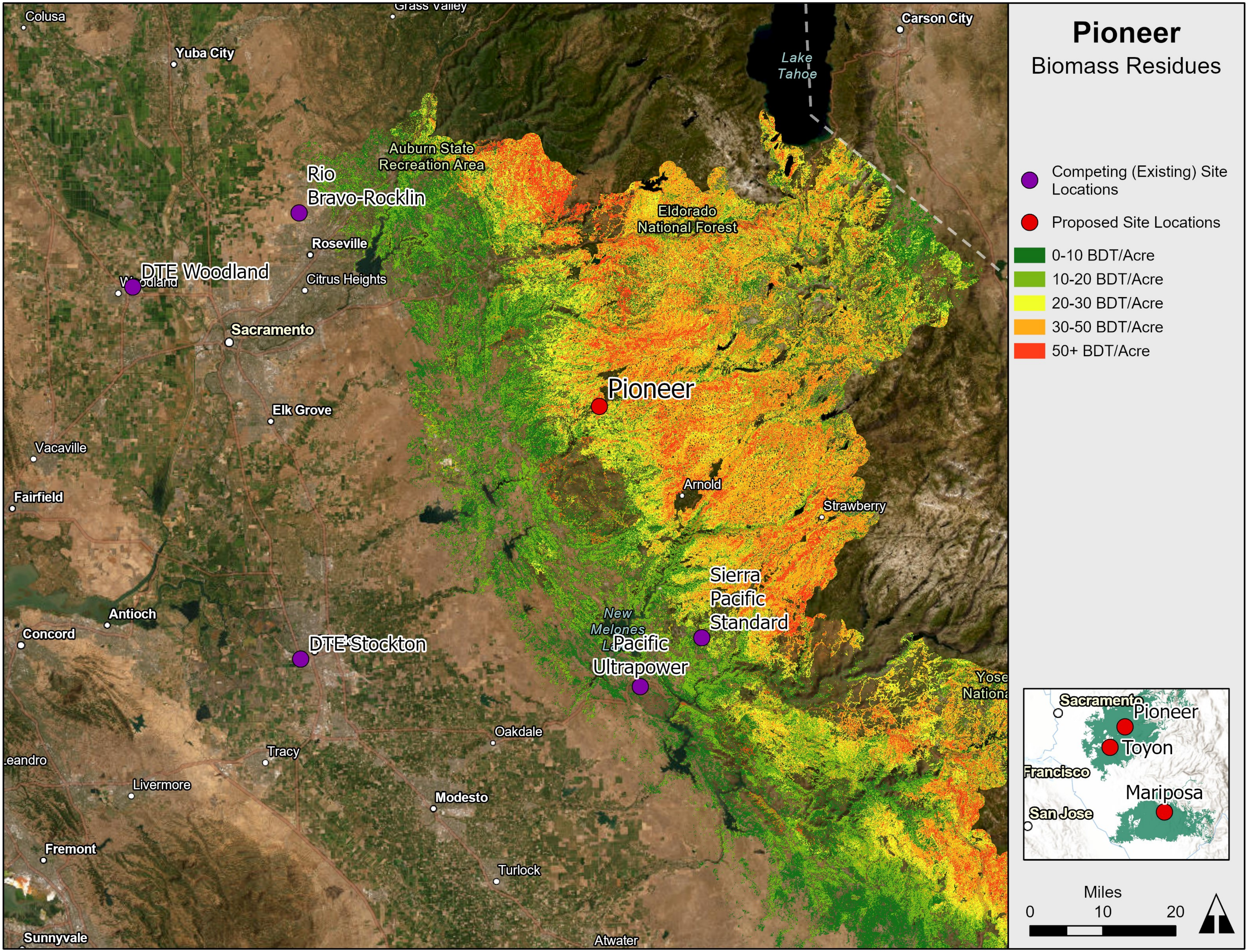

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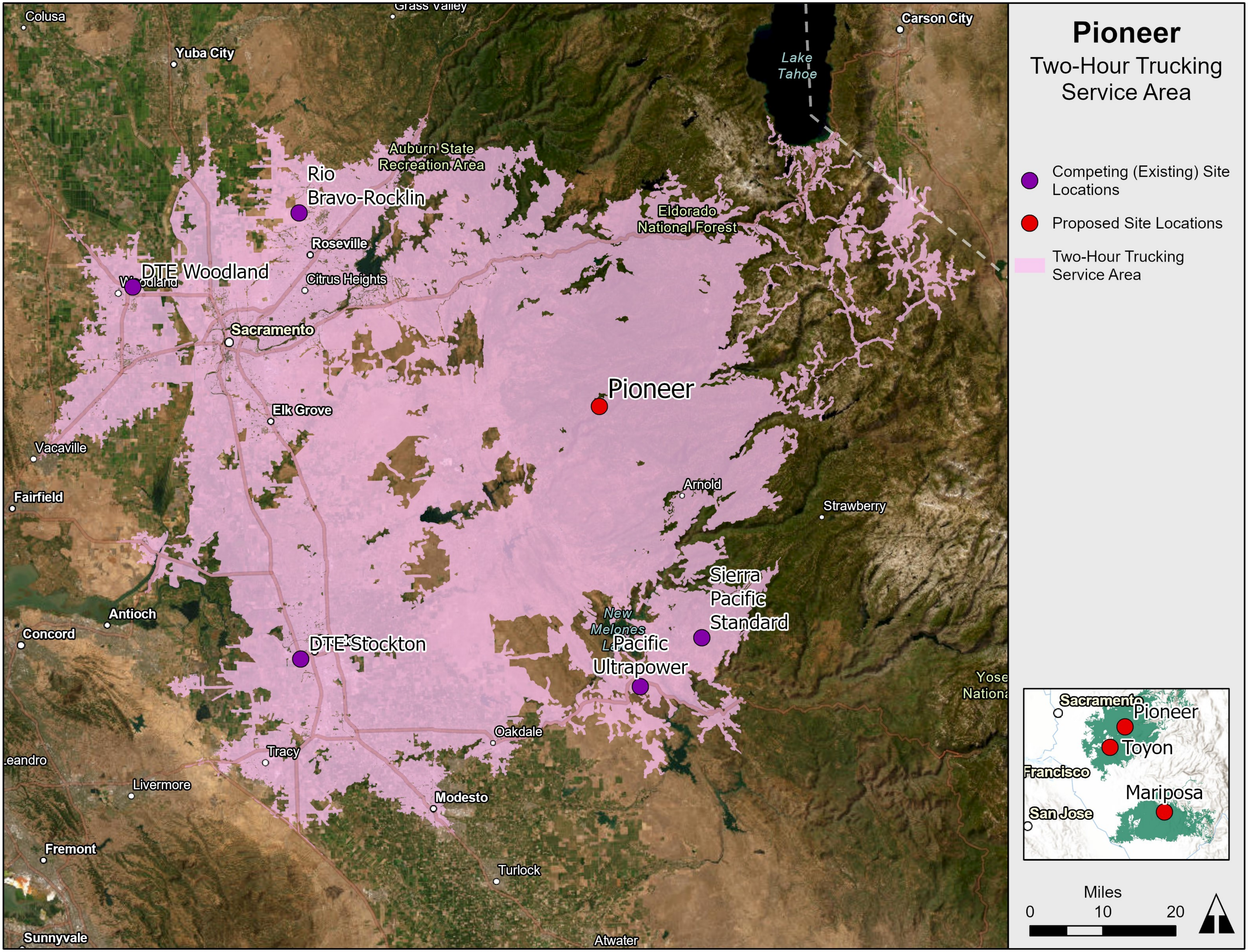

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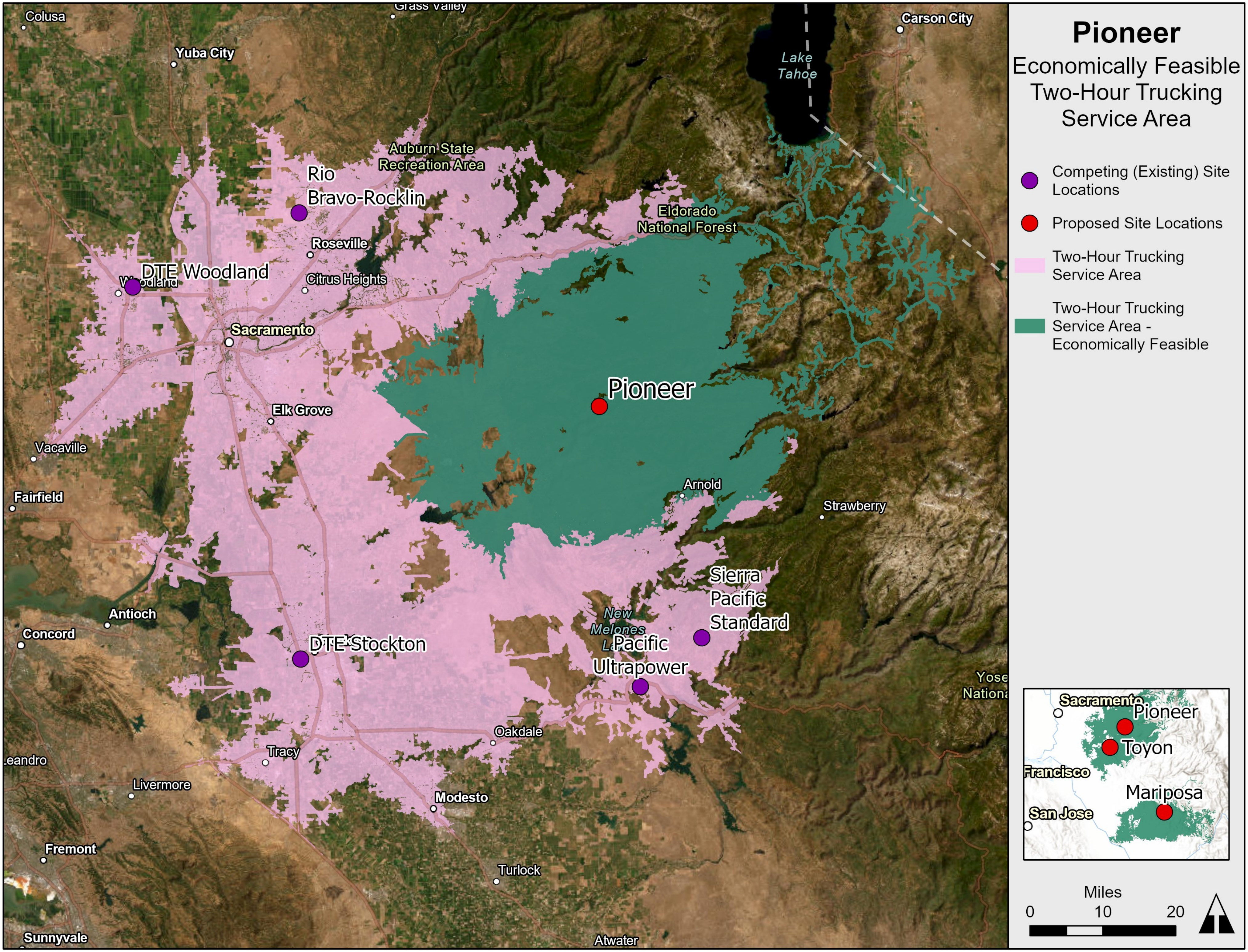

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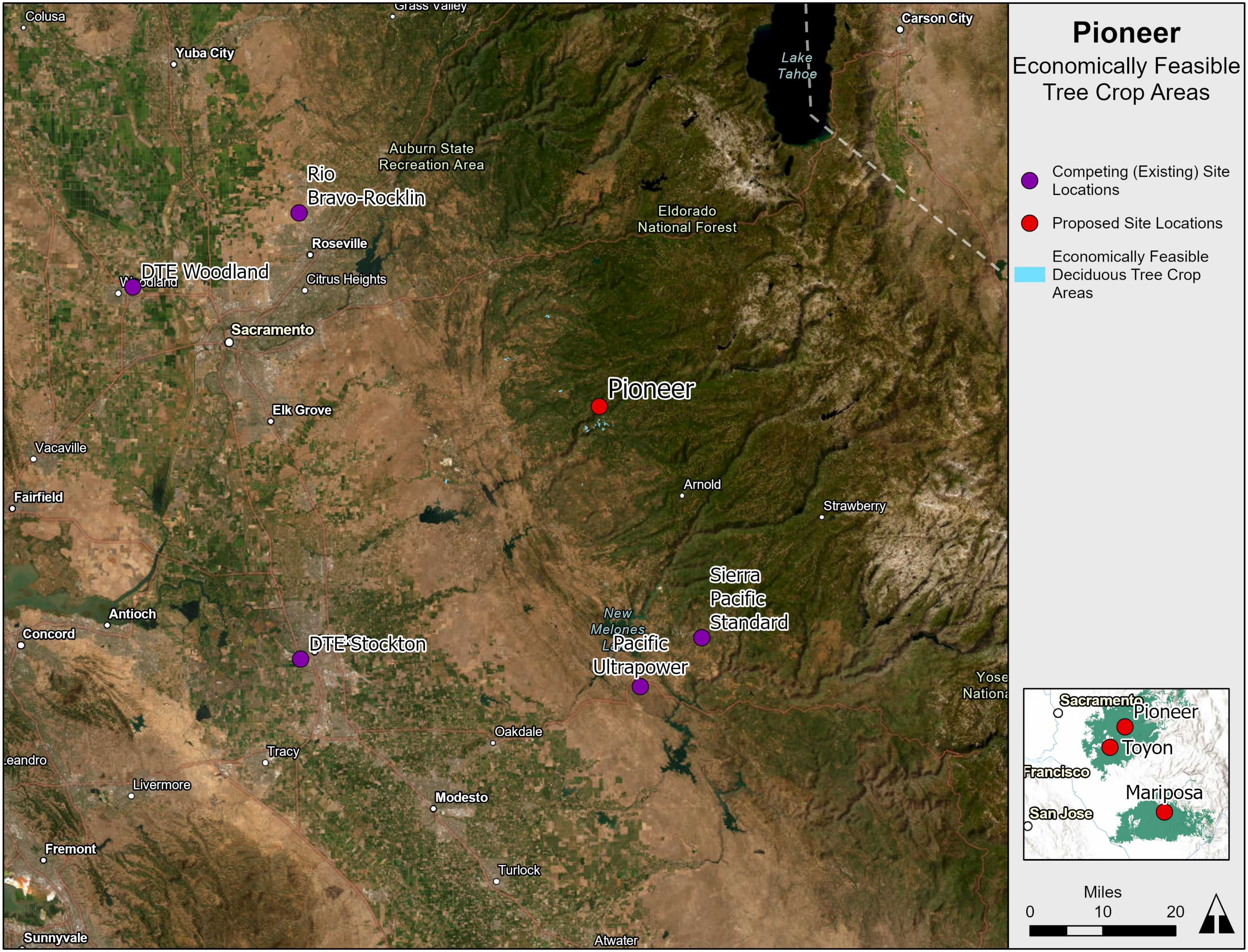

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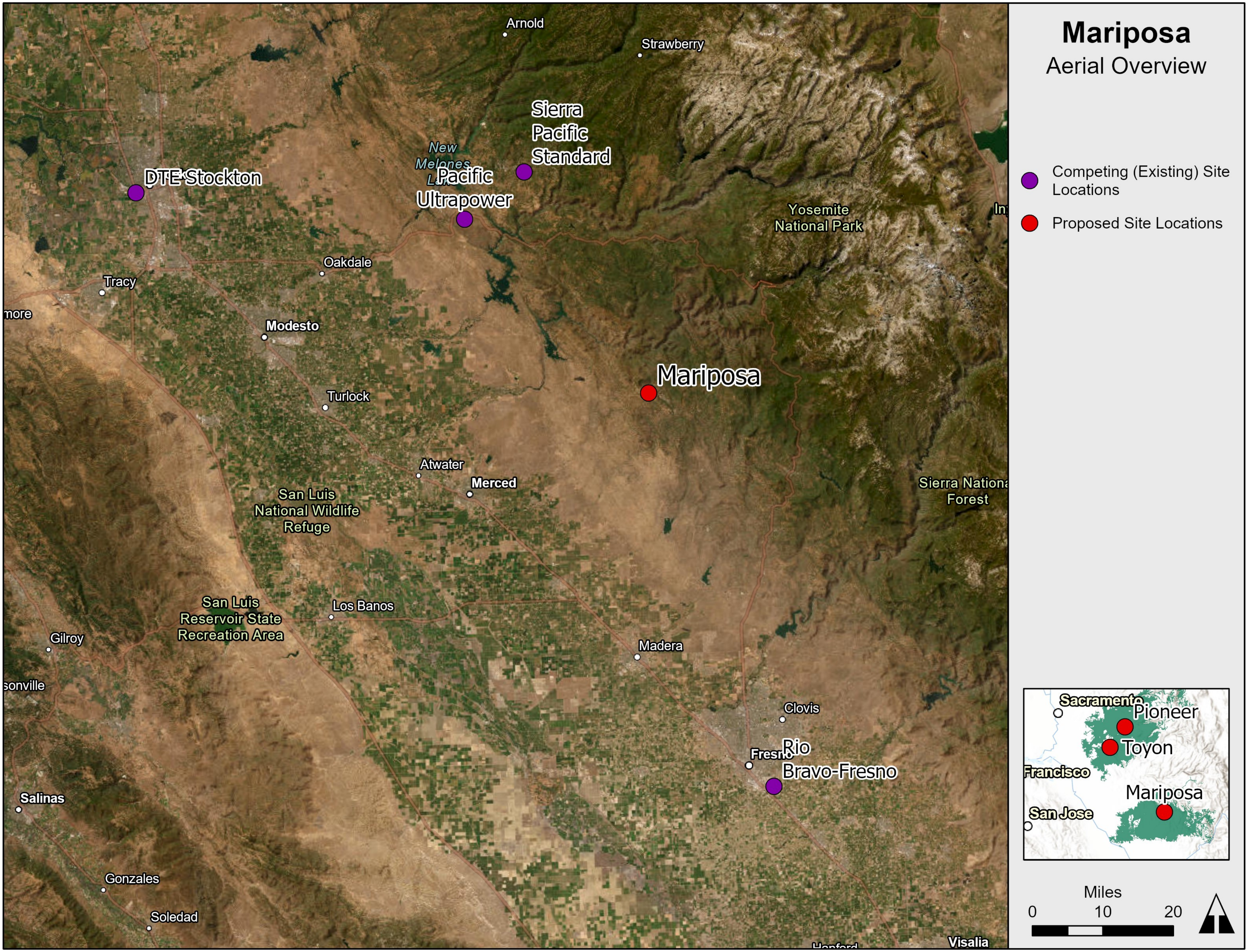

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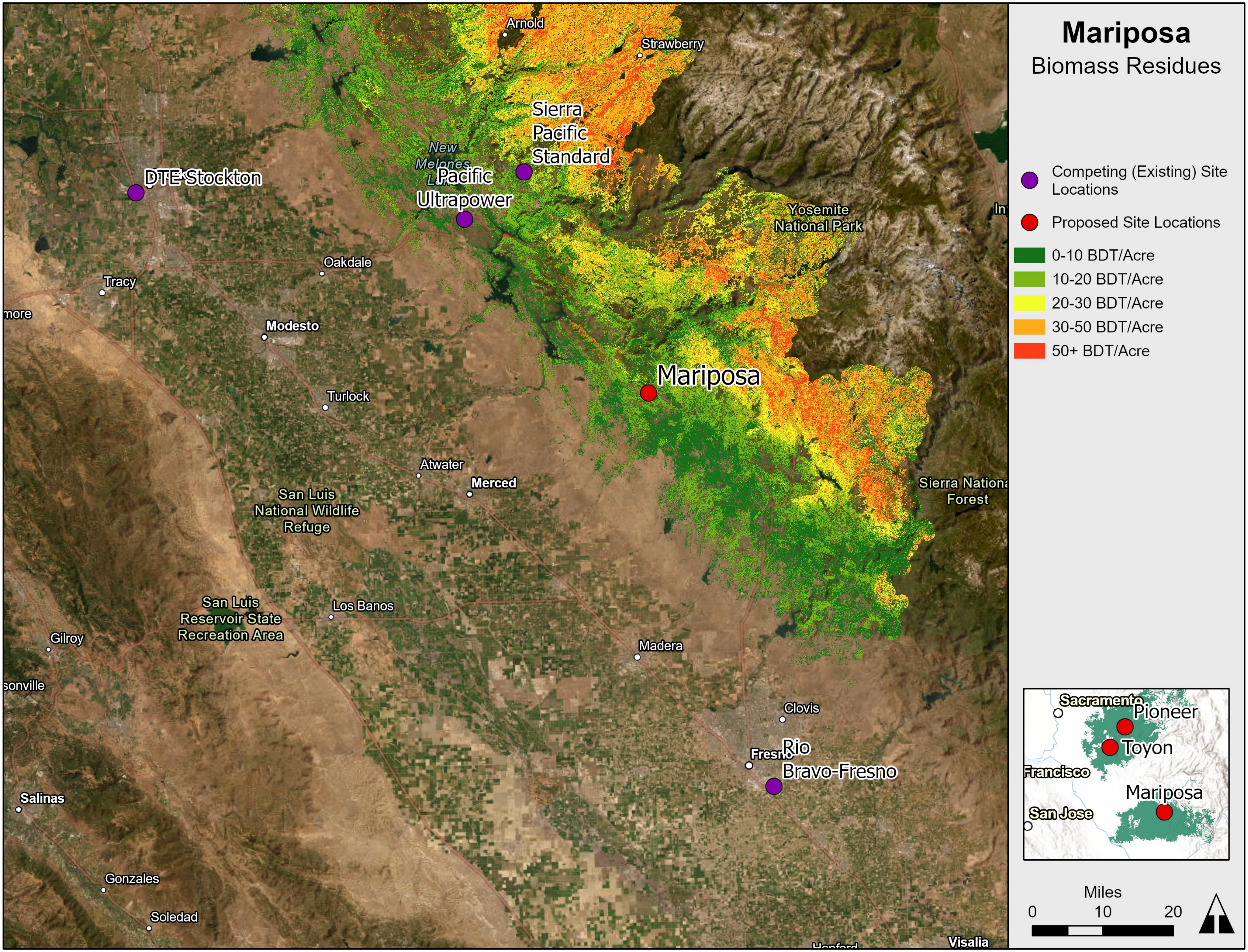

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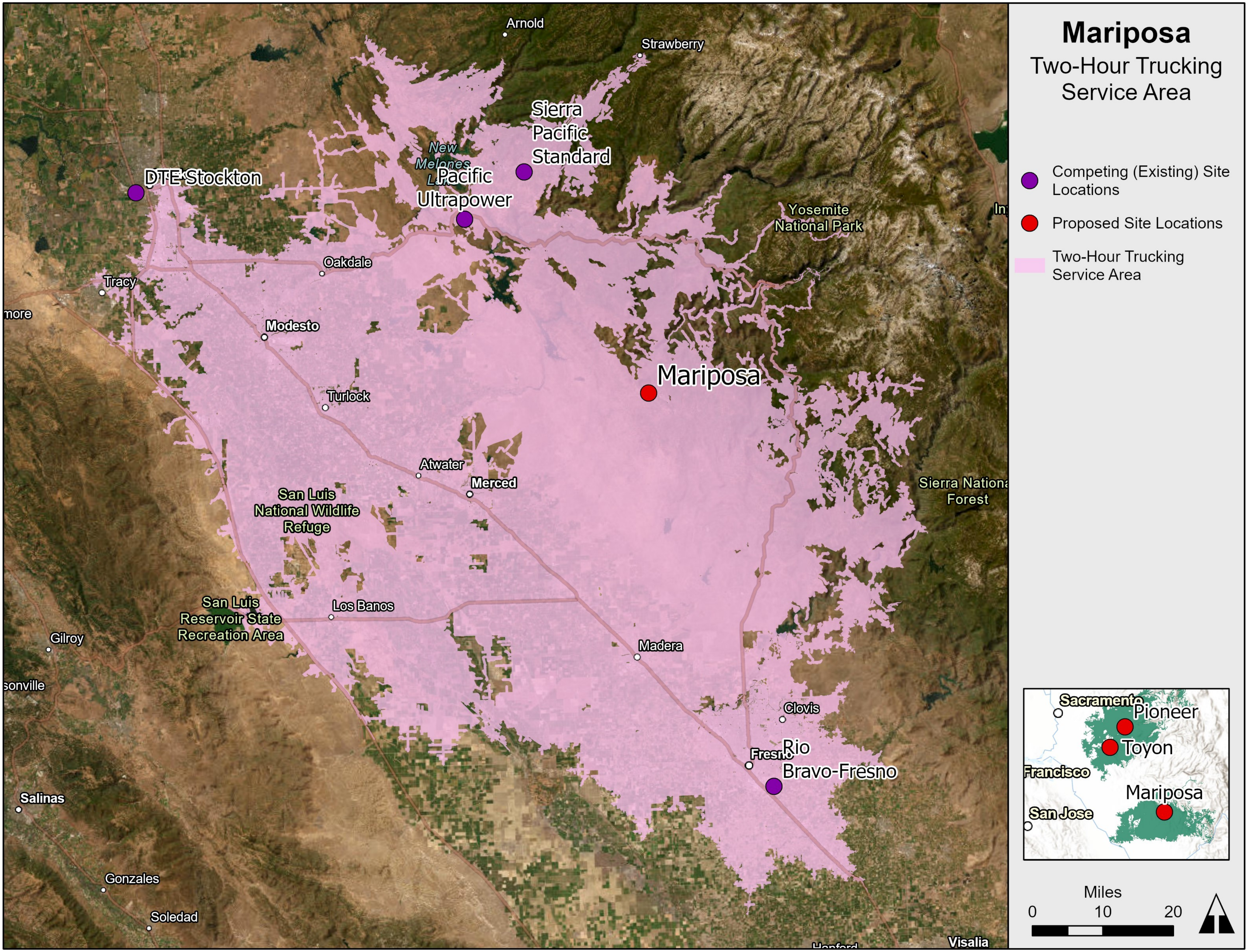

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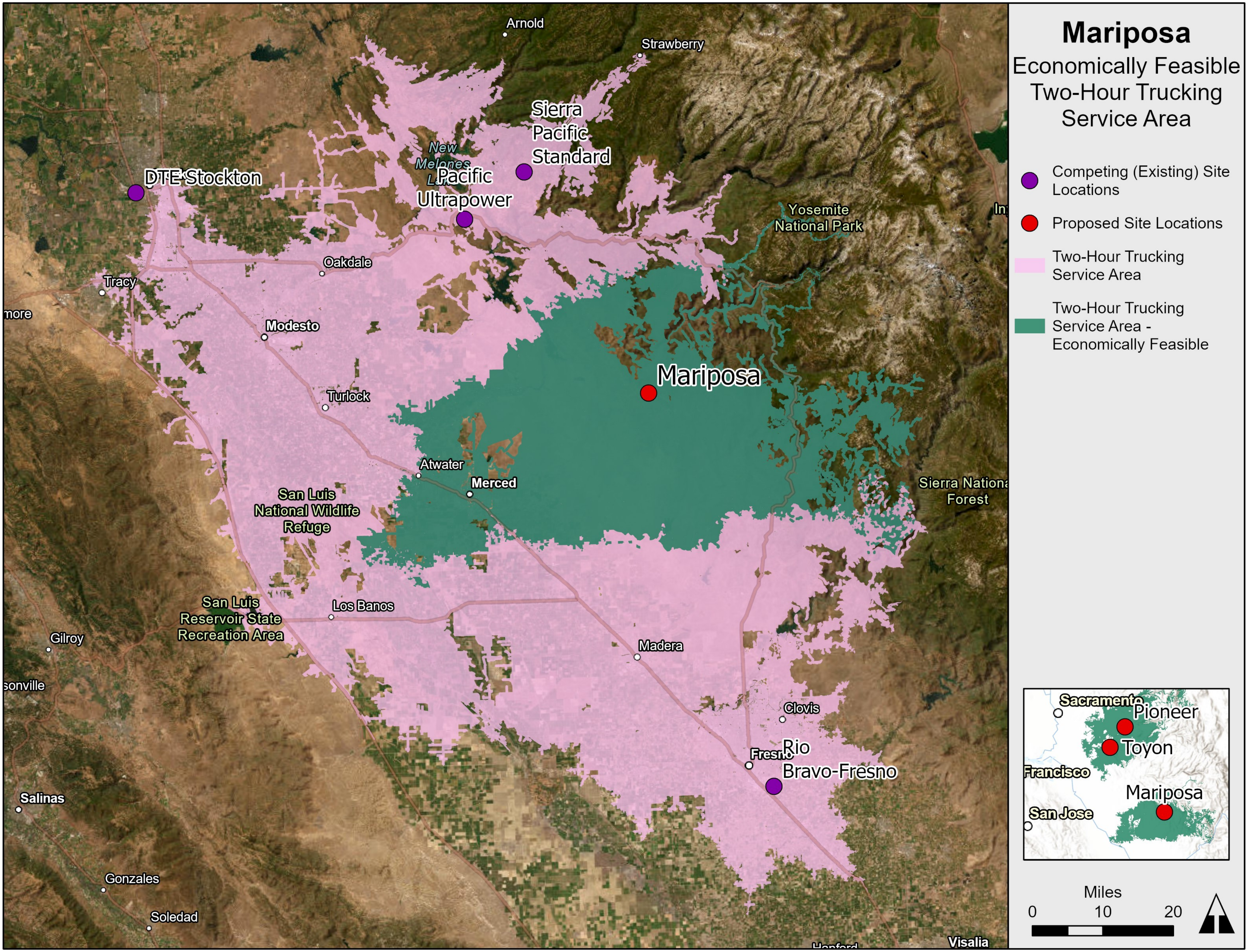
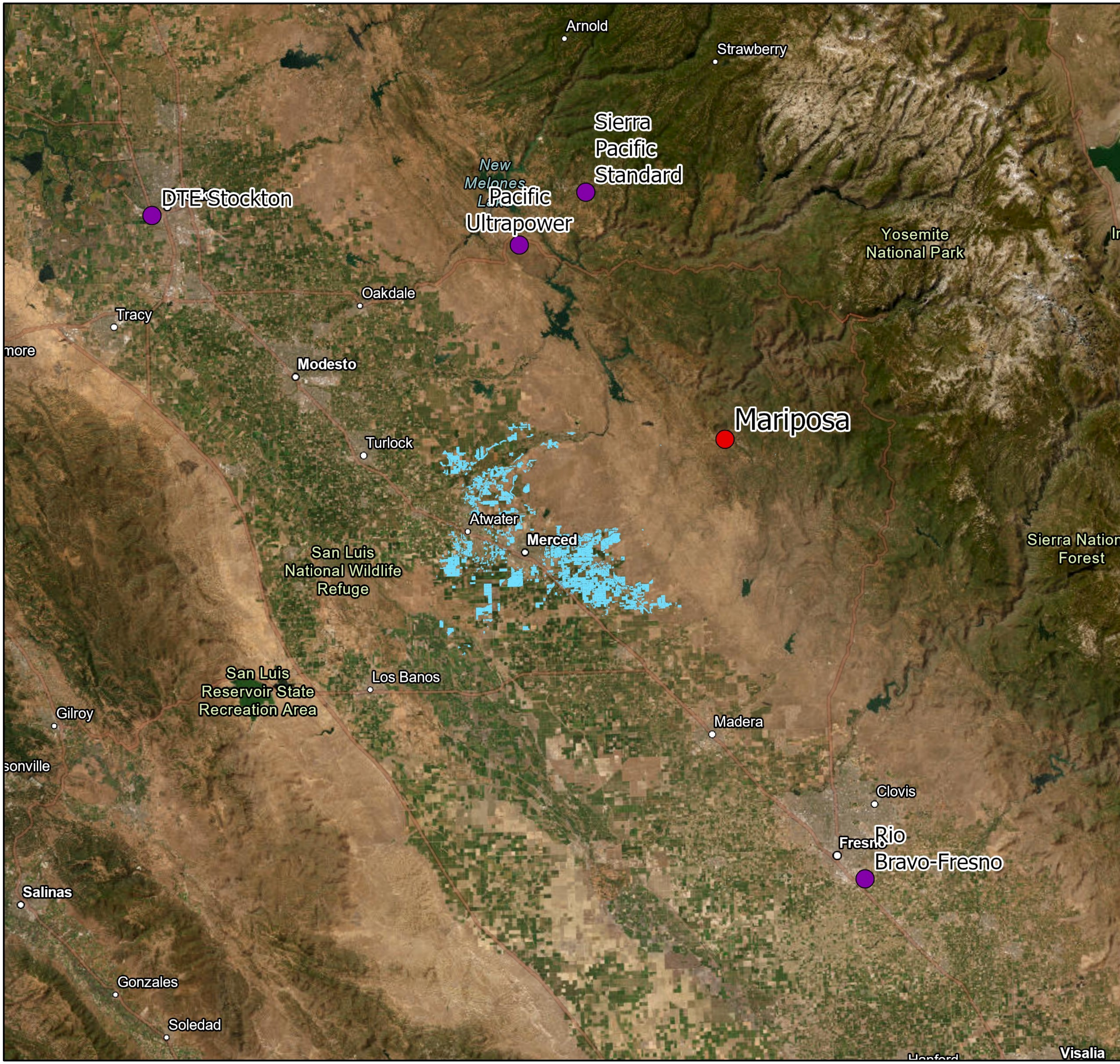


Date Exported: 1/31/2025

Mariposa

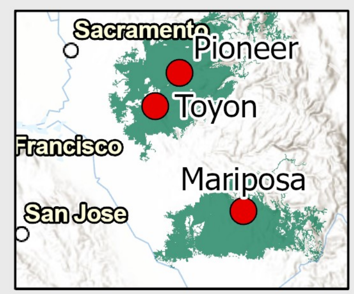
Economically Feasible Tree Crop Areas



Competing (Existing) Site Locations

Proposed Site Locations

Economically Feasible Deciduous Tree Crop Areas



Miles

0 10 20

Date Exported: 1/31/2025

APPENDIX C. SIMULATION MODEL: FIREWOOD PROCESSING

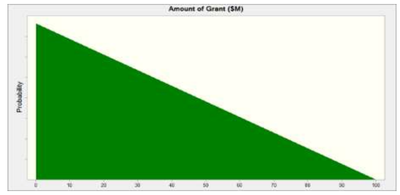
Monte Carlo Simulation Assumptions

Worksheet: [Wildephor_CSSA Firewood Processing_Financial Sensitivity_2025-04-25_CB_CORR.xlsx]Cash Flow

Assumption: Amount of Grant ($M) — Cell: C73

Triangular distribution with parameters:

Minimum	0
Likeliest	0
Maximum	100

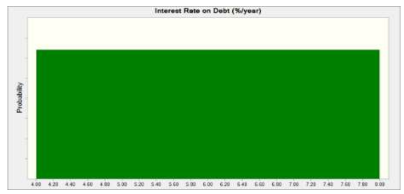


Correlated with:	Coefficient
Interest Rate on Debt (%/year) (C68)	-1.00

Assumption: Interest Rate on Debt (%/year) — Cell: C68

Uniform distribution with parameters:

Minimum	4.00
Maximum	8.00



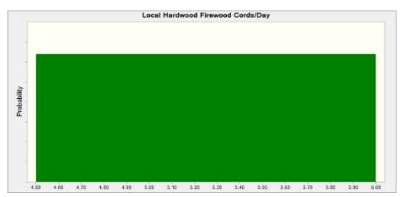
Correlated with:	Coefficient
Amount of Grant ($M) (C73)	-1.00

Worksheet: [Wildephor_CSSA Firewood Processing_Financial Sensitivity_2025-04-25_CB_CORR.xlsx]Product Sales

Assumption: Local Hardwood Firewood Cords/Day — Cell: D8

Uniform distribution with parameters:

Minimum	4.50
Maximum	6.00

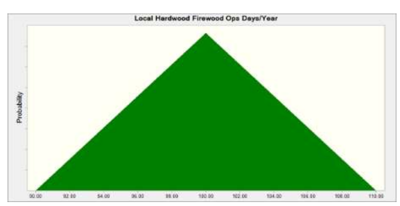


Correlated with:	Coefficient
Local Softwood Firewood Cords/Day (D6)	1.00

Assumption: Local Hardwood Firewood Ops Days/Year — Cell: C8

Triangular distribution with parameters:

Minimum	90.00
Likeliest	100.00
Maximum	110.00

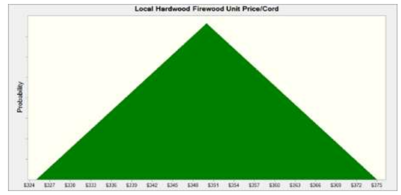


Correlated with:	Coefficient
Local Softwood Firewood Ops Days/Year (C6)	1.00

Assumption: Local Hardwood Firewood Unit Price/Cord **Cell: G8**

Triangular distribution with parameters:

Minimum	$325
Likeliest	$350
Maximum	$375

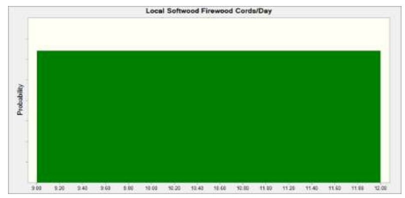


Correlated with:	Coefficient
Local Softwood Firewood Unit Price/Cord (G6)	0.50

Assumption: Local Softwood Firewood Cords/Day **Cell: D6**

Uniform distribution with parameters:

Minimum	9.00
Maximum	12.00

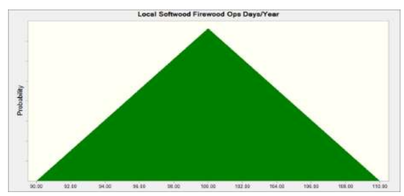


Correlated with:	Coefficient
Local Hardwood Firewood Cords/Day (D8)	1.00

Assumption: Local Softwood Firewood Ops Days/Year **Cell: C6**

Triangular distribution with parameters:

Minimum	90.00
Likeliest	100.00
Maximum	110.00

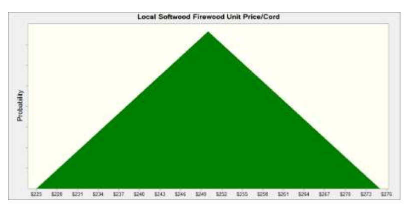


Correlated with:	Coefficient
Local Hardwood Firewood Ops Days/Year (C8)	1.00

Assumption: Local Softwood Firewood Unit Price/Cord **Cell: G6**

Triangular distribution with parameters:

Minimum	$225
Likeliest	$250
Maximum	$275

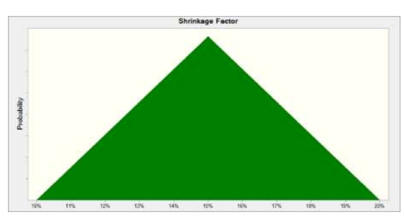


Correlated with:	Coefficient
Local Hardwood Firewood Unit Price/Cord (G8)	0.50

Assumption: Shrinkage Factor **Cell: F12**

Triangular distribution with parameters:

Minimum	10%
Likeliest	15%
Maximum	20%

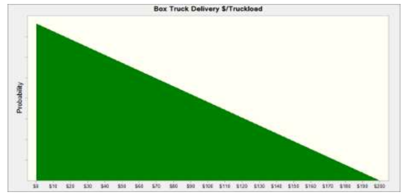


Worksheet: [Wildephor_CSSA Firewood Processing_Financial Sensitivity_2025-04-25_CB_CORR.xlsx]Feedstock Cost

Assumption: Box Truck Delivery $/Truckload **Cell: C10**

Triangular distribution with parameters:

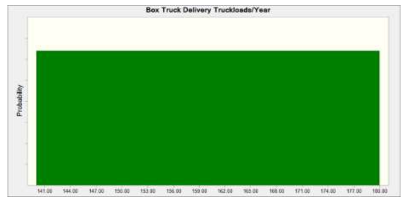
Minimum	$0
Likeliest	$0
Maximum	$200



Assumption: Box Truck Delivery Truckloads/Year **Cell: F10**

Uniform distribution with parameters:

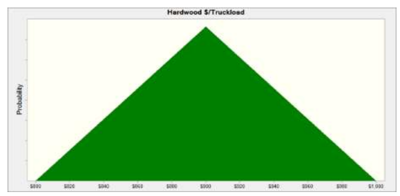
Minimum	140.00
Maximum	180.00



Assumption: Hardwood $/Truckload **Cell: C8**

Triangular distribution with parameters:

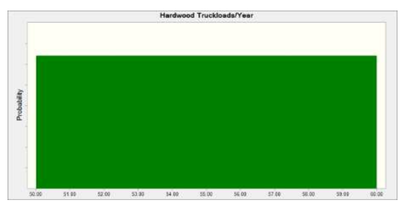
Minimum	$800
Likeliest	$900
Maximum	$1,000



Assumption: Hardwood Truckloads/Year **Cell: F8**

Uniform distribution with parameters:

Minimum	50.00
Maximum	60.00

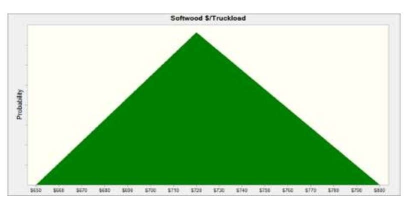


Correlated with:	Coefficient
Softwood Truckloads/Year (F6)	0.50

Assumption: Softwood $/Truckload **Cell: C6**

Triangular distribution with parameters:

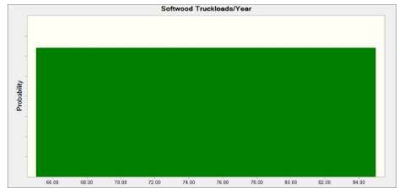
Minimum	$650
Likeliest	$720
Maximum	$800



Assumption: Softwood Truckloads/Year — Cell: F6

Uniform distribution with parameters:

Minimum	65.00
Maximum	85.00



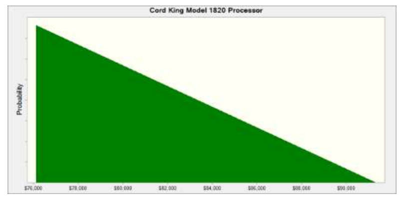
Correlated with:	Coefficient
Hardwood Truckloads/Year (F8)	0.50

Worksheet: [Wildephor_CSSA Firewood Processing_Financial Sensitivity_2025-04-25_CB_CORR.xlsx]CAPEX

Assumption: Cord King Model 1820 Processor — Cell: D6

Triangular distribution with parameters:

Minimum	$76,100
Likeliest	$76,100
Maximum	$91,320

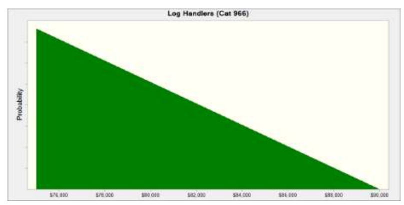


Correlated with:	Coefficient
Self-Loading Box Truck (D8)	1.00
Log Handlers (Cat 966) (D11)	1.00

Assumption: Log Handlers (Cat 966) — Cell: D11

Triangular distribution with parameters:

Minimum	$75,000
Likeliest	$75,000
Maximum	$90,000

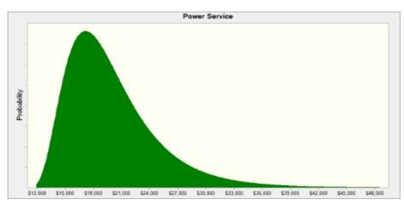


Correlated with:	Coefficient
Cord King Model 1820 Processor (D6)	1.00

Assumption: Power Service — Cell: D26

Lognormal distribution with parameters:

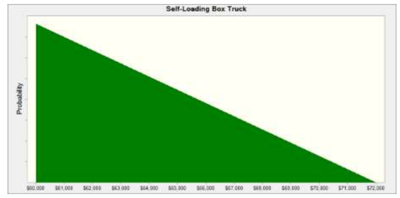
Location	$10,000
Mean	$20,000
Std. Dev.	$5,000



Assumption: Self-Loading Box Truck **Cell: D8**

Triangular distribution with parameters:

Minimum	$60,000
Likeliest	$60,000
Maximum	$72,000



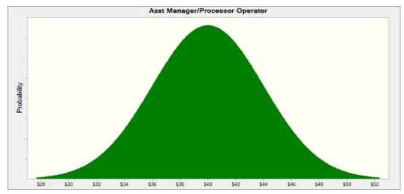
Correlated with:	Coefficient
Cord King Model 1820 Processor (D6)	1.00

Worksheet: [Wildephor_CSSA Firewood Processing_Financial Sensitivity_2025-04-25_CB_CORR.xlsx]OPEX

Assumption: Asst Manager/Processor Operator **Cell: E7**

Normal distribution with parameters:

Mean	$40
Std. Dev.	$4

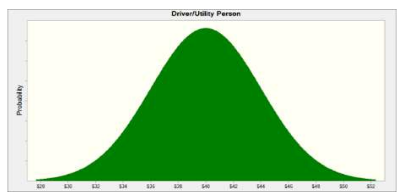


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Driver/Utility Person **Cell: E10**

Normal distribution with parameters:

Mean	$40
Std. Dev.	$4

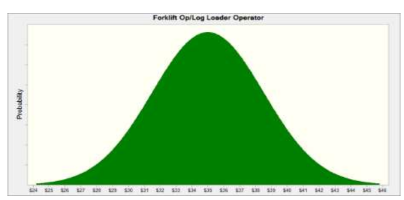


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Forklift Op/Log Loader Operator **Cell: E9**

Normal distribution with parameters:

Mean	$35
Std. Dev.	$4

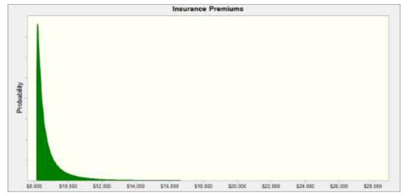


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Insurance Premiums **Cell: G43**

Lognormal distribution with parameters:

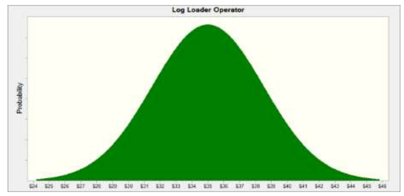
Location	$8,100
Mean	$9,000
Std. Dev.	$1,800



Assumption: Log Loader Operator **Cell: E8**

Normal distribution with parameters:

Mean	$35
Std. Dev.	$4

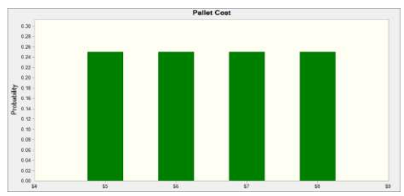


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Pallet Cost **Cell: E38**

Discrete Uniform distribution with parameters:

Minimum	$5.00
Maximum	$8.00



Assumption: Plant Manager/Log Buyer **Cell: E6**

Normal distribution with parameters:

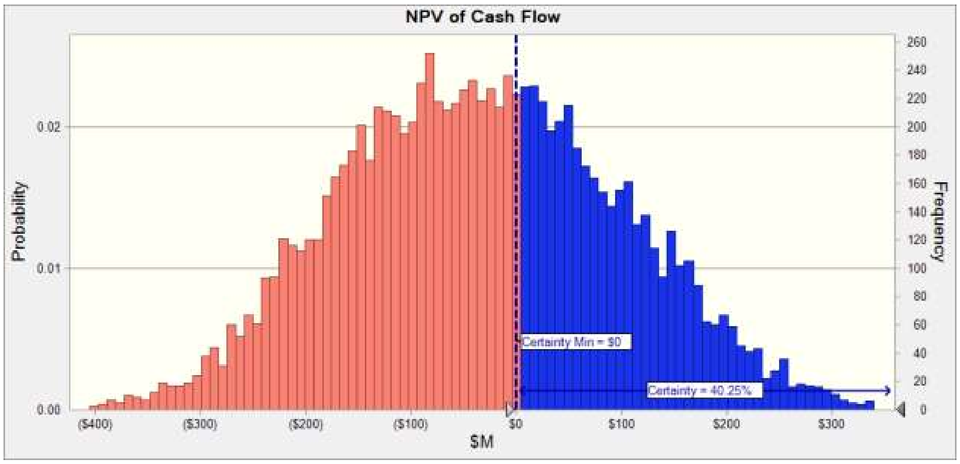
Mean	$60
Std. Dev.	$6

Correlated with:	Coefficient
Asst Manager/Processor Operator (E7)	1.00
Log Loader Operator (E8)	1.00
Driver/Utility Person (E10)	1.00
Forklift Op/Log Loader Operator (E9)	1.00

End of Assumptions

Forecast: NPV of Cash Flow **Cell: J11**

Summary:
Certainty level is 40.25%
Certainty range is from $0 to ∞
Entire range is from ($590) to $416
Base case is $9
After 10,000 trials, the std. error of the mean is $1



Statistics:	Forecast values
Trials	10,000
Base Case	$9
Mean	($33)
Median	($36)
Mode	---
Standard Deviation	$133
Variance	$17,749
Skewness	0.0913
Kurtosis	2.72
Coeff. of Variation	-4.04
Minimum	($590)
Maximum	$416
Range Width	$1,006
Mean Std. Error	$1

Percentiles:	Forecast values
0%	($590)
10%	($205)
20%	($150)
30%	($110)
40%	($73)
50%	($36)
60%	$1
70%	$39
80%	$83
90%	$145
100%	$416

FIREWOOD PROCESSING - RETURN ON INVESTMENT

This cash flow model allows the user to calculate net present value (NPV) and the return on equity (ROE) for investment in a firewood processing business given the cost of logs, other operating expenses, quantities of product sold and the sale prices for that product, income tax parameters, operational life of the facility, and other pertinent inputs.

Input values highlighted in yellow.	
Calculated values highlighted in red.	
Monte Carlo assumptions highlighted in green.	
Monte Carlo forecasts highlighted in blue.	

FIREWOOD PROCESSING OPERATIONS
Assumes producing 16 cords/day (100 days/yr).
Assumes accelerated depreciation (10 years).
Assumes financing is 50% debt and 50% equity.

IRR Required	17%
Product Sales ($M)	
Local softwood sales	223
Local hardwood sales	164
Wholesale sales	0
Sensitivity-Add/Subtract	0
Total Sales	***387***
Feedstock Cost ($M)	
Softwood logs	54
Hardwood logs	50
Mixed log loads	0
Sensitivity-Add/Subtract	0
Total Cost of Feedstock	***104***
Capital Costs ($M)	
Equipment	285
Buildings, Roads, Power	0
Land	0
Sensitivity-Add/Subtract	0
Total Capital Cost	***285***
O&M Costs ($M)	
Labor	206
Maintenance	5
Insurance	9
Property Tax	0
Utilities	7
Lease Expense	1
Legal	2
General & Administrative	10
Subtotal (less labor & maintenance)	29
Other	42
Sensitivity-Add/Subtract	0
Total O&M Costs	**283**

IRR Achieved (%)	18.6%
NPV of Cash Flow ($M)	$ 9

Taxes & Royalties	
Federal Income Tax Rate (%)	35.00
State Income Tax Rate (%)	8.84
Tax Depreciation Method	M-10
Investment Tax Credit (%)	0%
Escalation	
Escalation-Product Sales (%)	1.00
Escalation-Feedstock (%)	1.00
Escalation-Labor (%)	1.00
Escalation-Maintenance (%)	1.00
Financing	
Debt ratio (%)	50
Equity ratio (%)	50
Interest Rate on Debt (%/year)	5.00
Economic Life (years)	20
Rate of Equity Required (%/year)	17%
Weighted Cost of Capital (%/year)	2.59%
Total Cost of Plant ($M)	285
Amount of Grant ($M)	0
Grant (% of Total Capital Cost)	0%
Salvage Value (%)	10%
Total Equity Invested ($M)	142
Total Debt Invested ($M)	142
Capital Recovery Factor, Equity (%)	5.09%
Capital Recovery Factor, Debt (%)	8.02%
Annual Debt Payment ($M/year)	11
Debt Reserve ($M)	0

Adapted from TSS Consultants

FIREWOOD ANNUAL PRODUCT SALES						
			Cords/Year			
Product	**Ops Days/Year**	**Cords/Day**	**Gross (Wet)**	**Shrinkage**	**Unit Price/Cord**	**Revenue**
Local Softwood Firewood	100	10.5	1,050	158	$250	$223,125
Local Hardwood Firewood	100	5.5	550	83	$350	$163,625
Total Product Sales	**100**	**16**	**1,600**	**240**		**$386,750**
			Shrinkage	**15%**	**Avg Price/Cord**	**$284**

Adapted from TSS Consultants

FIREWOOD LOG PROCUREMENT COST						
Source	**$/Truckload**	**Cords/Truckload**	**Cost/Cord**	**Truckloads/Year**	**Cords/Year**	**Total Cost**
Softwood	$720	9	$80	75	675	$54,000
Hardwood	$900	9	$100	56	504	$50,400
Box Truck Delivery	$0	2	$0	160	320	$0
Total Feedstock Cost				**291**	**1,499**	**$104,400**
					Avg Cost/Cord	**$70**

Adapted from TSS Consultants

FIREWOOD PROCESSING CAPITAL EXPENSES				
Equipment	**Number**	**Unit Cost**	**Total Cost**	**Comments**
Cord King Model 1820 Processor	1	$76,100	$76,100	Includes 16' conveyor w/covered operator's cab (delivered)
Kiln-direct 12 Cord Capacity	1	$25,000	$25,000	Includes 12 half cord baskets (delivered)
Self-Loading Box Truck	1	$60,000	$60,000	To transport firewood logs or sawlogs
Skid Steer	1	$25,000	$25,000	With forks and bucket (shared with sawmill)
Half Cord Cages		$650	$0	Could fabricate for about $400 each
Log Handlers (Cat 966)	1	$75,000	$75,000	With log grapples and bucket (shared with sawmill)
Delivery Truck (Flatbed)	1	$10,000	$10,000	Truck for delivery of product to local markets
Plastic Wrapping Machine		$1,400	$0	Plastic wrapper to wrap firewood bundles
Banding Equipment		$4,000	$0	For banding firewood for shipping
Spare Parts/Tools	1	$150	$150	Chain sharpener
Subtotal			**$271,250**	
Contingency		5%	$13,563	
Total Equipment Cost			**$284,813**	
Sitework				
Gravel for Site	1	$18,000	$18,000	1,000 cubic yards delivered (shared with sawmill)
Electrical			$0	
Heat & AC			$0	
Power Service	1	$20,000	$20,000	PG&E (some undergrounding required; shared with sawmill)
Roads			$0	
Yard Paving			$0	
Engineering			$0	
Subtotal			**$38,000**	
Contingency		5%	$1,900	
Total Sitework Cost			**$39,900**	
Building Lease				
Portable Office Trailer	1	$4,380	$4,380	Yearly rental (shared with sawmill)
Restroom	1	$0	$0	Included with office trailer
Total Building Cost			**$4,380**	
Land Cost	**Acres**	**Unit Cost**	**Total Cost**	
Building Area & Yard	2	$0	**$0**	

Adapted from TSS Consultants

FIREWOOD PROCESSING OPERATING EXPENSES				
Position	**Number**	**Rate ($/Hour)**	**Cost**	**Comments**
Plant Manager/Log Buyer	1	$60	$48,000	8 hours/day; 100 days/year
Asst Manager/Processor Operator	1	$40	$32,000	8 hours/day; 100 days/year
Log Loader Operator	1	$35	$28,000	8 hours/day; 100 days/year
Forklift Op/Log Loader Operator	1	$35	$28,000	8 hours/day; 100 days/year
Driver/Utility Person	1	$40	$32,000	8 hours/day; 100 days/year
Subtotal - Direct	**5**		**$168,000**	
Paid Time Off		5%	$8,400	
Training/Preventative Maintenance		3%	$5,040	
Unscheduled Down Time		0%	$0	
Workers Comp		7%	$11,760	
Social Security		6%	$10,416	
Medicare		1%	$2,436	
Subtotal - Indirect			**$38,052**	
Total Labor Cost			**$206,052**	
General & Admin			**$10,000**	
Total Burdened Labor Cost			**$216,052**	
Unit Burdened Labor Cost ($/Cord)			**$135.03**	

OTHER OPERATING COSTS				
Item	**Qty/Year**	**Unit Cost**	**Total Cost**	**Comments**
Operating Supplies				
Bands	200	$7.50	$1,500	Banding to load firewood
Pallets	6,600	$6.00	$39,600	Assumes 3 pallets per cord
Fuel for Kiln	0	$7,000	$0	As per Kiln-direct
Plastic rolls	66	$17	$1,122	18"x1500' 90 gauge;
Subtotal			**$42,222**	15 ft of wrap per pallet
Insurance (Fire, Liability)			$9,000	
Property Tax			$0	
Utilities (Fuel)			$7,100	
Land Lease			$1,200	
Legal			$2,000	
Subtotal			**$19,300**	
Total Other Operating Costs			**$61,522**	

ANNUAL MAINTENANCE				
Item	**Qty/Year**	**Unit Cost**	**Total Cost**	**Comments**
New Chainsaw Bar	6	$106	$636	
New Chainsaw Chain	8	$25	$200	
New Chainsaw Sprocket	4	$25	$100	
New Chainsaw File Wheels	10	$20	$200	
Yard Maintenance	1	$1,000	$1,000	Bark cleanup
Other Saw Maintenance	12	$250	$3,000	Lube
Kiln Maintenance	0	$2,083	$0	As per Kiln-direct
Total Annual Maintenance			**$5,136**	
Periodic Maintenance	**Interval**			
New Diesel Engine	5 Years	$7,000	**$7,000**	

Adapted from TSS Consultants

APPENDIX D. SIMULATION MODEL: SMALL-SCALE SAWMILL

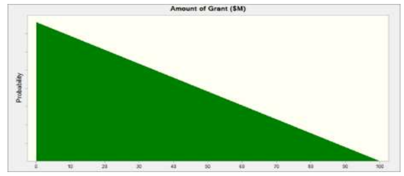
Monte Carlo Simulation Assumptions

Worksheet: [Wildephor_CSSA Small-Scale Sawmill_Financial Sensitivity_2025-06-11_CB_CORR.xlsx]Cash Flow

Assumption: Amount of Grant ($M) — Cell: C73

Triangular distribution with parameters:

Minimum	0
Likeliest	0
Maximum	100

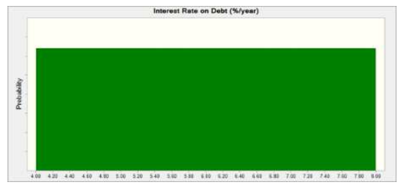


Correlated with:	Coefficient
Interest Rate on Debt (%/year) (C68)	-1.00

Assumption: Interest Rate on Debt (%/year) — Cell: C68

Uniform distribution with parameters:

Minimum	4.00
Maximum	8.00



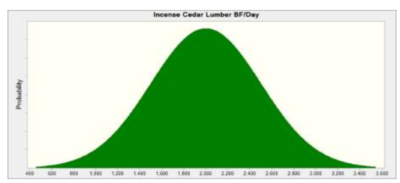
Correlated with:	Coefficient
Amount of Grant ($M) (C73)	-1.00

Worksheet: [Wildephor_CSSA Small-Scale Sawmill_Financial Sensitivity_2025-06-11_CB_CORR.xlsx]Product Sales

Assumption: Incense Cedar Lumber BF/Day — Cell: D8

Normal distribution with parameters:

Mean	2,000
Std. Dev.	500

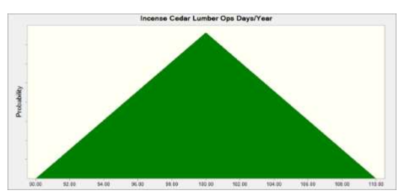


Correlated with:	Coefficient
Pine & Fir Lumber BF/Day (D6)	1.00

Assumption: Incense Cedar Lumber Ops Days/Year — Cell: C8

Triangular distribution with parameters:

Minimum	90.00
Likeliest	100.00
Maximum	110.00

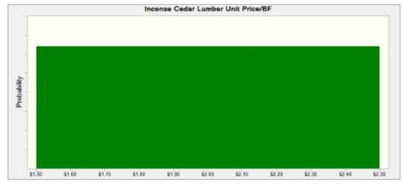


Correlated with:	Coefficient
Pine & Fir Lumber Ops Days/Year (C6)	1.00

Assumption: Incense Cedar Lumber Unit Price/BF — **Cell: G8**

Uniform distribution with parameters:

Minimum	$1.50
Maximum	$2.50

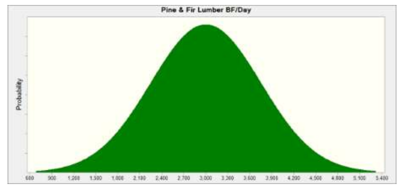


Correlated with:	Coefficient
Pine & Fir Lumber Unit Price/BF (G6)	0.50

Assumption: Pine & Fir Lumber BF/Day — **Cell: D6**

Normal distribution with parameters:

Mean	3,000
Std. Dev.	750

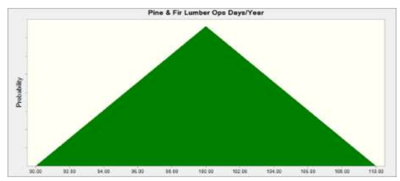


Correlated with:	Coefficient
Incense Cedar Lumber BF/Day (D8)	1.00

Assumption: Pine & Fir Lumber Ops Days/Year — **Cell: C6**

Triangular distribution with parameters:

Minimum	90.00
Likeliest	100.00
Maximum	110.00

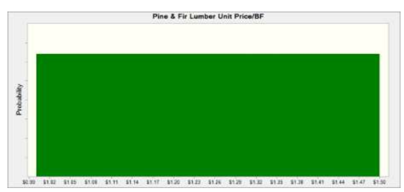


Correlated with:	Coefficient
Incense Cedar Lumber Ops Days/Year (C8)	1.00

Assumption: Pine & Fir Lumber Unit Price/BF — **Cell: G6**

Uniform distribution with parameters:

Minimum	$1.00
Maximum	$1.50

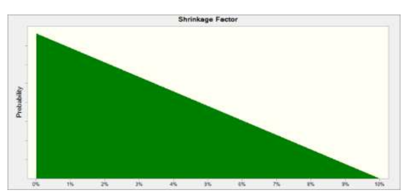


Correlated with:	Coefficient
Incense Cedar Lumber Unit Price/BF (G8)	0.50

Assumption: Shrinkage Factor — **Cell: F12**

Triangular distribution with parameters:

Minimum	0%
Likeliest	0%
Maximum	10%

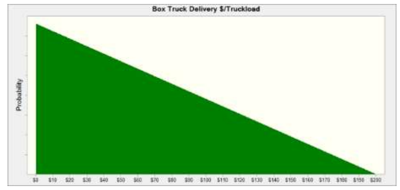


Worksheet: [Wildephor_CSSA Small-Scale Sawmill_Financial Sensitivity_2025-06-11_CB_CORR.xlsx]Feedstock Cost

Assumption: Box Truck Delivery $/Truckload — **Cell: C10**

Triangular distribution with parameters:

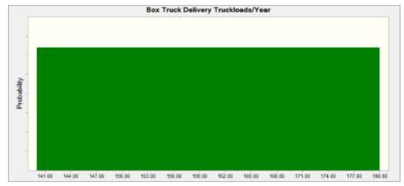
Minimum	$0
Likeliest	$0
Maximum	$200



Assumption: Box Truck Delivery Truckloads/Year — **Cell: F10**

Uniform distribution with parameters:

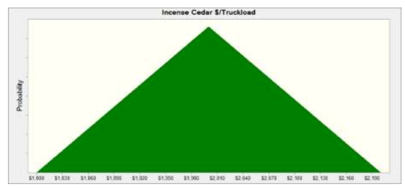
Minimum	140.00
Maximum	180.00



Assumption: Incense Cedar $/Truckload — **Cell: C8**

Triangular distribution with parameters:

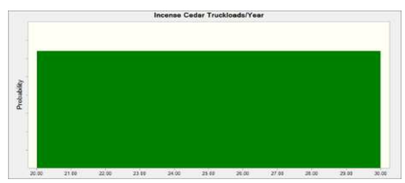
Minimum	$1,800
Likeliest	$2,000
Maximum	$2,200



Assumption: Incense Cedar Truckloads/Year — **Cell: F8**

Uniform distribution with parameters:

Minimum	20.00
Maximum	30.00

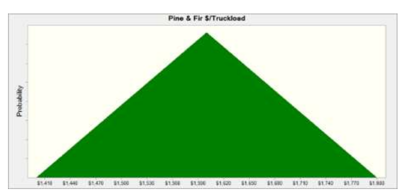


Correlated with:	Coefficient
Pine & Fir Truckloads/Year (F6)	0.50

Assumption: Pine & Fir $/Truckload — **Cell: C6**

Triangular distribution with parameters:

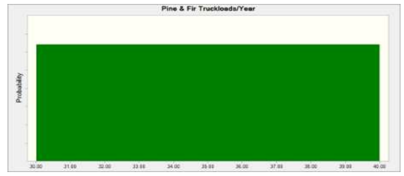
Minimum	$1,400
Likeliest	$1,600
Maximum	$1,800



Assumption: Pine & Fir Truckloads/Year **Cell: F6**

Uniform distribution with parameters:

Minimum	30.00
Maximum	40.00



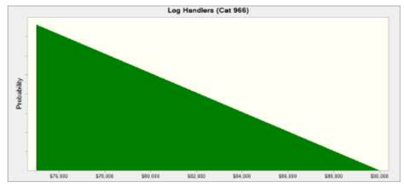
Correlated with:	Coefficient
Incense Cedar Truckloads/Year (F8)	0.50

Worksheet: [Wildephor_CSSA Small-Scale Sawmill_Financial Sensitivity_2025-06-11_CB_CORR.xlsx]CAPEX

Assumption: Log Handlers (Cat 966) **Cell: D10**

Triangular distribution with parameters:

Minimum	$75,000
Likeliest	$75,000
Maximum	$90,000

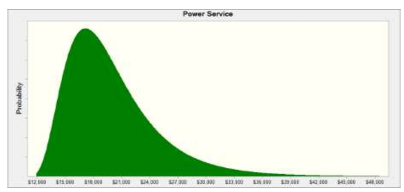


Correlated with:	Coefficient
Wood-Mizer LT40 Sawmill (D6)	1.00

Assumption: Power Service **Cell: D24**

Lognormal distribution with parameters:

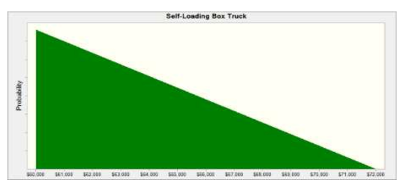
Location	$10,000
Mean	$20,000
Std. Dev.	$5,000



Assumption: Self-Loading Box Truck **Cell: D8**

Triangular distribution with parameters:

Minimum	$60,000
Likeliest	$60,000
Maximum	$72,000

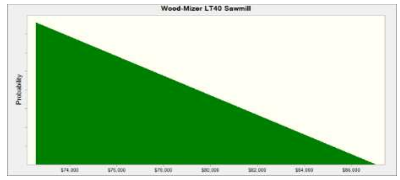


Correlated with:	Coefficient
Wood-Mizer LT40 Sawmill (D6)	1.00

Assumption: Wood-Mizer LT40 Sawmill **Cell: D6**

Triangular distribution with parameters:

Minimum	$72,545
Likeliest	$72,545
Maximum	$87,054



Correlated with:	Coefficient
Log Handlers (Cat 966) (D10)	1.00
Self-Loading Box Truck (D8)	1.00

Worksheet: [Wildephor_CSSA Small-Scale Sawmill_Financial Sensitivity_2025-06-11_CB_CORR.xlsx]OPEX

Assumption: Asst Manager/Mill Operator **Cell: E7**

Normal distribution with parameters:

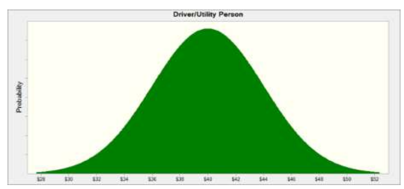
Mean	$40
Std. Dev.	$4

Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Driver/Utility Person **Cell: E10**

Normal distribution with parameters:

Mean	$40
Std. Dev.	$4

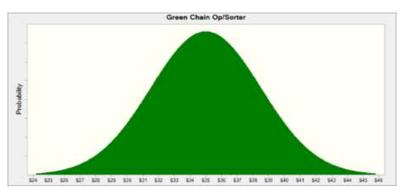


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Green Chain Op/Sorter **Cell: E9**

Normal distribution with parameters:

Mean	$35
Std. Dev.	$4



Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Insurance Premiums **Cell: G40**

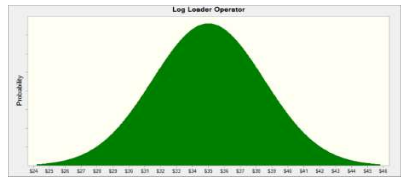
Lognormal distribution with parameters:

Location	$8,100
Mean	$9,000
Std. Dev.	$1,800

Assumption: Log Loader Operator **Cell: E8**

Normal distribution with parameters:

Mean	$35
Std. Dev.	$4

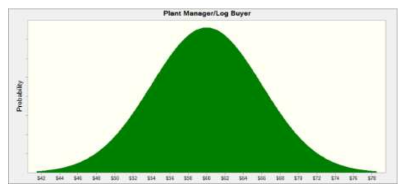


Correlated with:	Coefficient
Plant Manager/Log Buyer (E6)	1.00

Assumption: Plant Manager/Log Buyer **Cell: E6**

Normal distribution with parameters:

Mean	$60
Std. Dev.	$6

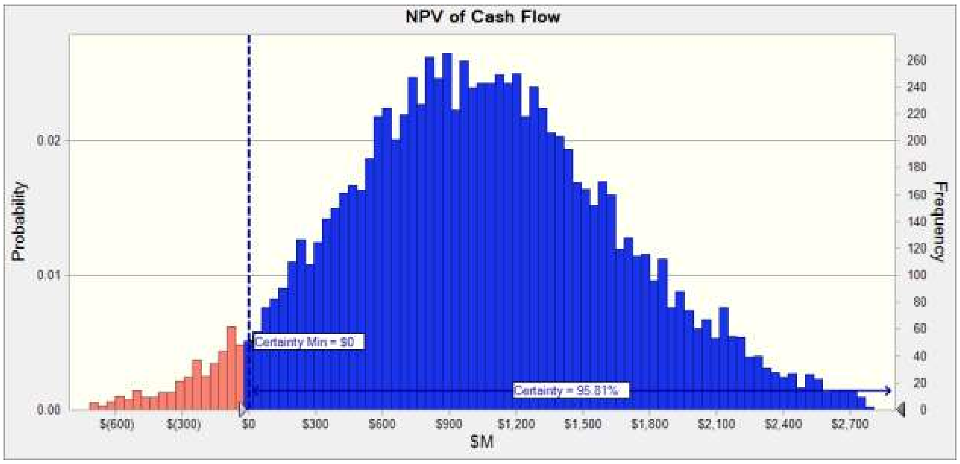


Correlated with:	Coefficient
Log Loader Operator (E8)	1.00
Driver/Utility Person (E10)	1.00
Green Chain Op/Sorter (E9)	1.00
Asst Manager/Mill Operator (E7)	1.00

End of Assumptions

Forecast: NPV of Cash Flow **Cell: J11**

Summary:
Certainty level is 95.81%
Certainty range is from $0 to ∞
Entire range is from $(1,125) to $3,832
Base case is $1,159
After 10,000 trials, the std. error of the mean is $6



Statistics:	Forecast values
Trials	10,000
Base Case	$1,159
Mean	$1,046
Median	$1,024
Mode	---
Standard Deviation	$629
Variance	$396,168
Skewness	0.2038
Kurtosis	3.12
Coeff. of Variation	0.6015
Minimum	$(1,125)
Maximum	$3,832
Range Width	$4,957
Mean Std. Error	$6

Percentiles:	Forecast values
0%	$(1,125)
10%	$256
20%	$523
30%	$707
40%	$867
50%	$1,024
60%	$1,182
70%	$1,349
80%	$1,565
90%	$1,869
100%	$3,832

SMALL-SCALE SAWMILL - RETURN ON INVESTMENT

This cash flow model allows the user to calculate net present value (NPV) and the return on equity (ROE) for investment in a small-scale sawmill business given the cost of logs, other operating expenses, quantities of product sold and the sale prices for that product, income tax parameters, operational life of the facility, and other pertinent inputs.

Input values highlighted in yellow.
Calculated values highlighted in red.
Monte Carlo assumptions highlighted in green.
Monte Carlo forecasts highlighted in blue.

SAWMILL OPERATIONS
Assumes producing 5 MBF/day (100 days/yr).
Assumes accelerated depreciation (10 years).
Assumes financing is 50% debt and 50% equity.

IRR Achieved (%)	177%
NPV of Cash Flow ($M)	$ 1,159

IRR Required	17%
Product Sales ($M)	
Local pine & fir sales	375
Local incense cedar sales	400
Wholesale sales	0
Sensitivity-Add/Subtract	0
Total Sales	***775***
Feedstock Cost ($M)	
Pine & fir logs	56
Incense cedar logs	50
Mixed log loads	0
Sensitivity-Add/Subtract	0
Total Cost of Feedstock	***106***
Capital Costs ($M)	
Equipment	286
Buildings, Roads, Power	0
Land	0
Sensitivity-Add/Subtract	0
Total Capital Cost	***286***
O&M Costs ($M)	
Labor	206
Maintenance	5
Insurance	9
Property Tax	0
Utilities	7
Lease Expense	1
Legal	2
General & Administrative	10
Subtotal (less labor & maintenance)	29
Other	7
Sensitivity-Add/Subtract	0
Total O&M Costs	**247**

Taxes & Royalties	
Federal Income Tax Rate (%)	35.00
State Income Tax Rate (%)	8.84
Tax Depreciation Method	M-10
Investment Tax Credit (%)	0%
Escalation	
Escalation-Product Sales (%)	1.00
Escalation-Feedstock (%)	1.00
Escalation-Labor (%)	1.00
Escalation-Maintenance (%)	1.00
Financing	
Debt ratio (%)	50
Equity ratio (%)	50
Interest Rate on Debt (%/year)	5.00
Economic Life (years)	20
Rate of Equity Required (%/year)	17%
Weighted Cost of Capital (%/year)	2.59%
Total Cost of Plant ($M)	286
Amount of Grant ($M)	0
Grant (% of Total Capital Cost)	0%
Salvage Value (%)	10%
Total Equity Invested ($M)	143
Total Debt Invested ($M)	143
Capital Recovery Factor, Equity (%)	5.09%
Capital Recovery Factor, Debt (%)	8.02%
Annual Debt Payment ($M/year)	11
Debt Reserve ($M)	0

Adapted from TSS Consultants

SAWMILL ANNUAL PRODUCT SALES						
			BF/Year			
Product	**Ops Days/Year**	**BF/Day**	**Gross**	**Shrinkage**	**Unit Price/BF**	**Revenue**
Pine & Fir Lumber	100	3,000	300,000	0	$1.25	$375,000
Incense Cedar Lumber	100	2,000	200,000	0	$2.00	$400,000
Total Product Sales	**100**	**5,000**	**500,000**	**0**		**$775,000**
			Shrinkage Factor	**0%**	**Avg Price/BF**	**$1.55**

Adapted from TSS Consultants

SAW LOG PROCUREMENT COST						
Source	**$/Truckload**	**MBF/Truckload**	**Cost/MBF**	**Truckloads/Year**	**MBF/Year**	**Total Cost**
Pine & Fir	$1,600	4	$400	35	140	$56,000
Incense Cedar	$2,000	4	$500	25	100	$50,000
Box Truck Delivery	$0	1	$0	160	160	$0
Total Feedstock Cost				**220**	**400**	**$106,000**
					Avg Cost/MBF	**$265**

Adapted from TSS Consultants

SAWMILL CAPITAL EXPENSES				
Equipment	**Number**	**Unit Cost**	**Total Cost**	**Comments**
Wood-Mizer LT40 Sawmill	1	$72,545	$72,545	Includes accessories, debarker, and delivery
Kiln-direct 12 Cord Capacity	1	$25,000	$25,000	Shared with firewood business
Self-Loading Box Truck	1	$60,000	$60,000	Shared with firewood business
Skid Steer	1	$25,000	$25,000	Shared with firewood business
Log Handlers (Cat 966)	1	$75,000	$75,000	With log forks and bucket (shared with firewood business)
Delivery Truck (Flatbed)	1	$10,000	$10,000	Truck for delivery of product to local markets
Spare Parts/Tools	1	$2,500	$2,500	Miscellaneous spare parts
Blade Sharpening Machine	1	$2,400	$2,400	Band saw sharpener
Subtotal			**$272,445**	
Contingency		5%	$13,622	
Total Equipment Cost			**$286,067**	
Sitework				
Gravel for Site	1	$18,000	$18,000	1,000 cubic yards delivered (shared with firewood business)
Electrical			$0	
Heat & AC			$0	
Power Service	1	$20,000	$20,000	PG&E (some undergrounding required; shared with firewood)
Roads			$0	
Yard Paving			$0	
Engineering			$0	
Subtotal			**$38,000**	
Contingency		5%	$1,900	
Total Sitework Cost			**$39,900**	
Building Lease				
Portable Office Trailer	1	$4,380	$4,380	Yearly rental (shared with firewood business)
Restroom	1	$0	$0	Included with office trailer
Total Building Cost			**$4,380**	
Land Cost	**Acres**	**Unit Cost**	**Total Cost**	
Building Area & Yard	2	$0	**$0**	

Adapted from TSS Consultants

SAWMILL OPERATING EXPENSES				
Position	**Number**	**Rate ($/Hour)**	**Cost**	**Comments**
Plant Manager/Log Buyer	1	$60	$48,000	8 hours/day; 100 days/year
Asst Manager/Mill Operator	1	$40	$32,000	8 hours/day; 100 days/year
Log Loader Operator	1	$35	$28,000	8 hours/day; 100 days/year
Green Chain Op/Sorter	1	$35	$28,000	8 hours/day; 100 days/year
Driver/Utility Person	1	$40	$32,000	8 hours/day; 100 days/year
Subtotal - Direct	**5**		**$168,000**	
Paid Time Off		5%	$8,400	
Training/Preventative Maintenance		3%	$5,040	
Unscheduled Down Time		0%	$0	
Workers Comp		7%	$11,760	
Social Security		6%	$10,416	
Medicare		1%	$2,436	
Subtotal - Indirect			**$38,052**	
Total Labor Cost			**$206,052**	
General & Admin			**$10,000**	
Total Burdened Labor Cost			**$216,052**	
Unit Burdened Labor Cost ($/BF)			**$0.43**	

OTHER OPERATING COSTS				
Item	**Qty/Year**	**Unit Cost**	**Total Cost**	**Comments**
Operating Supplies				
Fuel for Kiln	1	$7,000	$7,000	Propane
Subtotal			**$7,000**	
Insurance (Fire, Liability)			$9,000	
Property Tax			$0	
Utilities (Fuel)			$7,100	
Land Lease			$1,200	
Legal			$2,000	
Subtotal			**$19,300**	
Total Other Operating Costs			**$26,300**	

ANNUAL MAINTENANCE				
Item	**Qty/Year**	**Unit Cost**	**Total Cost**	**Comments**
New Chainsaw Bar	6	$106	$636	
New Chainsaw Chain	8	$25	$200	
New Chainsaw Sprocket	4	$25	$100	
New Chainsaw File Wheels	10	$20	$200	
Yard Maintenance	1	$1,000	$1,000	Bark cleanup
Other Saw Maintenance	12	$250	$3,000	Lube
Kiln Maintenance	0	$2,083	$0	As per Kiln-direct
Total Annual Maintenance			**$5,136**	
Periodic Maintenance	**Interval**			
New Diesel Engine	5 Years	$7,000	**$7,000**	

Adapted from TSS Consultants