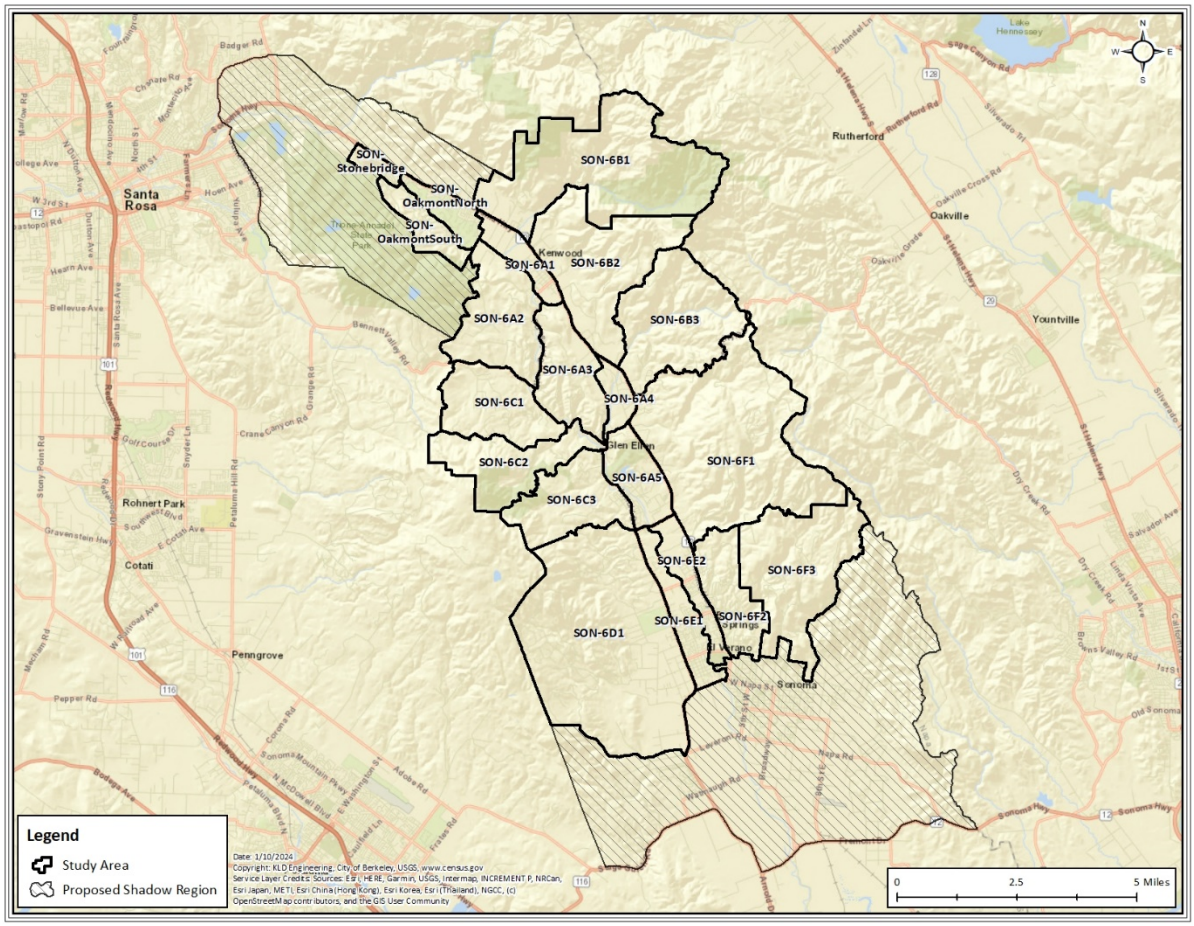
Sonoma Valley, California
Wildfire Evacuation Time Estimate Study

Prepared for

The Board of the Valley of the Moon Alliance



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I. Introduction

Wildfires, and the impacts thereof, are a critical issue facing the world. Increased temperatures, drought, unusually low humidity, and increased winds contribute to the increase in frequency and severity of wildfires. One of the most critical concerns during a wildfire is the availability of transportation services and facilities to evacuate people who are at risk. Under normal circumstances, the transportation system provides capacity for evacuation (of both those who can evacuate independently as well as those who need transportation assistance) and allows for emergency responders to enter an area at risk. During a wildfire, however, the transportation system can become inadequate due to unsafe roadway conditions, abandoned vehicles blocking the roadway, and/or traffic congestion. As a result, the risk to public health and the environment – and the potential for loss of life – increases.

The Sonoma Valley is located between the Sonoma Mountains and the Mayacamas Mountains. The valley includes the communities of Kenwood, Glen Ellen, El Verano, Boyes Hot Springs, Fetters Hot Springs-Agua Caliente, and Sonoma. These communities house approximately 13,500 homes and 32,500 residents. The primary route giving access to the valley is California Highway 12 (CA-12). In the event of a wildfire, there would likely be significant traffic volume on CA-12 such that the evacuation of the valley would be constrained. The valley is densely populated as these communities only occupy about 32 square miles of land. All of these factors could contribute to difficulties in an emergency evacuation.

Due to the proximity of the valley to natural and undeveloped lands and the recent occurrence of wildfires in the area, residents, employees and visitors may need to evacuate if a wildfire were to ignite in or near the valley. One critical element of wildfire emergency planning is knowing how long it would take to evacuate the valley such that an evacuation can be ordered and these communities can be cleared prior to the fire reaching them based on times predicted by fire spread models.

The Board of the Valley of the Moon Alliance (VOTMA) and the residents of Sonoma Valley wish to conduct an Evacuation Time Estimate (ETE) study to determine how long it would take to evacuate the valley under various circumstances, and to explore the sensitivity of ETE to various factors including, but not limited to:

- Number of evacuating vehicles per household
- Police performing traffic control at critical intersections
- Impact of development and increased population as a result
- Mobilization time or time to prepare to evacuate

II. Statement of Qualifications

Background

KLD Associates, Inc. (KLD) was founded in 1971. KLD was under contract with the Federal Highway Administration (FHWA) in the late 1970's to develop traffic simulation software. After the incident at the Three Mile Island nuclear facility in Pennsylvania in 1979, FHWA recommended KLD to the Federal Emergency Management Agency (FEMA) to develop a traffic simulation software specific to evacuation. Over the next several years, KLD developed the Dynamic Evacuation (DYNEV) software under contract to FEMA. By the late 1980's, DYNEV was being used to develop evacuation plans and compute ETE for most nuclear power plants in the United States.

DYNEV was used throughout the 1980's for ETE studies and development of evacuation plans for active nuclear plants, as well as for plants seeking licensure. DYNEV was also used to improve evacuation plans for several chemical stockpiles in the U.S. as part of the Chemical Stockpile Emergency Preparedness Program (CSEPP) during the 1980's. In the early 1990's and early 2000's, DYNEV was used for most nuclear plants in the United States to update ETE studies and emergency evacuation plans based on the latest decennial Census data.

Recent Emergency Evacuation Planning and ETE Experience for Nuclear Power Plants (NPP)

In 2006 through 2011, KLD was the industry leader in ETE studies for NPPs, having done the ETE studies for 16 of 19 new plant applications filed with the U.S. Nuclear Regulatory Commission (NRC). During that time, KLD developed the standard methodology and technical report for ETE studies for NPPs. In 2009 through 2011, KLD senior staff were actively involved with the Nuclear Energy Institute (NEI) and with Entergy (one of the largest electrical utilities in the country at the time) to review draft rulemaking from the NRC that pertained to ETE studies for NPPs. The draft rule on ETE was molded into a more reasonable and practical (for industry) final rule in large part due to the efforts and professional opinions of KLD senior staff.

In 2012, all NPPs in the United States were required to update their ETE studies to account for 2010 Census data and the new regulations and guidance published by the federal government in November 2011. KLD won the contracts to perform the ETE studies for 59 of the 65 NPPs in the United States. All studies were completed and submitted to the NRC on time. All 59 of the studies were found by the NRC to be in compliance with the regulations and guidance (the NRC does not "approve" studies, it only finds them to be "in compliance") without revision. In addition to our work in the United States, KLD has done ETE studies for 6 NPPs in Japan, all 4 NPPs in Canada, the only NPP in Slovenia, and for a NPP in the United Arab Emirates which is still under construction. We are called upon regularly by NEI to answer industry questions related to ETE. We have appeared before the NRC regularly to answer questions related to ETE. We have done work for 62 of the 65 NPPs in the United States in the last fifteen years . KLD also won the contracts to update the ETE studies for all 56 active NPPs after the 2020 Census data was released.

The goals of an ETE study for a NPP are:

- Identify all the people (permanent residents, employees, tourists) and special/critical facilities (schools, daycares, hospitals, nursing homes, senior living facilities, correctional facilities) within a 10-mile radius (called the Emergency Planning Zone or EPZ) of the NPP that would need to be evacuated in the event of an accident at the NPP.

- Develop a computerized replica of the physical roadway system within the EPZ of the NPP, which includes all potential evacuation routes calibrated with the correct number of lanes and the correct speed limit, and identifying all of the traffic signals, stop signs and yield signs.
- Assign the people and special/critical facilities to roadways using Census data, the physical location of facilities, and Geographic Information Systems (GIS) software.
- Perform a demographic survey of the people living, working and recreating within the EPZ to identify how many vehicles they would use to evacuate and how long it would take them to mobilize (prepare to leave work, drive home from work, pack essential items at home) prior to evacuating.
- Input the location and number of vehicles, the roadway system, and the mobilization time to a traffic/evacuation simulation model (i.e., DYNEV) to compute how long it will take to evacuate the EPZ.
- Test the impact on evacuation time of implementing different tactics such as implementing contraflow (using inbound lanes as additional outbound lanes) on critical evacuation routes, identifying critical intersections to have police control traffic, and encouraging households to carpool and evacuate in a single vehicle.
- Develop an emergency plan for the NPP based on the results of the ETE study.
- Test the emergency plan regularly through drills and exercises.
- Improve the emergency plan based on lessons learned from drills and exercises.

The workflow of an ETE study for a NPP is directly applicable to the scope of work needed for Sonoma Valley.

Recent Emergency Evacuation Experience for Wildfires

In addition to KLD's extensive experience in evacuation planning for NPPs, we have done several evacuation studies and emergency plans for wildfires:

1. **San Lorenzo Valley, California** – KLD was contracted by Pacific Gas & Electric (PG&E) to conduct a pilot **wildfire ETE study** for a cluster of seven communities in the San Lorenzo Valley between Santa Cruz and San Jose. The goals of the study were twofold: (1) determine how long it would take to evacuate these communities (individually and as a whole); and (2) provide a framework/methodology for other cities/communities in high fire risk areas to estimate how long it would take to evacuate. There are approximately 21,000 permanent residents living in the seven communities. The study included several sensitivity studies to test different tactics that could reduce ETE. The study also included consideration of employees, tourists, special facilities (schools, daycares, medical facilities, etc.) and those with functional and access needs.
2. **Laguna Beach, California** – KLD was contracted by the City of Laguna Beach to conduct a **wildfire ETE study** and update existing emergency plans based on the results of the ETE study. The scope of work was similar to the San Lorenzo Valley study. The city wanted to identify communities that have limited egress/ingress routes, as well as develop a traffic management plan to facilitate egress during an emergency and reentry once the area is safe for return. Similar to the San Lorenzo Valley study above, the study included several sensitivity studies and consideration of various population groups that could potentially evacuate.

3. **Ashland, Oregon** - KLD was contracted by the City of Ashland to conduct a **wildfire ETE study.** The purpose of the study was to identify and address deficiencies in wildfire emergency preparedness by creating an evacuation plan including elements such as population density, fuels, weather, and traffic models. The project tasks included conducting a vulnerability assessment to identify the most at-risk areas and population groups, including the disabled population, those without vehicles, tourists, and other needs and limitations. A wildfire occurred in the study area for this project during the project. KLD's President was interviewed by local media regarding the study: **https://kobi5.com/news/ashland-city-to-make-changes-to-emergency-evacuation-plan-138042/**
4. **Ocean Hills, Oceanside, California** – KLD recently completed a project with the City of Oceanside to conduct a pilot **wildfire ETE study** for the community of Ocean Hills, with a permanent resident population of approximately 8,000 people. The purpose of the study was to identify all critical facilities (schools, daycares, medical facilities), all tourist attractions (churches, golf courses, etc.) and major employers in the community, then estimate the potential evacuating population for the community. A detailed traffic/evacuation simulation model was built to estimate how long it would take to evacuate the community. Several sensitivity studies were conducted to test different tactics to potentially reduce ETE. Finally, an emergency evacuation plan template was created based on the results of the evacuation study to provide for an orderly evacuation in the event of an emergency. This study and the emergency plan template will be used to develop plans for other communities in the City of Oceanside.
5. **Morro Hills, Oceanside, California** – KLD was contracted a private developer to conduct a **wildfire ETE study** for the community of Morro Hills, with a permanent resident population of approximately 2,000 people. The purpose of the study was to identify how long it would take residents, employees and visitors to evacuate the community for several different scenarios. A detailed traffic/evacuation simulation model was built to estimate how long it would take to evacuate the community. Several sensitivity studies will be conducted to determine if a 600 unit housing complex to be developed would have a measurable impact on the ETE, including consideration of short-term and long-term roadway improvements associated with the development.
6. **Sammamish, Washington** – KLD is currently under contract with the City of Sammamish to conduct a **wildfire ETE study** for the city located just east of Seattle with a permanent resident population of approximately 70,000 people. The scope of work was very similar to the previous wildfire projects discussed above.
7. **Santa Barbara County, California** – KLD is currently under contract with Santa Barbara County to determine how long it would take to evacuate several population centers within the county. The project is a multi-year project funded by a federal grant. The scope of work is very similar to the aforementioned wildfire ETE studies. The project also includes an extensive GIS analysis to determine portions of the county that have significant population, limited egress routes, and high fire risk. Finally, the project includes an extensive public outreach and public education element to determine public knowledge on wildfire emergency planning before the project and after the project.

8. **Berkeley, California** - KLD is currently under contract with the City of Berkeley to determine how long it would take to evacuate the city. The scope of work is very similar to the aforementioned wildfire ETE studies. The project also includes an extensive GIS analysis to determine impacts of traffic calming devices on response times for fire trucks and other emergency responders.
9. **Oakmont, California** – KLD recently completed a wildfire ETE study for the community of Oakmont in California. Similar to the other wildfire ETE studies, this project identified how long it would take to evacuate Oakmont, and Wild Oak, in the event of a wildfire. The study analyzed several 'what-if' scenarios, including wildfire approach and direction, as well as the impact of new developments and new roadways.

The team members assigned to this project and their qualifications are discussed in Section V. KLD has extensive emergency evacuation planning experience for all hazard types. We have been in the emergency planning business for more than 40 years and have dozens of clients who will attest to our expertise and professionalism. There is not another company in the U.S. that has the amount of experience that KLD has. Figure 1 shows the breadth of KLD's emergency evacuation planning.

III. References

As discussed above, KLD has done more than one hundred emergency evacuation planning studies in the last decade. Client contact information for the most relevant projects are provided below:

Oakmont, California

Client: Oakmont Village Association
Contact: Christel Antone, General Manager
Phone: 707-539-1611
Email: christel@oakmontvillage.com

City of Berkeley, California

Client: The City of Berkeley
Contact: Sarah Lana, Emergency Services Manager
Phone: 510-435-6326
Email: slana@berkeleyca.gov

City of Ashland Wildfire Egress Study, Oregon

Client: City of Ashland
Contact: Tighe O'Meara, Police Chief
Phone: 541-552-2142
Email: Tighe.omeara@ashland.or.us

Ocean Hills Wildfire Egress Study and Emergency Plan, California

Client: City of Oceanside Fire Department
Contact: David Parsons, Division Chief
Phone: 760-435-4313
Email: dparsons@oceansideca.org

IV. Scope of Work

The tasks necessary to complete the ETE study are as follows:

1. Define Study Area
2. Project Kickoff Meeting
3. Road Survey
4. Develop Link-Node Analysis Network
5. Demographic and Special Needs Survey
6. Data and Information Gathering
7. Identify Evacuation Zones and Scenarios
8. Compute Baseline Evacuation Time Estimates (ETE)
9. Sensitivity Studies for Impacts of Various Concerns
    a. Mobilization time
    b. Vehicles per household (carpooling)
    c. Shadow evacuation (impacts from communities surrounding the valley/outside of ordered evacuation)
    d. Roadway closures
    e. Traffic control along Highway 12
    f. New development and increased population
        i. Existing and proposed roadway improvements for new developments
10. Documentation
11. Final Meeting

TASK 1: DEFINE STUDY AREA

The focus of the ETE study will be the Sonoma Valley bounded to the north by Oakmont and to the south by the northern boundary of Sonoma. The study area will include Oakmont (which was already included and analyzed in a previous study[1]), Kenwood, Glen Ellen, Eldridge, Fetters Hot Springs-Agua Caliente, Boyes Hot Springs, El Verano, and all unincorporated inhabited areas in between these communities and the mountain ranges to the east and west[2]. In addition, the study will consider a Shadow Region surrounding the valley. A Shadow Region is an area outside the declared evacuation area wherein people may voluntarily evacuate and could potentially delay the egress of those people in the evacuation area. Given the widespread impact of wildfires, it is highly likely that communities neighboring the valley will also be evacuating. The evacuation of these neighboring communities could slow the egress of the valley. Figure 2 shows the proposed study area including the valley and the proposed Shadow Region. Stonegate and portions of the Skyhawk Community and Bennett Valley are considered to the west, while Sonoma, Buena Vista, and Four Corners are considered to the east[3].

KLD will discuss with stakeholders whether the valley should be divided up into various Emergency Management Zones (EMZs) that could possibly be evacuated individually or as a group in an emergency, or whether the valley would just be evacuated as a whole for all wildfire emergencies.

1 The work to gather data in this area is, therefore, not included in this scope of work and the cost reflects that.
2 As an option, Sonoma, Buena Vista, Temelec, and Four Corners can be added for additional cost. See Table 3.
3 If the option in Footnote 1 is exercised, the Shadow Region will extend to Highway 116/Highway 12 near Big Bend and Schellville.

The proposed study area will be at most 70 square miles with a permanent resident population of at most 70,000 people. Any changes in the study area boundaries could result in additional cost.

TASK 2: PROJECT KICKOFF MEETING

A project kickoff meeting will be held with key stakeholders, including but not limited to representatives from VOTMA and any other willing stakeholders identified by the project team. A PowerPoint presentation will be given summarizing the evacuation expertise of the project team and outlining the proposed methodology for the study. The presentation will also focus on data needed from the stakeholders and key project assumptions. Meeting notes will be taken and provided electronically to stakeholders after the meeting, as well as a copy of the attendance roster for the meeting. If it coincides with the road survey (Task 3), the kick-off meeting can be in person. If the meeting cannot be held during the road survey, the meeting will be virtual.

The demographic survey (Task 5) will be discussed at the project kickoff meeting with the stakeholders, including the questions to be asked, the methodology for administering the survey, and the means of notifying the public about the survey.

TASK 3: ROAD SURVEY

A field survey of the roadways within the study area will be conducted by experienced traffic engineers. The survey will identify the key features of the roads that comprise the highway network within the study area. A tablet personal computer equipped with GIS software and GPS will be used to gather data during the survey. Data will be gathered to describe the topology and characteristics of the highway system. A video and audio recording of the survey will be taken. Traffic signal locations will be identified, as will stop control and other highway signage. A representative sampling of traffic signal timings will be taken for pre-timed signals, if there are any. Speed advisory signing will be noted; grade, horizontal curvature, pavement and shoulder widths will be estimated. Actual free speeds (speed that traffic is actually moving at, which is typically about 10% higher than the posted speed limit) will be observed, as well as lane usage.

Estimates of highway capacity will be based on data compiled during the field survey and by applying the procedures of the 2022 Highway Capacity Manual (HCM). KLD will also use tools such as Google Earth and GIS software for aerial imagery to confirm the number of lanes on roadways and the location of traffic signals.

KLD will gain approval from the stakeholders and notify law enforcement prior to conducting the road survey.

TASK 4: DEVELOP LINK-NODE ANALYSIS NETWORK

A detailed computer representation of the roadway system within the study area will be developed. This representation consists of a network defined by nodes which represent intersections and locations where the characteristics of the road change (horizontal curve, grade change, add or drop a lane), and links which represent the sections of roadway between nodes. This representation of the roadway system, referred to as the link-node analysis network, is accepted practice in computer modeling and defines the input

data for the DYNEV model (discussed in Task 8). Figure 3 provides an example of the link-node analysis network created for the wildfire ETE study for Oakmont.

The detailed attributes of the physical highway system gathered during the road survey will be input for each link and node such that the link-node analysis network is an exact replica of the actual physical roadway network in the study area. This is imperative in computing accurate ETE.

Any traffic control points or traffic management tactics identified in the existing local, city, or county emergency plans (if there are any) will be modeled explicitly to make sure they are efficient and necessary to improve evacuation traffic flow.

TASK 5: DEMOGRAPHIC SURVEY

Some of the data critical to an evacuation study (e.g., the number of vehicles residents will use to evacuate, the time it will take people to mobilize/prepare for evacuation) are not available through the Census. Historically, this data for an ETE study was gathered through a telephone survey of residents within the study area. However, given the limited reliance upon landline telephones and the privacy protection on cellular phones, telephone surveys are becoming increasingly difficult to complete.

KLD proposes the following approach for conducting a community demographic survey, which has been used for several wildfire ETE studies in California, Oregon, and Washington in the past 5 years:

- Develop a demographic survey instrument (list of questions to be asked) in consultation with stakeholders. Stakeholders will provide all comments on the survey in an email and KLD will make the necessary revisions to the survey. One round of comments and revisions is included in this scope.
- Publish the survey online. An example of the demographic survey used in the San Lorenzo Valley in California can be seen at the following website: **http://surveys.kld.engineering**
- Develop an electronic postcard and/or poster advertising the demographic survey and the need for the community to participate to enhance emergency planning. A scannable QR code will be included on the postcard and poster which can be scanned using a smart device and bring the user directly to the survey website. Figure 4 is an example of the postcard used for the San Lorenzo Valley study.
- Work with the stakeholders to distribute the survey to the people living and working in the valley through their communication platforms (website, social media, etc.)

The goal is to get completed surveys from approximately 375 households, which corresponds to roughly a 5% sampling error (acceptable for engineering studies) at the 95% confidence level for the approximately 11,150 households in the valley.

A statistical analysis of the data gathered from the demographic survey will be conducted to gather important demographic information (average household size, number of evacuating vehicles per household, percentage of households with commuters, etc.) and mobilization/preparation times for the ETE study. Mobilization times are a vital piece of an ETE study as they determine the distribution of evacuating vehicles entering the roadway system over time after an advisory to evacuate. Accurate mobilization times lead to realistic estimates of evacuation time.

TASK 6: DATA AND INFORMATION GATHERING

There are people living, working and/or recreating in the valley. All potential evacuees must be considered when computing ETE. KLD will conduct an extensive data collection effort, with the assistance of VOTMA, to identify permanent residents, major employers, tourist attractions, special facilities (schools, preschools, medical facilities, senior living, correctional facilities, etc.) if any, transit-dependent population (those people who do not own or have access to a private vehicle), and population with functional and access needs within the valley.

Permanent resident population in the study area will be based on 2020 Census data. These data will be extrapolated to Year 2024 using growth rates computed from the U.S. Census Bureau's annual population estimates. KLD will work with the stakeholders to identify the remaining population groups in the valley, including making phone calls to individual facilities to gather data if needed.

The number of transportation resources available (trains, buses, wheelchair transport and ambulances) within the valley and through mutual aid (i.e., from the City of Santa Rosa) will be estimated. The number of transportation resources needed to evacuate the transit-dependent population, special facilities, and those with functional and access needs will be estimated. If there is a shortfall, additional resources needed from neighboring communities or the state will be identified. All data gathered will be mapped using GIS software.

In addition to gathering data, KLD will request any existing emergency plans or wildfire mitigation plans from stakeholders. These plans will be reviewed and the actions taken by responding agencies during a wildfire will be reflected in the ETE simulation models.

In accordance with federal guidance, only permanent resident population will be considered in the Shadow Region.

KLD is a New York-based company, which can sometimes lead to difficulty when trying to obtain population data and other information from critical facilities out of state. As such, KLD will rely heavily upon VOTMA and project stakeholders to assist in gathering data as they are familiar with the critical facilities in the area.

TASK 7: IDENTIFY EVACUATION REGIONS AND SCENARIOS

As discussed in Task 1, KLD will work with stakeholders to identify whether the valley will be divided into EMZs or if the communities will evacuate as a whole. An Evacuation Region is a grouping of EMZs to be evacuated. This study will consider evacuation of each individual EMZ, of various regions (to be discussed with stakeholders), and of the entire study area at once.

A scenario is a combination of circumstances, including time of day, day of week, season, special events and weather conditions. Scenarios define the population components, response times for the affected population groups, and applicable highway speeds and capacities. This study will consider several scenarios to capture the temporal variations in the number of people to be evacuated. Two bounding temporal variations (highest and lowest demand) will be considered, and three directional variations will be considered. Two cases (high and low demand) will allow vehicles to travel eastbound and/or

westbound on Highway 12. Two cases (high and low demand) will consider a wildfire to the north/west wherein all evacuees are forced to the south/east. The last two cases (high and low demand) will consider a wildfire to the south/east wherein all evacuees are forced to the north/west. These two cases will bound the evacuation as they are the worse case scenarios for the valley.

All regions and scenarios will be reviewed with the stakeholders to assure their agreement prior to computing any ETE.

TASK 8: COMPUTE EVACUATION TIME ESTIMATES (ETE)

The Dynamic Evacuation (DYNEV) II evacuation modeling system will be used to compute ETE for the valley. A brief history and overview of DYNEV is provided below:

> DYNEV was developed by KLD under contract to the Federal Emergency Management Agency (FEMA) in the early 1980's. KLD was doing traffic simulation work for the federal government in the late 1970's when the nuclear incident occurred at the Three Mile Island Nuclear Generating Station in Pennsylvania in 1979. The federal government saw the importance of building a traffic simulation model to determine how long it would take to evacuate the area around a nuclear plant and thus contracted KLD to develop such a model. The model has been significantly extended and refined over the past 40 years since its initial development.
>
> By the late 1980's DYNEV was being used to compute ETE for nearly all nuclear power plants in the United States. At that time, the U.S. Nuclear Regulatory Commission (NRC) sponsored an independent agency to undertake a study of the DYNEV model. Two reports were issued (NUREG/CR-4873, 4874) at the completion of the study. One of these reports, CR-4873, compared the results produced by the DYNEV model with field data obtained from a congested freeway environment in Austin, TX. The congested freeway environment was as close to a typical evacuation environment as could be studied. These reports concluded, "DYNEV produces results that are reasonably consistent with the observed data on a congested freeway." The NRC validated the DYNEV model again in 2016 using a rigorous regression analysis of population density and roadway density around U.S. nuclear plants and concluded that the ETE predicted by DYNEV were consistent with their findings.
>
> The DYNEV model is still being used today to compute ETE for every active nuclear power plant in the United States and Canada, as well as nuclear plants in Japan, Slovenia and the United Arab Emirates. The DYNEV model has also been used to complete ETE for other hazards in recent years including 5 wildfire evacuation studies in the Pacific Northwest, earthquake studies in California, potential terrorist attacks in our nation's capital, and hurricane evacuation studies on the Atlantic coast. DYNEV has been used to compute ETE for more than 100 evacuation studies in the U.S. and abroad in the last 40 years.
>
> An essential feature of an evacuation model is its ability to represent the routing pattern of evacuating trips. The model must be able to compute the outward-bound destinations of evacuation trips (trip "distribution") and their paths of travel to these destinations (trip "assignment"). KLD's Traffic Assignment and Distribution (TRAD) model, a component of DYNEV,

integrates the trip assignment and distributions using well-established behavioral "equilibrium" principles. Some other models do not have this capability: the analyst must "assume" vehicle routing patterns. Such approximations can artificially limit the number of travel paths, thereby unrealistically "focusing" traffic demand and improperly increasing ETE.

The core algorithms of DYNEV are aligned with international guidance for traffic engineering and traffic flow as documented in the 2022 Transportation Research Board's Highway Capacity Manual. DYNEV incorporates state-of-the-art "dynamic routing" that ensures the simulation of evacuating traffic represents reasonable driver behavior in the event traffic congestion creates an "imbalance" between traffic demand and capacity. Specifically, if traffic along an evacuation route experiences pronounced delays, it is reasonable to expect that evacuees will be inclined to select more attractive alternative routes.

Evacuees from the valley will be routed out of the valley in the general direction of major population centers.

The data gathered in the previous tasks are input into the DYNEV evacuation simulation model and ETE are computed for all regions and scenarios identified in Task 7. ETE will be provided as follows:

1. General population with vehicles
2. Transit-dependent population – residents who do not own or have access to a private vehicle
3. Special facility population:
    a. Schools, preschools, daycares
    b. Medical facilities
    c. Correctional facilities, if any
4. Homebound population with functional and access needs

Table 1 presents an example tabulation of ETE for a wildfire evacuation of the City of Ashland, Oregon. Table 2 is an example of ETEs for schools in the City of Ashland.

ETE for the general population will be computed at the 90^{th} and 100^{th} percentiles. ETE for all other population groups will be computed at the 100^{th} percentile only.

Screen captures from KLD's Evacuation Animation (EVAN) software will be provided to identify congestion patterns during evacuation and to locate potential bottlenecks. Figure 5, Figure 6, and Figure 7 are snapshots of an EVAN animation of the evacuation traffic environment for a wildfire evacuation of the City of Ashland, Oregon. The locations and extent of congestion (Level of Service, LOS F) are clearly visible. Traffic congestion peaks at 1 hour after the advisory to evacuate (Figure 5) and dissipates over the next several hours as shown in Figure 6 and Figure 7. A sequence of such snapshots displays the changing traffic environment over time. These visualizations of traffic congestion are invaluable as they clearly identify bottlenecks during evacuation and provide the starting point for potentially improving evacuation times.

TASK 9: SENSITIVITY STUDIES

The baseline (all roads operational) ETE is computed in Task 8. Task 9 will consist of several ETE sensitivity studies that will consider the impact on ETE of the following "what if" scenarios:

1. Mobilization time – if people take less time or more time to prepare to evacuate, what is the impact on ETE?
2. Number of evacuating vehicles per household – some ETE studies assume 1 evacuating vehicle per household. Other ETE studies rely on demographic studies which result in closer to 2 evacuating vehicles per household. What is the impact on ETE of varying numbers of vehicles per household?
3. Shadow Evacuation – federal guidelines suggest 20% shadow evacuation. What is the impact on ETE if there is no (0%) shadow evacuation, or full (100%) shadow evacuation?
4. Roadway Closures – flames and smoke during a wildfire could result in the closure of some potential evacuation routes for the community. This study will consider evacuation purely northbound if the fire is to the south and purely southbound if the fire is to the north.
5. Traffic Control – will police controlling traffic at critical intersections help to improve ETE?
6. Development and Increased Population – will development of vacant land in and near the valley cause population increases that could prolong ETE? Three variations will be tested for this sensitivity study. Any more variations will result in additional cost.

Running "what if" scenarios such as these will help the stakeholders develop a robust emergency plan and test different tactics to reduce evacuation time. If the baseline ETE is 5 hours and wildfire spread modeling indicates that the wildfire will reach the study area in 4 hours, encouraging carpooling and other tactics can be tested to see if the baseline ETE can be reduced below 4 hours.

The aforementioned congestion diagrams will be compared side-by-side for the what-if scenarios to visualize the impact of the various parameters on traffic flow and on ETE, as necessary. Figure 8 provides an example of a side-by-side comparison of congestion patterns for an evacuation of the City of Laguna Beach, CA with various road closures due to smoke and/or flames from a wildfire.

TASK 10: DOCUMENTATION

A technical report documenting the evacuation study will be drafted. The report will document the demand estimation methodology and results, the highway capacity estimation, the demographic survey results, the mobilization (trip generation) time distributions based on the demographic survey and the computed ETE in tabular and graphical format. Appendices will present a description of the traffic simulation and trip distribution and assignment algorithms utilized in the DYNEV modeling system, the technical details of the study and the supporting data.

A draft report will be provided to stakeholders in electronic format (Adobe Acrobat PDF) for review and comment. The final report will be issued after the final meeting (Task 11) with all comments from the final meeting resolved accordingly.

TASK 11: FINAL MEETING

Typically, the final meeting is held about 2 weeks after the stakeholders have had a chance to review the draft report. At the final meeting, KLD will give a comprehensive PowerPoint presentation which summarizes the methodology, data gathered, ETE results and recommendations. Ample time will be allotted for stakeholders to provide comments and feedback on the draft ETE report and to ask questions about the results. Meeting notes and a copy of the meeting attendance roster will be provided electronically after the meeting. It is assumed that this meeting will be held virtually.

TASK 12: VIDEO SUMMARY

Following the final meeting (Task 11), a video summarizing the methodology, data gathered, ETE results and recommendations will be created. This video will also include an active time demonstration of the evacuation impacts on the roadway system. The video file will be in MP4, or other similar formats shared over a secure File Transfer Protocol (FTP) link.

Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) are of the utmost importance to KLD in this project and in all projects that we do. Over the course of our 40 plus years of emergency planning experience, we have developed a rigorous QA/QC procedure. The procedure involves two levels of checking – the first is done by the analyst (engineer) and the second is done by the project manager. A checklist of several hundred items has been generated to ensure that every step of an evacuation study is done properly and double checked. Both the analyst and the project manager check each of these items, initialing and dating to ensure the check was complete. Like our methodology, our QA/QC procedure has been refined over the years based on feedback from stakeholders and from discussions with federal agencies.

V. Key Personnel

Rebecca Cohen, P.E., P.T.O.E. – Program Director of Evacuation and Emergency Planning at KLD – will be the point of contact with the stakeholders and provide oversight on this project. Ms. Cohen has conducted evacuation studies for most of her 11-year career, including extensive work on the wildfire evacuation studies in the San Lorenzo Valley, the City of Laguna Beach, the City of Sammamish, and Oakmont. She is currently leading the work efforts for the City of Berkeley and the County of Santa Barbara. She consistently completes jobs on schedule and within budget.

Lorena Moschetta, P.E. – Project Manager – will oversee the evacuation modeling and ETE computations. Ms. Moschetta has been working for our evacuation and emergency planning department since she started working at KLD in 2014. She managed over 15 nuclear power plant ETE studies after the most recent census, and she has assisted in the management of several wildfire ETE studies.

Efe Tuncer – Senior Traffic Engineer – will be the lead engineer for this project, developing the link-node analysis network, preparing the DYNEV input streams, running the simulations, and analyzing the results. He has been doing ETE work at KLD for the past five and half years, including being the lead analyst for the San Lorenzo Valley and the City of Laguna Beach evacuation studies. His college graduate studies were

specifically on evacuation as evidenced in his being a contributing author to NUREG/CR-7269, "Enhancing Guidance for Evacuation Time Estimate Studies" published in March 2020.

Amy Jiang – GIS Specialist II – will oversee GIS mapping and data collection for the study. Ms. Jiang has been doing GIS mapping and spatial analysis for evacuation studies for the last eight years at KLD.

Isabella Matragrano – Emergency Planning Specialist – will serve as a supporting analyst for this project. Isabella has assisted in the development of the ETE for Oakmont, the City of Berkeley and the County of Santa Barbara. She has also lead several sensitivity studies since her start at KLD in early 2023. Her responsibilities include data collection, development of preliminary inputs, stakeholder interaction, and report drafting.

Resumes for key project staff members will be furnished upon request.

VI. Project Cost

KLD is pleased to provide the project cost, broken down by task and direct labor costs, shown in Table 3 for your consideration. Travel and other direct costs are summarized in Table 4. Fully burdened (includes overhead, fringe benefits, fee, etc.) hourly rates are provided in Table 5.

The following assumptions are made in computing the job cost:

- The draft and final reports (Task 10) will be in electronic format. No hard copies will be provided.
- The study area (Sonoma Valley plus Shadow Region) will be at most 70 square miles with a permanent resident population of at most 70,000 people. A larger study area and more permanent resident population will result in additional cost. The additional cost associated with the addition of Sonoma, Buena Vista, Telemec, and Four Corners, plus a larger Shadow Region, is included in Table 3 as well.
- If there are existing emergency plans for the study area, they will be reviewed and critiqued. However, they will not be revised by KLD as part of this project.
- The demographic survey (Task 5) will be web based. The project stakeholders will advertise the web based demographic survey to local residents using their communication platforms (website, social media, etc.). One round of comments and revisions on the survey is budgeted. Additional revisions, after the first round of comments, will result in additional cost.
- There is one trip budgeted for this project for the road survey (Task 3). If the project kickoff meeting (Task 2) can be scheduled to coincide with the road survey, the meeting will be held in person. The final meeting (Task 11) will be a virtual meeting. A face-to-face meeting will result in an additional trip and additional cost. If the kickoff meeting cannot be scheduled in conjunction with the road survey, an additional trip would be needed which would result in additional cost. If desired, the kickoff meeting can also be held virtually.
- Task 7 includes at most 14 evacuation regions and at most 6 evacuation scenarios. Additional regions and scenarios will result in additional cost.
- The project stakeholders will assist in information and data gathering (Task 6) because they are local to the area and are familiar with staff operating special facilities in the area. Relying on KLD to gather all the project data will result in additional cost.

- The DYNEV model is proprietary and will not be a deliverable for this project. The results output by the model will be provided as tables and plots in the draft and final reports.
- The study will include the 6 sensitivity studies enumerated in Task 9. Additional sensitivity studies will result in additional cost.
- The unit costs shown in Table 4 assume the following:
    - Airfare – round trip flight. Also includes the cost of transportation to the departure airport and parking at the departure airport.
    - Hotel – typical nightly rates for standard hotels in the area
    - Subsistence – meals and beverages
    - Rental car – includes car rental, insurance, gas and tolls
    - The additional cost for surveying a larger area for the expanded study area is also included in the table.

This job is being bid as firm fixed price. Invoices will be submitted monthly indicating the percentage of each task completed, the overall project percentage completion and the corresponding dollar amount due. Our preferred payment terms are Net 30 or better.

VII. Project Schedule

KLD proposes the draft schedule shown in Table 6. Any delay in contract execution and notice to proceed with the project will result in similar delays to the completion of subsequent tasks.

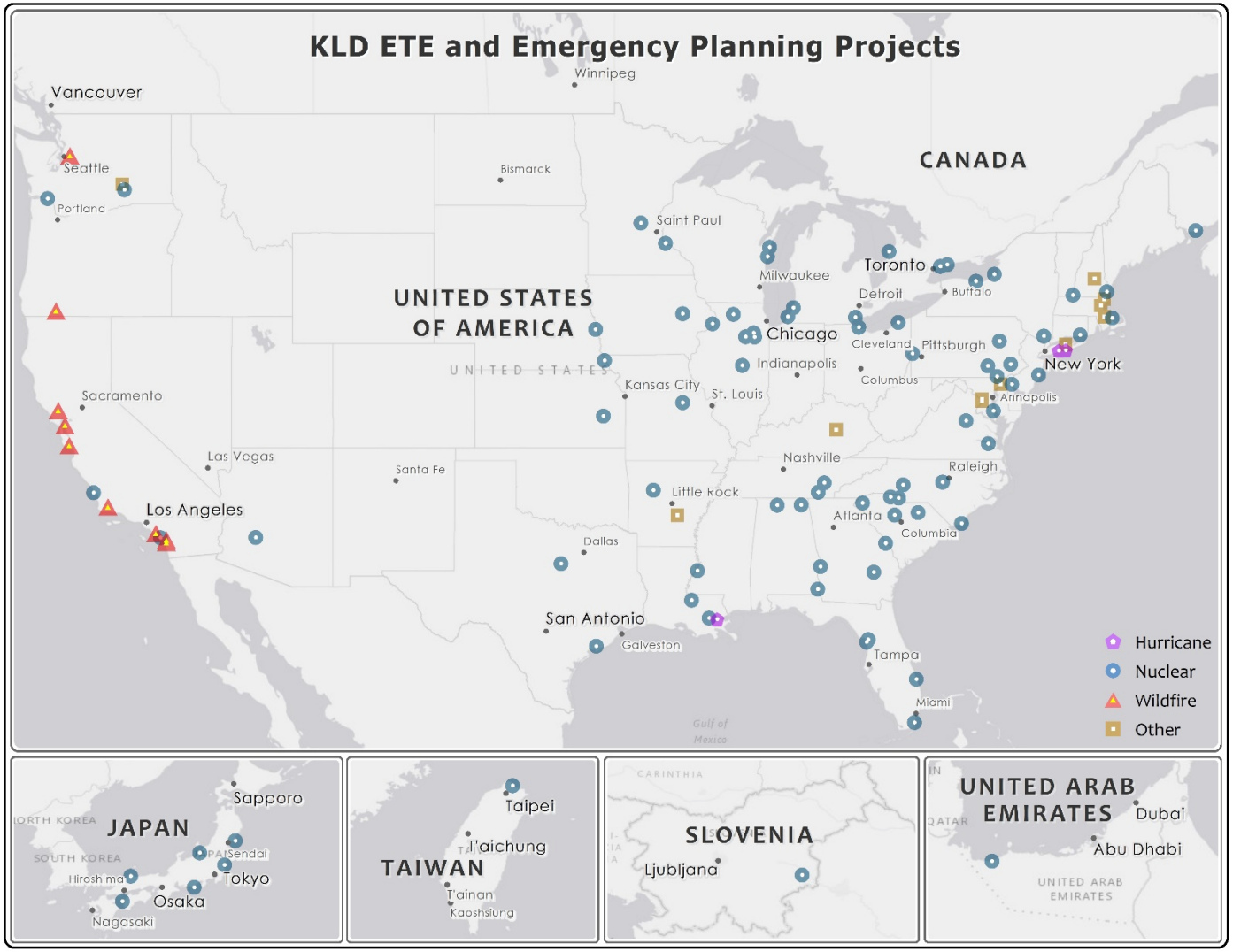

Figure 1. KLD Emergency Evacuation Planning Experience

KLD PROPOSAL 23-016

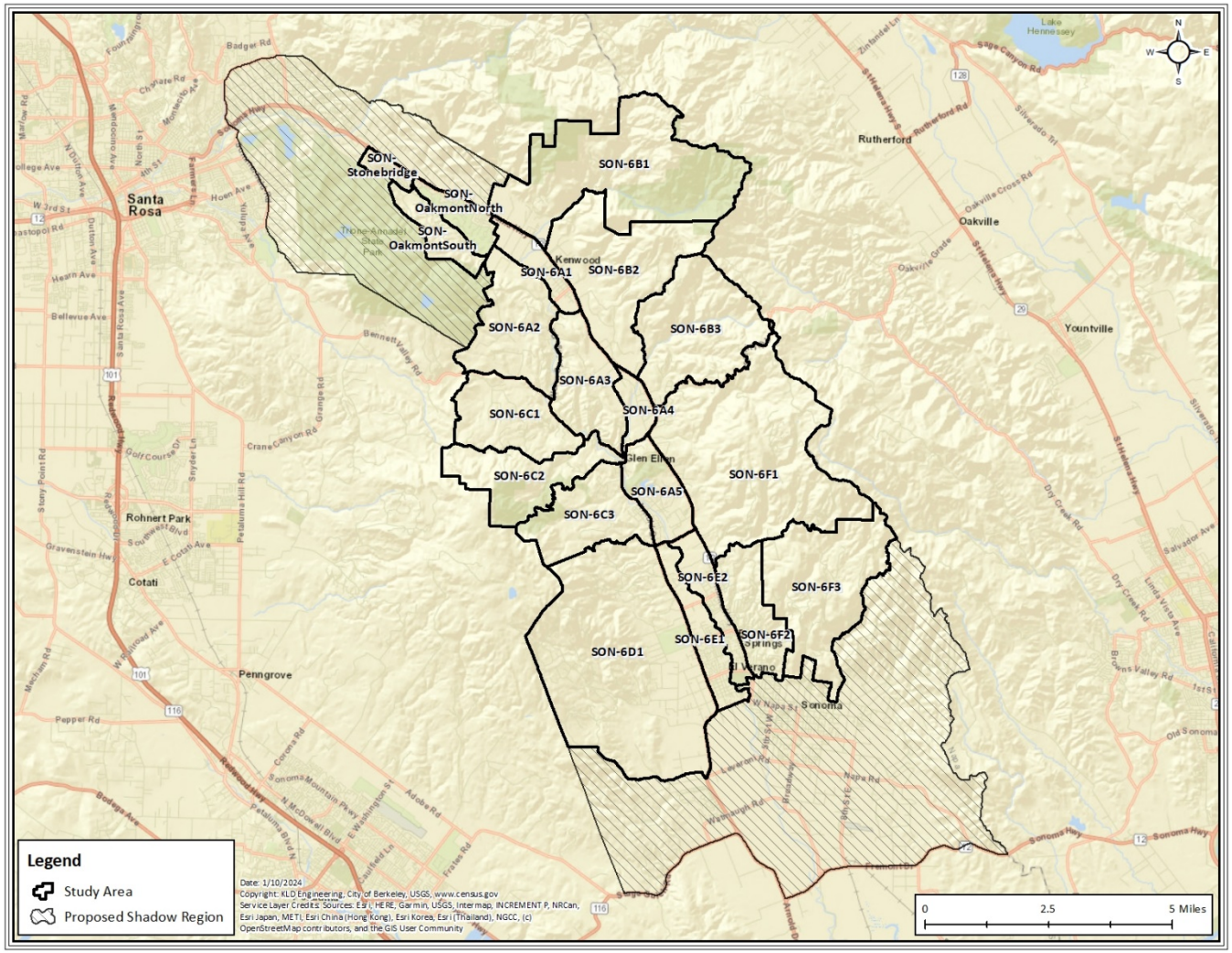

Figure 2. Proposed Study Area

Table 6. Proposed Project Schedule

Task Number	Description	Completion Date
N/A	Contract Execution/Notice to Proceed	3/1/2024
1	Define Study Area	3/23/2024
2	Project Kickoff Meeting	3/16/2024
3	Road Survey	3/16/2024
4	Develop Link-Node Analysis Network	3/29/2024
5	Demographic Survey	5/26/2024
6	Data and Information Gathering	5/26/2024
7	Identify Evacuation Regions and Scenarios	6/10/2024
N/A	Deliver Project Assumptions Memo	6/24/2024
8	Compute ETE	7/14/2024
9	Sensitivity Studies	7/28/2024
10	Documentation – Draft Report	8/19/2024
11	Conduct a Final Meeting	9/2/2024
12	Video Summary	9/16/2024
Final Technical Report and Project Completion		9/30/2024