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Memorandum

Date: June 13, 2017
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Subject: STAFF'S SUPPLEMENTAL TESTIMONY FILED IN RESPONSE TO COMMITTEE'S MARCH 10, 2017 ORDER FOR THE PUENTE POWER PROJECT (15-AFC-01)

On March 10, 2017, the California Energy Commission Committee (Committee) assigned to conduct proceedings on the Application for Certification for the Puente Power Project filed "Committee Orders for Additional Evidence and Briefing Following Evidentiary Hearings." In its May 11, 2017 Revised Committee Scheduling Order, the Committee specified that additional information regarding the topics of Soil and Water Resources (coastal flooding analysis), Traffic and Transportation Alternatives (impacts on aviation), and Compliance and Closure would be due on June 15, 2017.

Staff provides analysis in each of those areas below. In addition, Energy Commission staff includes, for the Committee's consideration, analysis of the air quality and public health impacts associated with the alternate technologies located at the alternate sites that staff analyzed for impacts on aviation.

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SUPPLEMENTAL TESTIMONY

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of Marylou Taylor, P.E. and Mike Conway, P.G.

INTRODUCTION

On March 10, 2017, the Committee filed "Committee Orders for Additional Evidence and Briefing Following Evidentiary Hearings." This section provides staff's response to items 2 through 5 of the Committee Orders: to discuss validation of the Coastal Storm Modeling System (CoSMoS); conduct a noticed workshop to discuss approaches for assessing coastal flooding risk, conduct a supplemental analysis for coastal flooding risk at the proposed Puente Power Project (Puente); compare results with the flooding risks identified in Federal Emergency Management Agency (FEMA) maps; and discuss mitigation measures necessary to maintain reliability.

SUMMARY OF CONCLUSIONS

Staff determined that the best approach to supplement the assessment of coastal flooding risk is utilizing CoSMoS 3.0 Phase 2, which is consistent with the state guidance for sea-level rise (using the most recent and best available science, considering timeframe and risk tolerance, considering storms and other extreme events, and changing shorelines). Model results show that projected flooding for the 100-year event with 2.0 feet of sea level rise does not reach the project site. Analysis of flood risks identified in FEMA maps, adjusted to account for two feet of sea level rise, is consistent with flooding as projected by CoSMoS. Staff also evaluated CoSMoS model results for two more conservative sea level rise scenarios (4.9 feet and 6.6 feet) which indicate that projected water elevations would not cause Puente to cease operations. Therefore, based on CoSMoS 3.0 Phase 2 model results, staff concludes that mitigation for maintaining Puente reliability against flooding is not warranted, but continues to recommend **SOIL&WATER-6** to monitor shoreline conditions and ensure no permanent flood control structures are implemented.

COSMOS 3.0 VALIDATION

The Coastal Storm Modeling System (CoSMoS) is a dynamic modeling approach developed by the United States Geological Survey (USGS) to predict coastal flooding due to both sea level rise (SLR) and storms driven by climate change for use in community-level coastal planning and decision-making. The first iteration of the model, CoSMoS 1.0, was released in 2014. The most recent version, CoSMoS 3.0 Phase 2, began rolling out Southern California data in November 2016 and data for Ventura County became available in May 2017. It can be viewed interactively at www.ourcoastourfuture.org. CoSMoS models all the relevant physics of a coastal storm (e.g., tides, waves, and storm surge), which are then scaled down to local flood projections and integrated with long-term coastal evolution (i.e., beach changes and cliff/bluff retreat).

The March 10, 2017 Puente Committee Orders direct staff to describe three aspects of CoSMoS 3.0, which are listed below and followed by staff's responses.

a) The relevant validation process for the model and the current state of that process;

b) Any relevant feedback received on the validity of the CoSMoS 3.0 model to present, and the degree to which feedback has resulted in modifications to the model; and

c) How the model currently incorporates sand, beach, and dune erosion/accretion, and beach angle change.

VALIDATION PROCESS

Verification of a numerical model implies that accurate representation of reality has been demonstrated. This is only possible in closed systems where all the components of the system are established independently and are known to be correct. Because natural systems (e.g. hydrology, geomorphology, oceanography) are never closed systems, verification of associated models is impossible. These models require input parameters which are commonly based on assumptions and/or incomplete data. In contrast, validation of a numerical model does not mean that it is a perfect representation of physical reality. A model that does not contain significant flaws, is internally consistent, and has been strenuously tested with observations can be said to be valid. However, model results may or may not be accurate, depending on the quality and quantity of the input parameters and the accuracy of its assumptions. The burden is on the modeler to demonstrate the degree of correspondence between the model and system that it seeks to represent, and to define the limits of that relationship (ORE 1994).

All model components of CoSMoS 3.0 Phase 2 have been extensively tested, calibrated, and validated with local, historic data on waves, water levels, and coastal change. Storm events were tested with extensive historical data, including large storms of November/December 1982, December 2005, and January 2010.

- Water levels from tides, storm surge, and longer-term sea level anomalies (e.g. Niño effects) were tested across the Southern California region using tide gauges extending from Santa Barbara County to San Diego County.
- Wave parameters (height, period, and direction) were tested using offshore and nearshore buoys across the region.
- The performance of wave run-up was tested through video camera analysis at Ocean Beach in San Francisco.
- Storm-driven morphodynamic change was tested using coastal response surveys at Torrey Pines State Beach in collaboration with Scripps Institution of Oceanography.
- Long-term shoreline change was tested by analyzing the CoSMoS-COAST model performance from 2005-2015, where semi-annual topographic-data were collected along the study site.

More details of the model validation can be found in the references section. Further, the primary components of CoSMoS utilize the Delft3D suite of models (e.g., SWAN, FLOW and XBeach), which have been extensively developed, tested, and validated globally for decades, with over 5,000 publications. For more information see https://oss.deltares.nl/web/delft3d/about.

MODIFICATIONS

Phase 2 of CoSMoS 3.0 began publishing county data approximately a year after the release of Phase 1. Model enhancements for CoSMoS 3.0 Phase 2 include:

- Improved system methodology from CoSMoS 1.0 for more accurate flood projections in high-interest embayments and estuaries
- Long-term coastal evolution projections for sandy beaches and cliffs produced from a collection of newly developed, state-of-the-art models informed by historical data
- Discharge from rivers for event response and long-term sediment supply
- An improved digital elevation model (DEM) that incorporates recent Light Detection and Ranging (LIDAR) survey data to create baseline elevation

INCORPORATION OF COASTAL CHANGES

CoSMoS 3.0 Phase 2 incorporates long-term morphodynamic change resulting from SLR and changing wave conditions. USGS published a report that summarizes data and methods used to develop CoSMoS 3.0 and its application to the coasts of Southern California (USGS 2017). In this section, staff highlights the different components of CoSMoS 3.0 Phase 2 and how it incorporates sand, beach, and dune erosion/accretion, and beach angle change.

Downscaling

CoSMoS 3.0 simulates coastal storm flooding under the influence of climate change by downscaling ocean and coastal storms from the global to local scale. **Soil & Water Resources Supplemental Testimony Supplemental Testimony Figure 1** is a schematic that shows the numerical model approach with each trapezoid representing individual components in the model. The global scale wave model (blue trapezoid) simulates wave growth and propagation across the entire Pacific basin based on wind speeds and directions for years 2010 through 2100 computed from a global climate model (GCM).[1] Projected deep water waves computed with the global scale wave model are propagated to shore with a suite of regional (Tier I) and local (Tiers II and III) models. Each model component uses results from the previous model in addition to other external forcings which drive the numerical model.

- **Tier I**: The regional scale model simulates tides, storm surge, sea level anomalies, and wave propagation and growth for the offshore region of Southern

[1] The GCM used was the earth systems model GFDL-ESM2M, developed by the National Oceanographic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory.

California (where water depths are at least 3,200 feet (ft), roughly 100 nautical miles from the shore). Model inputs include deep water wave parameters from the previous global scale wave model, atmospheric forcing (wind and sea level pressure) downscaled from a GCM, regional tidal forcing, and large-scale sea level anomalies often associated with El Niño events.[2]

- **Tier II**: This component of the model consists of 11 local-scale sub-models that simulate waves covering nearshore and shoreline areas. Multiple two-dimensional grids of varying resolutions extend from offshore depths of at least 100 ft (roughly three nautical miles from the shore) to well inland of the present day shoreline (to allow for wave and water level computations of the higher SLR scenarios). Model inputs include water levels and wave parameters from Tier I, atmospheric forcing (wind and sea level pressure) downscaled from a GCM, and river discharges developed from GCM model outputs associated with future storms.

- **Tier III**: This component is a one-dimensional, morphodynamic storm impact model specifically designed to simulate beach and dune erosion, overwash, and flooding of sandy coasts. Nearshore hydrodynamics, wave setup, total wave run-up and event-based erosion were simulated using cross-shore transects (an imaginary line perpendicular to the shoreline that runs from the water to inland areas) spaced approximately 100 meters (330 ft) apart to cover Southern California, totaling about 4,800 cross-shore transects from the U.S.-Mexico border to Point Conception. Model inputs include water levels and wave parameters from Tier II, and initial profiles reflecting long-term morphodynamic change (discussed below).

Long-term Change

As shown in **Soil & Water Resources Supplemental Testimony Figure 1**, the global scale wave model (blue trapezoid) uses a GCM to project deep water waves. Nearshore wave parameters are computed (gray trapezoid) at offshore depths of 30 ft for each cross-shore transect. These nearshore wave conditions are derived from a 30-year (1980 – 2010) hindcast,[3] modeled historical (1976 – 2005), and future projections (2011 – 2100) from the global scale wave model component. This nearshore waves model component produces the time-series used for long-term morphodynamic change modeling.

To predict long-term morphodynamic change (shown as the purple trapezoid) for a particular cross-shore transect, either a cliff recession model or a sandy coast shoreline change model was used, depending on its geologic characteristics. The sandy coast shoreline change model is applicable to the beach and dunes present near the Puente site. This model, the CoSMoS – Coastal One-line Assimilated Simulation Tool

[2] Sea level anomalies were developed using correlations with sea surface temperature anomalies from GCMs.
[3] Hindcasting is a technique to test a mathematical model by observing whether it would have correctly predicted a historical event. If a model can accurately hindcast, we can have some confidence in its forecasts of the future.

(COAST), predicts the lateral movement of the mean high water (MHW) line due to longshore and cross-shore transport by waves and sea-level rise.

Soil & Water Resources Supplemental Testimony Figure 2 is a schematic that shows the CoSMoS-COAST model, inputs, and outputs. It incorporates three process-based models (longshore transport, cross-shore transport, and shoreline migration due to SLR), historical trend analysis, and EKF data assimilation[4]. Because the coastline of Southern California includes a wide variety of beach settings, each cross-shore transect was manually given a designation that identifies which physical processes are applicable. For example, cobble beaches would not include long-shore or cross-shore transport, and small sandy pocket beaches (approximately one-half mile long or less) would not include long-shore transport. The Puente site is located along a long, sandy beach in an area where all processes of CoSMoS-COAST are applicable.

Thirty-six scenarios were run for each cross-shore transect that combine seven SLR projections and four coastal management scenarios. The coastal management scenarios stem from two decisions of whether or not to “hold the line” (prevent or allow the shoreline from receding past existing infrastructure) and “continue nourishment” (continue or cease the long-term, business-as-usual beach nourishment rate determined from recent historical data, 1995-2010).

Results from the CoSMoS-COAST model are used to represent the future position of the Mean High Water (MHW) shoreline for each SLR scenario. **Soil & Water Resources Supplemental Testimony Figure 3** is an example of calculated changes in the shoreline position and profile due to SLR. This shoreline position is used as a proxy for the entire long-term evolution of the beach profile and digital elevation model, including the dunes prior to modeling the storm events (e.g. 20-year storm, 100-year storm) developed through the regional (Tier I) and local (Tiers II and III) models. Using the framework of numerical models, maps were developed that account for the combined effects of storm intensity, direction, sea-level rise, astronomic tides, and long-term morphologic change.

STAFF WORKSHOP

Staff held a public workshop in the City of Oxnard on March 28, 2017 to identify and discuss the best approach or approaches to supplement the assessment of coastal flooding risk for Puente through 2050. Prior to the public workshop, staff issued written requests to the parties, agencies and interested organizations to provide specific information at the workshop to assist staff in completing the additional analysis required by the Committee Orders.[5] All of the invited agencies and organizations participated in the public workshop, including the U.S. Geological Survey, California Coastal Commission, Coastal Conservancy, and Ocean Protection Council. All of the issues

[4] An extended Kalman filter (EKF) for data assimilation is used to automatically adjust the model parameters during runtime to best fit any available observed shoreline data at the concurrent time step (VIT 2017).
[5] TN # 216663

specifically identified in the Committee Orders for discussion during the public workshop were discussed.[6]

Based on the discussions at the workshop and input from participants, staff determined the best approach to supplement the assessment of coastal flooding risk is utilizing CoSMoS 3.0 Phase 2. When staff wrote the Final Staff Assessment (FSA), results were not yet available for Ventura County so staff evaluated separate results from models CoSMoS 3.0 Phase 1 and CoSMoS-COAST to develop conclusions. After publication of the FSA, Ventura County data of CoSMoS 3.0 Phase 2 became available. The results for the study site do not differ significantly from Phase 1.

SUPPLEMENTAL STAFF ASSESSMENT

This supplemental analysis uses modeling results of CoSMoS 3.0 Phase 2 to assess coastal flooding risk for Puente through 2050. Staff's process is the same as in the FSA, which is consistent with the state guidance for sea-level rise (SLR) to evaluate risks of coastal flooding (COCAT 2013), and roughly follows Appendix B of the California Coastal Commission SLR Policy Guidance (CCC 2015).

STATE SEA LEVEL RISE GUIDANCE

Staff's analysis includes using the most recent and best available science, considering timeframe and risk tolerance, considering storms and other extreme events, and changing shorelines.

Best Available Science

State SLR guidance stresses the use of "the most recent and best available science". The National Research Council's 2012 West Coast Sea Level Rise Report (NRC 2012) was identified as the best available science at the time staff published the FSA. Since then, the California Ocean Protection Council (OPC) Science Advisory Team Working Group published "Rising Seas in California: An Update to Sea-Level Rise Science" (OPC 2017) to provide the scientific foundation for the pending update to the state SLR guidance document.[7] The report incorporates the recent advances in ice loss science and projections of SLR.

Timeframe and Risk Tolerance

The Committee Order directs staff to assess the coastal flooding risk for Puente through 2050. This is the same timeframe staff used for the FSA analysis. The 2012 NRC report provides scenarios that span a range of possible futures. **Soil & Water Resources Table 1** shows the near-term and long-term ranges as presented in the 2012 NRC report. For the FSA, staff chose as the conservative assumption that projected future SLR by 2050 would be of 2.0 ft, which is the top end of the range for that time period.

[6] TN # 217281 and TN # 216808
[7] Updated draft guidance will be circulated for formal public comment in the fall of 2017, with final adoption by the California Ocean Protection Council scheduled for January 2018.

Soil & Water Resources Table 1
California Sea Level Rise Projection using 2000 as the Baseline

Time Period	South of Cape Mendocino
2000 – 2030	0.13 to 0.98 ft
2000 – 2050	0.39 to 2.0 ft
2000 – 2100	1.38 to 5.48 ft

Source: NRC 2012

In its 2017 report, the OPC Working Group used a probabilistic approach to present the updated SLR projections for California. As shown in **Soil & Water Resources Table 2**, the most conservative value for 2050 is still at 2.0 ft and the most likely projection is at about one foot (plus-or-minus about three inches). By comparison, projections for 2100 are higher and more uncertain. The most conservative value is updated to 7.1 ft, and the "likely range" diverges by up to 12 inches from the median of 2.6 ft. The 2017 report gives staff greater confidence that using 2.0 ft as a conservative assumption for SLR by 2050 is appropriate for this analysis.

Soil & Water Resources Table 2
California Sea Level Rise Projections for Southern California

Probability	**2050 (feet)**	**2100 (feet)**
Median 50% probability SLR meets or exceeds…	0.9	2.6
Likely Range 67% probability SLR is between…	0.7 – 1.2	1.8 – 3.6
1-in-20 Chance 5% probability SLR meets or exceeds…	1.4	4.6
1-in-200 Chance 0.5% probability SLR meets or exceeds…	2.0	7.1

Source: OPC 2017 Table 1c
Note: SLR projections are for the tide gauge at La Jolla under RCP 8.5 (future scenario with no significant global efforts to limit or reduce emissions). Values are with respect to 2000 mean sea level as the baseline.

Storms and Other Extreme Events

CoSMoS 3.0 Phase 2 downscales data from GCMs to produce local scale parameters for modeling future flood hazards associated with SLR (see "Downscaling" discussion above). Winds, sea level pressures, and sea surface temperatures derived from GSMs were used to compute waves, storm surges, and sea level anomalies to simulate storms of three return periods (1-year, 20-year, and 100-year) under ten different SLR projections (from zero to 2.0 meters at 25 cm increments and 5.0 meters to represent an extreme SLR scenario). Also incorporated in the model are: alterations to coastal storm intensity and frequency associated with a changing climate; and fluvial discharges that might locally impede and amplify flooding associated with coastal storms.

For the FSA, staff used the 100-year storm which is the engineering standard for evaluating flood hazards and assumed that projected future SLR by 2050 would be 2.0 ft. Phase 1 of CoSMoS 3.0 does not have mapped results of the 2.0-ft SLR scenario, so staff evaluated the map showing the 1.0-meter (3.3-ft) SLR scenario. Phase 2 includes a 75-cm (2.5-ft) SLR scenario, which staff uses for this supplemental analysis.

Changing Shorelines

The discussion above (see "Long-Term Change") describes how CoSMoS-COAST incorporates long-term morphodynamic change due to SLR. The maps produced from CoSMoS 3.0 Phase 2 assume the coastal management scenario that "holds the line" (prevents the shoreline from receding past existing infrastructure) and provides "no nourishment" (all natural and manmade sources of sediment to the area stops as of 2010). These are appropriate for the Puente analysis because it represents a coastal management scenario that is realistic and conservative. As local sea level continues to rise, erosion would not occur at existing infrastructure (constructed with materials such as concrete, asphalt, riprap, and wood) and the line would be held. And assuming no nourishment after 2010 would be conservative because, as previously shown, this stretch of the shoreline has experienced an overall increase of beach width over the last 50 years.

RESULTS OF COSMOS 3.0 PHASE 2

Soil & Water Resources Supplemental Testimony Figure 4 shows projected flooding at the Puente site and MGS site for the scenario: 100-year storm, with 2.5 ft (0.75 meters) of sea level rise, and no sources of sediment. The reference lines used to draw Profile A and Profile B begin at the approximate location of the present-day shoreline (roughly mean sea level). Profiles A and B show that flooding extends approximately 600 feet inland from the present-day shoreline, crossing past the beach and into the dunes. However, the storm does not completely erode the entire dune system and flooding does not reach the Puente and MGS sites.

Staff notes that the green line in **Soil & Water Resources Supplemental Testimony Figure 4** represents present-day topography, prior to long-term shoreline evolution and storm-induced erosion. The projected water level (solid blue line) indicates the extent of beach and dune erosion, but final topography after the storm event is not shown. The dashed blue line shown in Profile A represents the small section of the dune that is elevated enough to avoid flooding. The aerial view of the site shows the area of flooding projected by the model.

COMPARISION WITH FEMA MAPS

The Puente Committee Orders ask staff to discuss how the modeled level of risk compares with the flooding risk identified in FEMA maps that reflect current conditions with two feet of sea-level rise. Staff reviewed the City of Oxnard's (Intervenor) testimony of Dr. Revell which included an analysis using the FEMA maps and similar flooding risk parameters (CITY 2017a), alongside available literature to address the Committee's request.

ADJUSTING FEMA FLOOD HAZARD ZONES

The California Department of Water Resources (DWR) and the California Ocean Science Trust are also interested in understanding the applicability of SLR predictions to future coastal development decisions. These entities sought the expertise of ESA environmental consultants for the preparation of "Relating Future Coastal Conditions to Existing FEMA Flood Hazard Maps" a Technical Methods Manual (TMM), a guidebook for incorporating SLR predictions into FEMA flood hazard maps (ESA 2016). The FEMA Flood Insurance Rate Maps (FIRMs) are intended to show areas subject to the one percent annual chance flood, where floodplain management standards and insurance purchase requirements apply to development projects. In coastal areas, the VE-Zones[8] are high hazard areas where wave action and/or high-velocity water can cause structural damage, so construction requirements are more stringent compared to other zones. The purpose of the TMM is to help development practitioners "adjust" the lateral and vertical extent of future FEMA risk zones under SLR conditions.

INTERVENOR USE OF TMM

The Intervenor consulted the TMM and calculated adjustments to the FEMA VE-Zone. The analysis included calculations for three transects, Upper, Middle, and Lower, that cross the project site boundary. The results of the analysis are shown in Table 3 and Figure 9 of "Testimony of Dr. Revell" (CITY 2017a). Table 3 shows the shift of the VE-Zone along the Upper transect that would be expected by year 2050, resulting from two feet of sea-level rise. The conclusion is that the VE-Zone would shift inland by 195 to 354 ft (CITY 2017a).

The analysis provided consists of two components, the shoreline change component, and an overtopping component. The shoreline change component is calculated based on beach slope and SLR. The Intervenor chose a 1:75 (height : length) slope, resulting in 150 ft of shoreline transgression, or landward movement.

The second component attempts to estimate the momentum and dissipation of wave energy. There are two estimates included, each represents a different method: (1) the Cox-Machemehl method, showing 45 ft of inland VE-Zone movement, and (2) the Modified TAW Equation (or Composite Slope method), showing 204 ft of inland VE-Zone movement.

After reviewing the methods suggested by the TMM and the available site topography, staff does not agree with the Intervenor's conclusion that the VE-Zone would be expected to move landward by 195 to 354 ft with two feet of SLR. Based on available data, staff would suggest modifications to the two components of the VE-Zone migration calculation. Staff's basis for this conclusion is discussed below.

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[8] VE-Zone must meet one of more of the following criteria: wave runup elevation is at least three feet above the eroded ground profile; wave overtopping splash exceeds the crest of a barrier by three feet or more; landward high-velocity flow (based on flood depth and velocity) is 200 ft^3/s^2 or more; breaking wave height is three feet more; and/or fits the criteria of a primary frontal dune zone (FEMA 2015c).

STAFF USE OF TMM

Staff also consulted the TMM and used methods similar to those employed by the Intervenor. Staff used different assumptions about shoreline change and dune height, however, and reached significantly different conclusions about changes in the VE Zone. Contrary to the Intervenor's conclusion, staff's analysis showed an almost negligible inland shift of the VE-Zone resulting from two feet of SLR. Two feet of SLR would be expected to result in a higher Total Water Level (TWL)[9], raising the current VE-Zone's corresponding elevation from 20 ft to 22 ft.[10]

The first component necessary to calculate the adjustment is the shift of the shoreline under a SLR scenario of two feet. For this component, staff used the CoSMoS-COAST model erosion prediction which the TMM considers an example of what would be the highest level quality predicted value for this component. CoSMoS-COAST shows shoreline regression (seaward movement) of 10 to 72 ft in this area. This is consistent with the recent history of coastal evolution at the site. Staff included an image of the CoSMoS-COAST transects and the shoreline change as **Soil & Water Resources Supplemental Testimony Figure 5**. For the purposes of this analysis, staff called this no change, zero feet of transgression.

The second component of the calculation is to calculate the elevation of increased run-up on the dune face along with the landward extent of over-topping, if necessary, where a negative freeboard condition would exist. Based on the assumption that the dunes are erodible, the TMM would suggest the following equation (1),

$$TWL_{future} = TWL_{existing} + SLR * F \qquad (1)$$

where TWL is total water level, SLR is sea-level rise, and F is the morphology factor. As was assumed by the Intervenor, staff assumed the dunes are erodible, which makes the morphology factor value 1. The existing TWL, as indicated on FEMA FIRM, is an elevation of 20 feet. The future TWL under the two feet SLR scenario would be,

$$TWL_{future} = 20 \text{ ft} + (2 \text{ ft} * 1)$$

$$TWL_{future} = 22 \text{ ft}$$

Using the same Upper, Middle, and Lower transects used by the Intervenor which have dune crest elevations that are 22, 28, and 26 ft, respectively, staff concludes the adjusted TWL would not exceed the crest of the dune at any transect. Also, since the dune crests would not be over-topped, a negative freeboard condition would not exist and the landward extent of the wave would be expected to terminate along the face of the dune complex. **Soil & Water Resources Supplemental Testimony Figure 6** shows staff's calculated location of the VE Zone limits along the dune front superimposed on the base image from the Intervenor's Figure 9 (CITY 2017a).

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[9] Total water level is the elevation of the water's surface when all wave components are included (e.g. tides, storm surge, sea level rise, etc.).

[10] All elevations in this analysis are reported relative to the Northern American Vertical Datum of 1988 (NAVD88).

CONCLUSION ABOUT THE USE OF ADJUSTED FEMA MAPS

Staff found the TMM methodology useful and instructive for understanding FEMA FIRMs and how they might be adjusted to account for sea-level rise. The methods provide an integrity test for beach terrains where sea-level rise will influence morphology.

The seaward side of the proposed Puente site is protected by a tall dune complex that does not appear susceptible to over-topping under the two feet of SLR scenario. The site is expected to benefit from continued shoreline regression (seaward movement) during the life of the project. The result of staff's analysis of wave reach is consistent with the storm inundation identified by CoSMoS 3.0 for the site vicinity. Staff did not discover any new evidence that would suggest a threat to the Puente site from SLR, through the expected 30-year operating life, ending in 2050.

NECESSARY MITIGATION

Items 4 and 5 of the Committee Order direct staff to:

4. Identify and discuss the feasibility of mitigation necessary to maintain reliability of the proposed project against flood water levels identified by staff's assessment of coastal flooding risk.
5. Identify and discuss any mitigation measures in addition to those identified under item 4, above, as necessary to maintain reliability of the proposed project if the beach and dunes in front of the project substantially narrow or erode, for example as caused by diminished sand replenishment or major storm events.

METHODOLOGY

To address these items, staff revisits the risk of flooding at the site and how it may affect reliability of Puente. Staff discusses assumptions built in to the CoSMoS model analyses and how these affect the water level estimates that could result in flooding at the site. Staff also does additional analysis of flooding potential considering even more conservative estimates of SLR followed by discussion of the need for mitigation to ensure reliable operation.

Criteria for Reliable Operation

As described in the **Power Plant Reliability** section of the FSA, measures of power plant reliability are based upon both the plant's actual ability to generate power when it is considered to be available, and upon starting failures and unplanned (or forced) outages. For practical purposes, reliability can be considered a combination of these industry measures; making a reliable power plant one that is available when called upon to operate. Power plant systems must be able to operate for extended periods without shutting down for maintenance or repairs. Achieving this reliability requires adequate levels of equipment availability, power plant maintainability, fuel and water availability, and resistance to natural hazards.

During the March 28, 2017 workshop, the applicant presented information to participants in response to staff's questions regarding Puente operations. Specifically, staff requested information about the minimum amount of flooding that would result in Puente being unable to operate. The applicant stated that, if standing water accumulated and storm water management systems were unable to temporarily manage water, Puente would operate with a water level elevation of approximately 15 ft (i.e., 1.5 ft above the finished grade of approximately 13.5 ft).[11] The facility's lowest critical component, an electronic instrument cabinet for gas valve control, is at 15 ft, consequently plant operations would safely shutdown if water levels reached this elevation.[12] Therefore, staff established the water level elevation threshold of 15 ft for maintaining reliability against flooding.

Assumptions

As with every other numerical model developed to represent a complex natural system, the CoSMoS model is not fail-safe. The complexity of coastal processes combined with the uncertainty of future waves, storms and sediment supply makes the task of predicting future coastal flooding very difficult. This section discusses some of the model's assumptions that introduce degrees of uncertainty in its results, as well as other assumptions used as conservative parameters or a margin of security against risk.

CoSMoS-COAST utilizes the historic nourishment rate of an area to develop projections for the rate of future nourishment.

The amount of nourishment (available sediment) to a particular area of shoreline directly affects its ability to recover from erosion. For the shoreline near the Puente site, the primary source of sediment is discharge from the Santa Clara River as well as the Ventura River. Although this stretch of the shoreline has experienced an overall increase of beach width over the last 50 years, infrequent severe floods are thought to be responsible for delivering the majority of sediment to the coast. Significant amounts of sediment from the Santa Clara River are closely tied to major flood events that occurred in 1969, 1978, 1993, and 2005 (SWS 2011). Because the rate of nourishment is expressed as the average annual amount per year, the model assumes a steady supply of sediment which does not represent the actual episodic nature of the supply.

The following assumptions help limit the potential risk of substituting steady nourishment in place of the actual episodic supply:

- Staff implemented the "no nourishment" option in the CoSMoS-COAST model, which stops all natural and manmade sources of sediment to the area as of 2010. This acts as a conservative parameter by assuming that during the life of the project, the Santa Clara River does not contribute any sediment to the shoreline, Ventura Harbor is no longer dredged, and sediment management at Channel Islands Harbor (or lack thereof) does not contribute any sediment to the project area shoreline.

[11] TN # 216784

[12] The elevation of the existing administration and warehouse buildings (i.e., top of concrete slab foundation) is at elevation 14 ft. Based on the applicant's presentation, staff understands this to mean that operations can continue regardless of water level elevation that floods these buildings.

- Staff assumes that 2.0 ft of SLR is expected by 2050. This also acts as a conservative parameter by assuming elevated water levels (see **Soil & Water Resources Table 2**).

CoSMoS assumes that the modeled 100-year storm occurs only once.

Pacific Coast beaches experience typical seasonal changes, where beaches become more narrow and flat during winter months then generally recover by the end of the summer. Storm erosion follows a similar but more rapid pattern compared to seasonal erosion and could require more time to recover. One large storm or a series of storms can potentially cause significant erosion that could take several seasons to several years to recover. Because CoSMoS models the 100-year storm only once, this assumes that all other storms are small enough and infrequent enough to allow the beach to recover prior to this large storm.

The following assumptions help limit the potential risk of accepting that the 100-year storm occurs only once:

- CoSMoS 3.0 Phase 2 models the 100-year storm assuming that it occurs during spring tide[13]. This acts as a conservative parameter by assuming elevated water levels due to astronomical tides.
- CoSMoS 3.0 Phase 2 incorporates flows from coastal rivers by estimating peak fluvial discharge rates based on sea level pressure gradients associated with atmospheric storm patterns for future storms. Fluvial discharges might locally impede and amplify flooding associated with coastal storms.
- Staff assumes that 2.0 ft of SLR is expected by 2050. This also acts as a conservative parameter by assuming elevated water levels (see **Soil & Water Resources Table 2**).
- Staff's assumption to limit the analysis to the year 2050, although directed by the Committee's Order, also reduces the likelihood that multiple large storms would occur in that timeframe. For example, the probability of a 100-year storm occurring twice in a 50-year period is 8 percent, compared to 18 percent of occurring twice in 100 years.
- Staff assumes that the proposed project's storm water management systems become overwhelmed and cease to effectively drain onsite water. This acts as a conservative parameter by allowing water to accumulate onsite.

COASTAL FLOODING RISK

As shown in **Soil & Water Resources Supplemental Testimony Figure 4**, no flooding is expected on any portion of the Puente site or existing MGS site.

[13] Contrary to what its name implies, spring tide is not related to the spring season. Instead it corresponds to the position of the moon. In Southern California, spring tide is the near-worst case tide levels that occur approximately twice every month for a total of approximately eight days. The worst case tide is the "King Tide" being slightly higher but much less frequent, occurring typically only twice (each for three to four days) per year.

Staff also evaluated two other scenarios using considerably more conservative SLR values of 4.9 ft and 6.6 ft. As presented in **Soil & Water Resources Table 2**, both of these values are beyond the "likely range" for 2100 projections. Model results in **Soil & Water Resources Supplemental Testimony Figure 7** show no flooding of the site with 4.9 ft of SLR and partial flooding with 6.6 ft of SLR.[14]

Soil & Water Resources Supplemental Testimony Figure 8 shows the profiles of projected flooding at the Puente site and MGS site for the 6.6-ft (2.0-meters) SLR scenario. Profile B, the projected water level elevation at the MGS site, is approximately 16 ft which continues to the facility's administration building and warehouse. Although Profile A shows that the projected water level elevation does not affect the Puente site, the flood map shows that the water level encroaches on the southern boundary of the site. Again, the green line in the profile represents present-day topography, prior to long-term shoreline evolution and storm-induced erosion. The projected water level (solid blue line) indicates the extent of beach and dune erosion, but final topography after the storm event is not shown. The dashed blue line shown represents the small section of the dune that is elevated enough to avoid flooding, and suggests that wave impacts would reshape the dunes considerably.

For perspective, **Soil & Water Resources Supplemental Testimony Figure 9** shows projected flooding for the 6.6-ft SLR scenario for the Oxnard coast between the Santa Clara River and Channel Islands Harbor. Flooding appears to propagate inland via streets, waterways, and low-lying areas of the Santa Clara River.

DISCUSSION

Staff concludes that mitigation for maintaining reliability against flooding is not warranted because the water level elevation projected for 2050 is less than 15 ft.

- Under the 2.5-ft and 4.9-ft SLR scenarios, no flooding is projected on any portion of the Puente site or existing MGS site due to the 100-year event. These conservative SLR scenarios also include the assumptions described above such as diminished sand replenishment, event concurrence with spring tide, and possible effects of river flows.
- Under the extreme condition of 6.6-ft SLR scenario, model results show no flooding toward the middle of the Puente site where the surface elevation is about 14.5 ft. This suggests that the small portion of the project site that shows flooding does not exceed elevation of 14.5 ft.
- Additionally, staff notes that removal of the existing ocean outfall structure and subsequent beach restoration would eliminate the open pathway for water. This is demonstrated in **Soil & Water Resources Supplemental Testimony Figure 7** for the 4.9-ft SLR scenario. The stretch of beach located adjacent to Mandalay Beach Park can more effectively reduce the wave energy that causes beach erosion.

[14] The green areas represent low-lying areas that are below the projected water level elevation but are not hydraulically connected to the flood. If the flood barrier was somehow removed or breached, these areas are expected to flood.

Staff has reached the same conclusion as in the FSA, that no mitigation for reliability is warranted. In the FSA, staff asserted that the likelihood of flooding is low and the redundant nature of the electrical grid system reduces the negative consequences of Puente becoming inoperable. In this analysis, staff reinforces the determination that the likelihood is extremely low that flood waters would result in Puente becoming inoperable. Staff notes that the FSA recommends Condition of Certification **SOIL&WATER-6** which requires development of a Beach and Dune Monitoring Plan. This condition of certification was not intended to mitigate a specific impact. However, it would include triggers for further action based on beach narrowing and/or dune loss, and require identification of measures that could halt or slow erosion without construction of shoreline protective devices. The condition would also prohibit construction of any permanent shoreline protection devices for the project which is important to the California Coastal Commission (CCC) for consistency with their policy and regulations.

Staff originally included this condition in the FSA to accommodate the CCC 30413(d) Report. As discussed in the FSA, the applicant indicated to staff their agreement to implement many of the CCC recommendations. Although the CCC recommendations exceed staff's recommended requirements with regards to potential erosion and flooding impacts, staff respects the CCC's position and the applicant's willingness to address their concerns. Staff further acknowledges that such a monitoring program could provide an early warning system for identifying changes to beach and shoreline conditions that are not expected and, if necessary, responsible parties can take any appropriate future actions to ensure reliability. Also, since staff concludes there is no need for mitigation to ensure power plant reliability, staff agrees it would be prudent to ensure no permanent structures should be constructed for Puente consistent with CCC policy and regulations. For these reasons, staff continues to recommend **SOIL&WATER-6.**

CONCLUSIONS

Staff's conclusions based on analysis of the information detailed above are as follows:

1. The best approach to supplement the assessment of coastal flooding risk is utilizing CoSMoS 3.0 Phase 2, which is consistent with the state guidance for sea-level rise (using the most recent and best available science, considering timeframe and risk tolerance, considering storms and other extreme events, and changing shorelines).

2. The use of 2.0 ft as a conservative assumption for sea level rise by 2050 is appropriate for this analysis.

3. Model results show that projected flooding for the 100-year event with 2.0 ft of sea level rise does not reach the project site. In addition, model results for two more conservative sea level rise scenarios (4.9 ft and 6.6 ft) indicate that projected water elevations would not cause Puente to cease operations.

4. Analysis of flood risks identified in FEMA maps, adjusted to account for two feet of sea level rise as described in the Technical Methods Manual, is consistent with flooding projections predicted by the CoSMoS model.

5. Mitigation for maintaining reliability against flooding is not warranted because the water level elevation projected for 2050 is less than 15 ft.

6. Despite staff's determination that mitigation is not required, staff continues to recommend **SOIL&WATER-6** to accommodate the California Coastal Commission 30413(d) Report.

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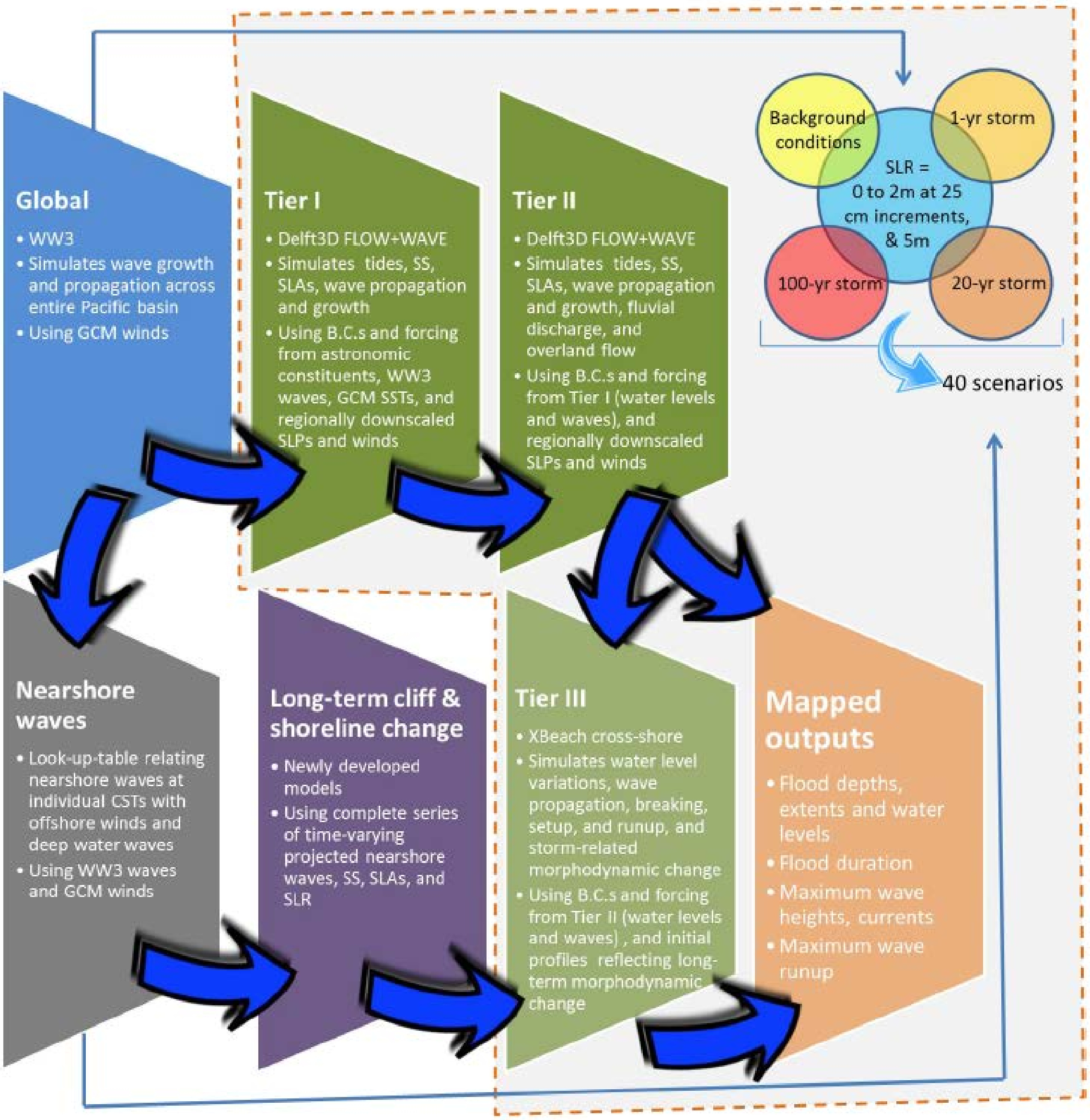
Puente Power Project – Schematic of CoSMoS 3.0 Phase 2



Abbreviations:

B.C.s - boundary conditions
CST - cross shore transect
GCM - global climate model
SLR - sea-level rise
SLP - sea-level pressure
SLA - sea level anomalies
SS - storm surge
SST – sea surface temperature
WW3 - WaveWatch3

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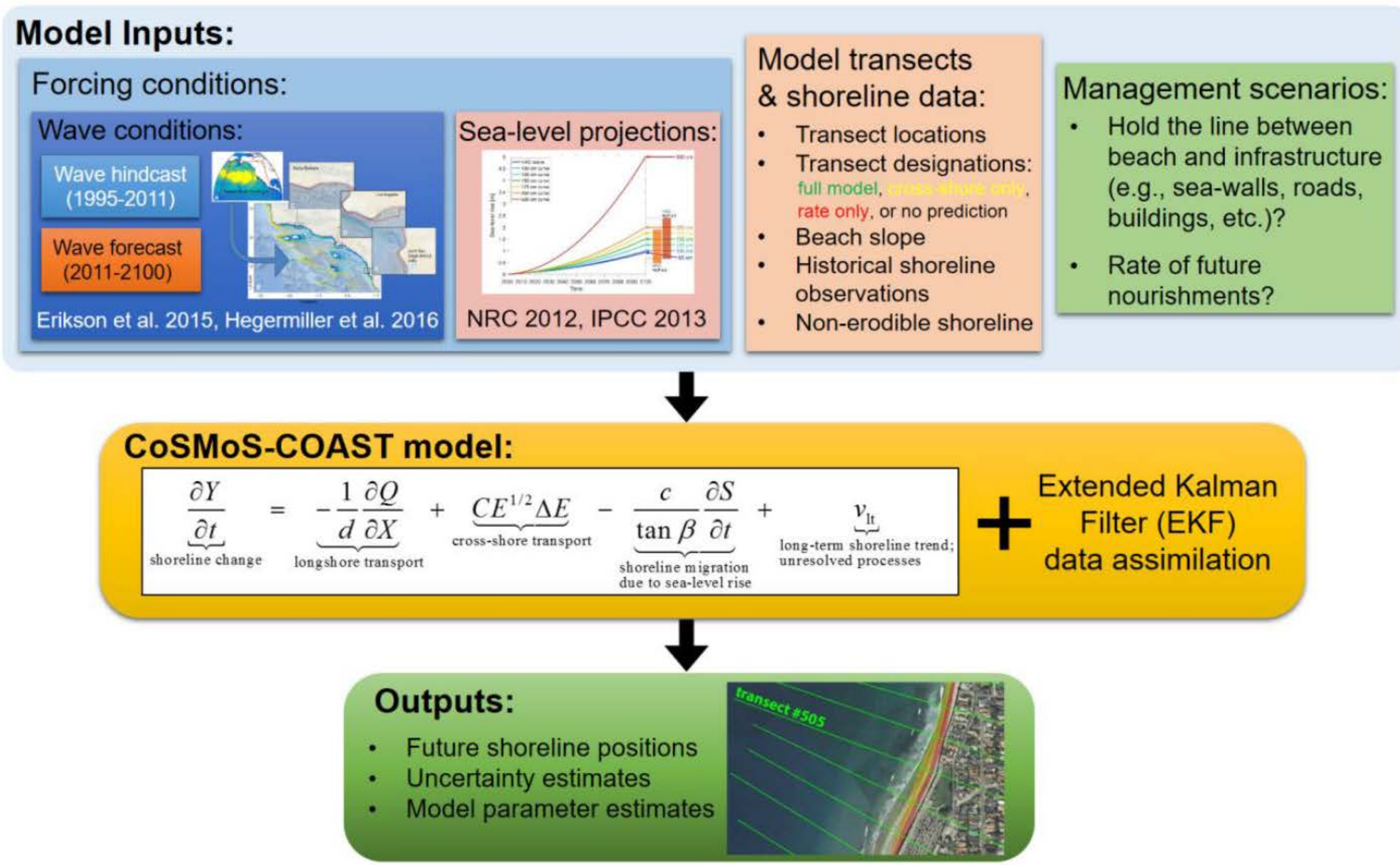
SOURCE: USGS 2017

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 2

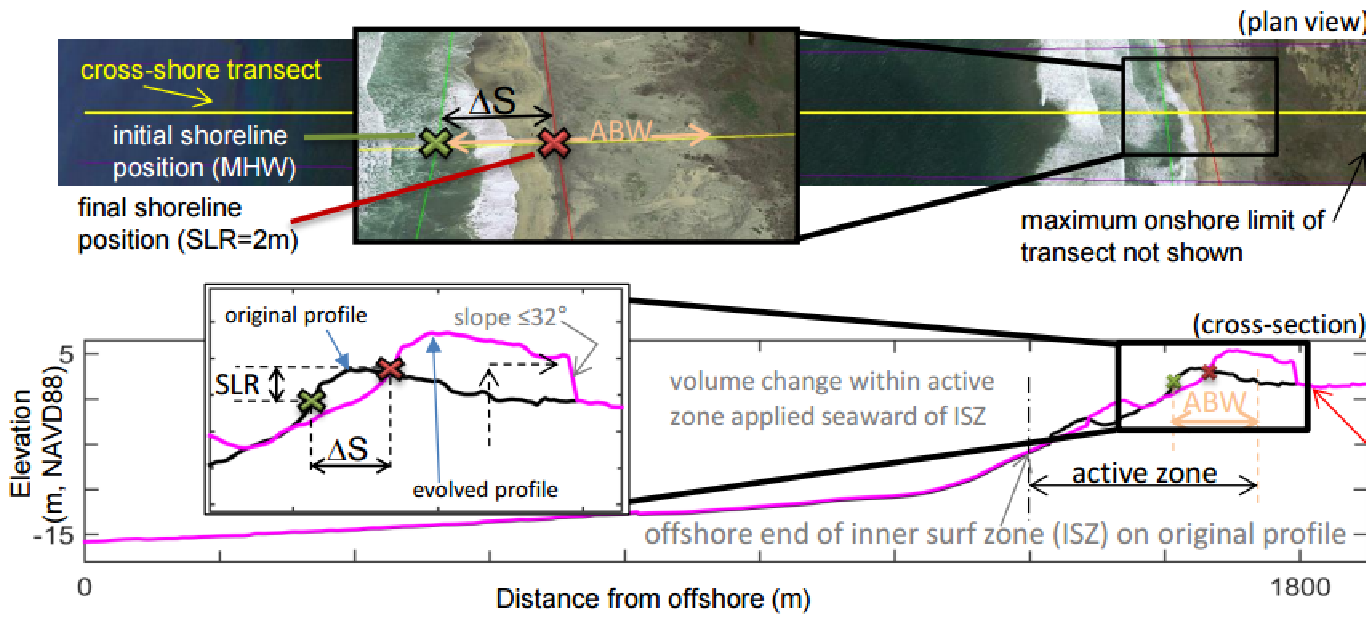
Puente Power Project – Schematic of CoSMoS-COAST



SOURCE: VIT 2017

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 3

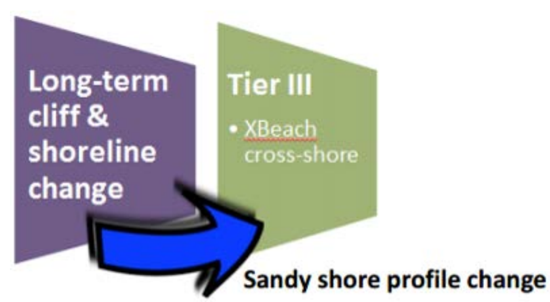
Puente Power Project – Example of Sandy Shore Profile Change



Landward Limit

1. profile assumed to be in 'dynamic' equilibrium
2. translate that section of the profile from the seaward end of the inner surf zone (ISZ) to a sub-aerial point that estimates the location of active tide, wave, and storm surge effects, or flood protection infrastructure by ΔS and SLR
3. volume change within active zone is applied seaward of ISZ

ΔS - change in mean high water position
ABW - active beach width
ISZ - inner surf zone
MHW - mean high water
SLR - sea level rise



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SOURCE: USGS 2017

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 4

Puente Power Project – Flooding Extent of 100-Year Total Water Level Event with 75cm Sea Level Rise

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SOURCE: NOAA 2009 – 2011 CA Coastal Conservancy Coastal Lidar Project – Hydro-flattened Bare Earth DEM, USGS CoSMoS 3.0 Phase 2 Water Level Projections-100 year Storm in Ventura County (75 cm) 15th April 2017, AECOM, and California Energy Commission

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 5

Puente Power Project – CoSMoS v3.0 Projections of Shoreline Change

Puente Power Project Site

Initial Shoreline

Transect

Projections of Shoreline Change – Sea Level Rise of 58 cm (1.9 ft) at January 2050

Final Shoreline (with no nourishment)

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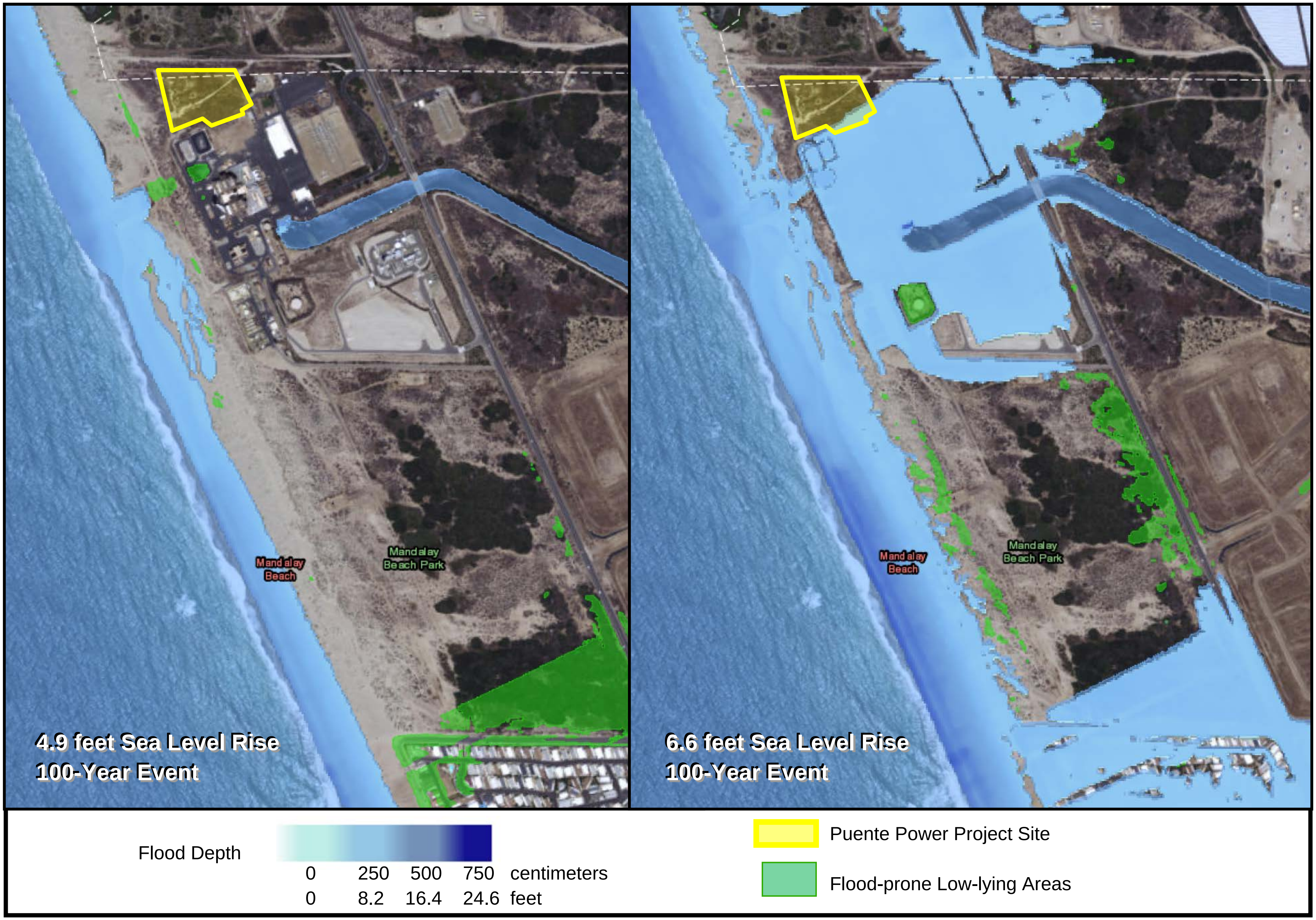
SOURCE: CoSMoS Southern California v3.0 Phase 2 (https://www.sciencebase.gov/catalog/folder/5633fea2e4b048076347f1cf) accessed May 9, 2017

Puente Power Project – Projections of FEMA VE-Zone Change

SOURCES: Modified from City 2017, Figure 9, and CCC 2012

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 7

Puente Power Project – Flooding Extent of 100-Year Event (Sea Level Rise 4.9 feet and 6.6 feet)



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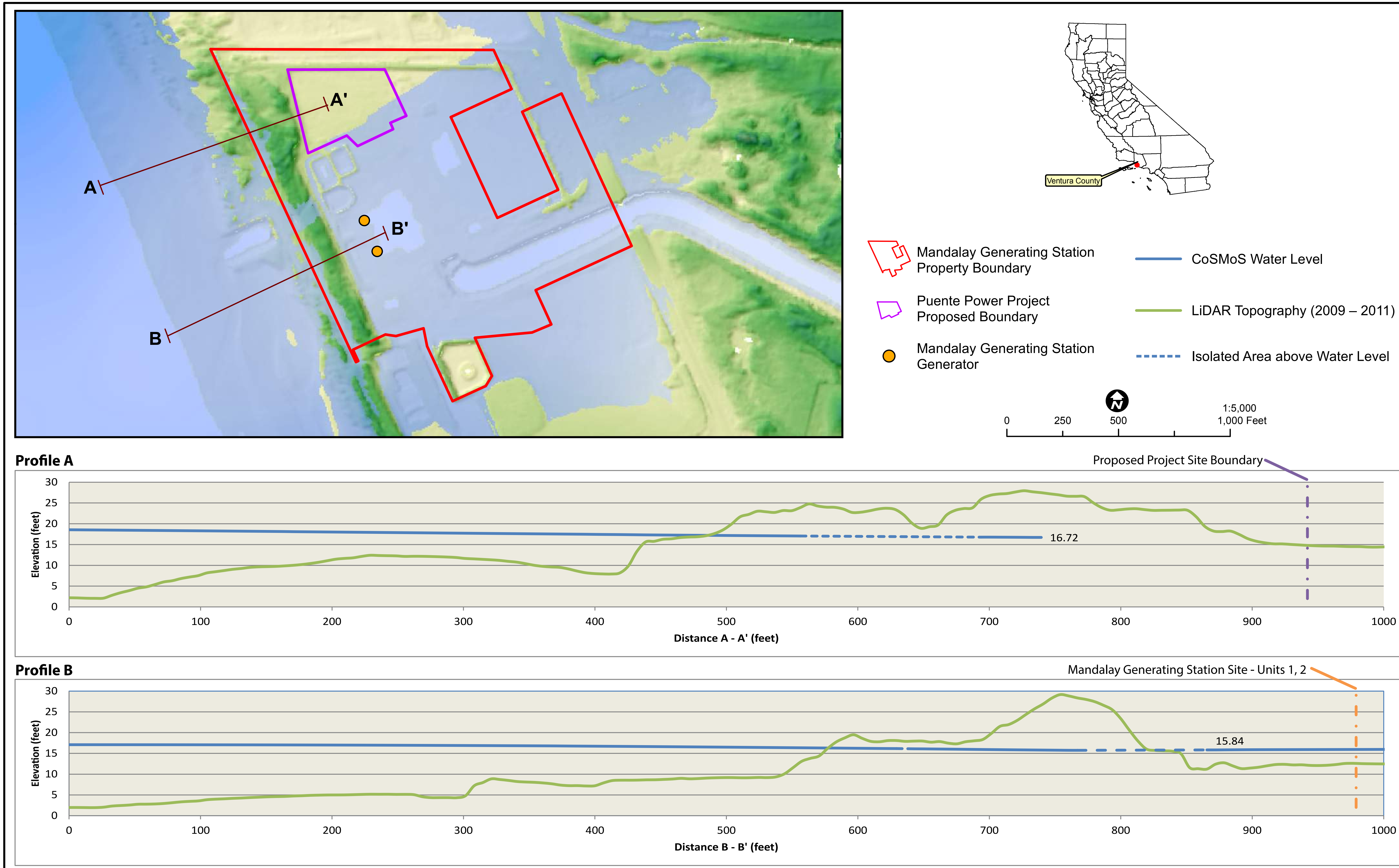
SOURCE: Our Coast, Our Future (http://data.pointblue.org/apps/ocof/cms/) accessed June 7, 2017

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 8

Puente Power Project – Flooding Extent of 100-Year Total Water Level Event with 200cm Sea Level Rise



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SOURCE: NOAA 2009 – 2011 CA Coastal Conservancy Coastal Lidar Project – Hydro-flattened Bare Earth DEM, USGS CoSMoS 3.0 Phase 2 Water Level Projections-100 year Storm in Ventura County (75 cm) 15th April 2017, AECOM, and California Energy Commission

SOIL & WATER RESOURCES

SOIL & WATER RESOURCES SUPPLEMENTAL TESTIMONY - FIGURE 9

Puente Power Project – Flooding Extent of 100-Year Event (Sea Level Rise 6.6 feet)

CALIFORNIA ENERGY COMMISSION - SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION

SOURCE: Our Coast, Our Future (http://data.pointblue.org/apps/ocof/cms/) accessed June 7, 2017

TRAFFIC AND TRANSPORTATION ALTERNATIVES

TRAFFIC AND TRANSPORTATION ALTERNATIVES
SUPPLEMTAL TESTIMONY

Testimony of
Jonathan Fong and Andrea Koch

SUMMARY OF CONCLUSIONS

Energy Commission staff evaluated the use of alternative combustion turbine generator (CTG) designs at the two off-site alternatives for the Puente Power Project (Puente or project): the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative. Staff determined that with the use of the alternative CTG designs (LM6000 and LMS100) at the alternative sites, the significance conclusions for impacts to aviation from thermal plumes would remain the same as for Puente at the alternative sites. For both CTG design alternatives, plume impacts to aviation at the Del Norte/Fifth Street Off-site Alternative would be significant and unmitigable, as with Puente. At the Ormond Beach Area Off-site Alternative, plume impacts from both alternative CTG designs would be potentially significant but less than significant with mitigation, as with Puente.

INTRODUCTION

In the Final Staff Assessment (FSA), staff concluded that development of the project at the Del Norte/Fifth Street Off-site Alternative would result in significant and unavoidable impacts to aviation, while development at the Ormond Beach Area Off-site Alternative would result in less than significant impacts to aviation. During the Evidentiary Hearings, staff modified the impacts conclusion for the Ormond Beach site, testifying that based on a letter received from Naval Base Ventura County (NBVC), impacts to aviation for the Ormond Beach site would be potentially significant and similar to aviation impacts at the proposed project site.

On March 10, 2017, after completion of the Evidentiary Hearings, the Committee issued an order for additional evidence. As part of this order, the Committee asked for an analysis of the use of one or more smaller (50-100 MW) turbines at the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative, instead of the larger turbine proposed by the applicant as part of Puente. The Committee wanted this analysis to help determine whether it is feasible to reduce or eliminate the identified potential impacts to aviation at these alternative sites.

In response to this order, Traffic and Transportation and Air Quality staff evaluated the thermal plumes that would be generated by one or more smaller turbines at the alternative sites and determined the resulting impacts to aviation. Traffic and Transportation staff also evaluated whether the exhaust stacks of the smaller turbines would penetrate navigable airspace at the alternative sites and require the applicant to file a “Notice of Proposed Construction or Alteration” (Form 7460-1) with the Federal Aviation Administration (FAA), to initiate the FAA’s obstruction hazard review of the structures. This analysis details staff’s findings.

POTENTIAL IMPACTS OF THERMAL PLUMES ON AIRCRAFT AND PILOT SAFETY

Using both the Spillane Approach and the Exhaust Plume Analyzer developed by the MITRE Corporation, Air Quality staff modeled the plumes from two alternative CTG designs. The first alternative design (LM6000 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 275 MWs. The facility would consist of up to five LM6000-PG Sprint CTGs (nominal 55 MWs each). The second alternative design (LMS100 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 300 MWs. The facility would consist of up to three LMS100-PB CTGs (100 MW each).

Staff evaluated the plume impacts from these alternative technologies at the alternative sites (the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative) and compared them to the plume impacts from the proposed project at these alternative sites.

Spillane Approach Plume Modeling

Staff typically uses the Spillane Approach to evaluate the velocity of thermal plumes exiting CTG stacks. Plume velocity is highest at a stack's exit point, reducing with increasing altitude. Plume velocity is also higher under conditions of calm wind and cool weather. Staff's calculations under the Spillane Approach assume these weather conditions, as well as simultaneous operation of all CTG stacks for each design alternative, in order to estimate the worst-case plume velocity.

Staff uses a peak vertical plume velocity of 10.6 meters per second (m/s) (or a 5.3 m/s average plume velocity) as a screening threshold for potential impacts to aircraft. Velocities higher than this can result in severe turbulence to aircraft that can threaten aircraft control and safety. Details of the plume analysis using the Spillane Approach can be found in **Appendix TT-1** of this analysis, and the results are discussed later in this document.

MITRE Exhaust Plume Analyzer

The FAA has recently identified the MITRE Corporation's Exhaust Plume Analyzer (MITRE model) as a potentially effective tool for assessing the impact that exhaust plumes may impose on flight operations (FAA 2015). MITRE does not provide output in terms of vertical velocity, which is the metric used by the Spillane Approach, discussed above. Instead, the MITRE model provides output in the form of graphical risk probability isopleths ranging from 10^{-2} to 10^{-7} risk probabilities for both "severe turbulence" and "upset" for four different aircraft types: (1) light sport aircraft, (2) light general aviation (GA) aircraft, (3) business jets, and (4) narrow body jets. The FAA has not yet provided guidance on how to evaluate the risk probability isopleth output of the MITRE model. However, the MITRE Corporation suggests that a probability of severe turbulence at an occurrence level of greater than 1 x 10^{-7} (called a Target Safety Level, or TSL) should be considered potentially significant. This is equivalent to one occurrence of severe aircraft turbulence in 10 million flights traversing through the area of the plume. More details on the MITRE model can be found in **Appendix TT-2** of this analysis.

The results of the MITRE model show that for the two alternative CTG designs at the alternative sites, as well as the Puente CTG design at the alternative sites, the MITRE-recommended TSL of 10^{-7} is exceeded up to more than 3,500 feet above ground level (AGL) for light sport aircraft and light GA aircraft (when the turbines are simultaneously operated). Business jets and narrow body jets would experience risks exceeding the TSL at lower altitudes. Please see Tables 2, 3, and 4 in **Appendix TT-2** for more information.

The MITRE model is subject to a few limitations, as discussed in **Appendix TT-2**. For example, the results in this case for the types of aircraft most vulnerable to impacts from plumes (light sport and light GA aircraft) were well above 3,000 feet AGL, outside the recommended output range of the model and above the 3,500 foot level provided as the highest extent in the model's graphical output files. Another major limitation is that the FAA has not yet provided guidance on how to evaluate the risk probability isopleth output of the MITRE model. Also, risk probability generated by the model is based on 8,760 hours of operation per year, while the simple cycle CTGs used in the design alternatives (and in the Puente project) would be limited to a much lower number of operational hours, and would likely operate even less in practice. This means that the risk probabilities generated by the MITRE model for the CTG design alternatives and Puente are likely overstated. For these reasons, as well as other limitations discussed in **Appendix TT-2**, Air Quality staff does not currently recommend use of the MITRE model for evaluating thermal plume impacts to aircraft.

Del Norte/Fifth Street Off-site Alternative

Traffic and Transportation staff has reviewed Air Quality staff's plume modeling to see if either of the CTG design alternatives would result in reduced impacts to aviation at the Del Norte/Fifth Street Off-site Alternative as compared to the Puente project.

Using the MITRE model, the MITRE-recommended TSL of 10^{-7} would be exceeded up to more than 3,500 feet AGL for light sport aircraft and light GA aircraft. This would be a significant impact, as aircraft would be expected to regularly pass over the site at altitudes below 3,500 feet AGL due to the close proximity of Camarillo Airport. However, as discussed earlier, staff does not recommend use of the MITRE model due to its limitations.

Using the Spillane Approach, staff found that at the Del Norte/Fifth Street Alternative, peak vertical plume velocity would exceed 10.6 m/s at altitudes below:

- 512 feet AGL for just one stack operating and up to 1,170 feet AGL if all five stacks were operating simultaneously for the LM6000 alternative design
- 656 feet AGL for just one stack operating and up to 1,333 feet AGL if all three stacks were operating simultaneously for the LMS100 alternative design

Using the Spillane Approach, thermal plumes for both the LM6000 and LMS100 alternative designs would drop below the critical velocity threshold at much lower altitudes than the plumes from Puente at the Del Norte/Fifth Street Off-site Alternative, as Puente's peak vertical plume velocity would exceed 10.6 m/s up to 2,375 feet AGL. The thermal plumes from the LM6000 design would drop below the threshold at the lowest altitude. It would produce plumes exceeding a peak vertical velocity of 10.6 m/s up to 1,170 feet AGL under worst-case conditions (cool, calm weather and simultaneous operation of all five stacks). Aircraft could fly at lower altitudes before being affected by the LM6000 and LMS100 plumes, as compared to Puente's plumes.

However, plume impacts to aviation would still be significant and unmitigable for both CTG design alternatives at the Del Norte/Fifth Street Off-site Alternative, regardless of how many stacks are operating. The Camarillo Airport is located approximately 1.4 miles from the site, and aircraft operating out of the airport would be expected to commonly overfly the site at low altitudes. According to aircraft arrival and departure tracks shown in Exhibits 2F and 2G of the Airport Comprehensive Land Use Plan for Ventura County, arriving aircraft and arriving and departing helicopters often pass very close to and sometimes directly over the Del Norte/Fifth Street alternative site. (See **Supplemental Testimony Figure 1** and **Figure 2** for details.) Many of these aircraft could fly at altitudes where they could experience severe turbulence from thermal plumes (up to 1,170 feet AGL for the LM6000 and up to 1,333 feet AGL for the LMS100) because the traffic pattern altitude for the nearby airport is 800 feet AGL for single-engine aircraft and 1,000 feet AGL for multi-engine and jet aircraft. Even if fewer stacks were operating, and peak vertical plume velocity was less than 10.6 m/s at the level of the traffic pattern (as it would be for both alternative CTG designs, for example, during operation of just one stack), pilots are advised by the FAA to avoid overflight of plumes out of caution (FAA 2015a), and it would be difficult for pilots to avoid these plumes so close to the traffic pattern. Therefore, even under this scenario, plume impacts to aviation would be significant and unmitigable.

There is also ultralight aircraft activity within the southwest quadrant of the airport, which is likely near the Del Norte/Fifth Street site located southwest of the airport (AIRNAV 2017). Ultralights are especially susceptible to impacts from plumes due to their light weight. Finally, the fact that aircraft may enter or exit the traffic pattern near the Del Norte/Fifth Street site makes them more vulnerable to impacts from plumes, not just because of their lower altitudes, but because turning aircraft could experience more severe impacts from plumes than aircraft flying straight ahead.

Ormond Beach Area Off-site Alternative

Traffic and Transportation staff also reviewed Air Quality staff's plume modeling to see if either of the CTG design alternatives would result in reduced impacts to aviation at the Ormond Beach Area Off-site Alternative as compared to the proposed project.

Using the MITRE model, the MITRE-recommended TSL of 10^{-7} would be exceeded up to more than 3,500 feet AGL for light sport aircraft and light GA aircraft. This would be a significant impact, as aircraft would be expected to pass over the site at altitudes below 3,500 feet AGL, especially given nearby aviation activity operating out of Naval Base

Ventura County (NBVC) Point Mugu. However, as discussed earlier, staff does not recommend use of the MITRE model due to its limitations.

Using the Spillane Approach, staff found that at the Ormond Beach Area Off-site Alternative, peak vertical plume velocity would exceed 10.6 m/s at altitudes below:

- 512 feet AGL for just one stack operating and up to 1,170 feet AGL if all five stacks were operating simultaneously for the LM6000 alternative design
- 656 feet AGL for just one stack operating and up to 1,333 feet AGL if all three stacks were operating simultaneously for the LMS100 alternative design

These results are the same as those for the Del Norte/Fifth Street Off-site Alternative.

Using the Spillane Approach, thermal plumes for both the LM6000 and LMS100 alternative designs would drop below the critical velocity threshold at much lower altitudes than the plumes from Puente at the Ormond Beach Area Off-site Alternative, as Puente's peak vertical plume velocity would exceed 10.6 m/s up to 2,375 feet AGL. The thermal plumes from the LM6000 design would drop below the threshold at the lowest altitude. It would produce plumes exceeding a peak vertical velocity of 10.6 m/s up to 1,170 feet AGL under worst-case conditions (cool, calm weather and simultaneous operation of all five stacks). Aircraft could fly at lower altitudes before being affected by the LM6000 and LMS100 plumes, as compared to Puente's plumes.

However, like the Puente project at the Ormond Beach Area Off-site Alternative, impacts from both alternative CTG designs would be potentially significant but less than significant with mitigation. This is true regardless of how many stacks would be operating. Aircraft at NBVC Point Mugu, located approximately 3 miles southeast of the Ormond Beach Area Off-site Alternative, conduct Field Carrier Landing Practice (FCLP) at Point Mugu from Runway 27 at 600 feet AGL. The standard FCLP traffic pattern does not result in overflight of the Ormond Beach Area Off-site Alternative, but aircraft could potentially overfly the site when Air Traffic Control extends the downwind leg of the pattern to accommodate air traffic on Runway 03/21. Also, according to NBVC Point Mugu, passenger aircraft departing the runway at NBVC Point Mugu regularly fly over or near the Ormond Beach alternative site while climbing between 1,000 and 3,000 feet AGL (NBVC 2017).

Although flights currently occur over the Ormond Beach Area Off-site Alternative, pilots could avoid low altitude overflight of the site. The site is located approximately 3 miles from NBVC Point Mugu and is not adjacent to an airport traffic pattern or under a published flight route. Staff would recommend conditions of certification similar to those for the project to reduce aviation impacts to less than significant. Conditions would include a requirement for the addition of a remark to applicable FAA aviation maps and documents and issuance of a Notice to Airmen warning pilots to avoid overflight of the site.

Potential for Exhaust Stacks to Obstruct Airspace Above the Site

The proposed Puente project consists of a single 188-foot-tall exhaust stack. This exhaust stack would penetrate the navigable airspace at both the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative, requiring the applicant to file a “Notice of Proposed Construction or Alteration” (Form 7460-1) with the FAA to initiate the FAA’s obstruction hazard review of the structure. If the FAA were to determine that the exhaust stack presented an obstruction hazard, impacts on the safety of aircraft would be potentially significant and unavoidable for these off-site alternatives.

Use of the alternative CTG designs reduces the exhaust stack heights, with the LM6000 alternative design using five 60-foot-high stacks, and the LMS100 alternative design using three 80-foot-high stacks. The only alternative CTG design scenario that would require FAA notification would be the LMS100 (with 80-foot-high stacks) at the Del Norte/Fifth Street Off-site Alternative, where the threshold for notification is a structure height of 73.9 feet. Obstruction impacts to aviation under this scenario would be potentially significant and unavoidable, like the proposed project at this site, if the FAA determined that the exhaust stacks presented an obstruction hazard. The LMS100 would not require notification at the Ormond Beach Area Off-site Alternative, where the threshold for notification is 158 feet. The LM6000, with its shorter 60-foot-high stacks, would not require notification at either site. Therefore, in every case but the LMS100 at the Del Norte/Fifth Street Off-site Alternative, FAA notification would not be required, and obstruction impacts to aviation would be less than those for Puente at the alternative sites, and not significant.

CONCLUSIONS

- The results of the MITRE model show that for the alternative CTG designs at the alternative sites, as well as for Puente’s CTG design at the alternative sites, the MITRE-recommended Target Safety Level of 10^{-7} is exceeded up to more than 3,500 feet above ground level (AGL) for light sport aircraft and light GA aircraft (when turbines are simultaneously operated). However, staff does not recommend use of the MITRE model due to the limitations discussed in **Appendix TT-2**.
- Using the Spillane Approach, both the LM6000 and LMS100 alternative designs would produce thermal plumes that would drop below the critical velocity threshold at much lower altitudes than the plumes from Puente at the Del Norte/Fifth Street Off-site Alternative. However, plume impacts to aviation would still be significant and unmitigable for both CTG design alternatives at the Del Norte/Fifth Street Off-site Alternative. The Camarillo Airport is located approximately 1.4 miles from the site, and aircraft operating out of the airport would be expected to commonly overfly the site at low altitudes, sometimes while turning to enter or exit the traffic pattern, making them more vulnerable to impacts from thermal plumes. There is also ultralight activity nearby, and ultralights are especially vulnerable to impacts from thermal plumes. Even if fewer stacks were operating, and peak vertical plume velocity was less than 10.6 m/s at the level of the traffic pattern (as it would be for both alternative CTG designs, for example, during operation of just one stack),

pilots are advised by the FAA to avoid overflight of plumes out of caution, and it would be difficult for pilots to avoid these plumes so close to the traffic pattern (FAA 2015a). Therefore, even under this scenario, plume impacts to aviation would be significant and unmitigable.

- Using the Spillane Approach, both the LM6000 and LMS100 alternative designs would produce thermal plumes that would drop below the critical velocity threshold at much lower altitudes than the plumes from Puente at the Ormond Beach Area Off-site Alternative. However, like the proposed project at the Ormond Beach Area Off-site Alternative, impacts from both alternative CTG designs would be potentially significant but less than significant with mitigation. Aircraft operations from NBVC Point Mugu do currently overfly the site, sometimes at lower altitudes, but pilots can avoid the site. Staff would recommend conditions of certification similar to those for Puente to reduce aviation impacts to less than significant. Conditions would include a requirement for the addition of a remark to applicable FAA aviation maps and documents and issuance of a Notice to Airmen warning pilots to avoid overflight of the site.
- The only alternative CTG design scenario that would require FAA notification would be the LMS100 (with 80-foot-high stacks) at the Del Norte/Fifth Street Off-site Alternative, where the threshold for notification is a structure height of 73.9 feet. Obstruction impacts to aviation under this scenario would be potentially significant and unavoidable, like for Puente at this site, if the FAA determined that the exhaust stacks presented an obstruction hazard.
- The LMS100 would not require notification at the Ormond Beach Area Off-site Alternative, where the threshold for notification is 158 feet.
- The LM6000, with its shorter 60-foot-high stacks, would not require notification at either site.
- In every case but the LMS100 at the Del Norte/Fifth Street Off-site Alternative, FAA notification would not be required, and obstruction impacts to aviation would be less than those for Puente at the alternative sites, and not significant.

REFERENCES

AIRNAV 2017 – AirNav, Camarillo Airport, http://www.airnav.com/airport/kcma, accessed May 2017.

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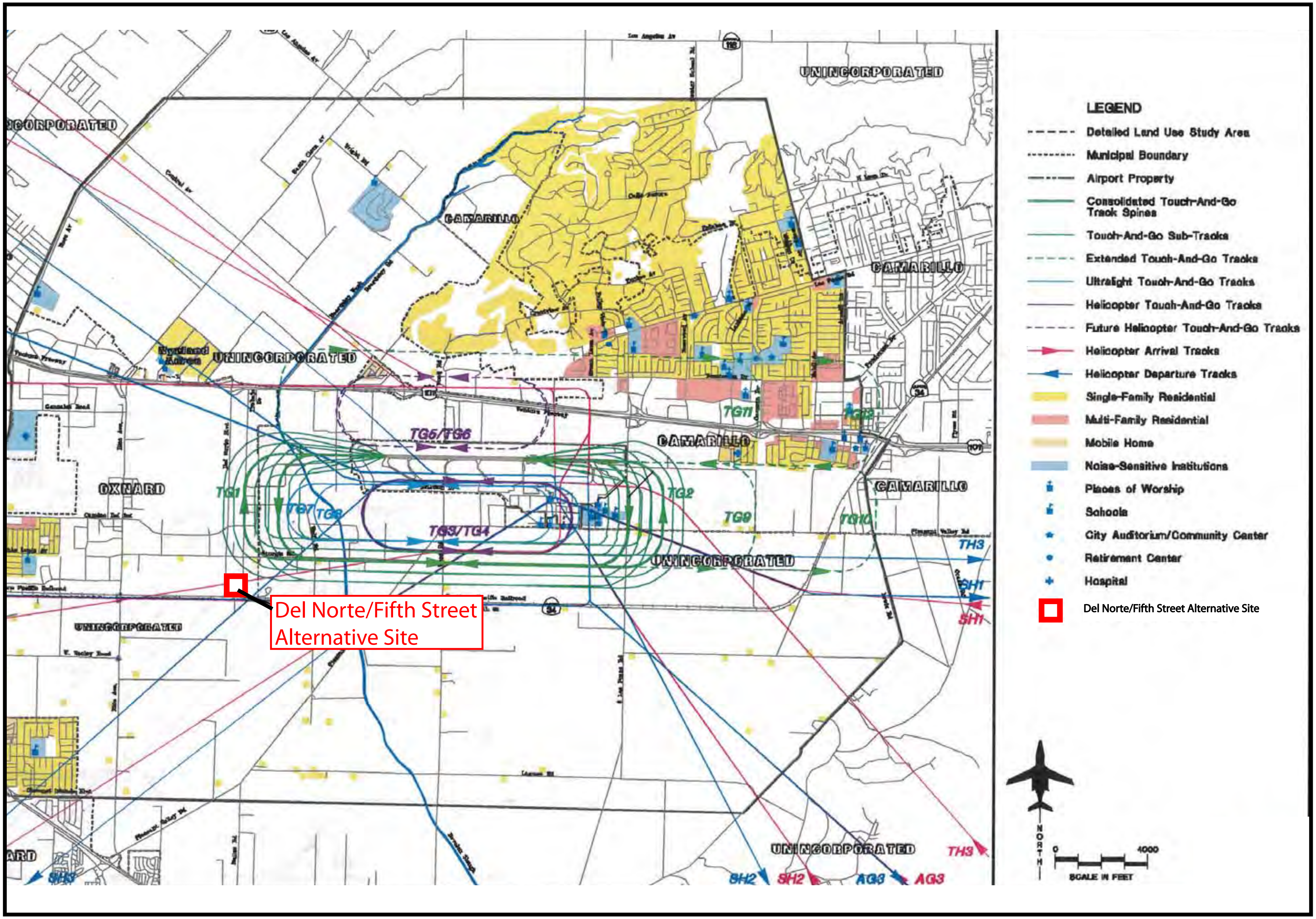
BVC 2017 – Department of the Navy, Naval Base Ventura County. FSA Comments (TN 215584), dated January 26, 2017. Submitted to CEC/Docket Unit on January 26, 2016. http://docketpublic.energy.ca.gov/PublicDocuments/15-AFC-01/TN215584_20170126T112931_Amanda_Fagan_Comments_NBVC_Comments_RE_FSA_Ormond_Beach_OffSite.pdf, accessed May 2017.

SUPPLEMENTAL TESTIMONY - FIGURE 1

Puente Power Project - Relation of the Del Norte/Fifth Street Off-site Alternative to Camarillo Airport Helicopter and Touch-and-Go Tracks

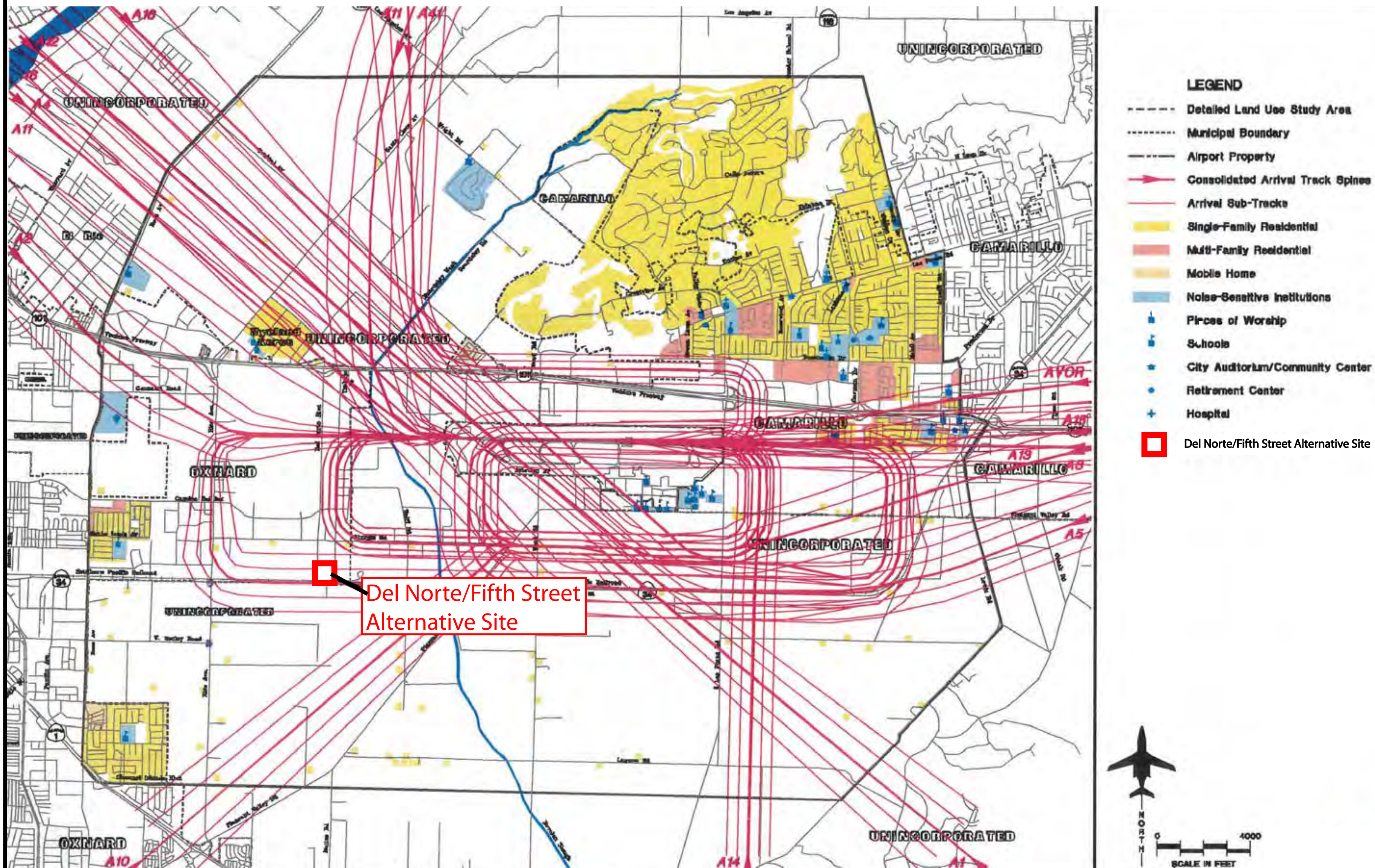


CALIFORNIA ENERGY COMMISSION - SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION

SOURCE: Ventura County Airport Land Use Plan

SUPPLEMENTAL TESTIMONY - FIGURE 2

Puente Power Project - Relation of the Del Norte/Fifth Street Off-site Alternative to Camarillo Airport Arrival Tracks



CALIFORNIA ENERGY COMMISSION - SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION

SOURCE: Ventura County Airport Land Use Plan

APPENDIX TT-1

THERMAL PLUME ANALYSIS FOR PUENTE PROJECT ALTERNATIVES – SPILLANE APPROACH

Testimony of Joseph Hughes, P.E.

INTRODUCTION

Following the completion of Evidentiary Hearings, the California Energy Commission (Energy Commission) Committee assigned to conduct proceedings on the Application for Certification (AFC) for the Puente Power Project (Puente) ordered staff to analyze the thermal plume(s) from the use of one or more smaller (50 – 100 megawatts [MWs]) combustion turbines instead of the larger single combustion turbine proposed by the applicant, for the two alternative sites analyzed in the Final Staff Assessment (FSA) - the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative. The Committee asks whether alternative technologies reduce or eliminate the previously identified potential impacts on aviation at these two alternative sites (TN: 216505).

The following provides an assessment of vertical plume velocities for the applicant-proposed turbine technology and for two alternative technology combustion gas turbines (CTGs) exhaust stack plumes. The results of the analyses can be applied to the Puente site and the two alternative sites, because the Spillane approach used in the analyses is dependent on calm wind conditions and does not depend upon local meteorology. This enables the analyses to compare the extent that the alternative turbine designs can mitigate the thermal plume impacts.

Staff completed calculations to determine the worst-case vertical plume velocities at different heights above ground based on the applicant-provided data for their design and using available operational exhaust data for the alternative combustion turbines. The purpose of this analysis is to provide documentation of the method used to estimate worst-case vertical plume velocities to assist evaluation of the proposed alternative project impacts on aviation safety in the vicinity of the two alternative sites using the Spillane approach. A separate analysis is presented in **Appendix TT-2** showing corresponding results using the MITRE model.

PROJECT DESCRIPTION

As proposed by the applicant, Puente would be a natural gas-fired, simple-cycle, air-cooled electrical generating facility that would have a single GE 7HA.01 combustion turbine generator (CTG) with a nominal generating capacity of 262 MW. To determine whether it is feasible to reduce or eliminate the previously identified potential significant and unavoidable impacts on aviation at the two alternative locations by utilizing different combustion turbine technologies with similar or less generating capacity, staff has evaluated thermal plume impacts from the following two alternative combustion turbine designs:

1. The first alternative design (LM6000 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 275 MW. The facility would consist of up to five LM6000-PG Sprint CTGs (nominal 55 MW each). Staff has calculated the thermal plume impacts from 1, 2, 3, 4, or 5 combustion turbines in simultaneous operation.

2. The second alternative design (LMS100 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 300 MW. The facility would consist of up to three LMS100-PB CTGs (100 MW each). Staff has calculated the thermal plume impacts from 1, 2, or 3 combustion turbines in simultaneous operation.

Each of these proposed alternatives (i.e. LM6000 Alternative and the LMS100 Alternative) would require heat rejection equipment, such as a wet surface air condenser or fin fan cooler for turbine inlet air cooling that would result in thermal plume impacts from the cooling equipment as well as from the main CTG stacks. However, previous analyses, such as the Alamitos Energy Center (AEC) FSA (CEC2016b, TN: 207151-1), have shown that thermal plume impacts from ancillary heat rejection equipment at simple-cycle facilities result in less significant thermal plumes than from the CTGs. Therefore, this analysis is limited to the CTGs exhaust stack and does not include the minor thermal plume impacts from the heat rejection equipment and process cooling.

Based on project design and site configurations for other AFCs consisting of similar equipment, these proposed alternatives (i.e., LM6000 Alternative and the LMS100 Alternative) are expected to fit at both alternative project locations (i.e. Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative). However, site reconfiguration, or staggering of construction with Mandalay 1 and 2 demolition activities may be necessary to fit the maximum number of CTGs in the LM6000 Alternative and/or the LMS100 Alternative at the Puente site.

PLUME VELOCITY CALCULATION METHOD

Staff has selected a calculation approach from a technical paper (Best 2003) to estimate the worst-case plume vertical velocities for the alternative technology exhausts. The calculation approach, which is also known as the “Spillane approach”, used by staff is limited to calm wind conditions, which are the worst-case wind conditions. The Spillane approach uses the following equations to determine vertical velocity for single stacks during dead calm wind (i.e. wind speed = 0) conditions:

(1) $(V^*a)^3 = (V^*a)_o^3 + 0.12^*F_o^*[(z-z_v)^2-(6.25D-z_v)^2]$

(2) $(V^*a)_o = V_{exit}^*D/2^*(T_a/T_s)^{0.5}$

(3) $F_o = g^*V_{exit}^*D^2{}^*(1-T_a/T_s)/4$

(4) $Z_v = 6.25D^*[1-(T_a/T_s)^{0.5}]$

Where: V = vertical velocity (m/s), plume-average velocity

a = plume top-hat radius (m, increases at a linear rate of $a = 0.16*(z- z_v)$

F_o= initial stack buoyancy flux m^4/s^3

z = height above stack (m)

z_v= virtual source height (m)

V_{exit}= initial stack velocity (m/s)

D = stack diameter (m)

T_a= ambient temperature (K)

T_s= stack temperature (K)

g = acceleration of gravity (9.8 m/s^2)

Equation (1) is solved for V at any given height above the stack (and then added to stack height to obtain height above ground) that is above the momentum rise stage for single stacks (where z > 6.25D) and at the end of the plume merged stage for multiple plumes. This solution provides the plume-average velocity for the area of the plume at a given height above ground; the peak plume velocity would be two times higher than the plume-average velocity predicted by this equation. As can be seen the stack buoyancy flux (F_o) is a prominent part of Equation (1). The calm condition calculation basis clearly represents the worst-case conditions, and the vertical velocity will decrease substantially as wind speed increases from calm conditions.

For multiple stack plumes, where the stacks are equivalent, the multiple stack plume velocity during calm winds was calculated by staff in a simplified fashion, presented in the Best Paper as follows:

(5) $V_m = V_{sp}*N^{0.25}$

Where: V_m = multiple stack combined plume vertical velocity (m/s)

V_{sp} = single plume vertical velocity (m/s), calculated using Equation (1)

N = number of stacks

Staff notes that this simplified multiple stack plume velocity calculation method predicts somewhat lower velocity values than the full Spillane approach methodology as given in data results presented in the Best paper (Best 2003).

GAS TURBINE DESIGN AND OPERATING PARAMETERS

The turbine design and operating parameter data for the LM6000 CTG exhaust stack was provided as part of the AFC for the Mission Rock Energy Center (Mission Rock) project (15-AFC-02). The turbine design and operating parameter data for the LMS100 CTG exhaust stack was provided as part of the AFC for the Alamitos Energy Center project (13-AFC-01). Because the exhaust parameters for the three different turbine technologies (i.e. GE 7HA, LM6000, and LMS100) were provided as part of separate AFCs for projects being proposed at separate locations, the exhaust parameters were provided at slightly different corresponding ambient temperatures. The differences in ambient temperature are negligible and do not significantly influence the corresponding exhaust parameters.

The vendor provided operating exhaust parameters for the three turbine technologies are shown in **Spillane Approach Tables 1-3**.

Spillane Approach Table 1
GE 7HA.01 CTG Exhaust Parameters

Parameter	GE 7HA.01		
Number of CTG Stacks	1		
Stack Heights (ft)	188 (57.3 meters)		
Stack Diameters (ft)	22 (6.71 meters)		
Distance Between Stacks (ft)	N/A		
CTG Load (%)	100		
Ambient Temperature (°F)	38.9	59.0	82
Exhaust Temperature (°F)	900	900	900
Exhaust Velocity in feet/second (ft/s) and meters/second (m/s)	155.7 (47.46 m/s)	159.2 (48.52 m/s)	151.30 (46.12 m/s)

Source: CEC2016a (TN: 214712)

Spillane Approach Table 2
LM6000 CTG Exhaust Parameters

Parameter	GE LM6000-PG		
Number of CTG Stacks	5		
Stack Heights (ft)	60 (18.29 meters)		
Stack Diameters (ft)	12 (3.66 meters)		
Distance Between Stacks (ft)[a]	100 (30.48 meters)		
CTG Load (%)	100		
Ambient Temperature (°F)	39.4	59	96
Exhaust Temperature (°F)	868	869	869
Exhaust Velocity in feet/second (ft/s) and meters/second (m/s)	102.9 (31.36 m/s)	103.1 (31.42 m/s)	105.2 (32.06 m/s)

Source: CAL2015 (TN: 207151-1)
Notes:

a. Average distance between stacks for the Mission Rock Energy Center for the LM6000 turbines and is used in this analysis to evaluate potential thermal plume merging.

Spillane Approach Table 3
LMS100 CTG Exhaust Parameters

Parameter	GE LMS100-PB		
Number of CTG Stacks	3		
Stack Heights (ft)	80 (24.38 meters)		
Stack Diameters (ft)	13.5 (4.11 meters)		
Distance Between Stacks (ft)[a]	100 (30.48 meters)		
CTG Load (%)	100		
Ambient Temperature (°F)	28	65.3	107
Exhaust Temperature (°F)	789	797	837
Exhaust Velocity in feet/second (ft/s) and meters/second (m/s)	109 (33.22 m/s)	109 (33.22 m/s)	99.2 (30.24 m/s)

Source: CEC2016b (TN: 213768)
Notes:
a. Staff evaluated turbine configurations and stack distances for several projects that have proposed, or consist of LMS100 turbines (i.e. Panoche Energy Center, Pio Pico, Amended Carlsbad Energy Center Project, and Alamitos Energy Center). Staff chose a distance between stacks of 100 feet to be a reasonable, conservative assumption and consistent with the operating design and exhausts parameters for the LMS100 CTGs to evaluate potential thermal plume merging.

PLUME VELOCITY CALCULATION RESULTS

As shown in **Spillane Approach Tables 1-3**, CTG exhaust velocities and temperatures for an individual CTG design only fluctuate slightly with ambient temperature. Therefore, the worst-case plume velocity impacts generally occur during colder ambient conditions due to thermal buoyancy. The Puente FSA, **Appendix TT-2**, Plume Velocity Analysis explained the worst-case predicted plume velocities occurred at 100 percent load without duct firing for the 38.9 ºF ambient temperature condition. This analysis compares the thermal plume impacts from the three CTG technologies using the exhaust parameters provided in **Spillane Approach Tables 1-3** at an ambient temperature of 38.9 ºF.

Using the Spillane approach method, the plume average vertical velocities at different heights above ground were determined by staff for calm conditions. Staff evaluated the potential for plume merging using the stack distances provided in **Spillane Approach Tables 1-3** and calculated plume diameters. Plumes begin merging when the radius of each of the two plumes added together equals the distance between the stacks. Merged stacks are calculated by adding the plume diameter to the stack diameter and dividing by the distance between stacks.

Spillane Approach Tables 4, 5, and 6 provides the estimated worst-case plume velocities for the three CTG technologies; GE 7HA, LM6000, and LMS100, respectively.

Spillane Approach Table 4
GE 7HA Worst-Case Predicted Plume Velocities (m/s)

GE 7HA (single stack)	
Height Above Ground (ft)	**Average Velocity (m/s)**
300	32.42
400	15.07
500	11.59
600	10.04
700	9.1
800	8.45
900	7.96
1000	7.57
1100	7.24
1200	6.97
1300	6.74
1400	6.53
1500	6.35
1600	6.19
1700	6.04
1800	5.91
1900	5.78
2000	5.67
2100	5.57
2200	5.47
2300	5.38
2400	5.29
2500	5.21
2600	5.14
2700	5.07
2800	5.00
2900	4.93
3000	4.87

Source: CEC2016a (TN: 214712)
Note: The GE 7HA exhaust plume's average vertical velocity is calculated to drop below 5.3 m/s (corresponding to a peak velocity of 10.6 m/s) at a height of approximately 2,375 feet above ground level.

Spillane Approach Table 5
LM6000 Alternative Worst-Case Predicted Plume Velocities (m/s)

LM6000														
1 Stack[a]			2 Stacks[b]			3 Stacks[c]			4 Stacks[d]			5 Stacks[e]		
Height (ft)	Velocity (m/s)	Number of Merged Plumes	Height (ft)	Velocity (m/s)	Number of Merged Plumes	Height (ft)	Velocity (m/s)	Number of Merged Plumes	Height (ft)	Velocity (m/s)	Number of Merged Plumes	Height (ft)	Velocity (m/s)	Number of Merged Plumes
300	6.83	1	300	6.83	1	300	6.83	1	300	6.83	1	300	6.83	1
400	5.91	1	400	6.08	1.12	400	6.08	1.12	400	6.08	1.12	400	6.08	1.12
500	5.36	1	500	5.86	1.44	500	5.86	1.44	500	5.86	1.44	500	5.86	1.44
600	4.97	1	600	5.72	1.76	600	5.72	1.76	600	5.72	1.76	600	5.72	1.76
700	4.67	1	700	5.56	2	700	5.61	2.08	700	5.61	2.08	700	5.61	2.08
800	4.44	1	800	5.28	2	800	5.52	2.40	800	5.52	2.40	800	5.52	2.40
900	4.25	1	900	5.05	2	900	5.45	2.72	900	5.45	2.72	900	5.45	2.72
1000	4.08	1	1000	4.86	2	1000	5.38	3	1000	5.39	3.04	1000	5.39	3.04
1100	3.94	1	1100	4.69	2	1100	5.19	3	1100	5.34	3.36	1100	5.34	3.36
1200	3.82	1	1200	4.54	2	1200	5.03	3	1200	5.29	3.68	1200	5.29	3.68
1300	3.71	1	1300	4.41	2	1300	4.89	3	1300	5.25	4.00	1300	5.25	4.00
1400	3.61	1	1400	4.30	2	1400	4.76	3	1400	5.11	4	1400	5.21	4.32
1500	3.53	1	1500	4.19	2	1500	4.64	3	1500	4.99	4	1500	5.17	4.64
1600	3.45	1	1600	4.10	2	1600	4.54	3	1600	4.87	4	1600	5.14	4.96
1700	3.37	1	1700	4.01	2	1700	4.44	3	1700	4.77	4	1700	5.04	5
1800	3.31	1	1800	3.93	2	1800	4.35	3	1800	4.68	4	1800	4.94	5
1900	3.24	1	1900	3.86	2	1900	4.27	3	1900	4.59	4	1900	4.85	5
2000	3.19	1	2000	3.79	2	2000	4.19	3	2000	4.51	4	2000	4.77	5

Spillane Approach Table 6
LMS100 Alternative Worst-Case Predicted Plume Velocities (m/s)

LMS100								
1 Stack[a]			2 Stacks[b]			3 Stacks[c]		
Height (ft)	Average Velocity (m/s)	Number of Merged Plumes	Height (ft)	Average Velocity (m/s)	Number of Merged Plumes	Height (ft)	Average Velocity (m/s)	Number of Merged Plumes
300	7.89	1	300	7.89	1	300	7.89	1
400	6.66	1	400	6.75	1.06	400	6.75	1.06
500	5.97	1	500	6.47	1.38	500	6.47	1.38
600	5.51	1	600	6.29	1.70	600	6.29	1.70
700	5.16	1	700	6.14	2	700	6.15	2.02
800	4.89	1	800	5.82	2	800	6.05	2.34
900	4.67	1	900	5.55	2	900	5.97	2.66
1000	4.49	1	1000	5.33	2	1000	5.89	2.98
1100	4.33	1	1100	5.15	2	1100	5.70	3
1200	4.19	1	1200	4.98	2	1200	5.51	3
1300	4.07	1	1300	4.84	2	1300	5.35	3
1400	3.96	1	1400	4.71	2	1400	5.21	3
1500	3.86	1	1500	4.59	2	1500	5.08	3
1600	3.77	1	1600	4.48	2	1600	4.96	3
1700	3.69	1	1700	4.39	2	1700	4.86	3
1800	3.62	1	1800	4.30	2	1800	4.76	3
1900	3.55	1	1900	4.22	2	1900	4.67	3
2000	3.48	1	2000	4.14	2	2000	4.58	3

Source: Staff calculations.
Notes:
a. Assumes only one turbine is in operation. When one turbine is in operation the plume average vertical velocity is calculated to drop below 5.3 m/s at a height of approximately 656 feet above ground.
b. Assumes two adjacent turbines are in simultaneous operation. When two adjacent turbines are in operation the plume average vertical velocity is calculated to drop below 5.3 m/s at a height of approximately 1,015 feet above ground.
c. Assumes all three turbines are in simultaneous operation. When three turbines are in operation the plume average vertical velocity is calculated to drop below 5.3 m/s at a height of approximately 1,333 feet above ground.

Spillane Approach Table 7 provides a comparison of the heights at which the plume velocities are expected to drop below the critical vertical velocity of concern of 5.3 m/s for the GE 7FA, five LM6000, and three LMS100 turbines.

Spillane Approach Table 7
Comparison of Worst-Case Predicted Plume Velocities (m/s)

	One GE 7HA	Three LMS100	Five LM6000
Height Above Ground (ft)	Average Velocity (m/s)	Average Velocity (m/s)	Average Velocity (m/s)
300	32.42	7.89	6.83
400	15.07	6.75	6.08
500	11.59	6.47	5.86
600	10.04	6.29	5.72
700	9.1	6.15	5.61
800	8.45	6.05	5.52
900	7.96	5.97	5.45
1000	7.57	5.89	5.39
1100	7.24	5.70	5.34
1200	6.97	5.51	5.29
1300	6.74	5.35	5.25
1400	6.53	5.21	5.21
1500	6.35	5.08	5.17
1600	6.19	4.96	5.14
1700	6.04	4.86	5.04
1800	5.91	4.76	4.94
1900	5.78	4.67	4.85
2000	5.67	4.58	4.77
2100	5.57	4.51	4.68
2200	5.47	4.43	4.61
2300	5.38	4.36	4.54
2400	5.29	4.30	4.47
2500	5.21	4.24	4.41

Source: Staff calculated.

As explained in the Traffic and Transportation FSA, a plume average vertical velocity of 5.3 m/s has been determined by staff to be the critical velocity of concern to light aircraft. FAA regulations state that an aircraft may not be operated below an altitude of 500 feet when flying over other than congested areas, or 1,000 feet above the highest obstacle when flying over congested areas (14 C.F.R., § 91.119). As shown in **Spillane Approach Table 7**, the CTG exhausts at 1,000 feet above ground for the 7HA, three LMS100, and five LM6000 turbines are estimated to be 7.57 m/s, 5.89 m/s, and 5.39 m/s, respectively. The CTG exhausts plume average vertical velocity for the 7HA, three LMS100, and five LM6000 turbines are calculated to drop below 5.3 m/s at a height of approximately 2,375 feet, 1,333 feet, and 1,170 feet, respectively.

The velocity values listed above in **Spillane Approach Tables 4-7** are plume average velocities across the area of the plume. The maximum plume velocity, based on a normal Gaussian distribution, is two times the plume average velocities shown in the table. Note that these calculated velocities would be the same at each potential site, varying only by the generation technology.

WIND SPEED STATISTICS

Since the Spillane approach method used by staff is limited to calm wind conditions, the frequency of occurrence of calm wind conditions needs to be evaluated for the project site area. However, calm wind statistics data is not needed as input for the plume modeling itself. The Puente FSA (CEC2016a) used meteorological data collected at the Oxnard Airport monitoring station. Staff expects that wind speeds would be similar among the three sites due to their proximity and orientation to the monitoring station and the fact that there are no substantial complex terrain features between the monitoring station and any of the three sites. The Puente site is located approximately 2.5 miles to the west of the monitoring station, the Ormond Beach alternative site is located approximately 4.5 miles to the south of the monitoring station, and the Del Norte alternative site is located approximately 4.5 miles to the east of the monitoring station.

Wind roses and wind frequency distribution data was collected at the Oxnard Airport for years 2009 through 2013. Calm winds for the purposes of the reported monitoring station statistics are those hours with average wind speeds below 0.5 m/s. The data shows that calm winds occurred 2.7 percent of the time and the average wind speed was 3.24 m/s. Wind speeds greater than or equal to 2.1 m/s occurred 32.7 percent of the time. Calm/low wind speeds conditions averaging an hour or longer appear to be infrequent in the site area (CEC2016a).

The Spillane approach method assumes calm winds, which would allow buoyant thermal plumes to have a worst-case average plume velocity as shown in **Spillane Approach Tables 4-7**. The calm wind condition basis represents the worst-case conditions, and is considered to be conservative; the vertical velocities will decrease substantially as wind speeds increase from calm conditions.

CONCLUSIONS

The CTG exhausts plume average vertical velocity for the 7HA, five LM6000, and three LMS100 are calculated to drop below 5.3 m/s at a height of approximately 2,375 feet, 1,170 feet, and 1,333 feet, respectively. The vertical velocities from the turbine exhausts at given heights above the stacks decrease as wind speeds increase. These low wind speed conditions lasting an hour or more <u>occur only 2.7 percent of the time</u>. Additionally, shorter periods of dead calm winds, lasting long enough to increase the vertical plume average velocities to heights up to peak heights, can also occur during hours with low average wind speeds.

The reader should refer to the **Traffic and Transportation** Section for a discussion of impacts to aviation.

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APPENDIX TT-2

THERMAL PLUME ANALYSIS FOR PUENTE PROJECT ALTERNATIVES – MITRE APPROACH

Testimony of Joseph Hughes, P.E.

INTRODUCTION

Following the completion of Evidentiary Hearings, the California Energy Commission (Energy Commission) Committee assigned to conduct proceedings on the Application for Certification (AFC) for the Puente Power Project (Puente) ordered staff to analyze thermal plume(s) from the use of one or more smaller (50 – 100 megawatts [MWs]) combustion turbines instead of the larger single combustion turbine proposed by the applicant, for the two alternative sites analyzed in the Final Staff Assessment (FSA) - the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative. The Committee asks whether alternative technologies reduce or eliminate the previously identified potential impacts on aviation at these two alternative sites (TN: 216505).

The following provides an assessment of aviation risks from thermal plumes using the MITRE Exhaust Plume Analyzer (MITRE model) for the applicant-proposed turbine technology and for two alternative technology combustion turbine generators (CTGs) exhaust stack plumes. The assessment provides the aviation risk from each of the three turbine technologies at the applicant-proposed site (Puente) and the two alternative sites, the Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative. A separate analysis of these configurations is presented in **Appendix TT-1** of the worst-case vertical plume velocities using the Spillane approach.

PROJECT DESCRIPTION

As proposed by the applicant, Puente would be a natural gas-fired, simple-cycle, air-cooled electrical generating facility that would have a single GE 7HA.01combustion turbine generator (CTG) with a nominal generating capacity of 262 MW. To determine whether it is feasible to reduce or eliminate the previously identified potential significant and unavoidable impacts on aviation at the two alternative locations by utilizing different combustion turbine technologies with similar or less generating capacity, staff has evaluated thermal plume impacts from the following two alternative combustion turbine designs:

3. The first alternative design (LM6000 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 275 MW. The facility would consist of up to five LM6000-PG Sprint CTGs (nominally rated at 55 MW each). Staff has calculated the thermal plume impacts from 1, 2, 3, 4, or 5 adjacent combustion turbines in simultaneous operation.

4. The second alternative design (LMS100 Alternative) would be a natural gas-fired, simple-cycle combustion turbine electrical generating facility rated at a nominal generating capacity of up to 300 MW. The facility would consist of up to three LMS100-PB CTGs (nominally rated at 100 MW each). Staff has calculated the thermal plume impacts from 1, 2, or 3 adjacent combustion turbines in simultaneous operation.

Each of these proposed alternatives (i.e. LM6000 Alternative and the LMS100 Alternative) would require heat rejection equipment, such as a wet surface air condenser or fin fan cooler for turbine inlet air cooling that would result in thermal plume impacts from the cooling equipment as well as from the main CTG stacks. However, previous analyses, such as the Alamitos Energy Center (AEC) FSA (CEC2016b, TN: 207151-1), have shown that thermal plume impacts from ancillary heat rejection equipment at simple-cycle facilities result in less significant thermal plumes than from the CTGs. Therefore, this analysis is limited to the CTGs exhaust stack and does not include the minor thermal plume impacts from the heat rejection equipment and process cooling. Additionally, as discussed in more detail below, at this time the MITRE model does not provide reasonable risk predictions on other types of thermal plume sources such as variable exhaust temperature thermal plume sources, including cooling towers and air-cooled condensers (ACC).

Based on project design and site configurations for other AFCs consisting of similar equipment, these alternatives (i.e., LM6000 Alternative and the LMS100 Alternative) are expected to fit at both alternative project locations (i.e. Del Norte/Fifth Street Off-site Alternative and the Ormond Beach Area Off-site Alternative). However, site reconfiguration, or staggering of construction with Mandalay 1 and 2 demolition activities may be necessary to fit the maximum number of CTGs in the LM6000 Alternative and/or the LMS100 Alternative at the applicant-proposed Puente site.

MITRE EXHAUST PLUME ANALYZER

On September 24, 2015, the Federal Aviation Administration (FAA) released a guidance memorandum (FAA 2015) recommending that thermal plumes be evaluated for impacts on air traffic safety. FAA determined that the overall risk associated with thermal plumes in causing a disruption of flight is low. However, it determined that thermal plumes in the vicinity of airports may pose a unique hazard to aircraft in critical phases of flight (such as take-off and landing). In this memorandum a new computer model, different than the analysis technique used by staff and identified in **Appendix TT-1** as the Spillane approach, is used to evaluate vertical plumes for hazards to light aircraft. It was prepared under FAA funding and available for use in evaluating exhaust plume impacts (except those from cooling towers or ACCs).

This new model, the MITRE Corporation's Exhaust Plume Analyzer (MITRE 2012), was identified by the FAA as a potentially effective tool to assess the impact that exhaust plumes may impose on flight operations in the vicinity of airports (FAA 2015). The MITRE model was developed to evaluate aviation risks from large thermal stacks, such as turbine exhaust stacks. The model provides output in the form of graphical risk probability isopleths ranging from 10^{-2} to 10^{-7} risk probabilities for both severe turbulence and upset for four different aircraft sizes. However, at this time the MITRE model does not provide reasonable risk predictions on other types of thermal plume sources such as variable exhaust temperature thermal plume sources, including cooling towers and ACCs. Furthermore, the MITRE model can only be used on a single set of inputs of stack parameters, such as the stack height, diameter, exit velocity, and exit temperature. Despite the current limitations of the MITRE model, the purpose of the analysis in this appendix is to determine if the use of one or more smaller CTGs (instead of the larger single combustion turbine proposed by the applicant) reduce or eliminate the previously identified potential impacts on aviation at the two alternative sites.

The FAA has not yet provided guidance on how to evaluate the risk probability isopleth output of the MITRE model. However, MITRE Corporation is suggesting that a probability of severe turbulence at an occurrence level of greater than 1×10^{-7} (called a Target Safety Level) should be considered potentially significant. This is equivalent to one occurrence of severe aircraft turbulence in 10 million flights. For the past 50 years, the MITRE Corporation has provided air-traffic safety guidance to FAA, and the recommended Target Safety Level is based on their experience (MITRE 2015a).

The MITRE model provides output to predict the probability of aircraft upset from plumes up to a maximum height of 3,500 feet above ground. However, the meteorological data used by the model is limited to a maximum height of 3,000 feet and the portion of the output above 3,000 feet reuses the 3,000 foot meteorological data. While it is possible to extend the vertical axis for the output plot, the MITRE Corporation has stated, “they cannot recommend doing so for this particular analysis [Puente]” (MITRE 2015b).

The MITRE model uses site specific computer-generated, three-dimensional meteorological data (atmospheric temperature and wind speed, varying with height above ground at the specific site location) combined with a series of aircraft airframe types to determine levels of turbulence and the resulting risk of upset effects on the various aircraft types. The data sources used to create the site-specific meteorological data are from the National Oceanic and Atmospheric Administration’s National Weather Service (NWS). These computer-generated data are averaged over 13-kilometer horizontal grid cells using a model covering the continental United States. The specific NWS measuring stations that provide this data were not identified in the model documentation. The model uses three years of the computer-generated site-specific hourly meteorological data to perform these calculations (MITRE 2012).

Staff conducted a preliminary evaluation of combustion turbine technologies identified in the Project Description above using the MITRE model. Results for four types of aircraft airframes are reported below for severe turbulence and the probability of an aircraft being affected by that turbulence. The MITRE Corporation recommends: “ …. *using a probability of occurrence of* 10^{-7} *as a Target Level of Safety (TLS) where, during these weather conditions, it is recommended that procedures are adjusted or the landing runway is changed if necessary to avoid this hazardous airspace.”* They also state that *“… with some further study the TLS of* 1×10^{-7} *could be reassessed.”*

The results for the most vulnerable types of aircraft (light sport aircraft and light general aviation) were well above 3,000 feet above ground, outside the recommended output range of the model and above the 3,500 foot level provided as the highest extent in the model's graphical output files. At this time, staff does not believe the MITRE model should be used for final work products until the vertical axis can be extended, the significance threshold is verified by the FAA or local aviation representatives, and the model capabilities are enhanced to include other thermal plume sources such as cooling towers and air-cooled condensers.

EQUIPMENT DESIGN AND OPERATING PARAMETERS

The combustion turbine exhaust stack parameters used for the MITRE model inputs are provided in **Appendix TT-2 Table 1**. The turbine design and operating parameter data for the LM6000 CTG exhaust stack was provided as part of the AFC for the Mission Rock Energy Center (Mission Rock) project (15-AFC-02). The turbine design and operating parameter data for the LMS100 CTG exhaust stack was provided as part of the AFC for the Alamitos Energy Center project (13-AFC-01). Because the MITRE model does not allow for variable exhaust, staff used the turbine exhaust parameters that correspond with the annual average ambient temperature case for each turbine technology for the MITRE model inputs.

Appendix TT-2 Table 1
Turbine Exhaust Parameters for MITRE Model Stack Inputs

Exhaust Parameters	LM6000	LMS100	7HA.01
Stack Height (ft)	60 ft	80 ft	188 ft
Stack Diameter (ft)	12 feet	13.5 feet	22 feet
Number of Stacks	up to 5	up to 3	1
Distance Between Stacks (ft)	100 feet	100 feet	N/A
Efflux Velocity (ft/s)	103.1 ft/s	109 ft/s	159.2 ft/s
Efflux Temperature (°F)	869 deg F	797 deg F	900 deg F

Source: CEC2016a (TN: 214712), CAL2015 (TN: 207151-1), CEC2016b (TN: 213768)

The MITRE model generated slightly different site specific weather/metrological data for each of the three sites analyzed: (1) the Puente site, (2) the Del Norte/Fifth Street Off-site Alternative, and (3) the Ormond Beach Area Off-site Alternative. The weather/metrological data was from January 1, 2011 thru December 30, 2013.

The MITRE model inputs required to generate the risk probability include the following:

- Stack height;
- Stack diameter;
- Efflux velocity;
- Efflux temperature;

- Number of exhaust stacks;
- Distance between exhaust stacks (if there are more than one stack); and
- Site specific meteorological data.

MITRE MODEL RESULTS

As explained above, the MITRE model provides output in the form of graphical risk probability isopleths ranging from 10^{-2} to 10^{-7} risk probabilities for both “severe turbulence” and “upset” for four different aircraft four types: (1) Light-Sport aircraft, (2) Light General Aviation (GA) aircraft, (3) Business Jets, and (4) Narrow-Body Jets. This appendix includes results for the Severe Turbulence scenario for each aircraft type. MITRE does not provide output in terms of vertical velocity, which is the metric produced by the Spillane approach that staff normally uses; it provides frequency of severe turbulence or upset above and downwind from the stack as a function of meteorological conditions at the site. The MITRE model impacts are based on each individual airframe size and how the vertical gusts impact each airframe based on their area/size and weight, where the model evaluates the frequency for vertical gusts from the plume to cause each impact or frequency level.

The MITRE generated risk probabilities of severe turbulence for specific aircraft types as a result of the Puente project (i.e. 7HA.01 CTG) and the two proposed alternative projects (i.e. LM6000 Alternative and the LMS100 Alternative) are provided in **Appendix TT-2 Tables 2** through **4** for the three sites analyzed (i.e. the Puente site, the Del Norte/Fifth Street Off-site Alternative, and the Ormond Beach Area Off-site Alternative).

As can be seen from **Appendix TT-2 Tables 2** through **4**, the light sport aircraft type experiences the highest risk probability from each of the three turbine technologies analyzed. This is because each risk probability for light sport aircraft is at a higher elevation above ground than the other three aircraft types. When all turbines are in concurrent operation, the MITRE-recommended TSL of 10^{-7} is exceeded more than 3,500 feet above ground at all three sites for light sport aircraft and light general aviation (GA) aircraft.

Because the results for light sport aircraft are the most at-risk of the four aircraft types evaluated and represent worst-case impacts, **MITRE Approach Tables 5** through **7** only provide the risk probability impacts to light sport aircraft from individual adjacent turbine exhaust stacks. Risks to other aircraft types would be at lower heights above ground.

LIMITATIONS OF THE MITRE MODELING RESULTS

At this time, the MITRE model has some limitations to adequately evaluate the thermal plume impacts from power plants on aviation. These limitations include the following:

- The MITRE model does not provide reasonable risk predictions for variable exhaust temperature thermal plume sources, such as cooling towers and ACCs;

- The MITRE model can only be used on a single set of inputs of stack parameters, such as the stack height, diameter, exit velocity, and exit temperature (therefore other nearby sources with different exhaust parameters cannot be evaluated simultaneously);
- The FAA has not yet provided guidance on how to evaluate the risk probability isopleth output of the MITRE model;
- The MITRE model provides output to predict the probability of aircraft upset from plumes up to a maximum height of 3,500 feet above ground. However, the meteorological data used by the model is limited to a maximum height of 3,000 feet;
- The MITRE model generated output risk probabilities commonly extend beyond the maximum modeling domain height of 3,500 feet;
- Risk probability is based on 8,760 hours of operation per year, while the simple cycle CTG(s) would be limited to a much lower number, and would likely operate even less in practice. Therefore, the risk probability is likely off by a factor of 10;
- The MITRE model is not supported and will likely not to be updated, making it nearly an obsolete tool.

Appendix TT-2 Table 2
MITRE Risk Probability of Severe Turbulence for Aircraft Type at the Puente Site

Puente Site					
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**			
		Light Sport Aircraft	**Light GA Aircraft**	**Business Jets**	**Narrow-Body Jets**
7HA.01 (262 MW, 1 Stack)	10^{-7}	Above 3,500	Above 3,500	3,225	1,500
	10^{-6}	Above 3,500	Above 3,500	2,600	1,300
	10^{-5}	Above 3,500	3,100	2,150	1,100
	10^{-4}	3,425	2,400	1,700	925
	10^{-3}	2,525	1,775	1,350	800
	10^{-2}	1,800	1,325	1,025	550
LM6000 (275 MW, 5 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,075	1,025
	10^{-6}	Above 3,500	3,050	1,750	1,000
	10^{-5}	Above 3,500	2,075	1,350	950
	10^{-4}	2,550	1,550	975	900
	10^{-3}	1,725	1,075	750	750
	10^{-2}	1,150	525	250	Height Not Provided
LMS100 (300 MW, 3 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,100	925
	10^{-6}	Above 3,500	2,925	1,800	900
	10^{-5}	Above 3,500	2,150	1,450	900
	10^{-4}	2,625	1,650	1,150	875
	10^{-3}	1,825	1,225	875	775
	10^{-2}	1,275	875	350	Height Not Provided

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.

Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500". Similarly, some risk probabilities had no calculated results for certain aircraft types and are shown as, "height not provided".

b. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW.

c. The LM6000 configuration consists of five CTGs, with five exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 275 MW.
The LMS100 configuration consists of three CTGs, with three exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 300 MW

Appendix TT-2 Table 3
MITRE Risk Probability of Severe Turbulence for Aircraft Type at Ormond Beach Area Off-site Alternative

Ormond Beach Area Off-site Alternative					
Technology	Risk Probability of Severe Turbulence	Height of Risk Probabilty (Feet Above Ground Level)			
		Light Sport Aircraft	Light GA Aircraft	Business Jets	Narrow-Body Jets
7HA.01 (262 MW, 1 Stack)	10^{-7}	Above 3,500	Above 3,500	3,425	1,475
	10^{-6}	Above 3,500	Above 3,500	2,700	1,275
	10^{-5}	Above 3,500	3,150	2,175	1,075
	10^{-4}	3,250	2,375	1,700	900
	10^{-3}	2,500	1,750	1,350	750
	10^{-2}	1,750	1,300	1,000	525
LM6000 (275 MW, 5 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,225	450
	10^{-6}	Above 3,500	Above 3,500	1,700	425
	10^{-5}	Above 3,500	2,100	1,275	425
	10^{-4}	2,500	1,500	800	375
	10^{-3}	1,650	1,000	375	350
	10^{-2}	1,075	475	250	Height Not Provided
LMS100 (300 MW, 3 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,200	875
	10^{-6}	Above 3,500	3,100	1,750	725
	10^{-5}	Above 3,500	2,150	1,400	375
	10^{-4}	2,550	1,625	1,100	375
	10^{-3}	1,750	1,200	800	350
	10^{-2}	1,200	800	325	Height Not Provided

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.

Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500". Similarly, some risk probabilities had no calculated results for certain aircraft types and are shown as, "height not provided".

b. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW.

c. The LM6000 configuration consists of five CTGs, with five exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 275 MW.

d. The LMS100 configuration consists of three CTGs, with three exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 300 MW.

Appendix TT-2 Table 4
MITRE Risk Probability of Severe Turbulence for Aircraft Type at the Del Norte/Fifth Street Off-site Alternative

Del Norte/Fifth Street Off-site Alternative					
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**			
		Light Sport Aircraft	**Light GA Aircraft**	**Business Jets**	**Narrow-Body Jets**
7HA.01 (262 MW, 1 Stack)	10^{-7}	Above 3,500	Above 3,500	3,100	1,500
	10^{-6}	Above 3,500	Above 3,500	2,550	1,300
	10^{-5}	Above 3,500	2,950	2,150	1,100
	10^{-4}	3,250	2,350	1,750	925
	10^{-3}	2,550	1,800	1,350	750
	10^{-2}	1,825	1,350	1,025	525
LM6000 (275 MW, 5 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,250	350
	10^{-6}	Above 3,500	2,800	1,775	300
	10^{-5}	Above 3,500	2,150	1,350	225
	10^{-4}	2,475	1,575	850	175
	10^{-3}	1,750	1,075	425	Height Not Provided
	10^{-2}	1,150	500	225	Height Not Provided
LMS100 (300 MW, 3 Stacks)	10^{-7}	Above 3,500	Above 3,500	2,200	925
	10^{-6}	Above 3,500	2,800	1,800	750
	10^{-5}	Above 3,500	2,175	1,450	325
	10^{-4}	2,500	1,700	1,150	250
	10^{-3}	1,800	1,225	875	175
	10^{-2}	1,275	850	325	Height Not Provided

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.

Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500". Similarly, some risk probabilities had no calculated results for certain aircraft types and are shown as, "height not provided".

b. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW.

c. The LM6000 configuration consists of five CTGs, with five exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 275 MW.

d. The LMS100 configuration consists of three CTGs, with three exhaust stacks (spaced 100 feet apart), and a nominal generating capacity of 300 MW.

Appendix TT-2 Table 5
MITRE Risk Probability of Severe Turbulence for Light Sport Aircraft from Individual Turbine Exhaust Stacks at the Puente Site

Impacts on Light Sport Aircraft at the Puente Site						
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		275 MW (5 Stacks)	**220 MW (4 Stacks)**	**165 MW (3 Stacks)**	**110 MW (2 stacks)**	**55 MW (1 Stack)**
LM6000	10^{-7}	Above 3,500	Above 3,500	Above 3,500	Above 3,500	2,900
	10^{-6}	Above 3,500	Above 3,500	Above 3,500	Above 3,500	2,075
	10^{-5}	Above 3,500	Above 3,500	3,500	2,600	1,750
	10^{-4}	2,550	2,450	2,250	1,800	1,325
	10^{-3}	1,725	1,700	1,600	1,350	1,050
	10^{-2}	1,150	1,150	1,100	975	800
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		300 MW (3 Stacks)	**200 MW (2 Stacks)**		**100 MW (1 Stack)**	
LMS100	10^{-7}	Above 3,500	Above 3,500		3,450	
	10^{-6}	Above 3,500	Above 3,500		2,850	
	10^{-5}	Above 3,500	3,200		2,050	
	10^{-4}	2,625	2,150		1,550	
	10^{-3}	1,825	1,550		1,200	
	10^{-2}	1,275	1,100		900	
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		262 MW (1 Stack)				
7HA.01	10^{-7}	Above 3,500				
	10^{-6}	Above 3,500				
	10^{-5}	Above 3,500				
	10^{-4}	3,425				
	10^{-3}	2,525				
	10^{-2}	1,800				

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.
Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500".

b. The LM6000 configuration consists of up to five CTGs, with five exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 55 MW for a total nominal generating capacity of 275 MW.

c. The LMS100 configuration consists of up to three CTGs, with three exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 100 MW for a total nominal generating capacity of 300 MW. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW

Appendix TT-2 Table 6
MITRE Risk Probability of Severe Turbulence for Light Sport Aircraft from Individual Turbine Exhaust Stacks at the Ormond Beach Area Off-site Alternative

Impacts on Light Sport Aircraft at the Ormond Beach Area Off-site Alternative						
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		275 MW (5 Stacks)	**220 MW (4 Stacks)**	**165 MW (3 Stacks)**	**110 MW (2 stacks)**	**55 MW (1 Stack)**
LM6000	10^{-7}	Above 3,500	Above 3,500	Above 3,500	Above 3,500	3,225
	10^{-6}	Above 3,500	Above 3,500	Above 3,500	Above 3,500	2,375
	10^{-5}	Above 3,500	Above 3,500	Above 3,500	2,600	1,700
	10^{-4}	2,500	2,400	2,225	1,825	1,300
	10^{-3}	1,650	1,625	1,525	1,300	1,000
	10^{-2}	1,075	1,075	1,050	875	700
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		300 MW (3 Stacks)	**200 MW (2 Stacks)**		**100 MW (1 Stack)**	
LMS100	10^{-7}	Above 3,500	Above 3,500		Above 3,500	
	10^{-6}	Above 3,500	Above 3,500		3,100	
	10^{-5}	Above 3,500	3,375		2,100	
	10^{-4}	2,550	2,150		1,550	
	10^{-3}	1,750	1,500		1,150	
	10^{-2}	1,200	1,050		825	
Technology	**Risk Probability of Severe Turbulence**	**Height of Risk Probabilty (Feet Above Ground Level)**				
		262 MW (1 Stack)				
7HA.01	10^{-7}	Above 3,500				
	10^{-6}	Above 3,500				
	10^{-5}	Above 3,500				
	10^{-4}	3,250				
	10^{-3}	2,500				
	10^{-2}	1,750				

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.
Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500".

b. The LM6000 configuration consists of up to five CTGs, with five exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 55 MW for a total nominal generating capacity of 275 MW.

c. The LMS100 configuration consists of up to three CTGs, with three exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 100 MW for a total nominal generating capacity of 300 MW.

d. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW.

Appendix TT-2 Table 7
MITRE Risk Probability of Severe Turbulence for Light Sport Aircraft from Individual Turbine Exhaust Stacks at the Del Norte/Fifth Street Off-site Alternative

Impacts on Light Sport Aircraft at the Del Norte/Fifth Street Off-site Alternative						
Technology	Risk Probability of Severe Turbulence	Height of Risk Probabilty (Feet Above Ground Level)				
		275 MW (5 Stacks)	220 MW (4 Stacks)	165 MW (3 Stacks)	110 MW (2 stacks)	55 MW (1 Stack)
LM6000	10^{-7}	Above 3,500	Above 3,500	Above 3,500	Above 3,500	2,675
	10^{-6}	Above 3,500	Above 3,500	Above 3,500	3,350	2,275
	10^{-5}	Above 3,500	Above 3,500	3,050	2,425	1,800
	10^{-4}	2,475	2,375	2,200	1,825	1,350
	10^{-3}	1,750	1,700	1,575	1,350	1,050
	10^{-2}	1,150	1,150	1,100	975	750
Technology	Risk Probability of Severe Turbulence	Height of Risk Probabilty (Feet Above Ground Level)				
		300 MW (3 Stacks)	200 MW (2 Stacks)		100 MW (1 Stack)	
LMS100	10^{-7}	Above 3,500	Above 3,500		3,100	
	10^{-6}	Above 3,500	Above 3,500		2,675	
	10^{-5}	Above 3,500	2,925		2,075	
	10^{-4}	2,500	2,175		1,600	
	10^{-3}	1,800	1,550		1,200	
	10^{-2}	1,275	1,125		875	
Technology	Risk Probability of Severe Turbulence	Height of Risk Probabilty (Feet Above Ground Level)				
		262 MW (1 Stack)				
7HA.01	10^{-7}	Above 3,500				
	10^{-6}	Above 3,500				
	10^{-5}	Above 3,500				
	10^{-4}	3,250				
	10^{-3}	2,500				
	10^{-2}	1,750				

Source: Staff generated using MITRE model with inputs from Appendix TT-2 Table 1.
Notes:

a. MITRE risk probabilities are provided for heights up to 3,500 feet above ground level in the graphical output files. Some results extend beyond the model's 3,500 foot maximum level and are shown as, "above 3,500".

b. The LM6000 configuration consists of up to five CTGs, with five exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 55 MW for a total nominal generating capacity of 275 MW.

c. The LMS100 configuration consists of up to three CTGs, with three exhaust stacks (spaced 100 feet apart). Each CTG has a nominal generating capacity of 100 MW for a total nominal generating capacity of 300 MW.

d. The 7HA.01 configuration consists of a single CTG, with one exhaust stack and a nominal generating capacity of 262 MW.

CONCLUSION

The results show that the use of one or more, smaller (50 – 100 megawatts [MWs]) combustion turbines instead of the larger single combustion turbine proposed by the applicant reduces the potential aviation risks caused by thermal plumes. This is because thermal plume impacts are directly related to heat rejection. Simple-cycle facilities with similar generating capacities will likely have similar heat rejection. Operating fewer turbines with less generating capacity, results in less heat rejection and therefore, less potential impacts on aviation.

As the number of smaller turbines operated is increased to match a similar generating capacity as the larger turbine proposed by the applicant (e.g. five LM6000 and three LMS100) the impacts on aviation become more similar to that of the larger turbine. However, there are still less impacts from operating five LM6000 (275 MW), or three LMS100 (300 MW), compared to operating one larger combustion turbine (262 MW) because the heat rejection is divided out and released by multiple stacks rather than a single stack.

Plume merging between multiple stacks is accounted for by the MITRE model. However, due to the distance between stacks (in this case assumed to be spaced 100 feet apart) the impacts are less than if the same heat rejection was released through a single stack.

The results show that impacts on aviation do not vary significantly from site to site. This is because atmospheric temperature, wind speed and other meteorological conditions used by the MITRE model to calculate risk probability do not vary significantly between the three sites analyzed.

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APPENDIX TT-3

Air Quality and Health Risk Assessment Alternatives Analysis
Testimony of William Walters, P.E.

SUMMARY

The Puente Siting Committee directed Energy Commission staff to evaluate “the use of one or more smaller (50-100 MW) combustion turbines (CT) instead of the larger combustion turbine proposed by the applicant at the two alternate sites…to determine whether it is feasible to reduce or eliminate the previously identified potential impacts on aviation.” (Docket 15-AFC-01, TN 216505, p. 3 Item 6) Staff prepared the analyses of the thermal plumes (i.e., the potential impacts on aviation) in the Traffic and Transportation section. But rather than leave it indeterminate whether the alternate technologies, located at the alternate sites, would result in potential air quality or public health impacts, the Energy Commission staff requested that Aspen Environmental Group (Aspen) perform an air quality and health risk assessment (HRA) to address combustion turbine type alternatives for the Puente Power Project.

There is some variability in the intensity of the worst-case air pollutant and health risk impacts determined for both the three sites and the different combustion turbine types. However, this quantitative analysis is consistent with staff’s qualitative analysis in the Alternatives section of the Final Staff Assessment (FSA) that stated that operations-related impacts would likely be similar to Puente. The worst-case impacts determined for each CT case are very similar between the Puente proposed project site and the two alternatives sites.

The H Frame combustion turbine configuration, regardless of the assumed site, never had the highest estimated impacts for configurations with assumed similar total megawatt (MW) capacity and generation. This is almost certainly due to the higher thermal buoyancy (combination of flow and temperature) for the single large stack associated with the applicant-proposed H Frame combustion turbine. For the applicant-proposed H Frame combustion turbine, the Puente site was found to have the lowest short-term impacts and the Del Norte alternative site the highest short-term impacts of the three sites, while the Del Norte alternative site was found to have marginally lower long-term impacts than the Puente site with the Ormond Beach alternative site having the highest long-term impacts.

However, the air quality and public health impacts from each of the configurations were similar or low enough (i.e., all impacts would be determined to be less than significant) to suggest no one configuration or site would be superior to another in the area of air quality. Also, since it was determined that the combustion turbine plumes did not interact significantly, the air quality and public health impacts would approximately decrease linearly with decreasing number of combustion turbines (i.e., impacts from four LM6000 CTs would be approximately 80 percent of the impacts from five of those same CTs, or two LMS100 CTs would have impacts approximately 66 percent of three of the same CTs, and so on).

ANALYSIS SCOPE AND ASSUMPTIONS

To more fully inform the Committee, interveners and the public, staff chose to complete additional project alternatives air quality and public health analyses, including the following:

1. Three LMS100 turbines rated at a nominal net capacity of 100 MW each,

2. Five LM6000 turbines rated at a nominal net capacity of 55 MW each,

The air quality and public health impacts are assessed at capacity and operating hours that equal or exceed the applicant-proposed project to determine upper boundary, worst case impacts.

This analysis compares the expected air quality and public health impact potentials for three different turbine models at the applicant-proposed Puente site and at two alternative sites, for a total of nine different potential combinations. The turbine models and sites chosen by staff are as follows:

Turbine Sites	Turbine Types
Puente Power Project Site (applicant-proposed)	H Frame (applicant-proposed)
Del Norte Alternative Site	LMS100 (3 or less turbines)
Ormond Beach Alternative Site	LM6000 (5 or less turbines)

The alternative sites are the sites evaluated in the Alternatives Section of the FSA. The number of combustion turbines proposed would allow for approximately the same maximum net megawatt (MW) production where the general properties of each of the combustion turbine gases are as follows:

Turbine Type	Output Per Turbine	Fuel Input per Turbine
H Frame	262 MW net	2572 MM/Btu/hr
LMS100	100 MW net (300 MW total)	890.2 MMBtu/hr (2,671 MMBtu/hr total)
LM6000	55.3 MW net (276.4 MW total)	565.6 MMBtu/hr (2,828 MMBtu/hr total)

There are other general differences between these combustion turbines. The LMS100 and LM6000 are aeroderivative combustion turbines, meaning their general design basis comes from the design of aircraft engines, while the H Frame CT is a heavy-duty frame combustion turbine. The startup/shutdown times (i.e. the amount of time not meeting normal steady state operation emissions limits) and the total increase in emissions during these non-steady state periods are slightly different and for some pollutant cases substantially different, respectively, for each of these combustion turbines. The LMS100 combustion turbine also has intercooling that increases thermal efficiency but also increases heat rejection needs that results in larger air cooled condensers or cooling towers. Finally, the differences in efficiencies and flexibility for dispatching different increments of energy (i.e. one LM6000 can deliver 30 MW, one H Frame cannot) would likely impact combustion turbine[s] dispatch order and how they would be dispatched by the California Independent System Operator to meet local electricity demand and to maintain the quality of the electricity.

The analysis provides a comparison of criteria pollutant impacts and health risk impacts for each of the nine possible combinations. This comparison is limited to the two critical criteria pollutants, nitrogen dioxide (NO_2) and respirable and fine particulate matter (PM10 and PM2.5), and for health risk at the point of maximum impact (PMI). A comparison of the carcinogenic, chronic, and acute health risk impacts is included. This analysis is limited to a comparison of the combustion turbine impacts and does not include any balance-of-plant emissions sources (diesel-fueled emergency engines, etc.). The other plant emissions sources, assuming dry cooling technologies are used regardless of the combustion turbine option would be the same regardless of the type of combustion turbine or the location of the site. Furthermore, plumes from balance-of-plant emissions sources are not expected to combine with the main stack plumes.

The following general assumptions were made in the modeling analysis:

- Each type of turbine project would fit at each of the alternative sites deployed at capacities that meet or are near the applicant-proposed capacity. The LMS100 and LM6000 options at the applicant-proposed site would likely require staged construction due to site constraints. This is because the space currently occupied by Mandalay Units 1 and 2 or other existing structures would be required.
- Where there are multiple combustion turbines they would be oriented in a row east to west with stack separations that are consistent with the plume velocity analysis (100 feet apart). This alignment is chosen because it would maximize incremental project impacts due to the prevailing wind direction.
- The stack parameters used are also consistent with those assumed for the plume velocity analysis and are provided in the thermal plume analysis.
- The meteorological data, receptor locations, and site stack base height and location for the Puente Power Project site were used as provided in the project's existing ambient air quality modeling file.
- The site stack base heights and locations for the two alternative locations were estimated using Google Earth elevation and Universal Transverse Mercator (UTM) coordinates.
- The stack parameter and emissions data for the LMS100 and LM6000 combustion turbines were taken from Mission Rock Energy Center (LM6000) and Pio Pico Energy Center (LMS100) siting case project data.
- Maximum emissions for each case were based on the maximum hourly and daily emissions noted for each case, and the annual emissions for each case were determined using a ratio of the MW production assumed for the applicant-proposed Puente H Frame and the Mission Rock and Pio Pico cases that were used as proxies for the other two combustion turbine alternatives.

The specific assumptions related to the emissions modeled and the combustion turbine stack parameters inputs used in the model are as follows:

Air Quality Table - 1
Combustion Turbine Modeled Emissions

Pollutant	Period	H Frame	LMS100 (3)	LM6000 (5)
NO_2	1-Hour Peak	143.2 lbs	79.89 lbs	58.25 lbs
	Annual	32.95 tons	31.47 tons	23.67 tons
PM10/PM2.5	24-Hour Peak	242.4 lbs	396 lbs	240 lbs
	Annual	10.68 tons	16.00 tons	10.52 tons
VOC	1-Hour Peak	52.2 lbs	19.59 lbs	6.8 lbs
	Annual	10.85 tons	8.67 tons	4.19 tons

Air Quality Table - 2
Combustion Turbine Modeled Stack Parameters

Modeling Parameter	H Frame	LMS100 (3)	LM6000 (5)
Stack Height	57.3 meters (188 feet)	24.38 meters (80 feet)	18.29 meters (60 feet)
Stack Diameter	6.71 meters (22 feet)	4.11 meters (13.5 feet)	3.66 meters (12 feet)
Exhaust Velocity	47.18 m/s (155 ft/s)	33.22 m/s (109 ft/s)	31.42 m/s (103 ft/s)
Exhaust Temperature	675.0 °K (755.4 °F)	698.2 °K (797.0 °F)	738.2 °K (869.0 °F)

The maximum hourly emissions values modeled are based on assumptions for the worst-case post-commissioning period start-up/shutdown conditions for each combustion turbine type. The following assumptions have been made for these worst-case hourly operating conditions:

Air Quality Table - 3
Combustion Turbine Worst-Case Hourly Emissions Assumptions

Assumption Type	H Frame	LMS100	LM6000
Combustion Turbine Starts	2 (one Cold/one Warm)	3	5
Combustion Turbine Shutdowns	1	0	0
Combustion Turbine Cold Start-up Time	30 minutes	30 minutes	30 minutes
Combustion Turbine Shutdown Time	12 minutes	10.5 minutes	9 minutes

These assumptions come from the Puente Power Project AFC and other recent licensing cases that proposed use of the other two combustion turbine types (Pio Pico Energy Center – LMS100s, and Mission Rock Energy Center - LM6000s). Some of these assumptions, based on these actual case data sources may be more conservative or less conservative, based on manufacturer guarantees for specific cases or risk aversion during the licensing/air quality permitting by each project applicant. Experience with more than a two-dozen peaking power plant siting cases with LMS100 and LM6000 combustion turbines has shown that in general, although not specifically shown in the values given in the above table, that simple-cycle aeroderivative combustion turbine types normally can start faster and with lower NOx and VOC emissions than simple-cycle heavy-duty combustion turbines. However, it should be noted that manufacturers have been working to reduce differences in start-up times between heavy-duty combustion turbines and aeroderivative combustion turbines. While lower startup times for aeroderivative combustion turbines may not be reflected in the times assumed for licensing/permitting for the cases noted above, it is borne out in the emissions assumptions that show much higher hourly NOx and VOC emissions assumptions for the one heavy-duty H Frame combustion turbine versus three LMS100 or five LM6000 combustion turbines.

AIR DISPERSION MODELING AND HRA ANALYSIS METHODS

The air dispersion modeling analysis was conducted using the most current version of AERMOD (model version model 16216r). The concentration output from this model, using 1 g/s emissions rate for each combustion turbine, was then adjusted by the actual emissions rate anticipated for each pollutant and averaging period modeled. Long term emissions (i.e. annual and five-year annual average for the HRA) were conservatively modeled without assumption for expected hour-of-day load factors (the analysis was done using a flat average hourly emissions profile). Nitrogen dioxide (NO_2) modeling did not include ozone limiting method (OLM) or plume volume molar ratio method (PVMRM) modeling to determine nitrogen oxides (NO_x) conversion to $NO_{2.}$ Rather, the worst-case NO_2 results were obtained by using the default Environmental Protection Agency (U.S. EPA) ambient ratio method (ARM) one-hour and annual values (0.75 and 0.80) to convert NO_x to NO_2.

The toxic air contaminant (TAC) emissions were determined using emissions factors from the U.S. EPA emissions factor reference document called AP-42 (Section 3.1 - Stationary Gas Turbines) and the California Air Resources Board (ARB) California Air Toxics Emissions Factor (CATEF) database consistently for all combustion turbine type exhausts. Differences in assumptions with the Puente health-risk assessment (HRA) presented in the FSA are as follows:

- The higher of the CATEF or AP-42 were conservatively used to determine emissions factors with the following exception: formaldehyde was based on AP-42. The high formaldehyde emissions factor value for electrical utility combustion turbines in CATEF would have created total TAC volatile organic compound (VOC) emissions higher than the total VOC emissions estimated for the combustion turbines (note: the CATEF formaldehyde emissions factor used in the FSA HRA was the CATEF value for cogeneration combustion turbines and not electrical utility combustion turbines). Using this conservative method, higher emissions factors were used for acetaldehyde, acrolein, benzene, naphthalene, total polycyclic aromatic hydrocarbons (PAHs), and propylene oxide.
- Control of VOC TACs emissions by the Carbon Monoxide (CO) catalytic oxidizer was assumed to be 50 percent as was assumed in the applicant and FSA analyses, except no control of semi-volatile PAH emissions was assumed to occur.

These emissions factor assumptions, which varied for the Puente, Pio Pico, and Missions Rock siting case data sources that were used to develop the assumptions for this comparative analysis, were standardized to obtain a more consistent comparison between the combustion turbine alternatives.

Maximum short-term organic TAC emissions, including the semi-volatile PAH emissions, were based on a ratio of the normal hourly VOC emissions and the peak hourly VOC emissions.

The concentration output from this model, using 1 g/s emissions rate for each combustion turbine, was used along with toxic air contaminant emissions factor data to calculated speciated concentration data to be input into the ARB Hotspots Analysis and Reporting Program Version 2 (HARP2) Risk Assessment Standalone Tool (RAST) model, that was designed to follow Office of Environmental Health Hazard Assessment (OEHHA) risk assessment guidance methods. The final output determined using the RAST model is the worst-case health risk impact values for each combustion turbine/alternative site combination.

IMPACT ANALYSIS RESULTS

The numeric results of this alternatives comparison modeling analysis for criteria pollutant impacts are provided in the Tables Attachment. The overall finding is that the emissions impacts for the combustion turbine alternatives at any of the three sites evaluated would not cause significant air quality or health risk impacts. There are differences in the intensity of the impacts between the nine combinations of combustion turbine types and sites, but those differences are not overly large and are not consistent between the short-term and long-term impacts; this means that there was no specific site and combustion turbine combination that was consistently estimated to provide worst-case impacts.

The peak incremental and total NO_2 and particulate matter (PM10 and PM2.5) impacts found for each of the modeled pollutant periods in this alternatives comparison analysis are as follows:

Air Quality Table - 4
Peak Criteria Pollutant Concentration Results Summary

Pollutant Case	Project Impact	Background	Total Impact	Limiting Standard	Alternative Case with Peak Impacts
NO_2 1-Hour	16.2 µg/m^3	107 µg/m^3 (State) 68 µg/m^3 (fed)	123 µg/m^3 (State) 84 µg/m^3 (fed)	339 µg/m^3 (State) 188 µg/m^3 (fed)	Del Norte Alternative Site 3 LMS100 combustion turbines
NO_2 Annual	0.047 µg/m^3	13 µg/m^3	13 µg/m^3	57 µg/m^3 (State) 100 µg/m^3 (fed)	Puente Site 5 LM6000 combustion turbines
PM10 24-Hour	0.75 µg/m^3	56.9 µg/m^3	57.7 µg/m^3	50 µg/m^3 (State) 150 µg/m^3 (fed)	Ormond Beach Alternative Site 3 LMS100 combustion turbines
PM10 Annual	0.028 µg/m^3	24 µg/m^3	24 µg/m^3	20 µg/m^3 (State)	Puente Site 3 LMS100 combustion turbines
PM2.5 24-Hour	0.75 µg/m^3	17.8 µg/m^3	18.6 µg/m^3	35 µg/m^3 (fed)	Ormond Beach Alternative Site 3 LMS100 combustion turbines
PM2.5 Annual	0.028 µg/m^3	9.4 µg/m^3	9.4 µg/m^3	12 µg/m^3 (State) 15 µg/m^3 (fed)	Puente Site 3 LMS100 combustion turbines

Note: see FSA Air Quality Table 10 and surrounding text for additional description/information on the background concentrations.

The modeled criteria pollutant impacts, except for PM10 where the background is already over the state standards, are all well below state and federal ambient air quality standards and the health risk values are all less than significant. The PM10 impacts are also less than significant due to their small addition to the existing background and are well below impact values provided in the FSA.

The peak incremental health risk impacts found for each of the modeled pollutant periods in this alternatives comparison analysis are as follows:

Air Quality Table - 5
Peak Health Risk Assessment Results Summary

HRA Case	Project Impact	Significance Threshold	Alternative Case with Peak Impacts
Cancer Risk	2.91×10^{-6}	10×10^{-6}	Puente Site 5 LM6000 combustion turbines
Chronic Risk	0.000696	1	Puente Site 5 LM6000 combustion turbines
Acute Risk	0.0276	1	Del Norte Alternative Site 3 LMS100 combustion turbines

The modeled health risks are all well below their respective significance thresholds. A comparison of modeling results for the different modeled time frames (1-hour, 24-hour, and long-term cancer risk) for each of the modeled cases are provided below:

Air Quality Table - 6
Peak Alternatives Case Impact Results Summary

	H Frame	LMS100 (3)	LM6000 (5)
1-Hour NOx Peak Impacts			
Puente Site	8.27 µg/m^3	12.25µg/m^3	13.95 µg/m^3
Del Norte Alternative Site	10.78 µg/m^3	**16.17 µg/m^3**	13.85 µg/m^3
Ormond Beach Alternative Site	9.61 µg/m^3	13.79 µg/m^3	11.59 µg/m^3
24-Hour PM10/PM2.5 Impacts			
Puente Site	0.080 µg/m^3	0.561 µg/m^3	0.488 µg/m^3
Del Norte Alternative Site	0.087 µg/m^3	0.726 µg/m^3	0.732 µg/m^3
Ormond Beach Alternative Site	0.114 µg/m^3	**0.750 µg/m^3**	0.675 µg/m^3
Peak Cancer Risk Impacts			
Puente Site	0.52×10^{-6}	**2.91×10^{-6}**	2.86×10^{-6}
Del Norte Alternative Site	0.51×10^{-6}	2.04×10^{-6}	2.17×10^{-6}
Ormond Beach Alternative Site	0.85×10^{-6}	2.85×10^{-6}	2.73×10^{-6}

Analysis of reduced turbine numbers for the LM6000 and LMS100 CT cases shows that the maximum impacts are approximately proportional to the number of CTs. So, if one were to revise those cases to a single CT, then the 1-hour NO_2 impacts would be highest for the H Frame at all sites, but the gas turbine cases with the peak 24-hour and long-term impacts remain the same.

SUMMARY AND ANALYSIS LIMITATIONS

There is some variability in the intensity of the worst-case air pollutant and health risk impacts determined for both the three sites and the different combustion turbine types. The worst-case impacts, for the specific configurations modeled, were found to occur at all three sites and for the two alternative combustion turbine cases depending on the time frame and pollutant. The H Frame combustion turbine configuration, regardless of the assumed site, never had the highest estimated impacts. This is almost certainly due to the higher thermal buoyancy (combination of flow and temperature) for the single large stack associated with the applicant-proposed H Frame combustion turbine.

For the applicant-proposed H Frame combustion turbine, the Puente site was found to have the lowest short-term impacts and the Del Norte alternative site the highest short-term impacts of the three sites, while the Del Norte alternative site was found to have marginally lower long-term impacts than the Puente site with the Ormond Beach alternative site having the highest long-term impacts.

However, the air quality and public health impacts from each of the configurations were similar or low enough (i.e., all impacts would be determined to be less than significant) to suggest no one configuration or site would be superior to another. Also, since it was determined that the combustion turbine plumes did not interact significantly, the air quality and public health impacts would approximately decrease linearly with decreasing numbers of combustion turbines (i.e., impacts from four LM6000 CTs would be approximately 80 percent of the impacts from five of those same CTs, or two LMS100 CTs would have impacts approximately 66 percent of three of the same CTs, and so on).

There are a few analysis limitations, the most important being the fact that the project site configurations were estimated and many of those estimated variables are subject to change or refinement if air quality issues were determined. Specifically, the stack heights and physical layout for the LMS100 and LM6000 combustion turbines could be engineered to reduce impacts. However, given that the results of the analysis did not show significant impacts for each of the combustion turbine type configurations as modeled, no additional refinement was performed.

The results of this analysis cannot be directly compared with the HRA results provided in the FSA for two primary reasons:

1) This comparison modeling analysis does not include the diesel-fueled emergency engine.

2) The TACs emissions estimation methods were standardized in a conservative manner for the three turbine cases, which caused the TAC emissions from the H Frame turbine to be different than what was modeled in the FSA HRA

COMPLIANCE AND CLOSURE

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BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION FOR THE: ***PUENTE POWER PROJECT***	**Docket No. 15-AFC-01**

Memorandum Regarding Staff's Response to the Committee's Request for Information on Compliance and Closure

I. Background

On March 10, 2017, the California Energy Commission Committee (Committee) assigned to conduct proceedings on the Application for Certification for the Puente Power Project filed "Committee Orders for Additional Evidence and Briefing Following Evidentiary Hearings" (Orders). The Orders request additional information regarding compliance and closure; specifically, the Committee ordered NRG Oxnard Energy Center, LLC (Applicant) and Energy Commission Staff (Staff) to respond to the following:

> *8. Supplement the existing analysis of the demolition of existing Mandalay units 1 and 2 to the extent necessary to analyze the environmental effects of Puente's demolition and removal.*

The discussion below addresses how an environmental impact analysis of future physical conditions that might exist 30 years into the future may be at odds with the California Environmental Quality Act (CEQA). Instead, Staff offers a qualitative analysis of potential environmental effects of Puente's demolition compared to demolition of Mandalay Units 1 and 2.

II. Discussion

The stated purpose of the environmental assessment required by CEQA is "to provide public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment." (Pub. Resources Code §21061.) To achieve this purpose, CEQA states that the existing physical environmental conditions in the vicinity of the project "at the time the environmental analysis is commenced" should normally constitute the baseline physical conditions for determining whether an identified impact reaches a level of significance. (Cal. Code Reg.s, tit. 14, §15125.) Using existing physical conditions, rather than hypothetical conditions, establishes "a realistic baseline that will give the public and decision makers the most accurate picture practically possible of the project's likely impacts." (*Neighbors for Smart Rail v. Exposition Metro Line Construction Authority, et al.* (2013) 57 Cal.4th 439, 449 [160 Cal.Rptr.3d 1, 304 P.3d 499]; *Communities for a Better Environment v. South Coast Air Quality Management Dist.* (2010) 48 Cal.4th 310, 322, 325, 328 [106 Cal. Rptr.3d 502, 226 P.3d 985].) The purpose of CEQA as an informational process cannot be met "by engaging in speculation as to future conditions and potential environmental consequences." (*Rio Vista Farm Bureau Center v. County of Solano* (1st Dist. 1992) 5 Cal.App.4th 351, 372 [7 Cal.Rptr.2d 307].)[15]

The future physical and regulatory conditions at, and in the vicinity of, the Puente site are uncertain. To carry forward a detailed CEQA analysis of the potential environmental effects of Puente's demolition and removal at a future date would require Staff to speculate as to the future state of the physical environment and to assume an invariable regulatory framework. This exercise would be arbitrary; an evaluation of potential environmental impacts must be based on facts and analysis, not opinions and unsupported conclusions. (*Concerned Citizens of Costa Mesa, Inc. v. 32nd District Agricultural Association* (1986) 42 Cal.3d 929, 935 [231 Cal.Rptr 748, 727 P2d 1029].) While the Final Staff Assessment in part includes and relies on future projections, such quantitative information and technical descriptions provide sufficient facts to consider future environmental conditions with more specificity than mere speculation. (Cal. Code Regs., title 20, § 15144 ["Drafting an [environmental impact report] . . . necessarily involves some degree of forecasting."]; Cal. Code Regs., title 20, § 15145 ["If, after thorough investigation, a lead agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact."].)

As discussed at the April 28, 2017 Committee Conference, Staff offers a qualitative comparison of potential environmental impacts between the demolition and removal of Mandalay Units 1 and 2 and the demolition and removal of the Puente facility. (Transcript of 04/28/2017 Committee Conference, TN# 217520, pages 66-68.) The qualitative comparison would use existing conditions to establish a baseline and to determine whether the environmental impacts of demolition of Puente would be "greater than," "less than," or "similar to" the impacts of demolition of Mandalay Units 1 and 2. The intent is to avoid a speculative analysis that may mislead readers about potentially significant environmental impacts.

Also for the Committee's consideration is Compliance Condition of Certification 15 (COM-15), included in the Final Staff Assessment. COM-15 requires that, no less than one year prior to closing, or upon an order compelling permanent closure, the project owner must submit a Final Closure Plan and Cost Estimate. The purpose of COM-15 is to ensure that a facility's eventual permanent closure and maintenance do not pose a threat to public health and safety and to environmental quality. Specifically, the Final Closure Plan requires the identification and assessment of all potential direct, indirect, and cumulative impacts and proposals of mitigation measures to reduce significant adverse impacts to a less-than-significant level. The plan must consider, at least, potential impacts to traffic, noise and vibration, soil erosion, air quality degradation, solid waste, hazardous materials, waste water discharges, and contaminated soil. Furthermore, the project owner must identify all current conditions of certification; applicable laws, ordinances, regulations, and standards; federal, state, regional and local planning efforts applicable to the facility; and proposed strategies for achieving and maintaining compliance during closure. Therefore, COM-15 requires the project owner to complete an environmental

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[15] See also *Topanga Beach Renters Assn. V. Department of General Services* (2nd Dist. 1976) 58 Cal.App.3d 188; *Atherton v. Board of Supervisors* (4th Dist. 1983) 146 Cal. App. 3d 346, 350, 351; *Kings County Farm Bureau v. City of Hanford* (5th Dist. 1990) 221 Cal.App.3d 692; *Towards Responsibility In Planning v. City Council* (6th Dist. 1988) 200 Cal.App.3d 671.)

assessment at the time of closure, which encompasses demolition and removal of Puente and associated structures.

III. Conclusion

To provide information of value to the public and the decision-makers, without assuming conditions of a baseline 30 years into the future, Staff has performed a qualitative analysis of the demolition and removal of Puente as compared to the previously analyzed demolition of Mandalay Units 1 and 2.

Date: June 15, 2017

Respectfully submitted,

*Original Signed By:*__________
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COMPARISON OF THE ENVIRONMENTAL EFFECTS OF THE DEMOLITION AND REMOVAL OF THE PUENTE POWER PROJECT AND MANDALAY GENERATING STATION UNITS 1 & 2

Testimony of Staff

INTRODUCTION

Energy Commission staff conducted a qualitative comparison of potential environmental impacts between the demolition and removal of Mandalay Generating Stations (MGS) Units 1 and 2 and the demolition and removal of the proposed Puente Power Project (Puente). The qualitative comparison uses existing conditions to establish a baseline and to determine whether the environmental impacts of demolition of Puente would be "greater than," "less than," or "similar to" the impacts of demolition of Mandalay Units 1 and 2.

Demolition and removal of MGS Units 1 and 2 to existing grade would involve a series of tasks associated with each of the following major parts:

- Asbestos removal;
- MGS Units 1 and 2 steam turbine plant equipment and buildings;
- MGS Units 1 and 2 boiler plant equipment and structures;
- 200-foot-tall stack, with the core structure felled by implosion using explosive charges placed per an engineered blast plan;
- All chemicals, hazardous materials, and contaminated equipment;
- Transformers and associated electrical equipment (such as isolated-phase buses, breakers, and transmission lines) up to the switchyard;
- Once-through cooling water system (steam condenser, pumps, intake structures); and
- Existing ocean outfall structure.

The above list excludes those equipment and structures associated with MGS Units 1 and 2 that would remain in place to serve Puente. Subgrade infrastructure that could present a safety risk if not filled would be filled with crushed concrete derived from demolition activities.

Demolition and removal of Puente to existing grade would involve a series of tasks associated with each of the following major parts. The following list includes those equipment and structures associated with MGS Units 1 and 2 that would remain in place to serve Puente:

- Combustion turbine power block structures;
- Exhaust stack, with the core structure felled by implosion using explosive charges placed per an engineered blast plan;

- All chemicals, hazardous materials, and contaminated equipment;
- Transformer and associated electrical equipment (such as isolated-phase buses, breakers, and transmission lines) up to the SCE switchyard;
- Cooling fan module;
- Service water storage tank;
- Demineralized water/reverse osmosis equipment and storage tanks (left from MGS with water loop extended to connect with Puente evaporative cooling water for combustion turbine);
- Fire water loop, pumps, and tank (left from MGS with the loop rerouted to connect to Puente power block);
- Emergency diesel generator;
- Ammonia receiving and storage system and tanks (left from MGS with ammonia line extended to interconnect to Puente's ammonia distribution system);
- Ammonia distribution system;
- Warehouse (left from MGS);
- Control room;
- Administration building (left from MGS);
- Storm water retention basins (left from MGS); and
- Septic system (left from MGS).

Subgrade infrastructure that could present a safety risk if not filled would be filled with crushed concrete derived from demolition activities. Demolition and removal equipment for MGS and Puente would be similar in terms of types and quantity. Demolition and removal activities associated with MGS would take approximately 15 months. Puente's simple-cycle unit would be smaller than MGS Units 1 and 2 taken together and its demolition and removal would not include asbestos removal, the once-through cooling system, and the ocean outfall structure. Therefore, Puente's simple-cycle unit would be expected to take less time than MGS to demolish and remove. However, Puente's demolition would include several equipment, structures, and buildings now serving MGS Units 1 and 2 that would remain in place to serve Puente, which may extend its demolition and removal to at least that of the MGS, or 15 months.

ENVIRONMENTAL EFFECTS

In the table below, the first column identifies the environmental effect identified in the Final Staff Assessment (FSA), the second column contains staff's conclusion of the impacts of the demolition of MGS Units 1 & 2, and the third column provides the comparison for Puente. Impact conclusions are indicated using these abbreviations:

LS = less-than-significant, no mitigation required
PSM = potentially significant impact that can be mitigated to less than significant

Air Quality
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential AQ impacts	PSM	Similar to MGS (PSM)

The air quality impacts would be similar for demolition and removal of MGS and Puente because the duration of demolition activities, numbers, and types of equipment used would be similar for the demolition of both projects. Therefore, the impacts for both Puente and MGS would be less than significant with mitigation.

Biological Resources
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Impacts to special-status plants and wildlife	LS	Similar to MGS (LS)
Potential noise impacts for nesting birds	PSM	Similar to MGS (PSM)

MGS Units 1 and 2 are located on disturbed or otherwise paved ground, and no additional land resources are assumed to be used to demolish Puente. Therefore, there are no impacts to special-status plants or wildlife associated with demolition and removal of these units. The demolition and removal of Puente are assumed to have impacts similar to the removal and demolition of MGS Units 1 and 2.

For Puente's demolition and removal, the noise baseline is assumed to be the present noise regime (same as MGS; TN #206698) and the demolition and removal activities and equipment would be similar to MGS in terms of types, quantity, and duration of work. Therefore, the noise impact would be similar to MGS and similar mitigation measures would need to be implemented. These mitigation measures (**BIO-8** and **BIO-10**) include pre-construction nest surveys and impact avoidance, and prohibit explosive demolition of the MGS during nesting season. Additionally, conditions **NOISE-6** through **NOISE-8** require all equipment to have state-of-the-art silencing buffering mechanisms, and restrict pile driving as well as the use of steam blows. Therefore, the potential noise impacts of Puente demolition are considered to be similar to MGS Units 1 and 2.

Cultural Resources
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential impacts on surficial archaeological and ethnographic resources	No impact	Greater than MGS (PSM)
Potential impacts to buried archaeological resources	No impact	Similar to MGS (No impact)
Potential impacts to built environment resources	No impact	Similar to MGS (No impact)

Impacts Surficial Archaeological and Ethnographic Resources

The demolition and removal of Puente would include removing the equipment and structures to grade, including the transformer and associated electrical equipment (such as isolated-phase buses, breakers, and transmission lines). One known surficial archaeological and ethnographic resource, CA-VEN-01804, is located in close proximity to the access road for the transmission line. Removal of the transmission line could potentially impact this site, but with adoption of the flag and avoid Condition of Certification, **CUL-9**, impacts to this site would be avoided.

Impacts to Buried Archaeological Resources

Construction of Puente could impact as yet, unknown buried resources, but with the adoption of Conditions of Certification **CUL-1** through **CUL-9** these impacts would be reduced to a less than significant level. Demolition and removal of Puente would not impact any buried archaeological resources because these impacts would be identified and mitigated during construction and there would be no additional ground disturbance associated with demolition and removal of Puente that could impact buried archaeological resources.

Impacts to Built Environment Resources

In 30 years, at the time of proposed demolition and removal of Puente, the structure itself and associated facilities would not be old enough to be considered a historical built environment resource and would be unlikely to be considered of exceptional importance under Criterion (g) of the National Register of Historic Places. Demolition and removal of Puente would not impact any currently known built environment resources adjacent to or near Puente, and therefore there would be no impact to this resource type from demolition or removal of Puente.

Geology and Paleontology
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential geologic hazard impact	PSM	Similar to MGS (PSM)

Potential impacts from demolition activities of MGS would be similar to Puente, and limited to geologic hazards. There would be no impacts to geologic, mineralogic, or paleontological resources from demolition activities. The severity of potential impacts to geologic hazards can increase with the amount of excavation and recompaction activity. When comparing demolition of Puente with demolition of MGS, these activities are essentially equivalent. The MGS demolition area of approximately four acres is similar in scale to the demolition area of Puente and associated structures (e.g. administration building, warehouse) which total roughly eight acres. Any excavation below grade would be backfilled and compacted to a density similar to, or slightly greater than the density of the surrounding soil to prevent subsidence or differential surface erosion.

In the FSA, staff concludes that potential impacts of MGS demolition would be less than significant with Condition of Certification **GEO-2** which requires geotechnical engineering analyses to support the site grading permit required for final grading of the site. For these reasons, staff further concludes that a condition of certification similar to **GEO-2** would reduce potential impacts of Puente's demolition to less than significant, similar to the demolition of MGS Units 1 and 2.

Hazardous Materials Management
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Risk of fire or explosion off-site from natural gas usage during project demolition and removal	PSM	Similar to MGS (PSM)
Risk of hazardous material spill impact en route (off-site) from hazardous materials transport to/from the project site	PSM	Similar to MGS (PSM)
Risk of hazardous materials spill or migration off-site from hazardous materials storage at and removal from on-site	PSM	Similar to MGS (PSM)
Risk of significant drawdown of emergency response services causing off-site impact	LS	Similar to MGS (LS)

For the Puente project's demolition and removal, the demolition and removal activities and equipment would be similar to those for MGS in terms of types, quantity, and duration of work. Therefore, under the proposed conditions of certification, there would be continued compliance with laws, ordinances, regulations, and standards (LORS) related to hazardous materials management.

Land Use and Planning

The possible requirement that the Puente facilities be demolished and removed when they are decommissioned would result in the cessation of energy facility use of the site. Demolition and removal of the Puente facilities would not physically divide an established community, and potentially would make the site available for future use. Any proposed subsequent uses of any portion of the site not subject to Energy Commission licensing or other discretionary authority would be subject to review and approval of a coastal development permit by the city of Oxnard.

Noise
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential noise impacts at noise-sensitive locations	PSM	Similar to MGS (PSM)

For Puente's demolition and removal, the noise baseline is assumed to be the present noise regime (same as MGS) and the demolition and removal activities and equipment would be similar to MGS in terms of types, quantity, and duration of work. Therefore, the noise impact would be similar to MGS and similar mitigation measures would need to be implemented. These mitigation measures include public notification of the work, restricting the work to daytime, avoiding the creation of excessive noise, noise complaint resolution measures, and an employee noise control program.

Public Health
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential public health impacts	LS	Similar to MGS (LS)

Demolition and removal equipment for MGS and Puente would be similar in terms of types and quantity. Demolition and removal activities associated with MGS would take approximately 15 months. The primary air toxic pollutant of concern from demolition activities is diesel particulate matter (diesel PM or DPM). However, Puente's simple-cycle unit would be smaller than MGS Units 1 and 2 taken together since its demolition and removal would not include asbestos removal, the once-through cooling system, and the ocean outfall structure.

The public health impacts would be similar for demolition and removal of MGS and Puente because the duration of demolition activities, numbers, and types of equipment used would be similar for the demolition of both projects. Therefore, the impacts for both Puente and MGS would be less than significant.

Socioeconomics
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Induce substantial population growth in an area, either directly or indirectly	LS	Similar to MGS (LS)
Displace substantial numbers of people and/or existing housing, necessitating the construction of replacement housing elsewhere	LS	Similar to MGS (LS)
Adversely impact acceptable levels of service for police protection and parks and recreation	LS	Similar to MGS (LS)

As stated above, demolition and removal equipment for MGS and Puente would be similar and the length of time for demolition and removal of about 15 months for MGS and Puente would also be similar. As such, staff assumes that project labor needs for the demolition and removal of Puente would be similar to MGS. As stated under the "Induce Substantial Population Growth" subsection of the **Socioeconomics** section of the FSA, the MGS demolition workforce would peak during months 7 to 11 with 74 workers and have an average workforce over the 15-month period of 54 workers. Additionally, approximately 95 percent of the demolition workforce would be drawn from Ventura and Los Angeles counties and thus would be considered local workforce, commuting daily to the project site. The remaining five percent of the demolition workforce would be considered non-local and likely seek lodging closer to the project site, returning to their primary residences on the weekends. Furthermore, as shown in **Socioeconomics Table 3** under the same subsection of the FSA, the total labor supply in the study area would be more than adequate to provide the demolition labor for MGS and the labor supply in the area is projected to continue to increase in the future. As a result, the demolition and removal of Puente would not induce substantial population growth, induce substantial increases in demand for parks or police protection services, or displace substantial numbers of people and/or housing, necessitating the construction of replacement housing elsewhere. Therefore, impacts under these criteria for the demolition and removal of Puente would be less than significant, similar to MGS.

Soil and Water
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential Water Quality Impacts	PSM	Similar to MGS (PSM)

Potential impacts from demolition activities of MGS would be similar to Puente. Water quality can be affected by sedimentation caused by erosion, by runoff carrying contaminants, and by direct discharge of pollutants (point-source pollution). The severity of potential impacts can increase with the amount of activity (project footprint and/or volume of earthwork), the amount and type of pollutants onsite (e.g. hazardous materials), and physical characteristics of the site (e.g. annual rainfall, proximity to water resources). When comparing demolition of Puente with demolition of MGS, most of these components are essentially equivalent. The MGS demolition area of approximately four acres is similar in scale to the demolition area of Puente and associated structures (e.g. administration building, warehouse) which total roughly eight acres. Although the differing technologies of both facilities would result in different processes and chemicals used to generate energy (steam turbines at MGS compared to the proposed natural- gas combustion turbine at Puente), prior to demolition all chemicals and hazardous materials would be drained from the equipment, and disposed of at a facility approved to receive the materials similar to MGS (See the Waste Management section of the FSA). Because the Puente and MGS sites are located adjacent to each other, physical characteristics would be the same (assuming the same baseline for rainfall and other climate conditions).

In the FSA, staff concludes that potential impacts of MGS demolition would be less than significant with Condition of Certification **SOIL&WATER-1** which requires compliance with the federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES) permit. In California, these requirements are administered by the State Water Resources Control Board to ensure that water quality standards are met. Although this permit is commonly referred to as the NPDES Construction General Permit, it also covers demolition activities anticipated for the demolition and removal of Puente. For these reasons, staff further concludes that a condition of certification similar to **SOIL&WATER-1** would reduce potential impacts of Puente's demolition to less than significant, similar to the demolition of MGS Units 1 and 2.

Traffic and Transportation
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential impacts to the traffic and transportation system	Less Than Significant With Mitigation	Similar to MGS (LSM)

For Puente's demolition and removal, the traffic and transportation baseline is assumed to be the present levels of service in the project vicinity (same as MGS). Demolition and removal traffic would be similar to MGS because the duration and numbers and types of vehicles and equipment needed for demolition would be similar for both projects. Demolition and removal of Puente would result in less-than-significant impacts to the traffic and transportation system with implementation of similar mitigation measures. These mitigation measures include obtaining roadway use permits, implementation of a traffic control plan, and restoring public roads, easements, and rights-of-way. Therefore, the impacts for both Puente and MGS demolition would be less than significant with mitigation.

Transmission Line Safety and Nuisance (TLSN)
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential TLSN impacts	No impact	Similar to MGS (No impact)

Demolition and removal equipment for MGS and Puente would have no impact on transmission line safety and nuisance.

Visual Resources
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential impacts to the visual character or quality	Overall Benefit Baseline Conditions Improved	Similar to MGS (Benefit)

For the demolition and removal of Puente, the visual character and quality baseline is assumed to be the present visual environment (same as MGS Units 1 & 2). Demolition and removal activities of Puente would be similar to MGS in terms of the removal of large industrial power plant components. Puente's demolition could take as long as the demolition of MGS – about 15 months. Similar to MGS demolition, Puente's demolition activities and associated equipment, trucks, and vehicles would be visible from offsite areas, in particular from Mandalay State Beach. Like MGS, the associated visual changes are considered adverse, but not significant. Any lighting associated with demolition would be designed and controlled similar to MGS demolition lighting so as not to adversely impact nighttime views. After demolition is complete, Puente's removal from the visual landscape would result in similar beneficial visual impacts compared to the removal of MGS.

Waste Management
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Potential Waste Management impact	PSM	Similar to MGS (PSM)

In the FSA, staff concludes that the waste management methods and mitigation measures that are proposed for MGS demolition would be adequate to ensure against significant impacts at the site and on the local waste management and disposal facilities. Since the same management methods and mitigation measures would be utilized for demolition of Puente, the waste management impacts from the two projects would be similar in their respective lack of significant impacts.

Worker Safety
Summary Comparison of Impacts of Demolition and Removal of Puente to MGS Units 1 & 2

Environmental Effect	MGS Units 1 & 2	Puente
Risk of fire or explosion impact off-site resulting from natural gas usage during demolition and removal	PSM	Similar to MGS (PSM)
Risk of significant drawdown of emergency response services causing off-site impact	LS	Similar to MGS (LS)

For the Puente project's demolition and removal, the demolition and removal activities and equipment would be similar to those for MGS in terms of types, quantity, and duration of work. Therefore, with the proposed conditions of certification, there would be continued compliance with laws, ordinances, regulations, and standards (LORS) related to worker safety and fire protection.

CONCLUSION

Demolition and removal activities of Puente would be similar to MGS in terms of the removal of large industrial power plant components. Puente's demolition could take as long as the demolition of MGS – about 15 months. The environmental impacts associated with the demolition and removal activities of Puente would also be similar to MGS. Potential impacts on surficial archaeological and ethnographic resources may be greater for Puente than MGS. Removal of the transmission line could potentially impact this site, but with adoption of the flag and avoid Condition of Certification, **CUL-9**, impacts to this site would be avoided.

APPENDIX -1 STAFF CONTRIBUTORS TO THE COMPARATIVE ANALYSIS OF THE DEMOLITION AND REMOVAL OF THE PUENTE POWER PROJECT AND MGS UNITS 1&2

This appendix lists staff responsible for the specific technical analysis in the **Comparative Analysis of the Demolition and Removal of the Puente Power Project and MGS Units 1 & 2**. Staff names are listed in their area of expertise.

Technical Area	Staff
Project Description	Shahab Khoshmashrab, P.E.
Air Quality	Joseph Hughes, P.E.
Biological Resources	Carol Watson / Jon Hillard
Cultural Resources	Matthew Braun / Melissa Mourkas
Geology & Paleontology	Paul Marshall, CEG / Garry Maurath, Ph.D., PG
Hazardous Material Mgmt.	Brett Fooks, P.E. / Geoff Lesh, P.E.
Land Use	Steven Kerr
Noise	Shahab Khoshmashrab, P.E.
Public Health	Huei-An (Ann) Chu, PH.D.
Socioeconomics	Lisa Worall
Soil & Water	Marylou Taylor, P.E.
Traffic & Transpiration	Jonathan Fong / Andrea Koch
Transmission Line Safety & Nuisance	Huei-An (Ann) Chu, PH.D.
Visual Resources	Eric Knight
Waste Mgmt.	Obed Odoemelam, Ph.D.
Worker Safety & Fire Protection	Brett Fooks, P.E. / Geoff Lesh, P.E.

FINANCIAL ASSURANCE MECHANISMS

Testimony of Christine Root

INTRODUCTION

In the March 10, 2017 *Committee Orders for Additional Evidence and Briefing Following Evidentiary Hearing*, the Committee asked staff to analyze the mechanisms for providing financial assurances (i.e., bonding) for the demolition and removal of the Puente facilities (TN# 216505).

ANALYSIS

Staff has identified the following mechanisms commonly used for providing financial assurances:

- Surety bond (or performance bond)
- Pledged savings account
- Closure insurance
- Irrevocable letter of credit
- Trust Funds
- A financial test and corporate guarantee for closure

A performance bond is an agreement between the project owner (the *Principal*), the Energy Commission (the *Obligee*), and the financial institution issuing the bond (the *Surety*). The Surety guarantees that the Principal will satisfactorily fulfill the terms of its agreement with the Obligee. If the Principal fails to do so, the Surety is required to pay a predetermined sum to the Obligee.

A pledged savings account is an agreed upon amount of cash placed into a dedicated account by the *pledger* (the project owner) to be paid to the *pledgee* (the Commission) if the pledger fails to meet its contractual obligations to the pledgee.

Closure insurance (or business interruption insurance) is a policy that insures the holder (the project owner) against loss of business revenue suffered due to disaster. This ostensibly ensures that the project owner would still be able to meet its obligation to the Commission in such an event.

An irrevocable letter of credit is a form of payment wherein the project owner’s bank commits to pay a predetermined amount to the *beneficiary* (the Commission) upon the project owner’s failure to meet the agreement terms. The letter cannot be amended or rescinded unless agreed upon by all three parties.

A trust fund is a predetermined amount of cash placed into a legal trust by the project owner to be paid out to the beneficiary (the Commission) upon the project owner's failure to complete of the terms of the agreement.

A financial test and corporate guarantee for closure requires the project owner to provide documentation of its ability to meet its financial obligations under the terms of the agreement and provide a pledge of financial assurance that includes a detailing of the types and sources of revenue along with timetables for availability of funds.

USE OF FINANCIAL ASSURANCE MECHANISMS IN OTHER ENERGY COMMISSION POWER PROJECTS

To analyze these mechanisms further, staff provides the following descriptions of past situations where financial assurances have been required and why, and also looks at power plant cases where Staff or the Commission determined that financial assurances were not necessary.

Financial assurance was required on the following projects:

Beacon Solar Energy Project (08-AFC-02)

Condition of Certification **BIO-19** in the Commission Final Decision required a funding mechanism be developed in consultation with staff to address the local biological resource related to facility closure. The verification for this condition stated that "[t]he financial assurances may be in the form of an irrevocable letter of credit, a performance bond, a pledge of savings account, or other equivalent form of security, as approved by the CPM [Compliance Project Manager]. (CEC 2010)"

Bottle Rock Project (79-AFC-04C)

The Bottle Rock Project Staff Analysis of Proposed Modification to the Compliance Conditions of Certification, proposed Condition of Certification **COM-16 Closure Financial Assurance,** which required the project owner to establish an irrevocable closure surety bond and standby trust fund. Staff determined that a closure surety bond was needed because of the power plant's historical under-performance and Bottle Rock Power Corporations, LLC questionable financial stability (CEC 2013). The total amount of the closure surety bond was set at $1,676,875[16] by the Commission in its Final Decision (CEC 2013a).

Financial assurance was proposed in the following cases and then later determined not to be needed:

Carlsbad Energy Center (07-AFC-06C)

The Carlsbad Energy Center Commission Final Decision states that because the project proposed reusing an existing power plant site and the project would improve the coastal profile with the removal of the Encina Power Station, the Commission determined it was

[16] The Decision contains an explanation of how the bond amount changed from Energy Commission staff estimate of $2,159,000 pre-contingency ($2,698,750 after), to $1,341,500 pre-contingency ($1,676,875 after). The $1,341,500 was adopted in the final decision with the contingency phased in over 6 years for a total amount of 1,676,875.

unnecessary to impose a closure funding requirement on the project (CEC 2015 page 4-2 and 4-3).

The Carlsbad Commission Final Decision (2012) included a recommendation to the Commission's Integrated Energy Policy Report Committee to consider the issue of requiring prepayment of closure expenses.

El Segundo Power Redevelopment Project (00-AFC-14C)

In the Preliminary Staff Assessment for the El Segundo Power Redevelopment Project, staff proposed Condition of Certification **COM-16 Financial Assurance for Closure and Post-Closure Care,** which would require the project owner to establish an irrevocable closure surety bond and standby trust fund. The surety bond amount would be determined in the Provisional Closure Plan and approved by the Compliance Project Manager. The standby trust fund designated the Energy Commission as the beneficiary (CEC 2014).

In objection to this condition, the Petitioner stated that decommission costs represented significant encumbrance and burden on the project and could not be predicted so far in advance. Petitioner also stated that they had begun the existing decommissioning procedures for the project at the time of the proceedings (Locke Lord 2014).

This condition was not included in the Final Staff Assessment. Staff included a statement that it agreed with the Petitioner's objection (CEC 2014a, page 7 – 12).

Energy Commission Projects Located on BLM Lands

U.S. Bureau of Land Management (BLM) policy is to include a due diligence and performance bonding requirement for installation of facilities. For the Ivanpah Solar Electric Generating System (07-AFC-05), the bonding requirement is imposed by the BLM as described in the October 2010 Record of Decision (BLM 2010 p. 17 and 29). For the Blythe Solar Energy Project (09-AFC-06), the BLM also required a reclamation and performance bond in the amount of $2,236,000 (BLM 2014).

In these cases, the BLM had the requirements and thus there was no need for staff to create an additional condition of certification for providing financial assurance for closure.

CONCLUSIONS AND RECOMMENDATIONS

There are a variety of viable options for providing financial assurances. In reviewing past circumstances under which staff recommended financial assurances for the demolition and removal of power plant facilities, staff has concluded that the surety (performance) bond is historically the most commonly used means used by the Energy Commission of assuring that the project owner can and will meet the financial obligations of decommissioning, demolition and removal of a facility.

If a condition of certification were to be required, staff recommends, as in the Beacon Solar Energy Project, to provide the wording "performance bond or other equivalent form of security, as approved by the CPM" to allow for flexibility. As an example, staff has provided a sample condition of certification.

EXAMPLE OF A CONDITION OF CERTIFICATION FOR FINANCIAL ASSURANCE

Staff provides, below, an example of a **Compliance and Closure** condition of certification.

SAMPLE CONDITION OF CERTIFICATION

Financial Assurance for Closure and Post-Closure Care. The project owner shall provide financial assurances to the Energy Commission, guaranteeing adequate and readily available funds to finance interim operation, facility closure, and post-closure site care, as needed.

Within 30 days following Compliance Project Manager (CPM) approval of the project owner's first Provisional Closure Plan and Cost Estimate, pursuant to COM-15, the project owner shall establish an irrevocable closure surety bond or other equivalent form of security, as approved by the CPM. The surety bond shall guarantee the project owner's performance of closure, as specified in the Provisional Closure Plan, and shall be in the amount of the CPM-approved Provisional Closure Cost Estimate. The surety bond (or CPM-approved equivalent) shall have as its beneficiary (or Obligee) the California State Energy Resources Conservation and Development Commission.

Within 60 days of CPM approval of each sequential Provisional Cost Estimate prepared pursuant to COM-15, the amount of the surety bond (or CPM-approved equivalent) shall be adjusted to reflect any change in the estimate. Within 30 days of making the adjustment, the project owner shall submit for CPM review and approval documentation of the adjustment. Each year, on the anniversary of the establishment of the surety bond (or CPM-approved equivalent), the project owner shall provide to the CPM documentation from the sureties of the bond's current value.

Using surety bond funds to implement closure may not fully satisfy the project owner's obligations under these conditions. Provisions from California bond and undertaking law, as well as other statutory and case law, may be applicable.

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