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(Pacific Gas and Electric)

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CALIFORNIA COASTAL COMMISSION

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**TECHNICAL MEMORANDUM**

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SUBJECT: Land preservation as compensatory mitigation for marine productivity impacts for Pacific Gas and Electric Company (PG&E) (Consistency Certification Application CC-0003-23 and CDP 9-25-0739)

DATE: October 14, 2025

SUMMARY

Preservation of the Diablo Canyon lands as compensatory mitigation for PG&E's continued operation of the Diablo Canyon Power Plant (DCPP) and its adverse effects on marine productivity would provide a meaningful land/seascape-scale approach specific to the affected geography. It would simultaneously benefit marine, avian, terrestrial, and aquatic productivity across the coastal ecotone, facilitate ecological resilience, and contribute directly to regional and state conservation goals. **This memo discusses key connections between the marine environment and broader land/seascape and establishes a clear nexus with ecological rationale for the use of out-of-kind mitigation to compensate for marine productivity impacts associated with the DCPP.**

INTRODUCTION

Continued operation of DCPP under the proposed 20-year license extension is expected to adversely affect the productivity of nearby marine ecosystems on the order of 9,365 acres per year, which is far greater than any other currently operating seawater intake system on California's coast.¹ Generally, the loss of marine productivity is challenging to compensate for, and such compensation has been typically provided through a limited set of off-site actions aimed at either 1) restoring or enhancing productivity in related marine ecosystems, or 2) funding existing coastal resource programs that do not necessarily occur within the same affected marine environment. Ensuring that these compensation efforts adequately replace lost productivity in a timely manner and/or in the regions that have sustained the actual impacts can be difficult.^{2,3} Given the magnitude of lost marine productivity estimated for DCPP, the infeasibility of other more commonly-used mitigation approaches near the site, and a history of challenges in delivering large-scale APF mitigation in California, **I was asked to consider a relatively more out-of-kind mitigation approach involving the conservation of adjacent lands, and to characterize the**

¹ The Area of Production Foregone (APF) is a value representing the number of acres of habitat that would be needed to replace the amount of productivity lost each year due to marine organism entrainment (i.e., mortality) through seawater intakes supporting onshore industrial facilities. The APF calculation is informed by field studies aimed at identifying and quantifying marine organisms within an area of affected waters, the latter of which is determined through hydraulic and oceanographic models. That data is then combined with details about the observed species' biology and used as model inputs to estimate the fraction of organisms that would be lost due to the industrial activity. The latter value is then used to determine the amount of equivalent habitat area needed to compensate for its replacement (i.e., APF) within some level of confidence.

ecological nexus of such an approach. In addition to having reviewed assorted materials associated with the project application, the site’s history, ecological databases, and a robust body of scientific literature, I was able to tour the Diablo Canyon lands with other Commission staff and PG&E personnel on October 8, 2025, and include some relevant observations herein.

Compensatory Mitigation Strategies

Under the Commission’s jurisdiction, mitigation for lost ecological resources is generally expected to be provided for in-kind and on- or near-site, in order to compensate for the types of resources actually impacted, and in areas that preserve their relative meaningfulness within the coastal landscape. At times, mitigation may occur off-site, removed from the location of sustained impacts, for reasons such as available space or opportunities that better serve the specific resources affected. Less often, mitigation may take the form of out-of-kind, meaning that the resources are replaced with something different; however, the use of out-of-kind mitigation is generally reserved for situations where in-kind is infeasible or out-of-kind would benefit the impacted resource in important ways. In these instances, **there must still be a clear nexus between the resources lost and those with which they are compensated.** For example, impacted habitat supporting a particular species may be compensated for with another habitat type supporting that same species (e.g., impacted upland habitat for a frog is provided for via less abundant aquatic habitat that is also used by the species). For the loss of marine productivity in coastal waters, the creation of coastal wetland and offshore reef habitats compensating for the productivity lost from open-water areas has been authorized with a number of projects approved by the Commission.⁴ Though compensation such as this may be provided with the aim of supporting select overlapping species across their various life history phases and thus, their productivity, doing so in different habitat types already represents a degree of out-of-kind mitigation.

In the case of the proposed license renewal for DCP, nearby in-kind mitigation and even out-of-kind approaches exclusively involving marine habitat at the scale needed for full compensation are considered infeasible.⁵

² Although the San Onofre Nuclear Generating Station mitigation project used a different calculation method for determining mitigation requirements, it is perhaps one of the most familiar intake mitigation projects (CDP 6-80-330-A), as it was quite large and also had significant marine life impacts. As compensation for the lost marine productivity over the 32-year operation life of the station, the Commission required construction of an artificial reef large enough to support 28 tons of reef fish and a minimum 150 acres of functioning and sustainable kelp forest habitat annually (or 896 tons and 4800 ac, cumulatively) and a minimum 150-acre coastal wetland. Both the reefs and wetlands have suites of performance criteria they must achieve for as many years as SONGS operated, following the initial implementation of the mitigation projects. As of 2024, 16 years since monitoring of the initial 150-acre mitigation reef build commenced and 4 years after an additional 198-acre remediation reef was constructed, the reef has received credit for 6 years of its relative annual performance criteria but still needs another 26, as well as achievement of the cumulative performance requirements. The latter remain at a deficit of 736 tons of reef fish and 4524 acres of kelp forest (Reed, et al. 2025). Monitoring of the wetland mitigation project commenced in 2012, but as of 2024, several performance criteria remain unmet and no credit has been issued – 32 years of mitigation remains outstanding for the wetlands (Smith, et al. 2025).

³ With respect to in lieu fee collection, the State Waterboards Once-Through Cooling (OTC) Program has historically funded programs in four categories, including enforcement of marine protected areas (MPAs), outreach and education concerning MPAs, research to help quantify the benefits of MPAs, and restoration intended to increase marine life associated with MPAs. In practice, while otherwise beneficial, it remains that these programs have rarely provided for the lost marine productivity or even the ecological functions and values near the geographies most impacted. Thus, the Diablo Canyon region has endured both a net loss of marine productivity and a significant displacement of resource value intended to compensate for that loss over the term of its operation to-date.

⁴ For example, see CDP E-06-013 (Poseidon Resources (Channelside) LLC – Carlsbad Desalination Facility), which had an APF of approximately 66 acres; CDP 09-21-0488 (Poseidon Water (Huntington Beach)), which had an APF of approximately 162 acres; and, CDP 1-21-0653 (Humboldt Bay Harbor, Recreation and Conservation District), which had an APF of approximately 28.5 acres.

⁵ It has been estimated that if PG&E were to provide its compensatory mitigation as an artificial reef as has been done for other projects, that reef would need to be somewhere between approximately 1,400 to 1,900 acres in order to compensate for DCP’s entrainment impacts. This is considered infeasible due to the large scale, lack of siting options in the vicinity, and the expense of such an undertaking. For comparison, the largest artificial reef in California to date is the SONGS mitigation, which totals 348 acres and has had ongoing challenges as discussed in **Footnote 1** above.

However, the ownership by PG&E and its subsidiaries of extensive coastal lands around DCPD provides a **unique opportunity to protect these from future development, preserve, and facilitate habitat enhancement on a large area of contiguous open space land immediately adjacent to the marine environment**. This area extends over nearly 14 miles of coastline and approximately 12,700 acres of marine, terrestrial, and aquatic ecosystems, where current land use is primarily agricultural (limited cattle grazing; 70.6%) or rural (22.9%), and much is surrounded by undeveloped open space, protected areas, and public lands (County of San Luis Obispo 2025). Information concerning the ecological resources on-site is somewhat limited as the lands have not been fully surveyed, but the **accounts that exist and my direct observations consistently suggest that much of the Diablo Canyon lands would likely qualify as environmentally sensitive habitat (ESHA)** – this is further detailed in the following sections.

THE DIABLO CANYON LANDS

Situated in central San Luis Obispo County, the Diablo Canyon lands include about 12,700 acres owned or controlled by PG&E and its subsidiaries. They consist of a relatively undeveloped area between Point Buchon and Point San Luis and extend from the shoreline into the Irish Hills (**Figure 1**). The DCPD itself is located on a 772-acre parcel near the center of this area, surrounding the mouth of Diablo Creek. Seawater is pulled in from the ocean nearby to support the DCPD once-through cooling system used to manage thermal loads generated by power plant activities and is then discharged as heated water back into the ocean environment. The Diablo Canyon lands are generally referred to by four areas: Parcel P is the 772-acre power plant site; North Ranch is an approximately 4,600-acre area extending from the power plant north to Point Buchon, and is also the site of the 6.6-mile Point Buchon coastal access trail; South Ranch is an approximately 5,000-acre area extending south to Point San Luis and includes the 8-mile long Pecho Coast coastal access trail; and, Wild Cherry Canyon is an approximately 2,400-acre area east of South Ranch that reaches to the community of Avila Beach. The coastal zone extends inland roughly a half mile, on average, whereas the Diablo Canyon lands owned or controlled by PG&E and its subsidiaries generally extend roughly 1.5 miles inland evenly and further in some locations. The lands are surrounded by a mosaic of public and private holdings including the approximately 8,000-acre Montaña del Oro State Park, the approximately 1,200-acre West Irish Hills parcel managed as a natural preserve area by the Bureau of Land Management, and the approximately 1,500-acre Hibberd Preserve managed by the Land Conservancy of San Luis Obispo. Further east, there are several additional large conservation easements bridging to these areas. Collectively, they represent the majority of the landscape surrounding the Diablo Canyon lands and western Irish Hills, and they provide for important ecological connectivity across the region. Broadly, the adjoining eastern lands support a multitude of habitat types including hardwood and coniferous forests, chaparral and coastal scrub, and a network of canyons and riparian corridors. Within the Diablo Canyon lands, a 1,200-acre deed restricted area includes Point San Luis and wraps inland and upcoast. To the west, the marine environment extends to the Pacific and includes the Point Buchon State Marine Reserve (SMR) and Point Buchon State Marine Conservation Area (SMCA) in state waters as well as the recently designated Chumash Heritage National Marine Sanctuary in federal waters. A brief description of the ecosystems known from the Diablo Canyon lands themselves is as follows.

Ecosystems

Due to their relative inaccessibility and expanse, outside of the DCPD itself, publicly accessible data from biological resource studies and surveys of the Diablo Canyon lands is limited, notable exceptions being a report to inform stewardship in the late 1990s, a baseline survey PG&E conducted over much of its North Ranch area ahead of a 2004 CDP application (Biosystems Analysis, Inc. 1996), and the subsequent North Ranch Managed Access

Plan also associated with that permit (LSA Associates, Inc. 2006).⁶ Additionally, PG&E has provided Commission staff with shapefiles from a more recent vegetation mapping effort conducted in 2016 and 2017 for the North Ranch and South Ranch areas, which refines the earlier understanding of the landscape, and was used during the October 2025 site visit to inform current on-the-ground observations.⁷ Combined with records from the DCPD parcel and records from areas immediately north and south of the Diablo Canyon lands that are rich with records of sensitive biological resources along the coast, evidence suggests that the vast areas in between should be no less significant. Some limited information on sensitive resources within the Diablo Canyon lands is available, including published and unprocessed records for a variety of flora and fauna (Figure 2).⁸ Collectively, the mosaic of data contributes insight and informs expectations of the area's ecological value and conservation potential.

Marine

Situated as a broad expanse of rocky headland jutting out towards the Pacific, the Diablo Canyon lands benefit from oceanographic influences including exposure to seasonal upwelling (peak April-May) and its delivery of cold, nutrient-rich waters (Walter, et al. 2018). Combined with the generally low level of anthropogenic inputs along this coast, these waters support high levels of ocean productivity. In the nearshore marine environment, which are areas protected under the Public Trust Doctrine as overseen by the State Lands Commission, there are several habitats including intertidal and subtidal, hard and soft bottom, and variable exposures to dominant wave conditions. As a result, the seascape supports a rich array of communities and species, which is widely recognized via the designations of State Marine Protected Areas (MPAs) near Point Buchon and the Chumash Heritage National Marine Sanctuary. Expansive rocky intertidal ecosystems, kelp forests, and offshore pinnacles provide important substrates and structure, while soft bottom areas provide other resource opportunities (e.g., space for invertebrate infauna). Sensitive marine species present include federally endangered black abalone (*Haliotis cracherodii*), federally threatened southern sea otter (*Enhydra lutris nereis*), and the occasional steller sea lion (*Eumetopias jubatus*, S2/State Delisted) or sea turtle (various species). Intertidal invertebrate diversity is reported as including 421 taxa and the subtidal as having 407. Of the 43 fish species documented in the vicinity of DCPD's intertidal zone, half were found only in this narrow band along the shore; by comparison, 102 fish species are reported from subtidal areas. Seaweeds (including many kelps) and other aquatic plants (i.e., seagrasses) total 179 species in the intertidal and 169 in the subtidal, with some but not complete overlap. In addition to southern sea otters, California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and northern elephant seals (*Mirounga angustirostris*) are considered residents in the surrounding area. California sea lion habitat use routinely includes important haul-outs at Lion Rock,

⁶ See CDP A-3-SLO-04-035 (Pacific Gas and Electric Company). The North Ranch baseline survey described habitat and vegetation types, wildlife use, geological attributes, and other coastal resources present on the site at that time. The North Ranch Managed Access Plan included the analytical process for sensitive resource avoidance when siting public access trails (LSA Associates, Inc. 2006).

⁷ The Commission's Mapping Unit was able to use the shapefiles provided to produce maps for staff use and interpretation when on-site and in developing this technical memorandum.

⁸ For example, records published in the California Natural Diversity Database (CNDDDB) illustrate that at Montaña de Oro State Park, immediately northeast of the Diablo Canyon lands, numerous rare and sensitive species occur including tidewater goby (*Eucyclogobius newberryi*), south-central California coast steelhead (*Oncorhynchus mykiss irideus*), San Diego desert woodrat (*Neotoma lepida intermedia*), monarchs (*Danaus plexippus*), Diablo Canyon blue grass (*Poa diabolii*), twisted horsehair lichen (*Sulcaria sprialifera*), chaparral ragwort (*Senecio aphanactis*), Pecho manzanita (*Arctostaphylos pechoensis*), and many others. To the south, towards Avila Beach, CNDDDB records indicate presence of California red-legged frog (*Rana draytonii*), tidewater goby, monarchs, Santa Margarita manzanita (*Arctostaphylos pilosula*), Hoover's bent grass (*Agrostis hooveri*), and chaparral ragwort, and many others. East of the Diablo Canyon lands, there are extensive records of sensitive plant species, particularly those associated with maritime chaparral such as Pecho manzanita, Santa Margarita manzanita, Oso manzanita (*A. osoensis*), dwarf soaproot (*Chlorogalum pomeridianum*), and woodland monolopia (*Monolopia gracilens*) as well as other plants more associated with grasslands and scrub like Diablo Canyon blue grass and Kellogg's horkelia (*Horkelia cuneata*).

Pup Rock, and Pecho Rock, and numerous other locations throughout this stretch of coast (PG&E 2023b).

The intertidal areas throughout the Diablo Canyon lands coastline are dominated by mixed bedrock and boulder substrata. Additionally, the presence of extensive sea caves, particularly along the northern reaches of the land, likely function as refuge for some marine life. Long-term studies have monitored the influence of the DCPD thermal plume discharge on intertidal communities across 19 sites spanning approximately five miles of coastline (Steinbeck, et al. 2005). Analyses indicate that altogether, the intertidal throughout this area is rich in diversity. Sites more distant from the DCPD showed greater cover in foliose seaweeds and species richness than those nearest. More recent routine monitoring within the Point Buchon SMR suggests that the intertidal community between Point Buchon and DCPD has relatively more tidal range than other nearby monitoring sites along Montaña de Oro and Avila Beach. While the latter's data suggests that the Diablo site has lower species richness and diversity than some other areas in the region, it also indicates that the Diablo community has been more stable through time.⁹ This may be due to a combination of being situated on the outer coast where wave intensity is greater (thus limiting some species from establishing), being located directly within the influence of seasonal upwelling, and having relatively limited exposure to land-based disturbances (e.g., contaminated runoff, visitor trampling) apart from DCPD operations.

Further offshore, kelp forests and rocky pinnacles are characteristic of the Point Buchon SMR along the northern stretch of the Diablo Canyon lands. These are highly productive habitats, supporting diverse communities of fish, invertebrate, and seaweed species throughout the water column. Giant and bull kelps (*Macrocystis pyrifera* and *Nereocystis luetkeana*, respectively) commonly form surface canopies while smaller-statured kelps form subcanopies, below which are yet another layer of lower-growing algae. Though less vertically structured, soft bottom habitats provide value for many benthic species, and open water above supports pelagic species. The Diablo area is within the transitional range between northern and southern marine influences, meaning that species associated with colder and warmer waters tend to mix here, as oceanographic conditions vary throughout the year.

Terrestrial, Aquatic, and Avian

The vegetation communities across the Diablo Canyon lands readily reflect the complex topography and soil conditions of the land, as well as histories of land use and fire. Generally, the cross-shore transect from shore to the Irish Hills progresses from the supratidal up to steep coastal bluffs, to a terrace of coastal grasslands, then coastal scrubs over undulating hills that transition to maritime chaparral as the land steepens towards ridges, with intergrading oak woodlands and eventually bishop pine forest. Running across these gradients are networks of canyons, drainages, and associated riparian habitats, which provide structural complexity and areas of enhanced productivity in the landscape that support many important wildlife functions. Though soils are generally non-hydric and well-drained here, freshwater wetlands fed by artesian springs exist in at least a few places and marshes also occur. Fine-scale vegetation mapping efforts have recently commenced for the whole of San Luis Obispo County (along with Monterey and San Benito Counties) but results are not yet available for review.¹⁰ Data from the 2016-2017

⁹ See <https://rockyintertidal.cisr.ucsc.edu/>

¹⁰ The Resource Conservation Districts from these three counties have teamed up to pursue the acquisition of high-resolution data that will inform land management into the future. Generated data will include topography, forest structure, impervious surfaces, fire weather, fuel loads, and fine-scale vegetation maps - see <https://www.coastalrcd.org/central-coast-fine-scale-vegetation-mapping-project> for more information. The fine-scale vegetation maps will involve characterizing vegetation communities to the current standards of the Manual of California Vegetation, which is more resolved than what is currently available (CNPS 2025). As it is released, this data will greatly refine

mapping effort refine earlier products and though the characterization of vegetation communities is still limited to descriptions coarser than will be available in a few years, even among these, many readily **appear likely to qualify as ESHA** under the Coastal Act.¹¹ **Figure 3** and **Figure 4** show the mosaic of vegetation across North Ranch and South Ranch, respectively, as documented in 2016-2017. **Figure 5** and **Figure 6** provide a satellite view of the land, also showing vegetation patterns across these respective areas. In some locations, I directly observed inconsistencies between mapped vegetation and current on-the-ground conditions, highlighting the need for more contemporaneous information to accurately characterize and quantify resources present – for example, in one area mapped as annual grassland, the area has apparently fallowed, and coastal scrub has substantially recolonized over the past many years. In another area mapped as sage scrub, there is a large stand of young trees establishing where fire had moved across the landscape in 2007 and from a distance, this appeared to potentially be bishop pine forest (personal observation).

Coastal bluff scrub borders the immediate bluff edge and is concentrated along the rocky, exposed margin, where it supports a unique assemblage of species that tolerate wind and salt exposure (e.g., maritime goldfields (*Lasthenia maritima*)). Since coastal bluff scrub is so tightly bound to this coastal margin and is generally considered rare, it is usually treated as ESHA.^{12,13} Some surveyed grasslands have been identified as **native coastal terrace prairie** (CTP), including areas with purple needlegrass components, and it is likely that more exists throughout the area given the limited disturbances across these lands (Biosystems Analysis, Inc. 1996; Stromberg, et al. 2001; PG&E 2023a). CTP is a rare and heavily impacted ecosystem and is typically recognized as ESHA.¹⁴ In addition, wide-spanning grasslands such as these often (and in this case, evidently do – see below) support raptor foraging and use by other sensitive wildlife, making them functionally important independent of their rarity. **Coastal sage and other scrub communities** – including what has been mapped within the DCPD site as Bush monkeyflower scrub (S3), Menzie’s golden bush scrub (S3), and black sage-California sagebrush scrub (S3S4), for example – intergrade with grasslands along the inland transition to maritime chaparral. Many of these coastal scrub communities are likely to qualify as ESHA based on what is known from the assorted mapping efforts and

understanding of the vegetation communities from across the expanse of the Diablo Canyon lands.

¹¹ Per Coastal Act Section 30107.5, the definition of ESHA effectively has three parts where the first concerns rarity, the second especially valuable [habitat], and the third with respect to sensitivity (**[enumeration]** and **emphases** added in the following): “*Environmentally sensitive area*” means any area in which **[1a]** plant or animal **life** or their habitats are either rare **or [1b]** especially valuable because of their special nature or role in an ecosystem **and [2]** which could be easily disturbed or degraded by human activities and developments.

ESHA determinations are made by the CCC using an array of technical information combined with professional judgement. Supporting these are the published rarity determinations **[1a]** for habitats and species made by qualified authorities such as California Department of Fish and Wildlife (CDFW), US Fish and Wildlife Service (USFWS), and California Native Plant Society (CNPS). For example, CDFW defines natural communities, animals, and plants with a global or state ranking of 1, 2, or 3 as rare and the CCC typically finds these [or their habitats] to qualify as ESHAs (note that these rankings also incorporate factors regarding sensitivity **[2]**). CCC also typically considers plant and animal species listed by the federal and state Endangered Species Acts (ESA and CESA, respectively) and/or identified under other special status categories by various authorities (e.g., California Species of Special Concern (SCC) per CDFW, plant taxa having a California Rare Plant Rank (CRPR) of ‘1B’ and ‘2B’ per CNPS) as qualifying. In addition, an ESHA determination may be made on the basis of an area constituting “especially valuable habitat” where it is of a special nature and/or serves a special role in the ecosystem **[1b]**, such as providing a pristine example of a habitat type, supporting important ecological linkages, representing the edge of distribution range (from which migration and genetic diversity are important), supporting important ecosystem services such as water quality protection or coastal resilience, or a specific resource or feature supporting multiple generations of a species.

¹² See <https://wildlife.ca.gov/Data/VegCAMP/Natural-Communities#unclassified>

¹³ Per CDFW’s 2010 list of vegetation communities characterized according to Holland (1986), northern coastal bluff scrub is ranked as S2.

¹⁴ Consistent with CDFW’s current guidance on natural communities, grasslands consisting of 10% or more cover by native grasses and forbs are generally interpreted as sensitive – see <https://wildlife.ca.gov/Data/VegCAMP/Natural-Communities#grasslands>. In addition, per CDFW’s 2010 list of vegetation communities characterized according to Holland (1986), coastal terrace prairie is generally ranked S2.

reports.¹⁵ **Maritime chaparral** also typically qualifies as ESHA, as do coast live oak woodlands. Chaparral communities occurring here appear to include brittle leaf-woolly leaf manzanita chaparral (S3), chamise – black sage chaparral (S4), and likely others. **Oak woodlands**, including the mapped coast live oak woodlands here, are often considered to constitute especially valuable habitat under the Coastal Act because they are considered a foundation species, meaning that they form the basis for complex habitat hosting multitudes of other species. Oak habitat requires substantial time to develop a mature canopy, and it provides numerous ecological functions and values throughout its area of cover (e.g., high levels of biodiversity and wildlife abundance relative to other communities, establishment of microclimate and pumping groundwater to surface soils, contributing to soil fertility and erosion control). **Bishop pine forest** (S3) occurs throughout the Diablo Canyon lands upper elevations and also qualifies as ESHA given its rarity across the state, and it appears that some highly sensitive associations likely occur here, including those where manzanita species are a key component of the community (personal observation).¹⁶ Bishop pine has two distinct populations across its range and it has been noted that specimens between the two are unable to share genetic information, making their protection all the more important – the southern population is mostly represented from nearby Montaña de Oro south to Santa Barbara County as scattered stands (Lanner 1999). **Riparian corridors** associated with drainages are generally recognized as especially valuable habitat ESHA on the basis of their many habitat functions, including but not limited to as corridors across many other interconnecting ecosystems in the landscape. In some cases, the vegetation communities occurring in these riparian areas may also qualify as rare (e.g., shining willow thickets (S3)).

Despite the relatively limited access and opportunities for observation and documentation of species by the public at large, a number of sensitive species have been officially reported from the Diablo Canyon lands and adjacent areas. Among known sensitive wildlife are south-central California coast steelhead (*Oncorhynchus mykiss irideus*, Distinct Population Segment 9 – federally threatened/S2 and SSC), tidewater goby (*Eucyclogobius newberryi*, federally endangered/S3 and SCC), California red-legged frog (*Rana draytonii*, federally threatened/S2S3 and SSC), American badger (*Taxidea taxus*, SCC), San Diego desert woodrat (*Neotoma lepida intermedia*, S3S4 and SSC), pallid bats (*Antrozous pallidus*, SCC), mountain lion (*Puma concolor*, State Candidate for Listing) and burrowing owls (*Athene cunicularia*, State Candidate for Listing, S2 and SCC). Many additional raptors have been reported soaring above and foraging in the grasslands or along the cliffs and bluffs (e.g., American peregrine falcons (*Falco peregrinus*, State Delisted-Recovered), golden eagles (*Aquila chrysaetos*, CA Fully Protected Species), Cooper’s hawk (*Accipiter cooperii*), Sharp-shinned hawk (*Accipiter striatus*), Ferruginous hawk (*Buteo regalis*), American kestrels (*Falco sparverius*), and merlin (*Falco columbarius*)). Brown pelicans (*Pelecanus occidentalis*, State Delisted-Recovered) are reported as using bluff habitat. Known sensitive plant species include Coulter’s saltbush (*Atriplex coulteri*, S2/1B.2), which is associated with coastal strand, bluffs, and sage scrub, and is at the northern edge of its range here; Diablo canyon blue grass (*Poa diaboli*, S2/1B.2) is a rhizomatous species apparently limited to the Diablo Canyon lands; several rare manzanitas – Pecho (*Arctostaphylos pechoensis*, S2/1B.2), Arroyo de la Cruz (*A. cruzensis*, S2/1B.2), and Santa Margarita (*A. pilosula*, S2/1B.2) – occur among coastal bluff scrub, coastal sage scrub, chaparral, and bishop pine

¹⁵ Per CDFW’s 2010 list of vegetation communities characterized according to Holland (1986), coastal sage scrubs are ranked S3, central coastal scrub is ranked S3 and central coast maritime chaparral is ranked S2 (CDFW 2010). The more recently identified scrub communities are noted above, though some characterizations from the 2016-2017 mapping effort are no longer recognized in the latest update by CDFW. Though it is uncertain how some of these communities would fit with present standards were they mapped today, the information available suggests many may qualify as ESHA.

¹⁶ Bishop pine – Monterey pine forest and woodland (*Pinus muricata* – *Pinus radiata*) Alliance, as characterized by the Manual of California Vegetation (CNPS 2025), is generally ranked S3 or rarer, depending on the specific community composition.

forests in the Diablo Canyon lands; chaparral ragwort (*Senecio aphanactis*, S2/1B.2) associates with coastal scrub and chaparral; Hoover's bent grass (*Agrostis hooveri*, S2/1B.2) occurs in grasslands and chaparral; and Hoffmann's snakeroot (*Sanicula hoffmannii*, S3/4.3) is associated with coastal scrub, coastal sage scrub, and chaparral communities, and has been reported extensively from around DCP. Additional sensitive species are likely to occur given the expansive area and limited search effort, and based on indications of suitable habitat (PG&E 2023a).

Concerning aquatic habitats, there are **four primary drainages** across the Diablo Canyon lands – Coon Creek, Diablo Creek, Irish Canyon Creek, and Pecho Creek. While the first two flow in a westerly direction and are mostly perennial, the latter two flow south and are considered intermittent. In addition, there are **at least 25 smaller streams spaced relatively regularly across the lands and directly interfacing with the coastline, and several others terminating slightly further inland, along the roads and coastal terraces**. There is also a natural seep-fed pond near DCP that was manipulated and expanded for ranching purposes in the 1960s. Coon Creek and Diablo Creek support small steelhead populations, though fish passage barriers associated with DCP currently limit fish excursions upstream in Diablo Creek. Federally endangered tidewater goby larvae and threatened California red-legged frogs (*Rana draytonii*) are known from both of these locations as well, along with several other more common amphibians.

In addition, many other plant and wildlife species occur or are considered as having a high potential to occur at the Diablo Canyon lands where they make use of the many relatively undisturbed ecosystems throughout the reach. This includes insects associated with each of the vegetation communities, potentially even monarchs nearer Montaña de Oro State Park; reptiles and amphibians like newts, salamanders, snakes, rare legless lizards (*Anniella pulchra*, SSC), and coast horned lizards (*Phrynosoma blainvillii*, SCC); birds associated with grasslands, riparian, and coastal scrub communities like California horned larks (*Eremophila alpestris actia*, Federal Candidate for Listing), loggerhead shrikes (*Lanius ludovicianus*, SCC), and California quail (*Callipepla californica*) as well as those with a stronger connection to the sea, which use bluffs, grasslands, and offshore rocks, such as herons, cormorants, and gulls, including for roosting and nesting; and, mammals like additional bat species, bobcats, and coyote (PG&E 2023a).

LAND-SEA CONNECTIONS ARE BIDIRECTIONAL

While the influences of land and sea upon one another are not necessarily symmetric, they have been documented extensively within the scientific literature and are generally recognized as inextricable (Beger, et al. 2010; Buckner, et al. 2017; Fang, et al. 2018). **Connectivity across land-based and marine ecosystems has been repeatedly exemplified by processes such as the passive transport of water, sediment, nutrients, energy, and propagules,¹⁷ as well as the active movement of wildlife** from one area to another (for example, see Alvarez-Romero, et al. 2011). Such transfers may be beneficial, neutral, or detrimental; concentrated or diffuse; intertwined or interfacing. Ecological connectivity may also be described as structural (relating to the spatial configurations of patches used within a landscape) or functional (relating to how freely resources or processes can proceed between and across patches) (Bishop, et al. 2017). Often, attention to the downslope movement of material from land to sea is emphasized and routinely reflected in land use policies and

¹⁷ A propagule is a vegetative structure that can be come detached from a plant, disperse, and generate new plant material – for example, seeds, spores, rhizomes, and regenerating branched material.

management strategies promoting watershed approaches.¹⁸ Species' reliance on both inland and marine ecosystems is also well-documented – for example, many salmonids depend on freshwater aquatic systems during early and reproductive life phases but spend the majority of their lives in the ocean environment. Though the influences of the marine environment on land resources are somewhat less celebrated, they are arguably important in supporting a multitude of ecosystem functions and values across coastal areas as well, including terrestrial productivity. Consequently, coastal ecosystems on one side of the ecotone are inevitably influenced by changes on the other.¹⁹ In other words, **changes on land will impact nearby marine ecosystems and changes in the ocean environment, including marine productivity, will affect adjoining lands.**

Land Influences on Marine Resources

Water Flows

The gravitational draw of surface water from upland areas to the coast is probably the most familiar flow from a land-based ecosystem to the marine environment. **Water itself functions as both a resource and a sculptor of the landscape** via watercourses and sheet flows. Where following consistent pathways, it shapes and bounds many geomorphic features and habitats including canyons, vegetated (riparian) corridors, floodplains, lagoons and estuaries, and beaches. Riparian features often function as important passageways for wildlife, including to coastal shores, whether for those species specifically associated with wetted habitats, using it as refuge from harsher elements (e.g., shade) or interactions with other organisms (e.g., predators), or for navigational guidance (Gregory, et al. 2021; Jensen, et al. 2022). As entry points to the marine environment, lagoons, estuaries, and beaches represent transitional areas that physically interact with intertidal and nearshore forces such as the tides and currents that set up salinity and thermal gradients between inland and marine waters. They also function as sources and sinks for sediment, and influence the dynamics of sandbars, dunes, etc. These dynamics driven by water are foundational in supporting marine productivity among plant, algal, and animal life forms.

Recent work in northern California has revealed that **freshwater flows into the coastal ocean play a surprisingly critical role in the stability of some kelp beds.** In their study, Ricart, et al. (2025) investigated why certain patches of bull kelp persisted instead of converting to sea urchin barrens as most did following a series of disturbances including marine heat waves and the demise of important urchin predators. What they discovered through a combination of observational and experimental investigations was a positive association between the persistent kelp beds with freshwater flows and their proximity to the small river mouths delivering them. Effectively, freshwater plume exposures driven by small flashy river systems (as opposed to that of sustained exposures associated with large rivers) appeared to challenge sea urchin physiology and limit their herbivory in these beds just enough without adversely affecting kelp survival. This has allowed for kelp continuance, and the persistent beds potentially have a role as source material for adjacent areas into the future. The authors **underscore the importance of land-sea**

¹⁸ For example, see the State Water Resources Control Board Watershed Management Initiative (https://www.waterboards.ca.gov/water_issues/programs/watershed/#wmi), California Wildfire & Forest Resilience Task Force (<https://wildfiretaskforce.org/about/action-areas/healthy-watersheds/>), and the United States Department of Agriculture's Natural Resources Conservation Service Watershed Program for California (<https://www.nrcs.usda.gov/programs-initiatives/watershed-programs/california/watershed-programs-california>).

¹⁹ Ecotones are the regions of transition between ecological communities, typically situated along an environmental gradient. In these areas, the confluence of resources (biological, but also physical and chemical) from each ecosystem supports relatively high biodiversity and provides for a dynamic space from which species move across different systems and may exercise adaptive potential. Ecotones may occur at various spatial scales - here, reference to the coastal ecotone is meant to envelope the gradient from offshore areas to the ridgelines of the Irish Hills.

connectivity in this system and suggest that it should factor into holistic conservation actions going forward.

Constituents

Surface flows also act as vectors carrying constituents such as sediment, organic matter, nutrients, and propagules downstream, aiding in their dispersal to coastal areas. This redistribution of material facilitates subsidies to areas where important resources might be otherwise limiting. For example, creeks and rivers introduce nutrients across floodplains or into nearshore ecosystems, sometimes resulting in pulses of enhanced productivity in these areas and at other times, under certain conditions, overwhelming them and leading to eutrophication (Justic, et al. 1993; Foley & Koch 2010; Devlin & Brodie 2023). In Mediterranean climates like central California, **nutrient supplies** to the coastal ocean tend to be episodic as a result of dry season build-up followed by flashy precipitation events that flush material downstream. **Small creeks and rivers distributed across the landscape – such as those found along the Diablo Canyon lands – provide spatially consistent doses of such material** as compared to the large river systems found in the Pacific Northwest, for example (Hill & Wheeler 2002; St. Pierre, et al. 2021). The offset of major precipitation events relative to the ocean upwelling season means that these upstream sources contribute meaningfully to coastal ocean productivity, effectively prolonging supplies to marine ecosystems (Warrick, et al. 2005). **Dissolved and particulate organic matter are also exported from terrestrial and aquatic ecosystems** to the ocean environment, supplementing these receiving areas with carbon, which is either consumed by marine organisms or eventually processed through the carbon cycle, including where it may become sequestered (Jassby, et al. 1993; He, et al. 2016). Flows also deliver **sediment** to nourish beaches and dunes supporting coastal species and can **facilitate the dispersal of species during episodic flushing events** like the federally listed tidewater goby (Warrick, et al. 2015; Aguilera & Melack 2018; Spies 2022). The **mobilization of debris and pollutants via surface flows from areas of human development** has also been well-documented, including the consequent degradation of coastal water quality and ecosystems (Sanchez-Cabeza & Druffel 2009; Hill 2024). Multifaceted research examining patterns of land use on streamflows and nearby marine ecosystems has been underway at the Santa Barbara Coastal Long-Term Ecological Research network site for roughly two decades, where studies have shown how watershed urbanization (development) has increased runoff volumes and nutrient loads compared to non-urbanized, natural landscapes and that the particulate organic matter in runoff is being taken up by suspension feeding invertebrates in the marine environment (Beighley, et al. 2003; Robinson 2005; Beighley, et al. 2008; Page, et al. 2008). In Hawaii, the concept of ‘ridge-to-reef’ or ‘mountain-to-sea’ management is based on recognizing the important linkages between land management decisions to protect watersheds and their quality, and the condition of downstream coral reefs (Delevaux, et al. 2018; Wada, et al. 2020).

Not surprisingly, **watershed management strategies have come to routinely recognize and aim to respond to such issues by improving upstream conditions that benefit resources extending to nearshore waters.**²⁰ For example, the State Water Resources Control Boards’ Watershed Management Initiative is embedded within its Strategic Plan.²¹ The concern of land use on water resources is also reflected in many policies, including the State’s Watershed, Clean Beaches, and Water Quality Act, which among other things, provided for the designation of 34 Areas of Special Biological Significance (ASBSs) along the coastal ocean and the monitoring and maintenance of water quality given the unusual varieties

²⁰ *Supra*.

²¹ See https://www.waterboards.ca.gov/water_issues/programs/watershed/

of aquatic life supported there.²² Similarly, the Statewide Critical Coastal Areas (CCAs) Committee comprised of 15 state agencies and others developed specific criteria beginning in the 1990's to identify and highlight coastal watersheds where management goals emphasize the improvement of degraded water quality and the protection of marine and estuarine waters with high resource value from polluted runoff – notably, **two of the 109 CCAs encompass the entire coastline of the Diablo Canyon lands.**²³ Under the California Coastal Act, several policies explicitly speak to the protection and management of coastal waters, including their productivity, quality, and processes, with recognition of their importance and influence on the marine environment.²⁴

Habitat Use

Another important connection between land and marine productivity relates to **the support functions coastal lands provide for certain marine wildlife, including for haul-outs, roosts, rookeries, and natal habitat.** Marine mammals, particularly seals and sea lions but also southern sea otters and occasionally northern elephant seals, use onshore areas including rocky and sandy shores as well as outcrops for places of rest and refuge. These areas generally function as places for repose, thermoregulation, predator avoidance, reproductive activities, and socialization. Seabirds also use areas along the land-sea margin for roosting, nesting, and breeding, including in some rare cases, areas that may be miles inland from the coast (Hazlitt, et al. 2010). At the Diablo Canyon lands, a large colony of nesting Brandt's cormorants (*Phalacrocorax penicillatus*) is known to use an offshore area near the DCPD breakwater for roosting and nesting. Other seabird and shorebird species known to use bluff and offshore rocky habitat include brown pelicans, pelagic cormorants (*Phalacrocorax pelagicus*), pigeon guillemots (*Cephus columba*), black oystercatchers (*Haematopus bachmani*), and western gulls (*Larus occidentalis*). In the 2006 North Ranch Managed Access Plan associated with CDP A-3-SLO-04-035, a series of maps documents **at least 20 sensitive marine bird nesting sites, 21 marine mammal haul-out sites, 19 sensitive terrestrial bird nesting sites, and 7 sensitive terrestrial mammal sites along the northern part of the Diablo Canyon lands** (LSA Associates, Inc. 2006). Some anadromous fishes like salmonids explicitly rely on the connection of inland aquatic habitats to the sea to carry out their life histories, and others like tidewater goby occupy the places where fresh and marine water mix. In the Diablo Canyon lands, **federally threatened South Central Coast steelhead (a salmonid species) are known from Coon Creek (along the border of North Ranch and Montana de Oro State Park), the lower reaches of Diablo Creek adjacent to the power plant, and nearby at San Luis Obispo Creek to the south of Wild Cherry Canyon, and tidewater goby larvae have been documented in waters near Point Buchon (North Ranch) and at the cove adjacent to the DCPD facility (Parcel P).** These marine animals and others depend upon the land and freshwater aquatic habitats adjoining their marine habitats for rest and to carry

²² CA PRC Division 20.4; also see, https://www.waterboards.ca.gov/water_issues/programs/ocean/asbs.html

²³ See <https://coastal.ca.gov/water-quality/critical-coastal-areas/identifying/> and <https://coastal.ca.gov/water-quality/critical-coastal-areas/> for more information.

CCA 'Pacific Ocean at Estero Bay' extends over 26,859 acres around the Morro Bay area, including waters along the northern end of the Diablo Canyon lands and Point Buchon, where it is listed in 2024 as 303(d) impaired for mercury and dichlorodiphenyltrichloroethane (DDT) contamination. See https://www.waterboards.ca.gov/water_issues/programs/tmdl/2023_2024state_ir_reports/apx-b-factsheets/04294.shtml for more information.

CCA 'Pacific Ocean, Pt. Buchon to Pt. San Luis' extends over 27,440 acres along the remaining length of the Diablo Canyon lands, including waters along the northern end of the Diablo Canyon lands and Point Buchon, where it is listed as a 303(d) impaired body for mercury contamination. See https://www.waterboards.ca.gov/water_issues/programs/tmdl/2023_2024state_ir_reports/apx-b-factsheets/04296.shtml for more information.

²⁴ CA PRC Division 20, Article 4 (Marine Environment), PRC Sections 30230-30236

out their essential life functions. Adverse impacts on the marine environment (i.e., via the loss of marine productivity) would be further exacerbated by any loss of the land-based habitat such species depend upon.

Additionally, rocky intertidal ecosystems are dependent on the provision of structurally complex substrate (e.g., tidepools, overhangs, crevices) at the very margin of land, where marine waters regularly ebb and flow but do not consistently inundate. **Erosion of material on bluff faces, in sea caves, and substrate, including from upstream forces, shapes the foundation for rocky intertidal areas.** Among the most densely occupied of marine ecosystems, intertidal productivity is particularly significant and yet, as it represents a space of extremes, is especially vulnerable to changes on both land and at sea (Mach, et al. 2017). As an example, some intertidal species are known to make use of organic matter derived from upland areas such that changes to these inputs may be consequential (Fairbanks Jr., et al. 2018). Other species – along with those in adjacent subtidal ecosystems – are especially **vulnerable to land runoff and other anthropogenically-associated effects** (Gorman, et al. 2009; Mach, et al. 2017). At the Diablo Canyon lands, outside the reach of the DCPD thermal discharge plume, rocky intertidal communities are expansive and seemingly stable whereas those nearer DCPD appear to respond as a function of the timing and intensity of thermal exposure; however, interactions of the plume with oceanographic conditions may also be influencing observed patterns (Steinbeck, et al. 2005). Similarly, **sandy beach ecosystems depend on processes occurring across the coastal margin including the erosion and wave activity that transforms rock to sand, as well as the many organisms aiding in the break-down of organic material and bioturbation.**²⁵ Importantly, an analysis of cumulative impacts across California’s 124 MPAs identified the Point Buchon SMR as the third-most affected and while approximately half of that is attributed to climate-specific forces, a quarter is attributed to land-based impacts. Though the latter are not specified for each location in the published research paper, land-based impacts categorically included sediment changes, organic and inorganic pollutants, nutrient runoff, light pollution, coastal engineering, beach access, and power plants (Mach, et al. 2017). Given the minimal development and restricted public access to the shoreline and nearshore in the subject area, it **seems most likely that effects attributable to the power plant (e.g., entrainment and thermal discharges) are significant drivers and will not be alleviated until the facility is eventually decommissioned; however, protection of the area against additional intensive development stressors would help to attenuate any synergistic effects and provide for a release from facility-induced stress when operations eventually cease.**

Anthropogenic Activity

The influence of anthropogenic development and land use upland of marine ecosystems has been well described by many (e.g., Halpern, et al. 2009; Strain, et al. 2014; Kennish 2021; Innocenti & Musco 2023). **Many of the greatest marine resource impacts result from alterations of hydrologic flow (e.g., stream channelization, dams, non-point source runoff), input of pollutants (e.g., nutrients, metals, pesticides), changes in land cover via the removal of native vegetation, and landform alterations (e.g., loss of natural topography, changes in erosion patterns).** Shoreline hardening to protect landward development is a familiar example of the latter, which effectively limits or even halts several natural processes essential to the continuance of marine productivity – for example, where shoreline hardening fixes the backshore and prevents the landward migration of the shoreline through natural erosion, entire habitats are at-risk of being lost to “coastal squeeze” (Heerhartz, et al. 2014). Where not carefully

²⁵ Bioturbation is the process where living organisms rework soils and sediments, effectively circulating and transforming materials. This includes activities such as burrowing and the ingestion and defecation of sediment. As a result, fluxes of organic material and nutrients extend deeper into the substrate and where covered by water, can provide for enhanced productivity in overlying areas.

managed, agriculture can also play a significant role in influencing adjacent marine waters, particularly via alteration of landform, hydrology, and the input of nutrients (e.g., from fertilizers or manure) leading to the eutrophication of coastal waters. Synthetic chemicals used in agriculture also have significant effects on marine life (Kittle & McDermid 2016; Hill 2024). The conversion of open space to residential and urban development brings with it demand for infrastructure and utilities, light and noise pollution, introductions of invasive species, and many additional disturbances to the natural landscape, interrupting the delicate balance of ecological processes and flows discussed above. **Presently, because the Diablo Canyon lands are relatively isolated and undisturbed, many of these anthropogenic influences are still limited here; however, changes in future land use could readily introduce them.**

Marine Influences on Land Resources

Wildlife Vectors

The same marine mammals and seabirds that rely on land resources to support their haul-outs, nesting, and roosting activities also directly affect the land, particularly along coastal margins. For example, research from around the globe has consistently documented the **importance of seabird guano inputs on surrounding ecosystems including terrestrial productivity** and even its contribution to the development of unique vegetation communities (Bosman & Hockey 1986; Polis & Hurd 1996). The nitrogen subsidies, particularly in nutrient-poor soils like those found throughout California's arid coastal climates, effectively fertilize and support more robust vegetation than would otherwise occur, which in turn supports a wider array of organisms and results in enhanced local biodiversity. **Seabirds may also actively select particular vegetation for nesting material and in that process, facilitate its dispersal** by transporting seeds or other reproductive material (Vasey 1985; Ellis 2005). Inadvertent seed dispersal by gulls has been documented as well (Calvino-Cancela 2010). In addition, **seabird eggs provide an important nutrition source for other animals**, including highly mobile consumers (e.g., terrestrial mammals) traversing from inland habitats to forage on marine-rich subsidies (Millus, et al. 2007; Zilz & Young 2022). **Marine mammal excrement is yet another source of marine nutrient inputs to land-based ecosystems**, as are episodic deliveries of marine carrion when it washes onshore and decomposes. Scavengers and detritivores consume carcasses, which results in the transfer of energy from marine ecosystems to those onshore (for example, see Polis, et al. 1997). Recent literature reviews emphasize that the **importance of marine carrion to land ecosystems is likely grossly underestimated** (Hyndes, et al. 2022). From larger taxa like mammals, fish, and birds, to insects and minute bacteria, marine deaths support avian, terrestrial, and even aquatic lives in complex food webs (Carlton and Hodder 2003; Dugan, et al. 2003; Piovita-Scott, et al. 2011; Lastra, et al. 2018; Lowman, et al. 2019).

Some salmonids represent another important marine subsidy to land-based ecosystems (Schindler, et al. 2003). Though they may spend early life history phases in rivers, it is the later ocean-going phases where their biomass develops as they forage on marine life. **When fish return to natal waters to spawn, these they transfer biomass built on marine productivity to inland areas**, where it eventually becomes food for other non-marine species via eggs or where it is released via decomposition when adult fish expire following spawning activities. Thus, salmonids routinely provide inland areas with sources of marine energy and nutrient inputs. **When anthropogenic activities diminish access to or the quality of salmonid-bearing streams for inbound fish, not only are populations adversely affected, but so are the entire ecosystems depending on them.** As noted above, small populations of steelhead are known to use habitat at Coon Creek and San Luis Obispo Creek at the borders of the Diablo Canyon lands, and these fish also occur within the lower reaches of Diablo Creek, though in the latter case they are precluded from

the upper watershed by passage barriers. Regardless, they are acting as vectors between marine and freshwater and other inland ecosystems.

Food Web Contributions

Terrestrial and avian species use beaches and intertidal habitats to forage on algal, invertebrate, and vertebrate marine species. Along the Gaviota Coast in Santa Barbara County, evidence suggests that a wide array of terrestrial and avian wildlife forage along beaches and intertidal zones, including highly mobile omnivores and carnivores such as foxes, coyote, bobcats, American badgers, raccoons, and striped skunks (Young & Zilz 2021; Zilz & Young 2022). Similarly, many of these, **particularly coyotes and raccoons, have been reported as frequent users of the Diablo Canyon lands' bluffs and beaches, presumably drawn to the ample food sources supported by the marine environment** (Biosystems Analysis, Inc. 1996). In the Channel Islands, stable isotope analyses of scat and whiskers revealed that a subset of threatened endemic island foxes consistently consume live and scavenged intertidal crustaceans associated with beaches (Page, et al. 2021).²⁶ Mainland foxes likely behave similarly. Though larger crabs were also detected in island fox diets, the majority of marine-dependent individuals mostly consumed a crustacean species associated with kelp forest wrack washed up on beaches or isopods associated with upper beach areas. Elsewhere, stable isotope analyses have been used to reveal that terrestrial lizards consuming invertebrates that consume marine algae are more abundant than conspecifics that do not, and that the lizards relying on marine resources also occupy relatively higher trophic levels in the coastal ecosystem (Barrett, et al. 2005). These are but a few examples of **wildlife species routinely exploiting products of the marine environment to sustain their livelihood while also often transferring nutrients and organic matter to less productive inland ecosystems** (e.g., via physiological byproducts such as scat, offspring, carrion). Such patterns have been widely recognized as both important and persistent, and though specific research and documentation of such transfers may not be readily available for the Diablo Canyon lands, it is reasonable to expect that marine productivity is supporting terrestrial productivity here in similar ways.

One of the best studied marine inputs to coastal ecosystems is algal wrack consisting of dislodged kelp, other seaweeds, and seagrasses washed onshore (e.g., Bustamante, et al. 1995; Dugan, et al. 2003; Lowman, et al. 2019). Recent work on the Santa Barbara coast has demonstrated clear connections across ecosystem boundaries, where abundances in offshore kelp transfer wrack to onshore areas, and cascading effects on shorebird populations and higher trophic levels are readily observed (Walter, et al. 2024). There, **in addition to providing a plethora of invertebrates for other organisms to forage on, algal wrack usually decomposes within beach and dune environments, breaking down through processes like desiccation, consumption by wildlife and microbes, and even sequestration when buried.** Emery, et al. (2025) have shown that connectivity between kelp forests and beaches has spatial and temporal structure and is greatest on highly localized scales (<10 km) and during the winter season – this means that disturbances along the coastal ecotone will have proximate effects. Sometimes, wrack is transported by wildlife to more inland areas – for example, in British Columbia, research has revealed that bald eagles use a long-lived woody kelp species to build nests, and that kelp typically appears soon after sea otters colonize an area where they consume the sea urchins that otherwise limit kelp establishment; thus, linkages exist between otters, kelp, urchins, and eagles (Rechsteiner, et al. 2018). In some stream

²⁶ Stable isotope analysis is a scientific technique where the ratios of naturally occurring non-radioactive variants of elements present in organic and inorganic samples are measured and interpreted as unique signatures, indicative of their environmental sources. It is a powerful tool, used in many technical disciplines including ecology, geology, hydrology, paleoclimatology, archaeology, and even forensics. In ecology, isotope signatures are frequently used to understand the flow of nutrients and organic material across food webs.

systems, marine wrack is transported upstream by tides or storm surges and left behind following their retreat. In all cases, the marine algal and plant material provides an important source of nutrients and organic material often lacking in inland (including freshwater) areas, and sometimes also contributes moisture that is slowly released to support coastal vegetation. In short, **algal wrack contributes significantly to terrestrial productivity.**

Habitat Structure & Functions

Marine-derived wrack not only augments productivity in coastal ecosystems, but **wrack is additionally a physical vehicle for the dispersal of associated marine species and functions as ephemeral shelter for smaller lifeforms**, all of which increase biodiversity on land (Dugan, et al. 2003; Klosinski 2015). For example, some shorebirds use clumps of algal wrack as refuge from wind or to hide from predators in an otherwise exposed area. Seabirds and other **avian species may harvest wrack for nesting material**, actively transporting it from the shoreline to upland areas where it eventually decomposes in terrestrial ecosystems (see Rechsteiner, et al. 2018), for example). **Complex holdfasts associated with giant kelp not only provide interstitial space for smaller organisms to occupy as habitat** but simultaneously offer a buffet of forage material for a multitude of species.

Coastal Vegetation

Coastal vegetation can be both directly and indirectly influenced by the marine environment. **In central California, the narrow margin of land along the shore typically experiences characteristically mild temperatures and increased moisture levels and consequently, supports unique plant communities that contribute to the diversity and productivity of terrestrial ecosystems.** Redwood forests, and maritime chaparral and coastal scrub (as their names suggest), are characteristic of California's coast and all largely depend on coastal fog to guard against the warmer and drier conditions found further inland (Dawson 1998; Potter 2014). Some species have even adapted to harvest fog, including a variety of lichens (Nash, et al. 1979). During the recent site visit, I observed such lichens growing decadently on coast live oaks throughout the Diablo Canyon lands (personal observation). Coastal grasslands also benefit from the presence of fog, and though this appears to vary by species, there appear to be physical adaptations such as shallow roots that help with fog water access (Corbin, et al. 2005). Temperate grasslands (along with Mediterranean biomes, represented by the coastal scrub and maritime chaparral) have been flagged as being at greatest risk of loss on a global basis (Hoekstra, et al. 2005). Coastal terrace prairie, a native grassland physiologically constrained to the coastal margin, supports the highest plant diversity of all North American grasslands and is widely recognized as one of the state's rarest ecosystems due to historical losses associated with agriculture and development (Stromberg & Griffin 1996). A study examining dozens of sites along California's central coast found that coastal terrace prairie had, on average, more than four times the diversity of coastal scrub communities and noted that **at San Luis Hill, located at the southern end of the Diablo Canyon lands, the coastal terrace prairie stands out as exemplary for its particularly high cover of native species** (Stromberg, et al. 2001).²⁷ The most shoreward plant communities, including those along coastal dunes and bluffs, are uniquely adapted to tolerate the considerable wind and salt exposure associated with the sea but are unable to compete with faster-growing vegetation inland, thus limiting their distribution to the narrowest of coastal margins.

Several of these maritime-dependent communities are considered rare but are known to occur within the Diablo Canyon lands, including those associated with coastal dunes and bluffs, coastal terrace prairie,

²⁷ San Luis Hill is located just inland of Point San Luis, within the Diablo Canyon lands and the 1200 acres protected by a deed restriction resulting from CDP A-3-SLO-06-017 (Pacific Gas and Electric Company).

coastal scrub and maritime chaparral (FODCL 2021; PG&E 2023a). **The loss of marine productivity from the DCPP licensing extension is likely to have limited but non-negligible effects on sensitive terrestrial plant communities**, including the loss of nutrient subsidies via direct (e.g., movement of plant material for nesting by seabirds) and indirect inputs (e.g., marine-enriched waste delivered by terrestrial wildlife) as well as the dispersal of native seed material (Calvino-Cancela 2010). However, **as these rare terrestrial communities depend on the coastal climate and landscape (e.g., soils, topography) as much as the space they occupy, changes across land or sea will likely have significant effects.**

Geomorphology

Hydrologic forces work on the land to break down mineral earth and produce the cobble, gravel, and sand that supply foundations for many ecosystems. At the edge of the sea, **coastal bluffs are subject to constant wave action, eroding over time to generate this material. Sea caves and arches similarly function as a source of substrate**, particularly when they yield to forces and collapse dramatically thereby delivering an episodic supply of new material to the marine environment – such features and events have been extensively documented throughout the North Ranch portion of the Diablo Canyon lands (LSA Associates, Inc. 2006). Dunes and beaches function as dynamic reservoirs for sand, seasonally responding to oceanic and aeolian forces. The development of dunes along sandy shores depends in part on the presence of material capable of trapping sand. In some systems, this may include pioneer vegetation arriving as seed in wind-blown areas, wood transported from upland ecosystems, or even involve the artificial placement of materials such as sand fencing. **Along California’s coast, beach wrack routinely promotes the formation of geomorphic dune features** as it is deposited along the upper beach and becomes buried by wind-transported sand enough to embed and form mounds. Under the right circumstances, those mounds grow into incipient dunes and eventually, as they become vegetated, may become foredunes and develop as important habitat as well as natural defense against storm surges and rising sea levels. **Reduced marine wrack inputs due to a less productive marine environment are likely to slow natural dune development significantly** (Dugan & Hubbard 2009; Hyndes, et al. 2022; Joyce, et al. 2022; Provost, et al. 2022). Though dunes are not a major component of the shore at the Diablo Canyon lands, they are nonetheless an important component of the mosaic where they do exist and would be expected to be affected by depressed marine wrack supplies.

Recent work on the Gaviota Coast in Santa Barbara County (approximately 60-70 miles downcoast) specifically examined the many facets of connectivity between marine and terrestrial ecosystems and **attributed the strength of the biological (and consequently physical and chemical) linkages to the relatively conserved condition of both ecosystems locally** (Zilz & Young 2022). They found marine foraging behavior by terrestrial species likely benefited from the area’s isolation and lack of anthropogenic disturbance, including the development of physical impediments (e.g., shoreline protection, roads, dams) and significant human presence. Others have also pointed to the substantial effects land use has on the degree of connection across coastal ecotones (Stoms, et al. 2005). Being relatively isolated and wild compared to much of California’s coast, the same might be expected of the Diablo Canyon lands as well.

LAND CONSERVATION FACILITATES COASTAL RESILIENCE

Coastal ecosystems worldwide experience stressors from both land and marine-based environments, particularly those that are anthropogenically driven (e.g., pollution, harvesting, land use change, development, climate disruption) (Belfiore 2003; Halpern, et al. 2009). The origin, nature, pace, and timing of these can vary widely. For example, mosaics of land cover may abruptly change when wildfire ignites and heterogeneously moves across the

landscape, whereas coastal squeeze due to sea level rise occurs as a steady directional pressure on the order of decades. Ecosystem responses to disturbance are inherently complex given the many resources, linkages, forces, and sensitivities to stress. This makes it challenging to anticipate where critical thresholds may exist, if and how recovery may proceed, and what adaptations may be available to individual species, communities, or systems. However, the **adaptive limits and strategies available to a given resource are finite. To the extent that the multitude of stressors on ecosystems can be managed and limited, time and space enable adaptive responses to new conditions and preserve capacities for resilience.**

As described in the previous section, the connections between land and sea across coastal ecotones are intertwined and substantial – what happens on land can affect the marine environment and vice versa. **Thus, a mitigation strategy that preserves land connected to the coast offers meaningful and sustained value to both marine and terrestrial ecosystems.**

Enhanced Marine Protected Area Functionality

Frameworks encouraging the inclusion of strategic land-sea connections, integrative planning, and ecosystem-based management in marine protected area (MPA) design have been proposed and echoed throughout the technical literature in recent decades (Belfiore 2003; Tallis, et al. 2008; Hazlitt, et al. 2010; Van Diggelen, et al. 2022; Ke, et al. 2024; Preston, et al. 2025). Some specifically emphasize the value of protecting land and sea, side by side (Stoms, et al. 2005; Alvarez-Romero, et al. 2011). While this may not always be feasible, the underpinning logic acknowledges the **importance of managing adjacent terrestrial lands to benefit marine resources and that functionally, these pairings are essential for successful marine conservation.** Land use ultimately affects adjoining marine environments, and onshore changes translate to nearshore areas by way of water, energy, nutrients, and other flows as described and referenced in earlier sections of this memo. By mitigating threats to marine productivity, preserving ecological linkages across coastal ecotones, and ensuring the necessary space for natural processes to continue, the coupling of land conservation with marine protected areas **can achieve multiple objectives with a holistic and synergistic approach.**

In its general feasibility criteria, California’s Marine Life Protection Act (MLPA) process included the co-location of land and marine protected areas (CDFW 2016). While such siting was not explicitly required, it was encouraged, and such opportunities have been realized in some locations while others remain to be pursued further. For example, several MPAs along the North Coast are located adjacent to State and/or National Parks, and the Point Conception SMR in Santa Barbara County now fully shares its coastline with the recently established 24,460-acre Dangermond Preserve (Butterfield, et al. 2019). **With the Point Buchon SMR sharing roughly 2.5 miles of shoreline with the North Ranch parcel, and the northernmost reach of the newly designated Chumash Heritage National Marine Sanctuary sharing roughly 3.5 miles of shoreline with the South Ranch parcel, formal conservation of Diablo Canyons lands would ensure that these adjoining areas, their resources and productivity, and the many flows connecting the land and sea between them could be protected into the future (Figure 1).**²⁸ This would safeguard an unusually intact and undisturbed stretch of California coast where marine life depend on the land to carry out important life functions and where natural processes will need to continue for the long-term health of marine ecosystems (e.g., bluff erosion supplying sand to dune, beach, and marine habitats at rates appropriate for maintaining healthy coastal dynamics). Marine ecosystems would simultaneously continue to receive the benefits of being buffered from stressors associated with inland activities and intensified land use (e.g., increased stormwater, pollutant loads, harvest and trampling in sensitive areas).

²⁸ Also, the Point Buchon SMCA is located just offshore of the SMR.

Continuity of Processes

Where development elsewhere may limit water flows, shoreline retreat, migration corridors, etc., open and relatively wild spaces maintain a spatial capacity for natural processes to continue and respond to remaining stressors. **Having room to realign and reorganize relative to physical pressures means that ecosystems and their processes may find those configurations that allow them to persist in some relatively functional form.** For example, intertidal ecosystems are generally organized as zones where a species' upper limit is set by some minimum level of marine inundation to manage physiological stress (e.g., desiccation, thermal tolerance), and its lower limit is set by its interactions with other species (e.g., competition for space, predation risk). As sea levels rise, these inundation zones will advance further inland and the species assemblages associated with each zone will adjust to the spaces where physiological and interactional stresses are balanced. Depending on the shape of the physical shoreline, zones may expand or compress, and communities of organisms may necessarily recombine; however, without room to migrate, they are at increased risk of being altogether lost. Space and geometry provide opportunity.

Equally important is the component of time, as resources and processes do not necessarily respond to disturbance or stressors in sync nor are they immediate or consistent. By providing sustained protection to important spaces, there is an allowance for ecological dynamics including offset processes like shifting precipitation patterns and responding streamflows or sediment dynamics, or the timing of species' response to other environmental cues (e.g., marine heat waves). Recent work has provided empirical evidence of the role MPAs can play in climate resilience, but without being provided the space and time to respond to stressors from all directions, such benefits may be inevitably lost (Ortiz-Villa, et al. 2025). **A key advantage to coupling land with marine conservation is the maximization of opportunities for spatial-temporal resilience, and to be able to manage for unimpeded natural processes so that ecosystems are able to persist under variable future conditions.**

Precluding Development-Associated Risk

Avoiding and minimizing the stress anthropogenic activities impose on ecosystems is core in conservation principles. In this case, the preservation of the relatively expansive and intact Diablo Canyon lands situated adjacent to other protected areas means that these expansive areas remain holistically buffered from development impacts and are afforded the best possible chance for their long-term continuance. Were the lands to be further developed, the **specific risks to resources would depend on the nature of that development but generally, could include adverse effects on land and sea via:**

- direct and indirect losses or degradation of ecosystems and their functions;
- habitat loss and fragmentation affecting sensitive species and communities;
- structural and functional impediments to wildlife migration across the coastal ecotone;
- increased cover of impermeable surfaces leading to increased and more rapid runoff;
- ground disturbance, grading, and topographical modifications that lead to loss of surface soils and soil structure, erosion, and discharges of elevated levels of sediment to coastline and nearshore habitats;
- degraded water quality from nutrient and pollutant inputs;
- disturbances associated with the ongoing repair and maintenance of infrastructure, including fuel modification;
- increased fire risk associated with human ignition sources;
- introduction of chemical, noise, and light pollution;

- elevated and persistent disturbance to wildlife and habitats associated with human presence and activities;
- introduction of non-native species, including invasive and horticultural plants as well as domestic animals that may take or disturb wildlife.

The synergistic and cumulative effects of such stressors have the potential to cascade or exacerbate ecological disturbances and losses, including in the marine environment. For example, non-point source runoff from a developed landscape may increase animal body burdens of contaminants to anadromous species already challenged by altered precipitation patterns and coastal lagoon dynamics, warming water temperatures, and shifting food sources. Similarly, increased runoff to intertidal areas may extend periods of physiological stress triggered by hyposaline conditions and introduce contaminated waters and sediments associated with roads and garden products, and roaming domestic animals that adversely affect native wildlife. Thus, **protection of the relatively undeveloped and intact Diablo Canyon lands offers significant opportunity to avoid introducing a multitude of new stressors that cannot be readily managed in contrast to those already being driven by climate disruption.**

Edge Effects

An important consideration in spatial strategies for resource protection is the proportion of a protected space's perimeter relative to its total area, or rather, how much edge exists where external influences may affect the area intended for protection. Edges are where an area is typically most vulnerable to anthropogenic impacts, whereas the core will be more insulated. This same logic underpins the designation of buffers around sensitive areas – buffers afford space to attenuate adjacent disturbances relative to the core protection areas. By siting protected areas adjacent to one another, whether these are composed of the same or different ecosystems, the relative proportion of perimeter exposed to anthropogenic influences is reduced and insulating values are enhanced while still facilitating subsidy transfers (e.g., productivity) across the protected systems (Polis, et al. 1997).

In terms of siting conservation lands relative to MPAs, coupling strategies help to blur the boundaries between land and sea and instead recognize coastal margins as dynamic zones warranting protection. At the Dangermond Preserve in Santa Barbara County, the entirety of the Point Conception SMR shoreline boundary is connected to the Preserve's, providing for seamless continuity as flows move across the region (Butterfield, et al. 2019). Researchers on the nearby Gaviota Coast have attributed observed use of intertidal habitats by highly mobile carnivores and omnivores to the area's generally intact connections between shore and inland ecosystems (Zilz & Young 2022). **Given the position of the Diablo Canyon lands amidst an assortment of already protected lands and ocean areas, it would be prudent to prioritize filling this gap to ensure long-term connectivity for the reciprocal flows extending between offshore areas and the Irish Hills while also minimizing the area's perimeter and maximizing its insulation from external perturbations.**

Multiple aspects of land conservation stand to foster resilience across coastal ecotones and the wider landscape when strategically employed. This is particularly the case when onshore areas are physically and functionally connected to marine ecosystems and are situated where they contribute to networks of related resource areas. By providing time and space for natural processes to occur unhindered, and limiting exposure to unnecessary anthropogenic stressors, ecosystems can have improved adaptive capacity for coping with unavoidable stressors like climate disruption.

ADDITIONAL CONSIDERATIONS

Though bidirectional connectivity and the fostering of coastal resilience provide a core of logic for pursuing land

conservation as compensation for marine productivity impacts associated with DCP operations, a few additional points are also worth mentioning. These are summarized below.

Wider Conservation Goals

Entities across all levels of government have expressed conservation goals consistent with the protection of the Diablo Canyon lands. These are generally summarized in the California Natural Resources Agency report, the *Diablo Canyon Power Plant Land Conservation and Economic Development Plan*, prepared in response to State Senate Bill 846 (CNRA 2023). This report notes that locally, San Luis Obispo County voters passed the **DREAM Initiative in 2000** with 74.66% support. The initiative was an advisory measure calling on County leadership and PG&E to set aside the Diablo Canyon lands for long-term habitat preservation, agriculture, and public use.²⁹ Other multi-jurisdictional and non-governmental organizational bodies such as the Friends of the Diablo Canyon Lands have also articulated **strategic visions and frameworks emphasizing the conservation of ecological, scenic, and cultural resources on the lands while providing for public access** as a leading priority (e.g., FODCL 2021). At a state level, Governor Newsom issued Executive Order N-82-20 in October 2020, better known as the **30x30 Initiative**, as it set a state goal of conserving 30% of California’s coastal waters and 30% of its lands by 2030. Key objectives associated with 30x30 are to: 1) conserve and restore biodiversity; 2) expand access to nature; and 3) mitigate and build resilience to climate change. **All of these are consistent with the concept of land protection in this instance**, as conservation of Diablo Canyon lands would facilitate progress towards the 30% land goal (while also contributing to healthy coastal ecosystems), ensure the continuance of nature so that it might be accessed with care, and foster the resilience of the coastal ecotone as it extends from offshore to inland areas, including the rich mosaics of natural resources therein.

Importantly, **the Coastal Act and California Coastal Management Program strongly emphasize environmental protection and conservation priorities.** Chapter 3 of the California Coastal Act provides specific guidance through its policies, and among these are resource protection and enhancement objectives. For example, Section 30230 leads with “Marine resources shall be maintained, enhanced, and where feasible, restored...”.³⁰ The following policy per Section 30231 provides for the maintenance and where feasible, restoration, of biological productivity and water quality in coastal waters.³¹ Speaking to terrestrial resources, Section 30240 calls for the protection of environmentally sensitive habitat areas as well as those areas adjacent to ESHA and parks and recreation areas.³² Each of these exemplifies the spirit of the law as a **commitment to preserving ecological functions and values across the coastal ecotone**, which in this case, the conservation of inland areas to

²⁹ See <https://diablocanyonpanel.org/decom-topics/diablo-canyon-lands/>

³⁰ Coastal Act Section 30230 (Marine resources; maintenance): *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

³¹ Coastal Act Section 30231 (Biological productivity; water quality): *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface waterflow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

³² Coastal Act Section 30240 (Environmentally sensitive habitat areas; adjacent developments): *(a) Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on those resources shall be allowed within those area. (b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.*

affected marine waters would facilitate.

Relative Productivity

Calculated impacts to marine productivity for the DCPP project form the basis of the compensatory mitigation requirement. Evaluating entrainment effects and the loss of productivity is a generally complex process, which requires substantial sampling and data collection to provide model inputs, carries levels of uncertainty, and is generally expected to vary not only for each specific intake system but the specific conditions of a given location over some period of time.³³ In terrestrial ecosystems, determining productivity is similarly complex and nuanced though employs different methods and modeling approaches, making it challenging to directly compare values across systems (Zhang, et al. 2025). Consequently, **representative productivity estimates by ecosystem are not readily available for comparison or to inform a strictly mathematical determination of mitigation acreages across each that would be needed to fully replace the marine productivity lost through continued DCPP operations.** Recent work using satellite data to compare net primary productivity between terrestrial and ocean systems found that on a global scale, terrestrial productivity has increased more than marine productivity decreased from 2003 to 2021. This is explained by observed responses to a warming climate across ecosystems and the authors suggest that **terrestrial productivity will be critical in compensating for lost productivity in the ocean** (Zhang, et al. 2025). While interpreting the detail of such global work to the Diablo Canyon lands specifically is challenging and potentially inappropriate, the point that terrestrial productivity is and will continue to be generally important for climate resilience is relevant to consideration of mitigation actions.

Environmentally Sensitive Habitat Areas

Though formal determinations of environmentally sensitive habitat areas (ESHA) per the Coastal Act have not been made over the entirety of the Diablo Canyon lands, it is likely that much would qualify and thus, **land conservation would serve multiple benefits by protecting marine productivity, its many connections to the land, and coastal resilience while simultaneously protecting sensitive land-associated habitats in-place.** San Luis Obispo County recognizes the majority of the Diablo Canyon lands (including all areas immediately adjacent to the coast) as a Sensitive Resource Area Combined Designation, which is applied to “areas with special environmental qualities, or areas containing unique or endangered vegetation or habitat resources”. The SRA designation provides for ESHA, wetlands, streams and riparian vegetation, terrestrial habitat protection, and marine habitats.³⁴ As discussed earlier, several vegetation communities known to occur on these lands are uniquely associated with maritime influences, including sensitive coastal scrubs, coastal terrace prairie, and maritime chaparral (Biosystems Analysis, Inc. 1996; PG&E 2023a). These occur in largely undisturbed expanses, mosaicked across the landscape, which further emphasizes their functions and values. Rare bishop pine forest also occurs here. In addition, drainages and their associated riparian corridors would typically be considered ESHA, as would the oak woodlands. The habitats of the many known sensitive species described from the Diablo Canyon lands (also discussed above) would have associated habitat qualifying as ESHA as well. Finally, ensuring long-term **protection of such terrestrial and aquatic resources at this time could avert challenges with any future development endeavors that would need to avoid these in order to maintain consistency with the Coastal Act’s ESHA policy.**³⁵

³³ Note that the calculation of the 9,365-acre annual APF for the DCPP project represents an average of productivity losses from all habitats the entrained organisms originate; however, it is generally understood that there is variability among marine habitats and that reefs are probably five to ten times as productive as the average productivity of the entire source water body, which includes sandy bottom, muddy bottom, and other less productive habitat types.

³⁴https://library.municode.com/ca/san_luis_obispo_county/codes/county_code?nodetd=TIT23COZOLAUS_CH23.07CODEST_23.07.160SE_REARSR; <https://opendata.slocounty.ca.gov/datasets/SLOCounty::sensitive-resource-area-combining-designation/about>

Current Agricultural Uses

Outside of Parcel P where the DCPD itself is located, the primary land use across the lower terraces of the Diablo Canyon lands is cattle grazing. Cattle grazing has occurred along the coastal terraces of both North Ranch and South Ranch since the late 1800s. **Use of a conservation easement to mitigate for losses of marine productivity is not necessarily incompatible with existing or modified grazing operations.** Indeed, carefully managed grazing is sometimes used as a conservation tool meant to address invasive vegetation management, fuel loads, or manipulations benefiting targeted species (Stromberg and Griffin 1996; D'Antonio, et al. 2002). However, caution is also warranted as domestic grazers can damage native vegetation, compact soils, and introduce nutrient loads that alter soil composition, thereby promoting the establishment of invasive vegetation and/or adding contaminated runoff that can degrade coastal water quality.³⁶ The existing 1200-acre deed restricted area on South Ranch is required to follow the earlier version of a joint technical reference prepared the US Department of the Interior (Pellant, et al. 2020). Any ongoing or future use of grazers on Diablo Canyon lands should be examined carefully with these points in-mind, combined with the current science and conservation goals, and be managed to avoid adverse effects to both land and marine ecosystems.

CONCLUSION

In-kind mitigation for DCPD's impacts to marine productivity will be infeasible due to the challenges of scale and siting any potential efforts that follow the Commission's precedent of related habitat creation. In addition, such efforts would result in substantial time lags, require massive investments from the applicant as well as staff and additional parties, and seem unlikely to readily succeed given what has been observed at other projects. Other marine habitat mitigation options like funding general restoration work or allocating resources to MPA enforcement have also fallen short of significantly benefiting marine productivity in the DCPD area, and moreover, have largely displaced mitigation effort to areas further removed from the originating impacts. This leaves the Diablo Canyon area sustaining a net loss in marine resource values, undermining the very reason MPAs like Point Buchon SMR and SMCA were initially established there. Similarly, the Chumash Heritage National Marine Sanctuary was recently designated with a primary goal of preserving marine biodiversity and includes areas adjacent to the Diablo Canyon lands that will be impacted by the proposed relicensing.

Given the important bidirectional **connectivity** of ecological resources across land and sea, the recognition of value in **protecting** both lands and waters across the coastal ecotone from anthropogenic threats, the regional and state **priorities** echoing the latter, and the unique **opportunity** in this instance to actually do so because the lands are not yet developed and are already held by the applicant, **the preservation of a large coastal region like this as out-of-kind mitigation simply makes sense.** This memo has aimed to lay out the technical rationale for using coastal land conservation as compensation for lost marine productivity but **in the simplest of terms, the nexus has to do with maintaining a variety of existing flows across a relatively intact and healthy coastal ecotone well into the future, managing the threats that can be addressed, and bridging with a number of already protected areas so that collectively, they have opportunity to sustain and provide for regional ecological resilience.** Land-based productivity here cannot match marine productivity, but by spatially and temporally adjusting for such differences, real and lasting benefits are indeed feasible.

³⁵ Coastal Act Section 30240 – language provided in footnotes above

³⁶ For example, see CD-0006-20 (US National Park Service). The allowable uses of land determined to constitute ESHA is guided by Coastal Act 30240 (see footnotes above).

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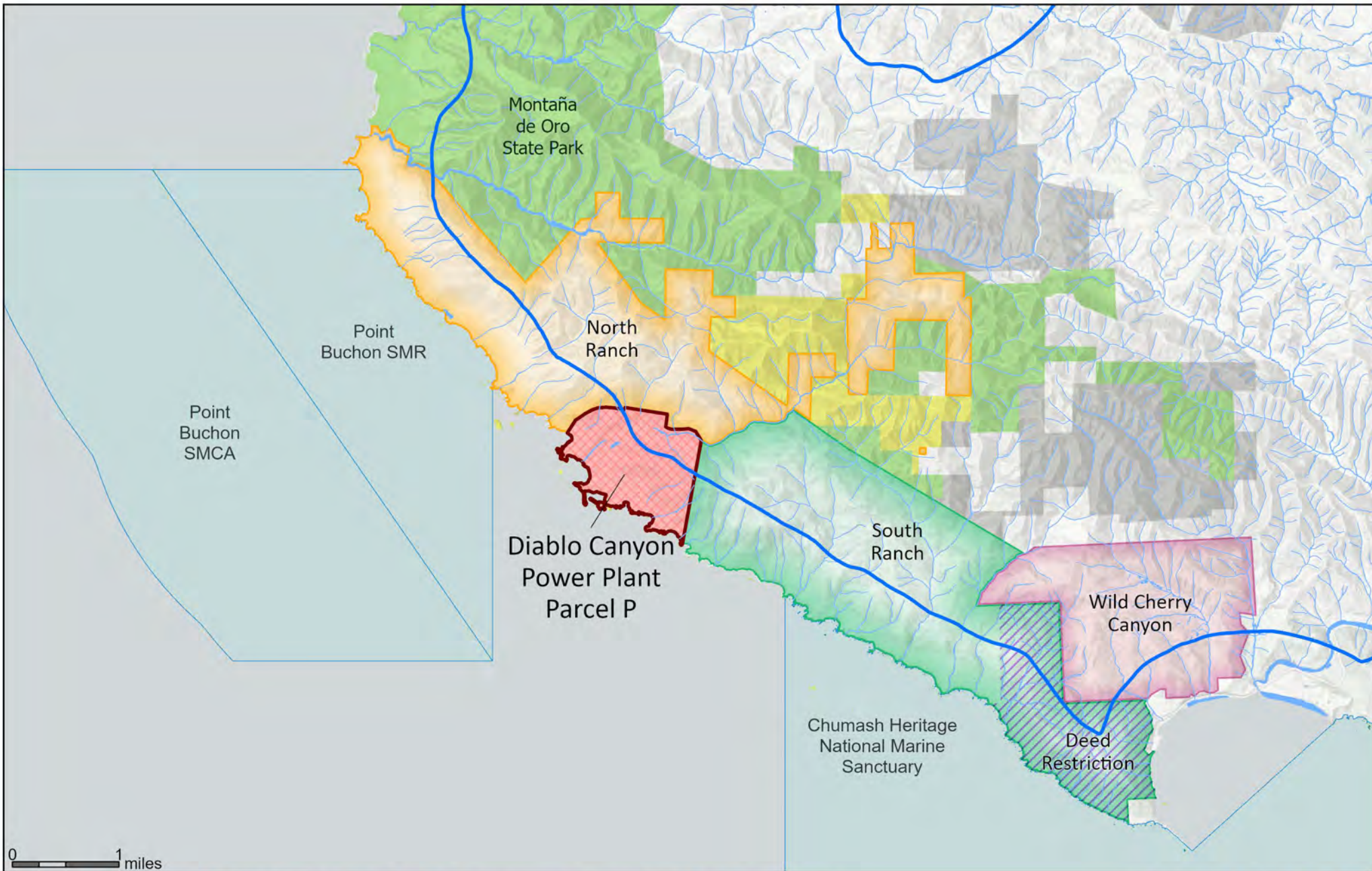


FIGURE 1: Diablo Canyon lands and surrounding protected areas



- Coastal Zone Boundary
- Diablo Canyon Power Plant
- North Ranch
- South Ranch
- Wild Cherry Canyon
- Deed Restricted (A-3-SLO-06-617)
- Bureau of Land Management
- California Dept of Parks and Recreation
- CCED Easement
- Marine Protected Area
- Watercourses and Wetlands

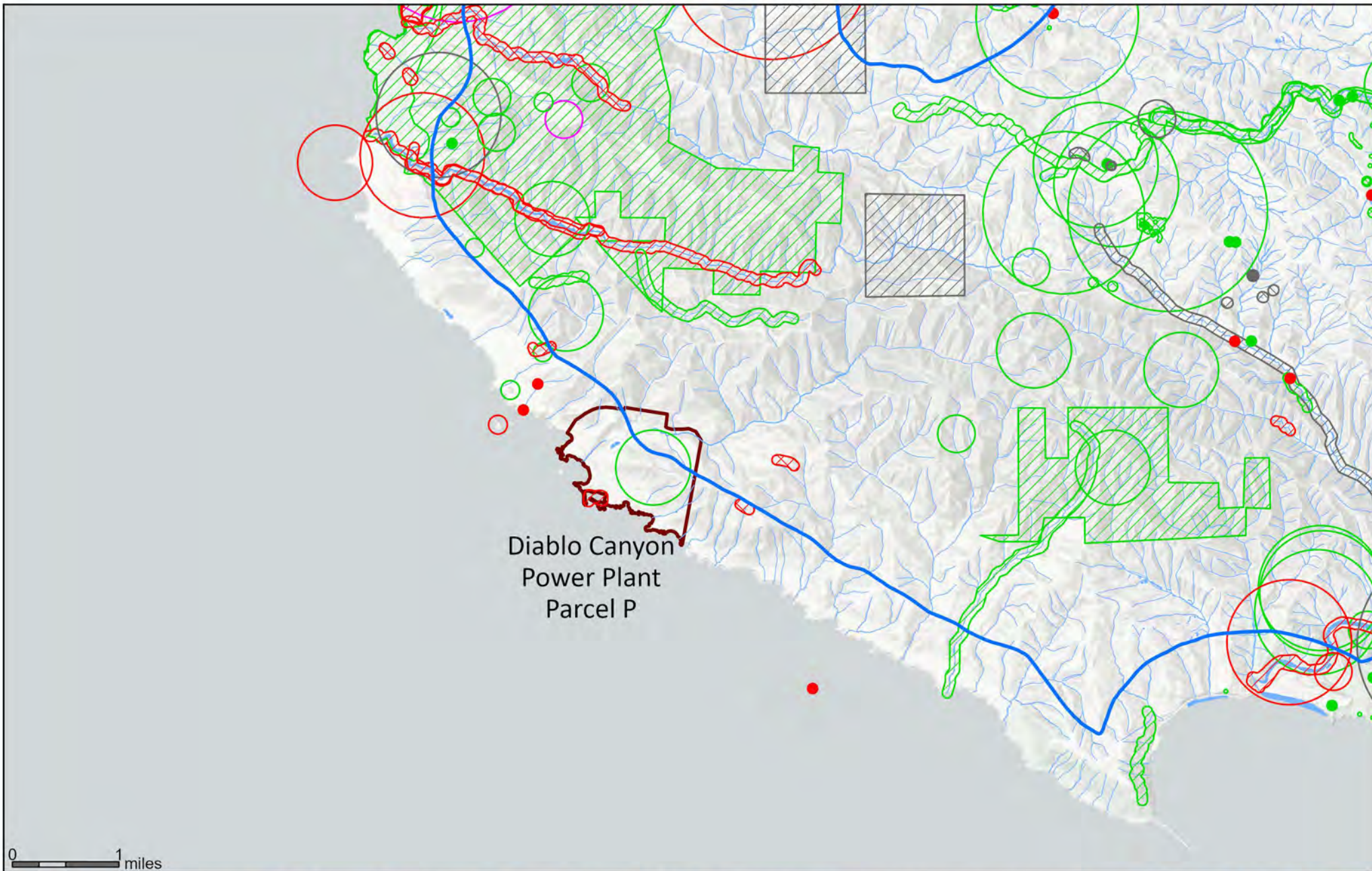


FIGURE 2: California Natural Diversity Database (CNDDDB) sensitive resource records



- | | | |
|---|--------------|---------------------------|
| ■ Plant | Specific | Coastal Zone Boundary |
| ■ Animal | Non-Specific | Diablo Canyon Power Plant |
| ■ Multiple | Circular | Watercourses and Wetlands |



For illustrative purposes only. CD October 2025
 Sources: NOAA, CNDDDB (Oct 2025), CPAD, CCED, NMFS, PG&E, © OpenStreetMap, CA Coastal Commission

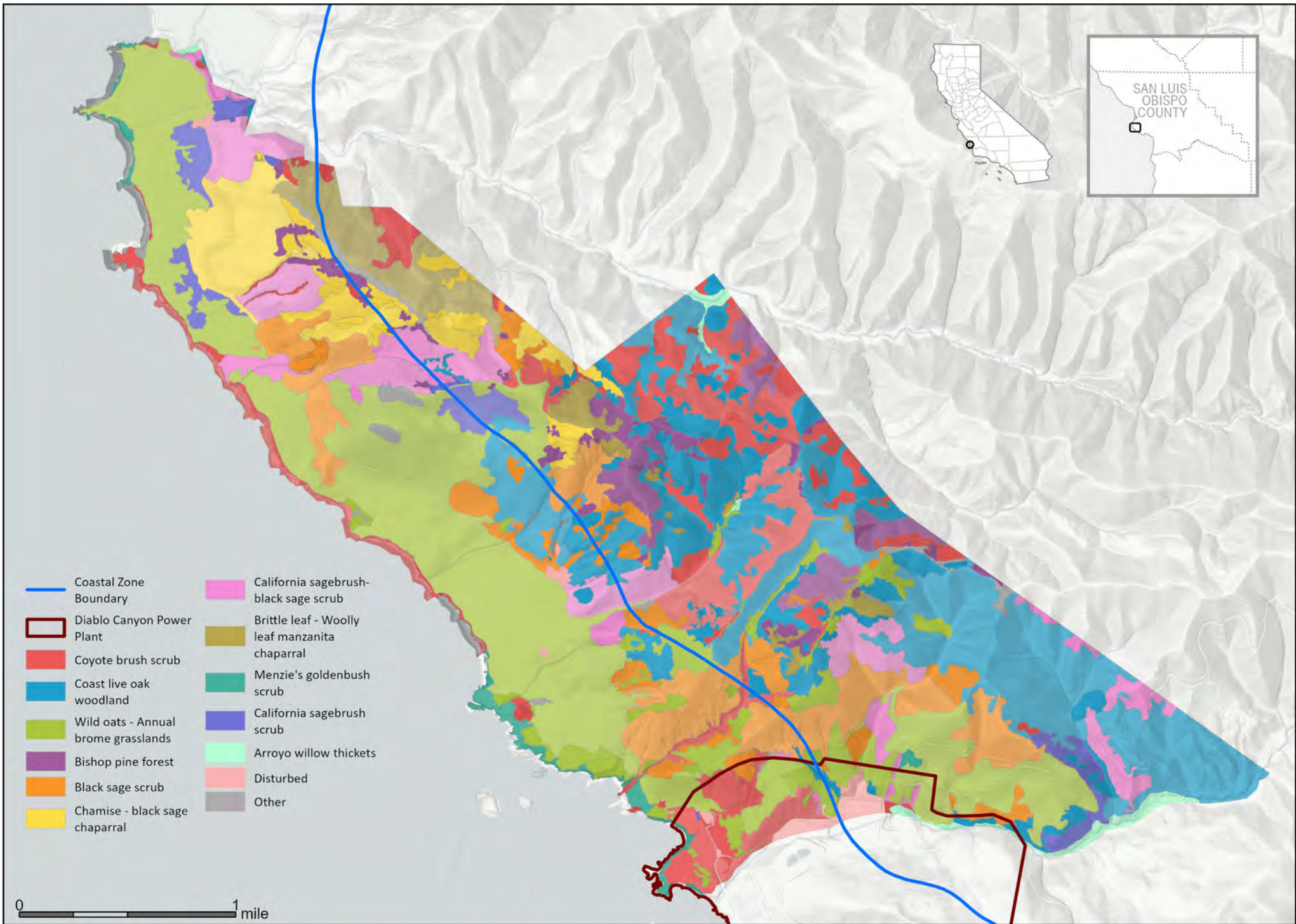


Figure 3: North Ranch vegetation mapping (2016-2017)

For illustrative purposes only. CD October 2025
 Sources: NOAA, CPAD, CCED, NMFS, PG&E,
 © OpenStreetMap, CA Coastal Commission



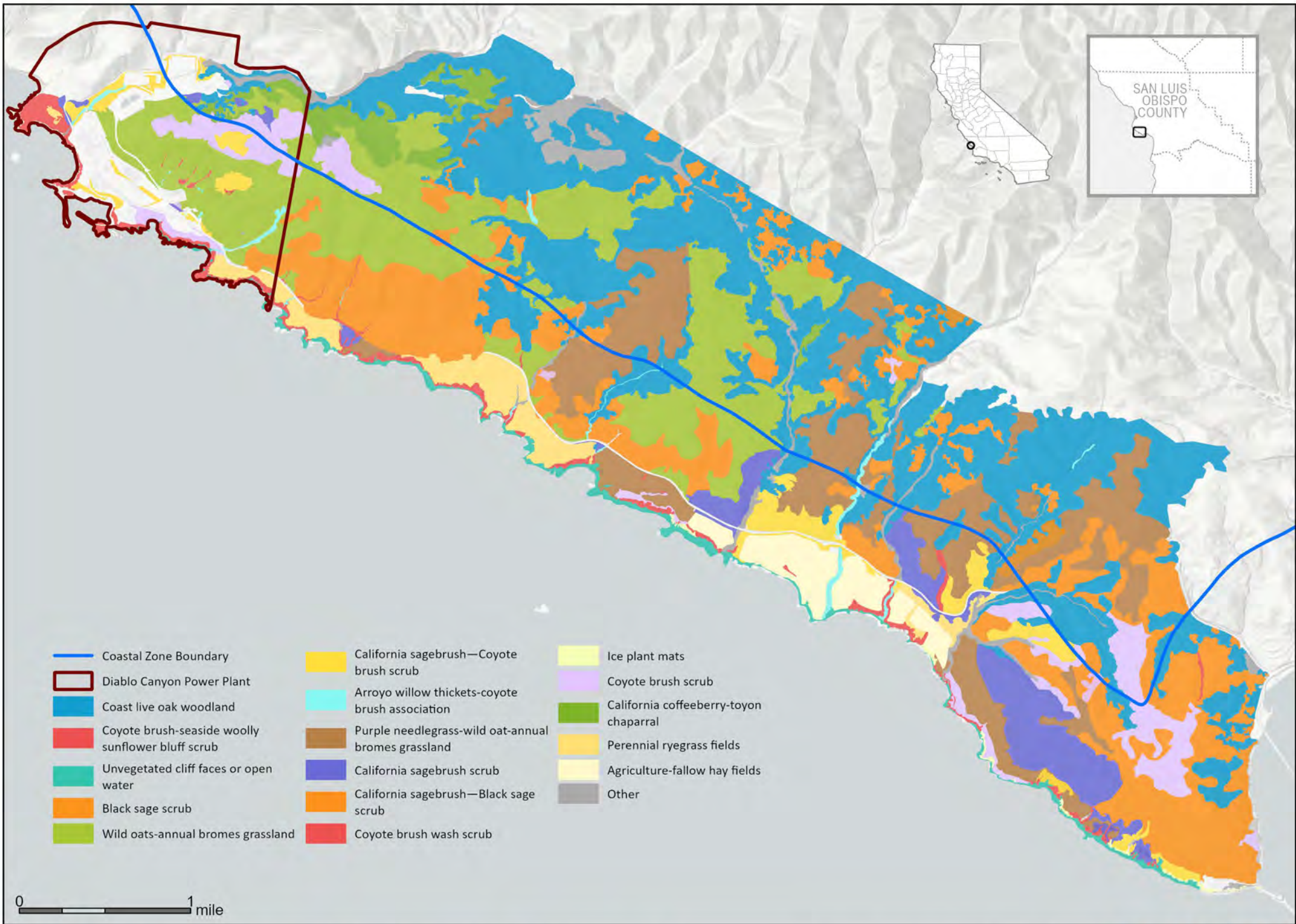


Figure 4: South Ranch vegetation mapping (2016-2017)

For illustrative purposes only. CD October 2025
 Sources: NOAA, CPAD, CCED, NMFS, PG&E,
 © OpenStreetMap, CA Coastal Commission



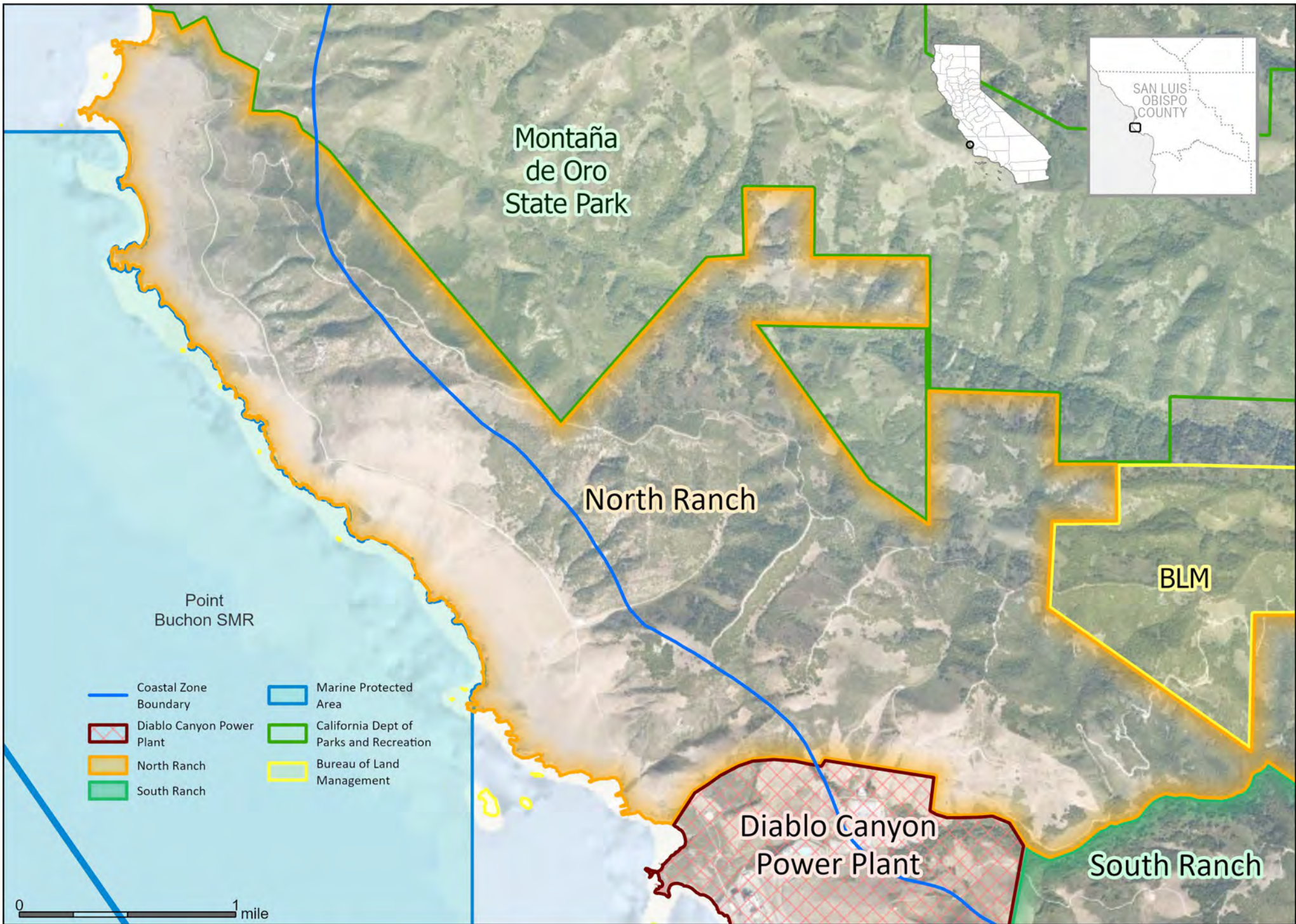


Figure 5: North Ranch satellite view

For illustrative purposes only. CD October 2025
 Sources: NOAA, CPAD, CCED, NMFS, PG&E,
 © OpenStreetMap, CA Coastal Commission

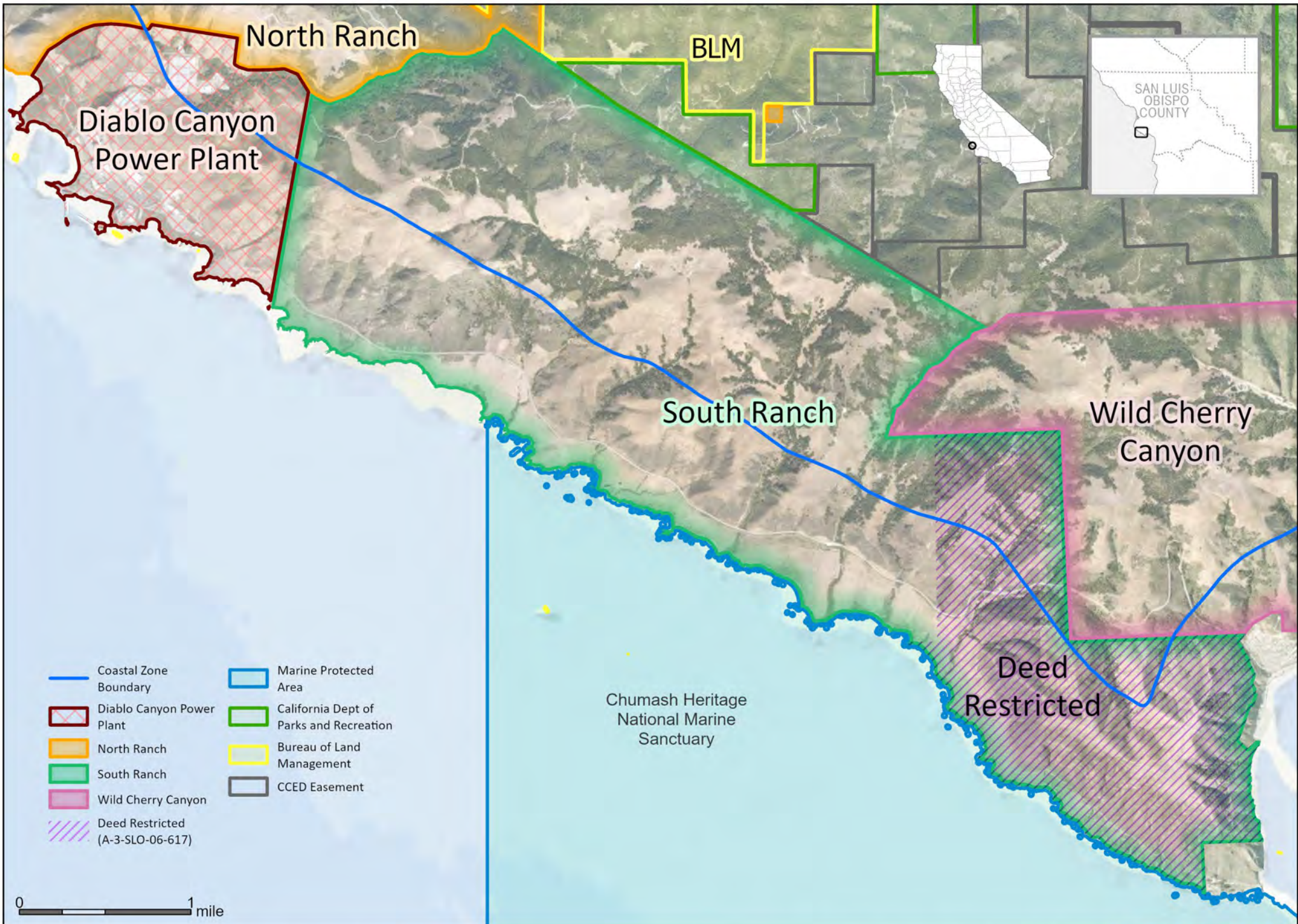


Figure 6: South Ranch satellite view

For illustrative purposes only. CD October 2025
 Sources: NOAA, CPAD, CCED, NMFS, PG&E,
 © OpenStreetMap, CA Coastal Commission

CALIFORNIA COASTAL COMMISSION

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**DIABLO CANYON GEOLOGIC HAZARDS TECHNICAL MEMORANDUM**

To: Energy, Ocean Resources & Federal Consistency Staff
From: Philip L. Johnson, P.G., C.E.G. Engineering Geologist
Date: October 16, 2025

INTRODUCTION

The Diablo Canyon Power Plant (DCPP) is a nuclear power plant that began operation in 1985. Though Pacific Gas & Electric Company (PG&E) previously planned to decommission the DCPP in 2025, Senate Bill 846 in 2022 provided for extending the operation of the DCPP through 2030. As part of the process to extend the operation of the DCPP, SB846 required an updated seismic hazard assessment. In response, PG&E issued a report (PG&E, 2024) that updated their previous probabilistic seismic hazard assessment (PSHA) report (PG&E, 2015). The purpose of the update report was to present new technical data developed since the previous PSHA report and to revise and update specific elements of the seismic hazard analysis to reflect the latest information regarding nearby faults that are potential sources of strong seismic ground motions (ground shaking) at the power plant.

Previous investigations of the region surrounding the DCPP identified the offshore Hosgri fault as the most significant seismic source for the DCPP site. In addition, the faults that bound the Irish Hills, the Los Osos fault on the northeast side and the Southwest Boundary Zone (SWBZ) fault on the southwest side are considered potentially important seismic sources due to the proximity of these faults to the DCPP. Other faults within the region are potential seismic sources, but the distances between those other faults and the DCPP are large enough that ground motions are likely to attenuate before reaching the DCPP. For example, the Casmalia fault and Lion's Head fault, which bound the Casmalia Hills, are more than 30 kilometers south of the DCPP. Ground motions from earthquakes on those faults would be felt at the DCPP, but they would likely attenuate significantly before reaching the site. By contrast, ground motions from nearby sources would travel a shorter distance and attenuate less. Thus, the greatest seismic ground shaking hazard comes from the Hosgri fault, Los Osos fault, and SWBZ fault zone.

We prepared this memorandum to summarize the Coastal Commission's review of the geologic hazards that could potentially impact the DCPP. Though a wide range of geologic hazards were considered, the primary focus of this memorandum is strong seismic shaking related to earthquakes on nearby faults. We consider this to be the most relevant hazard. Other hazards that we considered include fault rupture hazard, tsunamis, and landslides. This memorandum first discusses the regional geologic framework, then summarizes a review of nearby seismic sources and potential ground shaking hazards, then focuses on other geologic hazards (fault rupture, tsunami, and landslides), and last

summarizes the critique of the PSHA by Dr. Peter Bird and a response to that critique by a third party peer reviewer.

REGIONAL GEOLOGIC STRUCTURE

The DCPD is located on the southwest flank of the Irish Hills (Fig. 1). The Irish Hills lie within the southwestern portion of the Coast Ranges. The central portion of the Coast Ranges farther east is characterized by northwest-trending (approx. N30W to N40W) right lateral and reverse faults and folds and higher topography. By contrast, more westerly-trending faults (N60W to N70W) characterize the southwest Coast Ranges (Fig. 2). The Coast Ranges region is bordered on the south by the east-west trending Transverse Ranges that is characterized by east-west trending reverse and thrust faults formed by north-south shortening associated with clockwise rotation of the Transverse Ranges during opening of the Los Angeles Basin in Miocene time (23 to 5.3 Million years ago). The boundary between the Transverse and Coast Ranges is a south-dipping reverse fault, the Santa Ynez River fault. The southwestern Coast Ranges is separated from the Central Coast Ranges by the West Huasna fault.



Fig. 1 Map showing the location of the DCPD.

When viewed from a broad, regional perspective, the geologic structure of the southwestern Coast Ranges and the orientation of the Irish Hills, and the Casmalia Hills located farther south, is clearly different from the rest of the Coast Ranges and seem to be intermediate in orientation between the northwest-striking folds and faults farther east in the Central Coast Ranges and the east-west folds and faults of the Transverse Ranges. The orientation and style of geologic structures in this structural domain seems to indicate an element of north-south shortening, similar to the Transverse Ranges, within the southwest portion of the Coast Ranges. Structures in this unique domain are oriented more westerly than other Coast Ranges faults that are oriented approximately N30W to N40W and more northerly than Transverse Range faults that are mostly oriented East-West. In that sense, this structural domain appears to be transitional between the rest of the Coast Ranges to the east and the Transverse Ranges to the south.



Fig. 2 Map of known Quaternary active faults near the Diablo Canyon Power Plant.

REVIEW OF SEISMIC SOURCES

The Hosgri Fault

The Hosgri fault is a major seismic source located offshore approximately 4.9 km southwest of the DCP. The fault extends approximately 400 km from near Point Arguello at the south end to the town of Bolinas at the north end. Through most of that distance, the fault is offshore. It is a right lateral strike slip fault oriented sub-parallel to the San Andreas fault, and it intersects the San Andreas fault at the north end. The Southern California Earthquake Center database indicates that the Hosgri fault is capable of earthquakes in the magnitude range of Mw6.5 to Mw7.5.¹

Though the range of potential earthquake magnitudes is reasonably well understood due to the well-constrained fault length, the potential recurrence interval for major earthquakes is less well understood. Therefore, significant research has focused on defining the slip rate for the Hosgri fault, because slip rate is a commonly-used proxy for recurrence interval. That is, faults that have higher slip rates are expected to generate large magnitude earthquakes more frequently than faults with lower slip rates. For the purposes of this memorandum, we consider a major earthquake to be one with a magnitude of Mw6.0 or greater. Larger magnitude earthquakes are more likely to cause strong to violent ground

¹ Mw stands for moment magnitude which is a function of the area of fault rupture, the amount of slip during the earthquake, and the rigidity of the surrounding rock.

shaking that is capable of damaging structures. For any given fault, the higher the slip rate, the greater the hazard estimate in the PSHA.

Slip rate is estimated by first identifying a unique geological or geomorphic feature that is offset by the fault. Examples include offshore features such as paleo-shorelines or submarine channels or onshore features such as stream channels or marine terraces. Ideally, the offset feature would be oriented roughly perpendicular to the fault. The fault offset is measured by reconstructing the pre-offset geometry and measuring the amount of slip needed to restore the original geometry of the feature. The second element of slip rate is the age of the offset feature. For example, if a marine terrace is 124,000 years old (124 ka in geological terminology), and the terrace is offset 400 meters by a fault, the slip rate for that fault would be $400 \text{ m} / 124,000 \text{ yr} = 0.0032 \text{ m/yr} = 3.2 \text{ mm/yr}$. Fault slip is typically expressed in mm/yr. The primary sources of uncertainty in slip rate estimates are the reconstruction of features offset by the fault and dating of those offset features. There is some element of uncertainty in the pre-offset geometry and potential modification by the offset feature by erosion. All methods used for dating of sedimentary deposits or other geologic features have some element of uncertainty, even if the dating is considered successful.

PG&E (2024) proposed a slip rate model for the Hosgri fault that gives varied weights to slip rate estimates from four different sites along the fault (Fig. 3). From north to south, those sites are San Simeon, the Cross Hosgri Slope (CHS), Estero Bay, and Point Sal. In this section, we describe the data from the four slip rate sites and provide our estimation of the quality of those data. Data quality is important, because high quality data is likely to deserve a high weight in the PSHA, and lower quality data should receive a low weight (or zero weight) in the PSHA.



Fig. 3 Hosgri fault slip rate sites used by PG&E (2015, 2024).

In previous reports by the Diablo Canyon Independent Peer Review Panel (IPRP), which consists of representatives from several state agencies (including the California Coastal Commission and California Geological Survey), the IPRP has critiqued PG&E's approach to fault slip rates. Because slip rates are an important element in the PSHA, the IPRP has closely scrutinized these parameters. We continue that scrutiny both as a member of the IPRP and as a separate permitting agency.

San Simeon Slip Rate Site

The slip rate from the San Simeon site comes from offset of a strandline associated with an onshore marine terrace, the Oso Terrace (Hanson and Lettis, 1994). The Oso Terrace roughly correlates with a sea level high stand at marine isotope stage 7 (approximately 210 ka). Based on the mean clay accumulation in soils on the Oso Terrace, Rockwell, et al. (1994) estimated the age of the Oso Terrace at 200 ka to 230 ka. Since the publication of Rockwell, et al. (1994), significant advances in dating of soils using OSL² and cosmogenic nuclide dating indicate that the potential range of soil ages may be broader than first estimated. Improved dating of the Oso Terrace using newer methods appears warranted. Using the remaining fragments of the Oso Terrace north of San Simeon Bay, Hanson and Lettis (1994) identified a curved strandline and bedrock headland roughly similar to the geometry of the modern San Simeon Bay and other bay and headland shoreline geometries elsewhere on the coast. The Oso Terrace strandline has a curved rather than linear character, and the range of possible geometries for a curved strandline with a headland has significantly greater uncertainty than offset of a continuous feature with a simple, linear geometry that can be correlated across the fault. This complexity leads to much uncertainty in the offset measurement. Using a curved projection of the strandline across the fault, Hanson and Lettis (1994) estimated a minimum offset of 150m and a maximum offset of 550m. It is important to understand that this estimated offset is based on an assumed paleo-shoreline geometry that cannot be independently verified with physical evidence. It appears that the uncertainty in this paleo-shoreline model could be even greater than the stated range of minimum and maximum offsets. With the identified range of possible offsets and ages for the Oso Terrace from the older dating of the terrace (Rockwell, et al., 1994), the estimated slip rates range from 0.65 mm/yr to 2.75 mm/yr. PG&E (2024) chose a preferred slip rate of 1.8 mm/yr for the Hosgri fault at the San Simeon site, though we question the basis for that stated preference. Given the magnitude of uncertainty in the strandline and headland geometry and the limitations of soil dating method used for the Oso terrace, the overall uncertainty associated with the San Simeon slip rate site is quite large. Therefore, we judge the quality of the slip rate data from the San Simeon site to be low.

The Cross Hosgri Slope (CHS)

The CHS site is an offshore paleo-shoreline with a well-defined fault offset. The measured offset of the CHS lower slope break is 30.3 ± 9.4 m. Radiocarbon and OSL dating indicate an age of 11.7 ± 0.1 ka for the sediments that comprise the paleo-shoreline. Those data yield a slip rate of 2.6 ± 0.8 mm/yr with a high degree of confidence. The results of the CHS study were published in peer-reviewed articles (Johnson, et al., 2014; Medri, et al., 2022; and Kleusner, et al., 2023) in highly respected scientific journals. It should be noted that the peer review process followed by those journals includes scrutiny by impartial, third-party peer reviewers that are not paid by an interested party. That peer review process

² Optically stimulated luminescence (OSL) is an age-dating method that estimates the time elapsed since mineral grains (in soils or other samples) were last exposed to sunlight.

typically leads to rejection of research that does not meet scientific standards. The CHS studies meet those standards. We judge the quality of the slip rate data from the CHS to be high. It is our opinion that the CHS slip rate site provides the highest quality slip rate data currently available for the Hosgri fault.

In their most recent report, PG&E (2025) reviewed and critiqued the basis for the CHS slip rate. Their criticisms centered on how slumping, erosion, incision by marine currents, or deposition might have modified the lower slope break that U.S. Geological Survey (USGS) researchers (Johnson, et al., 2014; Kleusner, et al., 2023; and Medri, et al., 2023) used as a piercing line (i.e., a linear feature that the fault offsets). They also reconsidered the age constraints on abandonment of the shoreface. However, we note that any geologic features used for reconstruction of fault slip at any site are potentially subject to small changes over time due to erosion or deposition. The authors of the CHS studies acknowledged the potential for slumping to modify the upper slope, so they chose to use the lower slope break as the piercing point rather than the top of the shoreface. They also acknowledged that a thin deposit of sand and silt covers the shoreface, and they accounted for that in their model. There are uncertainties in reconstruction and age constraints on any offset feature; that is an inherent limitation to all fault offset reconstructions. At the CHS site, the offset measurements and dating of the offset feature are much more tightly constrained than other offshore slip rate sites along the Hosgri fault near the DCP, and in particular in comparison to the San Simeon site discussed above. The limitations of the data were fully vetted, and uncertainties evaluated during the process of publication, both as part of the USGS internal pre-publication review (which tends to be quite rigorous) and when submitted to the peer-reviewed scientific journal. That exhaustive review was done by impartial scientists who specialize in fault investigation and earthquake hazards. Thus, it is not clear that re-thinking of the slip rate from the CHS site is necessary or productive after extensive previous review by impartial scientists. The proposed expansion of slip measurement uncertainty for the CHS site by PG&E (2024) appears without merit. Oddly, it seems that the PG&E critique applies a much higher level of scrutiny to the CHS site than slip rate sites that have much greater fundamental shortcomings and larger uncertainties (Estero Bay and San Simeon slip rate sites).

Estero Bay Slip Rate Site

There are two problems with the slip rate from the offshore Estero Bay site: (1) large uncertainties regarding the age of the offset paleo-channels and (2) the highly questionable matching of paleo-channels across the Hosgri fault. The IPRP (2014) report describes these issues in detail. The Estero Bay site is in a portion of the outer continental shelf and upper continental slope that were not subaerially exposed during Quaternary sea level low stands. Dating of the offset paleo-channels is based on the estimated ages of bracketing strata that are thought to correlate with Quaternary unconformities.³ However, the would-be bracketing unconformities lack angular discordance and, thus, might not even be unconformities. The supposed “unconformities” may be conformable contacts. The dating of the paleo-channels relies on correlation of potential “unconformities” with sea level low stands of known age. However, it is unclear which known sea level low stands correlate with the potential “unconformities” that bracket the channels. The researchers (PG&E, 2014) proposed a

³ Unconformities are geological discontinuities that represent gaps in the sedimentary record, typically occurring as buried erosional or non-depositional surface separating two rock masses or strata of different ages. They occur when sedimentation is interrupted or when previously deposited sediments are eroded away.

mean age of the offset paleo-channel of 840 ka and a range of 590 ka to 1,530 ka, based on the proposed correlation between the bracketing “unconformities” and unconformities of known age. This broad range indicates very large uncertainties in age. It is our opinion that the proposed age correlations are questionable.

Measurements of fault offset at Estero Bay require accurate matching of the paleo-channels across the fault. However, attempts at matching paleo-channels east of the Hosgri fault with paleo-channels west of the fault have yielded questionable results. IPRP (2014) stated that “The most significant uncertainty in this interpretation is that the three channel fragments correlated across the fault may not have ever been parts of a single channel. Although the cross-sectional shapes of the channels present permissible matches, they do not allow a unique match with a high level of confidence. As observed in the fault parallel seismic profiles, many other candidates for matching channels can be envisioned. The IPRP was not convinced that the proposed channel correlation is sufficiently well defined that any slip rate calculation was justified with sufficient certainty to be relevant for seismic hazard assessments.” In the same report, IPRP (2014) further concluded that “The IPRP regards the channel restoration as possible, but far from a well-constrained, unique interpretation. In the absence of data to more conclusively demonstrate the proposed channel restoration, the IPRP regards the Estero Bay slip rate study as inconclusive and would not use results of the study to constrain slip rate on the Hosgri fault.” The Estero Bay site was not published in a peer-reviewed scientific journal, and it appears likely that a peer reviewer would have questioned the validity of the fault offset measurements and the dating of the paleo-channels for this study. The slip rate estimates for the Estero Bay site range from 0.39 to 4.71 mm/yr with a preferred value of 1.75 – 1.90 mm/yr. The very large uncertainties in the age of the paleo-channels and questions about the assumed “unconformities” as well as the inconclusiveness of the measured offsets demonstrate that the quality of slip rate estimates from the Estero Bay site is very low. In fact, the quality of slip rate data from this site is so low that we do not believe it should be considered as part of the seismic hazard model for the DCP.

Point Sal Slip Rate Site

A recent study by Nishenko, et al. (2025) sheds new light on the Hosgri fault at the offshore Point Sal site. Prior to that study, previous efforts to determine a slip rate at this site (PG&E, 2014) were less successful due to difficulties with resolving the age of the identified offset paleo-channel. We consider the quality of the slip rate estimate from that earlier study to be low. Improvements in understanding of the Point Sal site come from improved constraints on the age of the offset channel used for the Nishenko et al. (2025) study. The researchers identified one paleochannel (Channel F) that they could confidently correlate across the Hosgri fault. At the Hosgri fault, they measured 640 ± 80 m of right lateral offset of Channel F. They concluded that Channel F was incised either during Marine Isotope Stage 8 (MIS 8) at 250 ka or MIS 10 at 345 ka. They assigned a 95% confidence level to two fault slip rates using these two possible ages. The slip rates range from 2.56 ± 0.37 mm/yr for an MIS 8 age to 1.86 ± 0.26 mm/yr for an MIS 10 age. The average of these two slip rates is 2.21 mm/yr. Due to the uncertainty between the two potential ages of incision for Channel F, we judge the quality of the new slip rate data from the Point Sal site to be moderate.

Discussion of Hosgri Fault Slip Rate Data

Clearly, the data from the San Simeon and Estero Bay studies have very large uncertainties. Overall, the quality of data from these sites is low to very low. These issues have led us to question the fundamental accuracy and utility of the data from those two sites for the DCPD seismic hazard model. PG&E reports that address the Hosgri fault slip rate data (PG&E, 2015, 2024, and 2025) were written prior to publication of Nishenko, et al. (2025). At that time, we had concluded that the quality of slip rate data from previous studies of the Point Sal site was too low to merit inclusion in the overall slip rate for the offshore Hosgri fault in the DCPD seismic hazard model. However, with the publication of Nishenko, et al. (2025), the new slip rate estimates from the Point Sal site appear to warrant some weight in the slip rate model.

Slip rate data from the CHS site reaches a high standard of accuracy that none of the other slip rate sites on the Hosgri fault can match. Prior to the offshore research that identified and characterized the CHS site, older legacy sites provided the only slip rate data available for the Hosgri fault near the DCPD, though major shortcomings and large uncertainties associated with those sites remained as significant caveats at that time. It was weak data with severe limitations, but it was understood that it was the only data available. With the publication of the CHS data (and to a lesser extent the new data for the Point Sal site), our knowledge of the Hosgri fault slip rate has taken a step forward, and the lower quality sites are no longer relevant. We question whether data from the San Simeon or Estero Bay sites would survive a rigorous peer review process and be accepted in a major peer-reviewed scientific journal. The data quality problems with those sites have become too onerous to include them in the DCPD seismic hazard model now that much higher quality data are available.

In a recent report, PG&E (2025) addressed the weighting of Hosgri fault slip rates. They describe three legacy sites (San Simeon, Estero Bay, and older data for the Point Sal site) as “technically defensible” and argue that the Nuclear Regulatory Commission (NRC) Senior Seismic Hazard Analysis Committee (SSHAC) process requires inclusion of the “center, body, and range” of data from technically defensible slip rate sites. For reasons explained earlier in this report, we do not agree that the slip rate data from the San Simeon and Estero Bay sites are technically defensible. The quality of data from those sites is much too low to be described as technically defensible. That also applies to the older data from the Point Sal site; however, the recent publication by Nishenko, et al. (2025) represents a significant improvement over the previous data for the Point Sal site. In January 2025 when PG&E (2025) was published, that new data was not yet available, because it wasn’t published until June 2025. It is clear that of the four Hosgri fault slip rate sites considered for the DCPD seismic hazard model, the highest quality data comes from the CHS site. Now that new data are available for the Point Sal site (Nishenko, et al., 2025), there is greater justification for allowing some weight to that slip rate at a lower percentage (20%) than for the CHS slip rate. The San Simeon and Estero Bay sites are not technically defensible and should not be included in the DCPD seismic hazard model.

The three legacy sites yield slip rate data for the Hosgri fault that reflect fault slip averaged over hundreds of thousands of years. Given that fault slip rates change over time, it is much less likely that these three much older slip rate sites reflect the current slip rate for the Hosgri fault. PG&E (2025) indicates that a slip rate for a longer time interval, stretching back to mid-Pleistocene time, is preferred, because it would include more recurrence intervals. That is, it would capture a more statistically robust sampling of recurrence intervals

between earthquakes due to a much larger sample over longer time spans in the range of approximately 200,000 to 800,000 years. However, this ignores the likelihood that slip rates have changed over longer time intervals. There are examples of other faults that have variable slip rates (i.e., Bergen et al., 2017, Lifton et al., 2015), and in these cases a long-term average slip rate would significantly underestimate the seismic hazard relative to a Holocene slip rate. Perhaps uncertainties could diminish with time spans of multiple seismic cycles if fault slip rates were constant over those time spans, but in the case of the Hosgri fault, that does not overcome the fundamental data quality problems with the older San Simeon and Estero Bay sites or the uncertainties with the Point Sal site (Nishenko, et al., 2025).

Another notable characteristic of the San Simeon and Estero Bay sites is that PG&E's preferred slip rates from those sites are uniformly lower than the Holocene slip rate from the CHS site and the average of slip rates from the Nishenko, et al. (2025) study of the offshore Point Sal site. The result of including the San Simeon and Estero Bay sites is a significant reduction in the slip rate estimate carried forward into PG&E's seismic hazard analysis. This could be due to the noted inaccuracy in dating and offset measurements used to derive the slip rates from those two sites. In any case, the San Simeon and Estero Bay sites skew the data systematically toward a lower slip rate. The effect of the lower slip rate is to reduce the perceived seismic hazard associated with the Hosgri fault. Therefore, we encourage PG&E to drop the San Simeon and Estero Bay slip rate sites from their Hosgri fault slip rate calculations.

Conclusions Regarding the Hosgri Fault Slip Rate

Based on our review of slip rate data for the Hosgri fault, we recommend that PG&E give 80% weight to the CHS site (2.6 mm/yr) and 20% weight to the average slip rate from the Point Sal site (2.21 mm/yr) in their seismic hazard model. The SSHAC process does not require the inclusion of low quality or very low quality data, such as from the San Simeon and Estero Bay sites, or dilution of high-quality data with low to very low quality data. We conclude that the CHS site provides the most technically defensible slip rate data for the Hosgri fault near the DCP, and the Point Sal average slip rate deserves inclusion in the slip rate model at a lower weight of 20%. The San Simeon and Estero Bay sites should not receive any weight in the slip rate model for the Hosgri fault, because those sites are not technically defensible.

Irish Hills Faults

The DCP is located on the southwest side of the west-northwest oriented Irish Hills. This uplift is bounded on the north by the Los Osos fault and on the south by a set of faults known as the South Boundary Fault Zone (including the San Luis Bay, Wilmar Avenue, and San Luis Range faults), commonly abbreviated to SWBZ fault. Though the Los Osos and SWBZ faults are mostly on-land, they are not as well understood as the Hosgri fault. The geometry, sense of slip (reverse/thrust, strike-slip, etc.), and slip rate of these faults remain poorly defined.

PG&E (2015) identified three possible fault block geometry models for the faults that bound the Irish Hills. The first is the Outward-Vergent (OV) model that posits oblique reverse-dextral slip on the Los Osos fault with uplift of the Irish Hills the result of reverse slip accompanied by strike slip motion on both the south-dipping Los Osos fault and the north-dipping San Luis Bay fault. The Southwest-Vergent (SW) model calls for uplift of the Irish

Hills by thrust/reverse slip on the San Luis Bay fault and other Southwest Boundary Zone faults that dip approximately 45° northeast. The Northeast-Vergent (NE) model calls for uplift of the Irish Hills by northeast-vergent reverse slip on the Los Osos fault that dips approximately 50° to the southwest. PG&E (2015) gave the OV and SW fault block geometry models 40% weight (each) and the NE model 20% weight in their logic tree. The PG&E (2024) report restated the fault block geometry models from the PG&E (2015) report, because new data were not available to improve on these initial hypothetical fault geometries.

The uncertainty regarding the fault geometry model for the Irish Hills is not trivial, because the slip rate assigned to these faults is limited by the assumption that the faults are predominately or entirely dip-slip (reverse or thrust) faults dominated by vertical, rather than lateral, fault motion. The Irish Hills uplift rate from marine terrace dating is approximately 0.15 mm/yr to 0.2 mm/yr, and PG&E (2024) used that uplift rate as a proxy for slip rate on the faults bounding the Irish Hills. If those faults have a strictly reverse sense of slip, then the uplift rate would constrain the slip rate, and the slip rate would be low. However, if there is substantial lateral slip, the slip rate could be much higher than the uplift rate. Preliminary data from offshore studies (Watt, et al., 2015) show that the offshore Los Osos fault is a broad zone that includes vertical faults and flower structures, indicating a strike-slip fault geometry rather than the hypothesized reverse fault geometry. If the Los Osos fault is a strike slip fault (dominated by lateral motion), then the slip rate is not constrained by the uplift rate for marine terraces on the Irish Hills and may be much greater than currently considered in the seismic hazard model. Therefore, resolving the geometry and sense of slip on the faults bounding the Irish Hills is important for the understanding of slip rate and characterization of the seismic hazard in the Irish Hills and the DCP. The use of uplift rate as a proxy for fault slip rate could substantially underestimate the hazard posed by the Irish Hills faults.

It is our opinion that additional characterization of the Los Osos fault and the South Boundary Fault Zone is warranted to resolve the fault geometries and to better characterize the slip rates of those faults. Based on the demonstrated success of offshore seismic reflection methods, specifically at the CHS site along the Hosgri fault, the IPRP (2024) recommended offshore investigation of the faults that bound the Irish Hills. More detailed offshore investigation using low-energy seismic reflection methods may provide a better understanding of fault geometries and could identify offset features, such as paleo-shorelines, that could improve slip rate estimates for these faults. The Los Osos fault seems particularly promising, based on the results of initial studies (Watt, et al., 2015). Also, re-processing of older, high-energy seismic reflection data for the offshore Los Osos fault area may provide a deeper view of fault geometry. In addition, focused subsurface investigation onshore could also help to characterize the faults that bound the Irish Hills.

During 2025, the Diablo Canyon Independent Safety Committee (DCISC) convened a panel of three experts to review specific aspects of seismic hazard at the DCP and respond to an alternate seismic hazard model proposed by Dr. Peter Bird. This panel, known as the Seismic Review Team (SRT), are professors with strong expertise in three specific subdisciplines within the field of tectonics. The SRT issued a report on May 30, 2025 and made a presentation to the DCISC during June 2025. The structural geologist in the SRT, Dr. Michael Oskin, proposed a geologic model for the Irish Hills that accounts for the observed block-like vertical uplift without warping of the 120 ka marine terrace across most of the width of the Irish Hills, except at the SWBZ. That geologic model also accounts for the

dip of the SWBZ (38° NE, averaged from various field exposures) as well as the folding of Obispo Formation strata to form the Pismo Syncline in the center of the Irish Hills. Based on data from uplift of the 120 ka marine terrace, Dr. Oskin calculated an uplift rate of 0.18 ± 0.03 mm/yr for the Irish Hills. With that uplift rate and a fault dip of 38°, Dr. Oskin calculated a slip rate for the SWBZ of 0.29 ± 0.07 mm/yr over the past 120,000 years. Based on 2.6 ± 0.3 km of fault slip needed to explain folding of the Pismo syncline in the center of the Irish Hills over the past 5.1 Million years, he calculated a long-term slip rate of $2.6 \text{ km} / 5.1 \text{ Mya} = 0.5 \pm 0.1$ mm/yr. The tectonic model proposed by the SRT emphasizes active SWBZ thrust faulting rather than high-angle reverse faulting, and it discards the NE and OV models. The proposed model involves a ramp and flat geometry for the SWBZ with the fault system deepening to the northeast and possibly extending as far northeast as beneath the Santa Lucia Range. A ramp and flat geometry is typical of fold and thrust belts, so application of such a model is certainly possible. With the proposed model, the Los Osos fault becomes “the Los Osos trend” which could simply be a fold hinge along which minor faults accommodate folding, though Dr. Oskin also leaves open the possibility that the Los Osos fault could be a strike slip fault. The SRT recommends additional investigation of the SWBZ fault and the Los Osos fault to further evaluate the proposed model. The SRT further recommends development of kinematically constrained structural geologic models that explain the fault slip necessary for folding in the Irish Hills and improved dating of marine terraces and a nearby offshore low stand abrasion platform to improve understanding of slip rates. It is our opinion that the recommended additional investigation is warranted.

In response to criticisms from the IPRP (2024), PG&E (2025) stated that “the SSHAC process accounts for model uncertainties, such as those in the fault geometry models. Despite uncertainties in the geometry models, coastal terraces provide a strong constraint on uplift rates and are extremely useful for calculating seismic hazard. Sensitivity analysis in the 2015 report indicates that fault geometry is not a hazard significant source of uncertainty”. As explained above, the vertical uplift rate for the Irish Hills may not fully capture the slip on the Irish Hills faults. Uplift rate does not constrain lateral slip. It is not sufficient to assume a reverse fault geometry and sense of slip, given the indications of possible strike slip geometry for the offshore Los Osos fault. Also, if the SWBZ has a thrust fault geometry (<45° dip), we would expect a larger component of horizontal slip than with a high angle reverse fault. Therefore, additional investigation is needed to better characterize the faults bounding the Irish Hills and the slip rates for those faults. The marine terrace uplift rate may not be a suitable proxy for slip rate of Irish Hills faults.

PG&E (2025) indicate that “Between 2023 and 2024, PG&E sponsored the USGS assessing whether new techniques, including absolute age dating methods, thermochronology, basin wide erosion rates, and geomorphic indices could help inform fault geometries, deformation models and rates for faults beneath and around the Irish Hills. This work is ongoing.” We appreciate PG&E’s sponsorship of USGS research, and we have discussed the objectives of the ongoing efforts toward a landscape evolution model for the Irish Hills with Devin McPhillips of the USGS. This effort focuses on uplift history. Dating of marine terraces already provides some constraint on the Irish Hills uplift rate in the western Irish Hills, though a landscape evolution model may improve our understanding of the uplift history of the Irish Hills farther east.

We learned recently that PG&E intends to fund the U.S. Geological Survey to reprocess older offshore seismic reflection data in the vicinity of the Los Osos fault. We agree that this approach could be fruitful for better fault characterization, and we are eager

to see the results of that study. It is also our understanding that the USGS is planning to begin collecting low-energy Chirp sub-bottom profile data over the central coast offshore Santa Maria Basin stretching from approximately Purisima Point at the south end to approximately 1.7 miles south of Cambria at the north end. It is our understanding that the proposed offshore survey will include the Hosgri, Los Osos, Shoreline, Casmalia, and Lion's Head fault zones. We are encouraged to hear about that new effort, and we eagerly await the results of the new offshore studies.

FAULT RUPTURE HAZARD

There are no Quaternary faults mapped within the DCPD site or in the vicinity of reactor Units 1 and 2.⁴ It is our understanding that faults previously identified within the bedrock during excavations for the plant foundations do not offset the overlying Quaternary terrace deposits. Therefore, there is no evidence of late Pleistocene or Holocene reactivation of those faults. We consider the probability of fault rupture hazard to impact the DCPD to be very low.

TSUNAMI HAZARD

The primary concern with tsunami hazard is the potential for tsunami runup to overtop the sea bluff and inundate the marine terrace where the DCPD Units 1 and 2 are located. The pad grade elevation of DCPD Plants 1 and 2 is 87.9 ft (NAVD88), so only an exceptionally high wave runup value would reach those facilities. Other concerns include the potential for damage to the cooling water intake structure resulting from wave impact or lack of water at the intake structure during drawdown prior to runup of the tsunami wave.

In response to the earthquake and tsunami that damaged the Fukushima nuclear power plant in Japan in 2012, PG&E prepared a study to address the potential tsunami hazard at the DCPD site (PG&E, 2015b). That study indicates that the probable maximum tsunami water level at the intake structure is 32.8 ft (NAVD 88) elevation for distant tsunami sources. For a large, local submarine landslide (similar to the offshore Goleta landslide in Santa Barbara County) scenario with a modified breakwater bathymetry, the estimated runup on the steep slope behind the intake structure is 62.3 ft (NAVD88). These tsunami runup values do not appear to threaten Units 1 and 2.

The PG&E (2015b) report also indicates that the erosion control measures currently in place are sufficient to protect the intake structure, given the identified maximum runup. That report provides an estimated maximum drawdown elevation of -15.7 ft and indicates that the current cooling system pump design requires a minimum water level of -17.1 ft.

The U.S. Nuclear Regulatory Commission authorized a consultant, Taylor Engineering, to review the PG&E (2015b) study and evaluate whether that study adequately addressed the tsunami hazard at the DCPD site. The report (Taylor Engineering, 2017) from that study concluded that the maximum tsunami runup near the DCPD Surface Water Intake Structure (SWIS) would be +47.7 ft and maximum drawdown would be -15.1 ft (NAVD88) for a Goleta-type local, large submarine landslide source. For a major subduction zone type earthquake at the Aleutian Arc, the maximum runup near the SWIS was estimated to be

⁴ Fault Activity Map of California: California Geological Survey, <https://maps.conservation.ca.gov/cgs/fam/>; Quaternary Fault and Fold Database of the United States: U.S. Geological Survey, <https://earthquake.usgs.gov/cfusion/qfault>.

+37.6 ft and maximum drawdown was estimated to be -4.3 ft (NAVD88). For tsunami resulting from flank collapse of Kilauea volcano in Hawaii (mobilization of a large, rapidly-moving landslide from the volcano flank into the ocean), Taylor Engineering modeled the tsunami runup near SWIS as +25.9 ft and maximum drawdown of -7.9 ft (NAVD88).

More recently, PG&E retained a consultant, Environmental Resource Management (ERM), to update the Probabilistic Tsunami Hazard Analysis (PTHA) for the DCP (ERM, 2024). The resulting update report consists of a review of the results of previous tsunami hazard assessments for the DCP (PG&E, 2015; Taylor Engineering, 2017) as well as updating of the previous analyses. ERM (2024) found that the previous studies were quite conservative in finding potential tsunami runup ranging from 32.8 ft (NAVD 88) to 47.7 ft (NAVD 88) at the DCP.

It is our understanding that the California Geological Survey (CGS) is currently working on a database of offshore landslides that could potentially generate tsunamis. They intend to re-evaluate both local and distant sources for the next generation PTHA over the next several years. This updated database and PTHA should improve our understanding of tsunami hazard in California.

LANDSLIDE HAZARD

Several areas of landsliding have been identified within the DCP site (PG&E, 2023; PG&E, 2025a). However, none of the mapped landslides directly threaten DCP Units 1 and 2. There are several landslides mapped on the southern slope of Diablo Canyon directly upstream from the Independent Spent Fuel Storage Installation (ISFSI) storage pads area. These landslides do not threaten the ISFSI. They are directly upslope from the DCP electrical substation.

The Patton Cove Landslide is a landslide complex on the coastal bluff at the north end of Patton Cove. The headscarp of the landslide appears to be approximately 30 to 40 feet south of Diablo Ocean Drive, near the intersection with Reservoir Road. PG&E indicates that pavement cracks previously opened in Diablo Ocean Drive and the raw water line for fire suppression separated beneath the roadway following renewed movement in 1996 and 1997. The water line was repaired, and the pavement cracks were covered by resurfacing of the road in 2017 and 2024. PG&E (2023, 2024a) indicates that the resurfaced road will act as a strain gauge that should reveal any additional movement that impacts the road. PG&E should continue to monitor the roadway annually and consider taking steps to protect the road from potential upslope enlargement of the landslide complex. Diablo Ocean Drive is a vital access road for safe and reliable operation of the DCP.

DR PETER BIRD'S CRITIQUE OF THE PSHA

During 2023 and 2024, Dr. Peter Bird, an expert for the group Mothers for Peace, put forward a critique of PG&E's seismic hazard model for DCP. Dr. Bird proposed that a shallowly-dipping (approximately 20° dip) thrust fault beneath the Irish Hills poses a much greater hazard to the DCP than assumed in PG&E's seismic hazard model. He further asserted that the slip rate for that fault ranges from 2.0 mm/yr to 2.8 mm/yr. Though the rate of uplift is much lower than this slip rate implies, Dr. Bird asserts that the rate of crustal thickening beneath the Irish Hills is approximately 6 times greater than the uplift rate determined for the Irish Hills by dating of marine terraces. Dr. Bird also asserts that the M7.5

Noto Peninsula (Japan) earthquake of January 1, 2024 is a good analogue for a major thrust fault earthquake beneath the Irish Hills. Based on these assertions, Dr. Bird concluded that the risk posed by a potential major earthquake on a thrust fault beneath the Irish Hills is unacceptable.

The Seismic Review Team Response To Dr Bird's Critique

The SRT reviewed Dr. Bird's critique of PG&E's seismic hazard model, and they summarized the primary assertions of Dr. Bird's critique as follows:

- 1) PG&E underestimated the seismic hazard posed by a thrust fault under the DCP, because it made four false assumptions. Those assumptions are: (A) The Irish Hills were uplifted as a rigid block without internal deformation, (B) active thrust faults may dip at any angle, (C) Geologic Structures older than 0.33 Ma are irrelevant to the seismic hazard assessment for the DCP, and (D) GPS velocities for the Irish Hills are not relevant to site-specific hazard estimation.
- 2) Three different analytic methods give values of total slip on shallowly-dipping thrust faults under the Irish Hills in the range of 2.0 – 2.8 mm/yr. Those methods include isostatic calculations that yield an uplift rate of 2.8 mm/yr, thrust fault heave rate of approximately 2 mm/yr, and geodetic shortening rate of 2.2 mm/yr.
- 3) The January 1, 2024 (M 7.5) Noto Peninsula earthquake is a good analog for a major thrust fault earthquake beneath the Irish Hills.
- 4) The recurrence interval for a Noto Peninsula-type earthquake beneath the Irish Hills is 715-1000 years. This relatively short recurrence interval for an earthquake of this magnitude beneath the DCP poses a significant risk that is deemed to be unsafe.

The SRT (2025) evaluation and response to the four primary assertions of the Bird Critique are as follows:

- 1) The SRT found that removing the four false assumptions made for the PG&E seismic hazard assessment would have little or no effect on seismic hazard calculations.
- 2) The SRT asserted that Dr. Bird's slip rate estimates are not supported by the available data. Dr. Bird's slip rate for a blind thrust fault beneath the Irish Hills is 2 to 2.8 mm/yr. This comes from his assertion that active thrust faulting must explain not only 0.2 mm/yr of uplift but also a crustal thickening rate approximately 6 times larger than the uplift rate. However, the SRT points out that this assertion assumes an Airy isostasy model where local topographic relief is balanced by downward deflection of the base of the earth's crust (known as the Mohorovicic discontinuity, often abbreviated as the Moho). The SRT counters that the Airy isostatic model applies for larger regions and not local topography such as the Irish Hills. The flexural rigidity of the earth's lithosphere allows for spreading out the load over a larger area than the Irish Hills and reduces Moho depression.

Dr. Bird calculates a slip rate for a thrust fault under the Irish Hills using the following calculation: $0.2 \text{ mm/yr.} \times 6 / \text{SIN } 25^\circ = 2.8 \text{ mm/yr.}$ The SRT points out that the calculations change using the average dip of the SWBZ (averaged from exposures of the fault on the south flank of the Irish Hills), a more precise uplift rate of $0.18 \pm 0.03 \text{ mm/yr.}$ and no deflection of the Moho. Using those parameters, the slip rate

calculation becomes: 0.18 ± 0.03 mm/yr. $\times \text{SIN } 38^\circ \pm 3^\circ = 0.29 \pm 0.07$ mm/yr. The SWBZ is similar in location to Dr. Bird's hypothetical blind thrust fault beneath the Irish Hills, except that the SWBZ is exposed at the ground surface (not blind), and the slip rate is much lower than calculated by Dr. Bird.

- 3) The January 1, 2024 M7.5 Noto Earthquake is not a good analogue for a large thrust event beneath the Irish Hills. The SRT points out that there are significant tectonic differences between the Noto Peninsula in Japan and the Irish Hills. The Hills/SLPB. Large earthquakes (>M6) are more common in the historical record for the Noto Peninsula than the Irish Hills. At the Noto Peninsula, tectonic deformation is primarily compressional. At the Irish Hills, tectonic deformation includes both lateral shear and compression. The length of the Noto Peninsula fault is roughly twice the length of the SWBZ; this is significant, because fault length correlates roughly to maximum earthquake magnitude. Also, the asymmetric tilting of the Noto Peninsula is very different from the more symmetric uplift of the Irish Hills.
- 4) The SRT found that the recurrence interval for a Noto-type earthquake does not apply to thrust faulting beneath the Irish Hills. Though it is very unlikely that a Noto-type earthquake would occur in the Irish Hills, the SRT asserts that if a Noto-type earthquake model were applied to the Irish Hills, the recurrence interval would be approximately 20 to 30 times longer than the 715 to 1000 years calculated by Dr. Bird. The SRT used the Noto Peninsula uplift rate and calculated the recurrence interval for an event with slip similar to the January 1, 2024 Noto Earthquake. They then applied the uplift rate for the Irish Hills to calculate a recurrence interval for a similar event on the SWBZ fault. The calculations show that if a characteristic earthquake model is applied, the recurrence interval for the Noto Peninsula is 3,000 to 4,290 years, and the recurrence interval is 12,500 to 25,000 years for the Irish Hills. Applying a Gutenberg-Richter model, the recurrence interval for the Noto Peninsula is 4,000 to 5,700 years, and the recurrence interval for the Irish Hills is 16,700 to 33,300 years. Thus, even if a Noto-type event were considered plausible, the recurrence interval for such an event would be very long. This demonstrates a much lower hazard at the Irish Hills than Dr. Bird would assert.

The SRT (2025) concluded that Dr. Bird's critique of the PG&E seismic hazard model lacks merit. They also provided some original insights into potential geological and geophysical models for the Irish Hills, and they made several suggestions for further investigation and improvements to the seismic hazard model. As stated earlier, they recommended additional investigation of the SWBZ fault and the Los Osos fault to further evaluate the proposed model. They also recommend development of kinematically constrained structural geologic models that explain the fault slip necessary for folding in the Irish Hills and improved dating of marine terraces and a nearby offshore low stand abrasion platform to improve understanding of slip rates.

CONCLUSIONS

Though there are several geologic hazards worth considering in our evaluation of the safety and reliability of the DCP, the most significant is seismic ground shaking. For that reason, it is important to update the PSHA with the best available data regarding nearby seismic sources. Much debate over seismic source characterization focuses on the slip rates that apply for faults near the DCP.

For the Hosgri fault, the quality of slip rate data from the CHS site is higher than the data from any other slip rate site near the DCP. The recent study of the offshore Point Sal site (Nishenko, et al., 2025) provides additional slip rate data of moderate quality. The data quality problems and large uncertainties associated with the Estero Bay and San Simeon slip rate sites make these sites only useful as background information and are not suitable for inclusion in the PSHA. Therefore, we suggest that PG&E give the CHS slip rate (2.6 mm/yr) 80% weight and the average of the new slip rate data from the offshore Point Sal site (2.21 mm/yr) 20% weight in the Hosgri fault seismic hazard model.

The fault geometry and sense of slip for faults surrounding the Irish Hills remains unresolved in the current seismic hazard model. PG&E (2024) indicates that the slip rate for these faults is relatively low based on the uplift rate for marine terraces in the Irish Hills. However, the uplift rate does not constrain the rate of lateral slip on the bounding faults. Given that offshore data for the Los Osos fault indicates possible evidence of strike slip faulting, the assumption that the bounding faults have a purely reverse fault geometry may lead to significant underestimation of the slip rate for that fault. Therefore, we recommend additional investigation of the faults that bound the Irish Hills to evaluate fault geometry, sense of slip, and slip rate. Revisiting the offshore Los Osos fault to potentially identify fault geometries, offsets, and potential slip rate sites may prove fruitful as a first target of investigation. Both re-processing of existing offshore seismic data and acquisition of new Chirp seismic reflection profiling may yield useful results. Additional investigation focused on the SRT model for the SWBZ fault system also seems warranted. PG&E should carefully consider the detailed recommendations listed in the SRT (2025) report. It is our opinion that the additional investigation recommended by the SRT is warranted. PG&E should update the PSHA for the DCP based on new data from the recommended additional investigations.

PG&E should understand that additional investigation using both offshore and on-land geologic investigation is essential to answer questions regarding DCP seismic hazard. Additional sensitivity analyses based on assumptions rather than new field data are of only very limited use, and would not be sufficient to resolve the significant scientific questions summarized in this memorandum. Improvements to the Hosgri fault slip rate using higher weighting of high-quality data and removal of low-quality data is essential for improving the PSHA. Similarly, slip rates for the faults bounding the Irish Hills cannot rely solely on the Irish Hills uplift rate, if lateral slip is indicated. Additional investigation to determine a rate of lateral slip for the Los Osos fault is necessary to improve the PSHA. Additional investigation of the SWBZ fault, specifically focusing on fault geometry and slip rate, also appears warranted.

Based on the available mapping of Quaternary faults, the potential for fault rupture hazard to impact the DCP site is very low. Faults encountered within the bedrock at or near the ground surface do not appear to be active.

Based on our review of the available tsunami hazard reports for the DCP site, we conclude that the probability of tsunami runup reaching the elevation of DCP Units 1 and 2 within the design life of the structures is low. Similarly, the probability of drawdown going below the elevation of the SWIS intake structure appears to be low.

Though PG&E previously recognized several landslides within the DCP site, none of those landslides would directly impact DCP Units 1 and 2 or the Independent Spent Fuel Storage Installation (ISFSI). PG&E should continue to monitor the landslides on the site and

take action as needed to protect the site facilities and access roads. PG&E should consider taking proactive measures to protect Diablo Ocean Drive from potential upslope enlargement of the Patton Cove Landslide.

We have reviewed the critique of the Diablo Canyon PSHA offered by Dr. Peter Bird. Though we agree that the SWBZ fault system may be more accurately understood as a northeast-dipping thrust fault system than PG&E's model of a more steeply-dipping reverse fault, we do not agree with the slip rate estimate and crustal thickening hypothesis offered by Dr. Bird. It appears that the fault dip, uplift rate, and SWBZ slip rate estimates offered by the SRT are more realistic. Also, we do not agree that the M7.5 Noto Peninsula Earthquake is a good analogue for earthquakes in the Irish Hills. The seismotectonic setting, recurrence interval, and fault length at the Noto Peninsula are much different than for the faults bounding the Irish Hills. Though it is our opinion that significant improvements to characterization of the seismic hazard at the DCPD are needed, we do not agree with Dr. Bird's critique of the PSHA. We have concluded that PG&E should develop new data and update geologic models to improve the PSHA, but the dire assessment of the seismic hazard at the DCPD offered by Dr. Bird does not appear to be supported by the available data.



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