8.14. Paleontological Resources

Paleontological resources are fossils, the remains of prehistoric plants and animals, that are important scientific and educational resources because of their usefulness in (1) documenting the presence and evolutionary history of particular groups of extinct and extant organisms; (2) reconstructing the environments in which these organisms lived; and (3) determining the relative ages of the strata in which they occur and the geologic events that resulted in the deposition of the sediments that formed these strata. This section summarizes the assessment of potential impacts on paleontological resources that may result from construction of the Power Plant Replacement Project (PPRP, or the Project). As is normally the case with power generation facilities, no impacts to paleontological resources will occur from the operation of this facility. Prior paleontological resources assessments in the San Francisco Bay Area, a paleontological resources records review, and geological and paleontological studies in physiographically similar settings are the primary basis for this assessment.

8.14.1 Introduction

Chevron is proposing the PPRP to add an additional 60 megawatts (MW) net generation to its existing Refinery electrical generation located within Chevron's Richmond Refinery in the City of Richmond (see Figure 1.2-1) in Contra Costa County, California. The proposed PPRP will be integrated into Chevron's plans to meet its growing Refinery electrical load, and produce steam to replace an existing boiler plant that is approaching its end of life. The PPRP is a subset of the larger Richmond Refinery Renewal Project that is concurrently undergoing California Environmental Quality Act (CEQA) review by the City of Richmond. The California Energy Commission (CEC) has jurisdiction for only the PPRP portion of the Renewal Project that is the subject of this application.

The PPRP will consist of the following components:

- A nominal 43-MW net, natural gas- or liquid petroleum gas (butane)-fired cogeneration train consisting of one combustion turbine generator (CTG), a refinery fuel gas-fired heat recovery steam generator, 13.8-kV switchgear and ancillary equipment.
- Shutdown of the existing No. 1 power plant refinery steam boilers currently providing steam to the Refinery.
- A 17-MW net extraction, condensing steam turbine generator (STG), an associated cooling tower, and 12-kV switchgear installed as part of the new hydrogen production facility (the remainder of the hydrogen plant is under CEQA review as part of the Renewal Project). The new hydrogen plant will be a net generator of steam for both the STG and the Refinery steam system.
- Reconductoring of approximately 4,000 feet of existing onsite double-circuit overhead 115-kV transmission line to upgrade its ampacity. The reconductoring will reuse existing transmission line structures.

- Adjacent onsite service connections for fuel, reclaimed water, water, wastewater, steam, and electricity to existing piperacks, with the exception of the reconductoring noted above.

The Cogen 3000 portion of the PPRP will occupy approximately 0.5 acre within an existing 5.2-acre cogeneration facility, and the STG and associated equipment (H_2-STG) will occupy approximately 0.5 acre within a new 7.9-acre hydrogen plant that will be built as part of the Richmond Refinery Renewal Project. The PPRP will be located well within the heart of the existing 2,900-acre Richmond Refinery. Temporary construction laydown and parking for the PPRP will be provided in various existing laydown areas within the Refinery that are currently used for ongoing maintenance and project laydown. A complete description of the PPRP is provided in Section 2.0.

8.14.2 Laws, Ordinances, Regulations, and Standards

Paleontological resources are non-renewable scientific and educational resources protected by several federal and state statutes (California Office of Historic Preservation, 1983; see also Marshall, 1976; West, 1991; Fisk and Spencer, 1994; and Gastaldo, 1999), most notably by the 1906 Federal Antiquities Act and by the State of California's environmental regulations under CEQA (Section 15064.5).

Professional guidelines for the assessment and mitigation of impacts to paleontological resources have been disseminated by the Society of Vertebrate Paleontology (SVP, 1995 and 1996). These guidelines are followed by most professional paleontologists engaged in paleontological resources management and mitigation. Design and construction of this facility will be conducted in accordance with all laws, ordinances, regulations, and standards (LORS) applicable to paleontological resources. Federal and state LORS applicable to paleontological resources are summarized in Table 8.14-1 and discussed briefly below, along with relevant professional guidelines.

TABLE 8.14-1
Federal and State Laws, Ordinances, Regulations, and Standards Applicable to Paleontological Resources

LORS	Applicability	Project Conformity
Federal Antiquities Act of 1906	Protects paleontological resources on federal lands	Yes
CEQA, Appendix G	Requires that impacts to paleontological resources be assessed and mitigated on all discretionary projects, public and private	Yes
California Public Resources Code Chapter 1.7, Section 5097.5 (Stats.1965, c. 1136, p.2792)	Defines any unauthorized disturbance or removal of a fossil site or fossil remains on public land as a misdemeanor and specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources	Yes

8.14.2.1 Federal LORS

Federal protection for significant paleontological resources would only apply to this Project if any construction or other related Project impacts occur on federally owned or federally

managed lands, or if a federal entitlement would be required. Federal legislative protection for paleontological resources stems primarily from the Antiquities Act of 1906 (PL 59-209; 16 U.S.C. 431 et seq.; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. Since the Project site and its linear features (which are all located on the Richmond Refinery site) do not impact federally owned or managed land, federal LORS do not apply to this Project.

8.14.2.2 State LORS

The CEC environmental review process under the Warren-Alquist Act is considered functionally equivalent to that of CEQA (Public Resources Code Sections 21000 et seq.). CEQA requires that public agencies and private interests identify the potential environmental consequences of their proposed projects on any object or site of significance to the scientific annals of California (Division I, California Public Resources Code Section 5020.1 [b]). Guidelines for the Implementation of CEQA (Public Resources Code Sections 15000 et seq.) define procedures, types of activities, persons, and public agencies required to comply with CEQA. Appendix G in Section 15023 provides an Environmental Checklist of questions that a lead agency should address if relevant to a project's environmental impacts. One of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section V, Part c) is the following: "Would the project directly or indirectly destroy a unique paleontological resource or site…?"

Although CEQA does not define what is "a unique paleontological resource or site," Section 21083.2 defines "unique archaeological resources" as "…any archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

> [It] contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
>
> It has a special and particular quality such as being the oldest of its type or the best available example of its type.
>
> [It] is directly associated with a scientifically recognized important prehistoric or historic event."

This definition of "unique archaeological resources" is also applicable to recognizing "a unique paleontological resource or site." Additional guidance is provided in CEQA Section 15064.5 (a)(3)(D), which indicates "generally, a resource shall be considered historically significant if it has yielded, or may be likely to yield, information important in prehistory or history."

Section XVII, Part a, of the CEQA Environmental Checklist asks a second question applicable to paleontological resources: "Does the project have the potential to eliminate important examples of the major periods of California history or pre-history?" Fossils are important examples of the major periods of California prehistory. To be in compliance with CEQA, environmental impact assessments, statements, and reports must answer both these questions in the Environmental Checklist. If the answer to either question is *yes* or *possibly*, a

mitigation and monitoring plan should be designed and implemented to protect significant paleontological resources.

The CEQA lead agency having jurisdiction over a project is responsible for ensuring that paleontological resources are protected in compliance with CEQA and other applicable statutes. The lead agency with the responsibility to ensure that fossils are protected during construction of the Project is the CEC. California Public Resources Code Section 21081.6, entitled Mitigation Monitoring Compliance and Reporting, requires that the CEQA lead agency demonstrate project compliance with mitigation measures developed during the environmental impact review process.

Other state requirements for paleontological resource management are in California Public Resources Code Chapter 1.7, Section 5097.5 (Stats. 1965, c. 1136, p. 2792), entitled Archaeological, Paleontological, and Historical Sites. This statute defines any unauthorized disturbance or removal of a fossil site or fossil remains on public land as a misdemeanor and specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources. This statute does not apply to the PPRP since construction or other related impacts would not occur on publicly owned or managed lands.

8.14.2.3 City LORS

California Planning and Zoning Law requires each city jurisdiction to adopt a comprehensive, long-term general plan for its development. The general plan is a policy document designed to give long-range guidance to those making decisions affecting the future character of the planning area. It represents the official statement of the community's physical development as well as its environmental goals. The general plan also acts to clarify and articulate the relationship and intentions of local government to the rights and expectations of the general public, property owners, and prospective investors. Through its general plan, the local jurisdiction can inform these groups of its goals, policies, and development standards, thereby communicating what must be done to meet the objectives of the general plan.

The general plan for the City of Richmond (1994) contains no specific requirements, regulations, ordinances, conditions, standards, goals, or objectives designed to mitigate the negative impacts of development on paleontological resources.

8.14.3 Setting

San Pablo Bay is essentially a northern extension of San Francisco Bay and is the marine embayment occupying the structural trough in the central Coast Ranges immediately north of that occupied by San Francisco Bay. Like the Berkeley Hills to the east, San Pablo Point is a northwest-oriented ridge representing a western portion of the Coast Ranges Physiographic Province (Fenneman, 1931; Jahns, 1954). The Great Valley Physiographic Province is to the east and the Pacific Ocean is to the west.

The general Project area is located east of San Pablo Ridge (Figure 8.14-1), occupying the western periphery of a broad and level expanse of artificial fill, Quaternary alluvium, and estuarine sediment between the ridge on the west and the alluvial fan of the northern Berkeley Hills. The toe of the northern Berkley Hills lies about two miles to the east of the

Project site (Graymer et al., 1994). The site is entirely on historic fill used to "reclaim" this area from the Wildcat Creek estuary.

Land use in the vicinity of the Project site is industrial. To the east beyond the limits of the Refinery is an estuarine area[1] composed of a mosaic of cattail marsh and open water areas. The cogeneration unit's transmission line traverses this estuarine area[2]. The laydown areas for the Project are located within the Refinery proper. These areas are currently used by the Refinery as staging/laydown areas, so no new disturbances are expected. To the immediate west, the east flank of San Pablo Ridge rises rather abruptly as a northwest-southeast oriented hill. The site lies in the western portion of what was once a relatively large estuary that lay at the mouths of Wildcat and San Pablo Creeks, opening to San Pablo Bay to the north (Figure 8.14-1). Regarding the two principal components of the Project, the hydrogen generation facility is located approximately 232 feet east of the east flank of San Pablo Ridge, and the cogeneration facility is located about 970 feet east-northeast of the foot of the hill.

Maps of historic creek and estuarine habitats show that, in the vicinity of the Wildcat and San Pablo Creek drainages and the Project area, the historic topography descended rather steeply to near sea level. This is a pattern repeated throughout the Bay Area that frequently restricted the extent of commercial and industrial acreage originally available in the area. A great deal of artificial fill was dumped in many low-lying areas to extend the areas available to development in vicinity of the shore. The nearly-level ground that now extends east from the margin of the topographic highs of San Pablo Ridge to the Project area is artificial and composed entirely of historic fill used to build up the land of the estuarine marsh that originally lay immediately to the east of San Pablo Ridge
(Oakland Museum of California, n.d.).

8.14.4 Resource Inventory

The resource inventory addressing paleontological sensitivity of the Project site includes a consideration of the geological units that may yield fossils, the known records of fossil sites in the vicinity, and a field reconnaissance of the Project area.

The PPRP site and vicinity is thoroughly developed, with fill, concrete, asphalt, refining facilities and buildings covering the entire surface area. No rock outcrops or exposures of undisturbed sediments occur within the area potentially affected by Project construction. Due to the lack of geological exposures as a consequence of the industrialized nature of the Project area, and because the Projects are sited on artificial fill, no paleontological resources field survey was warranted. A field reconnaissance of the Project site, including the Hydrogen plant and the Cogeneration plant, was conducted in November 2006.

Rocks and sediments in the general vicinity can be divided into three distinct geological domains. The first and by far the oldest is bedrock composed of Mesozoic age (Jurassic and Cretaceous; older than 65 million years [my]) low-grade metamorphosed sediments named the Franciscan Complex. The Franciscan Complex forms the bedrock "basement"

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[1] This estuarine area is part of the Refinery's wastewater treatment system called the Aggressive Biological Treatment Area or Bioreactor for short.

[2] The cogeneration unit's electrical interconnection will use existing transmission line facilities which will require reconductoring only. No additional transmission line towers will be required for the cogen unit's interconnection to the Standard Oil Switching Station.

throughout the Bay Area. Sediments resting unconformably on the Franciscan Complex constitute the second major grouping. These are much younger sedimentary and volcanic rocks of Tertiary age that originated in different depositional basins as well as at different times and were subsequently folded and forced together along this tectonically active continental margin (Graymer et al., 1994). The third domain is represented by unconsolidated to poorly consolidated Quaternary (Pleistocene and Holocene) deposits. Formal names have been applied to Quaternary sedimentary sequences by some authors (see for instance Lawson, 1914). However, many geologists working in the San Francisco Bay Area have used informal designations, such as "old bay mud," "sand deposits," and "young bay mud." A summary of Quaternary stratigraphic nomenclature and age assignments based on studies throughout the Bay Area is presented in Table 8.14-2, and the data show that there is a general lack of agreement both on the nomenclature and on the age of different stratigraphic units in the Bay Area. The details of the Quaternary geology of the area are debated due to a number of factors, not the least being structural and stratigraphic complexity and a lack of exposures for study. Many Quaternary deposits in the area have limited local exposure and are discontinuous, and their relationships cannot be determined by tracing their lateral continuity due to that lack of exposure. It is evident from Table 8.14-2 that the statement of Savage (1951) applies more than a half-century later: "Many stratigraphic problems still exist in this area despite the fact that these problems have at times received the attention of competent geologists and paleontologists." New excavations in undisturbed sediment therefore can potentially yield important new geologic information or new fossils that could provide a more complete and accurate understanding of both the geological and biological history of the area.

Despite the apparent discrepancies, there is some consensus in these studies as well (Table 8.14-2). The major points of consensus, and therefore reliable aspects of the stratigraphic framework of the study area, include the following:

- The Franciscan Complex and related rocks, such as the Coast Range ophiolite, form the basement rock throughout this area. These are of Mesozoic age (Jurassic and Cretaceous; about 200 to 65 million years ago [mya]) and usually display some degree of metamorphic alteration.
- A pronounced interval separates Franciscan Complex and related rocks from overlying sediments, representing a hiatus of 40 my or more.
- The oldest sediments resting on the Franciscan Complex recognized thus far in the northern Berkeley Hills area (including San Pablo Ridge; Assemblage I of Graymer et al. [1994]) are middle to late Miocene age (about 12 to 9 mya). These are assigned to the Orinda and Moraga Formations and are frequently included in a larger sequence named the Contra Costa Group.
- Deposition of fossiliferous sediments in the Bay Area during the Quaternary was strongly affected by glacio-eustatic changes in sea level as well as by tectonism.

TABLE 8.14-2
Stratigraphic Nomenclature and Age Assignments for Quaternary Stratigraphic Units in the Project Area

Epoch	Glacial Age/ Marine Isotope Stage		Jones and Stokes, 2004	Trask & Rolston, 1951	Sloan, 1992		URS, 2001*	RWQCB, 2004	Clifton and Leithold, 1991
Holocene	Current Interglacial	Mid to Late Stage 1	n.d.	Bay Mud	n.d.		Young Bay Mud	Artificial fill	n.d.
								? *hiatus* ?	
		Latest Stage 2 to Stage 1	Young Bay Mud					Temescal Formation	
Late Pleistocene	Wisconsin Glacial Age (Stages 4-2)		San Antonio Fm	Posey Sand & Merritt Fm	San Antonio Fm.	n.d.	Upper Alluvial/Marine Sediments or San Antonio Fm	Alameda Formation	
	Last Interglacial (Stage 5)		Old Bay Mud	San Antonio Formation		Yerba Buena mud	Old Bay Mud or Yerba Buena Fm.		Colma Formation
Early to Middle Pleistocene	Previous glacial-interglacial cycles		? *hiatus* ?	Alameda Formation	n.d.		Lower Alluvial/ Marine Sediments (Alameda Fm)- marine facies	? *hiatus* ?	Merced Formation
			Alameda Fm (1.0 to 0.5 my)					Santa Clara Formation	
			hiatus				Lower Alluvial/ Marine Sediments (Alameda Fm)- continental facies		

Notes:
n.d. = not described.
Dashed lines are used to designate gradational boundaries.
"Hiatus" is gap in sequence due to erosion or non-deposition.
* Stratigraphic superposition, geology and nomenclature described, but no age assignments provided for most units.

- Low sea level during glacial ages is often represented by alluvial or fluvial gravels and sands while marine transgressions following sea-level rises during interglaciations are represented by bay and estuarine muds. There have been at least a half-dozen glacial-interglacial cycles in the past 0.7 my.
- In many areas on the shores of San Francisco and San Pablo Bays, including the present study area, estuarine sediments are overlain by artificial fill dumped into estuaries in the late 19th and early 20th centuries to expand developable acreage.

8.14.4.1 Paleontological Potential In The Project Vicinity

The geological units with the potential of occurring at the site of PPRP construction are discussed below as well as paleontological records relevant to their potential to yield additional, scientifically significant fossils. These are presented from oldest to youngest, and include all rock units within 3 miles of the Project vicinity mapped by Graymer et al. (1994), considered to be the local study area for this assessment.

Mesozoic Rocks—The Franciscan Complex, Coast Range Ophiolite, Undifferentiated Serpentine and Keratophyre. The Franciscan Complex is melange of rock units that were variably deformed and metamorphosed in a subduction zone at the western edge of the North American Plate (Hamilton, 1969; Page, 1981; Wakabayashi, 1992). Franciscan lithologies are predominantly meta-sedimentary rocks with subordinate volcanic rocks that are believed to represent trench fill and volcanic islands, respectively. In the Project area they include greenstone, sandstone, greywacke, and shale. San Pablo Ridge itself, immediately to the west of the Project area, is mapped as hard greywacke and shale (Graymer et al., 1994).

Franciscan rocks can be expected below artificial fill and Quaternary-age sediment at the Project site. Weathered sandstone bedrock representing Franciscan Complex sediment has been encountered at depths of 125 to 160 feet beneath the eastern portion of the Cogeneration plant site, and fractured shale was encountered at a depth of about 100 feet farther west and closer to San Pablo Ridge (URS, 2006a). As noted in section 8.14.3, the Hydrogen plant site is closer to the ridge and therefore Franciscan Complex rocks are expected at shallower depth, which indeed is the case. Sandstone occurs between 40 and 60 feet below the surface in some areas, and generally 90 to 140 feet below the surface elsewhere (URS, 2006b).

Fossils from Franciscan Complex rocks have been very important in unraveling the ages, depositional environments, and tectonic history of the continental margin during the Mesozoic. Based primarily on fossil evidence, rocks in the sequence have been dated as Jurassic, Cretaceous, and (rarely) early Tertiary. Although uncommon, low-grade metamorphic rocks of the Franciscan Complex have produced significant fossils at numerous localities in the past. Schlocker et al. (1958) reported a Cretaceous ammonite found in shales of the Alcatraz Terrane in northeastern San Francisco. Schlocker (1974) also referred to fossil plant remains in Franciscan rocks, although usually with such terms as "carbonaceous matter," "lignitic material," "large carbonaceous particles and layers," "large abundant paper-thin flakes of coaly material…," or "carbon having relict plant-cell structures." Other fossils reported from the Franciscan Complex range from those of the large marine reptilian piscivore, the ichthyosaur, to microfossils which frequently provide clearer indication of the age of a unit than do the vertebrate fossils. Radiolarian chert beds in

the Franciscan Complex produce microfossils (including radiolarians) important as biostratigraphic markers. Schlocker (1974) wrote: "In some chert beds fossils are so crowded that they touch each other." Limestone nodules and concretions in Franciscan shales often also contain abundant radiolaria (Schlocker, 1974). Fossil foraminifera have also been reported from Franciscan limestone (Kupper, 1956). Fossil gastropods (snails) and pelecypods (clams) have been reported from a locality on Alcatraz Island and elsewhere by Stewart (1930), Anderson (1938), and Ghent (1963). Plant microfossils (pollen and spores) and dinoflagellates have been reported in Franciscan shales (Evitt and Pierce, 1975; Damassa, 1979a and 1979b; Blake et al., 1984), and were instrumental in determining that some rocks included in the Franciscan Complex north of Cape Mendocino are as young as early Tertiary.

Other Mesozoic rocks within three miles of the Project site include the Coast Range Ophiolite, as well as keratophyre and serpentine/serpentinite. These are all igneous or metamorphosed igneous rock types and, due to their igneous origin they possess no paleontological potential and will not be addressed further in this assessment.

Middle Tertiary Sediments of the Contra Costa Group. Approximately 3 miles northeast of the Project area is the most pronounced geological feature in the vicinity, the Hayward Fault. To the east of the Hayward Fault Zone the terrain rises abruptly forming the Berkeley Hills, which extend from San Pablo Bay southeast for more than 40 miles forming the eastern margin of the Bay Area. The sediments exposed at and east of the Hayward Fault are often assigned to the Contra Costa Group, and in this area they are mapped by Graymer and others (1994) as the Orinda Formation, which comprises one unit of the Contra Costa Group.

The Orinda Formation is a terrestrial (although in some cases near to the shore) sedimentary sequence consisting of fluvial conglomerates, as well as sandstone, mudstone, and siltstone facies. Its upper age limit is constrained by radiometric dating of the overlying Moraga volcanics, reported by Tedford and others (2004) to date to about 10.3 mya. The Orinda Formation and the Contra Costa Group (undifferentiated) are fossiliferous, and the UCMP database includes entries for the following vertebrates from these Miocene deposits:

- *Gomphotherium* (primitive elephantid)
- *Hipparion, Nannipus,* and *Pliohippus* (primitive horses)
- *Barbourofelis* (a member of the primitive cat family Nimravidae)
- *Cranioceras* (deer-like artiodactyl)
- *Ticholeptus* (an oreodont; an extinct group of pig-like grazing animals)
- *Desmostylus* (an extinct sea-cow morphologically similar to hippopotami)

Tedford and others (2004) assign most of the Orinda Formation vertebrate material to the middle Clarendonian Land Mammal Age (LMA), or about 11 to 12 mya.

Based on the geological relationships illustrated by Graymer and others (1994) it is doubtful that Tertiary-age rocks of the Contra Costa Group, such as the Orinda Formation, range to the west of the Hayward Fault Zone (Figure 8.14-1) and occur at accessible depth in the Project area.

Quaternary Sediments. The oldest Quaternary sediments in the San Francisco Bay Area include those assigned to the San Antonio, Alameda, and Santa Clara Formations

(Table 8.14-2). They also include the Irvington Gravel and other older alluvial units uplifted by tectonic activity along the Hayward Fault. As noted above, due to repeated lowering and raising of the sea level and tectonic displacement in a very seismically active area, facies relationships among these sedimentary units are complex. Any one unit can be expected to have facies that record terrestrial, estuarine, and marine conditions during one time period. Moreover, many low areas on (and in) the San Francisco and San Pablo Bays have alternated between submerged and dry land in response to glacially controlled fluctuations of sea level. Depending on whether they were deposited during a high or low sea level stand, sediments can reflect environments varying from estuarine and intertidal mud flats, to swamps, streams and alluvial hill slopes of a terrestrial setting.

Early to Middle Quaternary age (1.7 to 0.13 mya) sediments are likely to lie at depth beneath the Project site because the current site lies above a topographic low representing the historic estuarine marsh of San Pablo and Wildcat Creeks (Oakland Museum, n.d.). As far as Late Quaternary (0.13 mya to present) sediments are concerned, most (but not all) studies in the Bay Area recognize a basal unit relating to the last interglacial sea-level high (Marine Isotope Stage 5; known also as the Sangamon) between about 130,000 and 75,000 years ago. In most cases it rests unconformably on older deformed sediments. In depo-centers such as the San Francisco Bay, the sediments are clays and muds assignable to the Old Bay Mud or Yerba Buena Formation; however, on topographically elevated surfaces these sediments are normally coarser grained and, despite the fact that they may simply represent facies changes within the same formation, have most often been assigned different names, in particular the Colma Formation and Merritt Sand (Table 8.14-2).

Sea level regression during the subsequent Wisconsin glacial age (ca. 75,000 to 10,000 years ago) witnessed the retreat of the shoreline far westward to about the position of the Farallon Islands. The coarser-grained terrestrial sediments relating to this period have been identified as the San Antonio Formation by some authors and the Merritt Sand or Merritt Formation by others (Table 8-14.2). This coarse sediment is in turn capped by the Young Bay Mud, marking the return of the ocean and marine deposition between 15,000 and 9,000 years ago. On the east side of San Francisco Bay the marine type Merritt Sand grades into and interfingers with terrestrial alluvial-fan deposits. Schlocker et al. (1958) named possibly equivalent sands the Colma Formation, while clearly stating that at least the marine portion of the Colma was “correlated with the Merritt Sand.”

The environment of deposition of Merritt Sand deposits varies greatly over short distances; it is a complex of Pleistocene marine and coastal sediments, including some interbedded gravel and silt, and clay beds. Depending on whether they were deposited during high or low sea-level, the environment in which they were deposited varies among offshore marine, estuarine, lagoonal, beach, paludal (swamp), lacustrine (lake), fluvial (stream), flood plain, and dune environments (Schlocker, 1974). Part of this complexity is due to the difficulty in discriminating between sand units that may, or may not, be related to one another in time and manner of deposition.

Latest Pleistocene and Holocene age (about 15,000 years to present) alluvium in the Bay Area was named the Temescal Formation by Lawson (1914), who included within this formation alluvial deposits younger than and overlying the Merritt Sand. The principal differences between the younger and older alluvium are stratigraphic position (separated by the Merritt Sand), lithologic components, degree of consolidation, topographic expression,

attitude (tilted versus flat-lying), and fossil content. According to Savage (1951), sediments in the Bay Area containing Rancholabrean LMA fossil faunas can often be distinguished from the older Pleistocene (Irvingtonian LMA) deposits because they are relatively flat-lying, while the older sediments are often tilted. This criterion has also been helpful to others in distinguishing older alluvium from younger alluvium (see Taliaferro, 1951; Hall, 1958; Helley et al., 1972). Like other units, depending on whether they were deposited during high or low sea level the depositional environment of Temescal Formation sediments varies from estuarine to swamp to stream.

Schlocker (1974) suggested that sediments of the Temescal Formation were deposited after about 14,000 years ago, when sea level began to rise with the melting of continental ice sheets at the close of the Wisconsin Glacial Age (Table 8.14-2) and the ocean re-entered San Francisco Bay. This then would make the "Young" or "Recent Bay Mud" of many authors quite literally the marine facies of the Temescal Formation. Atwater et al. (1977) note that with more radiocarbon dating tests, the incursion of the ocean into what would become the San Francisco and San Pablo Bays occurred between 11,000 and 9,000 years ago. Therefore virtually all of the Young Bay Mud unit is post-Rancholabrean (Holocene; Table 8.14-1) and would therefore possess only low paleontological sensitivity.

Young Bay Mud is recognized in nearly all of the geotechnical borings beneath and in the vicinity of the Project (URS, 2006a and 2006b). Based on the age relationship discussed immediately above, the lower contact of this unit can be used as the conceptual divider between sediment and fill of no to low paleontological sensitivity above, and sediment of moderate to high paleontological sensitivity below. At both the Cogen and the Hydrogen plant sites this contact ranges from about 19 to 28 feet below the surface.

Quaternary Fossil Records. From his survey of vertebrate faunas from the non-marine Quaternary deposits of the San Francisco Bay region, Savage (1951) concluded that two faunal divisions could be recognized. He assigned the earlier Pleistocene fauna to what eventually was designated the Irvingtonian LMA (older than ca. 400,000 years), and the later Pleistocene and Holocene fauna to the Rancholabrean LMA (younger than ca. 400,000 years). Deformed gravels with interbedded sand and clay on the west flank of the Berkeley Hills have yielded an abundant Early to Middle Pleistocene Irvingtonian fauna (Savage, 1951; Wahrhaftig et al., 1993; Jefferson, 1991a and 1991b), named for the productive quarries at Irvington in the southern Berkeley Hills. The Irvington Gravels are distinctly folded and the strata dip as much as 20° to 25° (Savage, 1951; Louderback, 1951; Hall, 1958). Lithologically similar and probably age-equivalent gravels occur elsewhere in the San Francisco Bay Area. These gravels have also yielded Irvingtonian-age land mammal fossils (for instance UCMP localities V-6322, V-3602, V-3604, and V-3605) and are probably correlative with the Irvington Gravels.

Fossils from sediments referred to the San Antonio, Alameda, Santa Clara, and Merced Formations by most (but not all; see Table 8.14-2) authors are Early to Middle Pleistocene in age, generally coeval with those reported from the Irvington Gravels and equivalents. The terrestrial mammals collected from these units include mammoths, musk oxen, horses, peccaries, camels, deer, elk, pronghorns, ground sloths, saber-tooth cats, dire wolves, coyotes, foxes, gophers, mice, and squirrels (Peabody, 1945; Savage, 1951; Stirton, 1951; Louderback, 1951; Hall, 1958).

The Colma Formation has produced significant marine and terrestrial fossils in the past. Rodda and Baghai (1993) reported bones and teeth of mammoth and extinct bison from sands and clays unconformably overlying the Franciscan Complex that they refer to as the Colma Formation. Fossil diatoms and pollen were also recovered from this site, with the former indicating an estuarine environment. A leg bone of a ground sloth (*Glossotherium* sp.) had been previously recovered from a shallow well in this same vicinity which is related to the same bone bed (Rodda and Baghai, 1993). A radiocarbon age of 25,380 +/- 1,100 years before present (ibid.) for fossils found at this site would, however, make it too young for the Colma Formation (Stage 5, or 128,000 to 75,000 years old). The standard deviation of the radiocarbon date is large, and it would take only a minute amount of modern carbon to make a sample that is older than the range of radiocarbon dating (>30,000 years for conventional counters) appear to be younger.

Savage (1951) listed other vertebrate fossil localities in the San Francisco Bay region to which he assigned an "undifferentiated Pleistocene" age. Some of these additional vertebrate fossils may also be referable to the Colma Formation. Schlocker (1974) reported fossil plant remains and a peat layer at the top of his Colma Formation possibly representing "an old soil that developed in or near local marshes or lakes." Marine facies of the Colma Formation (including some units identified as the Merritt Sand) have produced marine megafossils, marine and nonmarine diatoms, and sponge spicules (Schlocker, 1974).

Sediments assigned to the Temescal Formation (Table 8.14-2) have yielded fossil remains of petrified wood, marine mollusks and mammals, bony fishes, amphibians, reptiles, birds, and a diversity of extinct land mammals, including ground sloths, mammoth, mastodon, deer, horse, camel, and bison (Hay, 1927; Stock, 1925; Savage, 1951; Jefferson, 1991b). Fossils recovered from Wisconsin and Holocene-age sediments at sites in the area around San Francisco Bay also include microfossils useful in paleoenvironmental reconstructions (radiolaria, foraminifera, sponge spicules, coccoliths, diatoms, dinoflagellates, pollen, and spores) (Atwater et al., 1977; McGann et al., n.d.; Sloan 1992). Schlocker (1974) has also reported fossil plant remains from sediments he referred to as "Bay mud and clay." Bonilla (1971) reported fossil shells and plant remains from "Bay Mud." Generally, Holocene-age facies of the Temescal Formation would be assigned low paleontological potential, while latest Pleistocene facies (late Rancholabrean LMA) and the Younger Bay Mud would be assigned moderate to high paleontological potential depending on the setting.

8.14.4.2 Artificial Fill

Extensive mapping information is available for the San Francisco and San Pablo Bays showing where marshes and estuarine habitats existed in historic times, but are now filled in (Oakland Museum, n.d.). The practice of creating land by filling in the tidal flats and deeper estuaries on the shores of the Bay Area began about the time of the Gold Rush in response to the need for room to expand along the waterfront. Over time, more than 3 square miles of the most valuable land in San Francisco originated in this way (Schlocker, 1974). For fill, developers used whatever materials were available, including dune sand, alluvium, sediment dredged from the Bay, spoils from excavations, solid rock from quarries, and man-made debris, including foundry slag and garbage. Both the thickness and type of fill vary widely over short distances.

The area proposed for construction of the PPRP is located entirely on artificial fill, as is the route of the cogeneration unit's transmission line (URS, 2006b, Fig. 5). Artificial fill possesses no paleontological sensitivity. The thickness of artificial fill beneath and near the Cogeneration plant site, as determined from geotechnical borings, generally ranges from 10 to 14 feet (URS, 2006a). It is shallower (6 to 8 feet thick) in areas that appear to be underlain by Holocene and historic peat, sands and gravels of low paleontological sensitivity. The thickness of fill in the vicinity of the Hydrogen plant site is more variable, ranging from approximately 3.5 feet to as much as 13 feet in depth (URS, 2006b).

8.14.5 Impacts and Mitigation

This review found no records of fossil sites within the footprint of the Project, nearby laydown areas, or the transmission line. Artificial fill, which possesses no paleontological sensitivity, underlies the entire Project site. Holocene alluvium and then Young Bay Mud of low paleontological sensitivity occur below the fill, with older Quaternary alluvium and Franciscan bedrock of moderate to high paleontological sensitivity at the base of the section. The lower contact of the Young Bay Mud provides a useful marker for the upper limit of paleontologically sensitive sediment, and geotechnical investigations show that this depth ranges from 19 to 28 feet. Therefore, excavations at depths shallower than, conservatively, 15 feet would have no impact to scientifically significant paleontological resources.

Because excavations are expected to disturb only the top six feet or less of sediment in the Project area, and because the sediment to be disturbed at this shallow depth is chiefly artificial fill with no paleontological sensitivity, no impacts to paleontological resources are anticipated from Project construction. Nor are impacts anticipated from Project operation, which will not involve ground disturbance.

Because no impacts to paleontological resources will occur, no mitigation is recommended as part of PPRP implementation. It is noted that paleontological resources awareness training is included as a module in the general Worker Environmental Awareness Program.

Based on these findings, no further assessment is needed of impacts to paleontological resources resulting from the PPRP as described herein.

8.14.6 Involved Agencies and Agency Contacts

There are no state or local agencies having specific jurisdiction over paleontological resources. The CEQA lead agency having specific responsibility to ensure that paleontological resources are protected in compliance with CEQA and other applicable statutes during construction of the PPRP is the CEC. California Public Resources Code Section 21081.6, entitled Mitigation Monitoring Compliance and Reporting, requires that the CEQA lead agency demonstrate project compliance with mitigation measures developed during the environmental impact review process.

8.14.7 Permits Required and Permit Schedule

No state or local agency requires a paleontological collecting permit to allow for the recovery of fossil remains discovered as a result of construction-related earth moving on private or public lands, except for federal lands. However, since no federal lands are involved in this Project, no permits will be required.

8.14.8 References

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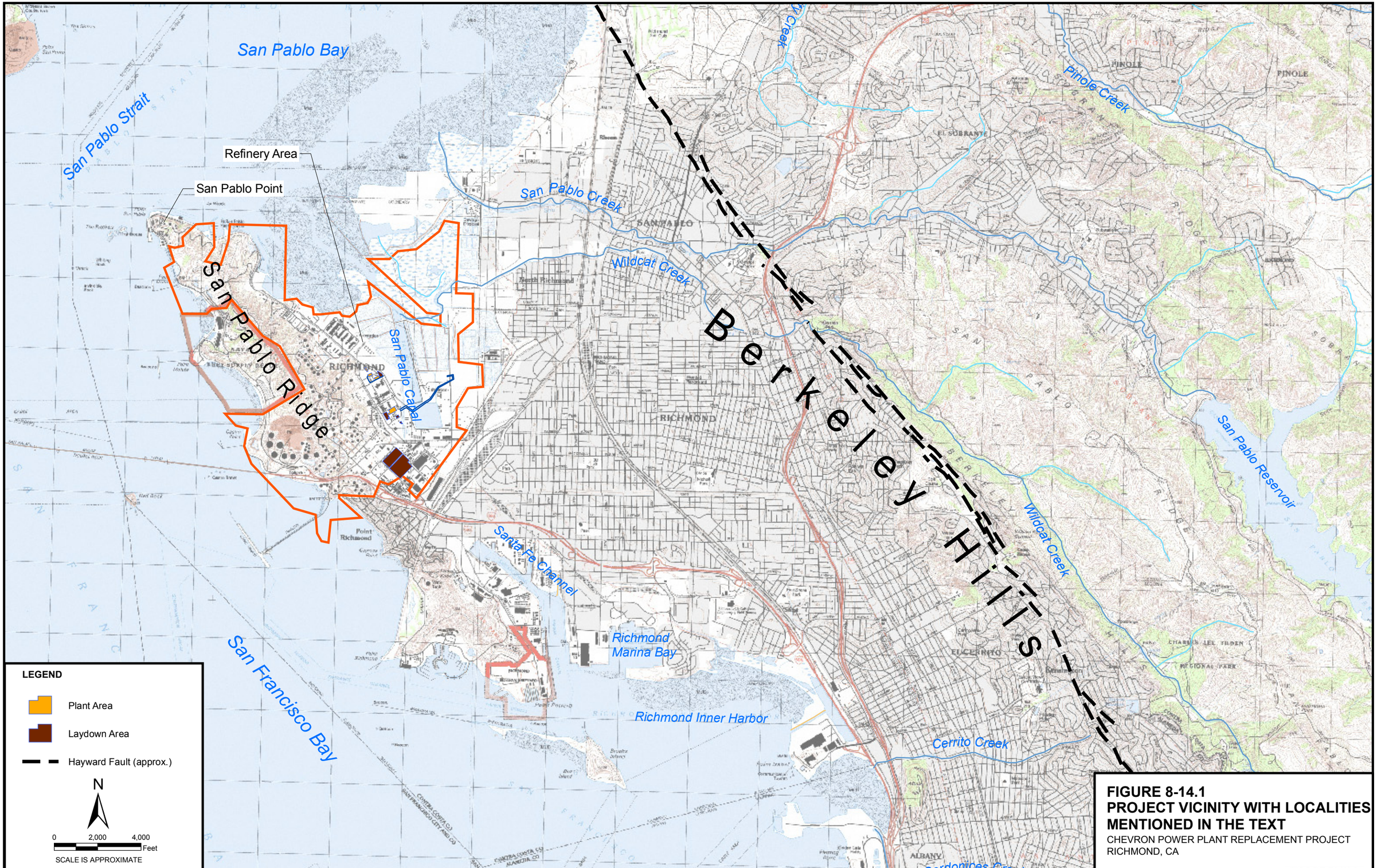

FIGURE 8-14.1
PROJECT VICINITY WITH LOCALITIES MENTIONED IN THE TEXT
CHEVRON POWER PLANT REPLACEMENT PROJECT
RICHMOND, CA

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