SR-91/SR-241 Express Lanes Connector Project

Paleontological Resources Identification and Evaluation Report

City of Anaheim

Orange County, California

California Department of Transportation District 12

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Summary of Findings

The Transportation Corridor Agencies (TCA), in cooperation with the California Department of Transportation (Caltrans), proposes to construct new direct connectors between State Route 241 (SR-241) and the State Route 91 (SR-91) Express Lanes. SR-241 is a toll-only facility, starting at the Oso Parkway interchange, in south Orange County, to its terminus at SR-91. The SR-91 Express Lanes is a two-lane toll facility on SR-91 in each direction, from State Route 55 (SR-55), to the Orange/Riverside County line (east of the SR-241 interchange). Currently, there is no direct connection between the SR-241 toll lanes and the SR-91 Express Lanes.

The SR-241/SR-91 Express Lane Connector Project (proposed project) was previously evaluated in the Eastern Transportation Corridor (ETC) 1994 Final Environmental Impact Report/Environmental Impact Statement (EIR/EIS). The Systems Management Concept (SMC) for the ETC project, proposed that each Build Alternative would be staged, incorporating general purpose traffic and eventually high-occupancy vehicle (HOV) lanes, to meet the forecasted demand. Under the SMC, ETC construction would be completed in one stage with three or more phases. The direct connectors were identified for Phase 2 of the ETC project.

The area studied for this project is the Area of Project Disturbance (APD) for all areas of the SR-91/SR-241 Express Lanes Connector Project where excavation is proposed. The locality search included a buffer area extending over 1 mile from the APD to assist with determining the paleontological sensitivities of geologic formations. The APD is based on the horizontal and vertical extent of anticipated ground-disturbing activities.

Where excavation may occur within the APD, nine types of sediment are exposed on the surface. Two of these sediments, Artificial Fill and late Holocene Landslide Deposits, do not have the potential to contain paleontological resources because of their young age (less than 11,700 years); however, they may be on top of units that do have the potential to contain paleontological resources. Two sediment types, Young Alluvial Fan Deposits and Young Axial Channel Deposits, do not have the potential to contain paleontological resources at depths shallower than approximately 10 feet (ft) below the surface, but may have the potential once a depth greater than 10 ft is reached. Five sediment types, the Schulz Ranch Member of the Williams Formation, the Santiago Formation, the Undifferentiated Sespe/Vaqueros Formation, the Topanga Formation, and Very Old Alluvial Fan Deposits have the potential to contain

paleontological remains. It should be noted that some areas within the APD—on the eastern end of the project on the south side of SR-91—where excavation will not occur, have exposures of the Silverado Formation and the Baker Canyon Member of the Ladd Formation.

Recommendations from the California Environmental Quality Act along with guidelines from Caltrans are consistent with the recommendations of the Society of Vertebrate Paleontology (SVP) and indicate that impacts to nonrenewable paleontological resources must be considered during project design and construction within sensitive sediments. The literature review and locality searches through museums and data maintained at LSA Associates, Inc., produced information showing that sediments dating from the Late Cretaceous to the Pleistocene Periods within the APD have the potential to contain significant nonrenewable paleontological resources. Thus, it is likely that paleontological resources will be encountered during the project excavation phase of construction within these sediments.

To reduce impacts to nonrenewable paleontological resources, recommendations are made for the development of a Paleontological Mitigation Plan (PMP) for those portions of the SR-91/SR-241 Express Lanes Connector Project that are identified as having a high paleontological sensitivity, which would follow Caltrans guidelines along with recommendations from the SVP prior to completion of final project design. These recommendations include the following:

- Attendance at the pregrade meeting by a qualified paleontologist or representative. At this meeting, the paleontologist will explain the likelihood for encountering paleontological resources, what resources may be discovered, the methods of recovery that will be employed, and what construction personnel should do in the event paleontological resources are encountered when a monitor is not present.
- A preconstruction field survey in areas identified as having high paleontological sensitivity after vegetation and paving have been removed, followed by salvage of any observed surface paleontological resources prior to the beginning of additional grading. This requirement is consistent with Mitigation Measure P-1 in the ETC EIR/EIS, which reads “In conjunction with final design, an intensive pregrading survey of the entire alignment to locate fossil sites not recorded during the environmental review process shall be conducted by a qualified paleontologist. Vertebrate remains and representative samples of invertebrate

remains shall be collected and recorded. The paleontologist shall, based on the field survey results, reclassify rock units of unknown importance to low, moderate or high importance."

- During construction excavation, a qualified vertebrate paleontological monitor shall initially be present on a full-time basis whenever excavation will occur within the sediments that have a high paleontological sensitivity rating, and on a spot-check basis for excavation in sediments that have a low sensitivity rating. Monitoring may be reduced to a part-time basis if no resources are being discovered in sediments with a high sensitivity rating (monitoring reductions, when they occur, will be determined by the qualified Principal Paleontologist). The monitor shall inspect fresh cuts and/or spoils piles to recover paleontological resources. The monitor shall be empowered to temporarily divert construction equipment away from the immediate area of the discovery. The monitor shall be equipped to rapidly stabilize and remove fossils to avoid prolonged delays to construction schedules. If large mammal fossils or large concentrations of fossils are encountered, Caltrans will consider using heavy equipment on site to assist in the removal and collection of large materials. This requirement is consistent with Mitigation Measure P-2 in the ETC EIR/EIS which reads "In conjunction with site preparation and grading, the paleontologist shall monitor clearing and grading in areas underlain by rock units of high importance full-time, in areas underlain by rock units of moderate importance on a half-time basis and will spot check but not monitor grading in areas underlain by rock units of low importance. If sufficient important fossil remains are found during field survey or construction monitoring in an area underlain by a rock unit of low or moderate importance, the paleontologist shall raise the importance of the rock unit and increase the monitoring effort, as appropriate. The number of monitors to be stationed in each construction area during grading shall be based on the amount of rock to be moved per day."
- Mitigation Measure P-3 in the ETC EIR/EIS states that "In conjunction with site preparation and grading, the paleontologist shall collect rock samples from suitable horizons in formations of high, moderate and unknown importance. At the paleontologist's discretion and to reduce any construction delay, the grading contractor shall assist in collecting the samples and moving them to an adjacent off site location for later transportation by the monitor to the Orange County Natural History Museum or a similar facility."
- Localized concentrations of small (or micro-) vertebrates may be found in all native sediments. Therefore, it is recommended that these sediments occasionally

be spot-screened on site through 1/8- to 1/20-inch mesh screens to determine whether microfossils are present. If microfossils are encountered, sediment samples (up to 3 cubic yards, or 6,000 pounds) shall be collected and processed through 1/20-inch mesh screens to recover additional fossils.

- Mitigation Measure P-4 in the ETC EIR/EIS states that "If fossil remains are found during site preparation, grading or construction, the paleontologist shall temporarily stop work and notify TCA of the work stoppage. The TCA shall follow the procedures in Chapter 7 of TCA Administrative Code for development of mitigation if mitigation is determined to be necessary."
- Recovered specimens shall be prepared to the point of identification and permanent preservation. This includes the sorting of any washed mass samples to recover small invertebrate and vertebrate fossils, the removal of surplus sediment from around larger specimens to reduce the volume of storage for the repository and storage cost, and the addition of approved chemical hardeners/stabilizers to fragile specimens. This requirement is consistent with Mitigation Measure P-5 in the ETC EIR/EIS which reads "After the completion of the on-site monitoring, the paleontologist shall process all collected rock samples for microvertebrate and other fossil remains, prepare and identify all collected remains, incorporate them into a retrievable storage system, and file accompanying field notes, maps and photographs at the Orange County Natural History Museum or a similar facility."
- Specimens shall be identified to the lowest taxonomic level possible and curated into an institutional repository with retrievable storage. The repository institutions usually charge a one-time fee based on volume, so removing surplus sediment is important. The repository institution may be a local museum or university with a curator who can retrieve the specimens on request. Caltrans requires that a draft curation agreement be in place with an approved curation facility prior to the initiation of any paleontological monitoring or mitigation activities.
- Preparation and submittal of the Paleontological Mitigation Report (PMR) documenting completion of the PMP for the Lead Agency (Caltrans). This requirement is consistent with Mitigation Measure P-6 in the ETC EIR/EIS, which reads "Following completion of the monitoring, identification, storage and documentation activities, the paleontologist shall prepare a summary report presenting an inventory and describing the significance of accessioned remains."

Implementation of these recommendations will reduce impacts to nonrenewable paleontological resources. More project-specific measures may need to be developed during preparation of the PMP to refine these measures during final project design.

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Chapter 1. Introduction

1.1. Project Description

The Transportation Corridor Agencies (TCA), in cooperation with the California Department of Transportation (Caltrans), proposes to construct new direct connectors between State Route 241 (SR-241) and the State Route 91 (SR-91) Express Lanes. SR-241 is a toll-only facility, starting at the Oso Parkway interchange, in south Orange County, to its terminus at SR-91. The SR-91 Express Lanes is a two-lane toll facility on SR-91 in each direction, from State Route 55 (SR-55), to the Orange/Riverside County line (east of the SR-241 interchange). Currently, there is no direct connection between the SR-241 toll lanes and the SR-91 Express Lanes.

The SR-241/SR-91 Express Lane Connector Project (proposed project) was previously evaluated in the Eastern Transportation Corridor (ETC) 1994 Final Environmental Impact Report/Environmental Impact Statement (EIR/EIS). The Systems Management Concept (SMC) for the ETC project proposed that each Build Alternative would be staged, incorporating general purpose traffic and eventually high-occupancy vehicle (HOV) lanes, to meet the forecasted demand. Under the SMC, ETC construction would be completed in one stage with three or more phases. The direct connectors were identified for Phase 2 of the ETC project.

The project is located within portions of Irvine Ranch Sections 23, 25, 26, and 28 Township 4 South Range 8 West and portions of Irvine Ranch Sections 28, 30, 32 and unsectioned areas of Township 3 South Range 8 West, San Bernardino Baseline and Meridian, and is depicted on the *Black Star Canyon, California* 7.5-minute series United States Geological Survey (USGS) topographic map. The location and regional vicinity of the proposed project are illustrated in Figure 1. All of the improvements and construction, including construction access and staging areas would occur within the existing Caltrans right-of-way.

1.2. Purpose and Need

1.2.1. Project Purpose

The purpose of the proposed project is to implement the buildout of the ETC, as approved in 1994, and attain compatibility with the proposed SR-91 Corridor Improvement Project (CIP), while minimizing environmental and financial impacts.

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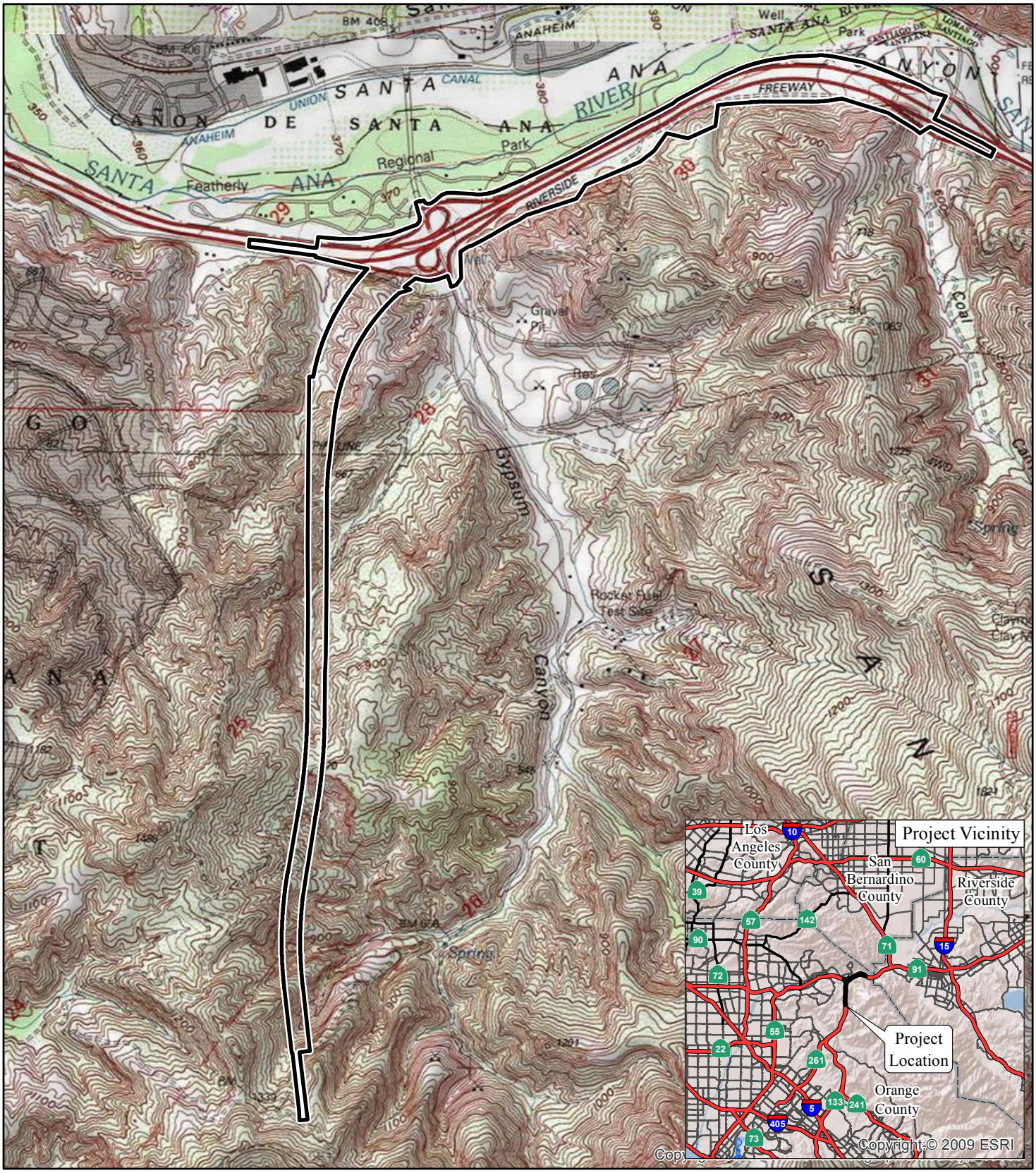

LEGEND

Project Location

FIGURE 1

N

0 1000 2000

FEET

SOURCE: USGS 7.5' Quad - Black Star Canyon (1988), CA

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SR-241/SR-91 Express Lanes Connector

Project Location

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As stated in the 1994 Final EIR/EIS, the overall objective of the ETC project was to accommodate traffic growth associated with planned and approved development in Orange County. Specifically, the ETC project was proposed to meet the following objectives:

- To provide relief for existing freeways;
- To help achieve the Regional Mobility Plan goals of reducing emissions from transportation sources;
- To improve traffic flow on the regional transportation system;
- To reduce current and projected congestion and air pollution along portions of SR-91, the Costa Mesa Freeway (SR-55), and Interstate 5 (I-5) by providing an alternative travel route in northeast Orange County;
- To service existing and planned development consistent with the General Plans of the County and the cities in areas that will benefit from the project;
- To employ advanced transportation technology for the maximum operational and design efficiency and automatic vehicle monitoring for toll collections; and
- To implement the County of Orange Master Plan of Arterial Highways.

1.2.2. Project Need

The need for the proposed project arises from the lack of connectivity between the SR-241 and the SR-91 Express Lanes, which results in a variety of deficiencies that negatively affect traffic flow and worsen an already congested SR-91 during peak hours. These deficiencies are described below:

- Northbound vehicles on SR-241 cannot access the eastbound SR-91 Express Lanes. Access from northbound SR-241 to eastbound SR-91 is provided by means of a two-lane connector that merges with the SR-91 general-purpose lanes. The limitations of the existing interchange connections require that northbound SR-241 motorists that want to use the eastbound SR-91 HOV lanes must weave across four lanes to access them.
- Westbound SR-91 Express Lane motorists cannot access southbound SR-241. Access from westbound SR-91 to southbound SR-241 is provided by means of a two-lane connector that diverges from the general-purpose lanes. The limitations of the existing interchange connections require that vehicles using the westbound SR-91 HOV lane weave across four lanes to access the southbound SR-241 connector ramp.

1.3. Project Alternatives

Two alternatives are being analyzed in this document: Alternative 1 (Two-Lane Express Lane Connector) and the No Build Alternative.

1.3.1. Alternative 1 (Two-Lane Express Lane Connector)

Alternative 1 would construct a median-to-median connector between SR-241 and SR-91. The connector would bring lanes from the median of northbound SR-241 to the existing eastbound SR-91 Express Lanes. The reverse movement would also be accommodated, from the westbound SR-91 Express Lanes to the median of southbound SR-241. The connector would be tolled.

Starting at the southern end of the project, the Windy Ridge Undercrossing would be widened on the southbound median side, and an additional lane and shoulder would be constructed for approximately 5,300 feet (ft) to match existing pavement on the northbound side. At this point, two lanes, one in both the northbound and the southbound direction, would be added by widening the existing median. The two new lanes would be constructed on bridge structures and fill within the area between the existing SR-241 general purpose connectors and would merge with the SR-91 mainline.

To accommodate the addition of the median-to-median connector, the existing eastbound SR 91 Express Lanes would be shifted to the south and an eastbound auxiliary express lane would be constructed along SR-91. The Gypsum Canyon on- and off-ramps and the northbound SR-241-to-eastbound SR-91 general purpose connector would be realigned to accommodate the SR-91 modifications. The number of existing eastbound SR-91 general purpose lanes would be maintained within the project limits.

The westbound SR-91 lanes would be restriped to accommodate the addition of the express lane that would feed into the southbound SR-241 median-to-median connector. The restriping would begin west of Coal Canyon, and would end east of the Gypsum Canyon Road Undercrossing.

The eastbound and westbound SR-91 Express Lanes would have a buffer to separate the express lanes from the general purpose lanes. The westbound SR-91 Express Lanes would have a 2 ft buffer, and the eastbound SR-91 Express Lanes would have 4 ft buffers on both sides: a buffer to the right to separate the general purpose lanes, and a buffer to the left to separate the express connector lane. In order to match the

existing eastbound lanes, at the eastern terminus of the project limits, the buffers would transition to 0 ft.

Alternative 1 would tie into the western limits of the initial SR-91 CIP, which will extend the SR-91 Express Lanes easterly to I-15. The Alternative 1 express lane connector would merge into the existing SR-91 Express Lanes, prior to the connection to the SR-91 CIP. Alternative 1 is compatible with the approved SR-91 CIP proposed lane configuration, including the number and widths of the express lanes, express auxiliary lanes, and general purpose lanes.

Retaining walls would be required on eastbound SR-91 in order to contain the grading within the existing right-of-way.

1.3.2. No Build Alternative

Under this alternative, no direct toll connector would be constructed between SR-241 and SR-91. This alternative would not close the toll connector gap between SR-241 and the SR-91 Express Lanes.

1.4. Purpose of Investigation

Significant nonrenewable paleontological resources including vertebrate fossils and unique or scientifically important invertebrate fossils and remains of fossil plants are recognized by the State of California and the National Environmental Policy Act of 1969 (NEPA). These regulations require that adverse effects to paleontological resources be avoided, or if they cannot be avoided, mitigated. NEPA does not specifically direct federal agencies to preserve paleontological resources, but preserving “important historic, cultural, and natural aspects of our natural heritage” (Section 1019(b)(4)) is interpreted to include fossils.

The paleontological records search and field assessment were conducted pursuant to the California Environmental Quality Act (CEQA), Public Resources Code (PRC) 21000 (Division 13), California Code of Regulations (CCR) 15000 (Title 14, Division 3, Chapter 1), CEQA Appendix G, PRC 5097.5. The assessment documents the potential for paleontological resources older than 10,000 years to occur in the project area.

1.4.1. California Department of Transportation Regulations

As this project is within a State highway right-of-way, the project is obligated to follow the guidelines specified in the Caltrans Standard Environmental Reference (SER). Specifically, the SER Environmental Handbook, Volume 1 Chapter 8

(Caltrans, 2012) deals with paleontology. The guidelines are designed to address impacts to paleontological resources prior to the beginning of construction. In most cases, three documents are required to be prepared: a Paleontological Investigation Report (PIR), a Paleontological Evaluation Report (PER), and a Paleontological Mitigation Plan (PMP). The PIR and PER are often combined into a single document. The PIR and PER must be prepared prior to completion of the Project Approval/Environmental Document (PA/ED) phase in order to minimize construction delays. The PMP must be developed prior to the beginning of construction.

The purpose of the PIR is to identify whether or not paleontological resources may be present within the project area; the purpose of the PER is to evaluate the significance of the resources, if it is determined that resources are likely to be present; and the purpose of the PMP is to develop mitigation for significant resources. Occasionally the PIR/PER will determine that, despite the results of the literature search, it is unlikely that the project will encounter significant resources during construction. This may be due to the removal of sensitive sediments as a result of previous construction in the area, or to the burying of sensitive sediments with fill deeper than depths that will be encountered during construction related to the project. In these cases, a PMP will not be required, and the reason will be specified in the PIR/PER. At the conclusion of grading, two additional documents may need to be prepared: a Paleontological Mitigation Report (PMR) and a Paleontological Stewardship Summary (PSS).

1.4.2. State Regulations

Under State law, paleontological resources are protected by both CEQA and PRC Section 5097.5.

Under CEQA, Appendix G, Lead Agencies are required to consider impacts to the direct or indirect destruction of unique resources that are of value to the region or State. Appendix G is a checklist with several choices given, including: Potentially Significant Impact, Less than Significant with Mitigation Incorporation, Less than Significant Impact, and No Impact. Specifically, in Appendix G, Section V (c), Lead Agencies are required to consider impacts to paleontological resources.

The California PRC Section 5097.5 states:

> (a) No person shall knowingly and willfully excavate upon, or remove, destroy, injure or deface any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including

fossilized footprints, inscriptions made by human agency, or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands. Violation of this section is a misdemeanor.

(b) As used in this section, "public lands" means lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof.

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Chapter 2. Significance

2.1. Definition of Significance

If a paleontological resource, such as a rock unit or formation with the potential to contain fossils, cannot be avoided during construction, the significance of the resource must be assessed before mitigation measures are proposed. According to Caltrans (2012), there are two generally recognized types of paleontological significance:

- **National:** A National Natural Landmark eligible paleontological resource is an area of national significance (as defined under 36 Code of Federal Regulations [CFR] 62) that contains an outstanding example of fossil evidence of the development of life on earth. This is the only codified definition of paleontological significance.
- **Scientific:** Definitions of a scientifically significant paleontological resource can vary by jurisdictional agency and paleontological practitioner.

Scientifically significant paleontological resources are "identified sites or geologic deposits containing individual fossils or assemblages of fossils that are unique or unusual, diagnostically or stratigraphically important, and add to the existing body of knowledge in specific areas, stratigraphically, taxonomically, or regionally" (Caltrans, 2012). Fossils are particularly important when they are found undisturbed in their primary context because they aid in stratigraphic correlation, evolution, and paleoclimatology.

Significant, nonrenewable fossil resources under Society for Vertebrate Paleontology (SVP) guidelines consist of "vertebrate fossils and their taphonomic and associated environmental indicators. This definition excludes invertebrate or botanical fossils except when present within a given vertebrate assemblage" or as defined by a project paleontologist or Lead Agency (SVP, 1995).

The SVP provides the following definitions of significance:

- **Significant Paleontological Resources** are fossils and fossiliferous deposits, here defined as consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded

human history and/or older than middle Holocene (i.e., older than about 5,000 radiocarbon years) (SVP, 2010).

- A **Significant Fossiliferous Deposit** is a rock unit or formation that contains significant nonrenewable paleontological resources, here defined as comprising one or more identifiable vertebrate fossils, large or small, and any associated invertebrate and plant fossils, traces, and other data that provide taphonomic, taxonomic, phylogenetic, ecologic, and stratigraphic information (ichnites and trace fossils generated by vertebrate animals, e.g., trackways or nests and middens, which provide datable material and climatic information). Paleontological resources are considered to be older than recorded history and/or older than 5,000 years before the present (SVP, 1995).

Generally, scientifically significant paleontological resources are identified sites or geological deposits containing individual fossils or assemblages of fossils that are unique or unusual, diagnostically or stratigraphically important, and that add to the existing body of knowledge in specific areas, stratigraphically, taxonomically, or regionally (SVP, 1995). Particularly important are fossils found in situ (undisturbed) in primary context (e.g., fossils that have not been subjected to disturbance subsequent to their burial and fossilization). As such, they aid in stratigraphic correlation, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology, the relationships between aquatic and terrestrial species, and evolution in general. Discovery of in situ fossil-bearing deposits is rare for many species, especially vertebrates. Terrestrial vertebrate fossils are often assigned greater significance than other fossils because they are rarer than other types of fossils. This is primarily due to the fact that the best conditions for fossil preservation include little or no disturbance after death and quick burial in oxygen-depleted, fine-grained sediments. While these conditions often exist in marine settings, they are relatively rare in terrestrial settings. This has ramifications with regard to the amount of scientific study needed to characterize an individual species adequately, so it affects relative sensitivities as they are assigned to formations and rock units.

In their Model Curation Program, Eisentraut and Cooper (2002) developed a useful analysis for judging whether fossils are scientifically significant. Using their analysis method, fossils can be judged scientifically significant if they meet any of the following criteria within the following categories:

- **Taxonomy:** Assemblages that contain rare or unknown taxa, such as defining new (previously unknown to science) species or that represent a species that is the first or has very limited occurrence within the area or formation.
- **Evolution:** Fossils that represent important stages or links in evolutionary relationships or that fill gaps or enhance underrepresented intervals in the stratigraphic record.
- **Biostratigraphy:** Fossils important for determining or confining relative geologic (stratigraphic) ages or for use in defining regional to interregional stratigraphic associations. These fossils are often known as biostratigraphic markers and represent plants or animals that existed for only a short and restricted period in the geologic past.
- **Paleoecology:** Fossils important for reconstructing ancient organism community structure and interpretation of ancient sedimentary environments. Depending on which fossils are found, much can be learned about the ancient environment from water depth, temperature, and salinity to what the substrate was like (muddy, sandy, or rocky) even to whether the area was in a high-energy location like a beach or a low-energy location like a bay. Even terrestrial animals can contain information about the ancient environment. For example, an abundance of grazing animals such as horse, bison, and mammoth suggest more of a grassland environment, while an abundance of browsing animals such as deer, mastodon, and camel suggest more of a brushy environment. Preserved parts of plants can also lend insight into what was growing in the area at a particular time. In addition, by studying the ratios of different species to each other's population densities, relationships between predator and prey can be determined.

  There is a complex but vital interrelationship among evolution, biostratigraphy, and paleoecology: biostratigraphy (the record of fossil succession and progression) is the expression of evolution (change in populations of organisms through time), which in turn is driven by natural selection pressures exerted by changing environments (paleoecology).
- **Taphonomy:** Fossils that are exceptionally well or unusually/uniquely preserved or are relatively rare in the fossil record. This could include preservation of soft tissues such as hair, skin, or feathers from animals or the leaves/stems of plants that are not commonly fossilized.

2.2. Summary of Significance

This document uses an abbreviated summary to define significance in paleontological resources.

- All vertebrate fossils that can be related to a stratigraphic context are significant and are considered a significant nonrenewable paleontological resource. Invertebrate and plant fossils as well as other environmental indicators associated with vertebrate fossils are considered significant. Certain invertebrate and plant fossils that are regionally rare or uncommon, or help to define stratigraphy, age, or taxonomic relationships are considered significant.

Chapter 3. Sensitivity

3.1. Definition of Sensitivity

Sensitivity is often stated "potential," since decisions about how to manage paleontological resources must be based on "potential" since the actual situation cannot be known until construction excavation for the project is underway. In accordance with the Caltrans SER guide for paleontology (Caltrans, 2012), the sensitivity of rock units and formations that may contain paleontological resources is assessed on the basis of high, low, or no potential for paleontological resources:

- **High Potential:** Rock units that, based on previous studies, contain or are likely to contain significant vertebrate, significant invertebrate, or significant plant fossils. These units include, but are not limited to, sedimentary formations that contain significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. These units may also include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration and ranked as highly sensitive. High sensitivity includes the potential for containing (1) abundant vertebrate fossils; (2) a few significant fossils (large or small vertebrate, invertebrate, or plant fossils) that may provide new and significant taxonomic, phylogenetic, ecologic, and/or stratigraphic data; (3) areas that may contain datable organic remains older than Recent, including *Neotoma* (sp.) middens; and/or (4) areas that may contain unique new vertebrate deposits, traces, and/or trackways. Areas with a high potential for containing significant paleontological resources require monitoring and mitigation.
- **Low Potential:** This category includes sedimentary rock units that (1) are potentially fossiliferous, but have not yielded significant fossils in the past; (2) have not yet yielded fossils, but possess a potential for containing fossil remains; or (3) contain common and/or widespread invertebrate fossils if the taxonomy, phylogeny, and ecology of the species contained in the rock are well understood. Sedimentary rocks expected to contain vertebrate fossils are not placed in this category because vertebrates are generally rare and found in more localized stratum. Rock units designated as low potential generally do not require monitoring and mitigation. However, as excavation for construction gets underway, it is possible that new and unanticipated paleontological resources

might be encountered. If this occurs, a Construction Change Order (CCO) must be prepared in order to have a qualified Principal Paleontologist evaluate the resource. If the resource is determined to be significant, monitoring and mitigation is required.

- **No Potential:** Rock units of intrusive igneous origin, most extrusive igneous rocks, and moderately to highly metamorphosed rocks are classified as having no potential for containing significant paleontological resources. For projects encountering only these types of rock units, paleontological resources can generally be eliminated as a concern when the Preliminary Environmental Analysis Report (PEAR) is prepared and no further action taken.

According to the SVP (2010) protection of paleontological resources includes: (a) assessment of the area's potential to contain significant paleontological resources that could be directly or indirectly impacted, damaged, or destroyed by the proposed development and (b) formulation and implementation of measures to mitigate these adverse impacts, including permanent preservation of the site and/or permanent preservation of salvaged fossils along with all contextual data in established institutions.

According to the SVP (2010) Paleontological Potential is the potential for the presence of significant nonrenewable paleontological resources. All sedimentary rocks, some volcanic rocks, and some metamorphic rocks have potential for the presence of significant nonrenewable paleontological resources, and review of available literature may further refine the potential of each rock unit, formation, or facies. The Society of Vertebrate Paleontology has four categories of sensitivity: High, Low, No, and Undetermined. If a geographic area or geological unit is classed as having undetermined potential for paleontological resources, studies must be undertaken to determine if that rock unit has a sensitivity of either High, Low, or None. These categories are described in more detail below.

3.1.1. High Potential

Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras), and some low-grade metamorphic rocks that contain significant paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or

lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones, etc.). Paleontological potential consists of both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units which contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, and rock units which may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.

3.1.2. Low Potential

Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or based on general scientific consensus, preserve fossils only in rare circumstances, and the presence of fossils is the exception not the rule, e.g., basalt flows or Recent colluvium. Rock units with low potential typically will not require impact mitigation measures to protect fossils.

3.1.3. No Potential

Some rock units have no potential to contain significant paleontological resources, for instance high-grade metamorphic rocks such as gneisses and schists, and plutonic igneous rocks such as granites and diorites. Rock units with no potential require no protection nor impact mitigation measures relative to paleontological resources.

3.1.4. Undetermined Potential

Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontological resources. A field survey by a qualified professional to determine the specific paleontological resource potential of these rock units is required before a paleontological resource impact mitigation program can be developed. In cases where no subsurface data are available, paleontological potential can sometimes be determined by strategically located excavations into subsurface stratigraphy.

Given the range of criteria that may be used, assessments of significance should be based on the recommendations of a professional Principal Paleontologist with expertise in the region under study, and on the resources found in that region. An evaluation of a particular rock unit's significance rests on the known importance of specific fossils. Often this significance is reflected as a sensitivity ranking relative to other rock units in the same region. Regardless of the format used by a paleontologist to rank formations, the importance of any rock unit must be explicitly stated in terms of specific fossils known or suspected to be present (and if the latter, why such fossils are suspected), and why these fossils are of paleontological importance. Some land-managing agencies may require the use of specific guidelines to assess significance, whereas others may defer to the expertise of local paleontologists and provide little guidance. Because each situation may differ, it is important that there is a clear understanding among project staff (Caltrans or local), consultants, and personnel from other agencies as to exactly what criteria will be used to assess the significance of rock units affected by a particular project.

If a paleontological resource is determined to be significant, of high sensitivity, or of scientific importance, a mitigation program must be developed and implemented. Mitigation can be initiated prior to and/or during construction. The former is more common for Caltrans projects. It should be pointed out that mitigating during construction poses a greater risk of construction delays. Mitigation is an eligible federal project cost in accordance with 23 United States Code 305 only if significance documentation acceptable to the Federal Highway Administration (FHWA) is submitted. Thus, coordination among Caltrans, FHWA, and all jurisdictional agencies is critical to formally establishing the significance of a resource.

As a practical matter, no consideration is generally afforded paleontological sites for which scientific importance cannot be demonstrated. If a paleontological resource assessment results in a determination that the site is insignificant or of low sensitivity, this conclusion should be documented in a PER and in the project's environmental document, in order to demonstrate compliance with applicable statutory requirements.

3.2. Summary of Sensitivity

This document uses an abbreviated summary to define paleontological sensitivity and the potential for significant paleontological resources.

- A formation or rock unit has paleontological sensitivity or the potential for significant paleontological resources if it previously has produced, or has

lithologies conducive to the preservation of vertebrate fossils and associated or regionally uncommon invertebrate and plant fossils. All sedimentary rocks and certain extrusive volcanic rocks and mildly metamorphosed rocks are considered to have potential for paleontological resources.

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Chapter 4. Methods

To ensure that research was comprehensive, the paleontological resources "Research Area" was expanded beyond the Area of Potential Disturbance (APD). A "Research Area" boundary of up to 1 mile (mi) on either side of the project APD was used as a study area. Research involved review of available geological and paleontological literature concerning or related to the stratigraphy of the project area and requests for paleontological locality data from Southern California museums (Appendices A and B).

4.1. Literature Review and Records Search

The locality search included a review of area geology and any fossil resources recovered within sediments similar to those that will be encountered during the project. In addition, the paleontological sensitivity of the sediments exposed in the project area was determined based on fossil finds from similar sediments in Southern California.

The purpose of a locality search is to establish the status and extent of previously recorded paleontological resources within and adjacent to the SR-91/SR-241 Express Lanes Connector Project area and to determine which geologic sediments were likely to be exposed during ground-disturbing activities associated with the proposed improvements. With this knowledge, an informed assessment can be made of the potential effects of the proposed project on paleontological resources in the area, anticipating the kinds of resources that might be encountered during earthmoving activities, and determining the paleontological sensitivities for each geologic formation or unit exposed in the project area.

In February 2007, during initial project scoping for paleontological resources, a locality search was completed through the Natural History Museum of Los Angeles County (LACM), the San Bernardino County Museum (SBCM), and records maintained at LSA Associates, Inc. (LSA). The locality search included the current APD along SR-241 as well as areas along SR-91 between SR-241 and State Route-71 (SR-71). Individuals contacted included Dr. Sam McLeod, Curator of Vertebrate Paleontology at the LACM, and Eric Scott, Curator of Vertebrate Paleontology at the SBCM. The results letters from the LACM and SBCM are provided in Appendices A and B, respectively.

4.2. Field Inspection

4.2.1. Pedestrian Survey

A pedestrian survey was not completed during preparation of this PIR/PER as much of the area is along existing freeways with little to no access to exposed sediment. However, two previous paleontological studies have been completed in the vicinity of the project that cover the same area. During the grading of SR-241, Paleo Environmental Associates, Inc. (PEA) provided paleontological mitigation monitoring. During preparation of the initial paleontological assessment of the SR-91 lane additions between SR-241 and SR-71, Chambers Group, Inc. (Chambers) completed a field survey of a majority of the project area (Wagner, 2006). The surveys conducted by Chambers included walking the areas of the proposed project and examining the exposed sediments in the areas of the proposed earthwork. The purpose of this survey was to confirm the geology as it is mapped, determine where potential cuts will occur, and determine whether any fossils were exposed on the surface.

4.3. Personnel

Brooks R. Smith is an Associate at LSA and a member of the Cultural and Paleontological Resources Group as well as a County of Orange Certified Paleontologist. Mr. Smith completed this PIR/PER. He has over 21 years of experience with paleontological salvage programs and has extensive experience collecting paleontological resources, as well as writing paleontological assessment reports, surveying for paleontological resources, salvaging large fossil specimens, conducting fossil identification and curation, and writing final mitigation monitoring reports at the conclusion of construction projects (see Appendix C).

Chapter 5. Results

5.1. Locality Search

5.1.1. Geology

The project area is located at the northern end of the Peninsular Range Geomorphic Province, a 900 mi long northwest-southeast trending structural block that extends from the tip of Baja California to the Transverse Ranges and includes the Los Angeles Basin (Norris and Webb, 1976). The total width of the province is approximately 225 mi, with a maximum landbound width of 65 mi (Sharp, 1976). This region is characterized by a series of mountain ranges separated by northwest-trending valleys subparallel to faults branching from the San Andreas Fault. The trend of topography is similar to that of the Coast Ranges Geomorphic Province located to the north, but the geology is more like that of the Sierra Nevada, with granitic rock intruding on the older metamorphic rocks. It contains extensive pre-Cretaceous (> 65 million years ago) igneous and metamorphic rocks covered by limited exposures of post-Cretaceous sedimentary deposits.

Specifically, the project is located in Santa Ana Canyon, where the Santa Ana River passes between the Santa Ana Mountains on the south and the Chino Hills to the north. According to the geology map prepared by Morton (2004) various geological units and formations have the potential to be encountered while excavating for this project. The formations and units that have the potential to be encountered include: the Schulz Ranch member of the Williams Formation, the Santiago Formation, the undifferentiated Sespe/Vaqueros Formation, the Topanga Formation, and Very Old Alluvial Fan Deposits. In addition, Quaternary deposits that include Holocene landslides, Young Axial Channel Deposits, and Young Alluvial Fan Deposits also occur within the project alignment. In addition, although not mapped by Morton (2004), Artificial Fill likely exists in some areas, based on prior development within the footprint of the project. Each of these units and locations where they will be encountered is depicted on Figure 2, summarized in Table A, and briefly described below.

5.1.1.1. Williams Formation

Late Cretaceous (middle to late Campanian) Williams Formation was deposited in a marine to non-marine environment. It is divided into three members: the Starr member, the Schulz Ranch member, and the Pleasants Sandstone member; however, some areas are also undifferentiated. The Starr member lies unconformably on both

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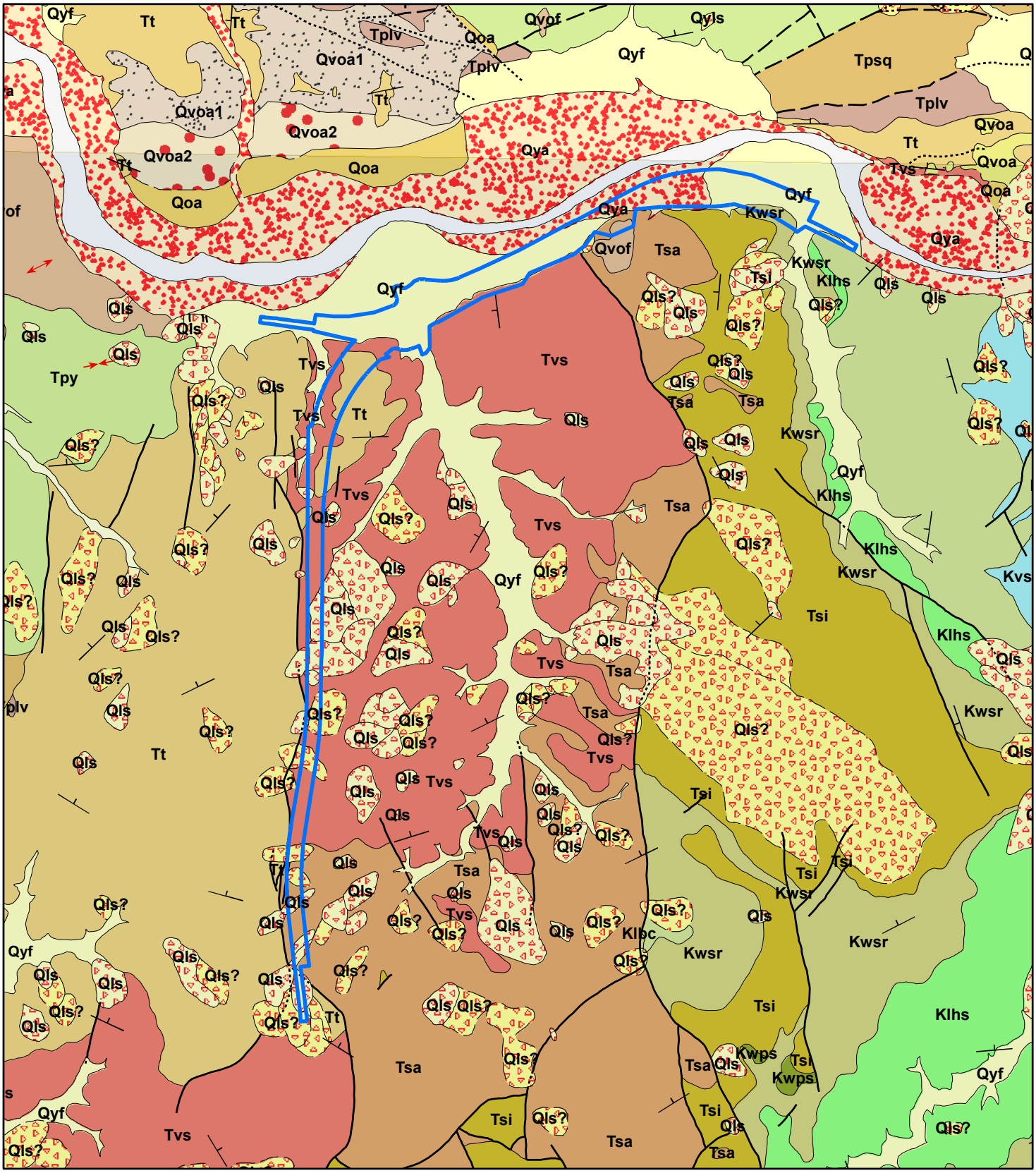

FIGURE 2

SR-241/SR-91 Express Lanes Connector

Project Location

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Table A Geologic Time Periods and Geologic Units within the State Route 91/State Route 241 Express Lane Connector Project APD

Epoch	Age (years ago)	Geologic Formation/Unit	Map Symbol
Quaternary Period			
Holocene	Less than 100	Artificial Fill (Not mapped, but known to be present)	af
Holocene	Less than 5,000	Landslide Deposits	Qls
Late Pleistocene to Holocene	126,000 to recent	Young Axial Channel Deposits	Qyf
Late Pleistocene to Holocene	126,000 to recent	Young Alluvial Fan Deposits	Qya
Early to middle Pleistocene	2.54 Ma to 300,000	Very Old Alluvial Fan Deposits	Qvof
Tertiary Period			
Middle Miocene	18–12 Ma	Topanga Formation	Tt
Early Miocene to Late Eocene	40–22 Ma	Undifferentiated Sespe Vaqueros Formation	Tvs
Middle Eocene	50–42 Ma	Santiago Formation	Tsa
Mesozoic Era			
Late Cretaceous	83–77 Ma	Williams Formation – Schulz Ranch Member	Kwsr

APD = Area of Project Disturbance
Ma = Million years

members of the Ladd Formation and in some areas on the Trabuco Formation and Basement complex rocks. The Starr member has a gradational and interfingering contact with the overlying Schulz Ranch member and has an unconformable contact in some areas with the overlying Pleasants Sandstone member. The Schulz Ranch member unconformably overlies both members of the Ladd Formation and has a gradational contact with the overlying Pleasants Sandstone member. The Pleasants Sandstone member has an unconformable contact with the overlying Silverado Formation. All members appear to correlate with the Chico Formation in the Coast Ranges and the Point Loma Formation in San Diego. The only member that is located within the project is the Schulz Ranch Member.

Schulz Ranch Member

The Schulz Ranch member appears to be deposited in a marine environment. It contains Campanian (83 to 71 million years [Ma] ago) fossils (Popenoe et al., 1960). The lower beds are composed of an olive-gray siltstone that grades to a gray white, fine to coarse grained conglomeratic sandstone in the upper beds. Pebbles and cobble clasts, generally well rounded granodiorite with minor metasedimentary and metavolcanics. Sandstone is angular and feldspathic biotite rich. In the shaly beds, montmorillonite and beidellite are the major clay minerals with minor amounts of kaolinite. The siltstone is moderately well bedded, while the conglomeratic sandstone

ranges from finely to massively bedded. Overall it reaches a maximum thickness of 1,400 ft (Morton, 1974). It outcrops in the southeastern corner of Orange County, east of Bell and Cristianitos Canyons and south of Crow Canyon.

5.1.1.2. Santiago Formation

The middle Eocene Santiago Formation is composed of marine and nonmarine sediments up to 2,690 ft thick. It conformably overlies the Silverado Formation and is in turn conformably overlain by the Undifferentiated Sespe/Vaqueros Formation. In general, the lower beds appear to be marine in origin while the upper beds are nonmarine in origin. The lower beds are light gray to yellowish gray, medium coarse-grained friable sandstone. In some areas the basal portion of these beds is a conglomerate up to 225 ft thick. The sandstone is arkosic, with essentially equal amounts of quartz and feldspar, and minor biotite that increases toward the top of the unit. The gravels are primarily siliceous plutonics and metavolcanics derived from the Santa Ana Mountains. It is massive, broadly crossbedded, and contains thin, discontinuous, lenticular lenses of greenish gray clay that are only tens of feet in lateral extent. Also present are lenses of fine siltstone and fine grained, well-bedded sandstone.

The upper beds are grayish yellow to white, friable, fine- to medium-grained sandstone interbedded with reddish brown and greenish gray mottled sandy siltstone and claystone and some small discontinuous lenses of pebbly conglomerate. The sandstone tends to be poorly sorted, poorly bedded, and angular to subangular. Conglomerate clasts are well-rounded red and green metavolcanics, light-colored plutonics, and sedimentary rocks. Montmorillonite is the main clay mineral in the siltstone and claystone lenses with minor amounts of kaolinite. Morton et al. (1976) believe that the upper beds in the northern Santa Ana Mountains, which consist of massive, pebbly sandstone, are possibly nonmarine. Schoellhamer et al. (1981) also suggest a nonmarine deposition in the Santa Ana Mountains.

5.1.1.3. Undifferentiated Sespe/Vaqueros Formation

The Late Eocene to Early Miocene Undifferentiated Sespe/Vaqueros Formation represents an interfingering of the Sespe Formation (nonmarine) and Vaqueros Formation (marine). Schoellhamer (1981) viewed the Undifferentiated Vaqueros/Sespe Formation as contemporaneous units by their interfingering. The Undifferentiated Sespe/Vaqueros Formation is composed of a varied sequence of interbedded marine and nonmarine sandstones and conglomerate. In general, the nonmarine beds are reddish in color and correlate to the Sespe Formation, and the

nonmarine beds are tan and correlate to the Vaqueros Formation. However, Lander (1994) indicates that some red beds contain marine faunas.

The Undifferentiated Sespe/Vaqueros Formation is distinguished from the Sespe Formation and Vaqueros Formation in the San Joaquin Hills and in the southern Santa Ana Mountains beginning approximately 2 mi south of Modjeska Canyon. The units range from 985 to 2,952 ft thick within the Santa Ana Mountains. Within the San Joaquin Hills, this Formation has been measured at over 2,200 ft thick (Conkling et al., 1997). The Undifferentiated Sespe/Vaqueros Formation overlies the Santiago Formation. Regarding the upper contact of this unit with the overlying Topanga, the comments of Schoellhamer et al. (1981) are of special note:

> The contact between the undifferentiated Sespe and Vaqueros Formations and the overlying Topanga Formation usually is easily recognized where the basal beds of the Topanga are fossiliferous conglomerate. The upper beds of the undifferentiated Sespe and Vaqueros, consisting of greenish-gray sandstone and silty sandstone and pinkish and reddish-brown sandstone contrast sharply with the overlying buff and tan massive conglomeratic sandstone of the Topanga. No evidence of an angular discordance between the Topanga and the underlying strata was found in the map area. The Topanga rests on various rock types of the Sespe and Vaqueros, probably as a result of changes from marine to nonmarine deposition within the Sespe and Vaqueros rather than of erosion prior to deposition of the Topanga.

Howard (1995) interpreted the sediments of the Sespe Formation as being derived from fluvial deltaic sources. The sequence varies as interbedded and interfingering marine and nonmarine claystones, siltstones, sandstones, and conglomerates. The nonmarine sequences are typically maroon to reddish in color and are primarily siltstones and claystones with varying amounts of sand. Marine sequences are typically light yellow-brown to grayish sandstones and conglomerates with occasional siltstone and claystone beds. Some sandstone and conglomerate beds may have been deposited by alluvial fans (Howard, 1995). Because of the interfingering, regional correlation of the Undifferentiated Sespe/Vaqueros Formation is difficult. Belyea and Minch (1989) stated that abrupt facies changes and lateral discontinuity hinder correlation of the Undifferentiated Sespe/Vaqueros Formation within the Northern Santa Ana Mountains.

The depositional environment for the Undifferentiated Sespe/Vaqueros Formation is one of a transitional zone between a generally braided/meandering river alluvial plain (the "Sespe Formation" of Belyea and Minch 1989) and a shallow sea ("Vaqueros Formation" of Belyea and Minch 1989). Belyea and Minch (1989) propose that the basal portion of the Sespe Formation represents braided river deposits with low sinuosity containing locally derived sand-dominated sediments. Belyea and Minch (1989) discuss a marker bed from higher up in the section that can be traced south from Gypsum Canyon to Santiago Creek to Aliso Divide to El Toro Road in the San Joaquin Hills. This marker bed was theorized to represent the following environments (from north to south): a torrential channel fill, a floodplain, a sabka/lagoon, and finally deltaic deposits. Toward the top of the section, the sediments suggest the progradation of nonmarine fluvial deposits into a marine basin (Belyea and Minch, 1989). At the very top of the section, as described by Belyea and Minch (1989), the continental Sespe Formation deposits interfinger with the marine Vaqueros Formation.

5.1.1.4. Topanga Formation

The Middle Miocene, marine, Topanga Formation is divided into four units: the undifferentiated Topanga Formation (Tt), the Bommer Member (Ttb), the Los Trancos Member (Ttlb), and the Paularino Member (Ttp). The Bommer, Los Trancos, and Paularino Members are distinguished from the undifferentiated Topanga Formation only in the northern to central San Joaquin Hills.

The Topanga Formation was first defined by Kew (1923) from a predominantly sandstone sequence in Topanga Canyon of the Santa Monica Mountains. It has been identified as middle Miocene by the presence of the *Turritella ocoyana* fauna of that age. The Topanga Formation is predominantly a sandstone sequence containing interbedded shales. The Formation rests disconformably on the Sespe and Vaqueros Formations and is overlain by the El Modeno Volcanics and the Puente and Monterey Formations (Schoellhamer, et al., 1981). Schoellhamer, et al. (1981) contends that the contact between the basal conglomerate and the underlying undifferentiated Sespe/ Vaqueros Formation is angular in the Northern Santa Ana Mountains. The basal unit of the Topanga Formation within the Northern Santa Ana Mountains is described as a conglomerate. This unit ranges from tan to gray and ranges in thickness from 6 to more than 30 ft. The conglomerate is erosion-resistant and well-cemented. Within this unit marine mollusks, including large pectinids (scallops) and oysters, are common (Schoellhamer, et al., 1981).

In general, the undifferentiated Topanga Formation consists of yellowish-gray, yellow brown to light brown silty sandstone interbedded with conglomerate and olive-gray siltstone to sandy siltstone. Quartz and feldspar dominate the sand composition. The upper beds contain a predominant amount of western bedrock detritus (mainly schists), while the lower beds contain a predominant amount of eastern bedrock detritus (metavolcanics, metasedimentary and granitic type rocks). Sand grains range from angular to subrounded. Pebbles are subrounded to rounded, and cobbles are subangular to subrounded, most thickly bedded but locally thin–medium bedded. Thicknesses range from 800 ft in the Puente Hills to 2,500 ft in the northern Santa Ana Mountains, 500 ft in the southern Santa Ana Mountains (Morton, et al., 1976), and 300 ft in the southern San Joaquin Hills (Vedder, 1970).

5.1.1.5. Very Old Alluvial Fan Deposits

The Very Old Alluvial Fan Deposits that are present within the project area were deposited during the early to middle Pleistocene (approximately 2.58 million to 300,000 years ago years ago). Pleistocene Alluvial Fan Deposits are composed mixtures of coarse-grained sand and cobble, gravel-sand deposits, and sometimes silty sand deposits. They are usually found on elevated terraces above the active stream channel, or on the sided of hills above a canyon or valley. They can also be found at depth below more recent alluvial deposits. These sediments are generally slightly to moderately consolidated, and when exposed on the surface, they have usually been dissected by erosional gullies, and have some soil development. Colors are variable and based on upstream geology, but are usually shades of reddish brown.

5.1.1.6. Late Pleistocene to Holocene Alluvium

Late Pleistocene to Holocene Alluvium also known as Young Alluvium is a geologically recent deposit of gravel, sand, silt, or mud that was deposited by flowing water in a stream or river. It is found within or very close to active stream and river drainages and is usually loosely consolidated. Sand grains are generally subangular to subrounded, while the gravels and cobbles are rounded to well-rounded. The upper several feet of these deposits may be quite young and less than several 1,000 years old. Within the project area there are two types of alluvial sediments from the Late Pleistocene to Holocene; this includes Young Axial Channel Deposits and Young Alluvial Fan Deposits. The Young Axial Channel Deposits are general restricted to wide valley floors and the Young Alluvial Fan Deposits are found on the alluvial fans that flank the wide valleys and are also found within narrow canyons.

5.1.1.7. Holocene Landslide Deposits

Holocene landslide deposits consist of blocks and flows of the underlying sediments and formations. As mapped these deposits are from the late Holocene and are all likely less than 5,000 years old. They formed as canyon cutting and aqueous erosion caused slope failure. Their composition is dependent on the underlying units that have slid. Sometimes they are no deeper than several feet and only involve movement of soil. However, sometimes they are massive, covering several acres (ac) with ruptures tens of feet deep extending well into the underlying bedrock. It should be noted that it is likely that these deposits were removed during construction, as geotechnical engineers would not want these deposits within the roadbed; however, they are discussed for completeness.

5.1.1.8. Artificial Fill

Artificial Fill is soil/dirt that is placed by humans and can be either unconsolidated or loosely compacted, or engineered and densely compacted. Composition varies and is dependent on the source. It is often mixed with modern debris such as bricks, concrete, asphalt, glass, or wood. Depending on the area, thickness can be less than 1 ft or less to several hundred feet. This unit is not mapped by Morton (2004) but likely exists in many areas of the project and was placed during the development of the SR-91 and SR-241.

5.2. Field Inspection

5.2.1. Survey Results

Chambers did not observe any fossils within any of the units that outcrop along the SR-91, but was able to confirm most of the mapped geology where it was exposed (Wagner, 2006).

During the monitoring program associated with the original construction of SR-241, PEA collected numerous fossils, including some that are within the current project limits (Lander, 2002).

Chapter 6. Paleontological Resources

6.1. Results from Records Search and Literature Review

6.1.1. Records Search Results

6.1.1.1. LACM

The LACM has one record of a vertebrate paleontological find within the project area and knows of other localities recovered nearby from formations/units that outcrop within the project area. Locality LACM 4315 is located within the Topanga Formation on the southwest side of the intersection of SR-91 and Gypsum Canyon Road (within the project APD), and it contained several species of sharks. LACM states that all units that the project crosses except the young alluvial deposits have the potential to contain significant paleontological remains.

The LACM recommends that a mitigation plan be developed that includes monitoring to quickly and professionally recover any fossils that may be encountered while not impeding development during grading within the Sespe/Vaqueros Formation and Santiago Formation. Any recovered fossils should be placed into a scientific institution for the benefit of current and future generations. A copy of the LACM locality search letter is attached at the end of this memorandum (Appendix A).

6.1.1.2. SBCM

The SBCM does not have any recorded localities within the project area. However, it knows of several localities, some within 0.5 mi of the project alignment, within similar formations/units that are within the alignment and may be encountered during ground-disturbing activities. These localities include SBCM 5.5.12 in the Santiago Formation that contained abundant gastropods and several from within Pleistocene alluvium from the nearby Chino Hills that contained extinct Pleistocene vertebrates. The SBCM states that the following formations may be encountered during ground-disturbing activities within the project area and have a high paleontological sensitivity: The Ladd Formation, Silverado Formation, Santiago Formation, Sespe and Vaqueros Formations, Topanga Formation, Puente Formation, and the older alluvium (nonmarine terrace deposits).

Because there are sediments within the project area that have high paleontological sensitivity, the SBCM recommends that a qualified vertebrate paleontologist develop a program to mitigate impacts to the nonrenewable resources that may be encountered

during excavation in these sediments. The mitigation program should be consistent with CEQA and follow guidelines of the SVP (see Appendix B).

6.1.2. Literature Search Results

6.1.2.1. Artificial Fill

Artificial Fill can contain fossils, but these fossils have been removed from their original location and are thus out of context. They are not considered to be important for scientific study.

6.1.2.2. Holocene Landslide Deposits

There is a potential for fossils within Late Holocene Landslide Deposits if the rock unit that slid contained fossils. However, the movement of these deposits has them out of context, and they are not considered to be scientifically significant. These deposits are considered to have a low paleontological sensitivity. Once excavation passes through these deposits the sensitivity of the area would change to that of the underlying unit, which in some cases may be high.

6.1.2.3. Young Alluvium

Young Alluvium includes Young Axial Channel Deposits and Young Alluvial Fan Deposits. These sediments were deposited during the late Pleistocene to Holocene. Although the approximate upper 10 ft of these sediments are can contain remains of plants and animals, generally not enough time has passed for the remains to become fossilized. In addition, the remains are contemporaneous with modern species, and these remains are usually not considered to be significant. However, once a depth of 10 ft is reached, it is likely the sediment will be older than 11,700 years old, and there will be a potential to encounter paleontological resources from the late Pleistocene. Fossils are known in similar deposits from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b, and 1987; Reynolds and Reynolds, 1991; and Miller, 1971). Mammoths are the indicator fossil for the Pleistocene Epoch, which is divided into the older Irvingtonian North American Land Mammal Age (NALMA) that spans the period between 1.8 million and 300,000 years ago, and the Rancholabrean NALMA that spans the last 300,000 years of the Pleistocene. The indicator fossil for the Rancholabrean NALMA is *Bison* sp. Both NALMAs contain other fossils such as horse, coyote, rodents, birds, reptiles, and fish that help describe climatic and habitat conditions during the last two million years. There is a potential for these types of fossils whenever Pleistocene alluvial sediments are exposed. Based on the age of

these sediments it is likely that fossils from the Rancholabrean NALMA will be encountered.

6.1.2.4. Very Old Alluvial Fan Deposits

Very Old Alluvial Fan Deposits were deposited during the early to middle Pleistocene. Like the Young Alluvium discussed above, Fossils are known in similar deposits from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b, and 1987; Reynolds and Reynolds, 1991; and Miller, 1971). Mammoths are the indicator fossil for the Pleistocene Epoch, which is divided into the older Irvingtonian NALMA which spans the period between 1.8 million and 300,000 years ago, and the Rancholabrean NALMA, which spans the last 300,000 years of the Pleistocene. The indicator fossil for the Rancholabrean NALMA is *Bison* sp. Both NALMAs contain other fossils such as horse, coyote, rodents, birds, reptiles, and fish that help describe climatic and habitat conditions during the last two million years. There is a potential for these types of fossils whenever Pleistocene alluvial sediments are exposed. Based on the age of these sediments, it is likely that fossils from the Irvingtonian NALMA will be encountered.

6.1.2.5. Topanga Formation

Abundant fossils have been found in the Topanga Formation, including bivalves, gastropods, barnacles, echinoderms, and marine and terrestrial plants. Marine mammals such as seals, sea lions, walruses, desmostylans, whales, dolphins, and sea cows are also well-documented from this Formation, as are sharks, rays, bony fish, rodents, and birds. During grading for SR-241, Lander (2003) recovered a rodent, several species of marine mammals, fish, sharks, rays, crabs, and mollusks from this Formation. Schoellhamer, et al. (1981) report 33 macrofossil localities within this unit in the northern Santa Ana Mountains that include a diverse genera of invertebrates such as gastropods, bivalves, echinoderms, and barnacles. None of these localities are within the project area; the closest locality is F141 (USGS S-14), located approximately 1,000 ft to the west of the SR-91/SR-241 interchange, on the south side of East Santa Ana Canyon Road. At this locality, several bivalves were collected.

6.1.2.6. Undifferentiated Sespe/Vaqueros Formation

Paleontological sites within these units are of very high significance. In the Undifferentiated Sespe/Vaqueros Formations in the Santa Ana Mountains, Chester Stock (CIT, Schoellhamer et al., 1981) found a locality (Cal Tech Locality S360 and V499) that yielded mammalian bone fragments within these sediments near Bolero

Lookout. These compared with, and are assumed to represent, proebrotheriid camels (Schoellhamer et al., 1981). In 1986–1987, RMW Paleo Associates discovered a large deposit of terrestrial and marine vertebrates from Bee Canyon (Raschke, 1988). These finds include cetacean (whale), oreodont (early artiodactyl), subhyracodon rhinoceros, proebrotheriid camel, and rodents. In 1991–1993, Paleo Environmental Associates, Inc. uncovered another large deposit of terrestrial and marine vertebrates from Santiago Canyon Landfill (Lander, 1994). These finds included sharks, rays, bony fish, frogs, snakes, lizards, tortoises, dogs, rabbits, shrews, hedgehogs, squirrels, mice, gophers, camels, oreodonts, deer, rhinoceros, and primitive three-toed horses. Many of these remains indicate an Arikareean North American Land Mammal Age for these sediments. In the San Joaquin Hills, during grading for the San Joaquin Hills toll road, vertebrate fossils of oreodonts, camels, rodents, and marsupials were recovered (Conkling et al., 1997). During grading for the SR-241 toll road, Lander (2003) reported finding a diverse fauna including turtles, lizards, snakes, marsupials, and mammals (including the first reported occurrence of a fossil primate from Orange County) from the terrestrial beds, and gastropods, bivalves, fish, sharks, rays, a possible crocodile, and a possible desmostylid from the marine beds. Schoellhamer et al. (1981) report 27 named fossil localities within this unit in the northern Santa Ana Mountains that preserve a diverse fauna of invertebrates, including gastropods, bivalves, echinoderms, barnacles, and one vertebrate locality.

6.1.2.7. Santiago Formation

Yerkes (1957) describes a fossiliferous buff to gray-brown in fine- to medium-grained concretionary sandstone in the upper part of the lower beds of the Santiago Formation that contains silicified logs. Schoellhamer et al. (1981) report 19 fossil localities within this unit in the northern Santa Ana Mountains that include a diverse fauna of invertebrates, including gastropods and bivalves. Lander (2003) reports that within Orange and San Diego Counties, the lower beds of this Formation contain numerous fossilized mollusks, while the upper beds contain fossilized logs up to 40 ft in length, leaves from several plant species, and the bones and teeth of lizards, snakes, turtles, birds, marsupials, and mammals. During grading for the SR-241 toll road, Lander (2003) found the oldest reported crocodilian remains from Orange County as well as some fossil plant remains.

6.1.2.8. Williams Formation Schulz Ranch Member

Popenoe et al. (1960) report that this member contains Campanian Stage (83 to 71 million years ago) fossils. Morton (1974) reports that there are palm fronds, unidentified leaf casts, and petrified wood chips within this member, mostly from the

lower siltstone beds. Schoellhamer et al. (1981) reports that bivalves of the genera *Trajanella*, *Opis*, and *Coralliochama* have been found in this member as well as the rudistid bivalve *Coralliochama* sp. Schoellhamer et al. (1981) also report the presence of the gastropod *Turritella chicoensis* that indicates this member was deposited during the Campanian Stage. Schoellhamer et al. (1981) also states that this member contains large to small blocks of redeposited bedrock that contains fossils that appear to be derived from the underlying Baker Canyon Member of the Ladd Formation.

6.1.3. Records Search and Literature Search Conclusions

The specific sensitivities for units within the study area are listed in Table B according to the Paleontological Potential Sensitivity Scale used by Caltrans. Sensitivities (and potential) for the Schulz Ranch Member of the Williams Formation, the Santiago Formation, the Undifferentiated Sespe/Vaqueros Formation, the Topanga Formation, and Very Old Alluvial Fan Deposits are all high based on the presence of significant fossil remains that have been recovered from these units in other areas. It is likely that similar significant resources may be encountered if these units are encountered during excavation associated with the SR-91/SR-241 Express Lanes Connector Project. Artificial Fill and Holocene Landslide Deposits are usually assigned a sensitivity of "low" in the event that excavation extends below the fill or landslide material to the underlying formation or unit. The Young Axial Channel Deposits and Young Alluvial Fan Deposits are too young to contain paleontological resources within the upper approximate 10 ft because the upper 10 ft is likely from the Holocene; however, once a depth of 10 ft is reached it is likely that the sediments are from the Pleistocene and are old enough to contain scientifically significant resources. Thus, once a depth of 10 ft is reached, the paleontological sensitivity of the area becomes High.

The Paleontological Resources Sensitivity Map (Figure 3) graphically presents a summary of the project study area and the underlying formations with paleontological sensitivity, presented as sensitivity polygons.

Paleontological resource sensitivity ratings for sedimentary polygons are consistent with those used by both Caltrans and the SVP:

- High sensitivity (H) is based on formations or mappable rock units that are known to contain or have the correct age and depositional conditions to contain significant paleontological resources.

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FIGURE 3

LEGEND

Study Area

Paleontological Resources Sensitivity

Low

Low 0-10', High below 10'

High

N

0 1250 2500

FEET

SOURCE:Microsoft (5/2010); Morton (2004)

I:\RBF1101\GIS\PaleoSens.mxd (12/9/2013)

SR-241/SR-91 Express Lanes Connector

Paleontological Resources Sensitivity Map

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Table B Geologic Units and Geologic Units and Paleontological Sensitivity[1] within the SR-91/SR-241 Express Lanes Connector Project APD

Geologic Unit	Paleontological Sensitivity (Caltrans)
Artificial Fill	Low
Holocene Landslide Deposits	Low
Young Axial Channel Deposits	Low 0 to 10 feet High below 10 feet
Young Alluvial Fan Deposits	Low 0 to 10 feet High below 10 feet
Very Old Alluvial Fan Deposits	High
Topanga Formation	High
Undifferentiated Sespe Vaqueros Formation	High
Santiago Formation	High
Williams Formation – Schulz Ranch Member	High

Source: SVP and Caltrans Guidelines.
[1] Also known as Paleontological Potential
APD = Area of Project Disturbance
Caltrans = California Department of Transportation
SR-91 = State Route-91
SR-241 = State Route 241
SVP = Society of Vertebrate Paleontology

- Low sensitivity (L) is determined by a qualified vertebrate paleontologist conducting a literature and records review as well as a field survey. Low sensitivity cannot be determined simply by looking for rock unit descriptions on a geologic map. For instance, an area mapped as Qal may actually be a thin, surficial layer of non-fossiliferous sediments covering fossil-rich Pleistocene sediments. An area mapped as granite may be covered by a Pleistocene soil horizon that contains fossils. The actual sensitivity must be determined by a records search and field inspection.

Figure 3 shows that portions of the project are located in areas identified with high paleontological sensitivity at surface and at depth, as well as areas of low paleontological sensitivity. Grading and excavation will occur with implementation of the proposed project.

6.1.4. Results Summary

The SR-91/SR-241 Express Lanes Connector Project is anticipated to disturb sediments with high potential to contain significant, nonrenewable paleontological resources. Portions of the project are located in areas identified as having high paleontological sensitivity at the surface and at depth. One LACM fossil locality is known to be within the project area and one SBCM locality is known to be within 0.5 miles. Both the LACM and the SBCM know of localities in other areas with the same

sediments that are present within the project area. Research also documented known fossil localities within sediments similar to those within the project, some located in proximity to the project area. Based on the positive results of this PIR/PER study, it is recommended that a PMP be prepared for this project following the Caltrans SER guidelines. These paleontological resource impact minimization measures within the PMP shall be incorporated into the plans, specifications, and estimates for the project.

6.2. Recommendations for Paleontological Mitigation Plan

The SVP and Caltrans present similar guidelines for adequate mitigation of impacts to significant, nonrenewable paleontological resources. Excerpts from individual guidelines follow:

6.2.1. Society of Vertebrate Paleontology

Recommended general guidelines for conformable impact mitigation to significant nonrenewable paleontological resources have been published by the SVP (1995) along with conditions of receivership that the repository institution can require when receiving fossils recovered from construction projects (SVP, 1996). In areas determined through a records check and field survey to have a high potential for significant paleontological resources, an adequate program for mitigating the impact of development should include the following:

- A preliminary survey and surface salvage of any observed fossils prior to construction
- Monitoring and salvage during project excavation
- Preparation, including screen washing to recover small specimens (if applicable) and specimen preparation to a point of stabilization and identification
- Identification, cataloging, curation, and storage in a museum or university that has a curator who can retrieve the specimens upon request
- A final report of the finds and their significance after all operations are completed

All phases of mitigation are to be supervised by a professional paleontologist who maintains the necessary paleontological collecting permits (if required) and repository agreements. The Lead Agency ensures compliance with the measures developed to mitigate the impacts of excavation during the initial assessment. To ensure compliance from the start of the project, a statement that confirms the site's potential sensitivity, confirms the repository agreement with an established institution, and indicates the program for impact mitigation should be deposited with the Lead Agency and contractors before work begins. The program will be reviewed and

accepted by the Lead Agency's designated vertebrate paleontologist. If a mitigation program is initiated early in the course of project planning, construction delays due to paleontologic salvage activities can be minimized or avoided.

6.2.2. California Department of Transportation

Caltrans has developed a similar set of guidelines to reduce impacts to paleontological resources. These recommendations start with avoidance of the resource area by the project and continue with recommendations for impact minimization measures during construction excavation.

6.2.2.1. Avoidance

Avoidance of project impacts can be achieved by project redesign so that paleontological resources are completely outside the project's impact area (e.g., a different alignment route that misses the resource or a construction approach that does not entail construction excavation that would impact fossiliferous strata).

6.2.2.2. Environmentally Sensitive Areas

A related strategy creates Environmentally Sensitive Areas (ESAs) around paleontological localities. ESAs are a standard part of Caltrans and FHWA toolkit to protect resources within or adjacent to a project while concurrently delivering the project. Generally, these involve some combination of fencing or cyclic monitoring as an alternative to excavation monitoring. In the event that the special measures prove ineffective for one reason or another, more traditional mitigation is necessarily called for. This fallback sometimes affects delivery schedules and/or total project costs. If viable and properly implemented, however, ESAs can reduce costs and time associated with more extensive traditional mitigation approaches.

6.2.2.3. Paleontological Mitigation Plan

Since the geology of California is diverse and the nature of the fossils that it contains varies from one outcrop to the next, Caltrans does not provide a generic paleontological resource impact mitigation, but instead presents a format for the PMP that can be utilized by the professional project paleontologist who has been retained to manage paleontological resources during project development. A full list of sections of the PMP is included in Caltrans' SER Environmental Handbook, Volume 1, Chapter 8 (Caltrans, 2012). Briefly, the PMP sections are:

- **Introduction:** A brief discussion of the goals of the proposed study, of the construction project effects, and why mitigation is needed (e.g., compliance with CEQA).

- **Background:** Pertinent information should be provided to demonstrate familiarity with the project area and the type of fossils and rock units under study.
- **Description of the Resource:** A description of the rock units, boundaries of the fossiliferous formations, and locations of exposures in the vicinity of the Project study area and in the APD.
- **Proposed Research:** A clear, concise description of why the paleontological resource is significant or has scientific importance, and how the study is expected to address current gaps in the paleontological data.
- **Scope of Work:** The work plan to mitigate project effects, including all fieldwork and laboratory efforts. This may include:
  - Procedures for interfacing paleontological and construction personnel developed in consultation with the Resident Engineer (RE).
  - Construction monitoring programs should be outlined.
  - Salvage methods should be outlined, from large specimen recovery to collection and processing of microfossils.
  - Recovered specimens should be prepared to a point of identification and stabilized for preservation in conformance with individual repository requirements.
  - All recovered specimens should be cataloged using the format of the proposed curation facility.
  - Not all located fossils need to be recovered. Criteria for the discarding of specific fossil specimens should be made explicit.
- **Decision Thresholds:** How and when fieldwork will achieve the study goals, allowing fieldwork to cease, or any circumstances under which additional effort might be needed to achieve study goals.
- **Schedule:** The schedule for completing the proposed work may appear as text or in graphic form (e.g., a timeline) and include a start date, the duration of fieldwork and laboratory processing, and the time required for report preparation.
- **Justification of Cost Estimate:** Provides narrative support for the cost estimate, including the basis for person-hour estimates, clarification of overhead percentages, and any other costs.
- **Cost Estimate:** This is often presented as an appendix; this documentation should present a tabular summary of costs for the proposed effort and include all proposed numbers and levels of personnel, time, and costs.
- **Bibliography:** The bibliography should include only those references cited in the plan.

- **Curation:** The curation facility should be identified and a draft curation agreement included. A curation agreement with an approved facility must be in place prior to initiating any paleontological monitoring or mitigation activities.

The plan should be prepared by or under the supervision of a qualified Principal Paleontologist and submitted for review sufficiently in advance of an anticipated start-work date so that all involved agencies have time to comment, the Lead Agency has time to adjust the plan to accommodate such input, and the plan may be resubmitted for all necessary approvals. It is imperative that all agencies with jurisdiction over a paleontological site are in agreement as to the level of effort in the mitigation plan, including agreement on the applicability of pertinent laws, regulations, and permit requirements. When properly designed, the PMP serves as a basis for obtaining any necessary permits from other agencies.

Specific interagency issues may include, but are not limited to, health and safety issues; employee access and egress; collection, removal, and stockpiling of fossiliferous sediment; wet screen processing of fossiliferous sediment and disposal of muddy wastewater; and use of chemicals (kerosene) to break down specific types of indurated fossiliferous sediment. Agency permits that may be needed for access or to conduct the work of monitoring and salvage should be applied for and obtained in advance of the project.

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Chapter 7. Summary

The SR-91/SR-241 Express Lanes Connector Project crosses five fossiliferous Late Cretaceous to middle Pleistocene sediments (the Schulz Ranch Member of the Williams Formation, the Santiago Formation, the Undifferentiated Sespe/Vaqueros Formation, the Topanga Formation, and Very Old Alluvial Fan Deposits) that were deposited during the last 83 million years and have a high paleontological sensitivity. These deposits all crop out at the surface and may also be encountered below the surface in areas where younger sediments are present. Two sediments, Young Axial Channel Deposits and Young Alluvial Fan Deposits, are present in some areas, have a low paleontological sensitivity from the surface to approximately 10 ft below the surface, and a high paleontological sensitivity below a depth of 10 ft. Two other sediments, Artificial Fill and Holocene Landslide Deposits, are present in some areas and have a low paleontological sensitivity; however; these sediments have variable thicknesses, and once excavation extends below them, the paleontological sensitivity for the area may change to either high or low, depending on the sensitivity of the sediment that is encountered. This study presents definitions of paleontological significance and sensitivity, the results of records search requests, and reviews of geological and paleontological literature.

This study does not anticipate special paleontological situations that would require project redesign to avoid critical localities or strata. However, because there are areas of high paleontological sensitivity within the proposed project study area, preparation of a Caltrans PMP is recommended prior to completion of final design within those areas of the proposed project identified as having high sensitivity. This PMP should be synthesized from outlines and guidelines provided by Caltrans and the SVP, and specifically tailored to the resources and sedimentary formations that will be encountered during excavation within the proposed project area.

This study recommends that the section of the PMP describing the excavation monitoring for the proposed project include the following:

- Attendance at the pregrade meeting by a qualified paleontologist or representative. At this meeting, the paleontologist will explain the likelihood for encountering paleontological resources, what resources may be discovered, the methods of recovery that will be employed, and what construction personnel should do in the event paleontological resources are encountered when a monitor is not present.

- A preconstruction field survey in areas identified as having high paleontological sensitivity after vegetation and paving have been removed, followed by salvage of any observed surface paleontological resources prior to the beginning of additional grading. This requirement is consistent with Mitigation Measure P-1 in the ETC EIR/EIS, which reads "In conjunction with final design, an intensive pregrading survey of the entire alignment to locate fossil sites not recorded during the environmental review process shall be conducted by a qualified paleontologist. Vertebrate remains and representative samples of invertebrate remains shall be collected and recorded. The paleontologist shall, based on the field survey results, reclassify rock units of unknown importance to low, moderate or high importance."
- During construction excavation, a qualified vertebrate paleontological monitor shall initially be present on a full-time basis whenever excavation will occur within the sediments that have a high paleontological sensitivity rating, and on a spot-check basis for excavation in sediments that have a low sensitivity rating. Monitoring may be reduced to a part-time basis if no resources are being discovered in sediments with a high sensitivity rating (monitoring reductions, when they occur, will be determined by the qualified Principal Paleontologist). The monitor shall inspect fresh cuts and/or spoils piles to recover paleontological resources. The monitor shall be empowered to temporarily divert construction equipment away from the immediate area of the discovery. The monitor shall be equipped to rapidly stabilize and remove fossils to avoid prolonged delays to construction schedules. If large mammal fossils or large concentrations of fossils are encountered, Caltrans will consider using heavy equipment on site to assist in the removal and collection of large materials. This requirement is consistent with Mitigation Measure P-2 in the ETC EIR/EIS, which reads "In conjunction with site preparation and grading, the paleontologist shall monitor clearing and grading in areas underlain by rock units of high importance full-time, in areas underlain by rock units of moderate importance on a half-time basis and will spot check but not monitor grading in areas underlain by rock units of low importance. If sufficient important fossil remains are found during field survey or construction monitoring in an area underlain by a rock unit of low or moderate importance, the paleontologist shall raise the importance of the rock unit and increase the monitoring effort, as appropriate. The number of monitors to be stationed in each construction area during grading shall be based on the amount of rock to be moved per day."

- Mitigation Measure P-3 in the ETC EIR/EIS states that "In conjunction with site preparation and grading, the paleontologist shall collect rock samples from suitable horizons in formations of high, moderate and unknown importance. At the paleontologist's discretion and to reduce any construction delay, the grading contractor shall assist in collecting the samples and moving them to an adjacent off-site location for later transportation by the monitor to the Orange County Natural History Museum or a similar facility."
- Localized concentrations of small (or micro-) vertebrates may be found in all native sediments. Therefore, it is recommended that these sediments occasionally be spot-screened on site through 1/8- to 1/20-inch mesh screens to determine whether microfossils are present. If microfossils are encountered, sediment samples (up to 3 cubic yards, or 6,000 pounds) shall be collected and processed through 1/20-inch mesh screens to recover additional fossils.
- Mitigation Measure P-4 in the ETC EIR/EIS states that "If fossil remains are found during site preparation, grading or construction, the paleontologist shall temporarily stop work and notify TCA of the work stoppage. The TCA shall follow the procedures in Chapter 7 of the TCA Administrative Code for development of mitigation if mitigation is determined to be necessary."
- Recovered specimens shall be prepared to the point of identification and permanent preservation. This includes the sorting of any washed mass samples to recover small invertebrate and vertebrate fossils, the removal of surplus sediment from around larger specimens to reduce the volume of storage for the repository and storage cost, and the addition of approved chemical hardeners/stabilizers to fragile specimens. This requirement is consistent with Mitigation Measure P-5 in the ETC EIR/EIS, which reads "After the completion of the on-site monitoring, the paleontologist shall process all collected rock samples for microvertebrate and other fossil remains, prepare and identify all collected remains, incorporate them into a retrievable storage system, and file accompanying field notes, maps and photographs at the Orange County Natural History Museum or a similar facility."
- Specimens shall be identified to the lowest taxonomic level possible and curated into an institutional repository with retrievable storage. The repository institutions usually charge a one-time fee based on volume, so removing surplus sediment is important. The repository institution may be a local museum or university with a curator who can retrieve the specimens on request. Caltrans requires that a draft curation agreement be in place with an approved curation facility prior to the initiation of any paleontological monitoring or mitigation activities.

- Preparation and submittal of the PMR documenting completion of the PMP for the Lead Agency (Caltrans). This requirement is consistent with Mitigation Measure P-6 in the ETC EIR/EIS, which reads "Following completion of the monitoring, identification, storage and documentation activities, the paleontologist shall prepare a summary report presenting an inventory and describing the significance of accessioned remains."

Implementation of these recommendations will reduce impacts to nonrenewable paleontological resources. More project-specific measures may need to be developed during preparation of the PMP to refine these measures during final project design.

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Appendix A. Records Search Results from the Natural History Museum of Los Angeles County

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Natural History Museum of Los Angeles County
900 Exposition Boulevard • Los Angeles, CA 90007

Vertebrate Paleontology Section
Telephone: (213) 763-3325
FAX: (213) 746-7431
e-mail: smcleod@nhm.org

31 January 2008

LSA Associates, Inc.
20 Executive Park, Suite 200
Irvine, California 92614-4731

Attn: Brooks Smith, Cultural and Paleontological Resources Group

re: Paleontological Resources Records Search for the proposed State Route 241 Connector to State Route 91 Project, LSA Project # CHM0702, near the City of Corona, Orange and Riverside Counties, project area

Dear Brooks:

I have searched our paleontology collection records for the locality and specimen data for the proposed State Route 241 Connector to State Route 91 Project, LSA Project # CHM0702, near the City of Corona, Orange and Riverside Counties, project area as outlined on the sections of the Prado Dam and Black Star Canyon USGS topographic quadrangle maps that you sent to me via e-mail on 30 January 2008. We have one vertebrate fossil locality that liee directly within the proposed project area, and other localities nearby from the same sedimentary deposits that occur in the proposed project area.

Along the Riverside Freeway (Highway 91) surface deposits in the lower lying portions of the proposed project route area in the Santa Ana River channel consist of younger Quaternary Alluvium, either as fluvial sands and gravels from the Santa Ana River or as fan deposits from the adjacent hills to the south. At the eastern end of the proposed project route area around the intersection with the Corona Freeway (Highway 71) there are exposures of older Quaternary Alluvium in the less steeply inclined portions of the elevated terrain. The more steeply inclined portions of the elevated terrain in the eastern end of the proposed project route area have exposures of the marine late Miocene Puente Formation (also known as the Sycamore Canyon Formation or members of the Monterey Formation in this area). Just west of the intersection of the Riverside Freeway (Highway 91) with Green River Road there are exposures of the marine middle Miocene Topanga Formation, the late Oligocene or early Miocene Sespe and Vaqueros Formations (these may be difficult to distinguish in this area but the Sespe Formation is typically terrestrial and the Vaqueros is typically marine), the Eocene Santiago Formation, the marine Paleocene Silverado Formation and the marine late Cretaceous Ladd Formation. On the west side of the Whittier Fault, just west of Riverside / Orange County line, there are exposures of the

Mesozoic Santiago Peak volcanics and then a reversal of the sequence of rocks from the Silverado Formation up through the Topanga Formation.

Further west along the proposed project route area, from just east of the intersection of the Riverside Freeway (Highway 91) with Coal Canyon Road, there are additional exposures of the marine late Cretaceous Ladd Formation, then exposures of the Paleocene Silverado Formation, the marine Eocene Santiago Formation, and late Oligocene to early Miocene Sespe / Vaqueros Formations undifferentiated. Where the proposed project route area turns south at the intersection of the Riverside Freeway (Highway 91) and the Eastern Transportation Corridor (Highway 241) there are further exposures of the late Oligocene to early Miocene Sespe / Vaqueros Formations undifferentiated and of the marine Middle Miocene Topanga Formation.

The igneous rocks of the Santiago Peak volcanics, of course, will be devoid of fossils. The younger Quaternary alluvial deposits found in the lower lying portions of the proposed project route area on the southern side of the Santa Ana River drainage typically do not contain significant vertebrate fossils, at least in the uppermost layers, and we have no vertebrate fossil localities anywhere nearby from such deposits. Our closest fossil vertebrate locality from older Quaternary deposits is LACM 1207, almost due east of the eastern-most portion of the proposed project route area between Corona and Norco, that produced a fossil specimen of deer, *Odocoileus*.

Our closest fossil vertebrate localities in the Puente Formation are about sixty localities, LACM 5560, 6307-6337, 7266-7267, 7269-7270, 7272-7284, 7373-7381, 7383, and 7386, just south of Los Serranos and west of the Corona Freeway (Highway 71) directly north of the western portion of the proposed project route area. These localities have produced a rich fauna of fossil fish and marine mammals (see attached for composite fauna from these localities). Our closest vertebrate fossil locality from the Topanga Formation is LACM 6292, along Santiago Canyon Road directly west of the Santiago Reservoir south-southwest of the proposed project route area, that produced a fossil specimen of dog shark, *Mustelus*. We have one vertebrate fossil locality, LACM 4315, from the marine Vaqueros portion of the Sespe / Vaqueros Formations undifferentiated, that lies directly within the proposed project route area. Locality LACM 4315, on the southwest side of the intersection of the intersection of the Riverside Freeway (Highway 91) and Gypsum Canyon Road, produced fossil specimens of basking shark, *Cetorhinus*, sand shark, *Carcharhinus*, angel shark, *Squatina*, and stingray, *Dasyatis*.

Our closest vertebrate fossil localities from the Santiago Formation all occur in San Diego County far to the south-southeast of the proposed project route area, but specimens from one of those localities, LACM 68102, including the fossil camel *Protylopus pearsonensis* and the fossil horned artiodactyl *Leptoreodon leptolophus,* were published in the scientific literature by D.J. Golz (1976. Eocene Artiodactyla of southern California. LACM Science Bulletin, 26:1-85). Our only Silverado Formation locality from this area, LACM 4634, produced a specimen of a fossil

turtle, Testudinidae. Our closest vertebrate fossil locality from the Ladd Formation is LACM 4221, in Silverado Canyon directly south of the eastern portion of the proposed project route area, produced specimens of the fossil sharks *Squalicorax* and *Cretolamna appendiculata*.

Excavations in the small exposures of the Santiago Peak volcanics in the proposed project route area will not encounter any fossils. Surface grading or shallow excavations in the younger Quaternary Alluvium exposed in the lower lying portions of the proposed project area are unlikely to encounter significant vertebrate fossils. Deeper excavations in those areas that extend down into older Quaternary deposits, however, as well as any excavations in the exposures of the Puente Formation, the Topanga Formation, the Sespe / Vaqueros Formations, the Santiago Formation, the Silverado Formation, or the Ladd Formation found in the more elevated portions of the proposed project route area, may well encounter significant remains of fossil vertebrates. Any substantial excavations in the proposed project area, therefore, should be monitored closely to quickly and professionally recover any fossil remains while not impeding development. Any fossils collected should be placed in an accredited scientific institution for the benefit of current and future generations.

This records search covers only the vertebrate paleontology records of the Natural History Museum of Los Angeles County. It is not intended to be a thorough paleontological survey of the proposed project area covering other institutional records, a literature survey, or any potential on-site survey.

Sincerely,

Samuel A. McLeod, Ph.D.
Vertebrate Paleontology

enclosures: appendix, invoice

Composite fossil fauna from Puente Formation localities just south of Los Serranos, Chino Hills
Localities LACM 5560, 6307-6337, 7266-7267, 7269-7270, 7272-7284, 7373-7381, 7383, and 7386

Osteichthyes		
Clupeiformes		
Clupeidae		- herrings
Ganolytes	*cameo*	
Xyne	*grex*	
Gadiformes		
Gadidae		- cods
Eclipes		
Moridae		- moras
Myctophiformes		
Myctophidae		- lanternfishes
Perciformes		
Carangidae		- jacks; amberjacks; pompanos
Decapterus		
Pseudoseriola		
Gempylidae		- snake mackerels; escolars; oilfishes
Thyrsocles	*kriegeri*	
Sciaenidae		- croakers
Lompoquia		
Scombridae		- mackerels & tunas
Sarda		
Scomber		
Serranidae		- sea basses & groupers
Sparidae		- porgies
Plectrites	*classeni*	
Salmoniformes		
Bathylagidae		- deep sea smelts
Salmonidae		- trouts & salmons
Oncorhynchus		
Scorpaeniformes		
Scorpaenidae		- scorpionfishes & rockfishes
Stomiatiformes		
Chauliodontidae		- viperfish
Chauliodus	*eximius*	
Sternoptychidae		- hatchetfishes
Argyropelecus		
Mammalia		
Carnivora		
Otariidae		- eared seal [sea lions]
Pithanotaria		
Cetacea		
Balaenopteridae		- rorqual baleen whales
Phocoenidae		- porpoises
Physeteridae		- sperm whales
Scaldicetus		

Appendix B. Records Search Results from the San Bernardino County Museum

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SAN BERNARDINO COUNTY MUSEUM

2024 Orange Tree Lane • Redlands, California USA 92374-4560
(909) 307-2669 • Fax (909) 307-0539 • www.sbcountymuseum.org
TDD (909) 792-1462

COUNTY OF SAN BERNARDINO
PUBLIC AND SUPPORT
SERVICES GROUP

ROBERT L. McKERNAN
Director

LSA

FEB 2 1 2008

RECEIVED
IRVINE

11 February 2008

LSA Associates, Inc.
attn: Brooks Smith
20 Executive Park, Suite 200
Irvine, CA 92614

re: **PALEONTOLOGY LITERATURE AND RECORDS REVIEW, SR-241 CONNECTOR TO SR-91, ORANGE AND RIVERSIDE COUNTIES, CALIFORNIA**

Dear Mr. Smith,

The Division of Geological Sciences of the San Bernardino County Museum (SBCM) has completed a literature review and records search for the above-named project alignment in Orange and Riverside Counties, California. The proposed project alignment traverses portions of sections 29, 30, and 31, Township 3 South, Range 7 West; sections 25, 26 (projected), 33 (projected), 34 (projected), 35 (projected), and 36, Township 3 South, Range 8 West; and section 4 (projected), Township 4 South, Range 8 West, San Bernardino Base and Meridian, as seen on the Black Star Canyon, California (1967 edition) and the Prado Dam, California (1967 edition, photorevised 1981) 7.5' United States Geological Survey topographic quadrangle maps.

Previous geologic mapping of the area (Durham and Yerkes, 1964; Rogers, 1965; Morton, 2004) indicates that the proposed project alignment traverses a number of geologic units with high potential to yield significant nonrenewable paleontologic resources, including (from oldest to youngest): the Baker Canyon and Holz Shale Members of the Ladd Formation (late Cretaceous Period) (= units **Klbc**, **Klhs**); the Silverado Formation (Paleocene Epoch) (= **Tsi**); the Santiago Formation (middle Eocene) (= **Tsa**); undifferentiated rocks of the Vaqueros and Sespe Formations (late Eocene through early Miocene Epochs) (= **Tvs**); the Topanga Formation (middle Miocene) (= **Tt**); the Yorba and Sycamore Canyon Members of the Puente Formation (Miocene and early Pliocene) (= **Tpy**, **Tpsc**); Quaternary very old fan deposits (early Pleistocene Epoch) (= **Qvof**); and Quaternary fan deposits (middle to later Pleistocene Epoch) (= unit **Qof**). The undifferentiated Sespe and Vaqueros rocks have high potential to yield significant nonrenewable paleontologic resources, and so are assigned high paleontologic sensitivity. The Quaternary fan gravels have undetermined paleontologic potential; depending upon their lithology, they may have high paleontologic sensitivity.

The late Cretaceous Ladd Formation consists of marine and locally nonmarine conglomerate, sandstone, siltstone and shale, and is fossiliferous throughout its extent. The Baker Canyon Conglomerate (**Klbc**) consists of marine and, possibly, locally nonmarine conglomerate; sparsely distributed sandstone beds yield abundant mollusc fossils (Morton, 2004). The Holz Shale Member

(= **Klhs**) consists of marine shale, siltstone, sandstone, localized conglomerate, and yields abundant foraminifera and megafossils (Morton, 2004). Although primarily marine in nature, the Ladd Formation has also yielded fossil remains of terrestrial vertebrates, particularly several fossils of extinct hadrosaurian dinosaurs (Hilton, 2003). This formation is therefore assigned high paleontologic sensitivity.

The Paleocene Silverado Formation (**Tsi**) contains coal seams, lignite beds and commercial clay deposits, as well as abundant fossil mollusks (Woodring and Popenoe, 1945) and vertebrate fossils. The Silverado Formation grades upwards into the Santiago Formation (**Tsa**), a continental and marine sandstone and conglomerate rock unit (Woodring and Popenoe, 1945; Schoellhamer and others, 1981). The lower part of this formation contains abundant marine mollusks, while the upper portion commonly yields silicified wood that is likely of terrestrial rather than marine origin (Morton, 2004).

Rocks of the undifferentiated Sespe and Vaqueros Formations (**Tvs**) consist of interbedded marine and nonmarine sandstones and conglomerates. Locally, marine fossil-bearing strata of the Vaqueros Formation are bed-by-bed interlayered with nonmarine rocks of the Sespe Formation, to such a degree that the formations cannot be mapped as separate units (Morton, 2004). The continental Sespe Formation and interbedded marine Vaqueros Formation are both abundantly fossiliferous; the former has yielded fossil remains of terrestrial vertebrate fossils ranging in age from the Eocene through to the early Miocene, while the marine Vaqueros Formation has yielded shallow water marine megafossils (Morton, 2004).

The Topanga Formation (**Tt**) is a shallow-water marine sandstone unit with small amounts of siltstone and conglomerate deposited during the middle Miocene Epoch, ~18 million years ago (mya) to 16 mya. Exposures of the Topanga Formation are highly fossiliferous throughout Los Angeles and Orange Counties. Marine vertebrates including pinnipeds, whales, dolphins and sea cows, as well as microplankton, clams, snails, bony fish, sharks, sea turtles, and birds have all been collected from this unit. The Topanga Formation has high paleontologic sensitivity throughout its extent.

The Puente Formation was originally named by Eldridge and Arnold (1907) from exposures in the Puente Hills. The Puente Formation is considered to be equivalent to the Upper Miocene Monterey Formation (Blake, 1856) which is widespread in the Coast Range province of California as well as in the Palos Verdes Hills and the San Juan Capistrano area (Bramlette, 1946; Vedder and others, 1957; Vedder, 1975; Woodring and others, 1940; Woodring and others, 1946; Schoellhamer and others, 1981). The Yorba and Sycamore Canyon Members of the Puente Formation (**Tpy**, **Tpsc**) are the uppermost and youngest of the Miocene sediments in this formation (Durham and Yerkes, 1964; Rogers, 1965). The Yorba Member has yielded foraminifera and fish scales from exposures in the Santa Ana Mountains; foraminifera are also abundant in a few sites in the Puente Hills. The fossils indicate a deep water depositional environment, probably greater than 1,800 feet. The thin-bedded, well-laminated sandstone probably reflects deposition by turbidity currents from shallower depths (Durham and Yerkes, 1964; Schoellhamer and others, 1981). The shoreline may have extended as far east as Ontario before trending south to the Santa Ana River (Woodford and others, 1946).

Until 1985, diagnostic fossils were reported to be sparse in the Sycamore Canyon Member both in the Santa Ana Mountains (Schoellhamer and others, 1981) and in exposures in the Puente Hills, although foraminifera are locally common. However, several thousand specimens have since been exposed and recovered from the Sycamore Canyon Member, representing a minimum of 62 identified taxa of microfossil invertebrates and megafossil vertebrates, invertebrates, plants, and marine algae. Taxa identified include whales, bird, marine turtle, shark, bony fishes, terrestrial leaves, wood, reeds, and seaweeds. These fossils, in conjunction with lithologic and stratigraphic data gathered during monitoring, indicated that deposition occurred in near-shore water at a depth near the oxygen-minimum boundary during the latest Miocene Epoch, approximately 8 million years before present.

Surface and subsurface deposits of Pleistocene fan sediments (**Qvof** and **Qof**) include gravels, sands, and clays (Morton, 2004). Of these lithologies, the sands and clays have high paleontologic sensitivity, while the gravels may not be as conducive to the preservation of paleontologic resources (although occasionally significant fossil remains can be recovered from such sediments). Pleistocene older alluvial sediments throughout Riverside County and the Inland Empire have been extensively reported to yield significant fossils of plants and extinct animals from the Ice Age (Jefferson, 1991; Reynolds and Reynolds, 1991; Woodburne, 1991; Springer and Scott, 1994; Scott, 1997; Springer and others, 1998, 1999, 2007; Anderson and others, 2002). Fossils recovered from these Pleistocene sediments represent extinct taxa including mammoths, mastodons, ground sloths, dire wolves, short-faced bears, sabre-toothed cats, large and small horses, large and small camels, and bison (Springer and Scott, 1994; Scott, 1997; Springer and others, 1998, 1999, 2007; Anderson and others, 2002).

For this review, Craig R. Manker of the Division of Geological Sciences, SBCM conducted a search of the Regional Paleontologic Locality Inventory (RPLI). The results of this records search indicated that no paleontologic localities are recorded from along the proposed project alignment. However, exposures of the Baker Canyon and Holz Shale Members of the Ladd Formation have yielded fossils from within ½ mile of the project corridor. Localities SBCM 5.5.4 - 5.5.6 are recorded in the RPLI as yielding leaf fragments, water reeds, and molluscs from this formation. The proximity of these localities to the project corridor demonstrates the high paleontologic sensitivity of the Ladd Formation in this region.

Exposures of the Silverado Formation within ½ mile of the proposed project alignment have yielded fossil remains from four localities (SBCM 5.5.7 - 5.5.9 and 5.5.11). Fossils recovered from these localities include water reeds, leaves, wood fragments (including some with insect borings), and abundant molluscs. These localities demonstrate the high paleontologic sensitivity of the Silverado Formation near the project alignment.

Exposures of the Santiago Formation immediately adjacent to the proposed project alignment have yielded fossils from locality SBCM 5.5.12. Fossils recovered from this locality include abundant gastropods. The proximity of this locality to the proposed project corridor demonstrate the high paleontologic sensitivity of the Santiago Formation in this area.

Exposures of the Puente Formation in the near vicinity of the proposed project alignment have yielded fossil resources from thirty-nine (39) resource localities (SBCM 1.116.16 to 1.116.23, 1.116.180 to 1.116.205, 5.5.35, 5.5.40, 5.5.44 - 5.5.45, and 5.5.47). Fossils identified from these localities include fish bones and scales, as well as shark teeth. Nearby exposures of the Puente Formation in Chino Hills to the northwest have yielded several hundred vertebrate fossils of Miocene age from over one hundred discrete resource localities. This wealth of fossil material clearly demonstrates the high paleontologic sensitivity of the Puente Formation in the vicinity of the proposed project corridor.

Additionally, numerous localities in the Chino Hills region have yielded fossil remains of extinct Pleistocene vertebrates from Pleistocene older alluvial sediments mapped (Durham and Yerkes, 1964; Rogers, 1965) as similar to the sediments present along the proposed project corridor.

Recommendations

The results of the literature review and the check of the RPLI at the SBCM demonstrate that excavation for the proposed project has high potential to impact significant nonrenewable paleontologic resources. This property is therefore assigned high paleontologic sensitivity along much of its length. Excavation into the Ladd Formation, the Silverado Formation, the Santiago Formation, undifferentiated rocks of the Vaqueros and Sespe Formations, the Topanga Formation, the Puente Formation, and/or older alluvium of Pleistocene age will require a qualified vertebrate paleontologist to develop a program to mitigate impacts to nonrenewable paleontologic resources. This mitigation program should be consistent with the provisions of the California Environmental Quality Act (Scott and Springer, 2003), as well as with regulations currently implemented by the County of Riverside and the proposed guidelines of the Society of Vertebrate Paleontology. This program should include, but not be limited to:

1. A full paleontologic resource assessment in advance of excavation or development, including a field survey, to locate and recover significant nonrenewable paleontologic resources exposed at the surface.

2. Monitoring of excavation in areas identified as likely to contain paleontologic resources by qualified paleontologic monitors. Based upon the results of this review, areas of concern along the proposed alignment include undisturbed surficial and subsurface rocks of the Ladd Formation, the Silverado Formation, the Santiago Formation, the Vaqueros and Sespe Formations, the Topanga Formation, the Puente Formation, and/or older alluvium of Pleistocene age. Paleontologic monitors should be equipped to salvage fossils as they are unearthed, to avoid construction delays, and to remove samples of sediments likely to contain the remains of small fossil invertebrates and vertebrates. Monitors must be empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens.

3. Preparation of recovered specimens to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates. Preparation

and stabilization of recovered fossils are essential in order to fully mitigate adverse impacts to significant resources (Scott and others, 2004).

4. Identification and curation of specimens into an established, accredited museum repository with permanent retrievable paleontologic storage (e.g. SBCM). These procedures are also essential steps in effective paleontologic mitigation (Scott and others, 2004) and CEQA compliance (Scott and Springer, 2003). The paleontologist must have a written repository agreement in hand prior to the initiation of mitigation activities. Mitigation of adverse impacts to significant paleontologic resources is not complete until such curation into an established museum repository has been fully completed and documented.

5. Preparation of a report of findings with an appended itemized inventory of specimens. The report and inventory, when submitted to the appropriate Lead Agency along with confirmation of the curation of recovered specimens into an established, accredited museum repository, would signify completion of the program to mitigate impacts to paleontologic resources.

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Please do not hesitate to contact us with any further questions you may have.

Sincerely,

Eric Scott, Curator of Paleontology
Division of Geological Sciences
San Bernardino County Museum

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Appendix C. Resume

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BROOKS SMITH
ASSOCIATE/PALEONTOLOGIST

LSA

EXPERTISE

Paleontological Assessment Reports and Paleontological Resources Impact Mitigation Programs

Archaeological and Paleontological Mitigation Monitoring Reports

Paleontological and Archaeological Resource Monitoring

Archaeological Excavation

Fossil Collection, Salvage, Identification and Curation

GPS Data Collection and Analysis

Geologic Data Collection and Interpretation

EDUCATION

University of California, Santa Cruz, B.S., Earth Science (Geology), 1989.

California State University, Fullerton, Archaeological field methods course on San Nicolas Island, June–July 1993.

PROFESSIONAL RESPONSIBILITIES

Mr. Smith is a project manager at LSA with 21 years of experience in paleontology. He is responsible for scheduling paleontological and archaeological monitors on both large- and small-scale projects, as well as acting as an intermediary between clients and agencies such as the United States Department of Interior, Bureau of Land Management (BLM), and the United States Department of Agriculture, Forest Service (Forest Service). Mr. Smith also prepares paleontological assessment reports, paleontological resources impact mitigation programs (PRIMPs), and monitoring reports following the completion of both cultural and paleontological mitigation monitoring.

While in the field, Mr. Smith acts as a Field Director or Co-Field Director during field surveys for paleontological and archaeological resources prior to grading activities. Mr. Smith also monitors for and collects cultural and scientific resources during grading activities; documents and tests archaeological sites; assists with the salvage of large fossil remains with the use of plaster casts; assists with large-scale wet and dry screening of sediments for fossils; collects and analyzes data from handheld global positioning system (GPS) units; and collects and analyzes geologic and geomorphic data for use in reports.

PROJECT EXPERIENCE

Coyote Canyon Landfill
Newport Beach, California
Mr. Smith provided paleontological mitigation monitoring during the time the Coyote Canyon Landfill was active. Mr. Smith collected resources, prepared resources to the point of identification, identified collected resources, and input the resources into the fossil catalog.

Frank R. Bowerman (FRB) Landfill
Orange County, California
Mr. Smith has provided paleontological resources monitoring on this project and assisted in the salvage of large-scale paleontological resources. Mr. Smith has prepared several year-end summary reports as well as 3-year summary reports documenting monitoring activities as well as finds. Mr. Smith also prepared a paleontological resources assessment for the landfill.

Prima Deshecha Landfill
San Juan Capistrano, California
Mr. Smith provided paleontological mitigation monitoring during excavation associated with landfill operations and collected paleontological resources as they were uncovered by the grading operations. Mr. Smith also assisted with cultural resources testing of several prehistoric sites that were within proposed expansion areas.

BROOKS SMITH
ASSOCIATE/PALEONTOLOGIST

LSA

PROFESSIONAL EXPERIENCE

Archaeological and Paleontological Surveyor, Monitor, Excavator, and Report Preparer; and Paleontological Field Director, LSA Associates, Inc., Irvine, California, July 1992–present.

Geologist, Mission Geoscience, Newport Beach, California, November 1993–February 1994.

Paleontologist, John Minch and Associates, San Juan Capistrano, California, February–June 1992.

Geologist, Soil and Testing Engineers, Inc., Placentia, California, September 1989–February 1992.

CERTIFICATIONS

40-Hour Hazardous Materials Handling and Response, current through October 2012

County of Orange, Certified Paleontologist

City of San Diego Qualified Paleontologist

PROFESSIONAL ORGANIZATIONS/ MEMBERSHIPS

San Diego Association of Geologists

UCSC Alumni Association

Society of Vertebrate Paleontology

PROJECT EXPERIENCE (CONTINUED)

California Department of Transportation
Orange, Riverside, and San Bernardino Counties, California
Mr. Smith has prepared numerous Paleontological Investigation Reports (PIRs) and Paleontological Evaluation Reports (PERs) for the California Department of Transportation (Caltrans) following the guidelines in the Caltrans Standard Environmental Reference, Environmental Handbook, Volume 1, Chapter 8 – Paleontology. These reports are usually combined into a single document and involve geological formation studies, paleontological research at local museums, and field surveys to help determine whether proposed Caltrans projects will encounter paleontological resources during project development, and if so, whether those paleontological resources are significant. Mr. Smith has also prepared Paleontological Mitigation Plans (PMPs) for Caltrans that include developed paleontological mitigation procedures that must be in place during Caltrans road widening projects in order to protect the significant paleontological resources that have the potential to be encountered during grading.

The Bluffs Retail Center
Newport Beach, California
LSA was retained by the Irvine Company to provide cultural and paleontological resource mitigation monitoring during grading associated with the Bluffs Retail Center located in Newport Beach. Mr. Smith provided archaeological and paleontological monitoring for this project. Mr. Smith also assisted with the salvage of several fossil localities that contained significant fossil shark teeth. Mr. Smith was also the lead author for the final paleontological mitigation monitoring report.

Orchard at Saddleback, Phase I
Lake Forest, California
LSA was retained by W.A.L.F. LLC to provide cultural and paleontological resource mitigation monitoring during grading associated with the Phase I portion of the Orchard at Saddleback, located within the City of Lake Forest. Mr. Smith provided archaeological and paleontological monitoring during grading and was the lead author for the final paleontological mitigation monitoring report.

Orchard at Saddleback, Phase II
Lake Forest, California
LSA was retained by Wetrust America to provide cultural and paleontological resource mitigation monitoring during grading associated with the Phase II portion of the Orchard at Saddleback, located within the City of Lake Forest. Mr. Smith provided archaeological and paleontological monitoring during grading and was the lead author for the final paleontological mitigation monitoring report, as well as co-author for the cultural resources monitoring report.

PROJECT EXPERIENCE (CONTINUED)

Del Mar Fairgrounds
Del Mar, California
LSA was retained by the 22nd District Agricultural Association to provide technical studies needed to assist the 22nd District Agricultural Association during future expansion plans at the Fairgrounds. Mr. Smith authored the paleontological resources assessment report.

Laguna Canyon Road (State Route 133) Widening
Orange County, California
LSA was retained by Caltrans to provide cultural and paleontological resource mitigation monitoring along Laguna Canyon Road during its widening and realignment between State Route 73 (SR-73) and Old Laguna Canyon Road. Mr. Smith provided archaeological and paleontological monitoring for this project, as well as preparation of stratigraphic sections and identification of paleontological specimens. Mr. Smith also assisted on the excavation of archaeological site CA-ORA-1055 and was the lead author for the final paleontological mitigation monitoring report, as well as a contributing author for the final archaeological mitigation monitoring report.

Los Coches Creek Area Middle School
El Cajon, California
Mr. Smith performed a cultural resources survey of an 80-acre parcel as part of an assessment report prior to the construction of the school. During the survey, Mr. Smith recorded numerous undiscovered prehistoric and historic cultural resources.

Marine Corps Base Camp Pendleton
San Diego, California
LSA was contracted to conduct extensive testing of an ethnographically recorded village site. Mr. Smith provided cultural resource testing of Site CA-SDI-10156/H. LSA was contracted to provide cult6ural resource monitoring during removal of potentially hazardous soil in the Stewart Mesa area of the base. Mr. Smith delineated known cultural resource sites and provided monitoring during excavation.

Southern California Edison (SCE) On-Call
Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties, California
LSA performs archaeological resource assessments for SCE's pole replacement program. Assessments include record searches for previously recorded resources and studies; field surveys around poles; recordation observed resources, if any; and recommendations. To date, over 1,000 poles have been assessed. Mr. Smith performed field surveys, recorded resources, and synthesized data.

State Route 73 Widening
Costa Mesa, California
LSA was contracted to provide paleontological monitoring during the widening of SR-73 between stations 74+00 and 82+00. The project area is located in the median of SR-73 within an approximately 0.5-mile stretch between the Birch Street overcrossing on the south and the northbound Bristol Street overcrossing on the north. Mr. Smith provided paleontological monitoring and fossil identification, and wrote the mitigation monitoring report.

San Joaquin Hills Transportation Corridor (State Route 73)
Orange County, California
LSA was contracted to provide paleontological mitigation monitoring for the San Joaquin Hills Transportation Corridor between El Toro Road in the south and Newport Coast Drive in the north. Mr. Smith provided paleontological resource monitoring (scheduling up to five monitors), fossil identification and curation, and assisted with writing the final mitigation monitoring report.

State Route 71 (SR-71) Widening
Chino, California
LSA was contracted to provide paleontological and cultural resource monitoring during the widening of SR-71. Mr. Smith provided paleontological and cultural resource monitoring, fossil identification, and curation of collected paleontological remains.

El Camino Real Widening North of Cougar Drive
Carlsbad, California
LSA provided paleontological resources mitigation monitoring during the widening of a portion of El Camino Real north of Cougar Drive in the City of Carlsbad from two lanes to three. The project involved removing a section of hill measuring approximately 100 feet long, 30 feet wide, and up to 15 feet high in the Cretaceous Point Loma Formation. LSA collected several fossil localities containing clams, snails, crabs, and plant material. Mr. Smith provided some of the monitoring for this project, and was the lead author for the mitigation monitoring report.

San Diego Gas & Electric (SDG&E) On-Call Environmental Services
California
LSA provides support documentation to SDG&E to satisfy Natural Communities Conservation Plan (NCCP), California Environmental Quality Act, California Public Utility Commission (CPUC), California Coastal Commission, United States Army Corps of Engineers (Corps), California Department of Fish and Wildlife (CDFW), and Regional Water Quality Control Board requirements. Mr. Smith mainly works on SDG&E projects that require cultural resource studies. Representative projects include the following:

- **Shadowridge-Meadowlark Tap: Rebuild TL 13811:** LSA provided a cultural resource assessment for an approximately 4-mile transmission line located in San Diego. The assessment included a cultural resources search through the South Coastal Information Center, and an intensive pedestrian survey for all proposed new pole locations and staging areas. Finally, LSA made recommendations for each separate pole location. Mr. Smith was involved in all aspects of the cultural resource assessment.
- **Firestorm 2007 Environmental and Biological Monitoring:** LSA provided on-call support for monitoring services immediately following the October 2007 wildfires in San Diego, including documentation of access road regrading and erosion control consultation; data compilation, analysis, and interpretation; and data form entry for compliance with Corps Regional General Permit 63. Mr. Smith provided both cultural and biological surveys along several of the burned pole alignments.

Southern California Gas Company (SCG)
Los Angeles County, California
LSA was retained by SCG to provide cultural resource monitoring for its Line 85, Line 119, and Line 225 located in the Angeles National Forest (ANF) north of Castaic Lake. As these lines pass through the ANF

and are located on land under the jurisdiction of the Forest Service, it was necessary for LSA to apply for an Archaeological Resources Protection Act (ARPA) Permit for each line. LSA's role on these projects was to ensure that mitigation measures developed by the Forest Service to protect cultural resources were implemented and followed. These measures included: providing worker training for the identification and importance of cultural resources; protecting the National Register of Historic Places-listed Old Ridge Route, a historic road built in 1915 between Los Angeles and Bakersfield; monitoring for cultural resources during construction and having a monitor present at each work area; counting and documenting the numbers and types of vehicles traveling along the Old Ridge Route on a daily basis; and providing video documentation of the Old Ridge Route both before and after the project was completed. Mr. Smith was the project manager for these three SCG projects and scheduled up to three monitors per day at various locations, depending on daily construction needs; provided cumulative vehicle counts on a weekly basis to the ANF; and coordinated between the ANF archaeologist and SCG as needed. Mr. Smith also assisted in preparing reports at the completion of each project documenting the results of the monitoring.

South Orange County Infrastructure Improvement Project, State Route 241 (SR-241)
Orange and San Diego Counties, California
The Transportation Corridor Agencies (TCA) proposes extending existing SR-241 from its current terminus at Oso Parkway south to Interstate 5, just south of San Clemente. The project is located in portions of both southern Orange County and northern San Diego County. Mr. Smith assisted during surveying all the unsurveyed portions of the project, recording new cultural resources that were discovered and writing the survey reports and other cultural resource documents associated with this project. Mr. Smith also provided cultural resource clearance during the initial geotechnical investigations associated with the project to ensure no undiscovered cultural resources were impacted.

Plains All American Pipeline (PAAPL)
Los Angeles County, California
LSA was retained as a subconsultant to Stantec Consulting to provide cultural resource monitoring during repairs to several of PAAPL's pipelines (including Line 2000 and Line 63), and during a geotechnical investigation to address landslide problems in the Angeles National Forest (ANF) north of Castaic Lake. As these projects are located on lands administered by the Forest Service, it was necessary for LSA to apply for an ARPA Permit for each project to protect cultural resources and ensure all protection measures required by the Forest Service were implemented and followed. These measures included: providing worker training for the identification and importance of cultural resources; protecting the National Register of Historic Places-listed ORR, a historic road built in 1915 between Los Angeles and Bakersfield; monitoring for cultural resources during construction and having a monitor present at each work area; counting and documenting the numbers and types of vehicles traveling along the ORR on a daily basis; and providing video documentation of the ORR both before and after each project's completion. Mr. Smith was the project manager for projects and scheduled monitors, provided cumulative vehicle counts on a weekly basis to the Forest Service; provided coordination between the Forest Service archaeologist, PAAPL, and Stantec as needed; and assisted with the preparation of the final monitoring reports.

SELECTED REPORTS

Paleontological Resources Analysis for the SR-55/Newport Boulevard Improvement Project, City of Costa Mesa, County of Orange, California. LSA project number TRT1101A. September 2012.

Paleontological Resources Identification Report for the State Route 55 Improvement Project Between Interstate 405 and Interstate 5, Cities of Santa Ana, Irvine, and Tustin, County of Orange, California. Report prepared for the California Department of Transportation, District 12. LSA project number HDR1102. September 2012.

Paleontological Mitigation Plan for the State Route 73 Detention Basin Storm Water Mitigation and Slope Stability Project, Cities of Laguna Niguel, Aliso Viejo, Laguna Beach, Irvine, and Newport Beach, County of Orange, California. Report prepared for the California Department of Transportation, District 12. LSA project number CDT1120. August 2012.

Paleontology Memo for the Towne Center Residential Project, City of Lake Forest County of Orange, California. LSA project number CLF1201. July 2012.

Paleontological Resources Assessment for the Camarillo Academy High School + Performing Arts Center, Ventura County, California. Report prepared for the Oxnard Union High School District. LSA project number OSD1102. July 2012.

Paleontological Resources Identification and Evaluation Report for the State Route 57/Lambert Road Interchange Improvement Project, City of Brea, County of Orange, California. Report prepared for the California Department of Transportation, District 12. LSA project number RBF1104. May 2012.

Paleontological Resources Impact Mitigation Plan for the CVS Pharmacy Store, City of Menifee, County of Riverside, California. Report prepared for KZ Development Company, LP. LSA project number KDZ1001. March 2012.

Paleontological Resources Impact Mitigation Plan for the South Coast Winery Report and Spa Hotel Expansion, Riverside County, California. Report prepared for South Coast Winery, Resort and Spa. LSA project number SGV1001. March 2012.

Paleontological Locality Search of the Proposed Valle Vista Channel Extension Project in the Community of Valle Vista, Riverside County, California. Letter report prepared for the Riverside Flood Control and Water Conservation District. LSA project number RCF1102. February 2012.

Paleontological Resources Assessment for the Taft Recycling and Sanitary Landfill, Kern County California. Report prepared for the Kern County Waste Management Department. LSA project number KCY1102. February 2012.

Paleontological Resources Assessment for the Cottonwood Avenue Building Expansion Project, City of Riverside, Riverside County, California. Report prepared for PanCal Sycamore Canyon 257 LLC. LSA project number PNC1101. February 2012.

Paleontological Mitigation Plan for the I-10/Tippecanoe Avenue Interchange Improvement Project, Phase 2, Cities of Loma Linda and San Bernardino, San Bernardino County, California. Report prepared for the California Department of Transportation, District 8. LSA project number RMN0802A. February 2012.

Paleontological Resources Identification and Evaluation Report for the Shoemaker Bridge Replacement Project, City of Long Beach, Los Angeles County, California. Report prepared for the California Department of Transportation, District 7. LSA project number URS1002. December 2011.

Paleontological Resource Assessment and Paleontological Resources Impact Mitigation Monitoring Plan for Stratford Ranch Industrial Park, Tentative Tract 36382, City of Perris, Riverside County, California. Report prepared for Mission Pacific Land Company. LSA project number MPL1101. December 2011.

Paleontological Mitigation Report for the Interstate 215/State Route 74 Interchange Improvements Project, Riverside County, California. Report prepared for the California Department of Transportation, District 8. LSA project number RCN1002. December 2011.

Paleontological Resources Assessment for the Quail Brush Generation Project, San Diego County, California. Report prepared for Tetra Tech EC. LSA project number TTE1101. November 2011.

Paleontological Mitigation Plan for the Tippecanoe Avenue Interchange Improvement Project, Phase 1, Cities of Loma Linda and San Bernardino, San Bernardino County, California. Report prepared for the California Department of Transportation, District 8. LSA project number RMN0802A. November 2011.

Paleontological Assessment for the Vancouver Street Sewer Extension Project, City of Carlsbad, San Diego County, California. Letter report prepared for the City of Carlsbad. LSA project number HCR1103A. November 2011.

Paleontological Analysis fort the State Route 125/State Route 94 Interchange Branch Connector Project, San Diego County, California. LSA project number TYL1003. October 2011.

Supplemental Paleontological Resources Identification and Evaluation Report for the Mid County Parkway Project, Riverside County, California. Report prepared for the California Department of Transportation, District 8. LSA project number JCV531. September 2011.

Paleontological Mitigation Plan, I-15/I-215 Interchange Improvements Project, Community of Devore, San Bernardino County, California. Report prepared for the California Department of Transportation, District 8. LSA project number LIM0705. September 2011.

Paleontological Monitoring Report for Geotechnical Trench Excavations for the I-15/I-215 Interchange Improvements Project, Community of Devore, San Bernardino County, California. Report prepared for the California Department of Transportation, District 8. LSA project number LIM0705. August 2011.

Paleontological Resources Assessment, Tentative Tract 36382, Altfillisch Property Project, City of Eastvale, Riverside County, California. Report prepared for Altfillisch Construction Company. LSA project number AFL1101. July 2011.

Addendum, Paleontological Identification and Evaluation Report for the Interstate 215/Barton Road Interchange Improvement Project, Cities of Grand Terrace and Colton, San Bernardino County, California. Report prepared for the California Department of Transportation, District 8. LSA project number SBA330. July 2011.

Paleontological Resources Assessment for the Southern California Edison Banducci Substation and Telecommunications Routes Project, Tehachapi, Kern County, California. Letter report prepared for Southern California Edison. LSA project number SCE1105A. July 2011.

Paleontological Resource Assessment for Utility Pothole Program, Interstate 15/Interstate 215 Interchange Improvements Project, San Bernardino County, California. Letter report prepared for the California Department of Transportation, District 8. LSA project number LIM0705. June 2011.

Paleontological Resources Assessment for the Ocotillo Sol Photovoltaic Project, Imperial County, California. Letter report prepared for the Bureau of Land Management, California Desert District. LSA project number SGE0905-T009B. May 2011.

Paleontological Mitigation Recommendations for Utility Pothole Program, Interstate 15/Interstate 215 Interchange Improvements Project, San Bernardino County, California. Letter report prepared for the California Department of Transportation, District 8. LSA project number LIM0705. April 2011.

Results of Archaeological Resource Monitoring for Plains All American Pipeline Line-2000 Dig 20 and 21 Anomaly Repair Projects, Angeles National Forest, Los Angeles County, California. Report prepared for Angeles National Forest, Supervisor's Office. LSA project numbers SNS1003 and SNS1005. April 2011.

Paleontological Resources Assessment for the Chevron Pipe Line Company Midway-Belridge Pipeline Replacement Project, Kern County, California. Report prepared for Chevron Pipe Line Company. LSA project number SNS1004. March 2011.

Cultural Resources Assessment and Class III Inventory for the Chevron Pipe Line Company Midway-Belridge Pipeline Replacement Project, Kern County, California. Report prepared for Chevron Pipe Line Company. LSA project number SNS1004. March 2011.

Paleontological Resources Assessment for the Perris Boulevard Widening Project, City of Perris, Riverside County, California. Letter report prepared for Mr. Kenneth Phung. LSA project number TLK1001. February 2011.

Paleontological Resources Assessment for the Perris Boulevard Widening Project, City of Perris, County of Riverside, California. Letter report prepared for the City of Perris. LSA project number TLK1001. February 2011.

Paleontological Resources Identification and Evaluation Report for the Shoemaker Bridge Replacement Project, City of Long Beach, Los Angeles County, California. Report prepared for the California Department of Transportation, District 7. LSA project number URS1002. February 2011.

Cultural Resources Monitoring for the Restoration Work for Southern California Gas Company's Line-85 Permanent Repairs Project, Angeles National Forest, Los Angeles County, California. Letter report prepared for the Angeles National Forest on behalf of Southern California Gas Company. LSA project number SCG0801. January 2011.

Paleontological Assessment for the Five Winds Ranch Project, City of Yucaipa, San Bernardino County, California. Letter report prepared for the City of Yucaipa Public Works Department. LSA project number YCA1002. November 2010.

Paleontological Mitigation Plan Mission Boulevard Widening Project, City of Ontario, San Bernardino County, California. District 08-SBD-O-Ontario. EA 08-924850. Report prepared for the California Department of Transportation, District 8. LSA project number DMJ0602. October 2010.

Paleontological Assessment for the CVS Pharmacy Store, Huntington Beach, California. Letter Report prepared for KZ Development Company, LP. LSA project number KDZ1002. October 2010.

Paleontological Assessment for the 5-Winds Ranch, City of Yucaipa, California. Letter Report prepared for the Public Works Department, City of Yucaipa. LSA project number YCA1102. October 2010.

Paleontological Resource Assessment for the Southern California Edison Pisgah Substation Upgrade/Expansion, San Bernardino County, California. Letter report prepared for Southern California Edison. LSA project number SCE0801Y. September 2010.

Paleontological Mitigation Report for the Vail Lake Transmission Main and Pump Station Project, Riverside County, California. Report prepared for Kennedy/Jenks Consultants. LSA project number KJE0601. September 2010.

Results of C*ultural Resources Monitoring for the Southern California Gas Company Ivy Street Bridge Pipeline Boring Project, City of Murrieta, County of Riverside, California.* (co-authored with Terri Fulton). Prepared for San Diego Gas and Electric Company. LSA project number SCG0602k. September 2010.

Results of Archaeological Resource Monitoring for Plains All American Pipeline Line-2000 Templin Highway Anomaly Repair Project, Angeles National Forest, Los Angeles County, California. (Co-authored with Antonina Delu, M.A., RPA). Prepared for the Angeles National Forest on behalf of Stantec Consulting Services. LSA project number SNS1002. September 2010.

Results of Archaeological Resource Monitoring for Plains All American Pipeline Osito Canyon Geotechnical Boring Project, Angeles National Forest, Los Angeles County, California. (Co-authored with Antonina Delu, M.A., RPA). Prepared for the Angeles National Forest on behalf of Stantec Consulting Services. LSA project number SNS1001. September 2010.

Paleontological Mitigation Plan for State Route 91 Widening Project Between State Route 55 and State Route 24, Cities of Anaheim and Yorba Linda, Orange County, California. District 12-ORA-91, PM 9.1 to 15.1. Prepared for the California Department of Transportation, District 12. LSA project number CDT1001. May 2010.

C*ultural Resources Monitoring for the Southern California Gas Company Trabuco Creek Bridge Betterment Project (eTS8327), City of San Juan Capistrano, Orange County, California.* Letter Report prepared for the City of San Juan Capistrano on behalf of Southern California Gas Company. LSA project number SCG0902. March 2010.

Results of Archaeological Resource Monitoring for Southern California Gas Company Line-119 Abandonment Project, Angeles National Forest, Los Angeles County, California. (Co-authored with Antonina Delu, M.A., RPA). Prepared for the Angeles National Forest on behalf of Southern California Gas Company. LSA project number SCG0602J. March 2010

Results of Archaeological Resource Monitoring for Southern California Gas Company Line-225 - Templin Highway Repair Project, Angeles National Forest, Los Angeles County, California. (Co-author with Antonina Delu, M.A. RPA) Prepared for the Angeles National Forest on behalf of Southern California Gas Company. LSA project number SCG0602I. March 2010.

Paleontological Resources Identification and Evaluation Report for State Route 91 Corridor Improvements Project, Cities of Anaheim, Yorba Linda, Corona, Norco and Riverside Counties of Orange and Riverside, California. Districts 8 and 12 – ORA-91-R14.43/R18.91; RIV-91-R0.00/R13.04; RIV-15-35.64/45.14. (Co-authored with Robert Reynolds and Michael Pasenko) Prepared for the California Department of Transportation, District 8. LSA project number PAZ0701. January 2010.

Paleontological Mitigation Report for the Widening of El Camino Real North of Cougar Drive, City of Carlsbad, San Diego County, California. Report prepared for the City of Carlsbad, Design Division. LSA project number HCR0803. January 2010.

Paleontological Resources Mitigation Plan for the Vail Lake Transmission Main and Pump Station Project, Riverside County, California. Report prepared for Kennedy/Jenks Consultants. LSA project number KJE0601. January 2010.

Draft Paleontological Identification and Evaluation Report for State Route 91 Westbound Widening (Northbound State Route 55 to the Westbound State Route 91 Connector through the Tustin Avenue Interchange), City of Anaheim, Orange County, California. Prepared for the California Department of Transportation, District 12. LSA project number CDT0806B. January 2010.

Paleontological Resources Assessment for the Imperial Valley Photovoltaic Project. Prepared for SDG&E Environmental Services. LSA project number SGE0905-T009B. December 2009.

Paleontological Resource Analysis of the Interstate 215/Washington Street Interchange Project, Cities of Colton and Grand Terrace, San Bernardino County, California. LSA project number SBA330. October 2009.

Cultural Resource Monitoring for the Del Obispo Street Undergrounding of Overhead Utilities and Widening, City of San Juan Capistrano, Orange County, California. (With Deborah McLean as primary author.) Prepared for the City of San Juan Capistrano. LSA project number CSJ0803. September 2009.

Paleontological Identification and Evaluation Report for I-215 High Occupancy Vehicle Gap Closure Project Cities of Colton, Grand Terrace San Bernardino, San Bernardino County, and City of Riverside, Riverside County, California. Prepared for the California Department of Transportation, District 8. LSA project number SBA330. August 2009.

Results of Archaeological Resource Monitoring for Southern California Gas Company Line-85 Permanent Repairs Project, Angeles National Forest, Los Angeles County, California. (Co-authored with

Antonina Delu, M.A., RPA). Prepared for the Angeles National Forest on behalf of Southern California Gas Company. LSA project number SCG0801. August 2009.

Paleontological Mitigation Plan State Route 91 Eastbound Lane Addition Project Between State Route 241 and State Route 71, Orange County, California, and Riverside County, California. Prepared for the California Department of Transportation, District 12. LSA project number CDT0805. May 2009.

Paleontological Resources Letter Report for the Moro Ridge Radio Site Project, Orange County, California. Prepared for the County of Orange. LSA project number ORG0801. May 2009.

Paleontological Identification and Evaluation Report for I-10/Tippecanoe Avenue Interchange Project, Cities of Loma Linda and San Bernardino, San Bernardino County, California. Prepared for the California Department of Transportation, District 8. LSA project number RMN0802. April 2009.

Paleontological Resources Due Diligence for the Lazy W Ranch Project in Hot Springs Canyon, Orange County California. Memo Prepared for Erin Razban, LSA Associates, Inc. LSA project Number LZW0901. March 2009.

Paleontological Resources Assessment for the Hanford Municipal Airport Improvements Project, City of Hanford, Kings County, California. Prepared for Mead & Hunt, Inc. LSA project number MHN0801. February 2009.

Paleontological Resources Identification and Evaluation Report for SR-73 Basin Sedimentation Project Between Jamboree Road and I-5/SR-73 Interchange; Cities of Laguna Niguel, Aliso Viejo, Laguna Beach, Irvine, and Newport Beach; County of Orange, California. Prepared for the California Department of Transportation, District 12. LSA project number CDT0807. January 2009.

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