CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

LOS ANGELES – ORANGE COUNTY – SAN DIEGO

PALEONTOLOGIC RESOURCES TECHNICAL EVALUATION

January 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

CALIFORNIA HIGH SPEED RAIL AUTHORITY

U.S. Department of Transportation
Federal Railroad Administration

CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Los Angeles – Orange County – San Diego

Paleontologic Resources Technical Evaluation

Prepared by:

SAN BERNARDINO COUNTY MUSEUM

For

Applied EarthWorks, Inc.

And

HDR

January 2004

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 ALTERNATIVES 2
1.1.1 NO-PROJECT ALTERNATIVE 2
1.1.2 MODAL ALTERNATIVE 5
1.1.3 HIGH SPEED TRAIN ALTERNATIVE 5

2.0 BASELINE / AFFECTED ENVIRONMENT 17
2.1 STUDY AREA (AREA OF POTENTIAL EFFECT) DEFINED 17
2.2 BRIEF GEOLOGIC AND PALEONTOLOGIC BACKGROUND OF REGION 17
2.3 DATA SOURCES 18
2.4 PALEONTOLOGIC LOCATIONS 18

3.0 METHODS FOR PALEONTOLOGIC RESOURCE ANALYSIS 23
3.1 DATA COLLECTION 23
3.2 LEGAL CITATIONS REGARDING THE PROTECTION AND PRESERVATION OF PALEONTOLOGIC RESOURCES 23
3.2.1 FEDERAL REGULATIONS 23
3.2.2 STATE OF CALIFORNIA – REQUIREMENTS 23
3.3 INTERPRETING PALEONTOLOGIC SENSITIVITY 24
3.3.1 PALEONTOLOGIC RESOURCES 24
3.3.2 DEFINING PALEONTOLOGIC SIGNIFICANCE 25
3.4 DETERMINATIONS OF ROCK UNIT SENSITIVITY 25
3.4.1 INVERTEBRATE FOSSILS 26
3.4.2 VERTEBRATE FOSSILS 26
3.4.3 DEFINITIONS 26

4.0 PALEONTOLOGIC IMPACTS 28
4.1 NO-PROJECT ALTERNATIVE 32
4.2 MODAL ALTERNATIVE 32
4.2.1 HIGHWAYS 32
4.2.2 AIRPORTS 34
4.3 HIGH SPEED TRAIN CORRIDORS AND STATION OPTIONS 34
4.3.1 HIGH SPEED RAIL ALIGNMENTS 34
4.3.2 HIGH SPEED RAIL STATIONS 35
4.4 CONVENTIONAL RAIL (LOSSAN) ALIGNMENTS AND STATION OPTIONS 37
4.4.1 CONVENTIONAL RAIL ALIGNMENTS 37
4.4.2 CONVENTIONAL RAIL STATIONS 43

5.0 REFERENCES 45

6.0 PREPARERS 50

LIST OF FIGURES

FIGURE 1.1.1 No-Project Alternative 3
FIGURE 1.1.2 Modal Alternative – Highway Alternative 6
FIGURE 1.1.3 Modal Alternative – Aviation Alternative 7
FIGURE 1.1.4 High Speed Train Alternative – Corridors and Stations 8
FIGURE 1.1.5A High-Speed Train Alternative: Alignment and Construction Type by Segment (Los Angeles to Irvine) 14
FIGURE 1.1.5B High-Speed Train Alternative: Alignment and Construction Type by Segment (Irvine Oceanside) 15
FIGURE 1.1.5C High-Speed Train Alternative: Alignment and Construction Type by Segment (Oceanside to San Diego) 16

LIST OF TABLES

TABLE 1.1.1 Programmed Improvements Included in the No-Project Alternative 4
TABLE 1.1.2 Modal Alternative: Highway Capacity Improvement Options for Year 2020 5
TABLE 1.1.3 Alignment and Station Options for High-Speed Train Alternative 10
TABLE 4.0 Detailed Analysis Table: Impacts to Paleontological Resources 28

ACRONYMS

APE	AREA OF POTENTIAL EFFECT
AUTHORITY	CALIFORNIA HIGH-SPEED RAIL AUTHORITY
CEQA	CALIFORNIA ENVIRONMENTAL QUALITY ACT
EIR	ENVIRONMENTAL IMPACT REPORT
EIS	ENVIRONMENTAL IMPACT STATEMENT
EPA	ENVIRONMENTAL PROTECTION AGENCY
FAA	FEDERAL AVIATION ADMINISTRATION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FRA	FEDERAL RAILROAD ADMINISTRATION
FTA	FEDERAL TRANSIT ADMINISTRATION
NEPA	NATIONAL ENVIRONMENTAL POLICY ACT
NRHP	NATIONAL REGISTER OF HISTORIC PLACES
RPLI	REGIONAL PALEONTOLOGIC LOCALITY INVENTORY, SBCM
RTP	REGIONAL TRANSPORTATION PLAN
SHPO	STATE HISTORIC PRESERVATION OFFICER
SBCM	SAN BERNARDINO COUNTY MUSEUM
SVP	SOCIETY OF VERTEBRATE PALEONTOLOGY
YBP	YEARS BEFORE PRESENT

1.0 INTRODUCTION

The California High-Speed Rail Authority (Authority) was created by the Legislature in 1996 to develop a plan for the construction, operation, and financing of a statewide, intercity high-speed passenger train system.[1] After completing a number of initial studies over the past six years to assess the feasibility of a high-speed train system in California and to evaluate the potential ridership for a variety of alternative corridors and station areas, the Authority recommended the evaluation of a proposed high-speed train system as the logical next step in the development of California's transportation infrastructure. The Authority does not have responsibility for other intercity transportation systems or facilities, such as expanded highways, or improvements to airports or passenger rail or transit used for intercity trips.

The Authority adopted a *Final Business Plan* in June 2000, which reviewed the economic feasibility of a 1,127-kilometer-long (700-mile-long) high-speed train system. This system would be capable of speeds in excess of 321.8 kilometers per hour (200 miles per hour [mph]) on a dedicated, fully grade-separated track with state-of-the-art safety, signaling, and automated train control systems. The system described would connect and serve the major metropolitan areas of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and I. The high-speed train system is projected to carry a minimum of 42 million passengers annually (32 million intercity trips and 10 million commuter trips) by the year 2020.

Following the adoption of the Business Plan, the appropriate next step for the Authority to take in the pursuit of a high-speed train system is to satisfy the environmental review process required by federal and state laws which will in turn enable public agencies to select and approve a high speed rail system, define mitigation strategies, obtain necessary approvals, and obtain financial assistance necessary to implement a high speed rail system. For example, the Federal Railroad Administration (FRA) may be requested by the Authority to issue a *Rule of Particular Applicability*, which establishes safety standards for the high-speed train system for speeds over 200 mph, and for the potential shared use of rail corridors.

The Authority is both the project sponsor and the lead agency for purposes of the California Environmental Quality Act (CEQA) requirements. The Authority has determined that a Program Environmental Impact Report (EIR) is the appropriate CEQA document for the project at this conceptual stage of planning and decision-making, which would include selecting a preferred corridor and station locations for future right-of-way preservation and identifying potential phasing options. No permits are being sought for this phase of environmental review. Later stages of project development would include project-specific detailed environmental documents to assess the impacts of the alternative alignments and stations in those segments of the system that are ready for implementation.

The decisions of federal agencies, particularly the Federal Railroad Administration (FRA) related to high-speed train systems, would constitute major federal actions regarding environmental review under the National Environmental Policy Act (NEPA). NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) if the proposed action has the potential to cause significant environmental impacts. The proposed action in California warrants the preparation of a Tier 1 Program-level EIS under NEPA, due to the nature and scope of the comprehensive high-speed train system proposed by the Authority, the need to narrow the range of alternatives, and the need to protect/preserve right-of-way in the future. FRA is the federal lead agency for the preparation of the Program EIS, and the Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency (EPA), the U.S. Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (USFWS), and the Federal Transit Administration (FTA) are cooperating federal agencies for the EIS.

[1] Chapter 796 of the Statutes of 1996; SB 1420, Kopp and Costa

A combined Program EIR/EIS is to be prepared under the supervision and direction of the FRA and the Authority in conjunction with the federal cooperating agencies. It is intended that other federal, state, regional, and local agencies will use the Program EIR/EIS in reviewing the proposed program and developing feasible and practicable programmatic mitigation strategies and analysis expectations for the Tier 2 detailed environmental review process which would be expected to follow any approval of a high speed train system.

The statewide high-speed train system has been divided into five regions for study: Bay Area-Merced, Sacramento-Bakersfield, Bakersfield-Los Angeles, Los Angeles-I via the Inland Empire, and Los Angeles-Orange County-I. This Paleontologic Resources Technical Evaluation for the Los Angeles – Orange County – San Diego Region is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES

1.1.1. No-Project Alternative

The No-Project Alternative serves as the baseline for the comparison of Modal and High-Speed Train alternatives (Figure 1.1.1). The No-Project Alternative represents the state's transportation system (highway, air, and conventional rail) as it existed in 1999-2000 and as it would be after implementation of programs or projects currently programmed for implementation and projects that are expected to be funded by 2020. The No-Project Alternative addresses the geographic area serving the same intercity travel market as the proposed high-speed train (generally from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and I). The No-Project Alternative satisfies the statutory requirements under CEQA and NEPA for an alternative that does not include any new action or project beyond what is already committed.

The No-Project Alternative defines the existing and future statewide intercity transportation system based on programmed and funded (already in funded programs/financially constrained plans) improvements to the intercity transportation system through 2020, according to the following sources of information:

- State Transportation Improvement Program (STIP)
- Regional Transportation Plans (RTPs) for all modes of travel
- Airport plans
- Intercity passenger rail plans (California Rail Plan 2001-2010, Amtrak Five- and Twenty-year Plans)

The No-Project Alternative for the Los Angeles – Orange County – San Diego Region includes highway expansion as well as conventional rail improvements to the existing LOSSAN Corridor that are programmed and funded for implementation through 2020. Table 1.1.1 summarizes the infrastructure components of the No-Project Alternative for this region. As with all of the alternatives, the No-Project Alternative will be assessed against the purpose and need topics/objectives for congestion, safety, air pollution, reliability, and travel times.

Figure 1.1.1
No-Project Alternative - California Transportation System

Table 1.1.1
Programmed Improvements Included in the No-Project Alternative
Los Angeles-Orange County-San Diego Region
(from 1998 and 2000 Regional Transportation Plans)

County	Type of Project	Description
INTERCITY HIGHWAY PROJECTS		
Los Angeles	HOV	HOV Project on SR-14 (Ave P-8 to Ave-L)
Los Angeles	HOV	HOV Project on I-710 (I-10 to I-210
Los Angeles	HOV	HOV Project on I-5 (SR-19 to I-710)
Los Angeles	Highway Widening	I-710 (I-10 to I-210) Additional Mixed Flow Lane
Los Angeles	Highway Widening	I-5 (Rosecrans to Orange Co) Additional Mixed Flow Lane
Los Angeles	Highway Widening	I-405 (US-101 to I-105) Additional Mixed Flow Lane
Los Angeles	Highway Widening	SR-57 (SR-60 to Orange Co) Additional Mixed Flow Lane
Orange	HOV	HOV Project on I-5 (SR-1 to Avenida Pico)
Orange	Highway Widening	I-5 (SR-91 to Los Angeles Co) Additional Mixed Flow Lane
Orange	Highway Widening	SR-91 (westbound auxiliary lane SR-57 to I-5) Additional Mixed Flow Lane
Orange	Highway Widening	SR-91 (auxiliary lanes SR-241 to SR-71) Additional Mixed Flow Lane
Orange	Highway Widening	SR-57 (auxiliary lanes Los Angeles Co to SR-91) Additional Mixed Flow Lane
I	Highway Interchange/Widening	I-5 at I-805 – New interchange with 10 freeway and 2 HOV lanes.
I	Highway Widening	I-5 from Mission Bay Drive to SR-52 – Addition of a northbound auxiliary lane.
I	Highway Widening	I-5 at SR-78 Interchange: NB-EB Connector – Widen auxiliary lane and ramp.
I	Highway Widening	I-15 from SR-163 to SR 78 – Addition of auxiliary lanes and meters. Bridge widening
I	Highway Widening	I-15 from SR-56 to Centre City Parkway – Addition of 4 HOV/Managed lanes
I	Highway Widening/HOV	I-5 from Del Mar Heights Road to Birmingham Drive – Upgrade from existing 8-lane freeway to 12-lane freeway and 2 HOV lanes.
I	Highway Interchange	I-15/SR-56 Interchange Ramp (EB-NB) – Loop ramp.
I	Highway Widening/HOV	I-5 from Del Mar Heights Road to Encinitas Boulevard – Upgrade from 8-lane freeway to 12-lane freeway and 2 HOV lanes.
I	Highway	I-5 from Encinitas Boulevard to La Costa Boulevard – Upgrade from 8-lane freeway to 10-lane freeway and 2 HOV lanes.
I	Highway	I-15 from SR-163 to SR-56 – Addition of 4 HOV/Managed lanes.
I	TSM	Intelligent Transportation Systems: Enhanced Incident/Emergency Response, Traveler/Commercial Vehicle Operations Information, and Management System Software.
CONVENTIONAL RAIL IMPROVEMENTS		
Los Angeles	Conventional Rail	Run through tracks at L.A. Union Station
Los Angeles	Conventional Rail	Continuous third main track from Union Station to Fullerton
Orange	Conventional Rail	Double tracking along Lincoln Avenue in Santa Ana
I	Conventional Rail	Extension of Double-Track at San Onofre
I	Conventional Rail	Extension of Double-Track in Oceanside
I	Conventional Rail	Sorrento-Miramar Double-Tracking and Curve Realignment
I	Conventional Rail	O'Neil to Flores Double-Tracking
I	Conventional Rail	Santa Margarita River Bridge Replacement and Double-Tracking
I	Conventional Rail	Fallbrook Junction Track Upgrades
I	Conventional Rail	Del Mar Bluffs Stabilization
I	Conventional Rail	False Bay Passing Track
I	Conventional Rail	Tecolote Creek Track Improvements and Bridge Replacement

Source: Parsons Brinckerhoff, California High-Speed Train Program Environmental Impact Report/Environmental Impact Statement, *System Alternatives Definition,* November 18, 2002

1.1.2 Modal Alternative

There are currently only three main options for intercity travel between the major urban areas of I, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco, and Sacramento: vehicles on the interstate highway system and state highways, commercial airlines serving airports between I and Sacramento and the Bay Area, and conventional passenger trains (Amtrak) on freight and/or commuter rail tracks. The Modal/System Alternative consists of expansion of highways, airports, and intercity and commuter rail systems serving the markets identified for the High-Speed Train Alternative. (Figures 1.1.2 and 1.1.3) The Modal Alternative uses the same inter-city travel demand (not capacity) assumed under the high-end sensitivity analysis completed for the high-speed train ridership in 2020. This same travel demand is assigned to the highways and airports and passenger rail described under the No-Project Alternative, and the additional improvements or expansion of facilities is assumed to meet the demand, regardless of funding potential and without high-speed train service as part of the system.

The Modal Alternative for the Los Angeles-Orange County-I Region is defined as further expansion of Interstate 5 (beyond the expansion planned under the No-Project Alternative), as well as expansion at the Long Beach Airport. Table 1.1.2 summarizes the highway expansion components of the Modal Alternative for this Region.

Table 1.1.2
Modal Alternative: Highway Capacity Improvement Options for Year 2020
Los Angeles – Orange County – San Diego Region
(2020 Intercity Travel Demand with Highway Expansion only)

Highway Corridor	Segment (To-From)	No. of Additional Lanes[1] (Total – Both Directions)
I-5	L.A. Union Station to I-10	4
I-5	I-10 to Norwalk	2
I-5	Norwalk to Anaheim	2
I-5	Anaheim to Irvine	2
I-5	Irvine to I-405	2
I-5	I-405 to SR-78	2
I-5	SR-78 to University Town Center	2
I-5	University Town Center to I Airport	2

Source: Parsons Brinckerhoff, California High-Speed Train Program Environmental Impact Report/Environmental Impact Statement, *System Alternatives Definition,* November 18, 2002

[1]Represents the number of through lanes, in addition to the total number of lanes in the No-Project Highway Network, that approximate an equivalent level of capacity to serve the representative demand.

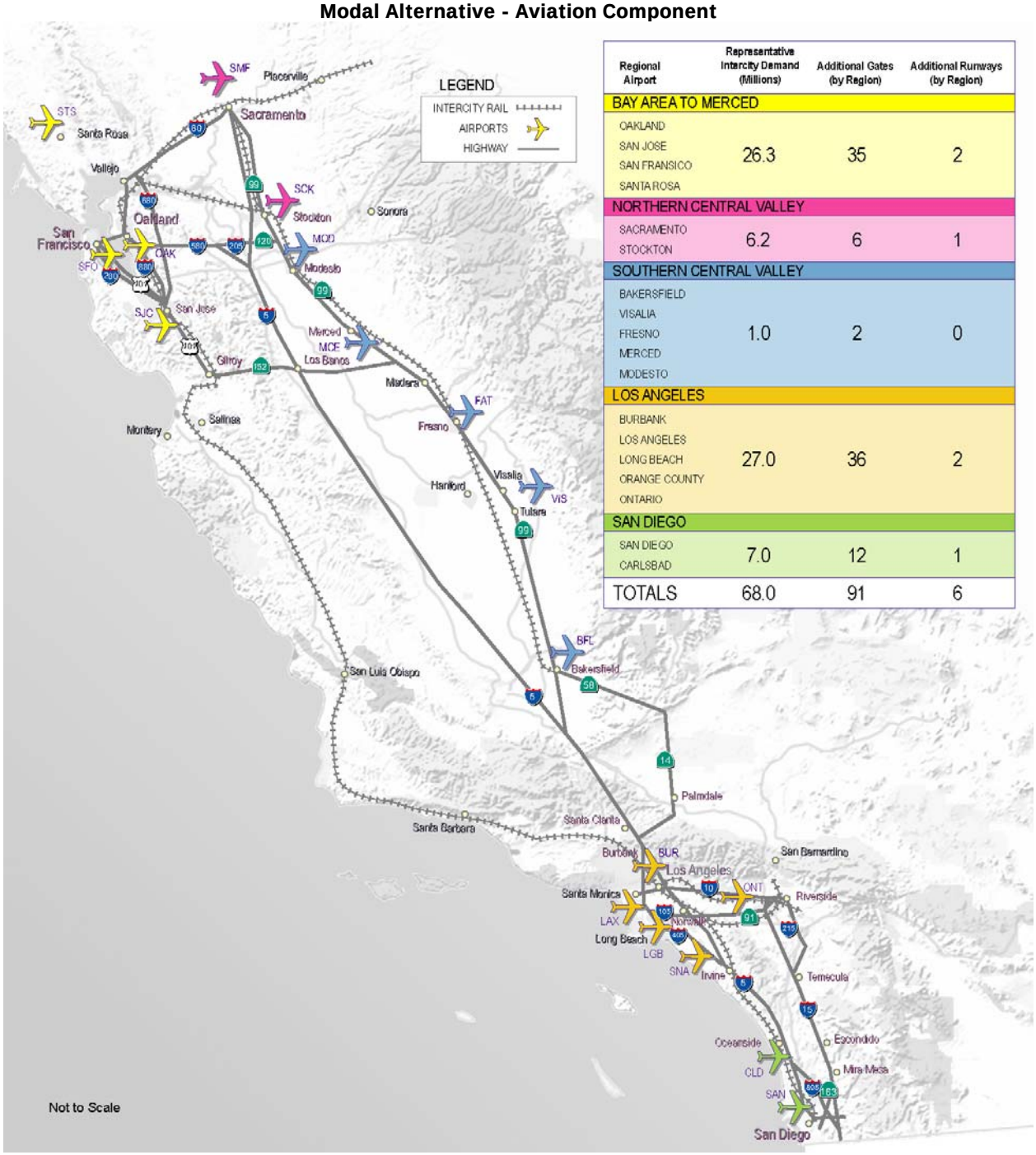
1.1.3 High Speed Train Alternative

The Authority has defined a statewide high speed train (HST) system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks, with state-of-the-art safety, signaling, and automated train control systems. State of the art high speed steel-wheel-on-steel-rail technology is being considered for the system that would serve the major metropolitan centers of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and I. (Figure 1.1.4)

The High-Speed Train Alternative includes several corridor and station options. A steel-wheel on steel-rail, electrified train, primarily on exclusive right-of-way with small portions of the route on shared track with other rail is planned. Conventional “non-electric” improvements are also being considered along the existing LOSSAN rail corridor from Los Angeles to San Diego. The train track would be either at-grade, in an open trench or tunnel, or on an elevated guideway, depending on terrain and physical constraints.

Figure 1.1.2
Modal Alternative - Highway Component

Figure 1.1.3
Modal Alternative - Aviation Component



Regional Airport	Representative Intercity Demand (Millions)	Additional Gates (by Region)	Additional Runways (by Region)
BAY AREA TO MERCED			
OAKLAND SAN JOSE SAN FRANSICO SANTA ROSA	26.3	35	2
NORTHERN CENTRAL VALLEY			
SACRAMENTO STOCKTON	6.2	6	1
SOUTHERN CENTRAL VALLEY			
BAKERSFIELD VISALIA FRESNO MERCED MODESTO	1.0	2	0
LOS ANGELES			
BURBANK LOS ANGELES LONG BEACH ORANGE COUNTY ONTARIO	27.0	36	2
SAN DIEGO			
SAN DIEGO CARLSBAD	7.0	12	1
TOTALS	68.0	91	6

Figure 1.1.4
HSR Alternative High-Speed Train Alternative – Corridors and Stations for Continued Investigation

For purposes of comparative analysis, the HST corridors will be described from station-to-station within each region, except where a by-pass option is considered when the point of departure from the corridor will define the end of the corridor segment. Table 1.1.3 summarizes the segments, improvements, and alignment and station options evaluated for the Los Angeles – Orange County – San Diego Region. The alignment segments are shown (north to south) in Figures 1.1.5A, B and C. These figures also show the proposed construction type for each alignment option (open trench, covered trench, tunnel, at-grade, or elevated), and where the alignment options would be located outside of an existing rail corridor.

LOSSAN Corridor Screening Process

A strategic planning process was undertaken as part of the evaluation of Conventional Rail improvements in the LOSSAN Corridor. This process was used to gain additional public input on the various rail improvement options being considered, and to reduce the number of alternatives to those that most reasonably and feasibly can meet the objectives, purpose, and need for the project. There are four locations within the LOSSAN Corridor where the initial range of alternatives was sufficiently broad to allow for the screening, or narrowing, of the alternatives to be carried forward in the Program EIR/EIS: San Juan Capistrano, Dana Point/San Clemente, Encinitas, and Del Mar.

Based on public and agency input, and technical, environmental and economic evaluations, a number of alternatives described in this technical report were subsequently eliminated from further consideration. The alternatives eliminated are shown in Table 1-3 in italics and gray shading. The environmental evaluation of these alternatives is included in this technical report, and was considered in the screening process. More detail on the screening process for the LOSSAN Corridor can be found in the final *Los Angeles to San Diego via Orange County Conventional Improvements Screening Repo*rt (Authority, 2003).

TABLE 1.1.3

Alignment and Station Options for High-Speed Train Alternative
Los Angeles – Orange County – San Diego Region

Alignment Segments and Station Locations Evaluated[1]	Description of Proposed Options & Improvements
HIGH-SPEED RAIL (HSR) & STATION OPTIONS	
LAX To Union Station	Construction of an electrified, grade-separated, dedicated track within an existing rail corridor. The train would be on an elevated structure from Union Station to Alameda Street, then transition into a trench that ends at LAX.
Stations	
LAX	New underground station.
Union Station To Anaheim Station via UPRR	Construction of an electrified, grade-separated, dedicated track within an existing rail corridor. Train would be on an elevated structure from Union Station, go into a trench at Slauson Avenue, move to at-grade across San Gabriel River, return to a trench up to La Canada Verde Creek, then become an aerial structure to Edison Field where it would go underground to a depressed station.
Stations	
Norwalk	New elevated station.
Anaheim	New underground station, built beneath existing station.
Union Station To Irvine Station via LOSSAN	Construction of fully grade-separated tracks within existing rail corridor, to be shared by electrified and conventional trains.
Stations	
Norwalk	Existing station. Proposed improvements include bypass tracks and additional parking.
Fullerton	Existing station. Proposed improvements include bypass tracks and additional parking.
Anaheim	Existing station. Proposed improvements include bypass tracks and additional parking.
Santa Ana	Existing station. Proposed improvements include bypass tracks and additional parking.
Irvine	Existing station. Expanded platform and parking, "terminal" tracks.
CONVENTIONAL RAIL (LOSSAN CORRIDOR) & STATION OPTIONS	
Union Station To Fullerton Station 4th Main Track	Construction of fourth main track in existing rail corridor between Commerce and Fullerton. Improvements can probably be accommodated within existing LOSSAN ROW except between Rio Hondo River and San Gabriel River.
Fullerton Station To Irvine Station	
Alignment Options:	
AT-GRADE between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	Grade separations at street intersections between Walnut Ave. (in Orange) and E. 17th Street in Santa Ana. At-grade curve straightening between Batavia Street and Walnut Ave. Improvements would be in existing rail corridor ROW, except for the curve realignment.
TRENCH between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	Fully grade-separate existing rail corridor in a covered trench (same alignment as above), including curve straightening.
Stations	
Fullerton	Existing station. Proposed improvements include bypass tracks, platform reconfiguration, and additional parking.
Anaheim	Existing station. Proposed improvements include bypass tracks and additional parking.
Santa Ana	Existing station. Proposed improvements include bypass tracks and additional parking.
Irvine	Existing station. Proposed improvements include bypass tracks and additional parking.

[1] Conventional Rail (LOSSAN Corridor) alignment and/or construction options shown in italics and gray shading were eliminated from further evaluation during the LOSSAN Corridor Strategic Plan screening process. See text for more detail.

TABLE 1.1.3

Alignment and Station Options for High-Speed Train Alternative Los Angeles – Orange County – San Diego Region (continued)

Alignment Segments and Station Locations Evaluated[1]	Description of Proposed Options & Improvements
Irvine Station To San Juan Capistrano City Limits (no improvements)	No improvements are proposed for this conventional rail segment under the High-Speed Train Alternative.
San Juan Capistrano (City Limits to Avenida Aeropuerto)	
Alignments	
Covered TRENCH/Cut-Fill between Trabuco Creek and Avenida Aeropuerto (trench goes under San Juan Creek); Double tracking	*Double-tracking via an open trench along the approach to and departure from the San Juan Capistrano Station (relocated from the existing track location on the west side of the station to the east side of the station), and a covered trench under the parking area at the station. This option would include curve realignment at San Juan Creek*
TUNNEL along I-5 between Hwy 73 and Avenida Aeropuerto (tunnel under Trabuco Creek and San Juan Creek); Double tracking	Double-tracking in a tunnel running the length of the City of San Juan Capistrano under Interstate 5.
AT-GRADE and Open TRENCH along east side of Trabuco Creek	Double-tracking at grade and in an open trench along the east side of Trabuco Creek, west of the existing rail alignment.
Stations	
San Juan Capistrano	Existing station (for Covered Trench alignment only): Proposed improvements include double tracking (by-pass tracks) and parking expansion. New station would be constructed with the At-Grade/Open Trench option along Trabuco Creek. New station would be below-grade in open trench. No station would be included in San Juan Capistrano for the I-5 tunnel option.
Dana Point/San Clemente (Avenida Aeropuerto To San Onofre Power Plant)	
Alignments	
Dana Point Curve Realignment; San Clemente - SHORT TRENCH; Double Tracking	*Double-tracking and straightening existing curve at Dana Point between San Juan Creek and Avenida Aeropuerto along the existing rail corridor; double-tracking in existing rail alignment in San Clemente in a covered trench for about 1,000 feet either side of the pier.*
Dana Point Curve Realignment; San Clemente - LONG TRENCH; Double Tracking	*Double-tracking and straightening existing curve at Dana Point between San Juan Creek and Avenida Aeropuerto along the existing rail corridor; double-tracking generally along existing rail corridor through San Clemente in a covered trench from about one mile north of San Mateo Creek to about 4,000 feet north of the pier. This trench option includes one section that leaves the existing corridor and goes underneath residences located west of the corridor between the municipal pier and North El Camino Real.*
Dana Point Curve Realignment; San Clemente - SHORT TUNNEL; Double Tracking	Double-tracking and straightening existing curve at Dana Point in existing rail corridor; double-tracking via a short tunnel that follows Interstate 5 between Palm Drive and San Onofre State Beach, north of the power plant. The short tunnel alignment leaves the Interstate 5 corridor at Avenida Palizada, turns toward the coast and runs underneath residential, industrial and vacant areas, connecting with the existing rail corridor just south of Camino Capistrano.

[1] Conventional Rail (LOSSAN Corridor) alignment and/or construction options shown in italics and gray shading were eliminated from further evaluation during the LOSSAN Corridor Strategic Plan screening process. See text for more detail.

TABLE 1.1.3

Alignment and Station Options for High-Speed Train Alternative Los Angeles – Orange County – San Diego Region (continued)

Alignment Segments and Station Locations Evaluated[1]	Description of Proposed Options & Improvements
San Clemente - LONG ONE-SEGMENT TUNNEL ; Double Tracking (crosses San Mateo and San Onofre Creeks)	*Double-tracking via a long, one- segment tunnel following Interstate 5 from San Onofre State Beach to Avenida Aeropuerto in San Juan Capistrano. This option precludes the need for curve realignment at Dana Point. The existing rail corridor along the coast between southern San Clemente city limits to approximately Avenida Aeropuerto in San Juan Capistrano would be removed from service (or at least not be further improved from its existing condition).*
San Clemente - LONG TWO-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	Double-tracking via a long, two- segment tunnel following Interstate 5 from San Onofre State Beach to Avenida Aeropuerto in San Juan Capistrano. This option precludes the need for curve realignment at Dana Point. This tunnel would have the same alignment as the one-segment long tunnel above except in a one-mile stretch near Avenida Pico, it would veer to the east edge of I-5 and daylight into an open trench for about 1,000 feet. The existing rail corridor along the coast between southern San Clemente city limits to approximately Avenida Aeropuerto in San Juan Capistrano would be removed from service (or at least not be further improved from its existing condition).
Stations	
San Clemente	The trench options for this segment would include a proposed below-grade station south of the municipal pier to replace the existing San Clemente Station. The tunnel options would eliminate the need for a train station downtown; a new below-grade station would be constructed along the tunnel alignment where the tunnel transitions to a trench.
Camp Pendleton (San Onofre Power Plant to Oceanside City Limits - Double tracking; crosses San Mateo, San Onofre, and Santa Margarita Creeks)	Construction of an at-grade second main track, in portions of this segment covering about six miles, that are not already double-tracked or will be under the conventional rail improvements included in the No-Project Alternative.
Oceanside/Carlsbad (Oceanside City Limits to Encinitas City Limits)	
Alignments	
Carlsbad - AT-GRADE; double tracking; crosses San Luis Rey, Buena Vista , Aqua Hedionda, and Batiquitos Lagoons	Double-tracking through Carlsbad in existing rail alignment at grade.
Carlsbad -TRENCH; double-tracking; crosses San Luis Rey, Buena Vista, Aqua Hedionda, and Batiquitos Lagoons	Double-tracking through Carlsbad in existing rail alignment in trench.
Stations	
Oceanside	Existing station. Proposed improvements include bypass tracks and parking expansion.

[1] Conventional Rail (LOSSAN Corridor) alignment and/or construction options shown in italics and gray shading were eliminated from further evaluation during the LOSSAN Corridor Strategic Plan screening process. See text for more detail.

TABLE 1.1.3

Alignment and Station Options for High-Speed Train Alternative Los Angeles – Orange County – San Diego Region (continued)

Alignment Segments and Station Locations Evaluated[1]	Description of Proposed Options & Improvements
Encinitas/Solana Beach (Encinitas City Limits to Solana Beach Station)	
Alignments	
Encinitas - AT-GRADE; Double Tracking; crosses San Elijo Lagoon	Double-tracking primarily at-grade, with a short trench segment for the rail corridor on either side of Birmingham Drive. This option would include reconfiguring the street intersection at Birmingham Drive and San Elijo Avenue, and close Chesterfield Drive at San Elijo Avenue. Another grade separation would occur at Leucadia Boulevard where the tracks would be depressed. Pedestrian undercrossings would be placed along the route.
Encinitas - SHORT TRENCH; Double Tracking; crosses San Elijo Lagoon	Double-tracking in same alignment as at-grade option above, but with an additional covered trench under Encinitas Boulevard and a transitional open trench about 1,500 feet either side of Encinitas Boulevard.
Encinitas - LONG TRENCH; Double Tracking; crosses San Elijo Lagoon	*Double-tracking in same alignment as options described above. Tracks would be in an open trench south of the Batiquitos Lagoon, then drop into a covered trench as they approach the downtown area, then return to an open trench up to the north end of the San Elijo Lagoon, where they transition to at-grade. Chesterfield Drive at San Elijo Avenue would be closed. Pedestrian crossings would be placed along the route.*
Stations	
Solana Beach	Existing station. Proposed improvements include platform modifications and parking expansion.
Del Mar(Solana Beach Station to I-5/805 Split)	
Alignments	
COVERED TRENCH on bluffs; crosses San Dieguito and Los Penasquitos Lagoons	*Double-tracking in a covered trench in the existing rail corridor alignment along the bluffs.*
TUNNEL under Camino Del Mar; crosses San Dieguito and Los Penasquitos Lagoons	Double-tracking via a tunnel underneath Camino Del Mar. Tunnel would begin at Jimmy Durante Boulevard, and daylight at Carmel Valley Road where tracks would then connect with the existing alignment across Los Penasquitos Lagoon. The existing rail track on the bluffs would be removed from service.
TUNNEL along I-5; crosses San Dieguito and Los Penasquitos Lagoons	Double-tracking via a tunnel that would run under Interstate 5 and daylight along the southern boundary of San Dieguito Lagoon. Tracks would reconnect with the existing rail at-grade near the Del Mar race track. The existing rail track on the bluffs would be removed from service.
I-5/805 Split To Hwy 52	
Alignments	
Miramar Hill Tunnel	Double-tracking via a tunnel through Miramar Hill.
I-5 Tunnel	Double-tracking via a tunnel under Interstate 5.
Stations	
UTC (Only applies to Miramar Hill Tunnel)	New station, proposed only with the Miramar Hill tunnel option. Station would be constructed underground.
Hwy 52 To Santa Fe Depot (Curve realignment; Double Tracking; San Diego River Bridge; Trench between Sassafras St and Cedar St)	Double-tracking in existing rail corridor for full length of segment. An existing curve just south of Highway 52 would be straightened, requiring two new bridges over wetlands in San Clemente Canyon. New bridges would also be constructed over Tecolote Creek and San Diego River. Tracks would be placed in a trench between Sassafras Street and Cedar Street.
Stations	
Santa Fe Depot	Existing station. Proposed improvements include bypass tracks and parking expansion.

[1] Conventional Rail (LOSSAN Corridor) alignment and/or construction options shown in italics and gray shading were eliminated from further evaluation during the LOSSAN Corridor Strategic Plan screening process. See text for more detail.

FIGURE 1.1.5A

High-Speed Train Alternative: Alignment and Construction Type by Segment (Los Angeles to Irvine)

FIGURE 1.1.5B

High-Speed Train Alternative: Alignment and Construction Type by Segment (Irvine to Oceanside)

FIGURE 1.1.5C

High-Speed Train Alternative: Alignment and Construction Type by Segment (Oceanside to San Diego)

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA (AREA OF POTENTIAL EFFECT) DEFINED

The study area for paleontologic resources is the Area of Potential Effect (APE) that was defined in consultation with the State Historic Preservation Officer (SHPO). At this programmatic Tier 1 level of analysis, the APE is the area within which information about the locations of paleontologic resource localities was obtained from the Regional Paleontologic Locality Inventory (RPLI) at the San Bernardino County Museum (SBCM), as well as from the Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County (NHMLAC) and the Department of Paleontology, San Diego Natural History Museum (SDNHM).

The APE for this undertaking is defined as 100 feet on each side of the centerline of proposed rail routes, both in non-urban and urban areas. The APE for freeway routes and around airports is defined as 100 feet beyond the existing freeway right-of-way and 100 feet beyond the existing airport property boundary. The reason for using 100 feet for urban rail corridors, freeways, and airports is that very little additional right-of-way would be affected in these areas. The 100 feet on each side of the railroad centerline in non-urban areas may require expansion to 500 feet on each side of the proposed project centerline if subsequent design features indicate that paleontologic resources beyond the presently defined APE might be affected.

Locations of easements and construction-related facilities, such as equipment staging areas, borrow and disposal areas, access roads, and utilities, have not been yet been identified. Locations for these will be identified as part of the construction design program for the alternatives selected for more detailed analysis in the next phase of the project. Thus, these items are not considered in the program level Tier-1 analysis, but this information will be available for Tier-2 site-specific EIR/EIS's. The APE will be modified to include these items as part of the Tier-2 analysis.

2.2 BRIEF GEOLOGIC AND PALEONTOLOGIC BACKGROUND OF REGION

The coastal and interior Los Angeles County and Orange County regions are comprised primarily of Quaternary alluvium, deposited during the Pleistocene and Holocene Epochs, overlying older rocks of marine, near-shore, or volcanic origin. Of these, the latter rocks have low paleontologic sensitivity. Quaternary alluvium of Holocene age present at the surface also has low paleontologic sensitivity, although in many cases this Holocene alluvium overlies older, fossiliferous sediments. Marine rocks exposed at the surface and present in the subsurface in the Orange County portion of the APE include the Capistrano Formation (shallow marine embayment, ~5 – 7 million ybp) and the Niguel Formation (sublittoral, ~4 – 6 million ybp) (Ingle 1971[2]; Morton 1999[3]; Vedder 1960[4]; White 1956[5], 1971[6]).

---

2 Ingle, J.C., 1971. Paleoecologic and paleobathymetric history of the late Miocene - Pliocene Capistrano Formation, Dana Point area, Orange County, California. Geological Guide Book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, 88 p.

3 Morton, D.M., 1999. Preliminary digital geologic map of the Santa Ana 30' x 60' quadrangle, southern California, version 1.0. United States Geological Survey Open-File Report 99-172. Digital preparation by R.M. Hauser and K.R. Ruppert. 42 p.

4 Vedder, J.G., 1960. Previously unreported Pliocene Mollusca from the southeastern Los Angeles basin. *United States Geological Survey Professional Paper* 400-B, p. B326-B328.

5 White, W.R., 1956. Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California. *Journal of Paleontology* 30: 237-270.

6 White, W.R., 1971. Biostratigraphy of the Capistrano Formation, Dana Point, California. In Berger, F.W. (ed.), Geological guide book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, p. 50-54.

The coastal San Diego region is made up of fossil-bearing rock units dating back to the beginning of the Paleocene Epoch and continuing through to the end of the Pleistocene Epoch. Most of the exposed rock units were deposited in marine or near-shore terrestrial environments. These rock units include (from oldest to youngest): the Delmar Formation [lagoon/estuary, ~49 – 50 million years before present (ybp); Link and Abbott, 1991]; the Torrey Sandstone (near-shore marine and barrier island/protected lagoon, ~48 – 49 million ybp; Kennedy 1975[7]); the Ardath Shale (outer continental shelf, ~47 – 48 million ybp; Kennedy 1975); the Scripps Formation (continental shelf, ~47 million ybp; May 1985[8]); the Capistrano Formation (deep continental shelf or adjacent continental slope, ~5 – 7 million ybp; Kennedy 1975); the San Mateo Formation (near-shore marine, ~2 – 7 million ybp; Woodford 1925[9]; Domning and Deméré 1984[10]); the San Diego Formation (open marine embayment, ~1.5 – 3 million ybp; Deméré' 1983); the Lindavista Formation (fluvial, ollusk, and shallow near-shore marine, ~0.5 – 1.5 million ybp; Kennedy 1975); the Bay Point Formation (near-shore marine, ~220,000 ybp; Hertlein and Grant 1939[11]); and unnamed terrace deposits (near-shore marine and nonmarine, ~80,000 – 180,000 ybp; Kern 1977[12]; Deméré 1981[13]; Kennedy 1975; Kern and Rockwell 1994[14]).

2.3 DATA SOURCES

Records searches were obtained from the Regional Paleontologic Locality Inventory (RPLI) at the SBCM, as well as from the Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County (NHMLAC) and the Department of Paleontology, San Diego Natural History Museum (SDNHM). A letter report with references, mapped site forms, and locality data sheets were provided by the SDNHM. At the time of this writing, the requested letter report with references from the NHMLAC had not yet been delivered; data from this report, upon submission, will need to be incorporated into future iterations of this document. Plotted locality data and computerized locality records are also available from the RPLI at the SBCM; these data were collated with the data received from the SDNHM by the staff of the SBCM for this report.

2.4 PALEONTOLOGIC LOCALITIES

Paleontologic resource localities are those sites where the fossilized remains of extinct animals and/or plants have been preserved. Generally speaking, fossils are preserved remnants of past life. In rare cases, plant and animal body parts may become incorporated into the lithosphere. This procedure, known as fossilization, is extremely infrequent when measured in "normal" time, but over the course of geological time has resulted in the preservation of abundant remains of past organisms.

---

7 Kennedy, M.P. 1975. Geology of the San Diego metropolitan area, California. Section A - Western San Diego metropolitan area. *California Division of Mines and Geology, Bulletin* 200:9-39.

8 May, J.A. 1985. Submarine-canyon system of the Eocene San Diego Embayment. In, P.L. Abbott (ed.), *On the Manner of Deposition of the Eocene Strata in Northern San Diego County. San Diego Association of Geologists*, fieldtrip guidebook, pp. 1-17.

9 Woodford, A.O. 1925. The San Onofre Breccia: its nature and origin. *University of California Publications in Geological Sciences*. 15:159-280.

10 Domning, D.P., and T.A. Deméré. 1984. New material of Hydrodamalis cuestae (Mammalia: Dugongidae) from the Miocene and Pliocene of San Diego County, California. San Diego Society of Natural History, *Transactions* 20:169-188.

11 Hertlein, L.G., and U.S. Grant, IV. 1939. Geology and oil possibilities of southwestern San Diego County. *California Journal of Mines and Geology* 35:57-78.

12 Kern, J.P. 1977. Origin and history of upper Pleistocene marine terraces, San Diego, California. *Geological Society of America, Bulletin* 88:1553-1566.

13 Deméré, T.A. 1981. A newly recognized late Pleistocene marine fauna from the City of San Diego, San Diego County, California. In, P.L. Abbott and S. O'Dunn (eds.), Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists, fieldtrip guidebook, pp. 1-10.

14 Kern, J.P., and T.K. Rockwell. 1994. Chronology and deformation of Quaternary marine shorelines, San Diego County, California. In, *Quaternary Coasts of the United States: Marine and Lacustrine Systems. Society of Economic Paleontologists and Mineralogists, Special Publication* 48:377-382.

In California, the rich geologic record of the state has resulted in numerous rock units with high paleontologic sensitivity being exposed at the surface. For this reason, the fossil record of California is exceptionally prolific, with abundant fossils representing diverse organisms having been recovered from rocks dating from more than one billion years before present (ybp), during the later Proterozoic Era, to the end of the Pleistocene Epoch around 11,000 ybp. These fossils have provided key data for charting the course of the evolution and extinction of life on the planet, both locally and globally, as well as for determining paleoenvironmental conditions, sequences and timing of sedimentary deposition, and other details of past millennia.

As discussed above, numerous geologic formations with high paleontologic sensitivity occur along the proposed alignment within the APE. In Orange County and eastern Los Angeles County, within and adjacent to the APE, marine rocks exposed at the surface and present in the subsurface include the Capistrano Formation and the Niguel Formation. The Capistrano Formation is a marine sandstone and siltstone dating to the latest Miocene and early Pliocene Epochs that has yielded fossil remains of foraminifera, echinoids and vertebrates – the latter including sharks and whales (White 1956[15], 1971[16]; Ingle 1971[17]). Included in the Capistrano Formation is the Oso Sand, a member of the Capistrano Formation that was deposited in a large shallow-marine embayment. The Oso Sand is one of the most prolific fossil-bearing units known from Orange County, having yielded fossil remains of fish, sharks, whales, sea lions, and other marine vertebrates from literally dozens of fossil localities. The Capistrano Formation is therefore assigned high paleontologic sensitivity.

The Niguel Formation is a shallow marine and nonmarine interbedded sandstone, conglomeratic sandstone and conglomerate that overlies the Capistrano Formation and dates to the middle to later part of the Pliocene Epoch (4 to 6 million years before the present) (Morton 1999[18]). The Niguel Formation was named by Vedder (1957[19]) for exposures near San Juan Capistrano. The sandstone component of this formation is brownish-grey, coarse-grained, and poorly sorted. The conglomerate portions of the formation are also brownish-grey, consisting of unsorted clasts ranging in size from 2.5 cm to 25 cm in diameter, which contain blocks of locally derived siltstone (Morton 1999). Fossils recovered from the Niguel Formation include marine ollusks indicative of deposition in sublittoral conditions (living near or just below the low tide level of a shore) (Vedder 1960[20]).

Those portions of the Niguel Formation that are made up primarily of massive, poorly sorted conglomerates are not likely to be highly fossiliferous. However, the fine-grained sedimentary beds that are also frequently present in the Niguel Formation are often fossiliferous, having yielded abundant marine invertebrate as well as vertebrate fossils (Morton 1999; Vedder 1960). For this reason, the Niguel Formation is assigned high paleontologic sensitivity.

In San Diego County, deposits mapped as the Delmar Formation occur within the proposed APE in the cities of Encinitas, Solana Beach, and Del Mar; localities identified from this formation have yielded well-

15 White, W.R., 1956. Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California. *Journal of Paleontology* 30: 237-270.

16 White, W.R., 1971. Biostratigraphy of the Capistrano Formation, Dana Point, California. In Berger, F.W. (ed.), Geological guide book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, p. 50-54.

17 Ingle, J.C., 1971. Paleoecologic and paleobathymetric history of the late Miocene - Pliocene Capistrano Formation, Dana Point area, Orange County, California. Geological Guide Book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, 88 p.

18 Morton, D.M., 1999. Preliminary digital geologic map of the Santa Ana 30' x 60' quadrangle, southern California, version 1.0. United States Geological Survey Open-File Report 99-172. Digital preparation by R.M. Hauser and K.R. Ruppert. 42 p.

19 Vedder, J.G., 1957. New stratigraphic names used on geologic map of the San Joaquin Hills - San Juan Capistrano area, Orange County, California. In Vedder, J.G., R.F. Yerkes and J.E. Schoellhamer, Geologic map of the San Joaquin Hills - San Juan Capistrano area, Orange County, California: United States Geological Survey Oil and Gas Inventory Map OM-193.

20 Vedder, J.G., 1960. Previously unreported Pliocene Mollusca from the southeastern Los Angeles basin. *United States Geological Survey Professional Paper* 400-B, p. B326-B328.

preserved to poorly preserved remains of estuarine invertebrates (e.g., clams, oysters, and snails) and estuarine vertebrates (e.g., sharks and rays), as well as well-preserved skull remains of aquatic reptiles (e.g., crocodile) and terrestrial mammals (e.g., tillodont and early rhinoceros) from near Encinitas (Givens and Kennedy 1979[21]; Hanna 1927[22]).

Deposits mapped as the Torrey Sandstone occur within the APE in the cities of Encinitas, Solana Beach, and Del Mar; localities from this formation have yielded important remains of fossil plants and marine invertebrates (Myers 1991[23]). Deposits mapped as the Ardath Shale occur within the proposed APE as it runs up the lower reach of Rose Canyon; localities from this formation have yielded diverse and well-preserved assemblages of marine microfossils (Bukry and Kennedy 1969[24]; Gibson 1971[25]; Steineck et al. 1972[26]), macroinvertebrates (Givens and Kennedy 1979; Hanna 1927), and vertebrates (e.g., sharks, rays, and bony fish). Deposits mapped as the Scripps Formation also occur within the proposed APE in the upper reach of Rose Canyon, as well as at the head of Soledad Canyon; fossils from this formation include remains of marine clams, snails, crabs, sharks, rays, and bony fishes (Givens and Kennedy 1979), as well as fossil reptiles (e.g., crocodile and turtle) and land mammals (e.g., uintathere, brontothere, rhinoceros, and mollusks) (Golz and Lillegraven 1977[27]; Walsh 1991[28]). Well-preserved pieces of fossil wood have also been recovered from the Scripps Formation.

Rocks mapped as the above-discussed Capistrano Formation occur within the proposed APE in the sea cliffs from Capistrano Beach south onto Camp Pendleton Marine Corps Base, as well as in the inland portions of San Clemente and in the region around the mouth of San Mateo Canyon. Localities identified from the Capistrano Formation have produced diverse assemblages of fossil marine vertebrates including sharks, rays, bony fishes, sea birds, toothed whales, baleen whales, sea cow, fur seals, and walruses. Unusual occurrences of fossil marine algae (kelp) have also been reported from the Capistrano Formation.

The San Mateo Formation crops out in sea cliff exposures from San Mateo Point near San Clemente, south along the western portion of Camp Pendleton Marine Corps Base to the San Luis Rey River in Oceanside (Young and Berry 1981[29]). The formation is especially well exposed in the valleys of the Santa Margarita and San Luis Rey rivers. This formation has produced very important and locally abundant remains of many kinds of fossil marine vertebrates including rays, sharks, bony fishes (Fierstine and Welton 1988[30]), sea birds (Howard 1982[31]), dolphins, sperm whale, baleen whales (Barnes 1976[32];

---

21 Givens, C.R., and M.P. Kennedy. 1979. Eocene molluscan stages and their correlation, San Diego area, California. In, P.L. Abbott (ed.), Eocene Depositional Systems, San Diego. Geological Society of America, fieldtrip guidebook, pp. 81-95.

22 Hanna, M.A. 1927. An Eocene invertebrate fauna from the La Jolla quadrangle, California. *University of California Publications in Geological Sciences*, 16:247-398.

23 Myers, J.A. 1991. The early Eocene Torrey Flora, Delmar, California. In, P.L. Abbott and J.A. May (eds.), *Eocene Geologic History San Diego Region. Society of Economic Mineralogists and Paleontologists, Pacific Section* 68:201-215.

24 Bukry, D., and M.P. Kennedy. 1969. Cretaceous and Eocene coccoliths at San Diego, California. California *Division of Mines and Geology, Special Report* 100:33-43.

25 Gibson, J.M. 1971. Benthonic foraminifera of the Ardath Shale and Stadium Conglomerate (Eocene, San Diego Basin, California. *Bulletin of the Southern California Academy of Sciences* 70:125-130.

26 Steineck, P.L., J.M. Gibson, and R. Morin. 1972. Foraminifera from the middle Eocene Rose Canyon and Poway formations, San Diego. *Journal of Foraminiferal Research* 2:137-144.

27 Golz, D.J., and J.A. Lillegraven. 1977. Summary of known occurrences of terrestrial vertebrates from Eocene strata of southern California. University of Wyoming, *Contributions to Geology* 15:43-65.

28 Walsh, S.L. 1991. Eocene mammal faunas of San Diego County. In, P.L. Abbott and J.A. May (eds.), *Eocene Geologic History San Diego Region. Society of Economic Mineralogists and Paleontologists, Pacific Section* 68:161-178.

29 Young, J.M., and R.W. Berry. 1981. Tertiary lithostratigraphic variations, Santa Margarita River to Aqua Hedionda Lagoon. In, P.L. Abbott and S. O'Dunn (eds.), *Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists*, fieldtrip guidebook, pp. 33-51.

30 Fierstine, H.L., and B.J. Welton. 1988. A late Miocene marlin, Makaira sp. (Perciformes, Osteichthyes) from San Diego County, California, U.S.A. *Tertiary Research* 10:13-19.

Barnes et al. 1981[33]), sea cow (Domning and Deméré 1984[34]), fur seals, walrus, and sea otter (Berta and Morgan 1985[35]). In addition, terrestrial mammal remains (e.g., horse, camel, llama, and peccary) have been recovered from these deposits. The most productive vertebrate fossil localities occur in the Lawrence Canyon area of north Oceanside. Exposures of the San Mateo Formation on Camp Pendleton have also produced diverse assemblages of marine invertebrates (e.g., clams, scallops, snails, and sea urchins).

Deposits mapped as the San Diego Formation occur within the APE as it runs through the Little Italy and Old Town communities of San Diego; localities identified from this rock unit have yielded extremely diverse assemblages of marine clams, scallops (Hertlein and Grant 1972[36]), snails, crabs, barnacles, sand dollars (Hertlein and Grant 1960[37]), sharks (Deméré and Cerutti 1981[38]), rays, bony fishes, sea birds (Chandler 1990[39]), walrus (Deméré 1994[40]), fur seal (Berta and Deméré 1984[41]), sea cow (Domning and Deméré 1984), dolphins (Barnes 1973[42]), and baleen whales (Deméré 1986[43]). In addition, rare remains of terrestrial mammals including cat, wolf, skunk, peccary, camel, antelope, deer, horse, and gomphothere have also been recovered from the formation. Rounding out this impressive fossil record is the occurrence of fossil wood and leaves including remains of pine, oak, laurel, cottonwood, and avocado (Axelrod and Deméré 1984[44]). Taken together this diverse assemblage of fossil organisms represents one of the most important sources in the world of information on Pliocene marine organisms and environments.

Deposits mapped as the Lindavista Formation occur within the APE in the mesa lands at the head of Soledad Canyon and Rose Canyon; localities from this formation are limited, and have been recorded from only a few areas (e.g., Tierrasanta, Mira Mesa, Kearney Mesa, and San Diego Mesa). Fossils collected from these sites consist of remains of nearshore marine invertebrates including clams, scallops,

---

31 Howard, H. 1982. Fossil birds from Tertiary marine beds at Oceanside, San Diego County, California, with descriptions of two new species of the genera Uria and Cepphus (Aves: Alcidae). Natural History Museum of Los Angeles County, *Contributions in Science* 341:1-

32 Barnes, L.G. 1976. Outline of eastern north Pacific fossil cetacean assemblages. *Systematic Zoology* 25:321-343.

33 Barnes, L.G., H. Howard, J.H. Hutchison, and B.J. Welton. 1981. The vertebrate fossils of the marine Cenozoic San Mateo Formation at Oceanside, California. In, P.L. Abbott and S. O'Dunn (eds.), Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists, fieldtrip guidebook, pp. 53-70.

34 Domning, D.P., and T.A. Deméré. 1984. New material of Hydrodamalis cuestae (Mammalia: Dugongidae) from the Miocene and Pliocene of San Diego County, California. San Diego Society of Natural History, *Transactions* 20:169-188.

35 Berta, A., and G.S. Morgan. 1985. A new sea otter (Carnivora: Mustelidae) from the late Miocene and early Pliocene (Hemphillian) of North America. *Journal of Paleontology* 59:809-819.

36 Hertlein, L.G., and U.S. Grant, IV. 1972. The geology and paleontology of the marine Pliocene of San Diego, California, Part 2b, Paleontology. *San Diego Society of Natural History, Memoir* 2:143-409.

37 Hertlein, L.G., and U.S. Grant, IV. 1960. The geology and paleontology of the marine Pliocene of San Diego, California, Part 2a, Paleontology. *San Diego Society of Natural History, Memoir* 2:73-133.

38 Deméré, T.A., and R.A. Cerutti. 1981. A Pliocene shark attack on a cetotheriid whale. *Journal of Paleontology* 56:1480-1482.

39 Chandler, R.M. 1990. Fossil Birds of the San Diego Formation, late Pliocene, Blancan, San Diego County, California. *Ornithological Monographs* 44:77-161.

40 Deméré, T. A. 1994. Two new species of fossil walruses (Pinnipedia: Odobenidae) from the upper Pliocene San Diego Formation, California; pp. 77-98. In, Berta, A. and T.A. Deméré (eds.), Contributions in Marine Mammal Paleontology Honoring Frank C. Whitmore, Jr., Proceedings of the San Diego Society of Natural History 29.

41 Berta, A., and T.A. Deméré. 1986. Callorhinus gilmorei n. sp. (Carnivora: Otariidae) from the San Diego Formation (Blancan) and its implications for otariid phylogeny. San Diego Society of Natural History, *Transactions* 21:111-126.

42 Barnes, L.G. 1973. Pliocene cetaceans of the San Diego Formation. In, R. Arnold and R.J. Dowlen (eds.), Studies on the Geology and Geologic Hazards of the Greater San Diego Area, California. San Diego Association of Geologists, fieldtrip guidebook, pp. 37-43.

43 Deméré, T.A. 1986. The fossil whale, Balaenoptera davidsonii (Cope 1872), with a review of other Neogene species of Balaenoptera (Cetacea: Mysticeti). *Marine Mammal Science* 2:277-298.

44 Axelrod, D.I., and T.A. Deméré. 1984. A Pliocene flora from Chula Vista, San Diego County, California. San Diego Society of Natural History, *Transactions* 20:277-300.

snails, barnacles, and sand dollars (G.L. Kennedy 1973[45]), as well as sparse remains of sharks and baleen whales (Deméré and Walsh 1993[46]).

Deposits mapped as the Bay Point Formation occur within the APE as it runs from downtown San Diego through Old Town and the east shore of Mission Bay; these rocks have produced large and diverse assemblages of well-preserved marine invertebrate fossils, primarily ollusks (Deméré 1981[47]; Hertlein and Grant 1939[48]; Stephens 1929[49]; Valentine 1959[50]), as well as remains of fossil marine vertebrates (i.e., sharks, rays, and bony fishes).

Finally, deposits mapped as "unnamed marine terrace deposits" occur intermittently within the proposed APE for the majority of its length from San Clemente to San Diego. These deposits generally cap the modern sea cliffs, but also extend inland to elevations of about 120 feet. The unnamed marine terrace deposits are extensively preserved in the areas of Torrey Pines State Reserve, Del Mar, Solana Beach, Encinitas, Carlsbad, and Oceanside. On Camp Pendleton Marine Corps Base these deposits are probably best exposed. Localities identified from these unnamed terrace sediments include marine invertebrate fossils such as mollusks, crustaceans, and echinoids (Emerson and Chase 1959[51]; Grant and Gale 1931[52]; Kern 1977[53]; Stephens 1929; Valentine 1960[54], 1961[55]), as well as sparse remains of marine vertebrates such as sharks, rays, and bony fish (Jefferson 1991[56]) from the basal unit of these deposits. The upper unit has produced sparse remains of terrestrial mammals such as camel, horse, and mammoth (Hertlein and Grant 1944[57]) from fossil collecting localities in San Diego, Solana Beach, and Camp Pendleton Marine Corps Base.

---

45 Kennedy, G.L. 1973. Early Pleistocene invertebrate faunule from the Lindavista Formation, San Diego, California. San Diego Society of Natural History, transactions 17:119-128.

46 Deméré, T.A. and S.L. Walsh. 1993. Paleontological Resources, County of San Diego. Prepared for the Department of Public Works, County of San Diego: 1-68.

47 Deméré, T.A. 1981. A newly recognized late Pleistocene marine fauna from the City of San Diego, San Diego County, California. In, P.L. Abbott and S. O'Dunn (eds.), Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists, fieldtrip guidebook, pp. 1-10.

48 Hertlein, L.G., and U.S. Grant, IV. 1939. Geology and oil possibilities of southwestern San Diego County. *California Journal of Mines and Geology* 35:57-78.

49 Stephens, F. 1929. Notes on the marine Pleistocene of San Diego County, California. San Diego Society of Natural History, *Transactions* 5:245-256.

50 Valentine, J.W. 1959. Pleistocene molluscan notes. I. The Bay Point Formation at its type locality. *Journal of Paleontology* 33:685-688.

51 Emerson, W.K., and E.P. Chace. 1959. Pleistocene mollusks from Tecolote Creek, San Diego, California. San Diego Society of Natural History, *Transactions* 12:335-345.

52 Grant, U.S., IV, and H.R. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California. San Diego Society of Natural History, Memoir 1:1-878.

53 Kern, J.P. 1977. Origin and history of upper Pleistocene marine terraces, San Diego, California. *Geological Society of America, Bulletin* 88:1553-1566.

54 Valentine, J.W. 1960. Habitats and sources of Pleistocene mollusks at Torrey Pines Park, *California. Ecology* 41:161-165.

55 Valentine, J.W. 1961. Paleoecologic molluscan geography of the California Pleistocene. *University of California Publications in Geological Sciences* 34:309-442.

56 Jefferson, G.T. 1991. A catalog of late Quaternary vertebrates from California. Natural History Museum of Los Angeles County, Technical Reports 7:1-129.

57 Hertlein, L.G., and U.S. Grant, IV. 1944. The geology and paleontology of the marine Pliocene of San Diego, California, Part 1, Geology. *San Diego Society of Natural History, Memoir* 2:1-72.

3.0 METHODS FOR PALEONTOLOGIC RESOURCES ANALYSIS

The paleontologic resources analysis for this program-level EIR/EIS is focused on a broad comparison of potential impacts to significant nonrenewable paleontologic resources along corridors for each of the alternatives (high-speed train and modal alternatives) and around stations. The potential impacts for each of these alternatives are compared with the No-Project Alternative.

3.1 DATA COLLECTION

An Area of Potential Effect (APE), or study area, was defined for the project. The APE for paleontologic resource localities was defined as 100 feet on each side of the centerline of proposed rail routes. The APE for freeway routes and around airports was defined as 100 feet beyond the existing freeway right-of-way and 100 feet beyond the existing airport property boundary. In non-urban areas, the APE may require expansion to 500 feet on each side of the proposed project centerline if subsequent design features indicate that paleontologic resources beyond the presently defined APE might be affected.

Records searches were obtained from the RPLI at the SBCM, as well as from the NHMLAC and the SDNHM, as described above. (At the time of this writing, the report from the NHMLAC had not yet been delivered.) The records searches provided the locations of known paleontologic localities within the APE. The number of paleontologic resource localities within the APE for each alternative was compared to assess the relative degree of potential impacts or effects for each alternative.

3.2 LEGAL CITATIONS REGARDING THE PROTECTION AND PRESERVATION OF PALEONTOLOGIC RESOURCES

3.2.1 Federal Regulations

Statutes of the United States of America that incorporate provisions for the protection of paleontologic resources include:

Federal Antiquities Act of 1906 (P.L. 59-209, 32 Stat. 225).

> Forbids and establishes criminal sanctions for disturbance of any object of antiquity on Federal land without a permit issued by an authorizing authority.

National Environmental Policy Act of 1969

(P.L. 91-190, 83 Stat. 852, 42 USC 4321-4327). Mandates policies to “preserve important historic, cultural and natural aspects of our national heritage” (Section 101.b4).

3.2.2 State of California – Requirements

Fossil remains are a limited, nonrenewable, highly sensitive, scientific resource. In California, these resources are afforded protection against adverse impacts under the authority of the following State of California legislation (California Office of Historic Preservation, 1983):

California Environmental Quality Act of 1970

> (13 Public Resources Code, 21000 et seq). Requires public agencies and private interests to identify the potential adverse impacts and/or environmental consequences of their proposed

project(s) to any object or site scientific to the scientific annals of California (Division 1, Public Resources Code: 5020.1 [b]).

Guidelines for the Implementation of CEQA (as amended 1 January 1999)

(CEQA Guidelines Sec. 15064.5). Provides protection for paleontologic resources by requiring that they be identified and mitigated as historical resources under CEQA. The CEQA Guidelines define historical resources broadly to include any object, site, area or place that a lead agency determines to be historically significant. The regulation goes on to provide that generally, a resource shall be considered "historically significant" if it has yielded or may be likely to yield information important in prehistory. Paleontologic resources fall within this broad category, and additionally are included in the CEQA checklist under "Cultural Resources."

Warren-Alquist Act

(PRC 25000 et seq.). Requires the California Energy Commission to evaluate energy facility siting in unique areas of scientific concern (section 25527).

Public Resources Code, Section 5097.5

(Stats 1965, c. 1136, p. 2792). Prohibits excavation or removal of any "...vertebrate paleontological site...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." Public lands are defined to include lands owned by or under the jurisdiction of the State of California or any city, county, district, authority or public corporation, or any agency thereof. Defines any unauthorized disturbance or removal of paleontologic, archaeologic and/or historic materials or sites located on public lands as a misdemeanor.

Public Resources Code, Section 30244.

Requires reasonable mitigation of adverse impacts to paleontological resources from development on public land.

3.3 INTERPRETING PALEONTOLOGIC SENSITIVITY

Under both state and federal guidelines for cultural resources (including paleontologic resources), impacts are potentially significant only if the resource being impacted has been determined to be significant. Section V(c) of Appendix G of CEQA makes reference to "unique paleontological resource(s) or site(s) or unique geological feature(s)". No definition of what constitutes a "unique" resource or site is provided. Some interpretation is therefore necessary to provide proper resource protection.

3.3.1 Paleontologic Resources

Paleontologic resources are the fossilized evidence of past life found in the geologic record. Despite the tremendous volume of sedimentary rock deposits preserved worldwide, and the enormous number of organisms that have lived through time, preservation of plant or animal remains as fossils is an extremely rare occurrence. Because of the infrequency of fossil preservation, fossils – particularly vertebrate fossils – are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they can provide, fossils are highly significant records of ancient life. They can provide information about the interrelationships of living organisms, their ancestry, their development and change through time, and their former distribution. Progressive morphologic changes observed in fossil lineages may provide critical information on the evolutionary process itself – that is, the ways in which new species arise and adapt to changing environmental circumstances. Fossils can also serve as important

guides to the ages of the rocks and sediments in which they are contained, and may prove useful in determining the temporal relationships of rock deposits from one area to another and the timing of geologic events. Time scales established by fossils provide chronologic frameworks for geologic studies of all kinds.

3.3.2 Defining Paleontologic Significance

Because of the infrequency of fossil preservation, fossils are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they provide, fossils can be highly significant records of ancient life. Given this, fossils can be considered to be of significant scientific interest if one or more of the following criteria apply:

1.) The fossils provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct;

2.) The fossils provide data useful in determining the age(s) of the rock unit or sedimentary stratum, including data important in determining the depositional history of the region and the timing of geologic events therein;

3.) The fossils provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas;

4.) The fossils demonstrate unusual or spectacular circumstances in the history of life; and/or

5.) The fossils are in short supply and/or in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and are not found in other geographic locations.

As so defined, significant paleontologic resources are determined to be fossils or assemblages of fossils that are unique, unusual, rare, uncommon, diagnostically or stratigraphically important, and/or those that add to an existing body of knowledge in specific areas – stratigraphically, taxonomically, and/or regionally. They can include fossil remains of large to very small aquatic and terrestrial vertebrates, remains of plants and animals previously not represented in certain portions of the stratigraphy, and fossils that might aid stratigraphic correlations, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology, and the relationships of aquatic and terrestrial species.

Determinations of the significance of paleontologic resources can only be made by qualified, trained paleontologists familiar with the fossils under consideration. Such determinations are best advanced in the light of a well-conceived and clearly defined treatment plan. With an efficient sampling plan based upon such a treatment program in effect, the ability of the paleontologists to recognize, recover and preserve significant paleontologic resources is greatly enhanced.

3.4 DETERMINATIONS OF ROCK UNIT SENSITIVITY

Sedimentary units which are paleontologically sensitive are those units with a high potential for containing significant paleontologic resources – that is, rock units within which vertebrate fossils or significant invertebrate fossils have been determined by previous studies to be present or likely to be present. These units include, but are not limited to, sedimentary formations that contain significant paleontologic resources anywhere within their geographical extent, as well as sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Determinations of paleontologic sensitivity must therefore consider not only the potential for yielding abundant vertebrate fossils but also the potential for production of a few significant fossils, large or small, vertebrate or invertebrate, which may provide new and significant taxonomic, phylogenetic, and/or stratigraphic data. Areas that may

contain datable organic remains older than Recent and areas that may contain unique new vertebrate deposits, traces, and/or trackways must also be considered paleontologically sensitive.

3.4.1 Invertebrate Fossils

Generally, invertebrate fossils recovered from marine sediments are often widely distributed throughout a given outcrop or formation, are found in predictable locations, and are both abundant and well preserved. In fact, many invertebrate fossils – particularly marine invertebrate fossils – can sometimes number in the millions, and can be exposed over miles of outcrop. Some invertebrate fossils are so prolific that they constitute major rock material, such as diatomaceous clay.

Given these general observations, it is clear that sedimentary exposures containing abundant, well-preserved, and extensively-distributed invertebrates – but lacking vertebrate fossils (see below) – are less paleontologically sensitive than limited exposures containing few fossils from a restricted depositional zone – for example, a narrow near-shore environment. In the first case, paleontologically significant data lost to adverse impacts (be such impacts development-related or otherwise) could very likely be easily recovered from any other exposures of the impacted formation which contained similar fossil density and species diversity. In the second instance, however – that of the limited exposures from restricted depositional environments – adverse impacts to paleontologic resources might not be ameliorated by fossil salvage elsewhere in the formation, since the fossil abundance and species representation would likely be very different. In this second case, the sediments under consideration would have higher paleontological sensitivity.

3.4.2 Vertebrate Fossils

Vertebrate fossils – fossils representing animals with backbones, including mammals, birds, reptiles, amphibians and fish – are much more rare than invertebrate fossils and are often more poorly preserved. In marine rock units, significant vertebrate fossils are generally much less common than invertebrate fossils. Paleontologic resource localities yielding vertebrate fossils are also frequently recovered from terrestrial (= non-marine) deposits; these continental deposits are generally less depositionally uniform than marine deposits, and fossilization is consequently even more infrequent. Further, in life vertebrates are often far less abundant than invertebrates (picture the difference between a herd of hundreds or even thousands of bison versus marine beds containing *hundreds of millions* of bivalves); the infrequency of fossilization and the vicissitudes of the many taphonomic factors involved result in vertebrate fossils being extremely rare relative to their original numbers in life. For these reasons, vertebrate fossil resources are considered to have very high paleontologic significance; geologic formations that have the potential to yield vertebrate fossil remains are therefore considered to have the greatest paleontologic significance – and, it follows, the highest paleontologic sensitivity.

3.4.3 Definitions

Literature research and institutional records searches have resulted in the designation of areas within the APE as having high, low, or undetermined paleontologic sensitivity. Provisions for mitigation of adverse impacts to significant nonrenewable paleontologic resources present within the boundaries of the APE were based upon these determinations of potential paleontologic sensitivity. The terms “high sensitivity,” “low sensitivity,” and “undetermined sensitivity” are described below.

<u>High Sensitivity</u>: Sedimentary units with a high potential for containing significant nonrenewable paleontologic resources are determined to have high paleontologic sensitivity. In these cases the sedimentary rock unit contains a high density of recorded vertebrate fossil sites, has produced vertebrate fossil remains within the APE and/or the vicinity, and is very likely to yield additional remains within the APE.

Low Sensitivity: The rock unit contains no or very low density of recorded resource localities, has produced little or no fossil remains within the APE and/or the vicinity, and is not likely to yield any remains within the APE. [Note: elsewhere in southern California, sedimentary exposures with few or no prior recorded sites have recently proven abundantly fossiliferous during paleontologic mitigation activities for other construction projects. For example, the Diamond Valley Lake in Hemet, Riverside County, California was originally determined to have "low to moderate" sensitivity, but subsequently has yielded thousands of well-preserved fossils of terrestrial Pleistocene Epoch vertebrates (Scott 1997[58]; Springer and Scott 1994[59]; Springer et al. 1998[60], 1999[61]) and plants (Anderson et al. 2002[62])].

Undetermined Sensitivity: The rock unit has limited exposure(s) in the APE, is poorly studied, and contains no recorded paleontologic resource localities. However, in other areas, the same or a similar rock unit contains sufficient paleontologic resource localities to suggest that exposures of the unit within the APE have potential for yielding fossil remains.

58 Scott, E., 1997. A review of *Equus conversidens* in southern California, with a report on a second, previously-unrecognized species of Pleistocene small horse from the Mojave Desert. *Journal of Vertebrate Paleontology* 17(3): 75-A.

59 Springer, K.B. and E. Scott, 1994. First record of late Pleistocene vertebrates from the Domenigoni Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 14 (3): 47A.

60 Springer, K.B., E. Scott, L.K. Murray and W.G. Spaulding, 1998. Partial skeleton of a large individual of *Mammut americanum* from the Domenigoni Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 18(3): 78-A.

61 Springer, K.B., E. Scott, J.C. Sagebiel and K.M. Scott, 1999. A late Pleistocene lake edge vertebrate assemblage from the Diamond Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 19(3): 77-A.

62 Anderson, R.S., M.J. Power, S.J. Smith, K.B. Springer and E. Scott, 2002. Paleoecology of a Middle Wisconsin deposit from southern California. *Quaternary Research* 58(3): 310-317.

4.0 PALEONTOLOGIC IMPACTS

Table 4.0 below lists each segment of the Los Angeles – Orange County - San Diego Region for the No-Project, Modal, High Speed Train and Conventional Rail alternatives. The number of rock units having high paleontologic sensitivity and the number of paleontologic resource localities recorded within each APE were assessed in order to provide an accurate interpretation of the overall ranking of high, low, or undetermined potential to impact significant nonrenewable paleontologic resources. This final evaluation is reached using both the raw data in the table below and incorporating professional assessments by the paleontologic staff regarding the significance of recovered resources from exposed rock units, and the likelihood of these rock units to contain additional paleontologic resources. Brief discussions of the rationale behind these judgments are presented following the table in paragraphs discussing each segment and its evaluation.

Table 4.0
Detailed Analysis/Comparison table:
Impacts to Paleontologic Resources
Los Angeles – Orange County – San Diego Region

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Formations with Undetermined Fossil Sensitivity	Fossil Resource Localities	Overall Rank
NO-PROJECT ALTERNATIVE					
NO-PROJECT	The No-Project Alternative includes the implementation of programmed improvements to highways and existing, conventional rail corridors by the year 2020. Environmental studies are being implemented independently for these improvements, and they do not constitute part of this Project. No additional impacts to paleontologic resources are expected to occur beyond those impacts addressed in the appropriate environmental documents for those projects.				
MODAL (I-5 AND AIRPORT EXPANSION)					
HIGHWAYS					
Union Station to LAX	There are no Modal Improvements proposed for this segment.				
Union Station to Fullerton Station	0	1	0	0	LOW
Fullerton Station to Irvine Station	1	1	0	0	HIGH
Irvine Station to San Juan Capistrano City Limits	4	1	0	0	HIGH
San Juan Capistrano	4	0	0	0	HIGH
Dana Point/San Clemente	2	1	0	5	HIGH
Camp Pendleton	2	1	0	1	HIGH

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Formations with Undetermined Fossil Sensitivity	Fossil Resource Localities	Overall Rank
Oceanside/Carlsbad	1	0	0	0	HIGH
Encinitas/Solana Beach	2	0	0	2	HIGH
Del Mar	2	1	0	8	HIGH
Interstate 5 / 805 Split to Highway 52	1	0	0	2	HIGH
Highway 52 to Santa Fe Depot	3	1	0	16	HIGH
AIRPORTS					
Long Beach Municipal Airport	1	1	0	0	HIGH
HIGH-SPEED TRAIN ALTERNATIVE					
HIGH-SPEED RAIL CORRIDORS & STATION OPTIONS					
UNION STATION TO LAX	1	2	0	0	HIGH
STATIONS					
LAX Station	1	0	0	0	HIGH
UNION STATION TO ANAHEIM (VIA UPRR)	0	1	0	0	LOW
STATIONS					
Norwalk Station	0	1	0	0	LOW
Anaheim Station	0	1	0	0	LOW
UNION STATION TO IRVINE (VIA LOSSAN)	1	2	0	0	HIGH
STATIONS					
Norwalk Station	0	1	0	0	LOW
Fullerton Station	0	1	0	0	LOW
Anaheim Station	0	1	0	0	LOW
Santa Ana Station	0	1	0	0	LOW
Irvine Station	0	1	0	0	LOW

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Formations with Undetermined Fossil Sensitivity	Fossil Resource Localities	Overall Rank
CONVENTIONAL RAIL (LOSSAN CORRIDOR) AND STATION OPTIONS					
ALIGNMENTS					
Union Station to Fullerton Station	0	1	0	0	LOW
Fullerton Station to Irvine Station	1	1	0	0	HIGH
STATIONS					
Fullerton Station	0	1	0	0	LOW
Anaheim Station	0	1	0	0	LOW
Santa Ana Station	0	1	0	0	LOW
Irvine Station	0	1	0	0	LOW
ALIGNMENTS					
Irvine Station to San Juan Capistrano City Limits	4	1	0	0	N/A No improvements proposed for this segment
San Juan Capistrano	2	0	0	0	HIGH
STATIONS					
San Juan Capistrano Station	2	0	0	0	HIGH
ALIGNMENTS					
Dana Point/San Clemente	1	0	0	3	HIGH
STATIONS					
San Clemente Station	1	0	0	0	HIGH
ALIGNMENTS					
Camp Pendleton	2	1	0	0	HIGH
Oceanside / Carlsbad	3	0	0	0	HIGH
STATIONS					
Oceanside Station	1	1	0	0	HIGH

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Formations with Undetermined Fossil Sensitivity	Fossil Resource Localities	Overall Rank
ALIGNMENTS					
Encinitas / Solana Beach	2	1	0	0	HIGH
STATIONS					
Solana Beach Station	1	1	0	3	HIGH
ALIGNMENTS					
Del Mar Solana Beach Station to Interstate 5	2	1	0	3	HIGH
Interstate 5 to Highway 52	2	1	0	1	HIGH
STATIONS					
UTC Station	2	0	0	0	HIGH
ALIGNMENTS					
Highway 52 to Santa Fe Depot	2	1	0	13	HIGH
STATIONS					
Santa Fe Station	1	1	0	0	HIGH

4.1 NO-PROJECT ALTERNATIVE

The No-Project Alternative includes the implementation of programmed improvements to highways and existing, conventional rail corridors by the year 2020. Environmental studies are being implemented independently for these improvements, and so they do not constitute part of this Project. No additional impacts to paleontologic resources are expected to occur beyond those impacts addressed in the appropriate environmental documents for those projects.

4.2 MODAL ALTERNATIVE

4.2.1 Highways

A. UNION STATION TO LAX

There is no modal alternative proposed between Union Station and LAX.

B. UNION STATION TO FULLERTON STATION

No paleontologic resource localities are recorded by the SBCM or the SDNHM within the APE along the Union Station to Fullerton Station modal alternative, which trends along Interstate 5 (I-5). No rock units with high paleontologic sensitivity are exposed at the surface, although the subsurface geology may have high sensitivity; this potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

C. FULLERTON STATION TO IRVINE STATION

No paleontologic resource localities are recorded by the SBCM or the SDNHM within the APE for this section, which runs for ~20.01 miles. Fossil-bearing sediments are present along this segment, however, and so an assessment of high paleontologic sensitivity is advanced. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

D. IRVINE STATION TO SAN JUAN CAPISTRANO CITY LIMITS

No paleontologic resource localities are recorded by the SBCM or the SDNHM within the APE along this segment of the I-5 from the Irvine Station to the San Juan Capistrano city limits. However, four (4) fossil-bearing rock units – the Capistrano Formation, the Niguel Formation, Quaternary marine sediments, and Quaternary terrace deposits – are present along this segment, and so an assessment of high paleontologic sensitivity is advanced herein. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

E. SAN JUAN CAPISTRANO

No paleontologic resource localities are recorded by the SBCM or the SDNHM within the APE along the 4.75-mile length of the San Juan Capistrano Modal segment. However, four (4) fossil-bearing rock units – the Capistrano Formation, the Niguel Formation, Quaternary marine sediments, and Quaternary terrace deposits – are present along this segment, and so an assessment of high paleontologic sensitivity is advanced herein. Additionally, rock units present

in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

F. DANA POINT TO SAN CLEMENTE

According to the records of the SBCM and the SDNHM, five (5) previously recorded paleontologic resource localities (SDNHM 4686 through 4690) are present within the 10.38-mile length of the Dana Point to San Clemente Modal Alternative. These localities are all identified from unnamed Pleistocene marine terrace deposits exposed along the entire length of this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

G. CAMP PENDLETON

One previously recorded paleontologic resource locality (SDNHM 5014) has been identified from along the 16.00-mile long Camp Pendleton Modal segment, as recorded by the SDNHM. Again, this locality is identified from unnamed Pleistocene marine terrace deposits exposed along almost the entire length of this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

H. OCEANSIDE TO CARLSBAD

No paleontologic resource localities are recorded by the SBCM or the SDNHM within the APE along the 10.18-mile length of the Oceanside to Carlsbad Modal APE. However, fossil-bearing rocks are present along this segment, and so an assessment of high paleontologic sensitivity is advanced herein. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

I. ENCINITAS TO SOLANA BEACH

Two (2) previously recorded paleontologic resource localities (SDNHM 3847 – 3848) are present within the 6.92-mile length of the Encinitas to Solana Beach Modal segment, according to the records of the SDNHM. These localities are identified from the Torrey Sandstone. In addition, exposures of unnamed Pleistocene marine terrace deposits are also exposed within the APE along this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

J. DEL MAR

The Del Mar modal segment runs for 6.44 miles south along the I-5 corridor. Eight (8) previously recorded paleontologic resource localities (SDNHM 2904, 3960, 3968, 3792 – 3793, 3804, 3960 and 3968) are present within the APE along this segment, identified from three (3) fossil-bearing geologic formations (Torrey Sandstone, Delmar Formation, unnamed lagoon deposits), as documented by the SDNHM. This segment is therefore assigned high paleontologic sensitivity throughout its extent. Additionally, rock units present in the subsurface may also have high

paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

K. I-5/805 SPLIT TO SR-52

The I-5/805 Split to SR 58 section measures 4.70 miles in length, and encompasses two (2) previously known paleontologic resource localities (SDNHM 5179 – 5180) recorded by the SDNHM. These localities are all identified from Eocene rocks exposed along the entire length of this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

L. SR-52 TO SANTA FE DEPOT

According to the records of the SDNHM, sixteen (16) previously recorded paleontologic resource localities (SDNHM 16, 38, 64, 75, 79, 146, 415, 704, 2983, 2987, 3040, 3718, 3761, 4819, 4828, and 5013) have been identified from along the SR 52 to Santa Fe Depot to Taylor Street segment. Three (3) fossiliferous rock formations (Ardath Shale, San Diego Formation, and marine terrace deposits) are exposed at the surface along this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

4.2.2 Airports

A. LONG BEACH MUNICIPAL AIRPORT

No paleontologic resource localities are recorded by either the SBCM or the SDNHM within the boundaries of the Long Beach Airport APE. However, the Long Beach Airport is located primarily on surficial sediments of Quaternary nonmarine terrace deposits. This sedimentary unit has high potential to contain significant nonrenewable paleontologic resources. As a result, the APE here has high paleontologic sensitivity.

4.3 HIGH SPEED TRAIN CORRIDORS AND STATION OPTIONS

4.3.1 High Speed Rail Alignments

A. UNION STATION TO LAX

(HSR Only)

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known from along the 15.75-mile long Union Station to LAX segment. However, Pleistocene older alluvial sediments are exposed at the surface along portions of this segment. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

B. UNION STATION TO ANAHEIM VIA UPRR

(North Termination at Hobart, south of Union Station)

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known from along this 25.21-mile long section of the Union Pacific Railroad (UPRR). Further, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may very well have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

C. UNION TO IRVINE VIA LOSSAN (ATSF)

(North Termination at Hobart, south of Union Station)

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known from along this 40.66-mile long section of the Atchison, Topeka and Santa Fe (AT&SF) or LOSSAN rail corridor. Further, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may very well have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

4.3.2 High Speed Rail Stations

A. LAX

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are recorded from within the proposed LAX Station location, situated at the eastern edge of LAX. However, the sediments exposed at the surface within this portion of the APE have high potential to contain significant fossil resources. For this reason, this segment is assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

B. NORWALK STATION-NEW ELEVATED STATION

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known in the immediate vicinity of the Norwalk Station – New Elevated Station option. Further, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

C. ANAHEIM STATION

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are recorded in the immediate vicinity of Anaheim Station, located at the current Metrolink Station north of Anaheim Stadium. Further, no fossiliferous rock formations are

mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

D. NORWALK STATION-EXISTING STATION WITH NEW PLATFORM

This station option will consist of construction of a new platform at the existing Metrolink Norwalk Station. According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known in the immediate vicinity of this portion of the APE. Further, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

E. FULLERTON STATION

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known in the immediate vicinity of the Fullerton Station. Additionally, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may be likely to have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

F. SANTA ANA

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known in the immediate vicinity of the Santa Ana Station. Additionally, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may very well have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

G. IRVINE

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are known in the immediate vicinity of the Irvine Station. Additionally, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

4.4 CONVENTIONAL RAIL (LOSSAN) ALIGNMENTS AND STATION OPTIONS

4.4.1 Conventional Rail Alignments

A. UNION STATION TO FULLERTON STATION

(LOSSAN/4th main track-North termination at Hobart, south of Union Station)

According to the records of the SBCM and the SDNHM, no previously identified paleontologic resource localities are recorded along the 20.60-mile Union Station to Fullerton Station section corridor. Also, no fossiliferous rock formations are mapped as exposed at the surface along this segment. This segment is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

B. FULLERTON STATION TO IRVINE STATION-AT GRADE

(AT-GRADE between Walnut (Orange) and E. 17th Street (Santa Ana))

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from this section, which extends 20.01 miles along the existing AT&SF (LOSSAN) rail corridor, sediments mapped at the surface are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

C. FULLERTON STATION TO IRVINE STATION-TRENCH

(TRENCH between Walnut (Orange) and E. 17th Street (Santa Ana))

The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from this section, which varies from the previous segment only in that a below-grade trench is proposed between Walnut Street in the City of Orange and E. 17th Street in the City of Santa Ana. This trench will be 2.30 miles (12,150 feet) in length. Sediments to be incised by excavation of this trench have high potential to contain significant nonrenewable paleontologic resources. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

D. IRVINE STATION TO SAN JUAN CAPISTRANO CITY LIMITS

(Irvine Station to Northern City Limits, City of San Juan Capistrano)

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities within the 8.93-mile length of the Irvine Station to San Juan Capistrano City Limits APE, four (4) different sedimentary rock units mapped at the surface – Capistrano Formation, Niguel Formation, Pleistocene marine terraces and Pleistocene nonmarine terraces – are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be

considered and incorporated during subsequent analyses. However, as no improvements along this portion of the project alignment are presently scheduled, no impacts to paleontologic resources are presently foreseen.

E. SAN JUAN CAPISTRANO-COVERED TRENCH/CUT AND FILL

(Northern City Limits, City of San Juan Capistrano to Avenida Aeropuerto)

The covered trench and cut and fill option from the northern city limits of San Juan Capistrano to Avenida Aeropuerto in the southern part of the city follows the existing ATSF rail line through downtown San Juan Capistrano. The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities along this 7.92-mile portion of the APE. However, two (2) different sedimentary rock units mapped at the surface (Capistrano Formation, Pleistocene nonmarine terraces) are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

F. SAN JUAN CAPISTRANO-TUNNEL ALONG I-5

(Northern City Limits, City of San Juan Capistrano to Avenida Aeropuerto)

The tunnel along I-5 option from the northern city limits of San Juan Capistrano to Avenida Aeropuerto varies from the existing ATSF rail line north of downtown San Juan Capistrano, and veers east to the I-5 corridor. As this option turns inland, it enters a tunnel, approximately 4.64 miles (24,500 feet) long, which proceeds under the I-5 corridor to the south of San Juan Creek, where the alignment both surfaces and rejoins the existing ATSF alignment.

The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities along this portion of the APE. However, two (2) different sedimentary rock units mapped at the surface (Capistrano Formation, Pleistocene nonmarine terraces) are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

G. SAN JUAN CAPISTRANO-AT-GRADE/OPEN TRENCH ALONG EAST SIDE OF TRABUCO CREEK
(Northern City Limits, City of San Juan Capistrano to Avenida Aeropuerto)

The At-grade/Open Trench along the east side of Trabuco Creek option from the northern city limits of San Juan Capistrano to Avenida Aeropuerto varies from the existing ATSF rail line north of downtown San Juan Capistrano and veers west to Trabuco Creek. A portion of this alignment would occupy a length of open trench, and pass west of downtown San Juan Capistrano before rejoining the existing ATSF alignment just south of the San Juan Creek.

The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities along this portion of the APE. This segment crosses surface exposures of Quaternary alluvium, which is not fossiliferous. However, this thin veneer of alluvium overlies the Capistrano Formation, which is potentially very fossiliferous. This segment is therefore assigned high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

H. DANA POINT/SAN CLEMENTE – SHORT TRENCH

(Avenida Aeropuerto to San Onofre Power Plant-SHORT TRENCH)

The Dana Point/San Clemente – Short Trench option from Dana Point to San Clemente (and beyond to the San Onofre Nuclear Power Station) follows the existing ATSF rail line along the Pacific coast for a length of 22.6 miles and includes an approximately 2.37 mile (12,500 feet) short trench section. This short trench section passes through San Clemente and the San Clemente station, which would be underground.

The records of the SDNHM list three (3) previously identified paleontologic resource localities (SDNHM 4076 and 4078-4079) from this portion of the APE. These localities are identified from the Capistrano Formation, which crops out at the surface all along the length of this segment. For this reason, this segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

I. DANA POINT/SAN CLEMENTE- LONG TRENCH

(Avenida Aeropuerto to San Onofre Power Plant-LONG TRENCH)

The long trench option from Dana Point to San Clemente also follows the existing ATSF rail line along the Pacific coast for the same 22.6 miles, but includes an approximately 3.03 mile (16,000 foot) long trench section. This option varies only in that this longer below grade trench is proposed.

Since Option H encounters the same sites as Option G above, and proposes similar construction methods, this option also has the same high potential to contain significant nonrenewable paleontologic resources, and so is assigned high paleontologic sensitivity.

J. DANA POINT/SAN CLEMENTE-SHORT TUNNEL

(Avenida Aeropuerto to San Onofre Power Plant-SHORT TUNNEL)

The short tunnel option from Dana Point to San Clemente (and beyond to the San Onofre Nuclear Power Station) runs for a length of 22.6 miles, and includes the Dana Point Curve realignment, but varies from the existing Atchison, Topeka and Santa Fe rail line north of downtown San Clemente, and veers inland to the I-5 corridor. As this option turns inland, it enters a tunnel, approximately 6.82 miles (36,000 feet) long, which proceeds under the I-5 corridor to near Baslione at San Onofre State Beach, where the segment both surfaces and rejoins the existing ATSF alignment.

The records of the SDNHM list three (3) previously identified paleontologic resource localities from near this portion of the APE. These localities (SDNHM 4076 and 4078-4079) are identified from the Capistrano Formation, which crops out at the surface throughout this area. For this reason, this segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

K. DANA POINT/SAN CLEMENTE-LONG ONE SEGMENT TUNNEL

(Avenida Aeropuerto to San Onofre Power Plant – LONG ONE-SEGMENT TUNNEL)

The long one-segment tunnel option from Dana Point to San Clemente also runs for a length of 22.6 miles, but varies from the existing Atchison, Topeka and Santa Fe rail line farther north of downtown San Clemente, and proceeds south by tunnel under the I-5 corridor and surfaces at San Onofre State Beach to rejoin the existing ATSF alignment. However, this option turns inland at Dana Point, and does not include the Dana Point Curve realignment. The long one-segment tunnel will be 9.09 miles (48,000 feet) long.

The records of the SBCM and the SDNHM list three (3) previously identified paleontologic resource localities from near this portion of the APE. These localities (SDNHM 4076 and 4078-4079) are identified from the Capistrano Formation, which crops out throughout the local area. For this reason, this segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

L. DANA POINT/SAN CLEMENTE-LONG TWO SEGMENT TUNNEL

(Avenida Aeropuerto to San Onofre Power Plant-Long – LONG TWO-SEGMENT TUNNEL)

The long two-segment tunnel option from Dana Point to San Clemente and beyond to the San Onofre Nuclear Power Station follows the same alignment as the long one-segment tunnel, that is, it veers inland and proceeds south by tunnel in the I-5 corridor and surfaces at San Onofre State Beach. This option also does not include the Dana Point Curve realignment. This option varies only in that the tunnel is broken up into two segments. The long two-segment trench will be 9.09 miles (48,000 feet) long.

Similar to the one-segment tunnel option discussed above, this option is primarily underground. It therefore has high potential to incise fossil-bearing sediments, and so is assigned high paleontologic sensitivity.

M. CAMP PENDLETON

(San Onofre Power Plant to Oceanside City Limits)

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities within the 15.65-mile length of the Camp Pendleton section of the APE, nevertheless two (2) different rock units that are mapped at the surface – the Capistrano Formation and Pleistocene marine terraces – are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

N. OCEANSIDE TO CARLSBAD-AT GRADE

(Northern City Limits of Oceanside to Northern City Limits of Encinitas)

The SBCM and the SDNHM do not record any previously identified paleontologic resource localities from along the 9.88-mile Oceanside to Carlsbad – At Grade APE. However, three (3)

different rock units that are mapped at the surface – Eocene rocks, the Capistrano Formation (as well as possible exposures of the Monterey Formation), and Pleistocene marine terrace deposits – are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

O. OCEANSIDE TO CARLSBAD-TRENCH

(Northern City Limits of Oceanside to Northern City Limits of Encinitas)

The Oceanside to Carlsbad-Trench option encompasses the same APE and archaeological sites as the at-grade option. However, a 0.95-mile (5,000 foot) long trench is proposed across downtown Carlsbad. Since sub-grade trenching increases the potential to encounter unknown paleontologic resource localities, this option has the same high paleontologic sensitivity as the above-described Oceanside to Carlsbad APE.

P. ENCINITAS TO SOLANA BEACH-AT GRADE

(Northern City Limits of Encinitas to Solana Beach Station)

The Encinitas to Solana Beach-At Grade option follows the existing ATSF rail line along the Pacific coast for 6.99 miles. Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE, nevertheless two (2) different rock units (Eocene rocks and Pleistocene marine terraces) that are mapped at the surface are potentially fossiliferous. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

Q. ENCINITAS TO SOLANA BEACH-SHORT TRENCH

(Northern City Limits of Encinitas to Solana Beach Station)

The Encinitas to Solana Beach-Short Trench option encompasses the same APE as the at-grade option, above. However, a 1.52-mile (8,000-foot) long trench is proposed through downtown Encinitas. Since sub-grade trenching increases the potential to encounter unknown paleontologic resource localities, this option also has high paleontologic sensitivity.

R. ENCINITAS TO SOLANA BEACH-LONG TRENCH

(Northern City Limits of Encinitas to Solana Beach Station)

The Encinitas to Solana Beach-Long Trench option encompasses the same APE as the at-grade and short trench options, above. However, as part of this option, a 5.30-mile (28,000-foot) long trench would pass through downtown Encinitas and downtown Cardiff-by-the Sea. Since sub-grade trenching increases the potential to encounter unknown paleontologic resource localities, this option is also assigned high paleontologic sensitivity.

S. DEL MAR-COVERED TRENCH

(Solana Beach Station to I-5)

Three (3) paleontologic resource localities (SDNHM 4306, 4313, and 4327) are recorded by the SDNHM from along the 9.15-mile length of this Del Mar-Covered Trench APE. Fossil-bearing sediments of the Delmar Formation, as well as Pleistocene marine terraces, occur at the surface all along this portion of the APE. This segment is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

T. DEL MAR-TUNNEL UNDER CAMINO DEL MAR

(Solana Beach Station to I-5)

The Del Mar-Tunnel under Camino Del Mar option proposes to continue the LOSSAN corridor in a straight line south at the point where the ATSF right-of-way bends west to the coast, and to tunnel under Main Street in Del Mar for a distance of 1.9 miles, then rejoin the ATSF alignment south of the City of Del Mar, and follow the existing tracks to I-5.

Three (3) paleontologic resource localities (SDNHM 4306, 4313, and 4327) are recorded by the SDNHM from the vicinity of this 9.3-mile portion of the APE. Additionally, as stated above, fossil-bearing sediments of the Delmar Formation, as well as Pleistocene marine terraces, occur at the surface all along this portion of the APE. This segment is therefore assigned high paleontologic sensitivity. Further, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

U. DEL MAR-I-5 TUNNEL

(Solana Beach Station to I-5)

The Del Mar-I-5 Tunnel option would veer from the existing ATSF right-of way just north of Del Mar racetrack and turn inland, passing along the southern shore of San Dieguito Lagoon. The HST would then proceed in a tunnel (or trench) along the I-5 corridor.

Three (3) paleontologic resource localities (SDNHM 4306, 4313, and 4327) are recorded by the SDNHM from the vicinity of this 9.3-mile portion of the APE. Additionally, as stated above, fossil-bearing sediments of the Delmar Formation, as well as Pleistocene marine terraces, occur at the surface all along this portion of the APE. This segment is therefore assigned high paleontologic sensitivity. Further, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

V. I-5/805 SPLIT TO HIGHWAY 52-MIRAMAR HILL TUNNEL

The I-5/805 Split to Highway 52-Miramar Hill Tunnel section measures 9.29 miles in length. One fossil resource locality (SDNHM 3407) is present along this length, according to the records of the SDNHM, recorded from fossiliferous sediments of the Delmar Formation that crop out along the majority of this portion of the APE. This segment is therefore assigned high paleontologic sensitivity. Further, rock units present in the subsurface may also have high paleontologic

sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

W. I-5/805 SPLIT TO HIGHWAY 52-I-5 TUNNEL

This tunnel continues the I-5 tunnel from north of Del Mar, surfacing at various spots, before rejoining the ATSF ROW in Rose Canyon, just north of State Route 52. The SDNHM records the presence of one paleontologic resource locality (SDNHM 3407) from along this portion of the APE. Fossil-bearing sediments of the Delmar Formation are exposed throughout most of the length of this segment. For this reason, this segment is assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

X. SR 52 TO SANTA FE DEPOT

Thirteen (13) paleontologic resource localities (SDNHM 16, 64, 2982 – 2983, 3013, 3291, 3675, 3718 – 3722, and 3761) are recorded by the SDNHM along the 10.28-mile long SR 52 to Santa Fe Depot section of the APE. Three (3) fossil-bearing rock units (Ardath Shale, Scripps Formation, and Pleistocene marine terraces) are exposed at the surface along this segment. This segment is assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

4.4.2 Conventional Rail Stations

A. FULLERTON STATION

The Fullerton Station alternative for the Conventional Rail option is the same as the Fullerton Station alternative discussed above for High Speed Rail. This portion of the APE has a low potential to impact paleontologic resources, and is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

B. ANAHEIM

The Anaheim Station alternative for Conventional Rail is also the same as the Anaheim Station alternative discussed above for High Speed Rail. This portion of the APE has a low potential to impact paleontologic resources, and is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

C. SANTA ANA

The Santa Ana Station alternative for Conventional Rail is also the same as the Santa Ana Station alternative discussed above for High Speed Rail. This portion of the APE has a low potential to impact paleontologic resources, and is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in

the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

D. IRVINE

The Irvine Station alternative for Conventional Rail is also the same as the Irvine Station alternative discussed above for High Speed Rail. This portion of the APE has a low potential to impact paleontologic resources, and is therefore assigned low paleontologic sensitivity (pending receipt and incorporation of pertinent data from the NHMLAC). However, rock units present in the subsurface may have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

E. SAN JUAN CAPISTRANO

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE, nevertheless two (2) different rock units that are mapped at the surface (Capistrano Formation and Pleistocene nonmarine terraces) have high potential to contain fossil resources. This station is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

F. SAN CLEMENTE

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE, nevertheless Pleistocene marine terraces present at the surface have high potential to contain fossil resources. This station is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

G. OCEANSIDE

The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE. However, Pleistocene marine terraces mapped at the surface have high potential to contain fossil resources. This station is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

H. SOLANA BEACH

The SBCM and the SDNHM record two (2) previously identified paleontologic resource localities from within this portion of the APE. Additionally, unnamed Pleistocene marine terraces mapped at the surface have high potential to contain fossil resources. This station is therefore assigned high paleontologic sensitivity. Further, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

I. UTC STATION

Although the records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE, nevertheless Eocene rocks and Pleistocene marine terraces present at the surface have high potential to contain fossil resources. This station is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

J. SANTA FE DEPOT

The records of the SBCM and the SDNHM do not list any previously identified paleontologic resource localities from within this portion of the APE. However, Pleistocene marine terrace deposits mapped at the surface do have high potential to contain fossil resources within portions of this part of the APE. This station is therefore assigned high paleontologic sensitivity. Additionally, rock units present in the subsurface may also have high paleontologic sensitivity. This potential for paleontologically sensitive sediments to be present must be considered and incorporated during subsequent analyses.

5.0 REFERENCES

Anderson, R.S., M.J. Power, S.J. Smith, K.B. Springer and E. Scott, 2002. Paleoecology of a Middle Wisconsin deposit from southern California. *Quaternary Research* 58(3): 310-317.

Axelrod, D.I., and T.A. Deméré. 1984. A Pliocene flora from Chula Vista, San Diego County, California. San Diego Society of Natural History, *Transactions* 20:277-300.

Barnes, L.G. 1973. Pliocene cetaceans of the San Diego Formation. In, R. Arnold and R.J. Dowlen (eds.), Studies on the Geology and Geologic Hazards of the Greater San Diego Area, California. San Diego Association of Geologists, fieldtrip guidebook, pp. 37-43.

Barnes, L.G. 1976. Outline of eastern north Pacific fossil cetacean assemblages. *Systematic Zoology* 25:321-343.

Barnes, L.G., H. Howard, J.H. Hutchison, and B.J. Welton. 1981. The vertebrate fossils of the marine Cenozoic San Mateo Formation at Oceanside, California. In, P.L. Abbott and S. O'Dunn (eds.), Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists, fieldtrip guidebook, pp. 53-70.

Berta, A., and T.A. Deméré. 1986. Callorhinus gilmorei n. sp. (Carnivora: Otariidae) from the San Diego Formation (Blancan) and its implications for otariid phylogeny. San Diego Society of Natural History, *Transactions* 21:111-126.

Berta, A., and G.S. Morgan. 1985. A new sea otter (Carnivora: Mustelidae) from the late Miocene and early Pliocene (Hemphillian) of North America. *Journal of Paleontology* 59:809-819.

Bukry, D., and M.P. Kennedy. 1969. Cretaceous and Eocene coccoliths at San Diego, California. California *Division of Mines and Geology, Special Report* 100:33-43.

Chandler, R.M. 1990. Fossil Birds of the San Diego Formation, late Pliocene, Blancan, San Diego County, California. *Ornithological Monographs* 44:77-161.

Deméré, T.A. 1981. A newly recognized late Pleistocene marine fauna from the City of San Diego, San Diego County, California. In, P.L. Abbott and S. O'Dunn (eds.), Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists, fieldtrip guidebook, pp. 1-10.

Deméré, T.A. 1983. The Neogene San Diego Basin: A review of the marine Pliocene San Diego Formation. In, D.K. Larue and R.J. Steel (eds.), Cenozoic Marine Sedimentation, Pacific Margin, U.S.A.. Society of Economic Paleontologists and Mineralogists, Pacific Section 28:187-195.

Deméré, T.A. 1986. The fossil whale, Balaenoptera davidsonii (Cope 1872), with a review of other Neogene species of Balaenoptera (Cetacea: Mysticeti). *Marine Mammal Science* 2:277-298.

Deméré, T. A. 1994. Two new species of fossil walruses (Pinnipedia: Odobenidae) from the upper Pliocene San Diego Formation, California; pp. 77-98. In, Berta, A. and T.A. Deméré (eds.), Contributions in Marine Mammal Paleontology Honoring Frank C. Whitmore, Jr., Proceedings of the San Diego Society of Natural History 29.

Deméré, T.A., and R.A. Cerutti. 1981. A Pliocene shark attack on a cetotheriid whale. *Journal of Paleontology* 56:1480-1482.

Deméré, T.A. and S.L. Walsh. 1993. Paleontological Resources, County of San Diego. Prepared for the Department of Public Works, County of San Diego: 1-68.

Domning, D.P., and T.A. Deméré. 1984. New material of Hydrodamalis cuestae (Mammalia: Dugongidae) from the Miocene and Pliocene of San Diego County, California. San Diego Society of Natural History, *Transactions* 20:169-188.

Ehlig, P.L. 1979. Miocene stratigraphy and depositional environments of the San Onofre area and their tectonic significance. In, C.J. Stuart (ed.), A Guidebook to Miocene Lithofacies and Depositional Environments, Coastal Southern California and Northwestern Baja California. Society of Economic Paleontologists and Mineralogists, Pacific Section, pp. 43-51.

Emerson, W.K., and E.P. Chace. 1959. Pleistocene mollusks from Tecolote Creek, San Diego, California. San Diego Society of Natural History, *Transactions* 12:335-345.

Fierstine, H.L., and B.J. Welton. 1988. A late Miocene marlin, Makaira sp. (Perciformes, Osteichthyes) from San Diego County, California, U.S.A. *Tertiary Research* 10:13-19.

Gibson, J.M. 1971. Benthonic foraminifera of the Ardath Shale and Stadium Conglomerate (Eocene, San Diego Basin, California. *Bulletin of the Southern California Academy of Sciences* 70:125-130.

Givens, C.R., and M.P. Kennedy. 1979. Eocene molluscan stages and their correlation, San Diego area, California. In, P.L. Abbott (ed.), Eocene Depositional Systems, San Diego. Geological Society of America, fieldtrip guidebook, pp. 81-95.

Golz, D.J., and J.A. Lillegraven. 1977. Summary of known occurrences of terrestrial vertebrates from Eocene strata of southern California. University of Wyoming, *Contributions to Geology* 15:43-65.

Grant, U.S., IV, and H.R. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California. San Diego Society of Natural History, Memoir 1:1-878.

Hanna, M.A. 1926. Geology of the La Jolla quadrangle, California. *University of California Publications in Geological Sciences*, 16:187-246.

Hanna, M.A. 1927. An Eocene invertebrate fauna from the La Jolla quadrangle, California. *University of California Publications in Geological Sciences*, 16:247-398.

Hertlein, L.G., and U.S. Grant, IV. 1939. Geology and oil possibilities of southwestern San Diego County. *California Journal of Mines and Geology* 35:57-78.

Hertlein, L.G., and U.S. Grant, IV. 1944. The geology and paleontology of the marine Pliocene of San Diego, California, Part 1, Geology. *San Diego Society of Natural History, Memoir* 2:1-72.

Hertlein, L.G., and U.S. Grant, IV. 1960. The geology and paleontology of the marine Pliocene of San Diego, California, Part 2a, Paleontology. *San Diego Society of Natural History, Memoir* 2:73-133.

Hertlein, L.G., and U.S. Grant, IV. 1972. The geology and paleontology of the marine Pliocene of San Diego, California, Part 2b, Paleontology. *San Diego Society of Natural History, Memoir* 2:143-409.

Howard, H. 1982. Fossil birds from Tertiary marine beds at Oceanside, San Diego County, California, with descriptions of two new species of the genera Uria and Cepphus (Aves: Alcidae). Natural History Museum of Los Angeles County, *Contributions in Science* 341:1-15.

Ingle, J.C., 1971. Paleoecologic and paleobathymetric history of the late Miocene - Pliocene Capistrano Formation, Dana Point area, Orange County, California. Geological guide book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, 88 p.

Jefferson, G.T. 1991. A catalog of late Quaternary vertebrates from California. Natural History Museum of Los Angeles County, Technical Reports 7:1-129.

Kennedy, G.L. 1973. Early Pleistocene invertebrate faunule from the Lindavista Formation, San Diego, California. San Diego Society of Natural History, transactions 17:119-128.

Kennedy, M.P. 1975. Geology of the San Diego metropolitan area, California. Section A - Western San Diego metropolitan area. *California Division of Mines and Geology, Bulletin* 200:9-39.

Kennedy, M.P., and G.W. Moore. 1971. Stratigraphic relations of upper Cretaceous and Eocene formations, San Diego coastal area, California. *American Association of Petroleum Geologists, Bulletin* 55:709-722.

Kennedy, M.P., and S.S. Tan. 1977. Geology of National City, Imperial Beach, and Otay Mesa quadrangles, southern San Diego Metropolitan area, California. California Division of Mines and Geology, Map Sheet 29.

Kern, J.P. 1977. Origin and history of upper Pleistocene marine terraces, San Diego, California. *Geological Society of America, Bulletin* 88:1553-1566.

Kern, J.P., and T.K. Rockwell. 1994. Chronology and deformation of Quaternary marine shorelines, San Diego County, California. In, *Quaternary Coasts of the United States: Marine and Lacustrine Systems. Society of Economic Paleontologists and Mineralogists, Special Publication* 48:377-382.

Link, M.H., and P.L. Abbott. 1991. Eocene sedimentary history, San Diego California: Overview and field trip stops. In, P.L. Abbott and J.A. May (eds.), *Eocene Geologic History, San Diego Region. Society of Economic Paleontologists and Mineralogists, Pacific Section* 68:1-26.

May, J.A. 1985. Submarine-canyon system of the Eocene San Diego Embayment. In, P.L. Abbott (ed.), *On the Manner of Deposition of the Eocene Strata in Northern San Diego County. San Diego Association of Geologists*, fieldtrip guidebook, pp. 1-17.

Morton, D.M., 1999. Preliminary digital geologic map of the Santa Ana 30' x 60' quadrangle, southern California, version 1.0. United States Geological Survey Open-File Report 99-172. Digital preparation by R.M. Hauser and K.R. Ruppert. 42 p.

Myers, J.A. 1991. The early Eocene Torrey Flora, Delmar, California. In, P.L. Abbott and J.A. May (eds.), *Eocene Geologic History San Diego Region. Society of Economic Mineralogists and Paleontologists, Pacific Section* 68:201-215.

Scott, E., 1997. A review of *Equus conversidens* in southern California, with a report on a second, previously-unrecognized species of Pleistocene small horse from the Mojave Desert. *Journal of Vertebrate Paleontology* 17(3): 75-A.

Springer, K.B. and E. Scott, 1994. First record of late Pleistocene vertebrates from the Domenigoni Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 14 (3): 47A.

Springer, K.B., E. Scott, L.K. Murray and W.G. Spaulding, 1998. Partial skeleton of a large individual of *Mammut americanum* from the Domenigoni Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 18(3): 78-A.

Springer, K.B., E. Scott, J.C. Sagebiel and K.M. Scott, 1999. A late Pleistocene lake edge vertebrate assemblage from the Diamond Valley, Riverside County, California. *Journal of Vertebrate Paleontology* 19(3): 77-A.

Steineck, P.L., J.M. Gibson, and R. Morin. 1972. Foraminifera from the middle Eocene Rose Canyon and Poway formations, San Diego. *Journal of Foraminiferal Research* 2:137-144.

Stephens, F. 1929. Notes on the marine Pleistocene of San Diego County, California. San Diego Society of Natural History, *Transactions* 5:245-256.

Valentine, J.W. 1959. Pleistocene molluscan notes. I. The Bay Point Formation at its type locality. *Journal of Paleontology* 33:685-688.

Valentine, J.W. 1960. Habitats and sources of Pleistocene mollusks at Torrey Pines Park, *California. Ecology* 41:161-165.

Valentine, J.W. 1961. Paleoecologic molluscan geography of the California Pleistocene. *University of California Publications in Geological Sciences* 34:309-442.

Vedder, J.G., 1957. New stratigraphic names used on geologic map of the San Joaquin Hills - San Juan Capistrano area, Orange County, California. In Vedder, J.G., R.F. Yerkes and J.E. Schoellhamer, Geologic map of the San Joaquin Hills - San Juan Capistrano area, Orange County, California: United States Geological Survey Oil and Gas Inventory Map OM-193.

Vedder, J.G., 1960. Previously unreported Pliocene Mollusca from the southeastern Los Angeles basin. *United States Geological Survey Professional Paper* 400-B, p. B326-B328.

Vedder, J.G.. 1972. Review of stratigraphic names and megafaunal correlations of Pliocene rocks along the southeast margin of Los Angeles Basin, California. In, E. Steinmeyer (ed.), Proceedings of the

Pacific Coast Miocene Biostratigraphic Symposium. *Society of Economic Paleontologists and Mineralogists, Pacific Section*, pp. 158-172.

Walsh, S.L. 1991. Eocene mammal faunas of San Diego County. In, P.L. Abbott and J.A. May (eds.), *Eocene Geologic History San Diego Region. Society of Economic Mineralogists and Paleontologists, Pacific Section* 68:161-178.

White, W.R., 1956. Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California. *Journal of Paleontology* 30: 237-270.

White, W.R., 1971. Biostratigraphy of the Capistrano Formation, Dana Point, California. In Berger, F.W. (ed.), Geological guide book, Newport Lagoon to San Clemente, Orange County, California. SEPM, Pacific Section, p. 50-54.

Woodford, A.O. 1925. The San Onofre Breccia: its nature and origin. *University of California Publications in Geological Sciences*. 15:159-280.

Young, J.M., and R.W. Berry. 1981. Tertiary lithostratigraphic variations, Santa Margarita River to Aqua Hedionda Lagoon. In, P.L. Abbott and S. O'Dunn (eds.), *Geologic Investigations of the San Diego Coastal Plain. San Diego Association of Geologists*, fieldtrip guidebook, pp. 33-51.

6.0 PREPARERS

Eric Scott Curator of Paleontology	**Master of Arts** (1990), Anthropology (Biological): University of California, Los Angeles, California. 18 years of experience as a professional vertebrate paleontologist. • Data collation and report writing
Kathleen Springer Senior Curator of Geological Sciences	**Master of Science** (1989), Geology: University of California, Riverside, California. 19 years of experience as a professional geologist and paleontologist. • Data collation and project supervision
Gregory Maxwell Collections Assistant	**Associate of Science** (2000), Geology: Crafton Hills Community College, Crafton Hills, California. 2½ years of experience as a museum professional. • Data collation and project assistance
Stephanie Fluitt Project Assistant	**Bachelor of Arts** (1998), Social Sciences: Bethany College, Scotts Valley, California. 2½ years of experience as a museum professional. • Project assistance