CALIFORNIA HIGH-SPEED TRAIN

Technical Report

DRAFT

Fresno to Bakersfield

Hanford West Bypass Paleontological Resources Report: Addendum

July 2012

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

Paleontological Resources Report – Addendum Fresno to Bakersfield Section Hanford West Bypass

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Acronyms and Abbreviations

Authority	California High-Speed Rail Authority
B.P.	Before Present
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
FRA	Federal Railroad Administration
HST	High-speed Train
Mph	Miles per hour
NALMA	North American Land-Mammal Age
NEPA	National Environmental Policy Act
PG	Professional Geologist
PRC	PaleoResource Consultants
SR	State Route
SVP	Society of Vertebrate Paleontology
UCMP	University of California Museum of Paleontology

Section 1.0
Introduction

1.0 Introduction

The California High-Speed Rail Authority (Authority) proposes to construct, operate, and maintain an electric-powered high-speed train (HST) system in California. When completed, the nearly 800-mile train system would provide new passenger rail service to more than 90% of the state's population. More than 200 weekday trains would serve the statewide intercity travel market. The HST would be capable of operating at speeds of up to 220 miles per hour (mph), with state-of-the-art safety, signaling, and automated train control systems. The system would connect and serve the major metropolitan areas of California, extending from San Francisco and Sacramento in the north to San Diego in the south.

The Authority and Federal Railroad Administration (FRA) undertook second-tier, project environmental evaluations for sections of the statewide HST System. PaleoResource Consultants (PRC) was retained by URS Corporation to complete a paleontological resource impact assessment on the Fresno to Bakersfield Section of the California HST System, and to prepare a technical report describing adverse impacts to paleontological resources stemming from project earth disturbance, and recommend measures designed to mitigate adverse impacts to paleontological resources. PRC's technical report identified five geologic units with high paleontological sensitivities that could be adversely affected by HST construction.

In 2011, two new alternatives to the currently proposed Fresno to Bakersfield alignment were proposed. The first, named the Hanford West Bypass (including both of its variations), would shift a segment of the currently proposed alignment to bypass Hanford to the west (Figure 1-1). The second, named the BNSF Alternative, would shift the currently proposed alignment 102 feet, but otherwise follow the general course of the current alignment. Of these two alternatives, the BNSF Alternative lies completely within the study area of the technical report; therefore, any adverse impacts to paleontological resources have already been considered and addressed in that report. Therefore, this report addendum will focus only on the Hanford West Bypass.

The purpose of this report addendum is to provide an assessment of potential adverse impacts on scientifically significant paleontological resources stemming from the construction of the Hanford West Bypass. Like the previously prepared technical report, this report addendum meets all requirements of the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA), and the standard measures for mitigating adverse construction environmental impacts on paleontological resources established by the Society of Vertebrate Paleontology (SVP 1995, 1996). Background research and a paleontological survey were conducted to identify paleontological resources that may be affected by the proposed HST alignment alternative. The paleontological study area for this assessment was a 1-mile radius around the proposed right-of-way and any potential facilities. The background research included the identification of potentially affected geologic units, and the analysis of their paleontological sensitivity. The research and analysis were based on published and unpublished geological and paleontological literature, museum records, and field survey.

The background research revealed that four geologic units may be affected by ground disturbance related to the construction of Hanford West Bypass, and that three of these geologic units are paleontologically sensitive, based on SVP (1995) criteria. The sensitive geologic units are the Riverbank Formation, Modesto Formation, and Tulare Lake beds. The research determined that each of these geologic units has, in the past, produced scientifically important paleontological resources.

All portions of the paleontological study area for which permission to enter had been obtained were surveyed by a team of PRC paleontologists during December 2011. This field survey, which included visual inspection of exposures of potentially fossiliferous strata in the study area, was conducted to document the presence of sediments suitable for containing fossil remains, and the

presence of any previously unrecorded fossil localities. The survey documented no previously unrecorded fossil localities within the paleontological study area.

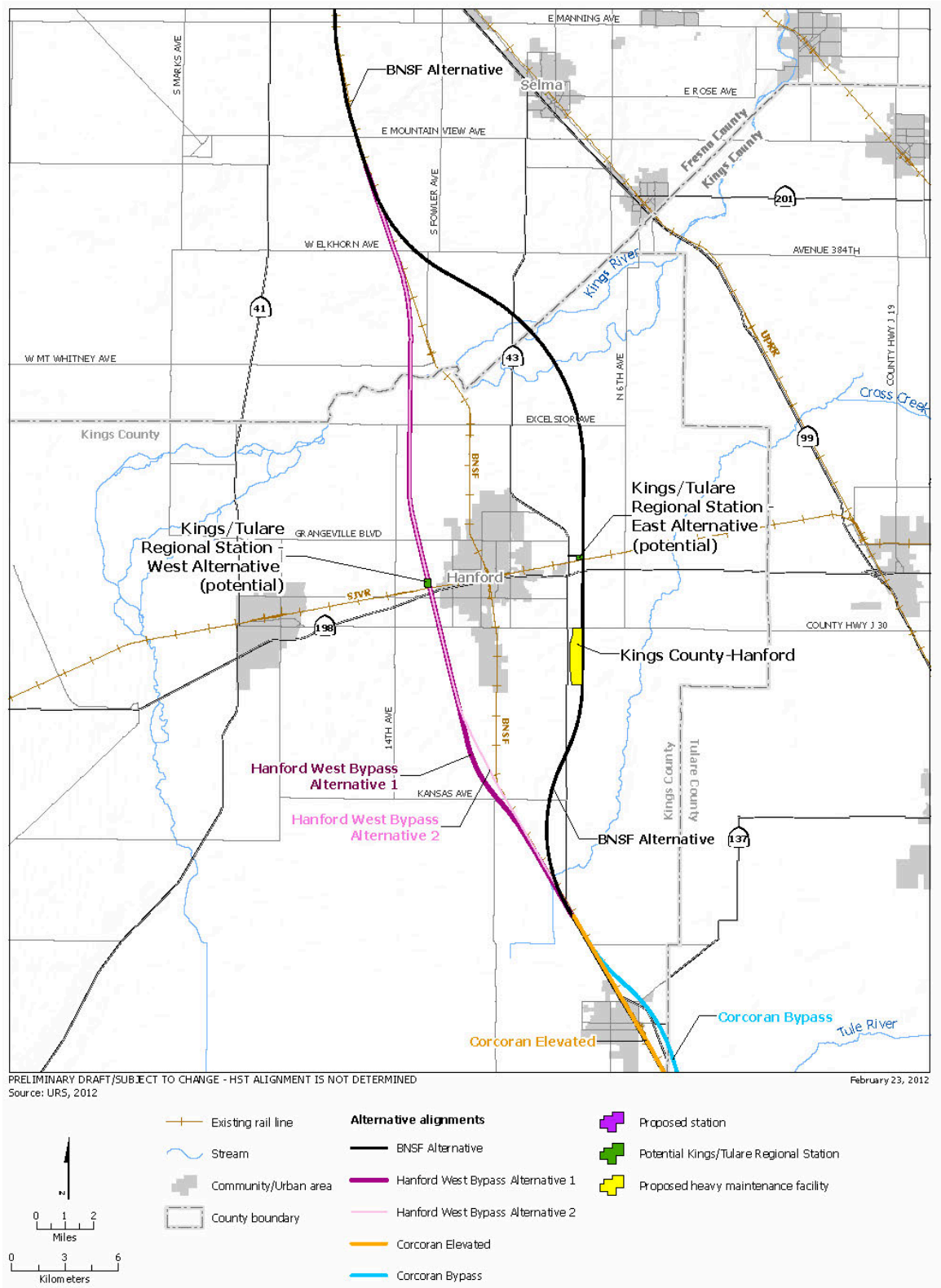

Figure 1-1
Hanford West Bypass Alternative

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Section 2.0
Survey Addendum

2.0 Project Description

2.1 Project Introduction

The Fresno to Bakersfield Section of the HST project would extend from Fresno to Bakersfield, and lie within Fresno, Kings, Tulare, and Kern counties, California. Depending on which route alternatives are selected, the Fresno to Bakersfield Section would be approximately 115 miles long and cross both urban and rural lands. To comply with the Authority's guidance of using existing transportation corridors when feasible, the Fresno to Bakersfield Section would be primarily sited adjacent to the existing BNSF Railway corridor. Alternative alignments are being considered where engineering constraints require deviation from the existing railroad corridor, and where environmental impacts could be avoided.

As indicated in Chapter 1.0, the HST alignment would be entirely grade-separated, meaning that crossings with roads, railroads, and other transport facilities would be at different heights (overpasses or underpasses) so that the HST would not interrupt or interface with other modes of transport. To achieve this, the Fresno to Bakersfield Section would include approximately 100 grade-separation road crossings. Right-of-way for the HST would be fenced to prohibit public or automobile access. The project footprint would primarily consist of the train right-of-way, which would typically be 100 feet wide, and consist of a northbound and a southbound track. Additional project footprint would be required to accommodate stations, multiple tracks at stations, power substations, and maintenance facilities. The Fresno to Bakersfield Section would include a station in Fresno, a station in Bakersfield, and a potential Kings/Tulare Regional Station in the vicinity of Hanford to provide service to Hanford, Tulare, Visalia, and Corcoran.

The Fresno to Bakersfield Section would include both at-grade and elevated track segments. At-grade track would be laid on an earthen rail bed topped with rock ballast, with a total height of approximately 6 feet; fill and ballast for the rail bed would be obtained from permitted borrow sites and quarries. Elevated track segments would be used to pass over long sections of urban development or elevated road structures, and would consist of viaduct or guideway structures made from cast reinforced-concrete columns, box girders, and platforms. The height of elevated track sections would range from 40 to 90 feet, and columns would be spaced 60 to 120 feet apart.

2.2 Project Alternatives

2.2.1 Hanford West Bypass (Alternatives 1 and 2)

The proposed Hanford West Bypass would diverge from the BNSF alignment at latitude 35°22'17"N and longitude 119°01'25"W, and would run to the west of the City of Hanford before remerging with the BNSF alignment at latitude 36°44'23"N and longitude 119°48'06"W, a distance of approximately 25 miles. The topography of the study area is primarily flat, ranging in elevation from approximately 285 feet (87 meters) to approximately 400 feet (123 meters). However, steep bluffs occur at some stream crossings. There are two proposed Hanford West Bypass Alternatives (1 and 2). However, these alternative alignments are approximately 100 feet (30 meters) apart; and, as a result, would have identical impacts to paleontological resources. These alternatives will therefore be considered together within this report addendum.

2.2.2 BNSF 102-Foot Shift

The BNSF 102-Foot Shift Alternative follows the BNSF alignment, and differs only from the currently proposed alignment by about 100 feet (30 meters). This alternative lies completely within the study area considered in the paleontological technical report, and any impacts

resulting from this alternative would be identical to the currently proposed alignment, and have already been considered in the technical report. This alternative will not be discussed further in this report addendum.

2.2.3 Bakersfield Hybrid

The Bakersfield Hybrid Alternative is within the Bakersfield urban area, and lies completely within the study area considered in the paleontological technical report; therefore, any impacts resulting from this alternative would be identical to the currently proposed alignment, and have already been considered in the technical report. This alternative will not be discussed further in this report addendum.

2.3 Affected Environment

The Hanford West Bypass is in the San Joaquin Valley, which constitutes roughly the southern two-thirds of the major north-northwest–oriented synclinorium that is variously referred to as the Valle Grande (Clark 1929), the Great Interior Valley (Harradine 1950), the San Joaquin Valley (Jahns 1954), the Great San Joaquin Valley (Piper et al. 1939; Davis et al. 1957), the California Trough (Piper et al. 1939), and the Great Valley (Fenneman 1931; Jenkins 1938; Hackel 1966). The Great Valley Physiographic Province (Jenkins 1938) is between the Sierra Nevada Physiographic Province on the east, and the Coast Ranges Physiographic Province on the west. The project is in the following U.S. Geological Survey 7.5-minute (1:24,000-scale) quadrangles, from north to south: Laton, Hanford, and Guernsey.

2.4 Regional Geologic Setting

The general geology of the San Joaquin Valley has been described in some detail by Mendenhall (1908), Mendenhall et al. (1916), Piper et al. (1939), Hoots et al. (1954), Davis et al. (1957, 1959, 1964), Davis and Hall (1959), Hoffman (1964), Croft and Wahrhaftig (1965), Hackel (1966), Croft and Gordon (1968), Bull (1973), Page (1986), Marchand (1977), Bartow and Marchand (1979), Marchand and Allwardt (1981), Lettis (1988), Bartow (1987, 1991), Beyer and Bartow (1988), Callaway and Rennie (1991), and Lettis and Unruh (1991), among others. Other authors who have specifically described the geology in portions of the paleontological study area include Page and LeBlanc (1969), Muir (1977), Bartow and McDougall (1984), Mitten (1984), and Bartow (1986). Surficial geologic mapping of all or part of the paleontological study area has been provided by Mendenhall et al. (1916), Jenkins (1938), Troxel and Morton (1962), Smith (1964), Matthews and Burnett (1965), Page and LeBlanc (1969), Jennings (1977), Bartow and Doukas (1978), Bartow (1984, 1991), and Wahrhaftig et al. (1993).

The information in these geologic maps, and published and unpublished reports, form the basis of the following discussion. Individual maps and publications are incorporated into this report and referenced where appropriate. For obtaining the older geological literature for this area, the exhaustive compilation entitled “Geological Literature on the San Joaquin Valley of California” by Maher et al. (1973) was particularly helpful. The aspects of geology pertinent to this report are the types, distribution, and age of the sediments immediately underlying the paleontological study area, and their probability of producing fossils during construction of this project alternative. The site-specific geology in the vicinity of this project alternative is discussed separately below.

The San Joaquin Valley is a great structural depression between the tilted Sierra Nevada block on the east and the complexly folded and faulted Coast Ranges on the west. The valley is filled with thick Mesozoic and Tertiary marine sediments and covered by a thin blanket of Quaternary alluvial sediments (Bailey 1966). The eastern side of the San Joaquin Valley is a nearly continuous series of coalescing alluvial fans; their apices occur where streams drain the western

slope of the Sierra Nevada. These low-relief alluvial fans form a continuous belt between the dissected uplands of the Sierra Nevada and the nearly flat surface of the valley floor. These fans are composed of undeformed to only slightly deformed alluvial deposits laid down primarily during Plio-Pleistocene time by streams that drained the adjacent uplands of the Sierra Nevada. Each alluvial fan consists of a mass of coarse to fine rock debris that splays outward from the mouth of its primary stream channel onto the valley floor as a fan-like deposit of well-sorted sand and gravel encased in a matrix of finer sediments, which are chiefly poorly sorted fine sand and silt deposited away from the stream channels on the alluvial plain. Our current interpretations and understanding of the alluvial deposits of major Sierran rivers is based on Arkley's studies (1962, 1964) of the Merced, Tuolumne, and Stanislaus river fans; Janda's (1966) and Janda and Croft's (1965) studies of the alluvium of the upper San Joaquin River; Schlemon's (1967, 1972) studies of the American River fan; Atwater's (1980) studies of the Mokelumne River fan; and most recently, the work of Weissmann et al. (2002, 2003) on the Kings River fan.

The alluvial deposits accumulated along the eastern side of the San Joaquin Valley consist of medium- to fine-grained sediment eroded from Tertiary and older volcanic, plutonic, and metamorphic rocks in the mountains to the east (Clark 1964). The alluvial fan deposits grade westward through gradually decreasing grain sizes from coarse pebble to cobble gravel at the Sierra Nevada foothills to clay-rich silt on the valley floodplain. The gravel, sand, and silt that compose these alluvial fans have—in the past—produced significant fossils; primarily large land mammals such as mammoths, mastodons, camels, bison, and horses. These paleontological resources are discussed further below.

The Quaternary geological materials composing many alluvial fans along the eastern side of the San Joaquin Valley can be divided into three stratigraphic units, which from oldest to youngest are the weakly cemented brown to tan sandstone and siltstone, referred to as the early- to middle-Pleistocene Turlock Lake Formation; the cemented reddish-brown sandstone, siltstone, and claystone of the middle-Pleistocene Riverbank Formation; and the slightly younger and less-consolidated late-Pleistocene and early-Holocene sedimentary sequence named the Modesto Formation.

The limiting geologic ages of these stratigraphic units found along the eastern side of the San Joaquin Valley are still uncertain. New excavations have the potential to yield important new information, new fossils, or other field evidence that may add to, confirm, or require modifying previous age interpretations. This new information would also have the potential to provide a more complete and accurate understanding of both the geological and the paleobiological history of the area.

2.5 Resource Inventory Methods

To develop a baseline paleontological resource inventory of the paleontological study area (1 mile surrounding the project footprint) and to assess the potential paleontological productivity of each stratigraphic unit present, the published and available unpublished geological and paleontological literature was reviewed, and stratigraphic and paleontologic inventories were compiled, synthesized, and evaluated (see below). These methods are consistent with SVP (1995) standard guidelines for assessing the importance of paleontological resources in areas of potential environmental effect. No subsurface exploration was conducted for this assessment.

The literature, geologic map, and museum records searches conducted for the previous paleontological technical study were deemed adequate to cover the Hanford West Bypass study area. The results of this background research were reviewed and applied to the Hanford West Bypass.

A field survey for this assessment was conducted in the paleontological study area to document the presence of sediments suitable for containing fossil remains, and to record the presence of any previously unrecorded fossil sites. All properties within 1 mile of the project footprint were surveyed from public access roads and public access lands. During the survey, stratigraphy was observed in recent excavations and the banks of drainage diversions, groundwater recharge basins, stormwater retention basins, streams, irrigation canals, ditches, and ponds.

The results of the background research and field survey were used to identify geologic units present in the study area, and assess their paleontological sensitivities. Sensitivity and significance criteria used in this addendum follow SVP standard guidelines (1995, 1996). These criteria are described in detail in the paleontological technical report.

Section 3.0
Findings

3.0 Findings

3.1 Stratigraphic Inventory

Regional geologic mapping in the vicinity of the Hanford West Bypass has been provided at a scale of 1:1,000,000 by Wahrhaftig et al. (1993); at a scale of 1:750,000 by Jennings (1977); at a scale of 1:500,000 by Mendenhall et al. (1916), Jenkins (1938), and Bartow (1991); at a scale of 1:320,000 by Troxel and Morton (1962); at a scale of 1:250,000 by Smith (1964) and Matthews and Burnett (1965); and at a scale of 1:125,000 by Page and LeBlanc (1969), Bartow and Doukas (1978), and Bartow (1984). These geologic maps were reviewed to determine the stratigraphic sequence of rocks that might be affected by project excavations. Unfortunately, in their geologic maps of the late Cenozoic deposits of the study area, these geologists have not always used formally named stratigraphic units, and have not consistently used the same map units. For the purpose of this report, the mappings of Matthews and Burnett (1965; 1:250,000) and of Smith (1964; 1:250,000) are referenced below, with their map units correlated to individual geologic formations.

Excavations in support of this project alternative have the potential to affect a number of Pleistocene to Holocene sedimentary units. They are, from oldest to youngest, the middle- to late-Pleistocene Riverbank Formation, the late-Pleistocene to early-Holocene Modesto Formation, the Pleistocene to Holocene Tulare Lake beds, and the Quaternary alluvium. Each of these formations is composed of arkosic alluvial sediments derived from the Sierra Nevada to the east.

Piper et al. (1939) published one of the first detailed maps and descriptions of Quaternary sediments in the northeastern San Joaquin Valley. These authors grouped all the Pleistocene strata together and named them the “Victor Formation.” Working in Stanislaus and northern Merced counties, Davis and Hall (1959) subdivided Pleistocene sediments equivalent to the “Victor Formation” into the Turlock Lake, Riverbank, and Modesto formations, from oldest to youngest. Subsequent authors (e.g., Marchand and Allwardt 1978; Bartow and Marchand 1979) adopted this nomenclature. Marchand and Allwardt (1981) recommended that the name “Victor Formation” be abandoned and that the Turlock Lake, Riverbank, and Modesto formations be accepted as uniform stratigraphic nomenclature for Quaternary deposits in the area. Most later workers have followed this recommendation, and these formation names are used in this report.

3.2 Project Geology

This section describes the project geology of the Riverbank Formation, the Modesto Formation, the Tulare Lake beds, and the Quaternary alluvium.

Riverbank Formation: The Riverbank Formation was first named by Davis and Hall (1959), who designated a type section along the southern bluff of the Stanislaus River within the City of Riverbank. However, sedimentary strata referred to the Riverbank Formation are found along the eastern margin of the Great Valley from near Chico in the north to at least Fresno County in the south (Marchand and Allwardt 1981; Helley and Harwood 1985; Marchand 1976). The Riverbank Formation consists of weakly consolidated reddish-brown to pink siltstones, sandstones, and pebble-to-cobble conglomerates with a few thin intervals of brick-red claystone. Where exposures are available in the general project vicinity, Riverbank Formation sediments consist of predominantly interbedded red to orange siltstones, and medium to fine sandstones; coarse sandstones and pebble conglomerates are present, but rare. Marchand and Allwardt (1981) placed the age of the Riverbank Formation between 450,000 and 130,000 years Before Present [B.P.] (middle Pleistocene).

Modesto Formation: The late Pleistocene to early Holocene–age Modesto Formation was also first named by Davis and Hall (1959), who designated a type section along the southern bluff of the Tuolumne River at the southern edge of the city of Modesto. The Modesto Formation is composed of interbedded, largely unconsolidated and poorly sorted, buff to yellowish-brown sandstones and siltstones with lesser amounts of pebble-to-cobble conglomerates. Alluvium assigned to the Modesto Formation is often lithologically indistinct from the underlying Riverbank Formation, but can be distinguished from it by stratigraphic position, degree of cementation (and therefore topographic expression), amount of deformation, and age. The older strata that constitute the Turlock Lake and Riverbank Formations have been deformed by tectonic activity related to uplift of the Sierra Nevada, and can sometimes be recognized from the overlying Modesto Formation by their non–flat-lying attitude. Also, because of their greater cementation, the older stratigraphic units often have a distinct topographic expression. Marchand and Allwardt (1981) dated the Modesto Formation as between about 42,400 and 12,000 years B.P. (late Pleistocene).

Tulare Lake Beds: The Tulare Lake beds are the remnants of a large freshwater lake in the southern San Joaquin Valley that persisted from the Pleistocene into historic times. This lake was once fed by the Kaweah, Kern, Kings, and Tule rivers, but has been dry (except during exceptionally wet years) since the end of the nineteenth century. The lake beds consist of sands, silts, and clays, with the Chatom silt (26,000 – 13,000 years B.P.) and Blakeley Canal silt (younger than 13,000 years B.P.) comprising the upper lake beds (Davis 1999).

Quaternary Alluvium: Quaternary alluvium is composed primarily of fluvial sands and gravels reworked from older formations and transported from topographically high, adjacent areas. Within in the project study area, the alluvium generally occurs as modern stream deposits, and/or forms a thin veneer over older geologic units.

3.3 Field Survey Results

The field survey for this assessment of the Hanford West alignment was conducted to document the presence of sediments suitable for containing fossil remains, and to record the presence of any previously unrecorded fossil sites. The results of this survey are presented below, with a brief summary of the observed stratigraphy and fossils.

The largely rural area surrounding the Hanford West alignment possessed few deep excavations in which the subsurface stratigraphy could be observed. Exposures that were found predominantly consisted of shallow irrigation ponds and canals, although some natural stream channels and banks were observed as well. The majority of Hanford West study area is agricultural land, and most of these shallow excavations were partially filled with soil and silt. In the northern portion of the study area, where exposures were more available and accessible, the stratigraphy observed generally consisted of buff to brown, poorly indurated, fine sandstones and siltstones interpreted to be correlative with the Modesto Formation. South of Hanford, where exposures were available and accessible, the stratigraphy tended more towards coarser arkosic sands, more consistent with Tulare Lake beds. No fossils were observed during this survey.

During the paleontological resource survey for the Hanford West Bypass, no previously unreported fossil localities were identified.

3.4 Paleontological Resource Inventory

An inventory of known paleontological resources discovered in the vicinity of the proposed project alternative is presented below, and the paleontological importance of these resources is assessed. The literature review and museum archival search conducted for this inventory documented no previously recorded fossil sites within the actual project footprint. The Los

Angeles County Museum of Natural History and the San Bernardino County Museum reports are provided as Appendices A and B, respectively. University of California Museum of Paleontology (UCMP) did not produce a detailed report, although its records search found only one pre-existing locality in the study area: UCMP locality V65101 (Holroyd 2009). The UCMP database notes that this locality consists of two Pleistocene horse teeth that were found "*6 miles from Corcoran in 19 feet of clay*." The locality data did not designate a geologic formation, and the exact location is unknown. The Kern River, Turlock Lake, Riverbank, and Modesto formations and the Tulare Lake beds have all yielded fossilized remains of extinct species at numerous previously recorded sites throughout the San Joaquin Valley (see discussion below). Also, several previously unrecorded fossil localities were identified during the field survey conducted in support of the Fresno to Bakersfield Section of the HST. These localities are described in the paleontological resources technical report.

Riverbank Formation. Sediments of the Riverbank Formation have yielded the fossilized remains of middle-Pleistocene plants and animals from numerous previously recorded fossil sites in the Great Valley (Fisk 2000). Fossil vertebrates of Irvingtonian to Rancholabrean North American Land-Mammal Age (NALMA) have been reported from Riverbank Formation sediments near their type area (Garber 1989, Jefferson 1991b) and at numerous other scattered locations along the eastern margin of the Great Valley (Fisk and Lander 1999; Lander 1999; Fisk 2000, 2001a, 2001b; Scott 2010). Fossils previously reported from the Riverbank Formation include clams, fish, turtles, frogs, snakes, birds, bison (*Bison* sp.), mammoths (*Mammuthus* sp.), mastodons (*Mammut* sp.), ground sloths (*Paramylodon* sp.), camels (*Camelops* sp.), horses (*Equus* sp.), pronghorns, deer, dire wolves (*Canis dirus*), coyotes (*Canis latrans*), rabbits (*Lepus* sp.), rodents (*Scapernus* sp.; *Neotoma* sp.), and land plant remains (including wood, leaves, and seeds).

Hilton et al. (2000) described a large fossil fauna from a paleosol (Hilton 2000, personal communication) in the Riverbank Formation discovered during excavations for Arco Arena (now Powerbalance Pavilion) in Sacramento. The presence of paleosols in the Riverbank Formation indicates that scientifically important fossil specimens may be discovered from other paleosol horizons in the Riverbank Formation. Excavations for the Fairmead Landfill in Madera County have exposed fossiliferous sediments of the Riverbank Formation, and significant vertebrate fossils have come from this stratigraphic unit (Dundas et al. 1996; UCMP records). Numerous fossil specimens have also been salvaged from the Riverbank Formation in the Fresno area as the result of paleontological mitigation, including mammoth bones and teeth and plant microfossils (Harmsen et al. 2008; Fisk and Mahan 2009). Also, during the field survey for the Fresno to Bakersfield Section, several paleosols containing fossil burrows and root casts and molds were found in sediments of the Riverbank Formation.

Because fossil vertebrates have been previously reported from the Riverbank Formation and because depositional conditions observed in exposures in the paleontological study area appear to be favorable for the preservation of fossils, there is potential for additional significant paleontological resources to be found in this stratigraphic unit. Using SVP (1995) criteria, the Riverbank Formation is judged to have high sensitivity.

Modesto Formation. Numerous vertebrate fossil localities have been reported from sediments referable to the Modesto Formation in the San Joaquin and Sacramento valleys.

Many of these sites are documented in surveys of Quaternary land mammal fossils made by Hay (1927), Stirton (1939, 1951), Savage (1951), Lundelius et al. (1983), and Jefferson (1991b), or in surveys of Quaternary birds, reptiles, and amphibians made by Miller and DeMay (1953) and Jefferson (1991a). Mammalian fossils have been the most helpful in determining the relative age of alluvial and age-correlative lacustrine deposits (Louderback 1951; Savage 1951).

Fossil vertebrates of Rancholabrean age and fossil wood have previously been reported from sediments of the Modesto Formation near its type area (Marchand and Allwardt 1981; Garber 1989; Jefferson 1991b), and at numerous other scattered locations in the Great Valley (Richards and McCrossin 1991; Fisk and Lander 1999; Lander 1999; Fisk and Mahan 2009). Jefferson (1991a, 1991b) compiled a database of California Pleistocene (primarily Rancholabrean NALMA) vertebrate fossils from published records, technical reports, unpublished manuscripts, information from colleagues, and inspection of museum paleontological collections at more than 40 public and private institutions. Jefferson (1991a, 1991b) listed numerous sites in Fresno, Kings, Tulare, and Kern counties that yielded Rancholabrean vertebrate fossils. Most of these localities are likely referable to the Modesto Formation. They include specimens of Pleistocene megafauna such as mammoth, bison, horse, camel, dire wolf, and many others (Jefferson 1991a, 1991b). Also, during the field survey for the Fresno to Bakersfield Section, vertebrate remains and several paleosols containing fossil burrows and root casts and molds were found in sediments of the Modesto Formation.

Because sediments referable to the Modesto Formation have yielded scientifically significant fossils in the past, and because depositional conditions appear to be favorable for the preservation of fossils, there is potential for additional significant paleontological resources to be found in sediments of the Modesto Formation. Because the Modesto Formation has produced significant fossils in the past, under SVP (1995) criteria, this stratigraphic unit is judged to have high sensitivity.

Tulare Lake Beds. Numerous important fossils have been reported from sediments deposited in ancestral Tulare Lake. Jefferson (1991a, 1991b) listed four sites in Kings County that yielded Rancholabrean vertebrate fossils from Tulare Lake sediments. These localities also produced specimens of Pleistocene megafauna such as mammoth, bison, and horse, among many others (Jefferson 1991a, 1991b). A locality known as the Witt Site has produced a diverse faunal assemblage representing late-Pleistocene to early-Holocene land mammals and fishes (Gobalet and Fenenga 1993). Mammalian specimens from this site include *Glossotherium harlani* (ground sloth), *Lepus californicus* (rabbit), *Thomomys* cf *T. bottne* (gopher), *Castor canadensis* (beaver), *Canis latrans* (coyote), *Canis dirus* (dire wolf), *Felis atrox* (lion), *Mustella vison* (mink), *Mammuthus columbi* (mammoth), *Equus occidentalis* and *Equus conversidens* (horses), *Camelops hesternus* (camel), *Cervus elaphus nannodes* (elk), *Odocoileus hemionus* (deer), *Antilocapra americana* (pronghorn), *Euceratherium collinum* (musk ox), and *Bison antiquus* (bison). Specimens from this assemblage have been radiometrically dated from approximately 60,000 to 7,000 years B.P. (Gobalet and Fenenga 1993). Davis (1999) provided a pollen analysis of cores taken through Tulare Lake beds, and has used the data to help reconstruct the climatic and floral history of the late Pleistocene to early Holocene of the San Joaquin Valley. Also, during the field survey for the Fresno to Bakersfield Section, several species of freshwater mollusks were found in Tulare Lake sediments.

Because sediments referable to the Tulare Lake beds have yielded scientifically significant fossils in the past, and because depositional conditions appear to be favorable for the preservation of fossils, there is potential for additional significant paleontological resources to be found in the sediments of the Tulare Lake beds. Because the Tulare Lake beds have produced significant fossils in the past, under SVP (1995) criteria, this stratigraphic unit is judged to have high sensitivity.

Quaternary Alluvium. During the geological and paleontological literature review and museum archival records searches for this paleontological resource impact assessment, no previously recorded fossil sites were found in Quaternary alluvium in the paleontological study area. During the field survey of prospective fossiliferous sediments, no indications were found that the Quaternary alluvium might be fossiliferous. Therefore, under SVP (1995) criteria, this stratigraphic unit is judged to have low sensitivity.

A summary of the paleontological sensitivities of each of these geologic units is presented in Table 3-1.

Table 3-1
Paleontological Sensitivities of Geologic Formations That May Be Affected by Construction of the Hanford West Bypass Alternative for the Fresno to Bakersfield Section of the California High-Speed Train

Map Symbol[a]	Age and Map Legend Identification	Formation	Location	Lithology	Paleontological Sensitivity[b]
Qb	Quaternary basin deposits	Unnamed	San Joaquin Valley	Floodplain deposits sand, silt, and clay	Low
Ql	Quaternary lake deposits	Includes the Tulare Lake beds	San Joaquin Valley	Lacustrine fine sand, silt, and clay	High
Qf	Quaternary fan deposits: includes the late-Pleistocene Modesto Formation	Modesto Formation	San Joaquin Valley	Interbedded, largely unconsolidated and poorly sorted, buff to yellowish-brown sandstone and siltstone with lesser amounts of pebble to cobble conglomerate	High
Qc	Pleistocene nonmarine	Riverbank Formation	San Joaquin Valley	Weakly consolidated reddish-brown to pink siltstones, sandstones, and pebble to cobble conglomerates, with a few thin intervals of brick-red claystone	High

Notes:
[a] Map units and symbols are from Geologic Map of California, Bakersfield Sheet (Smith 1964), and Geologic Map of California, Fresno Sheet (Matthews and Burnett 1965).
[b] SVP (1995) describes sedimentary rock units as having (1) high potential for containing significant paleontological resources, (2) low potential for containing paleontological resources, or (3) undetermined potential.

In the *Paleontological Resources Technical Report* prepared for the Fresno to Bakersfield Section of the HST, the alignment was subdivided into five "zones," based upon the geological formations likely to be encountered during project excavations.

Starting from the north, the following five zones were identified:

- Zone 1 is in the Fresno urban area, where Pleistocene sediments of the middle- to late-Pleistocene Riverbank Formation and/or the late-Pleistocene to early-Holocene Modesto Formation are exposed at or near the surface, and are known to overlie the early- to middle-Pleistocene Turlock Lake Formation.
- Zone 2 is in the largely rural area between Fresno and Hanford, where Quaternary alluvium overlies sediments of the late-Pleistocene to early-Holocene Modesto Formation.

- Zone 3 is from Hanford south to approximately west of Delano, where sediments of the Tulare Lake beds are exposed at or near the surface.
- Zone 4 extends from Delano south to Bakersfield, where the stratigraphy is similar to those found from Fresno to Hanford, with buff to brown, poorly indurated, fine sandstones and siltstones interpreted to be correlative with the Modesto Formation. These sediments are overlain by Quaternary alluvium.
- Zone 5 is in the Bakersfield urban area, where Quaternary alluvium is interpreted to overlie the Kern River Formation at an unknown depth.

Zones 1, 3, and 5 are considered to have high paleontological sensitivity because of the high potential to encounter significant paleontological resources. Zones 2 and 4 contain Quaternary alluvium at the surface that is considered to have low paleontological sensitivity because this unit is too recent to preserve significant fossils. However, at shallow depths, Zone 2 is underlain by the Modesto Formation, and Zone 4 is underlain by sediments correlative with the Modesto Formation, both of which have high paleontological sensitivities. Likewise, areas that have been previously disturbed are considered to have low paleontological sensitivity to the depth of the disturbance. Thus, depending on the depth of potential ground-disturbance (e.g., no disturbance or only very shallow excavations less than a few feet), Zones 2 and 4, along with urban areas, are considered to have low paleontological sensitivities in cases of no or only very shallow ground disturbance. For deeper ground disturbances, Zones 2 and 4, along with disturbed areas, would be considered to have the same high paleontological sensitivity as Zones 1, 3, and 5.

The Hanford West Bypass falls within Zones 2 and 3. Near the City of Hanford and north, sediments of the Modesto Formation underlie younger alluvium at a shallow depth (Zone 2). Excavations within Zone 2 are likely to impact the Modesto Formation. Deeper excavations could possibly impact the Riverbank Formation. South of the City of Hanford, the Tulare Lake beds are exposed at or near the surface and will be affected by project ground disturbance.

Although no fossil localities are known from within the footprint of the Hanford West Bypass, the presence of fossils in sediments of the Riverbank and Modesto formations, and in Tulare Lake sediments elsewhere in the area suggests that there is a high potential for additional similar fossil remains to be uncovered by excavations during project construction. Under SVP (1995) criteria, these stratigraphic units have a high sensitivity to potential impacts. The Quaternary alluvium, as defined above, was not found to contain or have the potential to contain paleontological resources in the study area. Under SVP (1995) criteria, this stratigraphic unit has a low sensitivity to potential impacts. Excavations in sediments with low paleontological sensitivity are not expected to affect significant paleontological resources. Disturbance of sediments with high paleontological sensitivity could have impacts to paleontological resources that are significant—but mitigable to a level below that of significant.

Potential impacts on paleontological resources resulting from construction of the Hanford West Bypass can be divided into construction impacts, and operation-related impacts. No impacts on paleontological resources are expected to occur from the continuing operation of the project or any of its related facilities. Construction impacts to paleontological resources primarily involve terrain modifications (clearing, grading, and excavations that encounter previously undisturbed sediment). Paleontological resources—including an undetermined number of fossil remains and unrecorded fossil sites; associated specimen data and corresponding geologic and geographic site data; and the fossil-bearing strata—can be adversely affected by (i.e., will be sensitive to) ground disturbance and earth moving associated with construction of the project. In addition, the construction of supporting facilities, such as temporary construction offices, laydown areas, and parking areas, have potential to cause adverse impacts to significant paleontological resources, if they also will involve new ground disturbance. Thus, any project ground disturbance can have

adverse impacts on significant paleontological resources. However, with a properly designed and implemented mitigation program, these impacts can be reduced to less than significant. The mitigation measures proposed below are consistent with SVP standard guidelines for mitigating adverse, construction impacts on paleontological resources (SVP 1995, 1996).

Recommended Mitigation Measures:

Recommended measures to mitigate adverse impacts resulting from the construction of the Hanford West Bypass would be identical to mitigation measures recommended in the paleontological resources technical report prepared for the Fresno to Bakersfield section of California HST. These measures are summarized again below.

Before construction begins, a qualified paleontologist should be retained to both design a monitoring and mitigation program, and implement the program during all project ground disturbance. The paleontological resource monitoring and mitigation program should include:

- Preconstruction coordination
- Construction monitoring
- Emergency discovery procedures
- Sampling and data recovery, if needed
- Preparation, identification, and analysis of the significance of fossil specimens salvaged, if any
- Museum storage of any specimens and data recovered
- Reporting.

Before construction begins, the paleontologist will conduct a field survey of exposures of sensitive stratigraphic units that will be disturbed, and any fossils discovered will be salvaged. Earth-moving construction activities will be monitored wherever these activities will disturb previously undisturbed sediment. Monitoring will not need to be conducted in areas where sediments have been previously disturbed, or in areas where exposed sediments will be buried, but not otherwise disturbed.

Prior to the start of construction, construction personnel involved with earth-moving activities will be informed of the following:

- Fossils may be discovered during excavating.
- Any fossils discovered are protected by laws.
- The appearance of common fossils will be provided.
- Proper notification procedures.

This worker training will be prepared and presented by a qualified paleontologist. Implementation of these mitigation measures will reduce the potentially significant adverse environmental impact of project ground disturbance and earth-moving on paleontological resources to an insignificant level by allowing for the salvage of fossil remains and associated specimen data—and corresponding geologic and geographic site data—that otherwise might be lost to earth-moving and to unauthorized fossil collecting.

Identifiable fossil remains salvaged during project construction could represent new taxa or new fossil records for the area, for the state of California, or for these stratigraphic units; and could be scientifically important and significant. They could also represent geographic or temporal range extensions. Moreover, discovered fossil remains could make it possible to more accurately determine the age, paleoclimate, and depositional environment of the sediments in which they were entombed. Fossil remains salvaged during project construction could provide a more comprehensive documentation of the diversity of animal and plant life that once existed in Fresno and Kings counties, and could result in a more accurate reconstruction of the geologic and

paleobiologic history of the San Joaquin Valley. The mitigation measures proposed above are consistent with SVP standard guidelines for mitigating adverse construction impacts on paleontological resources to be less than significant.

Section 4.0
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4.0 References

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Section 5.0
Preparer Qualifications

5.0 Preparer Qualifications

Lanny H. Fisk, Ph.D., PG

Dr. Fisk has over 25 years of experience as a professional paleontologist, and 20 years as a paleontological consultant conducting paleontological resource impact assessments and surveys, preparing CEQA and NEPA environmental documents and mitigation measures, managing environmental compliance monitoring programs, and coordinating and consulting with state and federal resource agencies to resolve environmental concerns regarding paleontological resources. He has supervised paleontological resource impact mitigation programs requiring monitoring of major earth-moving projects, recovery and collection of fossil remains and fossiliferous rock samples, supervision of field personnel, and preparation of progress and final reports. Dr. Fisk has supervised paleontological monitoring and salvaging of fossils, evaluated fossiliferous rock samples to determine need for microfossil processing, and identified fossil remains as part of paleontological monitoring and resource recovery programs for such major projects as the Pacific Gas and Electric Company–Pacific Gas Transmission Company Pipeline Expansion Project from Alberta, Canada, to Southern California; 360networks Northern California Fiber Optic Cable Project; Los Angeles Metro Rail Project; Eastern Transportation Corridor Tollway Project; Foothills Transportation Corridor Oso Tollway Project; Kettleman Hills Landfill; Sutter Energy Center Project; Newark Power Plant Project; Delta Energy Center Project; Los Medanos Energy Center Project; Blythe Energy Project; Gilroy Energy Center; Metcalf Energy Center; King City Energy Center; Pastoria Energy Facility; Otay Mesa Generating Project; Contra Costa Power Plant; Woodland Generating Station; Panoche Energy Center, California Department of Transportation (Caltrans) Highway 16 Excelsior Road Project, and Caltrans Highway 41 Reef Ridge Project.

David M. Haasl, Ph.D.

Dr. David M. Haasl joined the PRC team with a Ph.D. from the University of California, Davis, with a specialization in paleobiology; and an M.S. from Western Washington University, specializing in invertebrate paleontology. Most recently, he was Museum Scientist and Collections Manager at the University of California, Museum of Paleontology, in Berkeley, California, where he also served as Editor of the journal *PaleoBios*. He has published several scientific papers in paleontology, and has others in preparation.

Stephen J. Blakely

Mr. Blakely is a Staff Paleontologist at PaleoResource Consultants. He is responsible for the management of paleontological resource assessment and monitoring projects, and the preparation of proposals and technical reports. He has contributed to the preparation of several paleontological resource impact assessments, including several power plant projects (e.g., AUSRA-Carrizo Solar Farm, SES Solar Two, and Soda Mountain Solar Project). Mr. Blakely has also contributed to the preparation of paleontological mitigation and monitoring plans (e.g., Caltrans State Route [SR] 24 Caldecott Improvement Project and Caltrans SR 180 Sequoia Freeway Segment 3 Project). In addition to project management duties, Mr. Blakely performs field surveys for assessments, and has worked in the preparation laboratory and as a field paleontologist on monitoring projects. Mr. Blakely also has several years of experience working in the construction industry, and worked at the University of California, Davis, sedimentology laboratory.

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