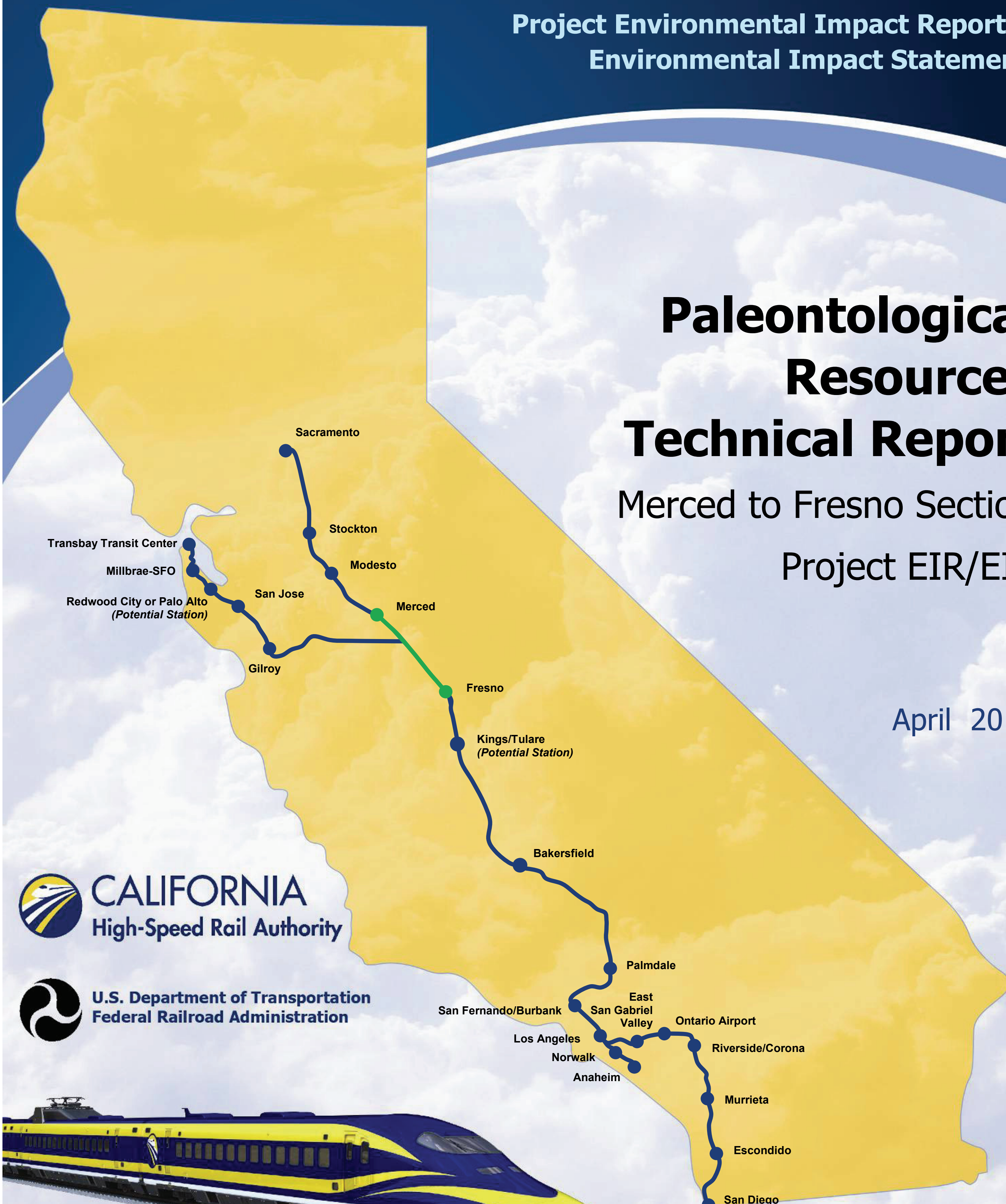
CALIFORNIA HIGH-SPEED TRAIN

Project Environmental Impact Report / Environmental Impact Statement



Paleontological Resources Technical Report

Merced to Fresno Section

Project EIR/EIS

April 2012

CALIFORNIA
High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

CALIFORNIA HIGH-SPEED TRAIN PROJECT EIR/EIS

TECHNICAL REPORT

Merced to Fresno Section
Paleontological Resources

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CH2M HILL

April 2012

California High-Speed Rail Authority and Federal Railroad Administration (Authority and FRA). 2012. *Merced to Fresno Section Paleontological Resources Technical Report, California High-Speed Train Final Project Environmental Impact Statement/Environmental Impact Report*. Prepared by AECOM and CH2M HILL. Sacramento, CA and Washington, DC. April 2012.

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List of Abbreviated Terms

APE	area of potential effects
Authority	California High-Speed Train Authority
BLM	Bureau of Land Management
BNSF	Burlington Northern Santa Fe
CGS	California Geological Survey
CEQA	California Environmental Quality Act
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
FRA	Federal Railroad Administration
HMF	heavy maintenance facility
H.R.	House of Representatives
HST	high-speed train
MM	Mitigation Measure
mph	miles per hour
n.d.	no date
NEPA	National Environmental Policy Act
OPLMA	Omnibus Public Land Management Act of 2009 (H.R. 146)
PRMMP	Paleontological Resources Monitoring and Mitigation Plan
SR	State Route
SVP	Society of Vertebrate Paleontology
UCMP	University of California Museum of Paleontology
UPRR	Union Pacific Rail Road
USDI	U.S. Department of the Interior

1.0 Introduction

The California High-Speed Train (HST) System is planned to provide intercity, high-speed service on more than 800 miles of guideway throughout California, connecting the major population centers of Sacramento, the San Francisco Bay Area, the Central Valley, Los Angeles, the Inland Empire, Orange County, and San Diego, as shown in Figure 1-1. It will use a state-of-the-art, electrically powered, high-speed, steel-wheel-on-steel-rail technology, which will include contemporary safety, signaling, and automated train-control systems. The trains will be capable of operating at speeds of up to 220 miles per hour (mph) over a fully grade-separated, dedicated guideway alignment.

Two phases of the California HST System are planned. Phase 1 will connect San Francisco to Los Angeles/Anaheim via the Pacheco Pass and the Central Valley . An expected express trip time between San Francisco and Los Angeles is mandated to be 2 hours and 40 minutes or less. (Phase 1 would be built in stages dependent on funding availability.) Phase 2 will connect the Sacramento to the rest of the Central Valley, and will extend the system from Los Angeles to San Diego.

Definition of HST System

The system that includes the HST tracks, structures, stations, traction powered substations, and maintenance facilities and train vehicles able to travel 220 mph.

The California HST System will be planned, designed, constructed, and operated under the direction of the California High-Speed Rail Authority (Authority), a state governing board formed in 1996. The Authority's statutory mandate is to develop a high-speed rail system that is coordinated with the state's existing transportation network, which includes intercity rail and bus lines, regional commuter rail lines, urban rail and bus transit lines, highways, and airports. The Merced to Fresno HST Section is a critical Phase 1 link connecting the Bay Area HST sections to the northern and southern portions of the system.

The Council on Environmental Quality provides for National Environmental Policy Act (NEPA) decision-making through a phased process. This process is referred to as *tiered* decision-making. This phased decision-making process provides for a broad level programmatic decision to inform more specific decisions using a tiered approach. A first tier programmatic environmental impact statement (EIS) addresses one large project with one overall purpose and need that would be too extensive to analyze in a traditional project EIS. The California Environmental Quality Act (CEQA) also encourages tiering and also provides for first-tier and second-tier EIRs.

The Merced to Fresno Section Project Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) is a second-tier EIR/EIS that builds upon and further refines work completed earlier as part of the two first-tier program EIR/EIS documents. The 2005 *Final Program EIR/EIS for the Proposed California High-Speed Train System* (Statewide Program EIR/EIS) provided a first-tier analysis of the general effects of implementing the HST System across two-thirds of the state. The *Final Bay Area to Central Valley HST Program Environmental Impact Report/Environmental Impact Statement (EIR/EIS)* (Authority and Federal Railroad Administration [FRA] 2008), and the *Bay Area to Central Valley HST Revised Final EIR* (Authority 2010) were also first-tier and programmatic documents but focused on the Bay Area to Central Valley region. As a result of CEQA litigation, the Authority rescinded its 2008 programmatic decision, prepared a Revised Final Program EIR, and made a new decision on the Bay Area to Central Valley route in 2010. A second legal challenge resulted in the Authority preparing a Partially Revised Final Program EIR. The Authority is expected to rescind its 2010 decisions and make a new set of decisions for the Bay Area to Central Valley connection prior to considering the Merced to Fresno HST Final Project EIR/EIS. The Authority's rescission of the 2008 and 2010 programmatic decisions does not invalidate FRA's federal decisions on the 2005 and 2008 Program EIR/EISs.

First-tier EIR/EIS documents provided the Authority and FRA with the environmental analysis necessary for evaluation of the overall HST System and for making broad decisions about general HST alignments and station locations for further study in second-tier EIR/EISs. These documents are available on the

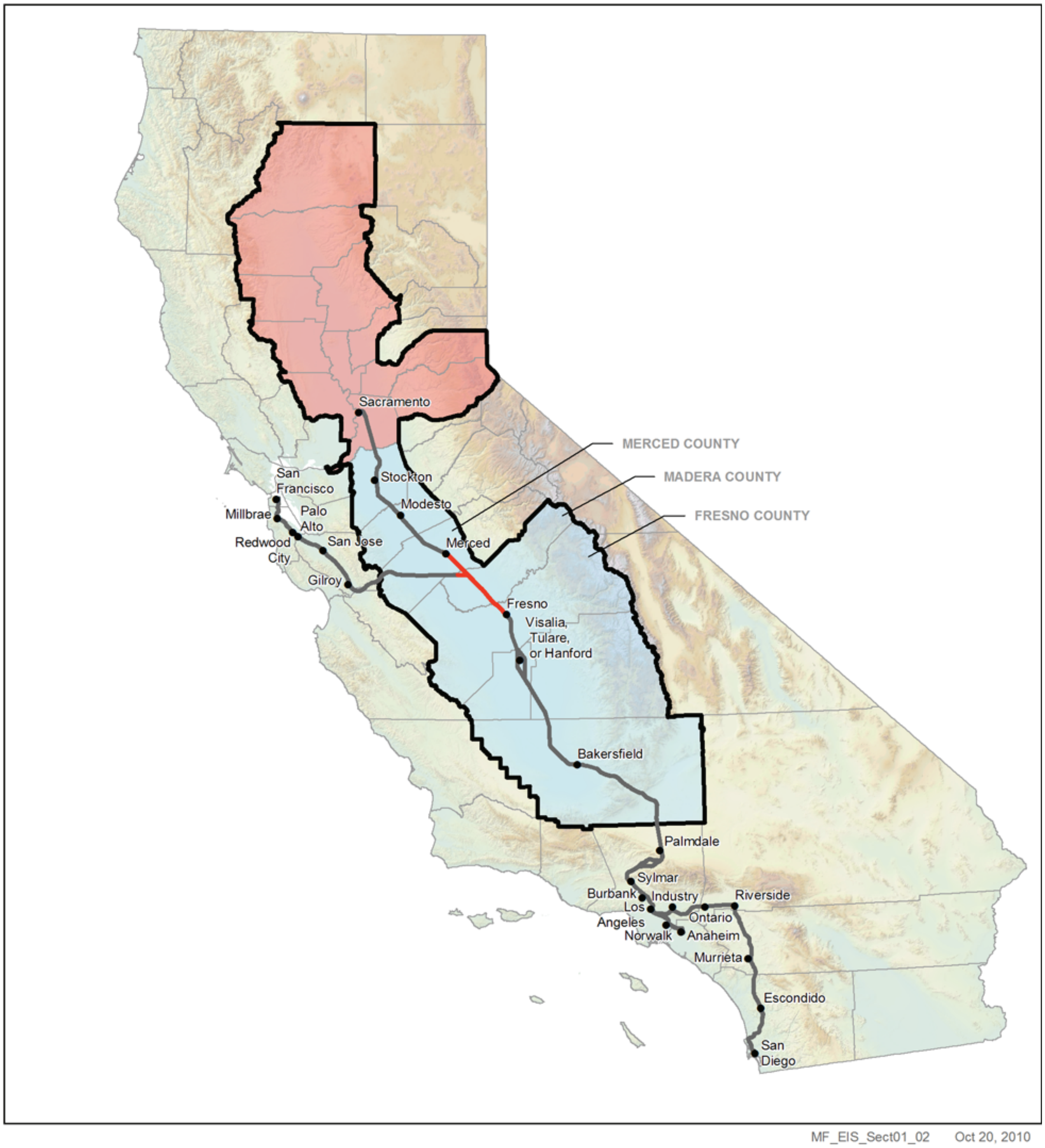


Figure 1-1
HST System in California

Authority's website: www.cahighspeedrail.ca.gov. This technical report has been prepared to support the Merced to Fresno Section Project EIR/EIS process, which analyzes the environmental impacts and benefits of implementing the HST in the more geographically limited area between Merced and Fresno and is based on more detailed project planning and engineering. The analysis therefore incorporates the earlier decisions and program EIR/EISs, and it provides more site-specific and detailed analysis.

For each of the environmental resources evaluated for the Merced to Fresno Section of the California HST System, analysts defined the study areas to be surveyed for existing conditions and to be analyzed for impacts**.** These study areas are defined with the following basic parameters:

- The potential area of disturbance or construction footprint, lying within the required right-of-way and consisting of areas required for construction, including staging areas and temporary construction easements. The construction footprint is common to all resource areas.
- A resource-specific buffer. The buffer varies by resource area. For the paleontological resources study, the buffer zone was 150 feet on either side of the right-of-way and 150 feet beyond the boundaries of all other facilities, and is used to ensure all geologic units potentially impacted during construction are considered.

This technical report provides support and detailed analysis of the paleontological resource related to the No Project Alternative and HST alternatives. This report describes the existing conditions, the range of possible impacts for each alternative, and the measures to avoid, minimize, or, if necessary, mitigate impacts of the project alternatives on paleontological resources. The analysis is based upon an approximate 15% design of the HST alternatives and has been conservatively estimated to quantify and qualify impacts; however, further design may reduce or change impacts.

The Program EIR/EIS documents included program-level analyses and one subsequent mitigation strategy for paleontological resources. This measure is assumed as part of the project description, thereby reducing the effects of the HST project, and is summarized as follows:

> Incorporate paleontological sensitivity measures during construction including educating workers of the possibility of encountering sensitive paleontological resources, monitoring during construction for these resources, and developing protocols for handling and recovering fossils discovered during field reconnaissance and/or construction.

Section 2 of this report describes the project and resource study area. Section 3 discusses the regulatory setting. Section 4 discusses the environmental setting. Section 5 evaluates the impacts on paleontological resources. The paleontological mitigation measures are provided in Section 6. Section 7 lists references cited and Section 9 lists the technical specialists who prepared this technical report.

2.0 Project Description

The purpose of the Merced to Fresno Section of the HST project is to implement the California HST System between Merced and Fresno, providing the public with electric-powered high-speed rail service that provides predictable and consistent travel times between major urban centers and connectivity to airports, mass transit systems, and the highway network in the south San Joaquin Valley, and to connect the northern and southern portions of the HST System. The approximately 65-mile-long corridor between Merced and Fresno is an essential part of the statewide HST System. The Merced to Fresno Section is the location where the HST would intersect and connect with the Bay Area and Sacramento branches of the HST System; it would provide a potential location for the heavy maintenance facility (HMF) where the HSTs would be assembled and maintained, as well as a test track for the trains; it would also provide Merced and Fresno access to a new transportation mode and would contribute to increased mobility throughout California.

2.1 No Project Alternative

The No Project Alternative refers to the projected growth planned for the region through the 2035 time horizon without the HST project and serves as a basis of comparison for environmental analysis of the HST build alternatives. The No Project Alternative includes planned improvements to the highway, aviation, conventional passenger rail, and freight rail systems in the Merced to Fresno project area. There are many environmental impacts that would result under the No Project Alternative.

2.2 High-Speed Train Alternatives

As shown in Figure 2-1, there are three HST alignment alternatives proposed for the Merced to Fresno Section of the HST System: the UPRR/SR 99 Alternative, which would primarily parallel the UPRR railway; the BNSF Alternative, which would parallel the BNSF railway for a portion of the distance between Merced and Fresno; and the Hybrid Alternative, which combines features of the UPRR/SR 99 and BNSF alternatives. In addition, there is an HST station proposed for both the City of Merced and the City of Fresno, there is a wye connection (see text box on page 2-3) west to the Bay Area, and there are five potential sites for a proposed HMF.

The Authority and FRA have identified the Hybrid Alternative as their preferred alternative for the north-south alignment between Merced and Fresno. The Hybrid Alternative would connect to San Jose to the west along one of three wye design options. The San Jose to Merced Section Project EIR/EIS will fully evaluate the east-west alignment alternatives and wye configurations, including the Ave 24 Wye, the Ave 21 Wye, and another wye design option, the SR 152 Wye, which has not been reviewed in this document. A decision regarding the preferred east-west alignment, including the preferred wye design option, will take place after circulation of the San Jose to Merced Section Project EIR/EIS; that decision will finalize the alignment and profile of the Hybrid Alternative. In addition, the Authority and FRA have identified the Mariposa Street Station Alternative as their preferred alternative for an HST station in Downtown Fresno.

2.2.1 UPRR/SR 99 Alternative

This section describes the UPRR/SR 99 Alternative, including the Chowchilla design options, wyes, and HST stations.

2.2.1.1 North-South Alignment

The north-south alignment of the UPRR/SR 99 Alternative would begin at the HST station in Downtown Merced, located on the west side of the UPRR right-of-way. South of the station and leaving Downtown Merced, the alternative would be at-grade and cross under SR 99. Approaching the City of Chowchilla, the UPRR/SR 99 Alternative has two design options: the East Chowchilla design option, which would pass Chowchilla on the east side of town, and the West Chowchilla design option, which would pass Chowchilla

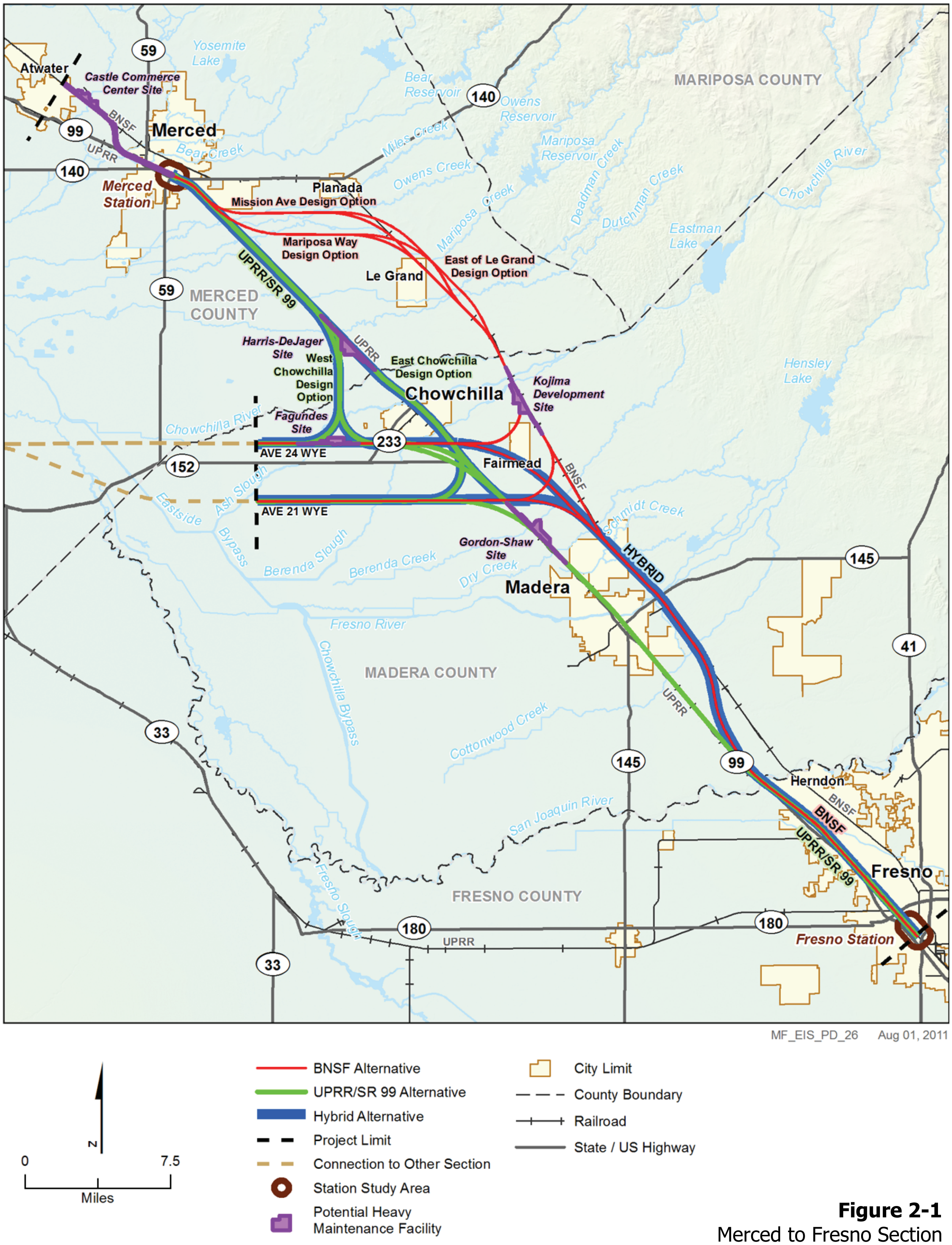


Figure 2-1
Merced to Fresno Section
HST Alternatives

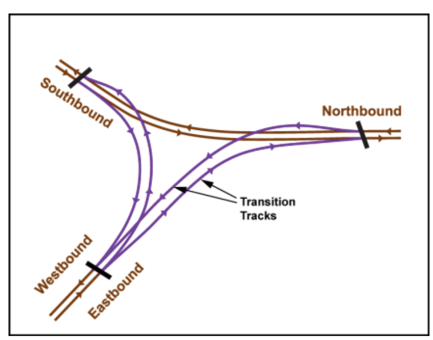
3 to 4 miles west of the city before turning back to rejoin the UPRR/SR 99 transportation corridor. These design options would take the following routes:

- **East Chowchilla design option:** This design option would transition from the west side of the UPRR/SR 99 corridor to an elevated structure as it crosses the UPRR railway and N Chowchilla Boulevard just north of Avenue 27, continuing on an elevated structure away from the UPRR corridor along the west side of and parallel to SR 99 to cross Berenda Slough. Toward the south side of Chowchilla, this design option would cross over SR 99 north of the SR 99/SR 152 interchange near Avenue 23½ south of Chowchilla. Continuing south on the east side of SR 99 and the UPRR corridor, this design option would remain elevated for 7.1 miles through the communities of Fairmead and Berenda until reaching the Dry Creek Crossing. The East Chowchilla design option connects to the HST sections to the west via either the Ave 24 or Ave 21 wyes (described below).
- **West Chowchilla design option:** This design option would travel due south from Sandy Mush Road north of Chowchilla, following the west side of Road 11¾. The alignment would turn southeast toward the UPRR/SR 99 corridor south of Chowchilla. The West Chowchilla design option would cross over the UPRR and SR 99 east of the Fairmead city limits to again parallel the UPRR/SR 99 corridor. The West Chowchilla design option would result in a net decrease of approximately 13 miles of track for the HST System compared to the East Chowchilla design option and would remain outside the limits of the City of Chowchilla. The West Chowchilla design option connects to the HST sections to the west via the Ave 24 Wye, but not the Ave 21 Wye.

The UPRR/SR 99 Alternative would continue toward Madera along the east side of the UPRR south of Dry Creek and remain on an elevated profile for 8.9 miles through Madera. After crossing over Cottonwood Creek and Avenue 12, the HST alignment would transition to an at-grade profile and continue to be at-grade until north of the San Joaquin River. After the San Joaquin River crossing, the HST alignment would require realignment (a mostly westward shift) of Golden State Boulevard and of a portion of SR 99 to create right-of-way adjacent to the UPRR railroad that would not preclude future expansion of these roadways. After crossing the San Joaquin River, the alternative would rise over the UPRR railway on an elevated guideway, supported by straddle bents, before crossing over the existing Herndon Avenue and again descending into an at-grade profile and continuing west of and parallel to the UPRR right-of-way. After elevating to cross the UPRR railway on the southern bank of the San Joaquin River, south of Herndon Avenue, the alternative would transition from an elevated to an at-grade profile. Traveling south from Golden State Boulevard at-grade, the alternative would cross under the reconstructed Ashlan Avenue and Clinton Avenue overhead structures. Advancing south from Clinton Avenue between Clinton Avenue and Belmont Avenue, the HST guideway would run at-grade adjacent to the western boundary of the UPRR right-of-way and then enter the HST station in Downtown Fresno. The HST guideway would descend in a retained-cut to pass under the San Joaquin Valley Railroad spur line and SR 180, transition back to at-grade before Stanislaus Street, and continue to be at-grade into the station. As part of a station design option, Tulare Street would become either an overpass or undercrossing at the station.

What is a "Wye"?

The word "wye" refers to the "Y"-like formation that is created where train tracks branch off the mainline to continue in different directions. The transition to a wye requires splitting two tracks into four tracks that cross over one another before the wye "legs" can diverge in opposite directions to allow bidirectional travel. For the Merced to Fresno Section of the HST System, the two tracks traveling east-west from the San Jose to Merced Section must become four tracks—a set of two tracks branching to the north and a set of two tracks branching to the south.

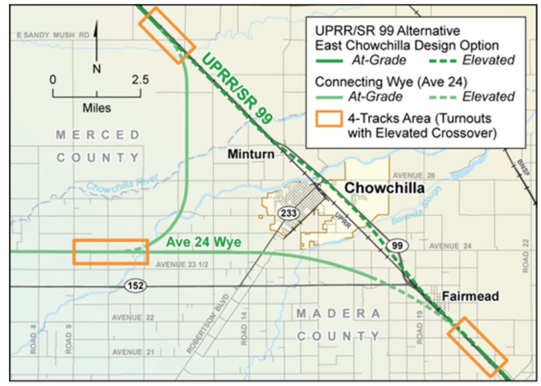


2.2.1.2 Wye Design Options

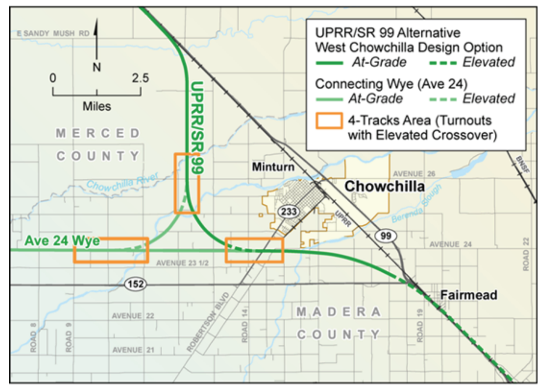
The following text describes the wye connection from the San Jose to Merced Section to the Merced to Fresno Section. There are two variations of the Ave 24 Wye for the UPRR/SR 99 Alternative because of the West Chowchilla design option. The Ave 21 Wye does not connect to the West Chowchilla design option and therefore does not have a variation.

Ave 24 Wye

The Ave 24 Wye design option would travel along the south side of eastbound Avenue 24 toward the UPRR/SR 99 Alternative and would begin diverging onto two sets of tracks west of Road 11 and west of the City of Chowchilla. Under the East Chowchilla design option, the northbound set of tracks would travel northeast across Road 12, joining the UPRR/SR 99 north-south alignment on the west side of the UPRR right-of-way just north of Sandy Mush Road. Under the West Chowchilla design option, the northbound set of tracks would travel northeast across Road 12 and would join the UPRR/SR 99 north-south alignment just south of Avenue 26. The southbound HST guideway would continue east along Avenue 24, turning south near SR 233 southeast of Chowchilla, crossing SR 99 and the UPRR railway to connect to the UPRR/SR 99 Alternative north-south alignment on the east side of the UPRR near Avenue 21½. Under the West Chowchilla design option, the southbound tracks would turn south near Road 16 south of Chowchilla, crossing SR 99 and the UPRR to connect to the UPRR/SR 99 north-south alignment on the east side of the UPRR adjacent to the city limits of Fairmead.



(a) Ave 24 Wye with the East Chowchilla Design Option



(b) Ave 24 Wye with the West Chowchilla Design Option

Figure 2-2a and b
Ave 24 Wye and Chowchilla Design Options

Figure 2-2a shows the wye alignment for the East Chowchilla design option and Figure 2-2b shows the alignment for the West Chowchilla design option. Together, the figures illustrate the difference in the wye triangle formation for each design option connection. The north-south alignment of the West Chowchilla design option between Merced and Fresno diverges along Avenue 24 onto Road 12, on the north branch of the wye, allowing the HST alternative to avoid traveling through Chowchilla and to avoid constraining the city within the wye triangle.

Ave 21 Wye

The Ave 21 Wye would travel along the north side of Avenue 21. Just west of Road 16, the HST tracks would diverge north and south to connect to the UPRR/SR 99 Alternative, with the north leg of the wye joining the north-south alignment at Avenue 23½ and the south leg at Avenue 19½.

2.2.1.3 HST Stations

The Downtown Merced and Downtown Fresno station areas would each occupy several blocks, to include station plazas, drop-offs, a multimodal transit center, and parking structures. The areas would include the station platform and associated building and access structure, as well as lengths of platform tracks to accommodate local and express service at the stations. As currently proposed, both the Downtown Merced and Downtown Fresno stations would be at-grade, including all trackway and platforms, passenger services and concessions, and back-of-house functions.

Downtown Merced Station

The Downtown Merced Station would be between Martin Luther King Jr. Way to the northwest and G Street to the southeast. The station would be accessible from both sides of the UPRR, but the primary station house would front 16th Street. The major access points from SR 99 include V Street, R Street, Martin Luther King Jr. Way, and G Street. Primary access to the parking facility would be from West 15th Street and West 14th Street, just one block east of SR 99. The closest access to the parking facility from the SR 99 freeway would be R Street, which has a full interchange with the freeway. The site proposal includes a parking structure that would have the potential for up to 6 levels with a capacity of approximately 2,250 cars and an approximate height of 50 feet.

Downtown Fresno Station Alternatives

There are two station alternatives under consideration in Fresno: the Mariposa Street Station Alternative and the Kern Street Station Alternative. The Authority and FRA have identified Mariposa Street Station as their preferred alternative.

Mariposa Street Station Alternative (Preferred Alternative)

The Mariposa Street Station Alternative is located in Downtown Fresno, less than 0.5 mile east of SR 99. The station would be centered on Mariposa Street and bordered by Fresno Street on the north, Tulare Street on the south, H Street on the east, and G Street on the west. The station building would be approximately 75,000 square feet, with a maximum height of approximately 60 feet. The two-level station would be at-grade, with passenger access provided both east and west of the HST guideway and the UPRR tracks, which would run parallel with one another adjacent to the station. Entrances would be located at both G and H Streets. The eastern entrance would be at the intersection of H Street and Mariposa Street, with platform access provided via the pedestrian overcrossing. The main western entrance would be located at G Street and Mariposa Street.

The majority of station facilities would be located east of the UPRR tracks. The station and associated facilities would occupy approximately 18.5 acres, including 13 acres dedicated to the station, bus transit center, surface parking lots, and kiss-and-ride accommodations. A new intermodal facility would be included in the station footprint on the parcel bordered by Fresno Street to the north, Mariposa Street to the south, Broadway Street to the east, and H Street to the west. The site proposal includes the potential for up to 3 parking structures occupying a total of 5.5 acres. Two of the three potential parking structures would each sit on 2 acres, and each would have a capacity of approximately 1,500 cars. The third parking structure would have a slightly smaller footprint (1.5 acres), with 5 levels and a capacity of approximately 1,100 cars. Surface parking lots would provide approximately 300 additional parking spaces.

Kern Street Station Alternative

The Kern Street Station Alternative for the HST station would also be in Downtown Fresno and would be centered on Kern Street between Tulare Street and Inyo Street. This station would include the same components and acreage as the Mariposa Street Station Alternative, but the station would not encroach on the historic Southern Pacific Railroad depot just north of Tulare Street and would not require relocation of existing Greyhound facilities. Two of the 3 potential parking structures would each sit on 2 acres and each would have a capacity of approximately 1,500 cars. The third structure would have a slightly smaller footprint (1.5 acres) and a capacity of approximately 1,100 cars. Like the Mariposa Street Station Alternative, the majority of station facilities under the Kern Street Station Alternative would be east of the HST tracks.

2.2.2 BNSF Alternative

This section describes the BNSF Alternative, including the Le Grand design options and wyes. It does not include a discussion of the HST stations, because the station descriptions are identical for each of the three HST alignment alternatives.

2.2.2.1 North-South Alignment

The north-south alignment of the BNSF Alternative would begin at the proposed Downtown Merced Station. This alternative would remain at-grade through Merced and would cross under SR 99 at the south end of the city. Just south of the interchange at SR 99 and E Childs Avenue, the BNSF Alternative would cross over SR 99 and UPRR as it begins to curve to the east, crossing over the E Mission Avenue interchange. It would then travel east to the vicinity of Le Grand, where it would turn south and travel adjacent to the BNSF tracks.

To minimize impacts on the natural environment and the community of Le Grand, the project design includes four design options:

- **Mission Ave design option:** This design option would turn east to travel along the north side of Mission Avenue at Le Grand and then would elevate through Le Grand adjacent to and along the west side of the BNSF corridor.
- **Mission Ave East of Le Grand design option:** This design option would vary from the Mission Ave design option by traveling approximately 1 mile farther east before turning southeast to cross Santa Fe Avenue and the BNSF tracks south of Mission Avenue. The HST alignment would parallel the BNSF for a half-mile to the east, avoiding the urban limits of Le Grand. This design option would cross Santa Fe Avenue and the BNSF railroad again approximately one-half mile north of Marguerite Road and would continue adjacent to the west side of the BNSF corridor.
- **Mariposa Way design option:** This design option would travel 1 mile farther than the Mission Ave design option before crossing SR 99 near Vassar Road and turning east toward Le Grand along the south side of Mariposa Way. East of Simonson Road, the HST alignment would turn to the southeast. Just prior to Savana Road in Le Grand, the HST alignment would transition from at-grade to elevated to pass through Le Grand on a 1.7-mile-long guideway adjacent to and along the west side of the BNSF corridor.
- **Mariposa Way East of Le Grand design option:** This design option would vary from the Mariposa Way design option by traveling approximately 1 mile farther east before turning southeast to cross Santa Fe Avenue and the BNSF tracks less than one-half mile south of Mariposa Way. The HST alignment would parallel the BNSF to the east of the railway for a half-mile, avoiding the urban limits of Le Grand. This design option would cross Santa Fe Avenue and the BNSF again approximately a half-mile north of Marguerite Road and would continue adjacent to the west side of the BNSF corridor.

Continuing southeast along the west side of BNSF, the BNSF Alternative would begin to curve just before Plainsburg Road through a predominantly rural and agricultural area. One mile south of Le Grand, the HST alignment would cross Deadman and Dutchman creeks. The alignment would deviate from the BNSF corridor just southeast of S White Rock Road, where it would remain at-grade for another 7 miles, except at the bridge crossings, and would continue on the west side of the BNSF corridor through the community of Sharon. The HST alignment would continue at-grade through the community of Kismet until crossing at Dry Creek. The BNSF Alternative would then continue at-grade through agricultural areas along the west side of the BNSF corridor through the community of Madera Acres north of the City of Madera; in the vicinity of Madera Acres, the HST Project would provide a grade separation of Road 26 and Road 28, which would cross over both the existing BNSF tracks and the new HST guideway. South of Avenue 15 east of Madera, the alignment would transition toward the UPRR corridor, following the east side of the UPRR corridor near Avenue 9 south of Madera, then continuing along nearly the same route as the UPRR/SR 99 Alternative over the San Joaquin River to enter the community of Herndon. After crossing the San Joaquin River, the alignment would be the same as for the UPRR/SR 99 Alternative

2.2.2.2 Wye Design Options

The Ave 24 Wye and the Ave 21 Wye would be the same as described for the UPRR/SR 99 Alternative (East Chowchilla design option), except as noted below.

Ave 24 Wye

As with the UPRR/SR 99 Alternative, the Ave 24 Wye would follow along the south side of Avenue 24 and would begin diverging into two sets of tracks (i.e., four tracks) beginning west of Road 17. Two tracks would travel north near Road 20½, where they would join the north-south alignment of the BNSF

Alternative on the west side of the BNSF corridor near Avenue 26½. The two southbound tracks would join the BNSF Alternative on the west side of the BNSF corridor south of Avenue 21.

Ave 21 Wye

As with the UPRR/SR 99 Alternative, the Ave 21 Wye would travel along the north side of Avenue 21. Two tracks would diverge, turning north and south to connect to the north-south alignment of the BNSF Alternative just west of Road 21. The north leg of the wye would join the north-south alignment just south of Avenue 24 and the south leg would join the north-south alignment just east of Frontage Road/Road 26 north of the community of Madera Acres.

2.2.3 Hybrid Alternative (Preferred Alternative)

This section describes the Hybrid Alternative, which generally follows the alignment of the UPRR/SR 99 Alternative in the north and the BNSF Alternative in the south. It does not include a discussion of the HST stations because the station descriptions are identical for each of the three HST alternatives. The Authority and FRA have identified the Hybrid Alternative as their preferred alternative.

2.2.3.1 North-South Alignment

From north to south, generally, the Hybrid Alternative would follow the UPRR/SR 99 alignment with either the West Chowchilla design option with the Ave 24 Wye or the East Chowchilla design option with the Ave 21 Wye. Approaching the Chowchilla city limits, the Hybrid Alternative would follow one of two options:

- In conjunction with the Ave 24 Wye, the HST alignment would veer due south from Sandy Mush Road along a curve and would continue at-grade for 4 miles parallel to and on the west side of Road 11¾. The Hybrid Alternative would then curve to a corridor on the south side of Avenue 24 and would travel parallel for the next 4.3 miles. Along this curve, the southbound HST track would become an elevated structure for approximately 9,000 feet to cross over the Ave 24 Wye connection tracks and Ash Slough, while the northbound HST track would remain at-grade. Continuing east on the south side of Avenue 24, the HST alignment would become identical to the Ave 24 Wye connection for the BNSF Alternative and would follow the alignment of the BNSF Alternative until Madera.
- In conjunction with the Ave 21 Wye connection, the HST alignment would transition from the west side of UPRR and SR 99 to an elevated structure as it crosses the UPRR and N Chowchilla Boulevard just north of Avenue 27, continuing on an elevated structure along the west side of and parallel to SR 99 away from the UPRR corridor while it crosses Berenda Slough. Toward the south side of Chowchilla, the alignment (with the Ave 21 Wye) would cross over SR 99 north of the SR 99/SR 152 interchange near Avenue 23½ south of Chowchilla. It would continue to follow along the east side of SR 99 until reaching Avenue 21, where it would curve east and run parallel to Avenue 21, briefly. The alignment would then follow a path similar to the Ave 21 Wye connection for the BNSF Alternative, but with a tighter 220 mph curve. The alternative would then follow the BNSF Alternative alignment until Madera.

Through Madera and until reaching the San Joaquin River, the Hybrid Alternative is the same as the BNSF Alternative. Once crossing the San Joaquin River, the alignment of the Hybrid Alternative becomes the same as for the UPRR/SR 99 Alternative, including the westward realignments of Golden State Boulevard and SR 99.

2.2.3.2 Wye Design Options

The wye connections for the Hybrid Alternative follow Avenue 24 and Avenue 21, similar to those of the UPRR/SR 99 and BNSF alternatives.

Ave 24 Wye

The Ave 24 Wye is the same as the combination of the UPRR/SR 99 Alternative with the West Chowchilla design option, and the Ave 24 Wye for the BNSF Alternative.

Ave 21 Wye

The Ave 21 Wye is similar to the combination of the UPRR/SR 99 Alternative with the Ave 21 Wye on the northbound leg and the BNSF Alternative with the Ave 21 Wye on the southbound leg. However, the south leg under the Hybrid Alternative would follow a tighter, 220 mph curve than the BNSF Alternative, which follows a 250 mph curve.

2.2.4 Heavy Maintenance Facility Alternatives

The Authority is studying five HMF sites (see Figure 2-1) within the Merced to Fresno Section, one of which may be selected. (The sponsor of the Harris-DeJager site withdrew its proposal from the Authority's consideration of potential HMF sites [Kopshever 2011]. However, to remain consistent with previous analysis and provide a basis of comparison among the HMFs, evaluation of the site continues in this document.)

- **Castle Commerce Center HMF site** – A 370-acre site located 6 miles northwest of Merced, at the former Castle Air Force Base in northern unincorporated Merced County. It is adjacent to and on the east side of the BNSF mainline, 1.75 miles south of the UPRR mainline, off of Santa Fe Drive and Shuttle Road, 2.75 miles from the existing SR 99 interchange. The Castle Commerce Center HMF would be accessible by all HST alternatives.
- **Harris-DeJager HMF site (withdrawn from consideration)** – A 401-acre site located north of Chowchilla adjacent to and on the west side of the UPRR corridor, along S Vista Road and near the SR 99 interchange under construction. The Harris-DeJager HMF would be accessible by the UPRR/SR 99 and Hybrid alternatives if coming from the Ave 21 Wye and the UPRR/SR 99 Alternative with the East Chowchilla design option and the Ave 24 Wye.
- **Fagundes HMF site** – A 231-acre site, located 3 miles southwest of Chowchilla on the north side of SR 152, between Road 11 and Road 12. This HMF would be accessible by all HST alternatives with the Ave 24 Wye.
- **Gordon-Shaw HMF site** – A 364-acre site adjacent to and on the east side of the UPRR corridor, extending from north of Berenda Boulevard to Avenue 19. The Gordon-Shaw HMF would be accessible from the UPRR/SR 99 Alternative.
- **Kojima Development HMF site** – A 392-acre site on the west side of the BNSF corridor east of Chowchilla, located along Santa Fe Drive and Robertson Boulevard (Avenue 26). The Kojima Development HMF would be accessible by the BNSF Alternative with the Ave 21 Wye.

3.0 Regulatory Setting

3.1 Regulatory Requirements

Paleontological resources are nonrenewable resources that are valued principally for their scientific data and educational potential. The following laws, regulations, and guidance apply to paleontological resources.

3.1.1 Federal Regulations

Federal regulations are applicable only to construction which is on or impacts federal land or, in some circumstances, requires a federal permit or entitlement. As such, these regulations are not directly applicable to this project. They are relevant, however, to the regulatory context of paleontological resources and are normally listed in paleontological resources assessments regardless of specific jurisdiction.

Federal Antiquities Act of 1906 (16 United States Code Section 431 to 433)

The Antiquities Act of 1906 prohibits appropriation, excavation, injury, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity" located on lands owned or controlled by the federal government. The act also establishes penalties for such actions and sets forth a permit requirement for collection of antiquities on federally owned lands. A number of federal agencies consider fossils to be objects of antiquity.

Omnibus Public Land Management Act

Signed into law on March 31, 2009, Title 6, Subtitle D of the Omnibus Public Land Management Act of 2009 (OPLMA; House of Representatives [H.R.] 146), Paleontological Resources Preservation, requires the secretaries of the Department of the Interior (exclusive of Indian trust lands) and the Department of Agriculture (insofar as U.S. Forest System lands are concerned) to "… manage and protect paleontological resources on Federal land using scientific principals and expertise . . . (and) develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources . . ." The OPLMA further describes requirements for permitting collection on federal lands, stipulations regarding the use of paleontological resources in education, continued federal ownership of recovered paleontological resources, and standards for acceptable repositories of collected specimens and associated data (OPLMA, H.R. 146, §§ 6303–6305). The OPLMA also provides for criminal and civil penalties for unauthorized removal of paleontological resources from Federal land (H.R. 146, §§ 6306–6309).

National Environmental Policy Act Protection for Paleontological Resources

While the National Environmental Policy Act (NEPA) does not provide specific guidance regarding paleontological resources, the requirements that the federal agencies take all practicable measures to "preserve important historic, cultural, and natural aspects of our national heritage" is interpreted to apply to paleontological materials, and paleontological resources are treated in a manner similar to that used for cultural resources, but are not subject to Section 106 of the National Historic Preservation Act.

3.1.2 State Regulations

California Environmental Quality Act of 1970 (Public Resource Code, Section 21000 et seq.)

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

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

1. Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
2. Has a special and particular quality such as being the oldest of its type or the best available example of its type.
3. Is directly associated with a scientifically recognized important prehistoric or historic event."

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

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

Native American Historic Resource Protection Act (Public Resource Code, Section 5097 et seq.)

This statute calls for the protection of "any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological sites, including fossilized footprints, inscriptions made by human agency, rock art, or any other archaeological, paleontological, or historical feature" on state land. State land, in this statute, is defined as lands owned by, or under the jurisdiction of, the state or any state agency, and excludes lands owned by or under the jurisdiction of a city, county, or district, or fire trails under the jurisdiction of the Division of Forestry. This statute only protects vertebrate fossils and trace fossils made by vertebrate organisms. Excavating vertebrate paleontological sites without permission of the public agency having jurisdiction over the lands is a misdemeanor.

California Environmental Quality Act Guidelines (14 California Code of Regulations, Section 15064.5 et seq.)

CEQA provides that a lead agency may find that "any object, building, structure, site, area, place, record, or manuscript" is historically significant or significant in the "cultural annals of California." The section provides that, generally, a resource may be considered historically significant if it has yielded or may be likely to yield information important in prehistory. Paleontological resources fall within this broad category and are included in the CEQA checklist under cultural resources.

Part V(c) of the CEQA Checklist in Appendix G of the Guidelines provides guidance relative to significant impacts on paleontological resources, indicating that a project would have a significant impact on paleontological resources if it would "directly or indirectly destroy a unique paleontological resource or site or unique geologic feature."

3.1.3 Other Considerations

Cities and counties within the study area do not have specific laws, regulations, or ordinances pertaining to paleontological resources.

3.2 Standards of Practice

The Society of Vertebrate Paleontology (SVP), a national organization of professional paleontologists, has established guidelines that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data recovery, specimen preparation, analysis, and curation (SVP 1995a, b; no date [n.d.]). Most practicing professional paleontologists follow the SVP guidelines, with appropriate accommodations for the last 16 years of scientific advancements. More recently, paleontological resources guidelines were promulgated by the U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) *Instructional Memorandum No. 2008-009* (BLM 2008), and these incorporate advancements that are being followed by many professional paleontologists conducting paleontological inventories on federal lands, as well as elsewhere. These are discussed further in Section 4.2.

4.0 Environmental Setting

4.1 Paleontological Resources

Paleontological resources are fossils, the remains or traces of prehistoric plants and animals. Fossils are important scientific and educational resources because they can help document the presence and evolutionary history of particular groups of organisms, reconstruct the environments in which these organisms lived, and provide a history of environmental change. Geologists also use fossils to determine the ages of sedimentary units in which they occur, and the nature of the geologic events that resulted in the deposition of the sediments.

4.2 Paleontological Sensitivity and Baseline Analysis

The paleontological sensitivity of a stratigraphic unit reflects (1) its potential paleontological productivity (and thus sensitivity), and (2) the scientific significance of the fossils it has produced. Thus, the potential paleontological productivity of a stratigraphic unit exposed in the study area is based on the abundance of fossil specimens and/or previously recorded fossil sites in exposures of the unit in the project vicinity.

To establish the paleontological sensitivity of sediments in the project vicinity, the baseline analysis included the following approach:

- Assessment of the potential paleontological productivity of each sedimentary unit exposed in previous studies that may be affected by implementation of the alternative alignments.
- Consideration of the potential for a geological unit exposed within the study area to contain a unique paleontological resource.

Paleontological sensitivity is, therefore, a qualitative assessment made by a professional paleontologist taking into account the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may be germane to evaluating the probability that fossils will be encountered. Table 4-1 defines the sensitivity ratings used for the purpose of this assessment.

Table 4-1
Paleontological Sensitivity Ratings Employed for the Purpose of this Analysis

Rating	Definition
High	Assigned when geological formations are known to contain paleontological resources that include rare, well-preserved, and/or fossil materials important to ongoing paleoclimatic, paleobiological, and/or evolutionary studies. These formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of many paleontologists, and can represent important educational resources.
Moderate	Assigned when stratigraphic units have occasionally but not commonly yielded fossils, have yielded fossils that are common elsewhere, and/or yield fossils that are stratigraphically long-ranging and well represented. This rating can also be applied to strata that have a locally unproven but distinct potential to yield fossil remains based on the stratigraphy and/or geomorphologic setting.
Low	Assigned when sediment is relatively recent, or represents a high-energy subaerial depositional environment where fossils are unlikely to be preserved. A low abundance of invertebrate fossil remains, or reworked marine shell from other units, can occur but the paleontological sensitivity would remain low due to their lack of potential to serve as significant scientific or educational purposes. This designation also applies to igneous rocks, which may include pockets of sediment which have the potential to preserve fossils, and young deposits, including Holocene deposits and artificial fill, in which fossils, if they exist, are typically out of stratigraphic context.

These sensitivity ratings (Table 4-1) follow the guidelines of the SVP (1995a,b), and also incorporate later refinements that allow more exacting effects analyses and mitigation measures. This includes a category reflecting "moderate" paleontological sensitivity. The inclusion of this category avoids the potential of creating false dichotomy between "high" and "low" ratings. It acknowledges that some geological units that have yielded fossil remains do so only infrequently for good geological reasons, and while they are not of "low" sensitivity, neither are they of "high" paleontological sensitivity. The category "Unknown" sensitivity was not included, as no geologic units of unknown sensitivity were found in the study area.

4.3 Paleontological Study Area

For paleontological resources, the study area is located within rural and urban areas of Merced, Madera, and Fresno counties and the jurisdictions of Atwater, Merced, Le Grand, Chowchilla, Madera, and Fresno. The study area for paleontological resources is defined as the area within 150 feet of the centerline of the north-south alignment and wyes for both the UPRR/SR 99 and BNSF alternatives, and within 150 feet of the footprint of the stations, HMFs, and other isolated project components. The study area includes the project's proposed physical ground disturbance footprint (for example, area of ground disturbance due to site preparation, project earthwork, and any boring, drilling, or trenching), regardless of the specific construction method to be used in construction, and the resource-specific buffer zone.

The project vicinity is located in the Great Valley of California, which is in the Great Valley Geomorphic and Physiographic Province (California Geological Survey [CGS] 2002). The Great Valley is a large flat valley bound by the Trinity Alps and Klamath Mountains to the north; the Sierra Nevada to the east; the Tehachapi Mountains to the south; and the Coast Ranges and San Francisco Bay to the west. The Great Valley is separated into the Sacramento Valley to the north and the San Joaquin Valley to the south. The study area is within the San Joaquin Valley. Its axial stream, the San Joaquin River, is offset to the west and flows northwest near the foot of the Coast Ranges, which means that most of the valley is underlain by the broad alluvial fans that extend from the Sierra Nevada.

4.4 Paleontological Setting

The study area is located on the eastern side of the San Joaquin Valley and crosses five alluvial fans issuing from the Sierra Nevada. From north to south, these are the Merced, Chowchilla, Fresno, San Joaquin, and Kings River fans. These fans slope gently westward, and the sediments thicken from east to west. At depth, the fans consist of deposits assigned to the Early and Middle Pleistocene Turlock Lake and Tulare formations, the Middle Pleistocene Riverbank Formation, and the Late Pleistocene Modesto Formation. Holocene alluvium and eolian deposits and historic fill overlying the Modesto Formation possess no formal designation. The Miocene to Pliocene Mehrten Formation, the Pliocene Laguna Formation, and the Early Pleistocene North Merced Gravel possess more limited presence, chiefly in the vicinity of Le Grand.

Outcrops in the region generally increase in age from west to east as older material is exposed by localized uplift near the foot of the Sierra Nevada. While the Modesto Formation is generally thin (frequently less than 20 feet thick), the deeper stratigraphic units can be many tens of feet thick (Frink and Kues 1954; Weissmann et al. 2005; Dundas et al. 1996). In some areas of Merced and Madera counties, older fossil sites have been found in deeper excavations and along river banks. From north to south, streams issuing from the Sierra Nevada that may expose older, potentially fossiliferous sediment include Bear Creek, Owens Creek, Deadman Creek, Chowchilla River, Dry Creek, Fresno River, Cottonwood Creek, and San Joaquin River.

4.5 Records Search and Results

Review of the geological literature and mapping, as well as consideration of the geography of the project alternatives, showed six named geological units and two unnamed units within the study area. These units are listed as follows, from youngest to oldest (Lettis and Unruh 1991), and are described in more detail in Section 4.5.1:

- Holocene sediment*
- Post-Modesto Formation sediments*
- Modesto Formation
- Riverbank Formation
- Turlock Lake Formation/Tulare Formation
- North Merced Gravel
- Laguna Formation
- Mehrten Formation

** For clarity, these two unnamed units were combined on Figures 4-1 through 4-4.*

In addition, the Great Valley Sequence of Mathews and Burnett (1965) is mapped in the Fresno area as Quaternary channel fill and alluvium that appears to be largely equivalent to postglacial (Holocene) alluvium. It should not be confused with the Great Valley Sequence as described by Dickinson and Rich (1972), which is a largely Mesozoic (older than 65 million years) series of deep-water marine sediments found chiefly in the Coast Ranges.

The Turlock Lake and Tulare formations are considered in part contemporaneous by some geologists (Lettis and Unruh 1991), and this interpretation was adopted in this report. Both were analyzed in the inventory review, as fossils are attributed to both formations in the paleontological literature. For consistency, this unit is referred to as the Turlock Lake Formation in this report.

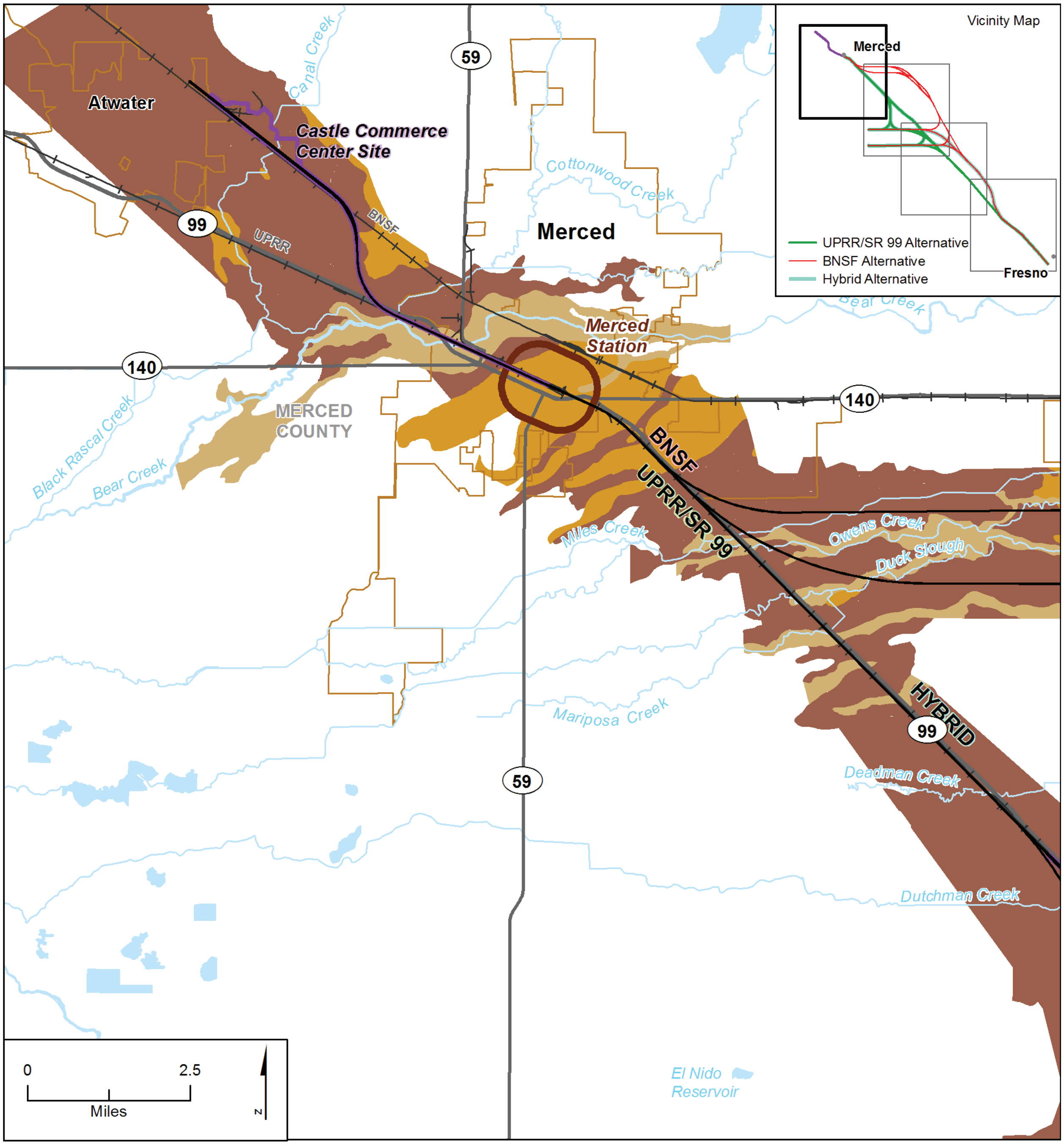
Figures 4-1 through 4-4 show the surficial geologic units within the study area. The portion of the project area near Fresno has not been mapped at as fine a scale as the rest of the project area and, consequently, the geological units in that region are portrayed in a more generalized fashion than those in the remainder of the project area.

4.5.1 Geologic Units in the Study Area

Because the surficial geology is well mapped in the majority of the project vicinity, database inquiries for fossil localities were restricted to the geological formations known to occur within the rights-of-way of the project alternatives. Two databases, the *PaleoBiology Database* (n.d.) and the *University of California Museum of Paleontology* (UCMP) *Database* (UCMP n.d)*,* were searched for records of fossils from these sedimentary units. The results are listed in Appendix A. The exact locations of paleontological sites are kept confidential to minimize unauthorized collecting activities. In addition to these databases a geological and paleontological literature review was conducted.

4.5.1.1 Modesto Formation

The Modesto Formation consists of sands and gravels, representing chiefly fluvial deposits, with silty sand and sandy mud overbank deposits forming a thin veneer over the older Riverbank Formation (Weissmann et al. 2005). Eolian facies (dune sands and sand sheets) of the Modesto Formation are also widespread in some parts of the San Joaquin Valley (Atwater et al. 1986). Because this formation includes contemporaneous but disconnected alluvial fan deposits (Weissmann et al. 2005), the lithology of the unit varies throughout the San Joaquin Valley. The most obvious regional variation is the influence of glacial activity on Modesto-age fan formation. In some portions of the project area the alluvial fans were affected by Late Pleistocene glacial activity in the Sierra Nevada, and the Modesto Formation is present (Weissmann et al. 2002), while other fans in the region were not affected by more recent Pleistocene glacial outwash, and the Modesto Formation is absent (Weissmann et al. 2005). Variations in lithology exist within each fan—for example, channel deposits are typically much coarser than the surrounding material, and fine-grained facies lack paleosols present in other portions of the fans (Weissmann et al. 2002). Fossil records attributed to the Modesto Formation are widely scattered, and could reflect the rare circumstance where a facies suitable for fossil preservation is encountered, such as that of a slough or



Source: USGS (1965, 1978). MF_TR_Paleo_01-04_a Aug 05, 2011

- HST Alignment
- Potential Heavy Maintenance Facility
- Station Study Area
- City Limit
- County Boundary
- Railroad
- Southern Limit of Coverage of Marchand and Allwardt (1978)

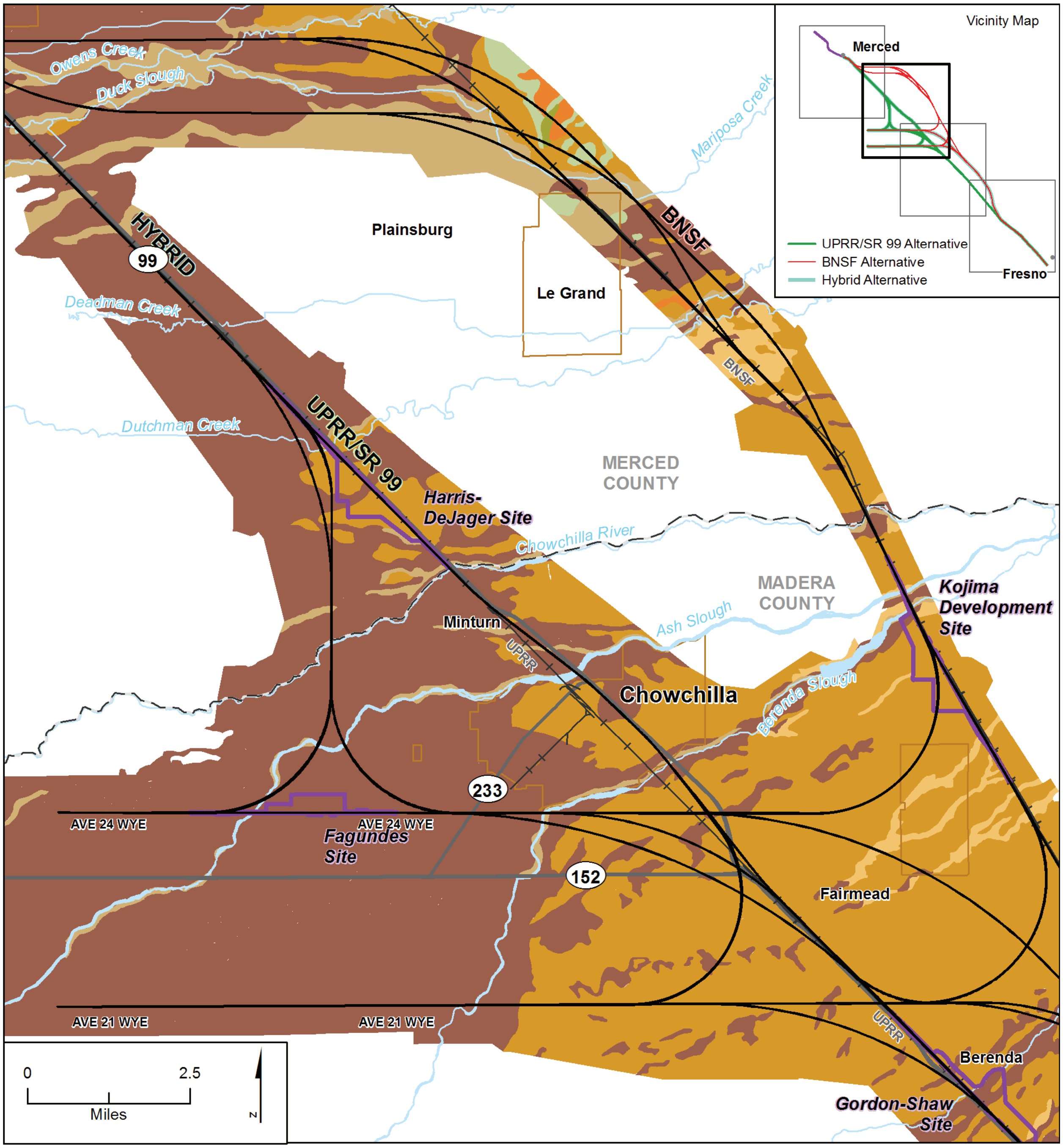
Coverage of Marchand and Allwardt (1978)
Youngest to Oldest

- Holocene, Post-Modesto
- Modesto subunit
- Riverbank subunit
- t2, Turlock Lake Formation
- Qtnm, North Merced Gravel
- Tl, Laguna Formation
- Tm, Mehrten Formation

Coverage of Matthews and Burnet (1965)

- Qsc, Great Valley Sequence - Stream Deposits
- Qf, Great Valley Sequence - Fans
- Qc, Pleistocene nonmarine

Figure 4-1
Surface Geology Employed for
Paleontological Assessments in the Merced Vicinity



Source: USGS (1965, 1978).

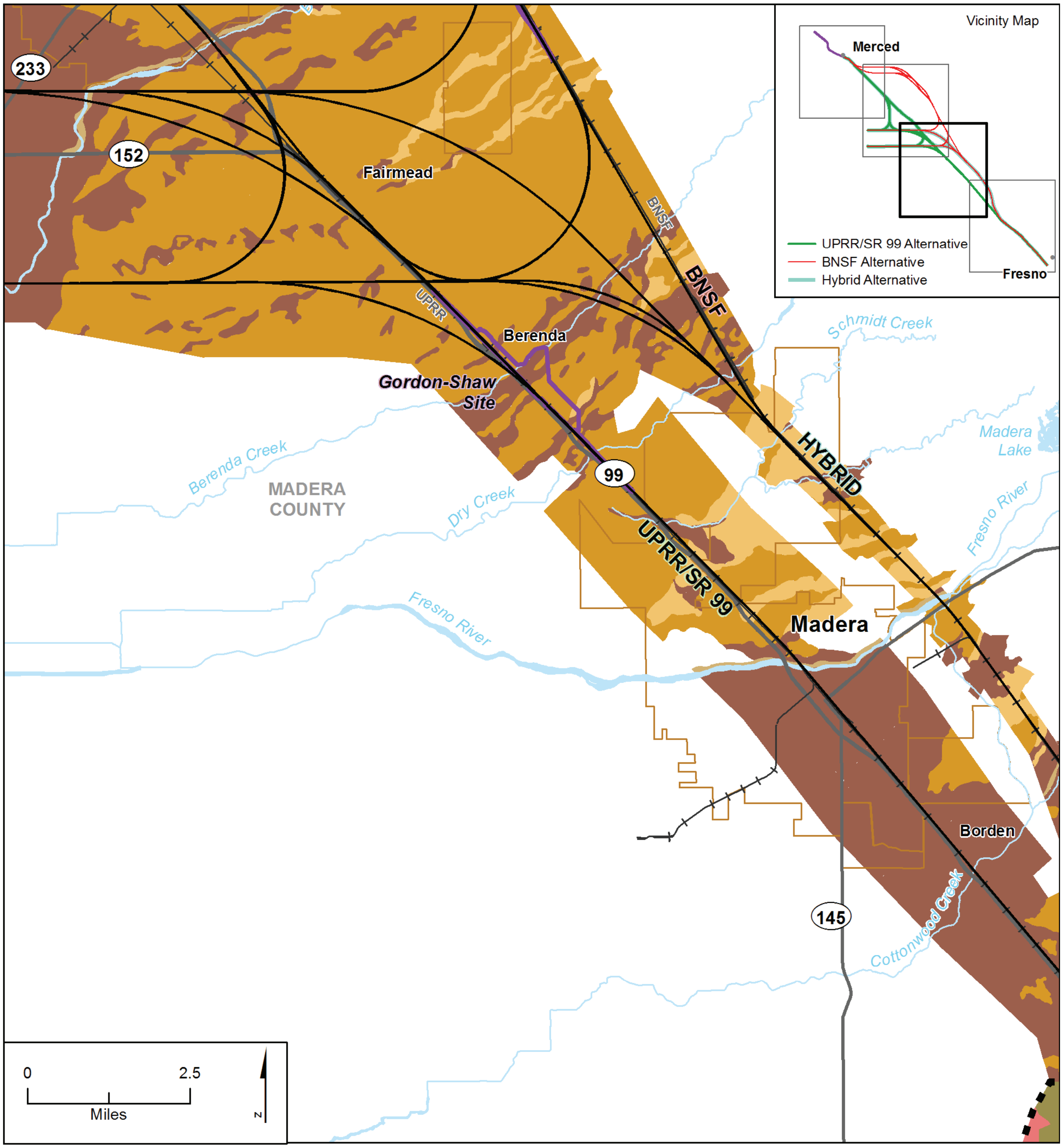
MF_TR_Paleo_01-04_b Aug 05, 2011

HST Alignment
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad
Southern Limit of Coverage of Marchand and Allwardt (1978)

Coverage of Marchand and Allwardt (1978)
Youngest to Oldest
Holocene, Post-Modesto
Modesto subunit
Riverbank subunit
t2, Turlock Lake Formation
Qtnm, North Merced Gravel
Tl, Laguna Formation
Tm, Mehrten Formation

Coverage of Matthews and Burnet (1965)
Qsc, Great Valley Sequence - Stream Deposits
Qf, Great Valley Sequence - Fans
Qc, Pleistocene nonmarine

Figure 4-2
Surface Geology Employed for
Paleontological Assessments in the Chowchilla Vicinity



Source: USGS (1965, 1978).

MF_TR_Paleo_01-04_c Aug 05, 2011

- HST Alignment
- Potential Heavy Maintenance Facility
- Station Study Area
- City Limit
- County Boundary
- Railroad
- Southern Limit of Coverage of Marchand and Allwardt (1978)

Coverage of Marchand and Allwardt (1978)

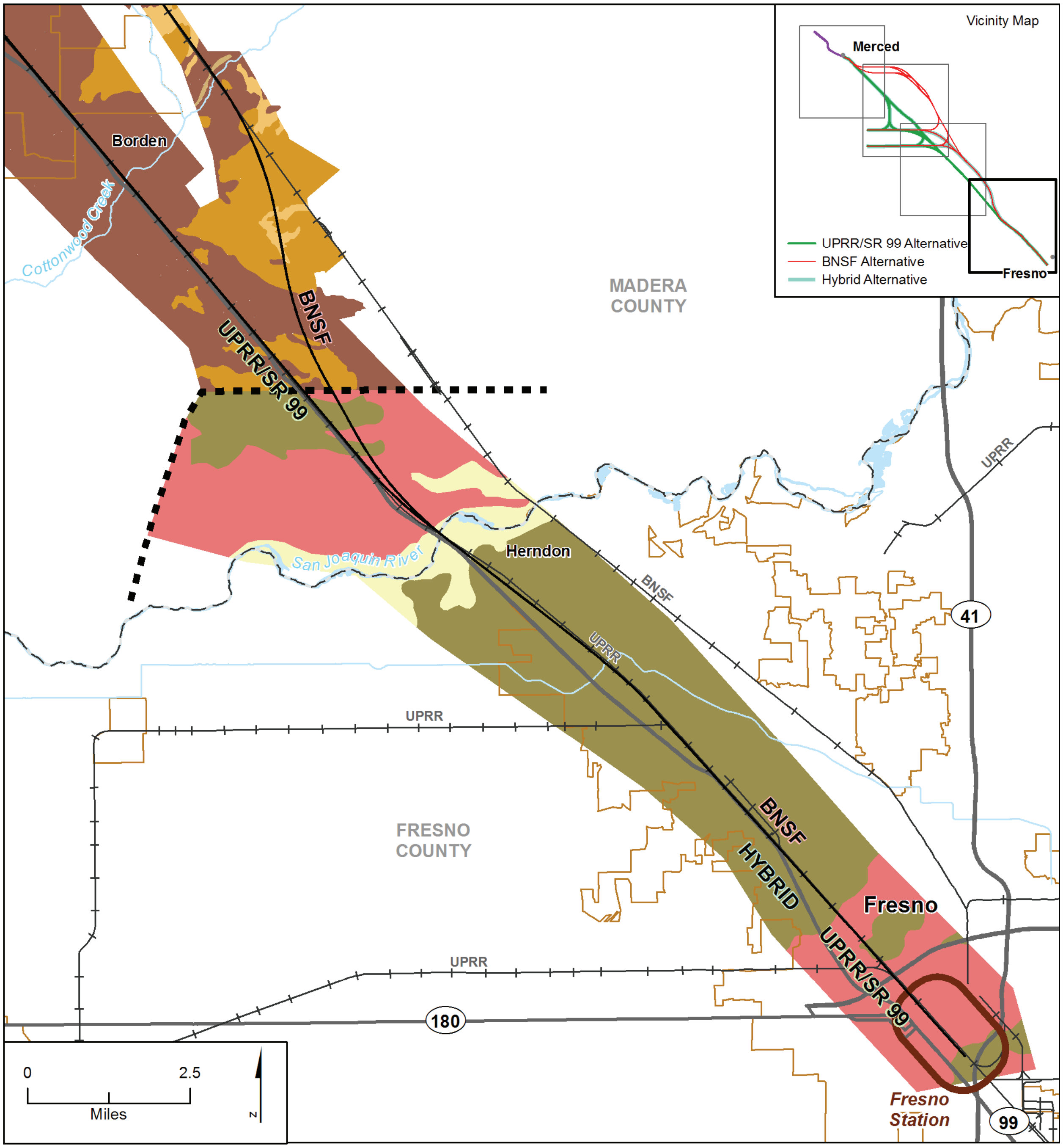
Youngest to Oldest

- Holocene, Post-Modesto
- Modesto subunit
- Riverbank subunit
- t2, Turlock Lake Formation
- Qtnm, North Merced Gravel
- Tl, Laguna Formation
- Tm, Mehrten Formation

Coverage of Matthews and Burnet (1965)

- Qsc, Great Valley Sequence - Stream Deposits
- Qf, Great Valley Sequence - Fans
- Qc, Pleistocene nonmarine

Figure 4-3
Surface Geology Employed for Paleontological Assessments in the Madera Vicinity



Source: USGS (1965, 1978).
MF_TR_Paleo_01-04_d Aug 05, 2011

HST Alignment
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad
Southern Limit of Coverage of Marchand and Allwardt (1978)

Coverage of Marchand and Allwardt (1978)
Youngest to Oldest
Holocene, Post-Modesto
Modesto subunit
Riverbank subunit
t2, Turlock Lake Formation
Qtnm, North Merced Gravel
Tl, Laguna Formation
Tm, Mehrten Formation

Coverage of Matthews and Burnet (1965)
Qsc, Great Valley Sequence - Stream Deposits
Qf, Great Valley Sequence - Fans
Qc, Pleistocene nonmarine

Figure 4-4
Surface Geology Employed
for Paleontological Assessments in the Fresno Vicinity

other slack-water deposit The UCMP Database includes 27 fossils from six localities attributed to the Modesto Formation in the San Joaquin Valley, in Yolo and Stanislaus counties. These sites have yielded mammal fossils, including *Megalonyx*, *Mammuthus*, *Bison*, and *Camelops*.

In some circumstances, it appears that vertebrate paleontological sites attributed to the Modesto Formation were in fact recovered from the Riverbank Formation based on soils characteristics and topographic setting (CEC, 2010). Although this finding is an inference and not quantitative, in light of the fact that there are relatively few paleontological localities (6) over the large area considered in the records review, it is concluded that the Modesto Formation has indeed yielded few paleontological sites. It also suggests that the Riverbank Formation appears to have greater potential to yield fossil material than the Modesto Formation.

4.5.1.2 Riverbank Formation

Like the Modesto Formation, the Riverbank Formation consists of a number of disconnected but contemporaneous alluvial fan deposits, and the lithology of this unit varies throughout the San Joaquin Valley, both on a regional scale and within each alluvial fan (Weissmann et al. 2002, 2005). The UCMP Database includes only eight fossil localities attributed to the Riverbank Formation, although as noted above some attributed to the Modesto Formation may have come from the Riverbank Formation. Several of those localities attributed to the Riverbank Formation are within the study area. This formation has yielded a large number of mammal fossils (*Mammuthus, Camelops, Glossotherium, Equus, Canis, Bison, Thomomys, Scapanus, Neotoma, Nothrotheriops, Megalonyx, Smilodon, Homotherium, Tetrameryx, Capromeryx, Hemiauchenia, Miraecinonyx, Lepus, Dipodomys, Notiosorex,* and *Vulpes*), as well as reptiles and amphibians (*Clemmys*, *Thamnophis*, and *Xerobates*), fish (*Orthodon*), and bird (not identified to genus level) remains. The Paleontology Database includes two sites in this portion of the San Joaquin Valley, and its records include fossils of one fish family, as well as fossils of the mammalian genera (*Equus, Camelops, Paramylodon, Mammuthus, Canis, Odocoileus, Bison, Scapanus, Sylvilagus, Thomomys, Spermophilus, Microtus, Reithrodontomys,* and *Neotoma*).

4.5.1.3 Turlock Lake and Tulare Formations

The Turlock Lake Formation, like the Modesto and Riverbank Formations, consists of a number of disconnected but contemporaneous alluvial fan deposits, and the lithology of this unit varies across the San Joaquin Valley, both on a regional scale and within each alluvial fan (Weissmann et al. 2002, 2005). The Turlock Lake Formation is not listed in the UCMP Database, but a generally age-equivalent formation (Lettis and Unruh 1991), the Tulare Formation (including the Corcoran Clay Member), is listed. Twelve fossil localities for the Tulare Formation are included in the UCMP Database and occur in this portion of the Great Valley, although none are within the immediate project vicinity. They include fossils from mammals (*Borophagus, Ischyrosmilus,* and *Equus*), reptiles (*Clemmys* and *Geochelone*), fish (*Acipenser, Archoplites,* and *Orthodon*), gastropods (*Crommium*), and plants (*Juglans, Abies, Arctostaphylos, Sequoiadendron, Polygonum,* and *Pinus*). The Paleontology Database lists four fossil sites in the Tulare Formation and one fossil locality attributed to the Turlock Lake Formation.

The Fairmead Landfill, which lies near the project construction footprint, has yielded a diverse fossil fauna, including large mammals (*Megalonyx, Paramylodon, Nothrotheriops, Mammuthus, Equus, Arctodus, Canis, Homotherium, Smilodon, Platygonus, Odocoileus, Capromeryx, Tetrameryx, Camelops,* and *Hemiauchenia*) and rodents (*Thomomys, Dipodomys, Spermophilus, Peromyscus, Microtus,* and *Neotoma*). These fossils were recovered from the Corcoran Clay Member of the Turlock Lake Formation, approximately 10 to 16 feet below the base of the Riverbank Formation and more than 40 feet below the surface (Dundas et al. 1996). The Corcoran Clay Member of the Turlock Lake Formation was deposited in a perennially wet habitat, in either a lacustrine (lake) or marsh environment, and there is evidence of in situ trampling of fossil bones. No vertebrate fossils were found in the overlying Riverbank Formation itself, although fossils from that unit have been uncovered elsewhere. The lower unit of the Riverbank Formation was deposited as an alluvial fan, and the upper unit as a filled fan channel. The extreme depth of the fossils recovered here, and the lack of material from the overlying Riverbank Formation, suggests that excavations to shallower depth are less likely to encounter fossils.

4.5.1.4 Mehrten Formation

The Mehrten Formation lies outside of the project area and is only encountered within the study area east of Le Grand. However, this formation may be encountered in the subsurface within the project area and is highly fossiliferous. The UCMP records 37 fossil locations, primarily from Stanislaus County (although several paleontological sites are in Merced County), and these locations have produced microfossils (foraminifera and ostrocods), and fossil mammals (*Mammut, Platybelodon, Hipparion, Pliohippus, Aphelops, Nannippus, Sphenophalos, Pliauchenia, Hypolagus, Otospermophilus, Prosthennops, Neohipparion, Merycodus, Teleoceras, Machairodus, Felis, Borophagus, Altomeryx, Pliotaxidea, Osteoborus, Procyon, Caster, Pseudaelurus, Dipoides, Tetrameryx, Sphenophalos, Paracamelus, Pediomeryx, Megalonyx, Gomphotherium, Hipparion, Sminthosimis, Pliohippus, Garberoceras, Copemys, Cupidinimux*), amphibians (*Taricha, Dicamptodon, Butrachoseps, Aneides*), reptiles (*Hesperotestudo, Clemmys, Gopherus, Geochelone*), fish (*Smilodonichthys, Orthodon*), and plants (*Quercus, Sequoia*). The Paleobiology Database includes five fossil sites in Stanislaus, Merced, and Tuolumne counties, and includes fossil fish (*Orthodon*) and mammals (*Megalonyx, Pliometanastes, Neohipparion, Dinohippus, Mustelidae, Plesiogulo, Pliotaxidea, Procyon, Borophagus, Pediomeryx, Dipoides,* Proboscidea, Hipparionini, Tayassuinae, Camelidae, Merycodontinae).

4.5.1.5 Other Geological Units

No fossil records from either the Laguna Formation (which is not exposed in the project area, but which may be encountered in the subsurface) or the North Merced Gravel were found in the UCMP database or the Paleobiology Database. Other geological units without formal designations, or that are generalized and non-specific, such as "Holocene alluvium," "Undifferentiated Modesto," "Post-Modesto Sediment," "Pleistocene non-marine" sediment, and "Great Valley Sequence" (*sic*), were not searchable using established databases (see Table 4-2). The paleontological sensitivity of the majority of these units is considered "low" for the purposes of this assessment. The other rational alternative is to consider these units as possessing "moderate" paleontological sensitivity, since the designation is also applied to units that are relatively poorly studied or otherwise possess unknown paleontological sensitivity (Table 4-1). However, as noted in Table 4-1, the strata that receive a "moderate" rating must have a "distinct potential to yield fossil remains based on the stratigraphy and/or geomorphologic setting." Based on the geological and paleontological literature review as well as on the records searches, the "distinct potential" for these sediments to yield fossils could not be identified. Further, most of these units are too young to include undisturbed fossils.

4.6 Stratigraphic Inventory

Table 4-2 summarizes the paleontological sensitivity of the sedimentary units found within the study area based on literature review and records searches, particularly on the geology of previous fossil sites located in the San Joaquin Valley, and summarized in the above analysis.

Table 4-2
Paleontological Sensitivity of Geological Units Identified in the Study Area

Formation, Member, or Unit Name	Sensitivity	Remarks
Unnamed Holocene sediment and Historic Fill	Low	This unnamed, unconsolidated sediment of post-glacial age typically yields no scientifically significant fossils. For the purpose of this analysis, this also includes fill and agricultural soils which possess no paleontological sensitivity.
Great Valley Sequence (*sic*)	Low	These sediments are of Recent (Holocene) age, and are too young to contain significant paleontological resources.
Undifferentiated Modesto and post-Modesto Holocene-age sediment	Low to Moderate	Modesto-age facies have moderate paleontological sensitivity. Holocene age facies have low sensitivity.
Modesto Formation	Moderate	This unit is a relatively thin alluvial veneer atop older sediment. The exceptions to this are channel deposits, characterized by coarse to fine sands and gravels, and eolian facies, both of which have little potential to preserve fossils. Slack-water deposits may have higher paleontological potential. However, many fossils attributed to this formation appear to be recovered from the contact between the Modesto and the Riverbank Formations, and may instead have come from a compound soil and associated basin-fill sediments marking the top of the Riverbank Formation (see below). Paleontological monitoring of excavations in the area (CEC 2010) did not record fossils from the Modesto Formation.
Riverbank Formation	Moderate	Compound soils developed in the upper 10 feet (3 meters) of this formation, as well as slack-water deposits, have yielded important vertebrate material. However, much of the unit is characterized by coarse to fine sands and gravels (alluvium and channel deposits) with little paleontological potential. Monitoring of excavations north of Merced (CEC 2010) produced few fossils in over a year of excavation.
Turlock Lake and Tulare Formations[a]	High	These formations are ranked high based on previous records attributed to the Turlock Lake Formation and the widespread presence of the fossiliferous Corcoran Clay Member of the Turlock Lake and Tulare formations.
North Merced Gravel	Low	No paleontological records for this unit were found in the database reviews or literature review.
Pleistocene Non-marine Sediment	Moderate	This mapping unit lies near Fresno and is not mapped at a scale where individual units can be identified. At this level of analysis it includes units with moderate as well as high sensitivity.
Laguna Formation	Low	No paleontological records for this unit were found in the database reviews or literature review.
Mehrten Formation	High	This unit includes sedimentary facies derived from igneous rocks, and has produced a large number of fossil sites.

[a] Considered synonymous for the purposes of this technical report.

5.0 Impacts

This section discusses impacts on paleontological resources based on the extent to which sediments of varying paleontological sensitivity may be affected by construction of the alignments, as well as the wyes, different design options and HMFs, and other project components. This section further lists the criteria used to conclude whether an impact would be significant. Measures to mitigate (that is, avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany each impact discussion.

5.1 Methods

As described in the preceding sections the paleontological sensitivity of the geological units potentially affected by the project alternatives was analyzed qualitatively, based on review of available literature, a paleontological records search, and on professional assessment of these data, consistent with the methods recommended by the SVP (1995a,b; n.d.). The potentially affected geological formations were mapped in the project vicinity (Figures 4-1 through 4-4), evaluations of their sensitivity were completed (see Table 4-2), and then the "footprints" of the various project components overlaid on those geological maps to evaluate the relative extent of impacts on sediments possessing high, moderate, or low paleontological sensitivity. At this level of analysis, the entire study area was analyzed, regardless of construction methods proposed for each component. For example, portions of alternatives that are to be constructed at-grade were not differentiated from portions of the alternatives that are to be constructed as elevated sections.

Using this approach, the number of acres of high, moderate, and low sensitivity sediments crossed by each construction alternative was calculated. Central to this analysis methodology is the assumption that impacts on paleontological resources are related to and directly proportionate to the extent of impacts on high- and moderate-paleontological sensitivity sediments. In a sense paleontological resources impacts are also inversely proportionate to impacts on low-sensitivity sediment, since the more this low-potential sediment is affected by a project alternative, the less the anticipated affect to paleontological resources.

Consistent with the general program wide mitigation strategies identified in the Program EIR/EIS prepared for the California High-Speed Rail Program, this analysis assumes that earthwork will be designed and conducted in accordance with all relevant requirements of Section 19 (*Earthwork*) of the most current Caltrans Standard Specifications (Caltrans 2001).

5.2 Significance Criteria

The SVP (1995a,b) identifies paleontological resources as non-renewable scientific and educational resources, and for the purposes of this analysis the loss or destruction of such a resource would constitute a significant impact. This is most typically thought of as occurring as a result of heavy-equipment damage of fossils, but may also occur when fossils are looted, or otherwise lost to the scientific world. This is consistent with CEQA (Section 3.1.2), which considers an impact that would directly or indirectly destroy a unique paleontological resource or site. All impacts on paleontological resources are considered adverse and potentially significant unless they result in recovery of the scientific and educational values of the resource.

For the sake of this analysis, the probability of a significant impact on paleontological resources during construction is directly related to the paleontological sensitivity of the sediments. While it is theoretically possible to adversely affect paleontological resources in low-sensitivity geologic units, it would be remote because the sediments are not known to contain fossils. The highest probability of significant adverse effects on paleontological resources results from disturbance of stratigraphic units with high paleontological sensitivity. These sediments have produced scientifically significant fossils, and recorded fossil localities are sufficiently frequent to anticipate encountering more (SVP 1995a,b). Significant impacts are possible from excavation in moderate sensitivity units; however, they are less likely than in high sensitivity units. One unit—the Pleistocene Non-marine Sediments—includes sediments of both moderate and low paleontological sensitivity. For the purposes of this analysis, this unit was considered to possess moderate paleontological sensitivity.

Paleontological resources which remain undisturbed in the sediment are considered to be unaffected by the project and adequately protected. Because fossils are likely to be exposed only during the excavation phase of construction, operation of the project as well as construction activities which do not result in subsurface disturbances (for example, laying tracks or post-excavation phases of construction of railway stations) have no potential to impact paleontological resources.

5.3 Impacts

5.3.1 No Project Alternative

Under the No Project Alternative, the project would not be constructed and paleontological resources would not be affected by the project.

5.3.2 High-Speed Train Alternatives

As stated, this section analyzes impacts based on the paleontological sensitivity of the sediments affected by project construction within the study area, regardless of the construction methods to be used. The first step in this analysis is to determine the extent to which geological units would be affected by the different alternatives and their components (Figures 4-1 through 4-4; Table 5-1). Their previously determined paleontological sensitivity (Table 4-2) is color coded in Table 5-1, so that the area (in acres) of sediment of different sensitivity affected by the individual project components can be seen. This is the principal basis for assessing an alternative's potential effect on paleontological resources.

5.3.2.1 Construction Period Impacts

Because the Modesto and Riverbank Formations extend over great portions of the landscape from Merced to Fresno (Figures 4-1 through 4-4), and because both these units possess moderate paleontological sensitivity, the extent of impacts on moderate sensitivity sediments are similar from alternative to alternative considered below. Therefore, the analysis described below focuses on the relative extent of impacts on high-sensitivity sediment as a more sensitive discriminator compared to the extent of impacts on moderate-sensitivity sediment. The extent of impacts on sediments of high paleontological sensitivity is considered proportionate to, and a proxy for, the extent of adverse impacts on scientifically significant paleontological resources.

UPRR/SR 99 Alternative

The potential for adverse impacts on significant paleontological resources during construction of the UPRR/SR 99 Alternative is directly related to the paleontological sensitivity of the units crossed by the alternative. The UPRR/SR 99 Alternative crosses geologic units ranging from low to high paleontological sensitivity. The majority of the alignment is underlain by the moderately sensitive Modesto and Riverbank Formations, while only a small portion (up to 1%) is underlain by the highly sensitive Turlock Lake Formation. The remainder of the alignment (7% to 8%) crosses geological units with low paleontological sensitivity. In terms of the absolute (not relative) area of high paleontological sensitivity affected, this alternative would have the least effect, with less than 20 acres of high-sensitivity sediment crossed by the paleontological Area of Potential Effect (APE).

Table 5-1
Acres of Identified Project Component Affecting Geological Units with Known Paleontological Sensitivity in the Study Area

Alternative Combinations	Geologic Units or Formations										Paleontological Sensitivity		
	hal	Qsc	mh	m	r	t2	Qc	Qtm	T1	Tm	High	Moderate	Low
UPRR/SR 99 Alternative													
East Chowchilla Design Option													
North-South Alignment	43	133	22	593	397	14	508	0	0	0	14	1,521	176
Ave 24 Wye	11	0	8	513	164	0	0	0	0	0	0	686	11
Ave 21 Wye	0	0	15	228	530	0	0	0	0	0	0	772	0
West Chowchilla Design Option													
North-South Alignment	42	133	33	892	379	14	508	0	0	0	14	1,812	176
Ave 24 Wye	2	0	8	362	0	0	0	0	0	0	0	371	2
BNSF Alternative													
Mission Ave Design Option													
North-South Alignment	53	166	8	409	714	224	483	0	5	0	224	1,614	224
Ave 24 Wye	41	0	16	613	724	70	0	0	5	0	70	1,352	46
Ave 21 Wye	37	0	13	473	638	56	0	0	5	0	56	1,124	41
Mission Ave East of Le Grand Design Option													
North-South Alignment	53	166	8	397	712	198	483	2	5	22	221	1,600	225
Ave 24 Wye	40	0	16	601	721	44	0	2	5	22	66	1,338	47
Ave 21 Wye	36	0	13	461	635	30	0	2	5	22	52	1,110	43

Alternative Combinations	Geologic Units or Formations										Paleontological Sensitivity		
	hal	Qsc	mh	m	r	t2	Qc	Qtm	T1	Tm	High	Moderate	Low
Mariposa Way Design Option													
North-South Alignment	153	166	8	355	639	228	483	0	6	0	228	1,485	326
Ave 24 Wye	141	0	16	559	648	73	0	0	6	0	73	1,223	147
Ave 21 Wye	137	0	13	419	563	59	0	0	6	0	59	995	143
Mariposa Way East of Le Grand Design Option													
North-South Alignment	138	166	8	361	656	203	483	1	0	11	214	1,508	306
Ave 24 Wye	126	0	16	565	665	48	0	1	0	11	60	1,246	127
Ave 21Wye	122	0	13	425	580	34	0	1	0	11	46	1,018	123
Hybrid Alternative													
Hybrid Alternative Connecting to Ave 24 Wye													
North-South Alignment	50	166	18	818	624	163	483	0	0	0	163	1,943	216
Ave 24 Wye	2	0	16	382	0	0	0	0	0	0	0	397	2
Hybrid Alternative Connecting to Ave 21 Wye													
North-South Alignment	52	166	8	508	610	145	483	0	0	0	145	1,610	218
Ave 21 Wye	0	0	15	219	405	0	0	0	0	0	0	638	0
HST Stations													
Downtown Merced Station	18	0	0	24	91	0	0	0	0	0	0	115	18

Alternative Combinations	Geologic Units or Formations										Paleontological Sensitivity		
	hal	Qsc	mh	m	r	t2	Qc	Qtm	T1	Tm	High	Moderate	Low
Downtown Fresno Station Alternatives													
Kern Street Alternative	0	69	0	0	0	0	8	0	0	0	0	8	69
Mariposa Street Station Alternative	0	55	0	0	0	0	7	0	0	0	0	7	55
Heavy Maintenance Facility Alternative													
Castle Commerce Center	24	0	0	322	14	0	0	0	0	0	0	336	24
Harris-DeJager	9	0	0	57	247	0	0	0	0	0	0	304	9
Fagundes	0	0	0	182	0	0	0	0	0	0	0	182	0
Gordon-Shaw	0	0	0	121	202	9	0	0	0	0	9	323	0
Kojima Development	3	0	0	19	311	7	0	0	0	0	7	331	3

Notes:

This table presents totals for each component (north-south alignment and wye) of each alternative design option. Tables 5-2 through 5-4, however, present totals for alternative combinations.

Green = low paleontological sensitivity; Yellow = moderate sensitivity; Orange = high sensitivity

Units not crossed by the segment or project component are indicated by "---"

Units underlying less than 1% of the alternative right-of-way are indicated by *

The map symbols for each unit were used:

hal – Holocene Sediment

Qsc – Great Valley Sequence (*sic*); Holocene stream and fan deposits

mh –Undifferentiated Modest and Post-Modesto Sediment

m- Modesto Formation

r – Riverbank Formation

t2 – Turlock Lake Formation/Tulare Formation

Qc – Pleistocene non-marine sediment

Qtnm – North Merced Gravel

T1 – Laguna Formation

Tm – Mehrten Formation

The UPRR/SR 99 Alternative also includes two wyes: the Ave 24 Wye and the Ave 21 Wye. Each wye is predominantly underlain by moderate sensitivity Modesto and Riverbank formation sediments. The UPRR/SR 99 Alternative includes three potential alignments near the City of Chowchilla (the West Chowchilla design option with the Ave 24 Wye, and the East Chowchilla design option with either the Ave 24 Wye or the Ave 21 Wye). Both the Ave 24 Wye and the Ave 21 Wye are predominantly underlain by the moderate-sensitivity Modesto and Riverbank formations. A small portion of the Ave 21 Wye also crosses the Turlock Lake Formation. Although the Turlock Lake Formation underlies less than 1% of the Ave 21 Wye, the Fairmead Landfill paleontological site is near the rights-of-way. This paleontological site has produced a diverse vertebrate fossil assemblage from the Turlock Lake Formation, although the fossiliferous strata were at depths exceeding 40 feet.

In order to assess the extent of potential impacts on paleontological resources resulting from the different components of this alternative, the analysis matrix presented in Table 5-2 was constructed to include all applicable design options. This table shows that the areas of high paleontological sensitivity affected, and therefore with high potential for adverse impacts on paleontological resources, would be restricted to approximately 1% of the construction footprint. In contrast, impacts on sediments with moderate paleontological sensitivity are extensive and account approximately 92% of the sediment crossed by the design option combinations. The area with low paleontological sensitivity accounts for from 7% to 8% of the construction footprint for the different options.

Table 5-2
Comparison of Acres Affected, and Proportion of Area Affected, by the UPRR/SR 99 Alternative and Its Respective Design Options

Alternative Combination	Paleontological Sensitivity					
	Acres			Percentage		
	High	Moderate	Low	High	Moderate	Low
UPRR/SR 99 Alternative with East Chowchilla design option and Ave 24 Wye	14	2,207	188	1	92	8
UPRR/SR 99 Alternative with East Chowchilla design option and Ave 21 Wye	14	2,294	176	1	92	7
UPRR/SR 99 Alternative with West Chowchilla design option and Ave 24 Wye	14	2,183	178	1	92	7

Downtown Merced and Downtown Fresno Station Areas

The substrate underlying Downtown Merced is mapped as predominantly the Riverbank Formation, with a small area of Modesto Formation under the northwest portion of the area (Marchand and Allwardt 1981). Both of these formations possess moderate paleontological sensitivity. The Great Valley Sequence is designated as having a low paleontological sensitivity, while the Pleistocene Nonmarine Sediment is designated as having a moderate paleontological sensitivity (Table 5-1). As is typical of urban areas, fill and disturbed sediment of low paleontological sensitivity are expected to extend to greater depth in the City of Merced than in the surrounding rural areas.

There are two proposed alternatives for the HST station in the City of Fresno: the Mariposa Street Station Alternative and the Kern Street Station Alternative. Both are underlain by approximately equal amounts of the Great Valley Sequence and Pleistocene Non-marine Sediment. These units are both designated as having moderate paleontological sensitivity (see Table 5-1). As with the Downtown Merced Station, both HST station alternatives in Fresno are expected to be underlain by fill and disturbed sediment.

BNSF Alternative

As described in Section 2, Project Description, the BNSF Alternative has four design options (Mission Ave, Mission Ave East of Le Grand, Mariposa Way, and Mariposa Way East of Le Grand) and two east-west wye connections (Ave 24 Wye and Ave 21 Wye). The design options principally cross units of moderate paleontological sensitivity (the Modesto and Riverbank formations). Their effects on sediments of high (Turlock Lake Formation) and low (Holocene sediment and Laguna Formation) sensitivity are less by about an order of magnitude (Table 5-3). The two East of Le Grand design options also cross units similar to those crossed by the options passing through Le Grand, except that the East of Le Grand options also cross the high-sensitivity Mehrten Formation (Figure 4-2). The remainder of the BNSF Alternative alignment crosses primarily the Modesto, Riverbank, and Turlock Lake formations. Each wye also crosses the Modesto, Riverbank, and the Turlock Lake formations.

Table 5-3
Comparison of Acres Affected, and Proportion of Area Affected, by the BNSF Alternative and Its Respective Design Options

Alternative Design Options	Paleontological Sensitivity					
	Acres			Percentage		
	High	Moderate	Low	High	Moderate	Low
BNSF Alternative with Mission Ave Design Option and Ave 24 Wye	294	2,966	270	8	84	8
BNSF Alternative with Mission Ave East of Le Grand Design Option and Ave 24 Wye	287	2,938	272	8	84	8
BNSF Alternative with Mariposa Way Design Option and Ave 24 Wye	301	2,708	473	9	78	14
BNSF Alternative with Mariposa Way East of Le Grand Design Option and Ave 24 Wye	274	2,754	433	8	80	13
BNSF Alternative with Mission Ave Design Option and Ave 21 Wye	280	2,738	265	9	83	8
BNSF Alternative with Mission Ave East of Le Grand Design Option and Ave 21 Wye	273	2,710	268	8	83	8
BNSF Alternative with Mariposa Way Design Option Ave 21 Wye	287	2,480	469	9	77	14
BNSF Alternative with Mariposa Way East of Le Grand Design Option Ave 21Wye	260	2,526	428	8	79	13

The potential for adverse impacts along this alternative, in terms of the extent of paleontologically sensitive sediment that may be affected, are summarized in Table 5-3. As in Table 5-2, these values are derived by estimating the area of each identified geologic unit lying beneath the alternative's construction footprint (including the design options and wyes). As in the UPPR/SR 99 Alternative, the Turlock Lake Formation underlies a small portion of the wyes in the BNSF Alternative. However, these wyes pass close to the Fairmead Landfill, an important paleontological locality. As noted above, portions of the BNSF Alternative close to Le Grand also cross the Mehrten Formation, which has a high paleontological sensitivity.

The area with high potential for adverse impacts on paleontological resources, considered for the purpose of this analysis to be the extent of high-sensitivity sediment affected, would comprise between 8% and

9% of the construction footprint under all design options (or between 260 and 301 acres; Table 5-3). Conversely, the amount of area underlain by units of low paleontological sensitivity ranges from 8% to 14% (or between 265 and 473 acres), depending on design option (Table 5-3).

Potential impacts for the HST stations would be the same as described under the UPRR/SR 99 Alternative.

BNSF Alternative Compared to the UPRR/SR 99 Alternative

Comparison of the areas of high paleontological sensitivity affected by the UPRR/SR 99 and BNSF alternatives (Tables 5-2 and 5-3, respectively) shows that the BNSF Alternative would affect more area with high paleontological sensitivity, with some tens of acres (14 acres) of high-sensitivity area being affected by the UPRR/SR 99 Alternative, compared to between 260 and 301 acres for the BNSF Alternative (Table 5-2 and Table 5-3). Therefore the BNSF Alternative has a measurably greater potential for adverse impacts on paleontological resources than the UPRR/SR 99 Alternative.

Sediments possessing low paleontological sensitivity underlie 7% to 8% of the area affected by the UPRR/SR 99 Alternative (176 to 188 acres), while they underlie about 8% to 14% of the BNSF Alternative (265 to 473 acres; Tables 5-2 and 5-3). Therefore, if the extent of low-sensitivity sediment alone were considered, the BNSF Alternative would have slightly less impact on paleontological resources. However, this is not considered as clear a discriminator as the extent of impacts on sediments of high paleontological potential, which are considered proportionate to the extent of adverse impacts on paleontological resources.

Hybrid Alternative

Hybrid Alternative combines elements of the UPRR/SR 99 and the BNSF alternatives; it lies in the same corridors and crosses the same geological units in about the same places as those alternatives. Therefore, the extent of adverse effects on paleontological resources that would occur from the implementation of the Hybrid Alternative would not differ greatly from that of the UPRR/SR 99 and BNSF alternatives.

The potential to adversely affect paleontological resources, as reflected by the extent of impacts on high-sensitivity sediment, is summarized in Table 5-4. As in Tables 5-2 and 5-3, these values are derived by estimating the area of each identified unit lying beneath the alternative’s total construction footprint (including the north-south alignment with the Ave 24 Wye, and the north-south alignment with the Ave 21 Wye; see Figures 4-1 through 4-4), and then applying the levels of sensitivity established for each (Table 4-2). As with the other alternatives, sediment of moderate paleontological sensitivity underlies most of the paleontological APE, at 86% of the total construction footprint (Table 5-4). However, the area of high-sensitivity sediment that would be crossed by the Hybrid Alternative combinations exceeds 100 acres in both alternative combinations (as shown in Table 5-1). Therefore, implementation of those alternative combinations would have greater adverse effect on paleontological resources than implementation of the UPRR/SR 99 Alternative, but somewhat less than that arising from implementation of the BNSF Alternative.

Table 5-4
Comparison of Acres Affected, and Proportion of Area Affected,
by the Hybrid Alternative

Alternative Combinations	Paleontological Sensitivity					
	Acres			Percentage		
	High	Moderate	Low	High	Moderate	Low
Hybrid Alternative with Ave 21 Wye Design Option	145	2,248	218	6	86	8
Hybrid Alternative with Ave 24 Wye Design Option	163	2,341	219	6	86	8

The potential to adversely affect paleontological resources for the HST stations would be the same as described under the UPRR/SR 99 Alternative.

Heavy Maintenance Facility

Five HMF sites were included in this analysis (Table 5-1). These sites overlie units ranging from low to high paleontological sensitivity. The Castle Commerce Center and Harris-DeJager HMF sites overlie Holocene sediment, and the Modesto and Riverbank formations. The Fagundes HMF site overlies undifferentiated Modesto and Post-Modesto sediment and the Modesto Formation. The Gordon-Shaw HMF site overlies the Modesto, Riverbank, and Turlock Lake formations. The Kojima Development HMF site overlies Holocene sediment and the Modesto, Riverbank, and Turlock Lake formations. These facilities were not included in the area underlying the alternatives discussed above.

5.3.2.2 Impacts During Operations

Because operation does not involve excavation, there would be no impacts on paleontological resources. No paleontologically sensitive sediment would be affected by operation, as no excavation would occur after construction was completed.

6.0 Proposed Mitigation Measures

Paleontological monitoring and mitigation measures are restricted to those construction-related activities that will result in the disturbance of paleontologically sensitive sediments. Therefore, no impacts on paleontologically sensitive sediments are anticipated from construction activities other than excavations. Deep excavation for bridge footings, drainage systems, and drilling for pole foundations may affect paleontological resources. In some areas surface grading may also impact high- or moderate-sensitivity soils. As previously noted, no impacts on paleontological resources are anticipated from the operational phase of this project because no excavations are anticipated after project construction. The impacts of excavation on paleontological resources can be mitigated by relocating the excavation, or by extracting the fossil(s). Because proper excavation and removal of paleontological resources does not lessen the scientific value of the resources, monitoring combined with proper excavation of any discovered paleontological resources reduces the impacts of construction on paleontological resources to less than significant levels.

Pale-MM#1: Engage a Paleontological Resources Specialist to Direct Monitoring during Construction.

At least 120 days prior to construction, a paleontological resources specialist (PRS) will be designated for the project and will be responsible for determining where and when paleontological resources monitoring should be conducted. Paleontological resources monitors (PRMs) will be selected by the PRS based on their qualifications, and the scope and nature of their monitoring will be determined and directed based on the Paleontological Resource Monitoring and Mitigation Plan (PRMMP). The PRS will be responsible for developing and implementing the Worker Environmental Awareness Program training. All management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take this training prior to beginning work on the project and will be provided with the necessary resources for response in case paleontological resources are found during construction. The PRS will document any discoveries, as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in CEQA Guidelines Section 15064.5.

Pale-MM#2: Prepare and Implement a Paleontological Resources Monitoring and Mitigation Plan (PRMMP).

Paleontological monitoring and mitigation measures are restricted to those construction-related activities that will result in the disturbance of paleontologically sensitive sediments. The PRMMP will include a description of when and where construction monitoring will be required; emergency discovery procedures; sampling and data recovery procedures; procedures for the preparation, identification, analysis, and curation of fossil specimens and data recovered; preconstruction coordination procedures; and procedures for reporting the results of the monitoring and mitigation program.

In general, the monitoring program will reflect site-specific construction of the selected option. The PRMMP will be consistent with Society of Vertebrate Paleontology guidelines (SVP 1995a,b) for the mitigation of construction-related impacts on paleontological resources. The PRMMP will also be consistent with the SVP (1996) conditions for receivership of paleontological collections and any specific requirements of the designated repository for any fossils collected.

Pale-MM#3: Halt to Construction when Paleontological Resources are Found.

If fossil or fossil-bearing deposits are discovered during construction, regardless of the individual making a paleontological discovery, construction activity in the immediate vicinity of the discovery will cease. This requirement will be spelled out in both the PRMMP and the Worker Environmental Awareness Program. Construction activity may continue elsewhere provided that it continues to be monitored as appropriate. If the discovery is made by someone other than a PRM or the PRS, a PRM or the PRS will immediately be notified.

Residual impacts on paleontological resources will be less than significant through the implementation of the above measures. Moreover, because the value of fossils lies primarily in their scientific and educational value, and recovery of discovered specimens and their curation in an accredited museum realizes those values, beneficial effects may result.

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8.0 Preparer Qualifications

W. Geoffrey Spaulding. Dr. Spaulding is a senior technologist and paleontologist with CH2M HILL with more than 25 years extensive experience in paleobiology, paleontology, and paleoecology. He also is accomplished in the study of site formation processes, and in the Quaternary geology and paleoclimatology of the western United States. He holds advanced degrees in paleobiology and paleoecology from the University of Arizona, and has more than three decades of technical experience in the Earth and Life sciences focusing on the deserts of western North America and on California. Prior to joining private industry, he was on the faculty of the University of Washington, Seattle. He has served as lead paleontologist on more than 20 construction projects in California, seven of them in the San Joaquin Valley.

James R. Verhoff. James Verhoff is a staff paleontologist with CH2M HILL. He has a degree in geology, specializing in paleobiology, from Bowling Green State University. He has served as staff paleontologist on a number of construction projects in California, four of which were in the San Joaquin Valley.

APPENDIX A

Results of Records Searches

Table A1
Results of UCMP Database Records Search

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
CL16	Fresno County	Fresno County					P	1
CL26	Mariposa County	Mariposa County					P	1
-2049	Merced County	Merced County	Quaternary	Pleistocene	Rancholabrean		V	1
-1368	Hornitos	Mariposa County	Quaternary	Pleistocene	Rancholabrean		IV	1
D4575	San Luis Dam	Merced County	Quaternary	Pleistocene			I	
PA1072	Turlock Walnut Energy Center	Stanislaus County	Quaternary	Pleistocene	Pleistocene		P	26
V3720	Thompson	Merced County	Quaternary	Pleistocene	Rancholabrean		V	1
V4401	Tranquillity	Fresno County	Quaternary	Pleistocene	Rancholabrean		V	149
V5206	Ehrreich	Madera County	Quaternary	Pleistocene	Irvingtonian		V	1
V6321	San Luis Dam	Merced County	Quaternary	Pleistocene	Irvingtonian		V	12
V6401	San Luis Canal	Merced County	Quaternary	Pleistocene	Irvingtonian		V	7
V65100	Riverdale	Fresno County	Quaternary	Pleistocene	Rancholabrean		V	1
V6536	Hornitos N	Mariposa County	Quaternary	Pleistocene	Rancholabrean		V	1
V6806	Merced River 1	Merced County	Quaternary	Pleistocene	Rancholabrean		V	4
V68141	Chicken Ranch Slough 2	Sacramento County	Quaternary	Pleistocene	Rancholabrean		V	2
V6846	Chicken Ranch Slough 1	Sacramento County	Quaternary	Pleistocene	Rancholabrean		V	1
V69129	Teichart Gravel Pit E 1	Sacramento County	Quaternary	Pleistocene	Rancholabrean		V	33
V69172	Merced Falls	Merced County	Quaternary	Pleistocene	Rancholabrean		V	1
V69181	Hornitos N	Mariposa County	Quaternary	Pleistocene	Rancholabrean		V	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
V72007	Garber Farm	Stanislaus County	Quaternary	Pleistocene	Rancholabrean		V	3
V72008	Brant Ranch	Stanislaus County	Quaternary	Pleistocene	Rancholabrean		V	1
V75126	Teichart Gravel Pit E 2	Sacramento County	Quaternary	Pleistocene	Rancholabrean		V	2
V81121	Laguna Seca Ranch	Fresno County	Quaternary	Pleistocene	Rancholabrean		V	1
V93128	Fairmead Landfill	Madera County	Quaternary	Pleistocene	Irvingtonian		V	194
V96015	Willow Slough 1	Yolo County	Quaternary	Pleistocene	Rancholabrean		V	8
V99464	Walnut Energy Center Unit B1	Stanislaus County	Quaternary	Pleistocene	Rancholabrean		V	6
V6747	Davis Gravel Pit	Sacramento County	Quaternary	Pleistocene	Rancholabrean		V	6
D3319	Buchanan Tunnel	Tuolumne County	Tertiary	Pliocene			IM	12
P3531	Charity Valley	Alpine County	Tertiary	Pliocene	Pliocene		P	
P3532	Eagle Meadow	Tuolumne County	Tertiary	Miocene	Miocene		P	
PA293	Webber Lake	Sierra County	Tertiary	Miocene	Miocene		P	3
PA574	Burlington Ridge	Nevada County	Tertiary	Miocene	Miocene	Burlington Ridge	P	38
PA623	Clear Creek Wood	El Dorado County	Tertiary	Late Miocene	Miocene		P	
PA762	Pulpit Rock I	Tuolumne County	Tertiary	Miocene	Miocene		P	
PA763	Pulpit Rock II	Tuolumne County	Tertiary	Miocene	Miocene		P	
PA860	Carson Pass III	Alpine County	Tertiary	Miocene	Miocene	Elephants Back	P	
PA1124	ES Carson Pass	Alpine County	Tertiary	Miocene	Miocene	Elephants Back	P	
PA1126	Juniper Claims	Tuolumne County	Tertiary	Miocene	Miocene	Juniper Claims	P	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
PA1193	ES Liberty	Amador County	Tertiary	Miocene	Miocene		P	
V2303	Columbia	Tuolumne County	Tertiary	Miocene	Clarendonian		V	3
V3212	Oakdale	Stanislaus County	Tertiary	Miocene	Hemphillian		V	17
V3436	Richard Incline	Tuolumne County	Tertiary	Miocene	Clarendonian		V	1
V3813	Schell Ranch 1	Stanislaus County	Tertiary	Miocene	Hemphillian		V	21
V3833	Two Mile Bar	Tuolumne County	Tertiary	Miocene	Clarendonian		V	22
V3919	Goodwin Dam	Calaveras County	Tertiary	Miocene	Clarendonian		V	1
V4019	Columbia	Tuolumne County	Tertiary	Miocene	Clarendonian		V	27
V5404	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	3
V5405	Turlock Lake, Site 2	Stanislaus County	Tertiary	Miocene	Hemphillian		V	67
V5836	Turlock Lake, Site 3	Stanislaus County	Tertiary	Miocene	Hemphillian		V	8
V5837	Turlock Lake, Site 4	Stanislaus County	Tertiary	Miocene	Hemphillian		V	9
V6171	Duck Creek	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V6545	Soulsbyville	Tuolumne County	Tertiary	Miocene	Clarendonian		V	
V6878	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	18
V65260	Soulsbyville	Tuolumne County	Tertiary	Miocene	Clarendonian		V	2
V65374	La Grange	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V65711	Turlock Lake General	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V67134	Schell Ranch 2	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V67135	Schell Ranch 3	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V67220	Black Rascal Creek 1	Merced County	Tertiary	Miocene	Hemphillian		V	3
V67223	Black Rascal Creek 2	Merced County	Tertiary	Miocene	Hemphillian		V	10

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
V68134	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	6
V68135	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V68136	Turlock Lake 8	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V68137	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V71137	Turlock Lake 10	Stanislaus County	Tertiary	Miocene	Hemphillian		V	4
V71138	Dallas-Warner Reservoir 1	Stanislaus County	Tertiary	Miocene	Hemphillian		V	7
V71139	Dallas-Warner Reservoir 2	Stanislaus County	Tertiary	Miocene	Hemphillian		V	2
V72004	Willm's Ranch	Stanislaus County	Tertiary	Miocene	Hemphillian		V	2
V72005	Coyote Hill 1	Stanislaus County	Tertiary	Miocene	Hemphillian		V	18
V72054	Griesner's Ranch	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V72055	Coyote Hill 2	Stanislaus County	Tertiary	Miocene	Hemphillian		V	2
V75066	Pg+e Test Trench	Stanislaus County	Tertiary	Miocene	Hemphillian		V	7
V76050	Camanche Reservoir	San Joaquin County	Tertiary	Miocene	Hemphillian		V	1
V80040	Fosters Max	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V80041	Dinghy Bay	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V80042	Sitting Duck Point	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V80043	Kiduva Drag	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V81248	Turlock Lake 11	Stanislaus County	Tertiary	Miocene	Hemphillian		V	5
V82047	Turlock Lake 12	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V90007	Turlock Lake 13	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V90008	Turlock Lake 14	Stanislaus County	Tertiary	Miocene	Hemphillian		V	2
V91098	Turlock Lake 15	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1

Table A2
Results of Paleobiology Database Records Search

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
164	Coalinga I	Fresno County	Tertiary	Pliocene	Pliocene		P	9
164	Coalinga I	Fresno County	Tertiary	Pliocene	Pliocene		P	9
251	Alcalde	Fresno County	Tertiary				P	
164W	Noren Wood	Fresno County					P	
1817-		Fresno County	Tertiary	Eocene			I	93
2054-		Fresno County	Tertiary	Miocene			I	
2055-		Fresno County	Tertiary	Miocene			I	
2066-		Merced County	Tertiary	Eocene			I	
2067-		Merced County	Tertiary	Eocene			I	
2068-		Merced County	Tertiary	Eocene			I	
2069-		Merced County	Tertiary	Eocene			I	
2071-		Merced County	Tertiary	Eocene			I	
2073-		Fresno County	Tertiary	Miocene			I	
2074-		Fresno County	Tertiary	Miocene			I	
2075-		Fresno County	Tertiary	Miocene			I	
2076-		Fresno County	Tertiary	Miocene			I	
2077-		Fresno County	Tertiary	Miocene			I	
2079-		Fresno County	Tertiary	Pliocene			I	
2080-		Fresno County	Tertiary	Pliocene			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
2081-		Fresno County	Tertiary	Pliocene			I	
2082-		Fresno County	Tertiary	Pliocene			I	
2084-		Fresno County	Tertiary	Pliocene			I	
2085-		Fresno County	Tertiary	Pliocene			I	
2087-		Fresno County	Tertiary	Pliocene			I	
2088-		Fresno County	Tertiary	Pliocene			I	
2089-		Fresno County	Tertiary	Pliocene			I	
2090-		Fresno County	Tertiary	Pliocene			I	
2092-		Fresno County	Tertiary	Pliocene			I	
2093-		Fresno County	Tertiary	Pliocene			I	1
2094-		Fresno County	Tertiary	Pliocene			I	
2095-		Fresno County	Tertiary	Pliocene			I	
2096-		Fresno County	Tertiary	Pliocene			I	2
2097-		Fresno County	Tertiary	Pliocene			I	
2098-		Fresno County	Tertiary	Pliocene			I	1
2099-		Fresno County	Tertiary	Pliocene			I	
2100-		Fresno County	Tertiary	Pliocene			I	
2101-		Fresno County	Tertiary	Pliocene			I	
2102-		Fresno County	Tertiary	Pliocene			I	
2103-		Fresno County	Tertiary	Pliocene			I	
2104-		Fresno County	Tertiary	Pliocene			I	
2105-		Fresno County	Tertiary	Pliocene			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
2106-		Fresno County	Tertiary	Pliocene			I	
2107-		Fresno County	Tertiary	Pliocene			I	
2108-		Fresno County	Tertiary	Pliocene			I	1
2109-		Fresno County	Tertiary	Pliocene			I	
2110-		Fresno County	Tertiary	Pliocene			I	1
2111-		Fresno County	Tertiary	Pliocene			I	
2117-		Fresno County	Tertiary	Paleocene			I	
2118-		Fresno County	Tertiary	Paleocene			I	
2119-		Fresno County					I	
2120-		Fresno County					I	
2121-		Fresno County					I	
2122-		Fresno County					I	
2123-		Fresno County					I	
2124-		Fresno County	Tertiary	Miocene			I	
2125-		Fresno County					I	
2126-		Fresno County	Tertiary	Miocene			I	
2127-		Fresno County	Tertiary	Miocene			I	
2128-		Fresno County	Tertiary	Miocene			I	
2129-		Fresno County	Tertiary	Miocene			I	
2250-		Fresno County	Tertiary	Miocene			I	1
2252-		Fresno County	Tertiary	Miocene			I	
2254-		Fresno County	Tertiary	Miocene			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
2255-		Fresno County	Tertiary	Miocene			I	
2256-		Fresno County	Tertiary	Miocene			I	
2257-		Fresno County	Tertiary	Miocene			I	
2258-		Fresno County	Tertiary	Miocene			I	
2259-		Fresno County	Tertiary	Miocene			I	
2260-		Fresno County	Tertiary	Miocene			I	
2261-		Fresno County	Tertiary	Miocene			I	
2262-		Fresno County	Tertiary	Miocene			I	
2263-		Fresno County	Tertiary	Miocene			I	
2264-		Fresno County	Tertiary	Miocene			I	
2265-		Fresno County	Tertiary	Miocene			I	
2266-		Fresno County	Tertiary	Miocene			I	
2267-		Fresno County	Tertiary	Miocene			I	
2268-		Fresno County	Tertiary	Miocene			I	4
2269-		Fresno County	Tertiary	Miocene			I	
2270-		Fresno County	Tertiary	Pliocene			I	
2271-		Fresno County	Tertiary	Miocene			I	
2273-		Fresno County	Tertiary	Miocene			I	
2274-		Fresno County	Tertiary	Miocene			I	1
2275-	Domengine Creek	Fresno County	Tertiary	Miocene			I	1
2276-		Fresno County	Tertiary	Miocene			I	6

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
2277-		Fresno County	Tertiary	Miocene			I	
2278-		Fresno County	Tertiary	Miocene			I	1
2279-		Fresno County	Tertiary	Miocene			I	1
2280-		Fresno County	Tertiary	Miocene			I	1
2283-		Fresno County	Tertiary	Miocene			I	3
2285-		Fresno County	Tertiary	Miocene			I	
2286-		Fresno County	Tertiary	Eocene			I	
2287-	Domengine Canyon	Fresno County	Tertiary	Eocene			I	1
2288-	Monocline Ridge	Fresno County	Tertiary	Miocene			I	
2289-		Fresno County	Tertiary	Eocene			I	
2290-		Fresno County	Tertiary	Eocene			I	
2291-		Fresno County	Tertiary	Eocene			I	5
2292-		Fresno County	Tertiary	Eocene			I	2
2293-		Fresno County	Tertiary	Eocene			I	2
2294-		Fresno County	Tertiary	Eocene			I	
668-		Fresno County	Tertiary	Eocene			I	1
669-		Fresno County	Tertiary	Miocene			I	
670-		Fresno County	Tertiary	Eocene			I	
671-		Fresno County	Tertiary	Eocene			I	
672-		Fresno County	Tertiary	Eocene			I	98
674-		Fresno County	Tertiary	Eocene			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
675-		Fresno County	Tertiary	Eocene			I	
88A	Merced	Merced County	Tertiary	Pliocene	Pliocene		P	
A1900		Merced County	Cretaceous	Late Cretaceous			I	
A1901		Merced County	Cretaceous	Late Cretaceous			I	
A1902		Merced County	Cretaceous	Late Cretaceous			I	
A1903		Merced County	Cretaceous	Late Cretaceous			I	
A1904		Merced County	Cretaceous	Late Cretaceous			I	
A1905		Merced County	Cretaceous	Late Cretaceous			I	
A1906		Merced County	Cretaceous	Late Cretaceous			I	
A1907		Merced County	Cretaceous	Late Cretaceous			I	
A2957		Merced County	Cretaceous				I	
A2958		Merced County	Cretaceous				I	
A2959		Merced County	Cretaceous				I	
A2961		Merced County	Jurassic				I	
A3005	Quinto Creek	Merced County	Cretaceous	Late Cretaceous			I	
A3006	Mustang Creek	Merced County	Cretaceous	Late Cretaceous			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A3007		Merced County	Cretaceous	Late Cretaceous			I	
A3051		Merced County	Tertiary	Eocene			I	
A3053		Merced County	Cretaceous	Late Cretaceous			I	
A3054		Merced County	Cretaceous	Late Cretaceous			I	
A3055		Merced County	Cretaceous	Late Cretaceous			I	
A3056		Merced County	Cretaceous	Late Cretaceous?			I	
A3057		Merced County	Cretaceous	Late Cretaceous		Garzas	I	
A3058		Merced County	Cretaceous	Late Cretaceous		Garzas?	I	
A3107		Merced County	Cretaceous	Late Cretaceous			I	
A3108		Merced County	Cretaceous	Late Cretaceous			I	
A3156		Merced County	Cretaceous	Late Cretaceous			I	
A3157		Merced County	Cretaceous	Late Cretaceous			I	
A3159		Merced County	Cretaceous	Late Cretaceous			I	
A3160	Quinto Creek	Merced County	Cretaceous	Late Cretaceous			I	1

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A3214		Merced County	Cretaceous	Late Cretaceous			I	
A3215		Merced County	Cretaceous	Late Cretaceous			I	
A3216		Merced County	Cretaceous	Late Cretaceous			I	1
A3217		Merced County	Cretaceous	Late Cretaceous			I	
A3218		Merced County	Cretaceous	Late Cretaceous			I	
A3219		Merced County	Cretaceous			Quinto	I	
A3220		Merced County	Cretaceous	Late Cretaceous		Garzas	I	
A3221		Merced County	Cretaceous	Late Cretaceous			I	
A3222		Merced County	Cretaceous	Late Cretaceous			I	
A3223		Merced County	Cretaceous	Late Cretaceous			I	
A3224		Merced County	Cretaceous	Late Cretaceous		Quinto	I	3
A3225		Merced County	Cretaceous	Late Cretaceous		Quinto	I	
A3261		Merced County	Tertiary	Eocene			I	
A3262		Merced County	Tertiary	Paleocene			I	1
A3380		Merced County	Cretaceous	Late Cretaceous			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A3381		Merced County	Cretaceous	Late Cretaceous			I	
A3382		Merced County	Cretaceous	Late Cretaceous		Quinto" Silt	I	
A3383		Merced County	Cretaceous	Late Cretaceous		Quinto" Silt	I	
A3384		Merced County	Cretaceous	Late Cretaceous		Garzas	I	
A3386	Quinto Creek	Merced County	Cretaceous			Lower Chico	I	
A3387		Merced County	Cretaceous				I	
A3388		Merced County	Cretaceous				I	
A3389		Merced County	Cretaceous	Late Cretaceous			I	
A3390		Merced County	Cretaceous	Late Cretaceous			I	
A3391		Merced County	Cretaceous	Late Cretaceous			I	
A3393		Merced County	Cretaceous	Late Cretaceous			I	
A3434		Merced County	Cretaceous	Late Cretaceous			I	
A3825		Merced County	Cretaceous	Late Cretaceous?			I	
A3834		Merced County	Cretaceous	Late Cretaceous?			I	
A3836		Merced County	Cretaceous	Late Cretaceous?			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A3838		Merced County	Cretaceous	Late Cretaceous?		Mercy Sand	I	
A3839		Merced County	Cretaceous	Late Cretaceous			I	
A3840		Merced County	Cretaceous	Late Cretaceous?		Garzas Sandstone	I	
A3841		Merced County	Cretaceous	Late Cretaceous?			I	
A3842		Merced County	Cretaceous	Late Cretaceous?			I	
A3843		Merced County	Cretaceous	Late Cretaceous			I	
A3845		Merced County	Cretaceous	Late Cretaceous?			I	
A3846		Merced County	Cretaceous				I	
A3847		Merced County					I	
A3848		Merced County	Cretaceous				I	
A3876		Merced County	Cretaceous	Late Cretaceous			I	
A3969		Merced County	Tertiary	Eocene			M	9
A3970		Merced County	Tertiary	Eocene			M	7
A3971		Merced County	Tertiary	Eocene			M	10
A3972		Merced County	Tertiary	Eocene			M	5
A3973		Merced County	Tertiary	Eocene			M	3
A3974		Merced County	Tertiary	Eocene			M	12

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A3975		Merced County	Tertiary	Eocene			M	12
A3976		Merced County	Tertiary	Eocene			M	27
A3977		Merced County	Tertiary	Eocene			M	30
A3978		Merced County	Tertiary	Eocene			M	5
A3979		Merced County	Tertiary	Eocene			M	2
A3980		Merced County	Tertiary	Eocene			M	67
A4663		Merced County	Cretaceous	Late Cretaceous			I	
A4664		Merced County	Cretaceous	Late Cretaceous			I	
A4684		Merced County	Cretaceous	Late Cretaceous		Garzas	IM	7
A6604		Merced County	Tertiary	Paleocene			I	
A6605		Merced County	Tertiary	Paleocene			I	
A6606		Merced County	Cretaceous	Late Cretaceous			I	
A6607		Merced County	Tertiary	Paleocene			I	
A6608		Merced County	Cretaceous	Late Cretaceous			I	
A6609		Merced County	Cretaceous	Late Cretaceous			I	
A6610		Merced County	Cretaceous	Late Cretaceous			I	
A6611		Merced County	Cretaceous	Late Cretaceous			I	

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
A6612		Merced County	Cretaceous	Late Cretaceous			I	
B4149	Butano Ridge	Merced County	North America	Cretaceous	Late Cretaceous		I	5
MF7689	Laguna Seca Creek	Merced County	Cretaceous	Late Cretaceous			M	7
MF7690	Laguna Seca Creek	Merced County	Cretaceous	Late Cretaceous			M	1
MF7694	Laguna Seca Creek	Merced County	Cretaceous	Late Cretaceous			M	2
P3312	Coalinga II	Fresno County	Tertiary	Pliocene	Pliocene		P	
P4117	Merced County	Merced County	Cretaceous	Late Cretaceous	Cretaceous		P	
PA616	Turlock Lake	Stanislaus County	Tertiary	Early Pliocene	Pliocene	Turlock Lake	P	102
V4021	Ciervo Creek	Fresno County	Tertiary	Miocene	Barstovian		V	1
V4040	Los Banos Creek	Merced County	Cretaceous	Late Cretaceous	Maastrichtian		V	1
V5404	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	3
V5405	Turlock Lake, Site 2	Stanislaus County	Tertiary	Miocene	Hemphillian		V	67
V5411	McClure Reservoir	Mariposa County	Jurassic	Late Jurassic	Late Jurassic		V	1
V5836	Turlock Lake, Site 3	Stanislaus County	Tertiary	Miocene	Hemphillian		V	8
V5837	Turlock Lake, Site 4	Stanislaus County	Tertiary	Miocene	Hemphillian		V	9
V6418	Laguna Seca	Merced County	Cretaceous	Late	Maastrichtian		V	6

Locality Number	Locality Name	County	Period	Epoch	Age	Flora or Fauna	Collection	Number of Specimens
	Creek			Cretaceous				
V65711	Turlock Lake General	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V68134	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	6
V68135	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V68136	Turlock Lake 8	Stanislaus County	Tertiary	Miocene	Hemphillian		V	
V68137	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V6878	Turlock Lake	Stanislaus County	Tertiary	Miocene	Hemphillian		V	18
V71137	Turlock Lake 10	Stanislaus County	Tertiary	Miocene	Hemphillian		V	4
V81248	Turlock Lake 11	Stanislaus County	Tertiary	Miocene	Hemphillian		V	5
V82047	Turlock Lake 12	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V90007	Turlock Lake 13	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V90008	Turlock Lake 14	Stanislaus County	Tertiary	Miocene	Hemphillian		V	2
V91098	Turlock Lake 15	Stanislaus County	Tertiary	Miocene	Hemphillian		V	1
V93018	Laguna Seca Ranch Section 36	Fresno County	Tertiary	Pliocene	Blancan		V	

Note: "?" indicates presence in original records but that there is uncertainty regarding the original classification of the specimen.