PALEONTOLOGICAL EVALUATION REPORT FOR THE U.S. HIGHWAY 50 HIGH OCCUPANCY VEHICLE LANES AND COMMUNITY ENHANCEMENTS PROJECT FROM KILOPOST 1.4 to 20.6 (POST MILE 0.9 to 12.8) IN SACRAMENTO COUNTY, CALIFORNIA

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10 March 2006

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Mr. Lastufka:

In accordance with Caltran's request, we have completed a paleontological resource impact assessment on the proposed Caltrans U.S. Highway 50 High Occupancy Vehicle Lanes and Community Enhancements Project located in Sacramento, California. Included in the report transmitted by this letter are the results of our investigation and our recommendations for mitigating the potential adverse impacts of Project construction on paleontological resources. It is our opinion that Project construction has the potential to cause adverse impacts to significant paleontological resources, specifically Quaternary vertebrate, plant, and ichnofossils in the Modesto and Riverbank Formations. However, these potential impacts can be reduced to a less than significant level as required by CEQA, provided that the recommendations contained in this report are incorporated into a monitoring and mitigation plan and that plan is fully implemented during Project excavating.

We thank you for the opportunity to perform this study. If you have any questions, or if we can be of further service, please contact us at your convenience.

Respectfully,

for PaleoResource Consultants

Lanny H. Fisk, PhD

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SECTION 1
INTRODUCTION

The purpose of this report is to provide an assessment of potential adverse impacts on scientifically significant paleontological resources (fossils) resulting from earth moving associated with construction by California Department of Transportation (Caltrans) of the proposed U.S. Highway 50 High Occupancy Vehicle (HOV) Lanes and Community Enhancements Project (hereinafter Project) in Sacramento County, California. PaleoResource Consultants (PRC) was retained by URS Corporation (URS) to do the assessment, which is presented below. This technical report of findings presents the results of the assessment and makes recommendations for mitigating the potential adverse impacts of earth moving on the known and suspected paleontological resources along the Project right-of-way (ROW). This paleontological resource impact assessment meets all requirements of the California Environmental Quality Act (CEQA) and the standard measures for mitigating adverse construction-related environmental impacts on paleontological resources established by the Society of Vertebrate Paleontology (SVP, 1995, 1996). This paleontological resources inventory and impact assessment was prepared by Dr. Lanny H. Fisk, PhD, PG, a California registered Professional Geologist (PG) and Senior Paleontologist with PRC.

Paleontological resources (fossils) are the remains or traces of prehistoric plants and animals. Fossils are important scientific and educational resources because of their use in (1) documenting the presence and evolutionary history of particular groups of now extinct organisms, (2) reconstructing the environments in which these organisms lived, (3) and in determining the relative ages of the strata in which they occur and of the geologic events that resulted in the deposition of the sediments that formed these strata.

The proposed Project would add HOV lanes within the existing median of U.S. Highway 50 from Sunrise Boulevard in City of Rancho Cordova to downtown Sacramento, plus provide California Highway Patrol (CHP) enforcement areas in the median at several locations. The Project would also incorporate the construction of on/off ramps in the median of U.S. Highway 50 in downtown Sacramento in three of four alternative sites. Because the stratigraphic unit exposed at all four alternative sites is the same and, therefore, potential adverse impacts to paleontological resources would be identical at all four sites, the alternatives are not discussed further in this report. Rather, in the discussion that follows, all four alternatives are included as part of the Project.

SECTION 2
SIGNIFICANCE

As defined by the SVP (1995), a paleontological resource can be significant if:

- It provides important information on the evolutionary trends among organisms, relating living organisms to extinct organisms.
- It provides important information regarding development of biological communities or interaction between botanical and zoological biota.
- It demonstrates unusual circumstances in biotic history.
- It is in short supply and in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and is not found in other geographic localities.

Under CEQA guidelines (PRC 15064.5 (a) (2)), public agencies must treat all historical and cultural resources (including paleontological resources) as significant unless the preponderance of evidence demonstrates that they are not historically or culturally significant.

In common with other environmental disciplines such as archaeology and biology (specifically in regard to listed species), the SVP (1995) considers any fossil specimen significant, unless demonstrated otherwise, and, therefore, protected by environmental statutes. This position is held because fossils are uncommon and only rarely will a fossil locality yield a statistically significant number of specimens representing the same species. In fact, vertebrate fossils are so uncommon that, in most cases, each fossil specimen found will provide additional important information about the characteristics or distribution of the species it represents.

An individual fossil specimen is considered scientifically important if it is:

- Identifiable,
- Complete,
- Well preserved,
- Age diagnostic,
- Useful in paleoenvironmental reconstruction,
- A type or topotypic specimen,
- A member of a rare species,
- A species that is part of a diverse assemblage, and/or
- A skeletal element different from, or a specimen more complete than, those now available for that species.

Identifiable land mammal fossils are considered scientifically important because of their potential use in providing accurate age determinations and paleoenvironmental reconstructions for the sediments in which they occur. Moreover, vertebrate remains are comparatively rare in the fossil record. Although fossil plants are usually considered of lesser importance because they are less helpful in age determination and more abundant, they are actually more sensitive indicators of their environment and, thus, as sedentary organisms, more valuable than mobile animals for paleoenvironmental reconstructions. For marine sediments, invertebrate and marine algal fossils, including microfossils, are scientifically important for the same reasons that land mammal and/or land plant fossils are valuable in terrestrial deposits. The value or importance of different fossil groups varies depending on the age and depositional environment of the stratigraphic unit that contains the fossils.

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined.

High Sensitivity. Stratigraphic units in which vertebrate or significant invertebrate fossils or significant suites of plant fossils have been previously found have a high potential to produce additional significant non-renewable fossils and are therefore considered to be highly sensitive. In keeping with the significance criteria of the SVP (1995), all stratigraphic units in which vertebrate fossils have previously been found have high sensitivity. Full-time monitoring is recommended during any project-related ground disturbance in stratigraphic units with high sensitivity.

Low Sensitivity. Stratigraphic units that are not sedimentary in origin or that have not been known to produce fossils in the past are considered to have low sensitivity. Monitoring is usually not recommended nor needed during project construction through a stratigraphic unit with low sensitivity.

Undetermined Sensitivity. Stratigraphic units that have not had any previous paleontological resource surveys or any fossil finds are considered to have undetermined sensitivity. After reconnaissance surveys, observation of artificial exposures (such as road cuts) and natural exposures (such as stream banks), and possible subsurface testing (such as augering or trenching), an experienced, professional paleontologist can often determine whether the stratigraphic unit should be categorized as having high or low sensitivity.

SECTION 3
LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

Paleontological resources are classified as non-renewable scientific resources and are protected by several federal and state statutes (California Office of Historic Preservation, 1983; Marshall, 1976; West, 1991; Fisk and Spencer, 1994; Gastaldo 1999), most notably by the 1906 Federal Antiquities Act and other subsequent federal legislation and policies and by the State of California's environmental regulations (CEQA, Section 15064.5). Professional standards for assessment and mitigation of adverse impacts on paleontological resources have been established by the SVP (1995, 1996). Design, construction, and operation of the proposed Project needs to be conducted in accordance with laws, ordinances, regulations and standards (LORS) applicable to paleontological resources. Therefore, LORS applicable to paleontological resources are summarized briefly below, together with SVP professional standards.

3.1 Federal LORS

Federal protection for significant paleontological resources would only apply to this project if any construction or other related project impacts occur on federally owned or federally managed lands, or if federal permits are required from any federal regulatory agency. Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (PL 59-209; 16 United States Code 431 *et seq.*; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal land. The Antiquities Act of 1906 forbids disturbance of any object of antiquity on federal land without a permit issued by the responsible managing agency. This act also establishes criminal sanctions for unauthorized appropriation or destruction of antiquities.

In addition to the Antiquities Act, other Federal statues protecting fossils include the following. The Historic Sites Act of 1935 (P.L. 74-292; 49 Stat. 666, 16 U.S.C. 461 *et seq.*) declares it national policy to preserve objects of historical significance for public use and gives the Secretary of the Interior broad powers to execute this policy, including criminal sanctions. The National Environmental Policy Act of 1969 (P.L. 91-190, 31 Stat. 852, 42 U.S.C. 4321-4327) requires that important natural aspects of our national heritage be considered in assessing the environmental consequences of any proposed project. The Federal Land Policy Management Act of 1976 (P.L. 94-579; 90 Stat. 2743, U.S.C. 1701-1782) requires that public lands be managed in a manner that will protect the quality of their scientific values. Paleontological resources are also afforded federal protection under 40 CFR 1508.27 as a subset of scientific resources. The Federal Highways Act of 1958 specifically extended the Antiquities Act to apply to paleontological resources and authorized the use of funds appropriated under the Federal-Aid Highways Act of 1956 to be used for paleontological salvage in compliance with the Antiquities Act and any applicable state laws. The language in the Highways Act makes it clear that Congress intended that, to be in compliance with the Antiquities Act, highway construction projects must protect paleontological resources.

3.2 State LORS

Guidelines for the Implementation of CEQA, as amended 7 September 2004 (Title 14, Chapter 3, California Code of Regulations: 15000 *et seq.*) define procedures, types of activities, persons, and public agencies required to comply with CEQA, and include as one of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section XIV, Part

a) the following: "*Will the proposed project directly or indirectly destroy a unique paleontological resource or site?*"

Other state requirements for paleontological resource management are in Public Resources Code Chapter 1.7, Section 5097.5, entitled Archaeological, Paleontological, and Historical Sites. This statute specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources and defines any unauthorized disturbance or removal of fossil remains or sites on public land as a misdemeanor.

3.3 County and City LORS

Sacramento County does not have mitigation requirements that specifically address potential adverse impacts to paleontological resources, nor does either the cities of Rancho Cordova or Sacramento.

3.4 Professional Standards

The SVP, a national scientific organization of professional vertebrate paleontologists, has established standard guidelines (SVP 1991, 1995, 1996) that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, and specimen preparation, identification, analysis, and curation. Most practicing professional paleontologists in the nation adhere closely to the SVP's assessment, mitigation, and monitoring requirements as specifically spelled out in its standard guidelines. The SVP's standard guidelines were approved by a consensus of professional paleontologists and are the standard against which all paleontological monitoring and mitigation programs are judged. Many federal and state regulatory agencies have either formally or informally adopted the SVP's "standard guidelines" for the mitigation of construction-related adverse impacts on paleontological resources, including both federal (FERC, USFS, BLM, NPS, etc.) and state agencies (CEC, CPUC, Caltrans, etc.).

Briefly, SVP guidelines require that each project have literature and museum archival reviews, a field survey, and, if there is a high potential for disturbing significant fossils during project construction, a mitigation plan that includes monitoring by a qualified paleontologist to salvage fossils encountered, identification of salvaged fossils, determination of their significance, and placement of curated fossil specimens into a permanent public museum collection (such as the designated California State repository for fossils, the University of California Museum of Paleontology at Berkeley).

SECTION
AFFECTED ENVIRONMENT

4.1 Geographic Location

The proposed Project is located in central Sacramento County, between Sunrise Boulevard in the City of Rancho Cordova and approximately 9th Street in downtown Sacramento, California (Figure 1). The center of the Sunrise Boulevard overpass over U.S. Highway 50 is located approximately at latitude 38^{o}36'32"N, longitude 121^{o}16'17"W. The ground surface in this vicinity is at approximately 33 meters (110 feet) elevation. The western project limits on U.S. Highway 50 is located approximately at latitude 38^{o}33'58"N, longitude 121^{o}30'12"W. The ground surface in this vicinity is approximately 4.5 meters (15 feet) elevation. The portion of U.S. Highway 50 proposed for construction is located on the eastern margin of the Sacramento Valley, near the westernmost foothills of the Sierra Nevada, and just north of the geographic center of the State of California. The Sacramento Valley comprises roughly the northern third of the major north-northwest oriented synclinorium called either the Valle Grande (Clark, 1929), Great Valley (Fenneman, 1931; Hackel, 1966), Central Valley (Jahns, 1954), Great Central Valley (Piper et al., 1939; Davis et al., 1957), or California Trough (Piper et al., 1939). The Central Valley Physiographic Province is located between the Sierra Nevada Physiographic Province on the east and the Coast Ranges Physiographic Province on the west. The general project area is bounded on the west by the floodplain of the Sacramento River and on the east by a gently inclined alluvial fan, which heads in the Sierra Nevada. The proposed project is located in the U. S. Geological Survey (USGS) Sacramento East, Sacramento West and Carmichael 7.5-minute (1:24,000 scale) Quadrangles.

4.2 Regional Geologic Setting

The geology in the vicinity of the proposed Project has been mapped or described by numerous workers, including Bryan (1923); Piper et al. (1939); Olmsted and Davis (1961); Strand and Koenig (1965); Shlemon (1967a, 1967b, 1972); Hansen and Begg (1970); Bartow and Marchand (1979); Marchand and Allwardt (1981); Wagner et al. (1981); and Amundson (1984). Surficial geologic mapping of the project vicinity has been provided at a scale of 1:1,000,000 by Wahrhaftig et al. (1993); at a scale of 1:750,000 by Jennings (1977); at a scale of 1:500,000 by Jenkins (1938); at a scale of 1:250,000 by Olmsted and Davis (1961), Strand and Koenig (1965), and Wagner et al. (1981); at a scale of 1:100,000 by California Department of Water Resources (1973); and at a scale of 1:62,500 by Helley (1979) and Helley and Harwood (1985). No 1:24,000-scale geologic maps are currently available for this area. The information in these geologic maps and published and unpublished reports form the basis of the following discussion. Individual maps and publications are incorporated into this report and referenced where appropriate. The site-specific geology of the Project ROW is discussed separately below. The aspects of geology pertinent to this report are the types, distribution, and age of sediments immediately underlying the Project ROW and their probability of producing fossils during Project construction.

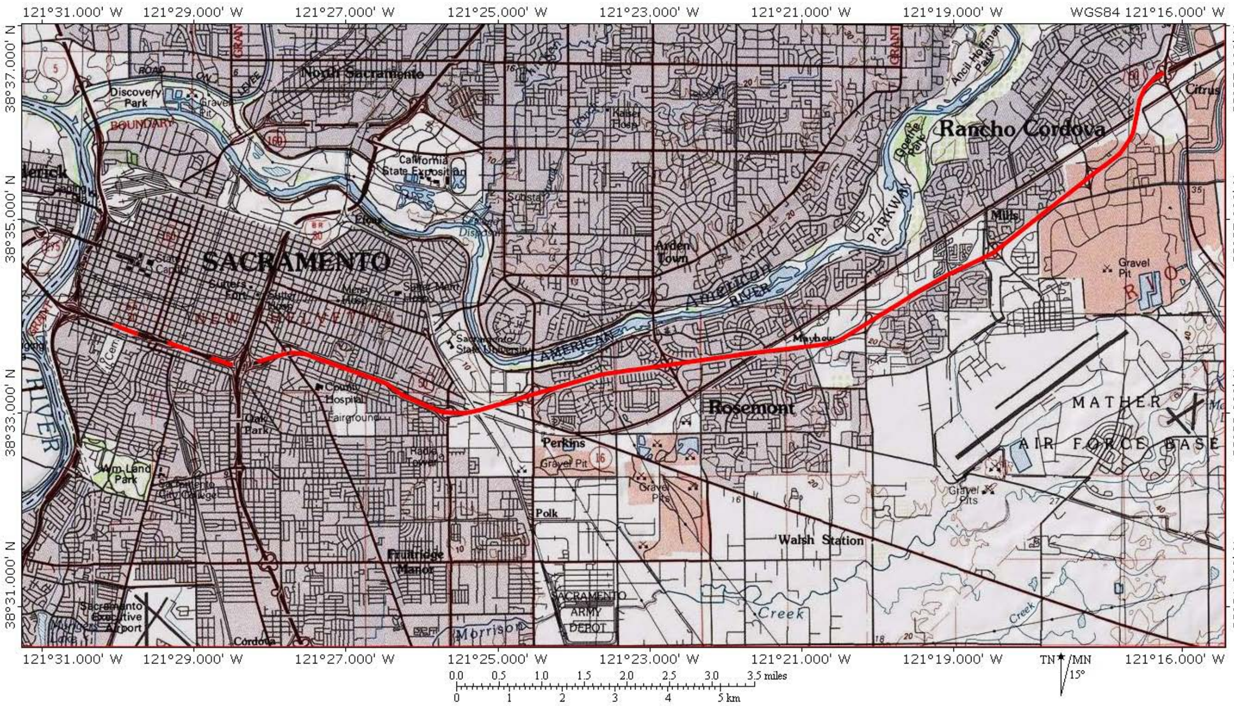

Figure 1. Map of the portion of the U.S. Highway 50 ROW proposed for construction. Modified from USGS Sacramento 1° X 2° (1:250,000 scale) Quadrangle.

The east side of the Central Valley is a nearly continuous series of coalescing alluvial fans, with their apices located where streams drain the west slope of the Sierra Nevada. These low relief alluvial fans form a continuous belt between the dissected uplands of the Sierra Nevada and the nearly flat surface of the Central Valley floor. These fans are composed of undeformed to only slightly deformed alluvial deposits laid down primarily during Plio-Pleistocene time by the streams that drain the adjacent uplands of the Sierra Nevada. Each alluvial fan consists of a mass of coarse to fine rock debris that splays outward from the mouth of its primary stream channel onto the valley floor as a fan-like deposit of well-sorted sand and gravel encased in a matrix of finer sediments, chiefly poorly sorted fine sand and silt deposited away from the stream channels on the alluvial plain. Our current interpretations and understanding of the alluvial deposits of major Sierran rivers lies in Arkley's (1962, 1964) studies of the Merced, Tuolumne, and Stanislaus River fans, Janda's (1966; Janda and Croft, 1965) study of alluvium of the upper San Joaquin River, Shlemon's (1967a) study of the American River fan, and Atwater's (1980) studies of the Mokelumne River fan.

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

In the Project vicinity, coalesced alluvial fans have been created by rock debris deposited by the American River, Cosumnes River, Morrison Creek, and adjacent smaller streams, all of which drain off the foothills of the Sierra Nevada Range. Geological materials composing these alluvial fans have been subdivided into stratigraphic units differently by different geologists.

The task of subdividing alluvial fan deposits into formal stratigraphic units is complicated by that fact that alluvial sediments are often lithologically similar. Davis and Hall (1959) addressed this problem by stating:

> "*An important problem in attempting to differentiate geologic units in alluvial areas is that the sediments often are derived from a common source and are deposited in similar environments. All or nearly all of the alluvium of the east side of the San Joaquin Valley is derived from granitic and associated rocks of the Sierra Nevada which lie to the east. Thus, the formations offer no textural or lithologic bases for subdivision. Nevertheless, the use of the topographic expression of the units in conjunction with the development of their soils makes it possible to define formations.*"

In the Project vicinity, sediments composing the coalesced American-Cosumnes River alluvial fan have been divided into four stratigraphic units, from oldest to youngest: weakly cemented siltstone, sandstone, and conglomerate of the Pliocene Laguna Formation exposed only on the upper alluvial fan, coarser but otherwise similar sediments of the Early Pleistocene Turlock Lake Formation, and a slightly younger and less consolidated, sedimentary sequence mapped as Middle Pleistocene to Early Holocene Riverbank Formation, Modesto Formation, or "Modesto/Riverbank formations undivided" that overlies the Turlock Lake and Laguna Formation on the lower portion of the alluvial fan. Each of these stratigraphic units has yielded fossil remains at previously recorded fossil localities within the Central Valley.

The Pliocene age Laguna Formation includes the oldest alluvium within the American-Cosumnes River alluvial fan, but is not easily distinguished from younger alluvial deposits of the Turlock Lake, Riverbank, and Modesto formations. The principal differences between these younger alluvial sediments and those of the Laguna Formation are stratigraphic position, degree of consolidation, topographic expression, attitude (tilted versus flat-lying), and fossil content. According to Savage (1951), sediments containing Late Pleistocene and Holocene fossil faunas can often be distinguished from Pliocene and older Pleistocene sediments by their relatively flat-lying attitude, while, in contrast, the older sediments containing Pliocene (Blancan North American Land Mammal Age (NALMA)) and Early to Middle Pleistocene (Irvingtonian NALMA) fossil faunas have often been slightly deformed or tilted by tectonic activity. This criterion has also been helpful to others in distinguishing older alluvium from younger alluvium (see for instance, Taliaferro, 1951; Davis et al., 1957; Hall, 1958; and Helley et al., 1972). On the American-Cosumnes River alluvial fan, the Turlock Lake Formation has a discontinuous distribution. It is represented primarily by gravel to cobble-size clasts in a coarse sand matrix originally named the "Arroyo Seco Gravel" by Piper et al. (1939). The Turlock Lake Formation typically forms a thin gravel veneer overlying the Laguna Formation on what has been interpreted as a pediment surface by most geologists working in the area. Since neither the Laguna nor Turlock Lake Formations are mapped as being present in the immediate vicinity of the Project ROW (Helley, 1979; Helley and Harwood, 1985), it is unlikely that these stratigraphic units will be impacted by Project construction. Consequently, these units will not be discussed further in this report.

The Quaternary alluvium of the American-Cosumnes River alluvial fan assigned to the Riverbank and Modesto Formations is lithologically indistinct from the underlying Turlock Lake and Laguna Formations, but can be distinguished from them by stratigraphic position, degree of cementation and therefore topographic expression, amount of deformation, and age. The Laguna Formation is believed to be Pliocene to possibly Early Pleistocene in age and the Turlock Lake Formation may be entirely Early Pleistocene. The age of the Riverbank Formation is probably Middle Pleistocene, and the Modesto Formation is Late Pleistocene to possibly Early Holocene in age (Helley et al., 1972; Bartow and Marchand, 1979; Marchand and Allwardt, 1981). Strata comprising both the Laguna and Turlock Lake Formations have been slightly deformed by tectonic activity related to uplift of the Sierra Nevada and can often be recognized from the overlying Riverbank and Modesto Formations by their non-flat-lying attitude. Because of their greater cementation, the older stratigraphic units also often have a distinct topographic expression. As Plio-Pleistocene uplift of the Sierra Nevada occurred, it exposed alluvial sediments of the Laguna, Turlock Lake, and Riverbank Formations to erosion. As streams cut through these older deposits, remnants were preserved as topographic highs with valleys filled with Modesto Formation and younger alluvial sediments.

4.3 Resource Inventory Methods

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

Geologic maps and reports covering the bedrock and surficial geology of the Project vicinity were reviewed to determine the exposed and subsurface rock units, to assess the potential paleontological productivity of each rock unit, and to delineate their respective areal distribution in the Project area. In addition, available soil surveys (Weir, 1950; Cole et al., 1954) and aerial photographs of the area were examined to aid in determining the areal distribution of distinctive sediment and soil types.

The number and locations of previously recorded fossil sites from rock units exposed in and near the Project ROW and the types of fossil remains each rock unit has produced were evaluated based on published and unpublished geological and paleontological literature (including previous environmental impact assessment documents (e. g., Fisk 2000, 2003) and paleontological resource impact mitigation program final reports (e. g., Fisk and Lander, 1999; Fisk, 2001; Fisk and Maloney, 2004)). The literature review was supplemented by an archival records search conducted at the University of California Museum of Paleontology (UCMP) in Berkeley, California, for additional information regarding the occurrence of fossil sites and remains on and near the Project ROW.

Field surveys, which included visual inspection of exposures of potentially fossiliferous strata in the Project area, were conducted to document the presence of sediments suitable for containing fossil remains and the presence of any previously unrecorded fossil sites. The field survey for this assessment was conducted on 04 and 05 January 2006 by Dr. Lanny H. Fisk, PhD, PG, Senior Paleontologist with PRC. During the field survey, stratigraphy was observed in numerous road cuts, stream banks, trenches and other excavations at construction sites, and the high walls of gravel pits. Cuts up to 6 meters (20 feet) deep are found on the Project ROW, but these have been largely vegetated and no longer expose the stratigraphy (Figure 2). A drainage ditch with up to 3.6 meters (12 feet) of exposed sediments parallels U.S. Highway 50 between Zinfandel Drive and Bradshaw Road (Figure 2).

Figure 2. Photograph of the U.S. Highway 50 ROW in the vicinity of Mather Field Road taken from the Routier Road overpass looking east. Note the grass cover completely obscuring the deep excavations in the vicinity to the Mather Field Road overpass over U.S. Highway 50. Also note the deep drainage ditch on the right paralleling the west-bound exit from U.S. Highway 50 at Mather Field Road.

4.4 Paleontological Resource Assessment Criteria

Under SVP (1995) criteria, a stratigraphic unit (such as a formation, member, or bed) known to contain significant fossils is considered to be "sensitive" to adverse impacts if there is a probability that earth-moving or ground-disturbing activities in that rock unit will either disturb or destroy fossil remains. This definition of sensitivity differs fundamentally from that for archaeological resources:

> "*It is extremely important to distinguish between archaeological and paleontological (fossil) resource sites when defining the sensitivity of rock units. The boundaries of archaeological sites define the areal extent of the resource. Paleontologic sites,*

however, indicate that the containing sedimentary rock unit or formation is fossiliferous. The limits of the entire rock formation, both areal and stratigraphic, therefore define the scope of the paleontologic potential in each case" (SVP, 1995).

This distinction between archaeological and paleontological sites is important. Most archaeological sites have a surface expression that allow for their geographic location. Fossils, on the other hand, are an integral component of the rock unit below the ground surface, and, therefore, are not observable unless exposed by erosion or human activity. Thus, a paleontologist cannot know either the quality or quantity of fossils present before the rock unit is exposed as a result of natural erosion processes or earth-moving activities. The paleontologist can only make conclusions on sensitivity to impact based upon what fossils have been found in the rock unit in the past, along with a judgment on whether or not the depositional environment of the sediments that compose the rock unit was likely to result in the burial and preservation of fossils.

Fossils are seldom uniformly distributed within a rock unit. Most of a rock unit may lack fossils, but at other locations within the same rock unit concentrations of fossils may exist. Even within a fossiliferous portion of the rock unit, fossils may occur in local concentrations. For example, Shipman (1977, 1981) excavated a fossiliferous site using a three dimensional grid and removed blocks of matrix of a consistent size. The site chosen was known prior to excavation to be richly fossiliferous, yet only 17% of the blocks actually contained fossils. These studies demonstrate the physical basis for the difficulty in predicting the location and quantity of fossils in advance of project-related ground disturbance.

Since it is unfortunately not possible to determine where fossils are located without actually disturbing a rock unit, monitoring of excavations by an experienced paleontologist during construction increases the probability that fossils will be discovered and preserved. Preconstruction mitigation measures such as surface prospecting and collecting will not prevent adverse impacts on fossils because many sites will be unknown in advance due to an absence of fossils at the surface.

The non-uniform distribution of fossils within a rock unit is essentially universal and many paleontological resource assessment and mitigation reports conducted in support of environmental impact documents and mitigation plan summary reports document similar findings (see for instance Lander, 1989, 1993; Reynolds, 1987, 1990; Spencer, 1990; Fisk et al., 1994; and references cited therein). In fact, most fossil sites recorded in reports of impact mitigation (where construction monitoring has been implemented) had no previous surface expression. Because the presence or location of fossils within a rock unit cannot be known without exposure resulting from erosion or excavation, under SVP (1991, 1995) standard guidelines, an entire rock unit is assigned the same level of sensitivity based on recorded fossil occurrences.

Using SVP (1995) criteria, the paleontological importance or sensitivity (high, low, or undetermined) of a rock unit is the measure most amenable to assessing the significance of paleontological resources because the areal distribution of that rock unit can be delineated on a topographic or geologic map. The paleontological importance of a stratigraphic unit reflects: (1) its potential paleontological productivity (and thus sensitivity), and (2) the scientific significance of the fossils it has produced. This method of paleontological resource assessment is the most appropriate because discrete levels of paleontological importance can be delineated on a topographic or geologic map.

The potential paleontological productivity of a stratigraphic unit exposed in a project area is based on the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near a project site. The underlying assumption of this assessment method is that exposures of a stratigraphic unit in a project site are most likely to yield fossil remains both in quantity and density similar to those previously recorded from that stratigraphic unit in and near the project site.

The following tasks were completed to establish the paleontological importance and sensitivity of each stratigraphic unit exposed in or near the Project site:

- The potential paleontological productivity of each rock unit was assessed based on previously recorded and newly documented fossil sites it contains at and/or near the Project site.
- The scientific importance of fossil remains recorded from a stratigraphic unit exposed at and/or near the Project site was assessed.
- The paleontological importance of a rock unit was assessed, based on its documented and/or potential fossil content in the area surrounding the Project site.

SECTION 5
<u>RESULTS</u>

5.1 Stratigraphic Inventory

Regional geologic mapping of Caltran's proposed U.S. Highway 50 Sacramento Project site and vicinity has been provided by Wahrhaftig et al. (1993; 1:1,000,000 scale), Jenkins (1938; 1:500,000 scale), Olmstead and Davis (1961; 1:250,000 scale), Strand and Koenig (1965; 1:250,000 scale), and Wagner et al. (1981, 1:250,000 scale). Larger scale mapping of the Project site has been provided by California Department of Water Resources (1973; 1:100,000 scale), Helley (1979; 1:62,500 scale), and Helley and Harwood (1985; 1:62,500 scale). Unfortunately, in their geologic maps of the Late Cenozoic deposits of the Project area, these geologists have not always used formally named stratigraphic units, nor have they consistently used the same map units.

Piper et al. (1939) published the first detailed map and descriptions of Quaternary sediments in Sacramento County. They named the Pliocene strata the Laguna Formation and the Pleistocene strata the "Victor Formation." Working in Stanislaus and northern Merced counties, Davis and Hall (1959) subdivided Pleistocene sediments equivalent to the "Victor Formation" into the Turlock Lake, Riverbank, and Modesto formations, from oldest to youngest. These formation names were later extended into Sacramento County by Shlemon (1967a, 1967b, 1971). In 1981, Marchand and Allwardt proposed that the name "Victor Formation" be abandoned and that the Turlock Lake, Riverbank, and Modesto formations be accepted as uniform stratigraphic nomenclature for Quaternary deposits in the area; their recommendations have been followed by most later workers (see for instance Bartow and Marchand, 1979; Helley and Harwood, 1985) and are followed in this report.

Olmstead and Davis (1961, 1:250,000 scale) mapped the area in the vicinity of proposed Project as "Laguna formation and related continental deposits" with Holocene "Victor formation and related deposits" along stream valleys. Strand and Koenig (1965, 1:250,000 scale) mapped the area as "Plio-Pleistocene non-marine" with Holocene "fan deposits" along stream valleys. The California Department of Water Resources (1973, 1:100,000 scale) mapped the area as "Arroyo Seco Gravels" (now considered part of the Turlock Lake Formation) and "South Fork Gravels" (an informal name no longer in use), with "Victor Formation" along stream valleys. Wagner et al. (1981, 1:250,000 scale), Helley (1979, 1:62,500 scale), and Helley and Harwood (1985, 1:62,500 scale) mapped the area as Riverbank Formation with Modesto Formation and unnamed Quaternary alluvium along stream valleys.

5.2 ROW Geology

In the most recent and most detailed geologic mapping available, Helley and Harwood (1985, 1:62,500 scale) indicate that the Project ROW has exposed at the surface continental deposits of the Riverbank Formation, Modesto Formation, and unnamed Quaternary alluvium (see Figures 3 and 4).

Riverbank Formation. The Riverbank Formation was first named by Davis and Hall (1959), who designated a type section along the south bluff of the Stanislaus River within the City of Riverbank. However, sedimentary strata referred to the Riverbank Formation are found along the eastern margin of the Sacramento Valley from near Chico in the north to Stanislaus County in the south (Marchand and Allwardt, 1981; Helley and Harwood, 1985). The Riverbank

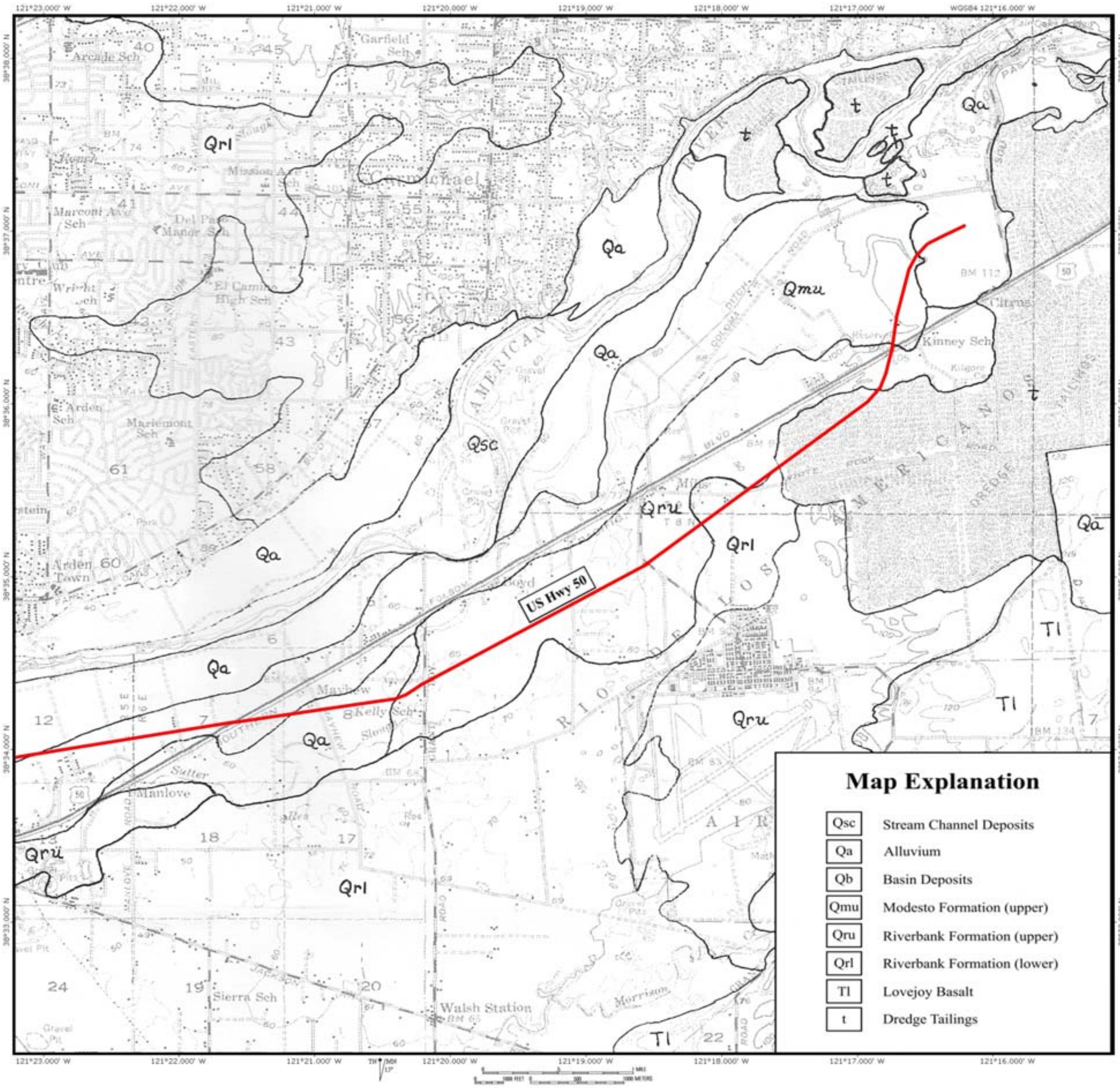

Figure 3. Geologic map of the east half of the U.S. Highway 50 project area (modified from Helley and Harwood, 1985; 1:62,500 scale). The approximate alignment of the U.S. Highway 50 ROW has been added to the 1954 USGS topographic base map used in the original geologic map.

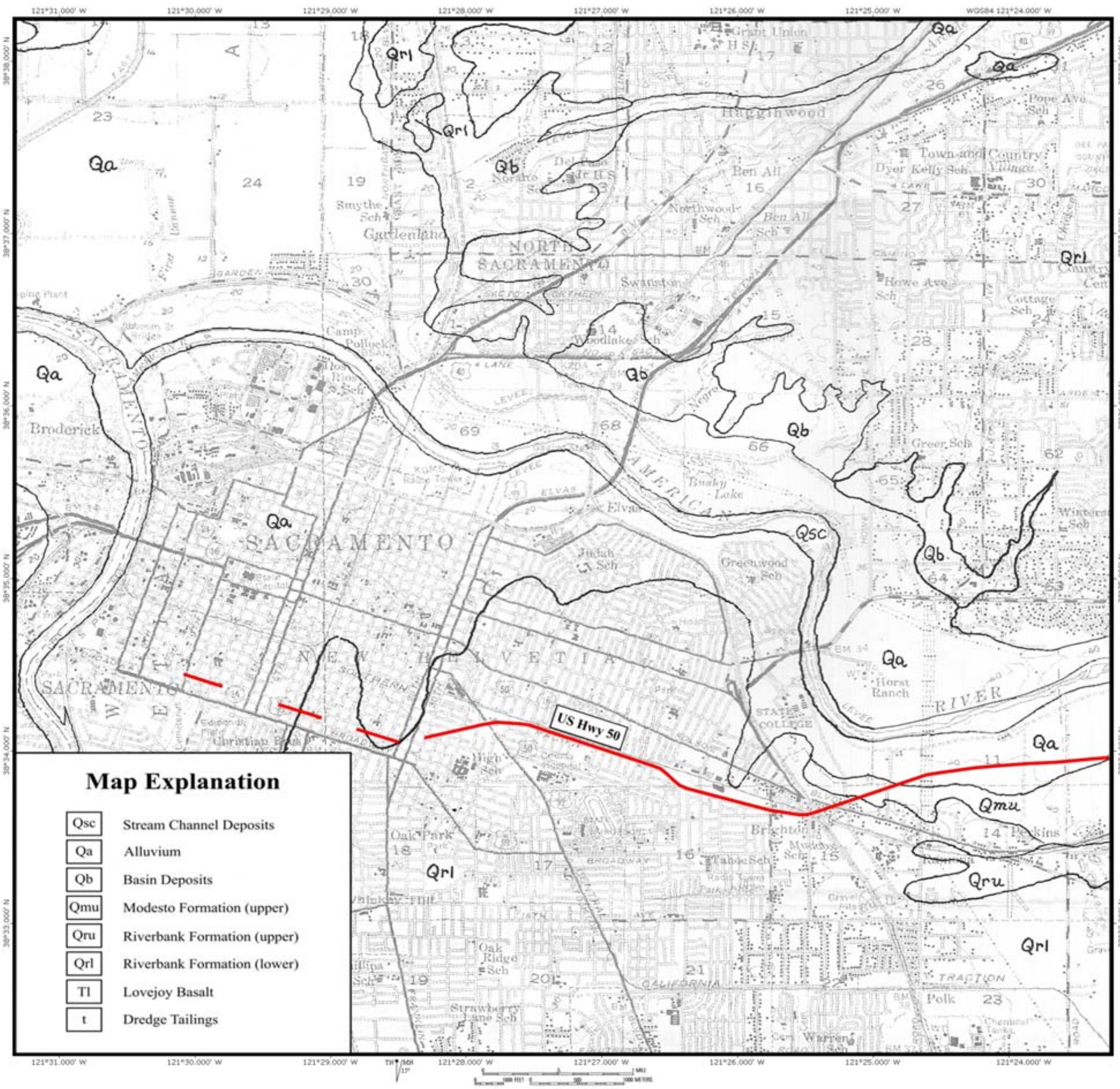

Figure 4. Geologic map of the west half of the U.S. Highway 50 project area (modified from Helley and Harwood, 1985; 1:62,500 scale). The approximate alignment of the U.S. Highway 50 ROW has been added to the 1954 USGS topographic base map used in the original geologic map.

Formation consists of weakly consolidated reddish-brown siltstones, sandstones, and pebble to cobble conglomerates with a few thin intervals of brick-red claystone. Where exposures were available along the east half of the U.S. Highway 50 ROW, coarse cobble conglomerates were abundant (see Figure 5). Marchand and Allwardt (1981) placed the age of the Riverbank Formation between 130,000 and 450,000 years BP, Middle Pleistocene.

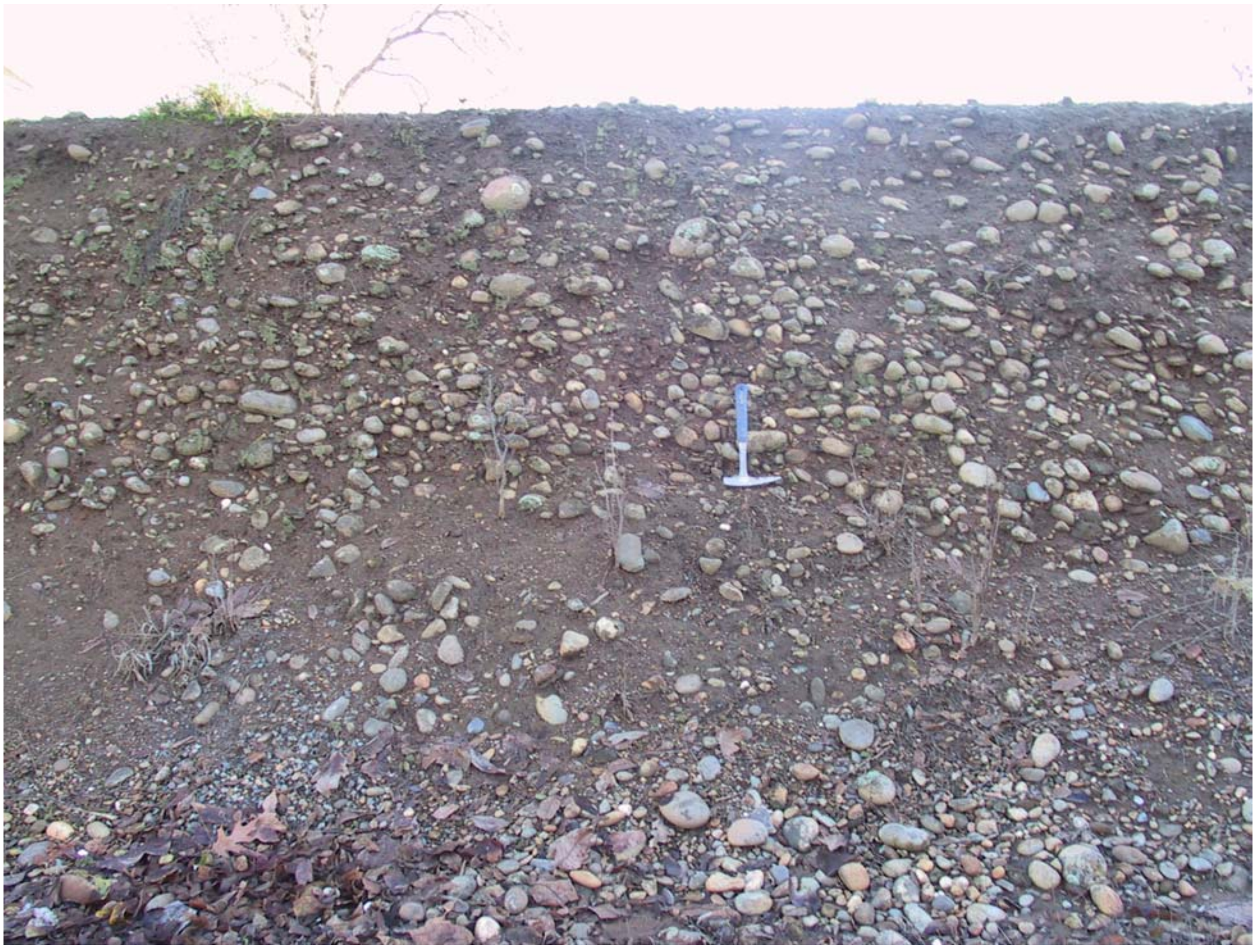

Figure 5. Photograph of an outcrop of upper Riverbank Formation cobble conglomerate exposed at 9986 Horn Road, approximately 0.40 kilometer (0.25 mile) north of U.S. Highway 50 between Mather Field Road and Bradshaw Road.

Modesto Formation. The Late Pleistocene Modesto Formation was first named by Davis and Hall (1959), who designated a type section along the south bluff of the Tuolumne River at the south edge of the City of Modesto. The Modesto Formation is composed of interbedded, largely unconsolidated, and poorly sorted, brownish sandstone and siltstone with lesser amounts of pebble to cobble conglomerate. These beds are primarily fluvial deposits and are believed to represent the depositional cycle between two major glacial stages in the Sierra Nevada (Davis and Hall, 1959; Hall, 1960; Marchand and Allwardt, 1981). Marchand and Allwardt (1981) gave the age of the Modesto Formation between about 42,400 and 12,000 years BP, Late Pleistocene.

Unnamed Quaternary Alluvium. The unnamed Quaternary Alluvium was used by Helley and Harwood (1985) for gravels, sands, silt, and clay deposited along the channels of modern streams and on their flood plains. This informal name is also applied to the lowest and therefore youngest river terraces along the American River north of U.S. Highway 50. The age of the unnamed Quaternary Alluvium is probably Holocene, although Helley and Harwood (1985) suggested the possibility that some sediments referred to this stratigraphic unit may be Late Pleistocene in age. Helley (1979) mapped these deposits simply as Holocene alluvial deposits.

5.3 Paleontological Resource Inventory

An inventory of known paleontological resources previously discovered in the vicinity of the proposed Project is presented below and the paleontological importance of these resources is assessed. The literature review and UCMP archival search conducted for this inventory documented no previously recorded fossil sites within the actual Project ROW. However, sediments of both the Riverbank and Modesto Formations have yielded fossilized remains of extinct species of continental vertebrates at numerous previously recorded fossil sites in the Central Valley (Fisk, 2000, 2001). A number of fossil sites have been reported from sediments of these formations in other exposures within 1.6 kilometers (1 mile) of the U.S. Highway 50 ROW. In addition, fossil remains were found at a previously unrecorded fossil site during the field survey of the proposed Project ROW and vicinity conducted for this assessment.

Riverbank Formation. Sediments of the Riverbank Formation have yielded the fossilized remains of Late Pleistocene plants and animals from numerous previously recorded fossil sites in the Sacramento Valley (Fisk 2000). Fossil vertebrates of Rancholabrean land-mammal age have been reported from Riverbank Formation sediments near their type area (Garber 1989, Jefferson 1991b) and at numerous other scattered locations along the eastern margin of the Central Valley (Fisk and Lander, 1999; Lander, 1999; Fisk, 2000, 2001a, b). Fossils previously reported from the Riverbank Formation include clams, fish, turtles, frogs, snakes, birds (including geese), bison, mammoths, mastodons, ground sloths, camels, horses, deer, dire wolves, coyotes, rabbits, rodents, and land plant remains (including wood, leaves, and seeds). Within Sacramento County the Riverbank Formation has produced significant fossil remains from more than a dozen separate localities (see Table 1). Marchand and Allwardt (1981) reported additional unidentified bones and petrified wood from the Sacramento area but did not provide specific locality information. The UCMP lists eight (8) localities that have produced vertebrate fossils from the Riverbank Formation within Sacramento County (see Table 1). Those known fossil localities closest to U.S. Highway 50 are shown in Figure 6.

During excavations for the construction of a SMUD power plant in south Sacramento, approximately 1.6 kilometers (1 mile) south of U.S. Highway 50, a paleosol (fossil soil horizon) was discovered in Riverbank Formation. This paleosol contained unidentifiable ichnofossils, including root and burrow molds and casts (Fisk, 2001a). The presence of this paleosol and others in the Riverbank Formation indicates that scientifically important fossil specimens may be discovered from paleosol horizons in the Riverbank Formation during future excavations in this vicinity.

During a field survey of prospective fossiliferous sediments near the Project ROW on 04 and 05 January 2006, I found ichnofossils (burrow casts and root casts and molds) in a series of paleosols in Riverbank Formation sediments exposed in a pit excavated for removal of a leaking underground tank along Folsom Boulevard (see Figure 7). This locality is less than 0.40 kilometer (0.25 mile) north of the proposed Project ROW (see Figure 8).

Table 1. Known fossil localities from the Riverbank Formation in Sacramento County.

Name	Location	Specimens	Reference(s)
ARCO Arena	Arco Arena, 3.6 meters (12 feet) deep NE/4 SW/4, Sect. 11, T7N, R6E	clams, birds, bison, ground sloth, camels, horses dire wolf, rodents, land plant seeds	Hilton and others 2000, Jefferson 1991a
Davis Gravel Pit UCMP V-6747	gravel pit on N. side of Jackson Road (Hwy 16) 0.1 mi. east of intersection with Florin-Perkins Road; NW/4 SW/4 Sect. 13, T8N, R5E	mammoth, camel, and horse	Shlemon 1967b; Hansen and Begg 1970; UCMP records
Perkins Gravel Pit	gravel pit near Perkins on Jackson Road (Highway 16), approx. in SE/4 SW/4, Sect. 14, T8N, R5E	mastodon, mammoth, and camel	Amundson 1984; Sacramento City College display case in Mohr Hall
Teichert Gravel Pit #1 UCMP V-69129	gravel pit along Manlove Road, SW/4NW/4, Sect. 19, T8N, R6E	fish, turtles, frogs, snakes, geese, bison, camel, horse, mammoth, ground sloth, deer, dire wolf, coyote, rodents, rabbit, land plant remains	Piper and others 1939; Shlemon and Hansen 1969; Hansen and Begg 1970; Amundson 1984; Jefferson 1991a, b; UCMP records
Teichert Gravel Pit #2 UCMP V-75126	gravel pit along Manlove Road, SW/4 NW/4, Sect. 19, T8N, R6E	land mammals	Hansen and Begg 1970; Harris 1985; Jefferson 1991a, b; UCMP records
East of Teichert Gravel Pits	east of gravel pit along Manlove Road SW/4 NW/4, Sect. 19, T8N, R6E	land mammals	Amundson 1984
Ehrhardt Avenue UCMP V-74086	W of Cosumnes River College NE/4 SW/4, Sect. 16, T7N, R6E	land mammals	UCMP records
Elk Grove Gravel Pit	gravel pit 2.4 kilometers (1.5 miles) north of Elk Grove NE/4 SW/4, Sect. 30, T7N, R6E	scapula of a horse	Piper and others 1939
Herald UCMP V-3524	1 kilometer (0.6 mile) SSW of community of Herald, NE/4 NE/4, Sect. 18, T7N, R6E	horse tooth	UCMP records; Fisk 2001b
Chicken Ranch Slough #1 UCMP V-6846	SE/4 SW/4, Sect. 28, T8N, R5E	mammoth	Jefferson 1991a; UCMP records
Chicken Ranch Slough #2 UCMP V-68141	SE/4 SW/4, Sect. 28, T8N, R5E	horse	Jefferson 1991a, UCMP records
Rocklin UCMP V-6952	S/2 NE/4 SE/4, Sect. 19, T11N, R7E in the City of Rocklin	land mammals	UCMP records
SMUD SCA Power Plant	center of Sect. 23, T8N, R5E	paleosol with ichnofossils (burrow and root casts and molds)	Fisk 2001a

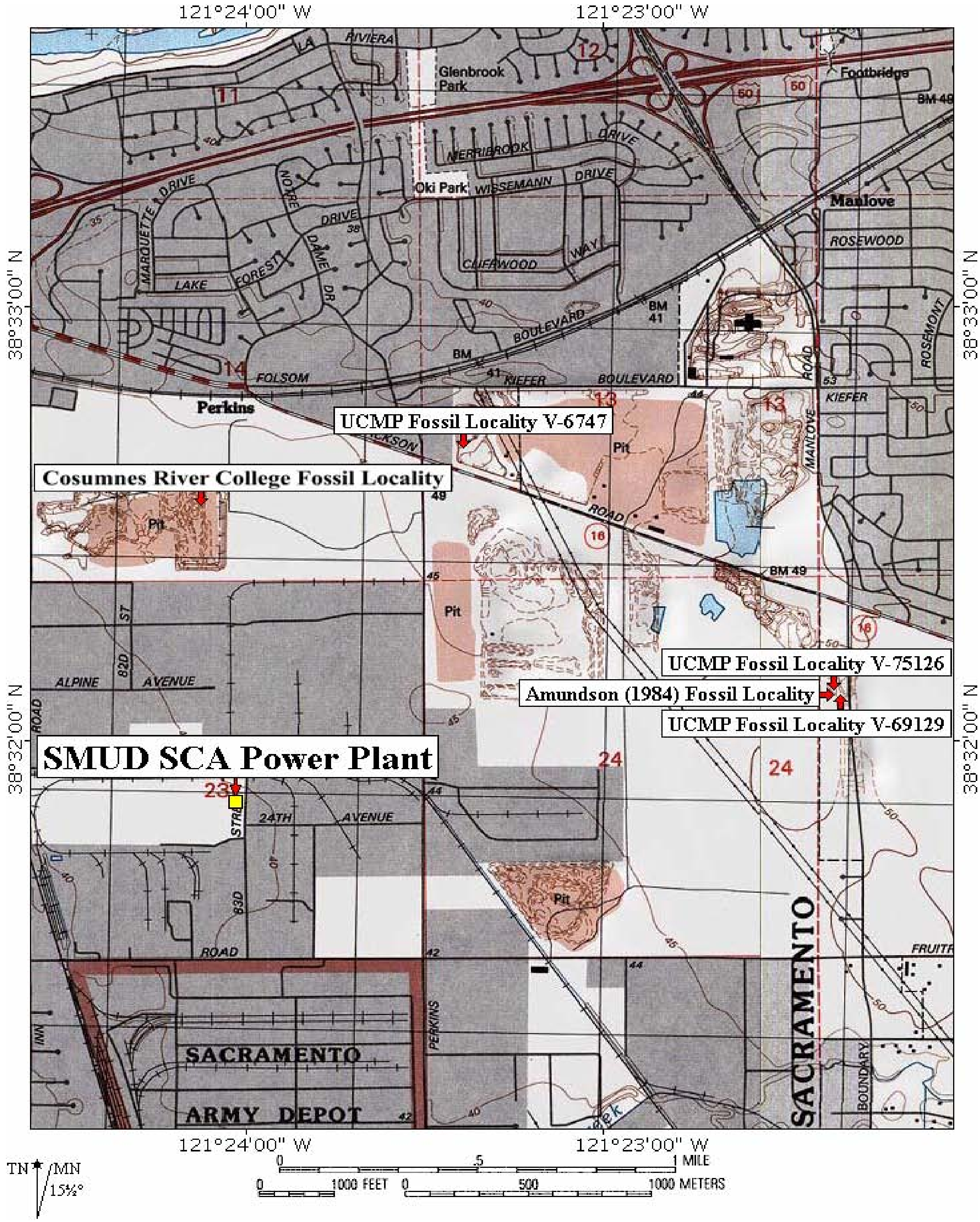

Figure 6. Map showing the location of known fossil localities 1.6 to 3.2 kilometers (1 to 2 miles) south of the proposed U.S. Highway 50 ROW. Map modified from USGS East Sacramento and Carmichael 7.5-minute (1:24,000 scale) Quadrangles.

Figure 7. Photograph of Riverbank Formation sediments exposed in a pit for the removal of a leaking underground tank at 5118 Folsom Boulevard, less than 0.40 kilometer (0.25 mile) north of U.S. Highway 50 between 59th Street and Stockton Boulevard. The light bands in the upper portion of the pit wall are paleosols (fossil soils) containing burrow and root casts and molds (ichnofossils).

These fossil remains previously recovered from the Riverbank Formation are scientifically significant because the taxa they represent had been previously unreported or only very rarely reported from the fossil record of California. Moreover, continental vertebrate remains are comparatively rare in the fossil record. In addition, paleontological data derived from a study of the fossil remains, in conjunction with geologic (particularly geochronologic, sedimentologic, and paleomagnetic) evidence, have been significant in documenting the origin and age of the Riverbank Formation and in reconstructing the Pleistocene geologic history of the Sacramento Valley and Sierra Nevada.

Since fossil vertebrates have been previously reported from this formation and since depositional conditions observed in exposures in the vicinity of the Project ROW appear to be favorable for the preservation of fossils, the Riverbank Formation is judged to have high sensitivity. There is a high probability of adverse impacts on paleontological resources resulting from ground disturbance during Project excavations in sediments of the Riverbank Formation.

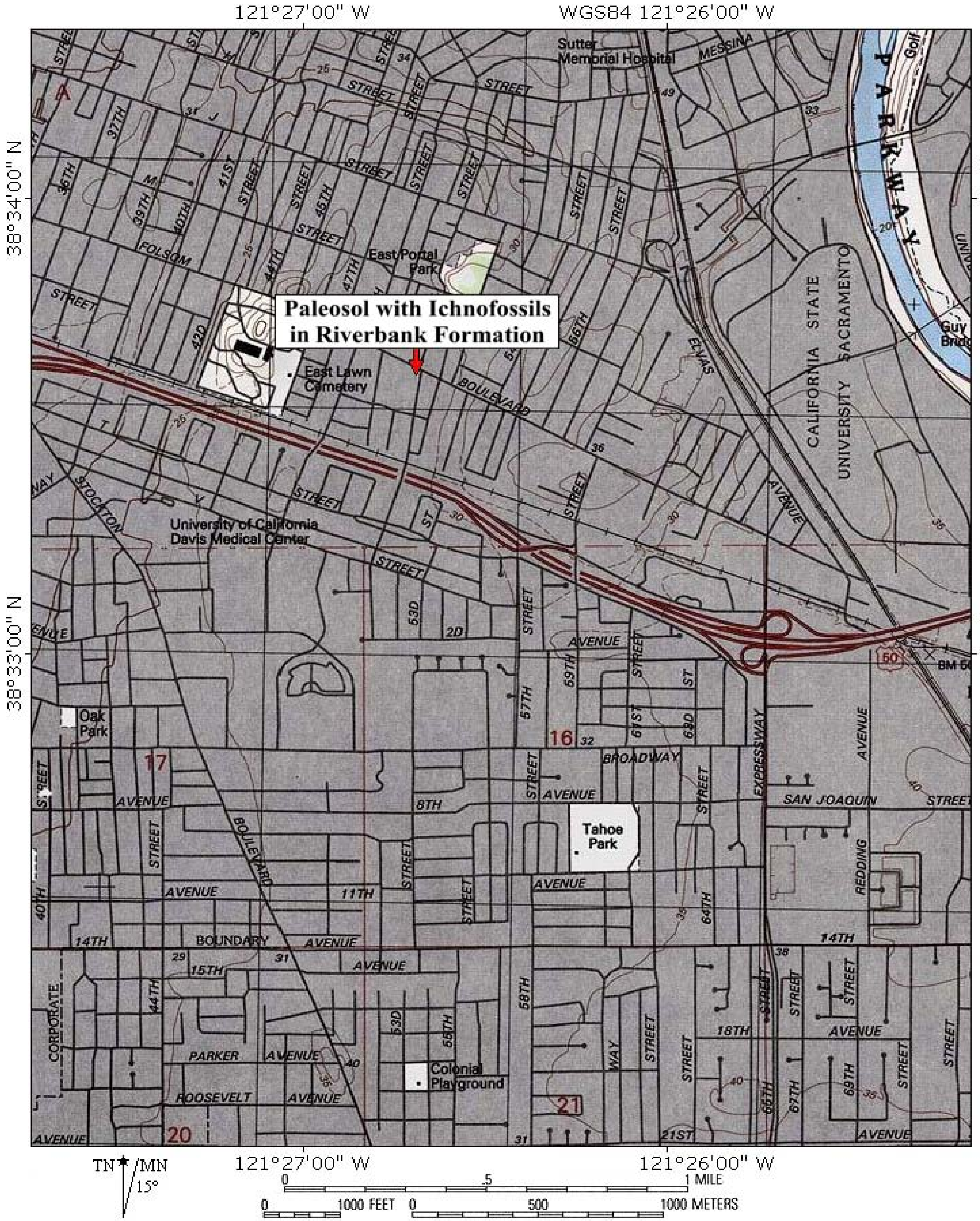

Figure 8. Map showing the location of a known fossil locality less than 0.40 kilometer (0.25 mile) north of the proposed U.S. Highway 50 ROW. Map modified from USGS East Sacramento 7.5-minute (1:24,000 scale) Quadrangle.

Modesto Formation. Fossil vertebrates of Rancholabrean land-mammal age and fossil wood have previously been reported from sediments of the Modesto Formation near its type area (Garber, 1989; Jefferson, 1991b; Marchand and Allwardt, 1981) and at numerous other scattered locations along the east side of the Central Valley (Fisk and Lander, 1999; Lander, 1999; Fisk and Maloney 2004). Jefferson (1991a, 1991b) compiled a data base of California Pleistocene (primarily Rancholabrean NALMA) vertebrate fossils from published records, technical reports, unpublished manuscripts, information from colleagues, and inspection of museum paleontological collections at over 40 public and private institutions. He listed seven (7) sites in Sacramento County that yielded Rancholabrean vertebrate fossils, including several UCMP localities. Some, if not all, these fossil sites would presumably be referable to the Modesto Formation. The mammals previously collected from this stratigraphic unit include mammoths, bison, horses, camels, ground sloths, and various rodents (Jefferson, 1991b; UCMP records). The age of these Late Pleistocene Rancholabrean faunas is primarily based on the presence of *Bison*, along with many mammalian species which are inhabitants of the same area today. Since it is possible that additional significant paleontological resources could be found in sediments of the Modesto Formation, this stratigraphic unit has high sensitivity for paleontological resources.

Unnamed Quaternary Alluvium. During the geological and paleontological literature review and museum archival records searches for this paleontological resource impact assessment, I found no previously recorded fossil sites in the unnamed Quaternary alluvium. During a field survey of prospective fossiliferous sediments on 04-05 January 2006, I found no indications that the unnamed Quaternary alluvium might be fossiliferous.

Summary. Although no fossils are known to directly underlie the proposed Project ROW, the presence of fossil sites in alluvial deposits of the Riverbank and Modesto Formations elsewhere suggests that there is a high potential for additional similar fossil remains to be uncovered by excavations in these formations during Project construction. Under SVP (1995) criteria, both these formations have a high sensitivity for producing additional paleontological resources. Identifiable fossil remains recovered from these formations during Project construction could be scientifically important and significant.

Identifiable fossil remains recovered during Project construction could represent new taxa or new fossil records for the area, for the State of California, or for a formation. They could also represent geographic or temporal range extensions. Moreover, discovered fossil remains could make it possible to more accurately determine the age, paleoclimate, and depositional environment of the sediments from which they are recovered. Finally, fossil remains recovered during Project construction could provide a more comprehensive documentation of the diversity of animal and plant life that once existed in Sacramento County and could result in a more accurate reconstruction of the geologic and paleobiologic history of the Central Valley and Sierra Nevada.

SECTION 6
ENVIRONMENTAL CONSEQUENCES

6.1 Potential Impacts from Project Construction

Potential impacts on paleontological resources resulting from construction of the proposed Project primarily involve terrain modification (excavations and drainage diversion measures). Paleontologic resources, including an undetermined number of fossil remains and unrecorded fossil sites; associated specimen data and corresponding geologic and geographic site data; and the fossil-bearing strata, could be adversely impacted by ground disturbance and earth moving associated with construction of the Project. Direct impacts could result from vegetation clearing, grading, widening of road cuts, and any other earth-moving activity that disturb or bury previously undisturbed fossiliferous sediments, making those sediments and their paleontological resources unavailable for future scientific investigation.

The planned site clearing, grading, and deeper excavation at the site could result in significant adverse impacts to paleontological resources. In addition, the construction of supporting facilities, such as temporary construction offices, laydown areas, and parking areas, have potential to cause adverse impacts on significant paleontological resources, as they also will involve extensive new ground disturbance. Thus, any project-related ground disturbance could have adverse impacts on significant paleontological resources. However, with a properly designed and implemented mitigation program, these impacts would be reduced to less than significant.

6.2 Cumulative Impacts

If the project were to encounter paleontological resources during construction, the potential cumulative effect would be significant. However, with a properly designed and implemented mitigation program, these impacts would be reduced to less than significant. The mitigation measures proposed below would effectively recover the scientific value of any significant fossils uncovered.

SECTION 7
MITIGATION MEASURES

This section describes proposed mitigation measures that would be implemented to reduce potential adverse impacts to significant paleontological resources resulting from Project construction. Mitigation measures are necessary because of potential adverse impacts of Project construction on significant paleontological resources within the Riverbank and Modesto Formations. The proposed paleontological resource impact mitigation program would reduce to an insignificant level the direct, indirect, and cumulative adverse environmental impacts on paleontological resources that could result from Project construction. The mitigation measures proposed below are consistent with SVP standard guidelines for mitigating adverse construction-related impacts on paleontological resources (SVP 1995, 1996).

Prior to construction, a qualified paleontologist should be retained to both design a monitoring and mitigation program and implement the program during all project-related ground disturbance. The paleontological resource monitoring and mitigation program should include preconstruction coordination; construction monitoring; emergency discovery procedures; sampling and data recovery, if needed; preparation, identification, and analysis of the significance of fossil specimens salvaged, if any; museum storage of any specimens and data recovered; and reporting. Prior to the start of construction, the paleontologist should conduct a field survey of exposures of sensitive stratigraphic units within the construction ROW that will be disturbed. Earth-moving construction activities should be monitored wherever these activities will disturb previously undisturbed sediment. Monitoring will not need to be conducted in areas where sediments have been previously disturbed or in areas where exposed sediments will be buried, but not otherwise disturbed.

Prior to the start of construction, construction personnel involved with earth-moving activities should be informed that fossils may be discovered during excavating, that these fossils are protected by laws, on the appearance of common fossils, and on proper notification procedures. This worker training should be prepared and presented by a qualified paleontologist.

Implementation of these mitigation measures will reduce the potentially significant adverse environmental impact of project-related ground disturbance and earth-moving on paleontological resources to an insignificant level by allowing for the recovery of fossil remains and associated specimen data and corresponding geologic and geographic site data that otherwise might be lost to earth-moving and to unauthorized fossil collecting.

With a well designed and implemented paleontological resource monitoring and mitigation plan, Project construction could actually result in beneficial effects on paleontological resources through the discovery of fossil remains that would not have been exposed without Project construction and, therefore, would not have been available for study. The recovery of fossil remains as part of Project construction could help answer important questions regarding the geographic distribution, stratigraphic position, and age of fossiliferous sediments in the Project area.

SECTION 8
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