

Interstate 205/Lammers Road Interchange Project



Paleontological Identification Report

City of Tracy

San Joaquin County, California

10-SJ-205-KP3.8/R8.5 (PM2.6/R5.1)

EA0H910K

July 2010



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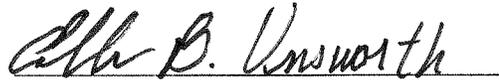
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U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration, and
STATE OF CALIFORNIA
Department of Transportation
CITY OF TRACY

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Interstate 205/Lammers Road Interchange Project Paleontological Identification Report (July 2010) Errata, September 2011

Note: Where necessary in this errata sheet, omitted text is struck out and new or replaced text is underlined, to indicate specific changes to the original document.

Alternative 1 was removed from consideration in August 2011 when it was determined not to be a geometrically viable alternative. Alternative 1 does not meet the interchanging spacing requirement per the Highway Design Manual Topic 501.3, “The minimum Interchange spacing shall be one mile urban areas, two miles in rural areas, and two miles between freeway-to-freeway interchanges and local street interchanges.” The available spacing between the existing partial Eleventh Street interchange and the proposed Lammers Road interchange would be only 0.8 mile. This deficiency was acknowledged and a mandatory design exception was sought. The exception was declined due to limited discussion regarding extenuating circumstances that prevented the alternative from achieving the required spacing and the existence of an alternative that did meet the spacing requirement (Alternative 5A).

Therefore the following changes are made:

Cover and Title Page: Change Post miles in title

10-SJ-205-~~KP3.8/R8.5 (PM2.6/R5.1)~~PM2.5/R4.9

Throughout Document: Disregard description of, analysis of, and reference to Alternative 1 throughout document.

Interstate 205/Lammers Road Interchange Project Paleontological Identification Report (July 2010) Errata, February 2011

Note: Omitted text is struck out. New or replaced text is underlined.

Page 2: Add the following to the *Alternative 1-New Spread Diamond Interchange at Lammers Road Discussion* immediately following the list of bullets.

Structures. The Lammers Road overcrossing would be designed to accommodate the future widening of I-205 to ten lanes.

Local Streets. Modifications would be required for various local streets to accommodate the new interchange. Local streets would be impacted temporarily during construction to accommodate contractor access and complete construction tasks.

Pedestrian and Bicycle Facilities. Pedestrian facilities would be provided across I-205 on both sides of Lammers Road in conformity with the City General Plan.

Drainage. Additional drainage improvements are required along the mainline due to the increase in paved surfaces and subsequent runoff. Drainage improvements include, but are not limited to, surface and subsurface drains and retention ditches along the auxiliary lanes between Lammers Road and Grant Line Road. Retention basins within the interchange area would be constructed to accommodate the storm runoff from the interchange ramps. There are no surface water bodies that are located within the project area and hence no treatment BMPs are required for the project.

Park and Ride Facilities. 1-acre Park and Ride facilities would be provided in the vicinity of the project at the southwest corner of the eastbound ramp intersection.

Landscaping. Standard landscaping would be provided within the new interchange improvements which may include trees and shrub in accordance with Caltrans allowances. Along I-205, erosion control would be provided on embankment side slopes and ditches. Other landscaping would be provided in accordance with mitigation requirements (e.g., due to the loss of existing trees within the I-205 corridor). Replacement landscaping may occur at an offsite location.

Page 3: Add the following to the *Alternative 5A-Modified Eleventh Street Partial Cloverleaf Interchange* immediately following the list of bullets.

Structures. The Eleventh Street Overcrossing would be designed to accommodate the future widening of I-205 to ten lanes. The existing Eleventh Street westbound on-ramp overcrossing would be demolished.

Local Streets. Modifications would be required for various local streets to accommodate the new interchange. Local streets would be impacted temporarily during construction to accommodate contractor access and complete construction tasks.

Pedestrian and Bicycle Facilities. Pedestrian facilities would be provided to cross I-205 on both sides of Lammers Road in conformity with the City General Plan.

Drainage. Additional drainage improvements are required along the mainline due to the increase in paved surfaces and subsequent runoff. Drainage improvements include, but are not limited to, surface and subsurface drains and retention ditches along the auxiliary lanes and basins within the interchange area. There are no surface water bodies that are located within the project area and hence no treatment best management practices (BMPs) are required for the project.

Park and Ride Facilities. 1-acre Park and Ride facilities would be provided in the vicinity of the project at the northeast corner of the Commerce Way and 11th Street intersection.

Landscaping. Standard landscaping would be provided within the new interchange improvements which may include trees and shrub in accordance with Caltrans allowances. Along I-205, erosion control would be provided on embankment side slopes and ditches. Other landscaping would be provided in accordance with mitigation requirements (e.g., due to the loss of existing trees within the I-205 corridor). Replacement landscaping may occur at an offsite location.

Page 9: Replace Figure 1 with attached Figure 1

Executive Summary

The California Department of Transportation (Caltrans), in cooperation with the City of Tracy (City), proposes to construct a new interchange at Lammers Road on Interstate 205 (I-205) between the Eleventh Street and Grant Line Road interchanges in northwest Tracy.

The proposed interchange improvements would eliminate the existing interchange at Eleventh Street/I-205 to provide full ramp movements at a new location. A new roadway segment would connect to the proposed interchange improvements, extending south from Eleventh Street on the south to Byron Road on the north, crossing over I-205 via a grade-separated structure, and connecting to the existing intersection at or near Lammers Road/Eleventh Street in the City of Tracy and at or near the intersection of Grant Line Road/Byron Road just outside City limits. Two alternatives are proposed. Alternative 1 consists of a spread diamond configuration to be constructed slightly west of the other alternative, Alternative 5A, a partial cloverleaf configuration.

A review of geologic maps, the project footprint, and proposed construction methods indicates that most of the project construction will be located within areas of low sensitivity for paleontological resources (artificial fill and Holocene alluvial fan deposits). The westernmost area of Alternative 5A would be located on Late Pleistocene alluvial fan deposits, which are highly paleontologically sensitive. Excavation associated with road grading and installation of utilities may affect fossil deposits within the westernmost area of the Alternative 5A footprint. There is also the potential for deeper excavations associated with both alternatives to disturb fossil deposits under Holocene alluvial fan deposits. Compliance with Caltrans Standard Specific 14-7 is adequate to manage potential paleontological resources discovered during project construction.

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List of Abbreviated Terms

APE	area of potential effect
Caltrans	California Department of Transportation
CIDH	cast-in-drilled hole
City	City of Tracy
I-205	Interstate 205
PIR	paleontological identification report
UCMP	University of California Museum of Paleontology

Paleontological Identification Report

Introduction

The California Department of Transportation (Caltrans), in cooperation with the City of Tracy (City), proposes to construct a new interchange at Lammers Road on Interstate 205 (I-205) between the Eleventh Street and Grant Line Road interchanges in northwest Tracy.

The proposed interchange improvements would eliminate the existing interchange at Eleventh Street/I-205 to provide full ramp movements at a new location. A new roadway segment would connect to the proposed interchange improvements, extending south from Eleventh Street on the south to Byron Road on the north, crossing over I-205 via a grade-separated structure, and connecting to the existing intersection at or near Lammers Road/Eleventh Street in the City of Tracy and at or near the intersection of Grant Line Road/Byron Road just outside City limits.

The project is included in the 2007 Federal Statewide Transportation Improvement Program and is included in the San Joaquin Council of Government's 2011 Regional Transportation Plan Tier 1 financially constrained list. Funding is proposed from a variety of sources including San Joaquin County Measure K Renewal sales tax program, and local Public Facility Fees generated by ongoing development, direct developer contribution and federal grants.

This paleontological identification report (PIR) describes the paleontological constraints associated with the Project and evaluates the potential impacts to paleontological resources.

Project Overview

Two build alternatives are being considered: Alternative 1—Spread Diamond Interchange and Alternative 5A—Modified Eleventh Street Partial Cloverleaf Interchange. Each alternative is discussed in more detail below.

Alternative 1—New Spread Diamond Interchange at Lammers Road

This alternative would provide a new interchange at Lammers Road over I-205, with four new connection points to I-205. The existing partial Eleventh Street interchange ramps to and from I-205 west would be retained. Lammers Road would be realigned as a six-lane arterial/expressway north of Eleventh Street with an overcrossing at I-205 and would extend north to Grant Line Road and realign with Byron Road. A spread diamond (Type L-2) interchange would be constructed for Lammers Road at I-205 approximately 1 mile east of the Eleventh Street interchange and 1.2 miles west of the Grant Line Road interchange. Auxiliary lanes would connect the ramps between Lammers Road and Grant Line Road in each direction. Local road improvements would include:

- realignment and extension of Grant Line Road over Byron Road to connect with Lammers Road north of I-205,
- extension of Commerce Way north of Eleventh Street to connect with the new alignment of Lammers Road south of I-205,
- revision of access to the Westgate neighborhood currently served by the existing Lammers Road, and
- construction of a new local road north of I-205 to connect Lammers Road and Byron Road.

Alternative 5A—Modified Eleventh Street Partial Cloverleaf Interchange

This alternative would reconstruct the existing Eleventh Street ramps on I-205 by replacing them with a partial cloverleaf (Type L-9) interchange at a realigned Eleventh Street, while closing and removing the existing Eleventh Street ramps to and from I-205 west. The replacement interchange would be located approximately 2.3 miles east of Mountain House Parkway interchange and 1.6 miles west of the Grant Line Road interchange. An auxiliary lane in the westbound direction along I-205 would connect the westbound Grant Line Road onramp to the westbound Eleventh Street exit ramp. Local road improvements would include:

- realignment and extension of Eleventh Street to curve to the north west of Lammers Road to connect to Byron Road north of I-205,
- realignment and extension of Grant Line Road over Byron Road to connect with Eleventh Street north of I-205, and

- construction of a new local road north of I-205 to connect Eleventh Street and Byron Road.

Vertical Area of Potential Effect

The vertical area of potential effect would be similar under the two alternatives.

Under both alternatives, construction of the proposed facilities would require grading and other ground-disturbing activities. Potential disturbances to the existing ground during construction are described below based on the current preliminary project design process (Dadala pers. comm.).

- Bridge design is not yet complete, but the overpass structure is expected to require a pile foundation. The depth of piles is expected to be on the order 50–70 feet. Piles would likely be driven rather than cast in place. Bridge construction would occur within the existing Caltrans right-of-way, which is presumed to have been subject to disturbance during construction of the existing roadways.
- Retention basins would be excavated to a depth of 4 feet.
- Trenches for installation of new storm drain culvert would be excavated to a maximum depth of 7 feet and maximum width of 10 feet.
- Traffic signals would be installed using cast-in-drilled hole (CIDH) pile foundations. Foundations would be drilled to an expected maximum depth of 16 feet.

Best Management Practice for Paleontological Monitoring

Caltrans plans to require the presence of a qualified paleontological monitor during all project activities that require excavation or other ground disturbance deeper than 3 feet. The paleontological monitor will work under the supervision of a paleontologist meeting Caltrans' qualifications for principal paleontologist. Areas where ground disturbance deeper than 3 feet is anticipated will be clearly demarcated on plan sheets provided to the principal (supervising) paleontologist.

Regulatory Setting

California Environmental Quality Act

CEQA affords protection to “any object [or] site ... that has yielded or may be likely to yield information important in prehistory” (State CEQA Guidelines Section 15064.5), which is typically interpreted as including fossil materials and other paleontological resources. In addition, destruction of a “unique paleontological resource or site or unique geologic feature” constitutes a significant impact under CEQA (State CEQA Guidelines Appendix G). The treatment of paleontological resources under CEQA is generally similar to the treatment of cultural resources, requiring an evaluation of resources in a project’s area of potential effect (APE); an assessment of potential impacts on significant or unique resources; and the development of mitigation measures, which may include monitoring combined with data recovery or avoidance (or both).

California Public Resources and Administrative Codes

Several sections of the California PRC protect paleontological resources. Section 5097.5 prohibits “knowing and willful” excavation, removal, destruction, injury, and defacement of any paleontological feature on public lands (lands under state, county, city, district, or public authority jurisdiction or under the jurisdiction of a public corporation), except where the agency with jurisdiction has granted express permission. Section 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands. The sections of the California Administrative Code relating to the State Division of Beaches and Parks afford protection to geologic features and “paleontological materials” but grant the director of the state park system authority to issue permits for specific activities that may result in damage to such resources, if the activities are in the interest of the state park system and for state park purposes (California Administrative Code Sections 4306–4309).

Caltrans Standard Specifications

Section 14-7 of the Caltrans Standard Specifications (included in the Amendments to the 2006 Standard Specifications, available at

http://www.dot.ca.gov/hq/esc/oe/specifications/SSPs/2006-SSPs/Sec_01-03/>), requires the following actions in the event paleontological resources are encountered during project construction: stopping all work within a 60-foot radius of the discovery; protecting the area of the discovery; and notifying the project engineer. Personnel are explicitly prohibited from removing paleontological resources from the job site, and work may not resume in the protected area until authorized.

San Joaquin County General Plan

The San Joaquin County General Plan (1992) indicates that the county takes two types of actions related to paleontological resources. First, most project applications require that information be gathered on resources; if resources are discovered, action must be taken to protect them. Second, if previously unknown resources are discovered during construction, construction must stop until a qualified professional is consulted and actions are taken to protect the resources.

City of Tracy General Plan

Policy P5 in the Community Character element of the City's current General Plan (City of Tracy 2006) mandates that paleontological discoveries on private lands are to be "adequately documented and conserved as a condition of removal" and requires a stop work until study and conservation measures have been implemented; presumably this includes discoveries on private lands where City right-of-way has been established. Compliance is presumed to be ensured through the City's grading inspection process.

Methods

Consistent with standard professional practice and Caltrans protocols, the project's potential to result in significant damage or loss of paleontological resources was evaluated based on preliminary project design, in consideration of site geology and the paleontological sensitivity of the geologic units potentially affected by the project.

Information on geologic setting and site paleontology presented in this PIR was derived from published scientific literature. In addition, the databases of several paleontological institutions were searched for records of fossil finds in the project vicinity and in the geologic units of interest elsewhere in San Joaquin County. No

new fieldwork or surveys were conducted for this PIR. Specific reference information is provided in the text; a complete reference list is presented at the end of this report.

The paleontological sensitivity of geologic units in the project area was assessed according to standard Caltrans criteria (California Department of Transportation 2008). The Caltrans criteria use three categories to describe the likelihood that a geologic unit contains significant fossil materials: high potential, low potential, and no potential, defined as shown in Table 1.

Table 1 Caltrans Paleontological Sensitivity Terminology

Sensitivity Designation (Potential to Contain Significant Paleontological Resources)	Characteristics of Geologic Units in This Category
High potential (High Sensitivity)	<p>This category consists of rock units known to contain significant vertebrate, invertebrate, or plant fossils anywhere within their geographic extent, including sedimentary rock units that are suitable for the preservation of fossils, as well as some volcanic and low-grade metamorphic rock units.</p> <p>This category includes rock units with the potential to contain:</p> <ul style="list-style-type: none"> • abundant vertebrate fossils; • a few significant vertebrate, invertebrate, or plant fossils that may provide new and significant taxonomic, phylogenetic, ecologic, or stratigraphic data (or all); • areas that may contain datable organic remains older than Recent; • areas that may contain unique new vertebrate deposits, traces, or trackways (or all); and • fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and cave deposits).
Low potential (Low Sensitivity)	<p>This category includes sedimentary rock units that:</p> <ul style="list-style-type: none"> • are potentially fossiliferous but have not yielded significant fossils in the past; • have not yet yielded fossils but have the potential to contain fossil remains; or • contain common or widespread (or both) invertebrate fossils of species whose taxonomy, phylogeny, and ecology are well understood. <p>Note that sedimentary rocks expected to contain vertebrate fossils are considered highly sensitive, because vertebrates are generally rare and found in more localized strata.</p>
No potential (No Sensitivity)	<p>This category includes rock units of intrusive igneous origin, most extrusive igneous rocks, and moderate- to high-grade metamorphic rocks.</p>

Source: California Department of Transportation, 2008.

Affected Environment

Geologic Setting

The City of Tracy, including the project alignment, is in the northwestern San Joaquin Valley. The San Joaquin Valley is the southern portion of California's Great Valley geomorphic province, which is dominated by the expansive alluvial plain that lies between the Sierra Nevada on the east and the Coast Ranges on the west. Subdivided into the Sacramento Valley to the north and the San Joaquin Valley to the south, the valley has an average width of about 50 miles and is overall about 400 miles long. Its southern end is defined by the Tehachapi Mountains north of Los Angeles, and its northern end is defined by the Klamath Mountains (Norris and Webb 1990; Harden 1998; Bartow 1991).

The City is located at the west margin of the Valley, where geologically Recent and nearly flat-lying Valley floor deposits meet alluvial fans developed along the east flank of the Diablo Range (Wagner et al. 1991).

As shown in Figure 1, the Alternative 1 alignment is situated on alluvial fan deposits of Holocene age (Qhf unit in Figure 1), which consist of moderately to poorly sorted and bedded sand, gravel, silt, and clay. Holocene alluvial fan deposits typically overlie Pleistocene alluvial fan deposits and locally form only a thin veneer atop the older strata (Knudsen and Lettis 1997); the depth to top Pleistocene in the project area is not known. Artificial fill (af) has been placed over native substrate materials along several major roadway alignments in the area, including the I-205 corridor and Byron Road (Knudsen and Lettis 1997). The thickness of fill materials in the project area is not known.

Extending slightly to the west of the Alternative 1 alignment, the Alternative 5A alignment is also situated primarily on Holocene alluvial fan deposits (Figure 1). However, the west end (approximately 3,000 linear feet of roadway) is directly underlain by Late Pleistocene alluvial fan deposits (Qpf in Figure 1), which are distinguished from younger alluvial fan strata by their greater dissection and differing degree of soil development (Knudsen and Lettis 1997).

Paleontological Sensitivity

Artificial fill materials are unlikely to contain fossil materials—fossil content in anthropogenic materials would be an unusual occurrence attributable to the source of the materials used as fill—and the fill deposits in the project area are accordingly evaluated as having no sensitivity for paleontological resources.

Holocene materials are not typically evaluated as paleontologically sensitive, because biological remains are not considered fossils unless they are older than 10,000 years. There may be site-specific exceptions to this general approach, but the University of California Museum of Paleontology (UCMP) database contains no records for fossil finds from Holocene units in San Joaquin County (University of California Berkeley Museum of Paleontology 2010). Accordingly, the Holocene alluvial fan deposits that immediately underlie the Alternative 1 alignment, and much of the Alternative 5A alignment, are considered to have no sensitivity to low sensitivity for paleontological resources.

The alluvial fan deposits of Pleistocene age, both those inferred to underlie Holocene deposits in the subsurface and those exposed at the surface at the west end of the Alternative 5A alignment, are considered to have high sensitivity for paleontological resources, consistent with the prevailing standard of care—California’s Pleistocene nonmarine strata have yielded a wealth of stratigraphically important vertebrate fossils, including the assemblages that defined both the Rancholabrean and Irvingtonian Stages of the North American Land Mammal Chronology, which is used as a reference by paleontologists and stratigraphers across the country. Because of this wealth of information, continental deposits of Pleistocene age are almost universally treated as paleontologically sensitive in California. Demonstrating the potential for vertebrate finds in San Joaquin County Pleistocene units, the UCMP database lists 29 records of vertebrate finds in the County. These include horse (*Equus* sp.), mammoth/mastodon (*Mammuthus/Mammot* sp.), camel (*Camelops* sp.), bison (*Bison* sp.), and ground sloth (*Megalonyx* sp.) (University of California Museum of Paleontology 2010). In the project area but outside the project footprint, fossil finds have been located south of I-205 along the I-580 corridor and the Delta-Mendota Canal (City of Tracy 2006:4.5-9).

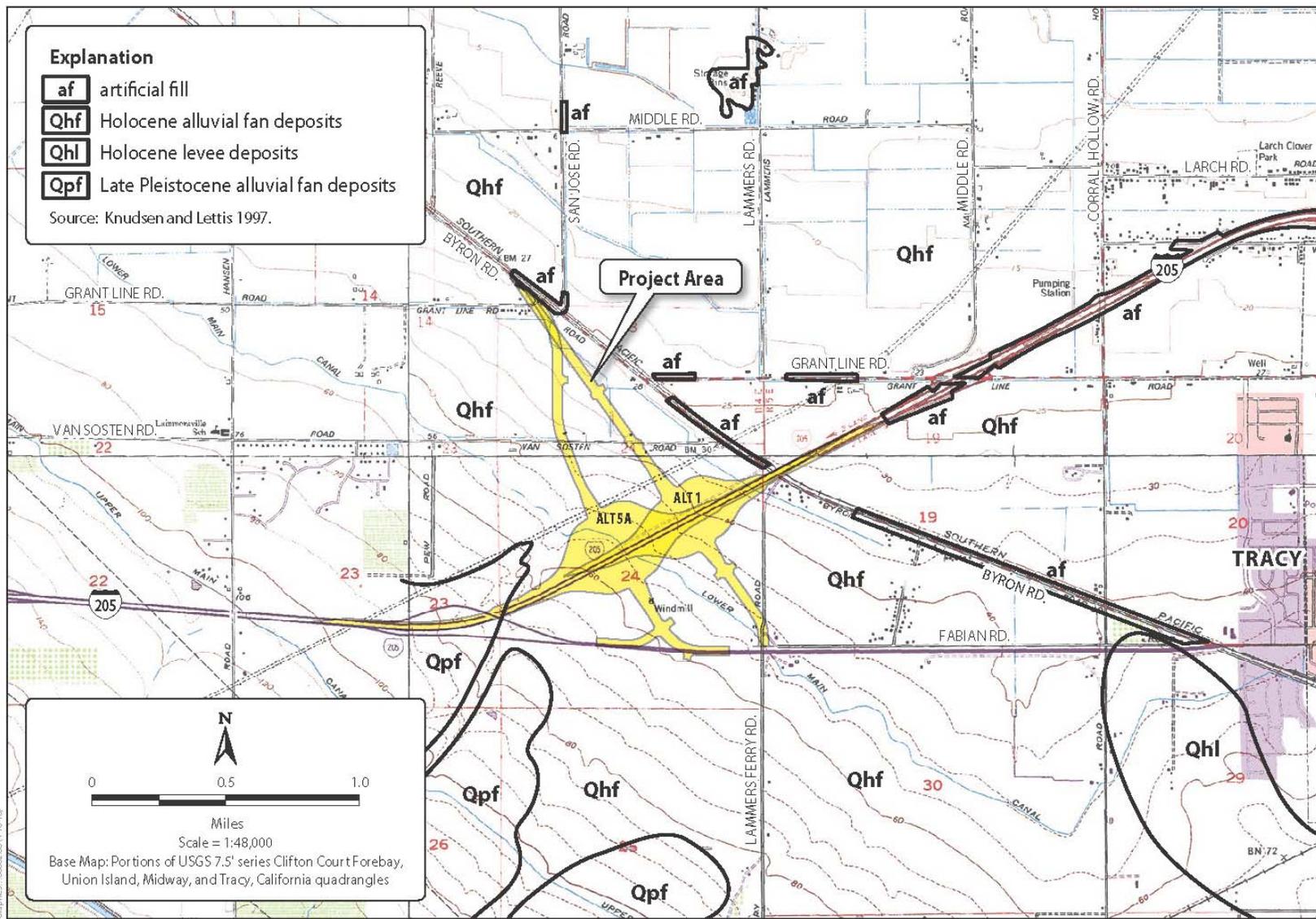


Figure 1 Geologic Map of Project Alignment, Showing Existing and Proposed Facilities

Potential for Significant Impacts

As identified above, artificial fill (af) materials are evaluated as having no sensitivity for paleontological resources, and native materials of Holocene age (Qhf) are evaluated as having no sensitivity to low sensitivity. Disturbance of these substrate types is not expected to result in significant impacts on paleontological resources.

If excavation in areas situated on Holocene alluvial fan deposits (Qhf) is deep enough to involve underlying alluvial fan materials of Pleistocene age, which are evaluated as having high sensitivity for paleontological resources, impacts could be significant. The severity of any impact would be directly related to the abundance and quality of materials present, if any, and the extent of disturbance and loss. It is difficult to assess the likelihood that Pleistocene materials would be disturbed, since the thickness of the Holocene in the project area is unknown. However, the driven piles will not expose materials that cannot be monitored. Drainage basin excavation will be shallow, extending to a depth of four feet in a location previously disturbed during construction of the 11th Street ramps. Likewise, installation of CIDH's and excavation for storm drains will primarily be occur in fill material.

Ground disturbance in areas situated directly on Pleistocene alluvial fan deposits (Qpf) (limited to the west end of the Alternative 5A alignment), which are evaluated as having high sensitivity for paleontological resources, could result in impacts on paleontological resources, depending on the extent of disturbance and the abundance and quality of any materials present. However, the only ground-disturbing activity in the portion of the project alignment directly underlain by Pleistocene alluvial fan deposits would be shallow grading related to road widening, which would be restricted to a narrow area and within the previously disturbed state right-of-way. Because of prior disturbance from agricultural activities, significant impacts are not considered likely, but there is some potential.

For all excavations, contractors would be required to implement the provisions of Caltrans Standard Specifications Section 14-7, which include a stop work and appropriate follow-up in the event paleontological resources are encountered during project construction. In addition, as identified in *Project Overview* above, Caltrans will implement a paleontological monitoring BMP requiring the presence of a qualified paleontological monitor during all excavation and ground disturbance extending to depths greater than 3 feet. This measure will ensure that the work with the greatest potential to

impact paleontological resources is monitored by a qualified professional, providing additional responsiveness in support of Standard Specifications Section 14-7 and the City's parallel Policy P5.

Potential to Avoid Paleontologically Sensitive Units

The project is proposed to meet specific roadway improvement needs identified for the Lammers Road/I-205 interchange and associated facilities; thus, if project goals are to be met, impacts cannot be avoided by relocating the project. However, to the extent the project is designed to reduce or eliminate disturbance of native substrate materials of Pleistocene age, the potential for significant impacts would be correspondingly reduced.

Alternative 1 would have greater potential to avoid disturbance of paleontologically sensitive units. The Alternative 1 alignment is situated on Holocene alluvial fan deposits; only the deeper excavations and drilling associated with this alternative would have any potential to involve sensitive strata, and the potential for disturbance would be really limited.

Avoidance of paleontological sensitive units would be impossible under Alternative 5A because the west end of the Alternative 5A alignment is situated on Pleistocene alluvial fan deposits.

Conclusions

Significant impacts on paleontological resources are not anticipated under Alternative 1 because of its location on Holocene substrate. There would be some potential for disturbance of underlying, highly sensitive, Pleistocene materials during deeper drilling and excavations for Alternative 1, but the extent of any disturbance would be limited, and, with a monitoring and stop work proviso in place, significant impacts on fossil resources would be effectively avoided.

Significant impacts on paleontological resources are possible under Alternative 5A because of the extent of grading required in Pleistocene substrate. Based on the geologic context of the project site, the western portion of the project area is more sensitive for significant fossils. However, shallow grading and prior ground disturbance from agricultural activities reduce the likelihood of encountering significant paleontological resources during project excavation.

Recommendations, Constraints, and Coordination Requirements

If either alternative is identified as the preferred approach, compliance with Caltrans Standard Specification 14-7 will be required to mitigate potential paleontological resources uncovered during construction.

Preparers

This PIR was prepared by Ellen Unsworth (BA, geology, Sacramento State University; MS, biology/geology/technical communication, Boise State University) and peer reviewed by Anna Busing (CA PG-7955; BS, earth sciences, University of California, Los Angeles; PhD, geology, University of California, Santa Barbara).

Ellen Unsworth is an environmental analyst with a background in geology and biology. Her training includes an MS in interdisciplinary studies (geology, biology, and technical communication) from Boise State University in Idaho and extensive experience preparing paleontological resources impact analyses.

Anna Busing is a senior geologist and CEQA/NEPA compliance expert who specializes in leading teams responsible for large and challenging environmental documents. In addition to managing project teams, she provides peer review in geology, seismicity, and soils; paleontology; mineral resources; and related topics. She is also active in geohazards abatement planning and in the development of paleontological resources mitigation strategies. Before joining ICF International, Anna was an independent consultant offering services in applied sedimentology and stratigraphy. Prior to that, as a tenured faculty member at California State University, Hayward (now California State University, East Bay), she led student research teams and taught classes ranging from introductory geology for non-majors to senior field geology courses and advanced graduate-level seminars. She and her students were among the first researchers to use the Neogene stratigraphic record to test quantitative reconstructions of past movement on the San Andreas fault system, and she continues active research on this topic. Results of her research have appeared in a number of venues, including publications of the U.S. Geological Survey and Society for Sedimentary Geology.

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Personal Communication

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