Appendix I: Paleontological Technical Study

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PALEONTOLOGICAL TECHNICAL STUDY

Stockton Diamond Grade Separation Project

City of Stockton, San Joaquin County, CA

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Abbreviations, Acronyms, and Initialisms

B.A.	Bachelor of Arts
BLM	Bureau of Land Management
BNSF	BNSF Railway
B.S.	Bachelor of Science
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CHSRA	California High Speed Rail Authority
FRA	Federal Railroad Administration
GIS	Geographic Information System
M.S.	Master of Science
NEPA	National Environmental Policy Act
PFYC	Potential Fossil Yield Classification
PRMP	Paleontological Resources Monitoring Plan
Project	Stockton Diamond Grade Separation Project
SJRRC	San Joaquin Regional Rail Commission
UCMP	University of California Museum of Paleontology
UPRR	Union Pacific Railroad
USC	United States Code

Executive Summary

The San Joaquin Regional Rail Commission (SJRRC), on behalf of the California High Speed Rail Authority (CHSRA) under assignment by the Federal Railroad Administration (FRA), is proposing the Stockton Diamond Grade Separation Project (proposed Project) to improve operational efficiency at the at-grade crossing of the Union Pacific Railroad (UPRR) and BNSF Railway (BNSF) freight lines (Stockton Diamond or Diamond) in the City of Stockton, San Joaquin County, California.

CHSRA is the federal environmental lead agency under the National Environmental Policy Act (NEPA) and SJRRC is the state environmental lead agency under the California Environmental Quality Act (CEQA).

The purpose of this report is to identify and evaluate potential impacts on paleontological resources resulting from the proposed Project. All work was conducted in compliance with applicable state and local regulations. The paleontological study for the proposed Project included review of geologic maps, literature, museum records, and online databases. A pedestrian survey was also conducted on October 1, 2020, to review the proposed Project area site geology and check for the presence of any surficial fossils. The results of the review and site visit were used to complete paleontological sensitivity and impact analyses.

The proposed Project area is mapped entirely as early Holocene- to late Pleistocene-age Modesto Formation but no native, undisturbed exposures were observed during the pedestrian survey. Disturbed silty sand to coarse silty sands was observed. While not mapped, arial photographs indicate recent artificial fill from previous construction is present. Additionally, the preliminary geotechnical memorandum prepared for the proposed Project (Kleinfelder 2020) indicates that artificial fill is present starting at the ground surface and extending to depths of 2 to 15 feet in the vicinity of the proposed Project. The pedestrian survey noted that the railroad was covered by imported gravel while most of the survey area was paved and developed. Activities within the proposed Project area may potentially result in significant impacts on paleontological resources where native sediments of the early Holocene- to late Pleistocene-age Modesto Formation are encountered during excavations.

Due to the potential for impacts on paleontological resources in the proposed Project area, preparation and implementation of a Paleontological Resources Monitoring Plan (PRMP) is recommended. The PRMP should include provisions for periodic spot checks during excavations to check for the presence of Holocene- to late Pleistocene-age Modesto Formation, and full-time monitoring should be implemented if the Modesto Formation is observed. In the event of unanticipated paleontological resource discoveries during proposed Project-related activities, work in the immediate vicinity of the discovery should be halted until it can be evaluated by a qualified paleontologist.

1.0 Introduction

The purpose of this study is to identify and evaluate potential impacts on paleontological resources resulting from the Stockton Diamond Grade Separation Project. SJRRC and CHSRA require this document to fulfill their responsibilities as the lead agencies under CEQA and NEPA, respectively. All work was conducted in compliance with applicable state and local regulations.

1.1 Project Purpose and Need

The purpose of the proposed Project is to provide grade separation at the current at-grade crossing of UPRR and BNSF rail lines. Grade separations allow for trains to move freely with fewer interruptions at higher overall speeds. Reducing the complexity of traffic movements at the Stockton Diamond reduces the potential for rail, vehicle, and bicycle/pedestrian conflicts in the vicinity of the crossing.

Substantial freight movements between the Port of Stockton and points east, north, and south must pass through the Stockton Diamond. The at-grade crossing is an operational constraint that results in delays to the regional rail network where these two heavily traveled rail lines intersect. Passenger rail services also pass through the Stockton Diamond using both the UPRR and BNSF tracks. The proposed Project is critical to the expansion of intercity and commuter rail service between the San Joaquin Valley and both Sacramento and the San Francisco Bay Area.

1.2 Project Description and Location

The proposed Project is located in the City of Stockton in San Joaquin County, California (Figure 1 and 2). The grade separation would use a flyover to elevate the UPRR rail lines over the BNSF tracks with the BNSF tracks staying at current grade. The proposed UPRR flyover alignment would be east of the existing tracks to minimize impact on rail operations. The elevated alignment will span from Lafayette Street in the north to Charter Way in the south. New at-grade road crossings would be constructed east of the existing track crossings at Main, Market, Lafayette, Hazelton, and Scotts Streets.

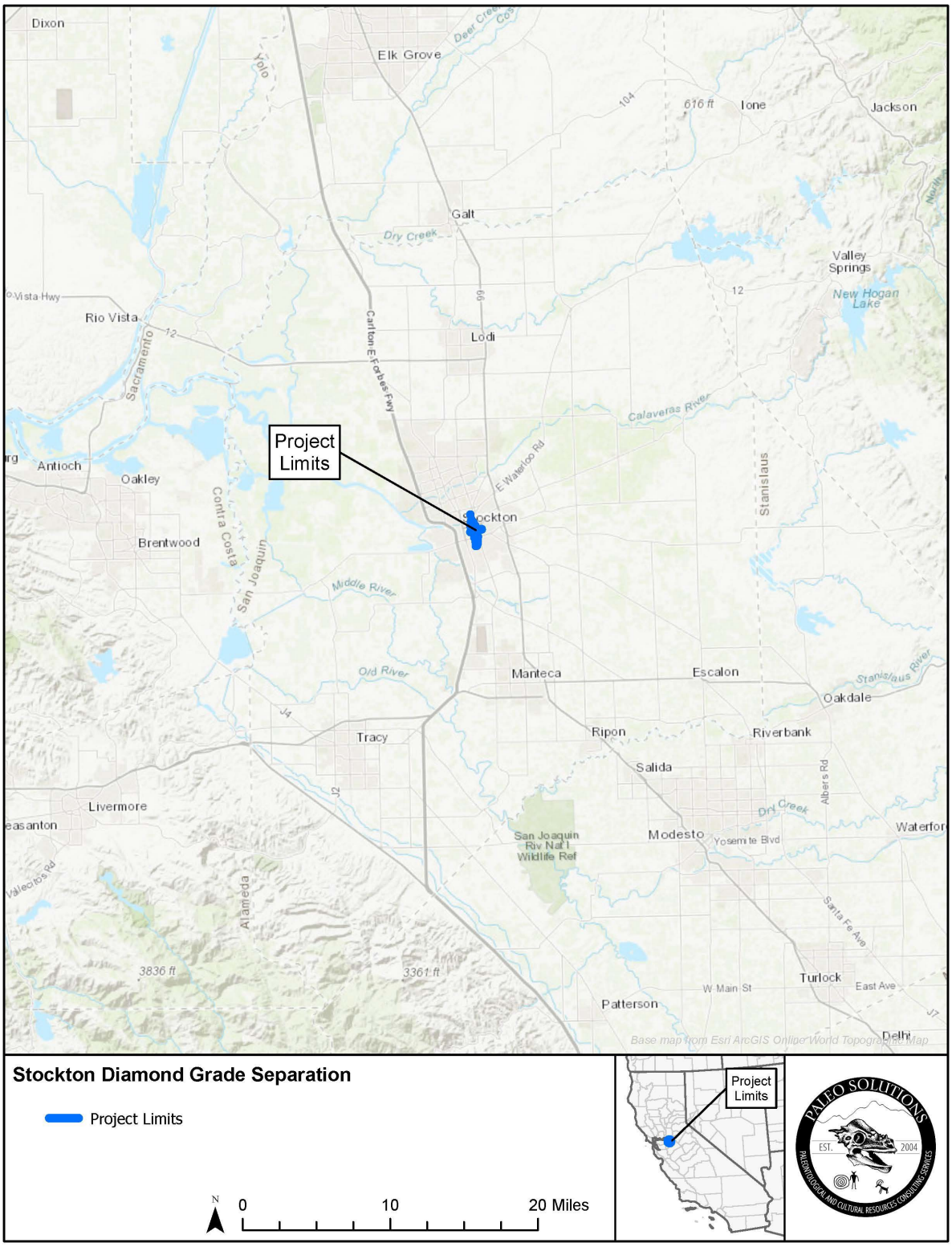

Figure 1. Project location map.

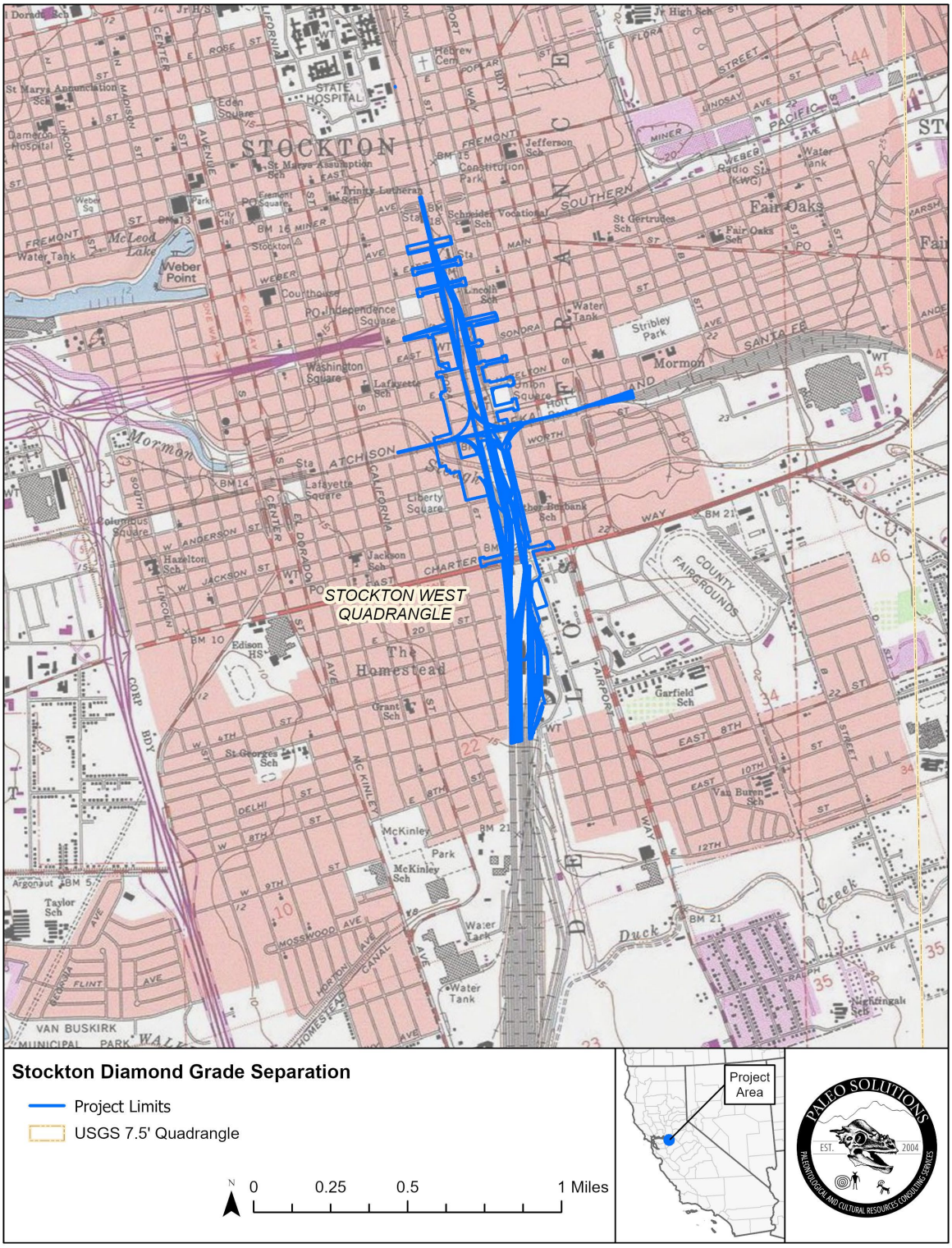

Figure 2. Project overview ma

2.0 Definition and Significance of Paleontological Resources

As defined by Murphey and Daitch (2007):

> "Paleontology is a multidisciplinary science that combines elements of geology, biology, chemistry, and physics in an effort to understand the history of life on earth. Paleontological resources, or fossils, are the remains, imprints, or traces of once-living organisms preserved in rocks and sediments. These include mineralized, partially mineralized, or unmineralized bones and teeth, soft tissues, shells, wood, leaf impressions, footprints, burrows, and microscopic remains. Paleontological resources include not only fossils themselves, but also the associated rocks or organic matter and the physical characteristics of the fossils' associated sedimentary matrix.
>
> The fossil record is the only evidence that life on earth has existed for more than 3.6 billion years. Fossils are considered non-renewable resources because the organisms they represent no longer exist. Thus, once destroyed, a fossil can never be replaced. Fossils are important scientific and educational resources because they are used to:
>
> - Study the phylogenetic relationships amongst extinct organisms, as well as their relationships to modern groups;
> - Elucidate the taphonomic, behavioral, temporal, and diagenetic pathways responsible for fossil preservation, including the biases inherent in the fossil record;
> - Reconstruct ancient environments, climate change, and paleoecological relationships;
> - Provide a measure of relative geologic dating that forms the basis for biochronology and biostratigraphy, and which is an independent and corroborating line of evidence for isotopic dating;
> - Study the geographic distribution of organisms and tectonic movements of land masses and ocean basins through time;
> - Study patterns and processes of evolution, extinction, and speciation; and
> - Identify past and potential future human-caused effects to global environments and climates."

Fossil resources vary widely in their relative abundance and distribution and not all are regarded as significant. According to Bureau of Land Management (BLM) Instructional Memorandum 2009-2011, a "Significant Paleontological Resource" is defined as:

> "Any paleontological resource that is considered to be of scientific interest, including most vertebrate fossil remains and traces, and certain rare or unusual invertebrate and plant fossils. A significant paleontological resource is considered to be of scientific interest if it is a rare or previously unknown species, it is of high quality and well-preserved, it preserves a previously unknown anatomical or other characteristic, provides new information about the history of life on earth, or has an identified educational or recreational value. Paleontological resources that may be considered not to have scientific significance include those that lack provenience or context, lack physical integrity due to decay or natural erosion, or that are overly redundant or are otherwise not useful for research. Vertebrate fossil remains and traces include bone, scales, scutes, skin impressions, burrows, tracks, tail drag marks, vertebrate coprolites (feces), gastroliths (stomach stones), or other physical evidence of past vertebrate life or activities" (BLM 2008).

Vertebrate fossils, whether preserved remains or track ways, are classified as significant by most state and federal agencies and professional groups and are specifically protected under the California Public Resources Code. In some cases, fossils of plants or invertebrate animals are also considered significant and can provide important information about ancient local environments.

The full significance of fossil specimens or fossil assemblages cannot be accurately predicted before they are collected and, in many cases, prepared in a laboratory and compared with previously collected fossils. Pre-construction assessment of significance associated with an area or formation must be made based on previous finds, characteristics of the sediments, and other methods that can be used to determine paleoenvironmental and taphonomic conditions.

3.0 Laws, Ordinances, Regulations, and Standards

This section presents the regulatory requirements pertaining to paleontological resources that apply to the proposed Project.

3.1 Federal Regulatory Setting

An evaluation of potential impacts on paleontological resources may be appropriate and/or required if a project is wholly or partially financed using federal funding, sited on federal lands, involves a federal permit, includes a perceived federal impact, and/or federal laws and standards apply. The management and preservation of paleontological resources on public and federal lands are prescribed under various laws, regulations, and guidelines.

3.1.1 National Environmental Policy Act (16 USC Section 431 et seq.)

NEPA, as amended, requires analysis of potential environmental impacts on important historic, cultural, and natural aspects of our national heritage (United States Code [USC], Section 431 et seq.; 40 Code of Federal Regulations [CFR], Section 1502.25). NEPA directs federal agencies to use all practicable means to "Preserve important historic, cultural, and natural aspects of our national heritage" (Section 101(b) (4)). Regulations for implementing the procedural provisions of NEPA are found in 40 CFR 1500 1508.

3.2 State Regulatory Setting

3.2.1 California Environmental Quality Act

The procedures, types of activities, persons, and public agencies required to comply with CEQA are defined in the Guidelines for Implementation of CEQA (State CEQA Guidelines), as amended on March 18, 2010 (Title 14, Section 15000 et seq. of the California Code of Regulations), and further amended January 4, 2013, and December 28, 2018. One of the questions listed in the CEQA Environmental Checklist is: "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" (State CEQA Guidelines Appendix G, Section VII, Part F).

3.2.2 State of California Public Resources Code

The State of California Public Resources Code (Chapter 1.7), Sections 5097 and 30244, includes additional state level requirements for the assessment and management of paleontological resources. These statutes require reasonable mitigation of adverse impacts on paleontological resources resulting from development on state lands, and define the excavation, destruction, or removal of paleontological "sites" or "features" from public lands without the express permission of the jurisdictional agency as a misdemeanor. As used in Section 5097, "state lands" refers to lands owned by, or under the jurisdiction of, the state or any state agency.

"Public lands" refers to lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof.

3.3 Local Regulatory Setting

3.3.1 San Joaquin County

The San Joaquin County General Plan (2016) does not have any goal or policy regarding paleontological resources.

3.3.2 City of Stockton

The City of Stockton General Plan (2018) does not have an explicit goal or policy regarding paleontological resources but goal LU-5 regards protected resources and it aims to protect, maintain, and restore natural and cultural resources. Policy LU-5.2 protects natural resource areas, fish and wildlife habitat, scenic areas, open space areas, agricultural lands, parks, and other cultural/historic resources from encroachment or destruction by incompatible development. Policy LU-5.2 has two actions that involve paleontology. Action LU5.2D requires that, prior to project approval, a qualified archaeologist or paleontologist (1) conduct a record search at an appropriate historical or archaeological repository, (2) conduct field surveys where appropriate, (3) prepare technical reports, where appropriate, meeting appropriate standards, and (4) prepare a treatment plan in accordance with appropriate standards when development cannot avoid an archaeological or paleontological deposit. Action LU-5.2G requires compliance with appropriate state and federal standards to evaluate and mitigate impacts on cultural resources, including tribal, historic, archaeological, and paleontological resources.

4.0 Methods

The paleontological study for the proposed Project included reviews of geologic maps, literature, and online databases. The geology underlying the proposed Project area was reviewed, as well as any geologic units occurring within a half-mile radius. A paleontological pedestrian survey was conducted on October 1, 2020. The results of the reviews and pedestrian survey were used to complete a paleontological sensitivity analysis, which also used the BLM Potential Fossil Yield Classification (PFYC) system, and an impact analysis.

Vincent Zhao, M.S., co-authored this report with Courtney Richards, M.S., and Elisa Barrios, B.S., prepared the GIS maps. Copies of this report will be submitted to HDR, SJRRC, and CHSRA. Paleo Solutions, Inc. will retain an archival copy of all project information.

5.0 Analysis of Existing Data

The proposed Project is located within the Great Valley Geomorphic Province. The Great Valley Geomorphic Province is trough bounded by the Sierra Nevada mountains to the east and by the Coast Ranges to the west. This Province has experienced near continuous sediment deposition since the Jurassic and is now characterized by an alluvial plain (Norris and Webb 1990).

5.1 Geologic Context

Based on a review of geologic mapping by Wagner et al. (1991), the proposed Project area is entirely underlain by early Holocene- to late Pleistocene-age Modesto Formation. While not mapped within the proposed Project area, aerial photographs also indicate that recent artificial fill related to previous construction is present. Therefore, artificial fill is also included in this analysis.

5.1.1 Artificial Fill

Artificial fill consists of recent deposits of previously disturbed sediments emplaced by construction operations and is found in areas where recent construction has taken place. The color is highly variable, and sediments are mottled in appearance. These sediments are not mapped within the boundaries of the proposed Project area but are likely to be encountered within previously disturbed portions of the proposed Project area. Additionally, the preliminary geotechnical memorandum prepared for the proposed Project (Kleinfelder 2020) indicates that artificial fill is present starting at the surface and extending to depths of 2 to 15 feet in the vicinity of the proposed Project.

5.1.2 Modesto Formation

The early Holocene- to late Pleistocene-age Modesto Formation has its type section in Stanislaus County, California, within the Ceres 7.5-minute quadrangle. It is exposed along the Tuolumne River in eastern Modesto, as well as east of Modesto and Turlock almost to the San Joaquin River (Davis and Hall 1959). The Modesto Formation was deposited in the San Joaquin Valley during the last major series of depositional events during the Pleistocene. It was deposited by the San Joaquin River as a series of alluvial fans of the San Joaquin River consisting of arkosic sand, silt, and clay (Marchand and Allwardt 1981). The Modesto Formation can be divided into upper and lower members. The upper member ranges in age from 26 to 9 thousand years (ka) and consists of unconsolidated coarse sand and silt. The lower member ranges in age from 73 to 29 ka and consists of consolidated, well-sorted silt and fine-grained sand, silty sand, and sandy silt (Atwater 1982; Marchand and Allwardt 1981).

5.2 Paleontological Resources

Paleontological literature reviews, a University of California Museum of Paleontology (UCMP) online paleontological database search, and a UCMP record search were conducted. While there are no localities within the proposed Project area, the results indicate that there are three localities within the vicinity of the proposed Project area (Holroyd 2020). UCMP localities V2016003, V2016004, and V2016005 are reported from the Modesto Formation in San Joaquin County, which were recorded during construction of the South Stockton Six-Lane Project near the intersection of Highway 99 and Mariposa Road (Holroyd 2020; UCMP 2020). A list of specimens recovered from these localities is not provided in the UCMP database at this time, but Holroyd (2020) indicated that they include a camelid maxilla, the lower jaw of a bison, and other less diagnostic mammal postcranial bones. These finds ranged in depth from 11.5 to 26 feet below the surface and 8 to 16.5 feet above contact with Holocene-age alluvium of the Modesto Formation.

The UCMP database also contains records of additional localities from the Modesto Formation within the Central Valley that produced scientifically significant vertebrate fossils, including ground sloth (*Megalonyx jeffersoni*), mammoth (*Mammuthus columbi*), horse (*Equus* sp.), camel (*Camelops* sp.), bison (*Bison latifrons*), rodents, reptiles, and plants (UCMP 2020). Additionally, recent basin excavations into the Modesto Formation paleosol and overbank deposits at the Le Grand Road overpass in Merced County resulted in the recovery of 1,667 Pleistocene mammal, bird, reptile, and fish fossils (Gust et al. 2012), which have added greatly to the fossil record of this geologic unit.

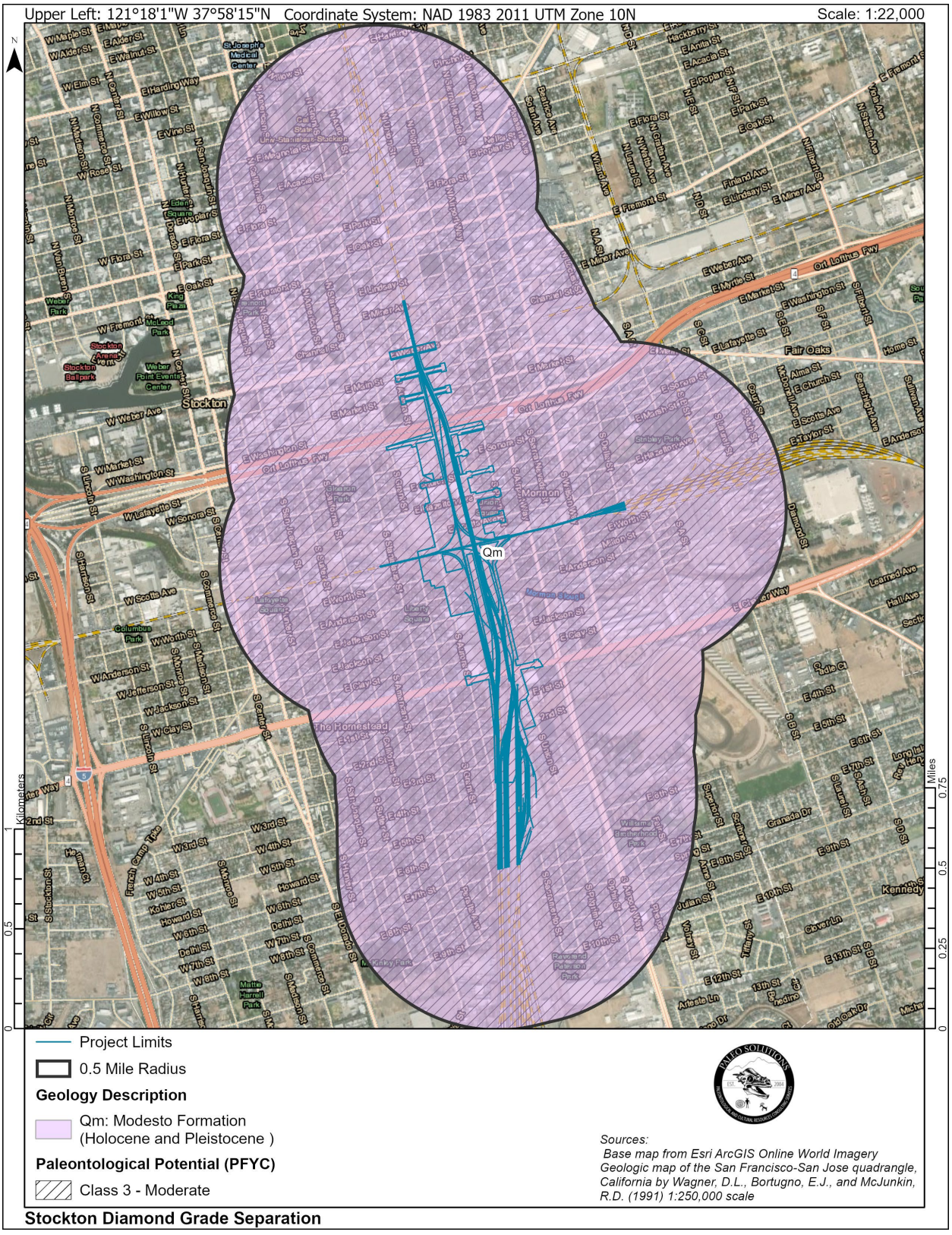

Figure 3. Project geology map.

6.0 Field Survey

Cross qualified archaeologist/paleontologist Brooke Hambley, B.A., conducted a field survey on October 1, 2020. The field visit consisted of a pedestrian survey along the roads and alignment of the proposed Project area from Weber Avenue to 4th Street. Some northern portions of the railroad alignment were not walkable due to the narrow right-of-way (Figure 4). The northern half of the proposed Project area survey was conducted via street access while the southern half was along the track alignment.

No undisturbed native sediment was observed. Most of the alignment has been paved and developed with much of the railway alignment covered with imported gravel (Figures 5 and 6). Disturbed silty sands were observed where foot traffic exposed the underlying sediment, primarily between Worth Street and Charter Way (Figure 7). At Main Street, an electrical box has some disturbed coarse silty sands (Figure 8).

No paleontological resources where observed.

Figure 4. Narrow right-of-way along the tracks near South Pilgrim Street, view southwest.

Figure 5. Typical disturbance along the right-of-way at East Hazelton Avenue, view northwest.

Figure 6. Typical disturbance along the railroad with some exposed disturbed sediment at East Weber Avenue, view southeast.

Figure 7. Exposed disturbed sediment from area cleared of gravel along the tracks, view northwest.

Figure 8. Disturbed coarse silty sand by electrical box with some exposed disturbed sediment along the tracks at East Main Street, view northwest.

7.0 Sensitivity and Impact Analysis

Based on the results of the geologic map review, literature review, online database review, museum record search, and field survey, the paleontological sensitivity of the geologic units within the proposed Project area were ranked and an impact analysis was performed.

7.1 Sensitivity Analysis

Paleontological sensitivity rankings were assigned using the BLM PFYC system, which is intended to aid in predicting, assessing, and mitigating paleontological resources.

7.1.1 Criteria for Evaluating Paleontological Potential

The PFYC system was developed by BLM (BLM 2016). Because of its demonstrated usefulness as a resource management tool, PFYC has been used for many years for projects across the country, regardless of land ownership. It is a predictive resource management tool that classifies geologic units on their likelihood to contain paleontological resources on a scale of 1 (very low potential) to 5 (very high potential). The PFYC ranking system is summarized in Table 1.

Table 1. Potential Fossil Yield Classification (BLM 2016)

BLM PFYC Designation	Assignment Criteria Guidelines and Management Summary (PFYC System)
1 = Very Low Potential	Geologic units are not likely to contain recognizable paleontological resources.
	Units are igneous or metamorphic, excluding air-fall and reworked volcanic ash units.
	Units are Precambrian in age.
	Management concern is usually negligible, and impact mitigation is unnecessary except in rare or isolated circumstances.
2 = Low Potential	Geologic units are not likely to contain paleontological resources.
	Field surveys have verified that significant paleontological resources are not present or are very rare.
	Units are generally younger than 10,000 years before present.
	Recent eolian deposits.
	Sediments exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely.
	Management concern is generally low, and impact mitigation is usually unnecessary except in occasional or isolated circumstances.
3 = Moderate Potential	Sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence.
	Marine in origin with sporadic known occurrences of paleontological resources.
	Paleontological resources may occur intermittently, but these occurrences are widely scattered.
	The potential for authorized land use to impact a significant paleontological resource is known to be low-to-moderate.
	Management concerns are moderate. Management options could include record searches, pre-disturbance surveys, monitoring, mitigation, or avoidance. Opportunities may exist for hobby collecting. Surface-disturbing activities may require sufficient assessment to determine whether significant paleontological resources occur in the area of a proposed action and whether the action could affect the paleontological resources.

BLM PFYC Designation	Assignment Criteria Guidelines and Management Summary (PFYC System)
4 = High Potential	Geologic units that are known to contain a high occurrence of paleontological resources.
	Significant paleontological resources have been documented but may vary in occurrence and predictability.
	Surface-disturbing activities may adversely affect paleontological resources.
	Rare or uncommon fossils, including nonvertebrate (such as soft body preservation) or unusual plant fossils, may be present.
	Illegal collecting activities may impact some areas.
	Management concern is moderate to high depending on the proposed action. A field survey by a qualified paleontologist is often needed to assess local conditions. On-site monitoring or spot-checking may be necessary during land disturbing activities. Avoidance of known paleontological resources may be necessary.
5 = Very High Potential	Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources.
	Significant paleontological resources have been documented and occur consistently.
	Paleontological resources are highly susceptible to adverse impacts from surface disturbing activities.
	Unit is frequently the focus of illegal collecting activities.
	Management concern is high to very high. A field survey by a qualified paleontologist is almost always needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designated of areas of avoidance, or special management designations should be considered.
U = Unknown Potential	Geologic units that cannot receive an informed PFYC assignment.
	Geological units may exhibit features or preservational conditions that suggest significant paleontological resources could be present, but little information about the actual paleontological resources of the unit or area is unknown.
	Geologic units represented on a map are based on lithologic character or basis of origin but have not been studied in detail.
	Scientific literature does not exist or does not reveal the nature of paleontological resources.
	Reports of paleontological resources are anecdotal or have not been verified.
	Area or geologic unit is poorly or under-studied.
	BLM staff has not yet been able to assess the nature of the geologic unit.
	Until a provisional assignment is made, geologic units with unknown potential have medium to high management concerns. Field surveys are normally necessary, especially prior to authorizing a ground-disturbing activity.

7.1.2 Sensitivity Analysis Results

Scientifically significant fossils are generally not known from artificial fill since any discovered resource would lack context. Using BLM (2016) guidelines, these deposits have a low paleontological potential (PFYC 2).

The early Holocene- to late Pleistocene-age Modesto Formation, if encountered at unknown depth beneath the surface of artificial fill and disturbed sediment, is considered to have a moderate paleontological potential (PFYC 3) using BLM (2016) guidelines since it has produced scientifically significant vertebrate fossils in the proposed Project vicinity.

7.2 Impact Analysis

Impacts on paleontological resources can generally be classified as either direct, indirect, or cumulative. Direct adverse impacts on surface or subsurface paleontological resources are the result of destruction by breakage and crushing as the result of surface disturbing actions including construction excavations. In areas that contain paleontologically sensitive geologic units, ground disturbance has the potential to adversely impact surface and subsurface paleontological resources of scientific importance. These fossils and the paleontological data they could provide, if properly recovered and documented, could be adversely impacted (damaged or destroyed) by ground disturbance, rendering them permanently unavailable to science and society.

Indirect impacts typically include those effects that result from the continuing implementation of management decisions and resulting activities, including normal ongoing operations of facilities constructed within a given project area. They also occur as the result of the construction of new roads and trails in areas that were previously less accessible. This increases public access and therefore increases the likelihood of the loss of paleontological resources through vandalism and unlawful collecting. Human activities that increase erosion also cause indirect impacts on surface and subsurface fossils as the result of exposure, transport, weathering, and reburial.

Cumulative impacts can result from incrementally minor but collectively significant actions taking place over time. The incremental loss of paleontological resources over time as a result of construction-related surface disturbance or vandalism and unlawful collecting would represent a significant cumulative adverse impact because it would result in the destruction of non-renewable paleontological resources and the associated irretrievable loss of scientific information.

There are no documented paleontological localities within the boundaries of the proposed Project area; however, fossils are recorded in the vicinity from the early Holocene- to late Pleistocene-age Modesto Formation in San Joaquin County and elsewhere in the Central Valley (Holroyd 2020; UCMP 2020).

Based on available excavation information, the proposed Project has the potential to encounter native early Holocene- to late Pleistocene-age Modesto Formation beneath the artificial fill and disturbed sediment during excavations starting at depths as shallow as 2 to 15 feet below the current grade and may result in adverse direct impacts on paleontological resources.

No indirect or cumulative impacts on paleontological resources are anticipated.

8.0 Conclusions and Recommendations

Based on the analysis of geologic maps, literature, museum records, and online databases, as well as the current proposed Project description and excavation descriptions, construction activities for the proposed Project may result in significant impacts on paleontological resources if the early Holocene- to late Pleistocene-age Modesto Formation is encountered during excavations.

Due to the potential for impacts on paleontological resources in the subsurface of the proposed Project, preparation and implementation of a PRMP is recommended. The PRMP should include provisions for periodic spot checks during excavations to check for the presence of early Holocene- to late Pleistocene-age Modesto Formation, and implementation of full-time monitoring if early Holocene- to late Pleistocene-age Modesto Formation is observed. In the event of unanticipated paleontological resource discoveries during proposed Project related activities, work in the immediate vicinity of the discovery should be halted until it can be evaluated by a qualified paleontologist.

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