APPENDIX T

PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT TECHNICAL REPORT

(see PDF files on enclosed CD)

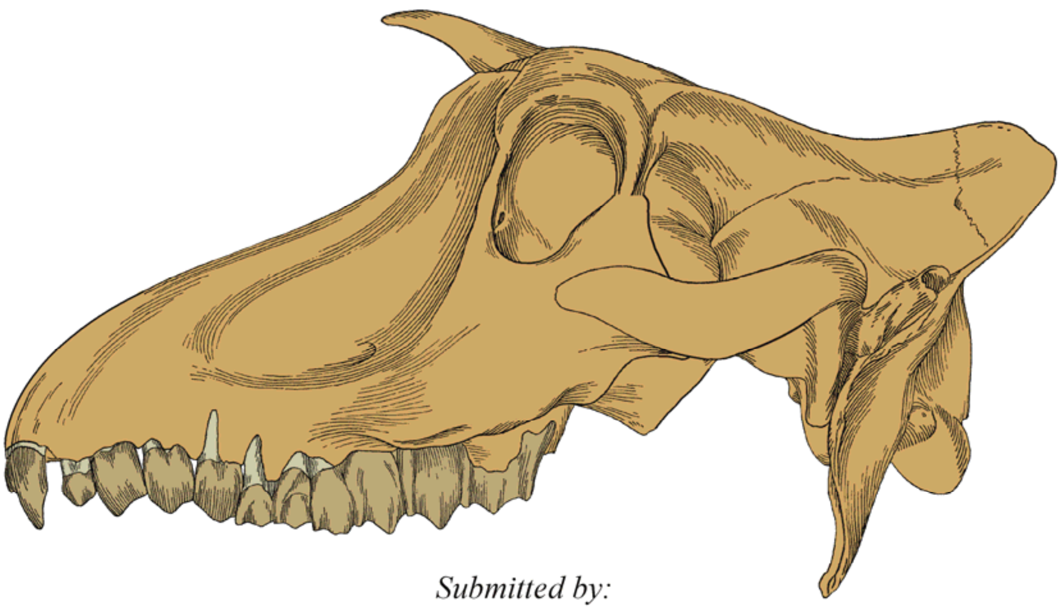
PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT TECHNICAL REPORT
prepared in support of
DESERT QUARTZITE SOLAR PROJECT
Southeastern Riverside County, California

Submitted to:

Statistical Research, Inc.
21 West Stuart Avenue
Post Office Box 390
Redlands, California 92373-0123

On behalf of:

Desert Quartzite, LLC
135 Main Street, 6th Floor
San Francisco, California 94105



Submitted by:

Robert E. Reynolds
&
E. Bruce Lander, Ph.D.
Paleo Environmental Associates, Inc.
2248 Winrock Avenue
Altadena, California 91001-3205

626/797-9895
paleo@earthlink.net

PEAI
PALEO ENVIRONMENTAL ASSOCIATES, INCORPORATED

March 2016

2013-13
desert quartzite.doc

PALEO ENVIRONMENTAL ASSOCIATES

PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT TECHNICAL REPORT
prepared in support of
DESERT QUARTZITE SOLAR PROJECT
Southeastern Riverside County, California

submitted to:

Statistical Research, Inc.
21 West Stuart Avenue
Post Office Box 390
Redlands, California 92373-0123

on behalf of:

Desert Quartzite, LLC
135 Main Street, 6th Floor
San Francisco, California 94105

Submitted by:

Robert E. Reynolds
&
E. Bruce Lander, Ph.D.
Paleo Environmental Associates, Inc.
2248 Winrock Avenue
Altadena, California 91001-3205

626/797-9895
paleo@earthlink.net

March 2016

MANAGEMENT SUMMARY

Statistical Research, Inc., on behalf of Desert Quartzite, LLC, retained Paleo Environmental Associates, Inc., to conduct a paleontological resource literature review, archival search, and preliminary paleontological resource assessment for the Desert Quartzite Solar Project (Project). The approximately 5,010-acre Project site is situated on Federal land (4,850 acres) with a 160-acre private parcel. The Project is located 0.5 mile south of Interstate 10 and 7.0 miles west-southwest of Blythe in southeastern Riverside County, southeastern California. The Project includes development of a photovoltaic solar energy generating farm and a transmission line extending about 3 miles west of the northwestern corner of the Project site.

The Project site is underlain by five continental sedimentary formations of Pliocene through late Pleistocene age. Five soil horizons (paleosols) have developed on these older formations, with two starting development in the late Pleistocene Epoch and three in the Holocene.

The coarse sediments of the Bullhead Alluvium have produced a fossil horse bone. Soils developed on older Pleistocene terrace deposits have produced over 800 continental vertebrate specimens at newly recorded fossil localities 5 to 7 miles south of the Project site in the Rio Mesa Solar Electric Generating Facility (Rio Mesa) Project area. Eolian deposits in the latter project area have yielded reworked Pleistocene fossil remains. Thin Holocene deposits of fans, dunes and active washes cover less than 20 percent of the Project site. Those deposits cover fossiliferous soils and sediments and also might contain reworked fossils. Thus, Pliocene and Pleistocene deposits exposed at the surface, fan deposits and stabilized eolian deposits in the shallow subsurface, and surficial older soils in the Project site all have potential for containing scientifically important vertebrate fossil remains.

Each stratigraphic unit in the Project area was evaluated using the United States Bureau of Land Management (BLM) Potential Fossil Yield Classification (PFYC) System. The privately owned parcel inholding was compared with the Riverside County paleontological impact sensitivity map where Riverside County has jurisdiction under California Environmental Quality Act (CEQA). Based on this evaluation, the mapped deposits within the Project site have the following potential:

(1) The Pliocene Bullhead Alluvium (Tba) and Pleistocene terrace deposits (Qot) have a very high potential for producing scientifically important vertebrate fossil remains and are assignable to Class 3a and Class 5a.
(2) Two late Pleistocene soils are developed over the mapped sediments (Item No. 1 above) and based on local fossil occurrences are assignable to Class 5b.
(3) Shallow subsurface fan deposits of probable Pleistocene age have moderate to unknown (Class 3b) potential for containing vertebrate remains.
(4) The stabilized portions of the eolian deposits have a moderate to unknown (Class 3b) potential for containing vertebrate remains.
(5) Active, thin alluvial fan, dune, and wash deposits have a low potential for containing fossil remains (Class 2).

Project-related earth-moving activities might result in the disturbance or loss of fossil remains and associated specimen and locality data at previously unrecorded fossil localities. Consequently, it is recommended that a preconstruction field survey of the entire Project site be conducted to verify the potential for fossil remains being encountered by Project construction. During the survey, fossils found exposed at the surface will be subject to a treatment plan developed in support of Project construction. Results of the survey will be used to develop a Project-specific paleontological resource impact mitigation plan/program (PRIMP) to be implemented during Project-related earth-moving activities. The Project PRIMP will be based on standard mitigation measures issued by the Society of Vertebrate Paleontology.

This preliminary paleontological resource inventory and impact assessment recommends that:
(1) a preconstruction field survey of the entire Project site be conducted,
(2) fossils found during the survey be recovered and fully treated, and
(3) a Project-specific PRIMP be developed and implemented during earth-moving activities associated with Project construction.

The PRIMP, which will be based on the results of this inventory/assessment and the preconstruction field survey, will include:

(1) a worker awareness training program that will provide information on fossil recognition and procedures to be implemented when fossil remains are discovered (e.g., temporary avoidance of fossil site by earth-moving equipment, notification of Project and PRIMP personnel);
(2) activities to be conducted by qualified paleontologic monitors as part of paleontologic monitoring of earth-moving activities in portions of the Project area determined to have moderate or high sensitivity during the preconstruction field survey;
(3) fossil recovery techniques to be used by the monitors or other PRIMP personnel;
(4) methods for recording specimens, potentially fossiliferous sediment samples, and associated specimen, sample, and locality data;
(5) procedures for collecting and processing sediment samples that might contain fossil remains too small to be seen by a monitor in the field;
(6) a treatment plan for dealing with all remains recovered by monitoring and sample processing; and
(7) preparation of a comprehensive final mitigation program report of results and finding for submission to the BLM and the designated museum repository.

Implementation and completion of the PRIMP would reduce adverse Project-related impacts on the paleontological resources of the Project site to a less-than-significant level.

TABLE OF CONTENTS

INTRODUCTION

Paleontological resources include (1) fossil remains or specimens, (2) the corresponding fossil localities, (3) the respective fossil-bearing layers or the entire stratigraphic or sedimentary units, and (4) associated specimen data and geologic or geographic locality data. Fossil remains are any indication of past life, particularly the bones and teeth of vertebrates, the shells of invertebrates, the tests of microfossils, and the wood and leaves of land plants, as well as impressions and trackways. In response to the National Environmental Policy Act of 1969 (NEPA), the United States Bureau of Land Management (BLM) and the Society of Vertebrate Paleontology (SVP) consider fossil specimens, particularly vertebrate remains, scientifically highly important or significant if they represent (1) remains that are identifiable with respect to element and lower-level taxon (e.g., family, genus, or species), (2) a new or rare species, (3) a topotype specimen (a specimen collected from the same locality and stratigraphic interval as the specimen on which the species represented was based), (4) a geographic or temporal range extension, (5) an age-diagnostic species, (6) an environmentally sensitive species, or (7) a specimen more complete than, or a skeletal element different from, those previously available for the species. Time-diagnostic species can confirm, refine, or correct previous estimates regarding the geologic age of the fossil-bearing strata. Remains of an environmentally sensitive species can enhance the understanding of paleoenvironments. These criteria would apply to any fossil remains occurring in the Desert Quartzite Solar Project (Project) area.

Statistical Research, Inc., retained Paleo Environmental Associates, Inc. (PEAI), on behalf of Desert Quartzite, LLC, to conduct paleontological resource archival searches and a literature review, to compile an initial baseline resource inventory, and to prepare a preliminary impact assessment in support of Project construction. No paleontological field survey was conducted as part of this study. The Project site is situated on public land administered by the BLM, California Desert District, and contains an inholding of private land.

PROJECT LOCATION AND DESCRIPTION

The 5,010-acre Project site is 0.5 mile south of Interstate 10 (I-10) and 7 miles west of Blythe in southeastern Riverside County, California (Figure 1). The proposed Project will include development of a photovoltaic solar energy generating farm and an associated 3-mile-long gen-tie line. Project construction will require earth-disturbing activities including disking, grading, cut and fill, and trenching. Some excavations might reach depths of 10 feet.

The Project area is reached from I-10 by exiting at Mesa Drive and proceeding south to Blythe Way, then west for 2.5 miles to the Project site. The study area for this evaluation includes the Project area and a surrounding 1.0-mile-wide buffer zone. Topographic map coverage of the Project area is provided at a scale of 1:100,000 by the United States Geological Survey (USGS) Blythe 30 x 60 Minute Quadrangle (1965), and at a scale of 1:24,000 by the USGS Roosevelt Mine (1983) and Ripley (1952, photorevised 1970, 1976) Quadrangles, California—Riverside County, 7.5-Minute Series (Topographic). The Project area includes all or parts of sections 3–7, 9–15, and 22–24 of Township 7 South and Range 21 East of the San Bernardino Base and Meridian.

PURPOSE OF STUDY

The Project site is on public land administered by the BLM, California Desert District, and contains an inholding of private land under the jurisdiction of County of Riverside. This paleontological resource inventory and impact assessment provides (1) a baseline paleontological resource inventory of the Project site that focuses on stratigraphic units and fossil localities therein, and the taxa represented by the remains recovered from each unit in and near the project area, (2) a preliminary evaluation of the potential productivity of a unit using the BLM Potential Fossil Yield Classification (PFYC) system (Appendix C), and (3) recommendations for mitigating any adverse impact on paleontological resources that would accompany construction-related earth-moving activities at the Project site.

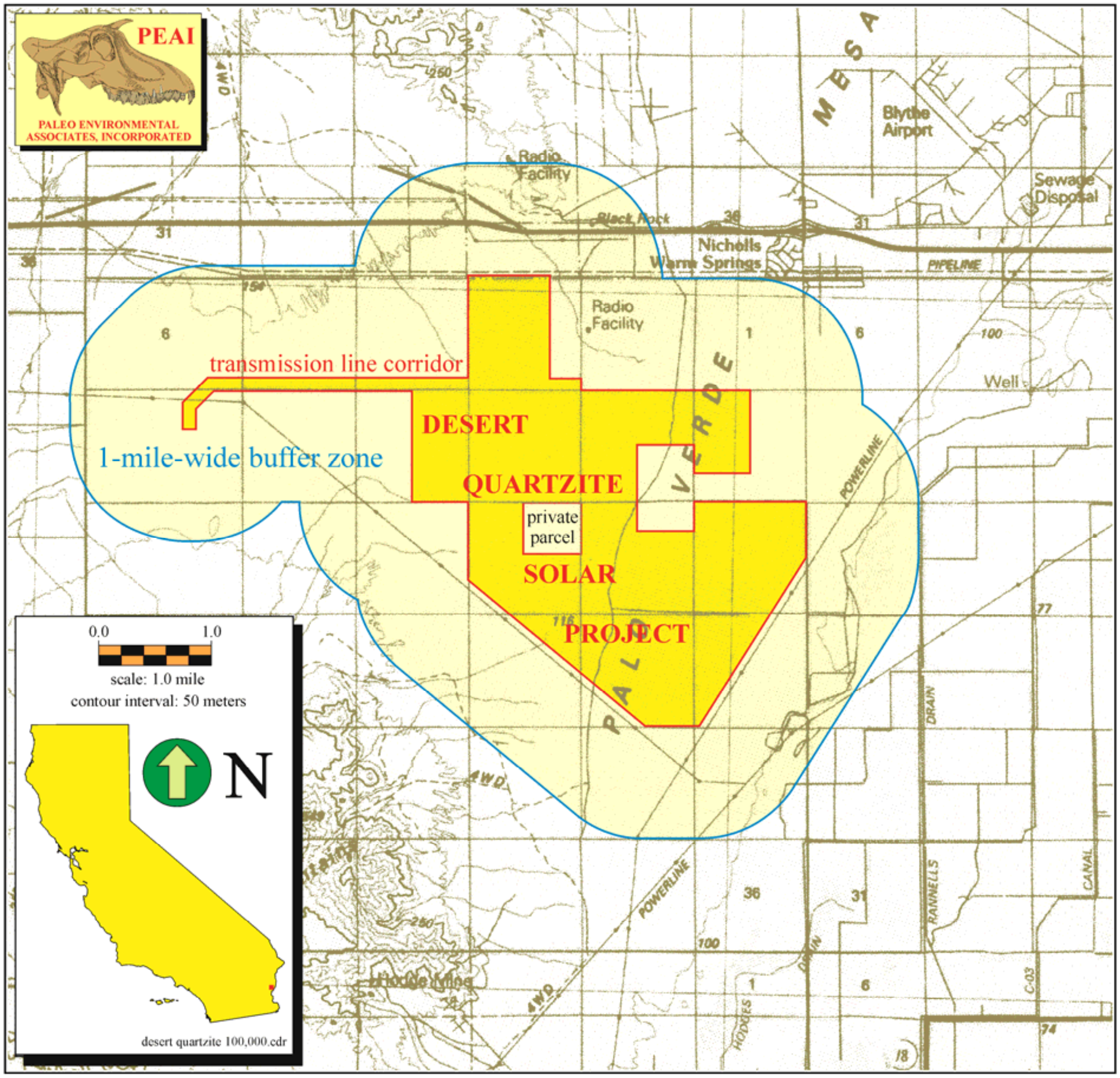


Figure 1.—Topographic map, Desert Quartzite, LLC, Desert Quartzite Solar Project, northeastern Riverside County, California. Base map: United States Geological Survey Blythe 30 x 60 Minute Quadrangle (1986).

PERSONNEL

This preliminary paleontological resource assessment report was prepared by Mr. Robert E. Reynolds, PEAI senior vertebrate paleontologist, with the assistance of Dr. E. Bruce Lander, PEAI principal paleontologist. Dr. Lander has a Ph.D. degree in paleontology. Each author has decades of experience conducting research on the vertebrate paleontological resources of the Mojave Desert Province and preparing paleontological resource assessments in support of other major construction projects in the region. Mr. Reynolds has prepared such documents using the PFYC system, which is now required by the BLM for conducting paleontological resource assessments in support of projects on Federal land. Resumes are provided in Appendix D.

A BLM cultural resource use permit is required for conducting a paleontological resource field survey on Federal land. A valid permit for conducting such an investigation (BLM Permit No. CA-13-06P; expiration date 8-2016) is held by Mr. Reynolds. A Paleontological Fieldwork Authorization will be requested from the BLM Palm Springs Field Office before the recommended preconstruction field study is conducted.

METHODS

As part of this inventory and assessment, surficial geologic maps of the Project area by Stone (1990, 2006) and Hayhurst and Bedrossian (2010) were reviewed to determine if any potentially fossil-bearing stratigraphic or sedimentary unit underlay the area. Outcrop data compiled during the literature review were compared with Google Earth aerial imagery covering the Project site. Paleontological and geologic literature were reviewed to document the occurrence of any previously recorded and published fossil locality in sedimentary and soil units in or near the Project area from the same units as those exposed therein. Archival searches were conducted at the Natural History Museum of Los Angeles County Department of Vertebrate Paleontology (LACM) and the San Bernardino County Museum (SBCM) for additional information on any such fossil locality and to document the occurrence of any other previously recorded but unpublished fossil locality from stratigraphic units in or near the Project site (see Appendix E). R. E. Reynolds' field notes were reviewed for additional pertinent information. The results of the data searches were used to compile a paleontological resource inventory of the Project area by stratigraphic unit and to assess the paleontological productivity of each unit using the BLM PFYC system. A field survey was beyond the scope of this preliminary assessment, but a preconstruction survey is recommended for the next phase of the inventory and assessment.

SETTING

The Project area lies very near the eastern margin of the southeastern Mojave Desert Province, which is bounded to the east by the Colorado River (Jahns, 1954). The floor of Chuckwalla Valley west of the Project site is 360 feet above mean sea level and the surface of the Colorado River to the east is at 330 feet. The Big Maria Mountains north of the Project area and the Mule Mountains to the southwest reach elevations of 2,400 and 1,100 feet, respectively. Elevations in the northwestern project area range from 476 feet along the transmission line corridor to 364 feet along the eastern margin of the project. The Project area sits on Palo Verde Mesa, which is covered by creosote scrub brush, palo verde, ironwood, and ocotillo.

GEOMORPHOLOGY

Geomorphic terraces in the Project area grade lower from northwest to southeast and constrain the age of underlying sedimentary formations and the sequence of erosion across the Project site. At the northern end of the Project area, the concordant upper surfaces developed on the Bullhead Alluvium outcrops indicate initial planation of the oldest local deposit at an elevation of 463 feet. Those deposits and the erosional surface were later incised by an incursion of the Colorado River, when it had a higher base level than today. That incision event was followed by depositional and subsequent planation events that produced the Palo Verde Mesa Upper Terrace (unit Qpv of Stone 2006 = unit Qot of Hayhurst and Bedrossian 2010) at an elevation of 430 feet at the northern end and 360 feet at the southern end of the Project area.

After planation of the Palo Verde Mesa Upper Terrace, the Colorado River cut those deposits before laying down late Pleistocene "middle terrace deposits" and "lower terrace deposits" (Holocene unit Qr of Stone 2006 = unit Qa of Hayhurst and Bedrossian 2010). The latter two units are 130 feet lower than the Upper Terrace. The date on a "middle terrace" soils of 13,600 years old at the Rio Mesa Project site (J. D. Stewart, January 2016 personal communication to R. E. Reynolds, PEAI) is latest Pleistocene in age and supports an earlier late Pleistocene or Rancholabrean North American Land Mammal Age (NALMA) assignment for the Palo Verde Mesa Upper Terrace on which the Project site is located.

GEOLOGY

The surficial geologic map of the Project area (Figure 2) is based on mapping by Hayhurst and Bedrossian (2010), which incorporated data from maps by Stone (2006, 1990). None of those maps records the outcrops of the Bullhead Alluvium (Reynolds et al. 2008) at the northern end of the Project site.

The mountain ranges in the southeastern Mojave Desert Province are composed mostly of Mesozoic granitic and metamorphic basement rocks, early Miocene sedimentary strata, and extrusive volcanic rocks. Outside the Project area, the Big Maria Mountains to the north and the McCoy Mountains to the northwest contain late Paleozoic to middle Mesozoic sediments metamorphosed by intrusion of Cretaceous granitic plutons. The Mule Mountains to the southwest contain plutonic and volcanic rocks of Triassic to Jurassic age. Early Miocene strata are located on the

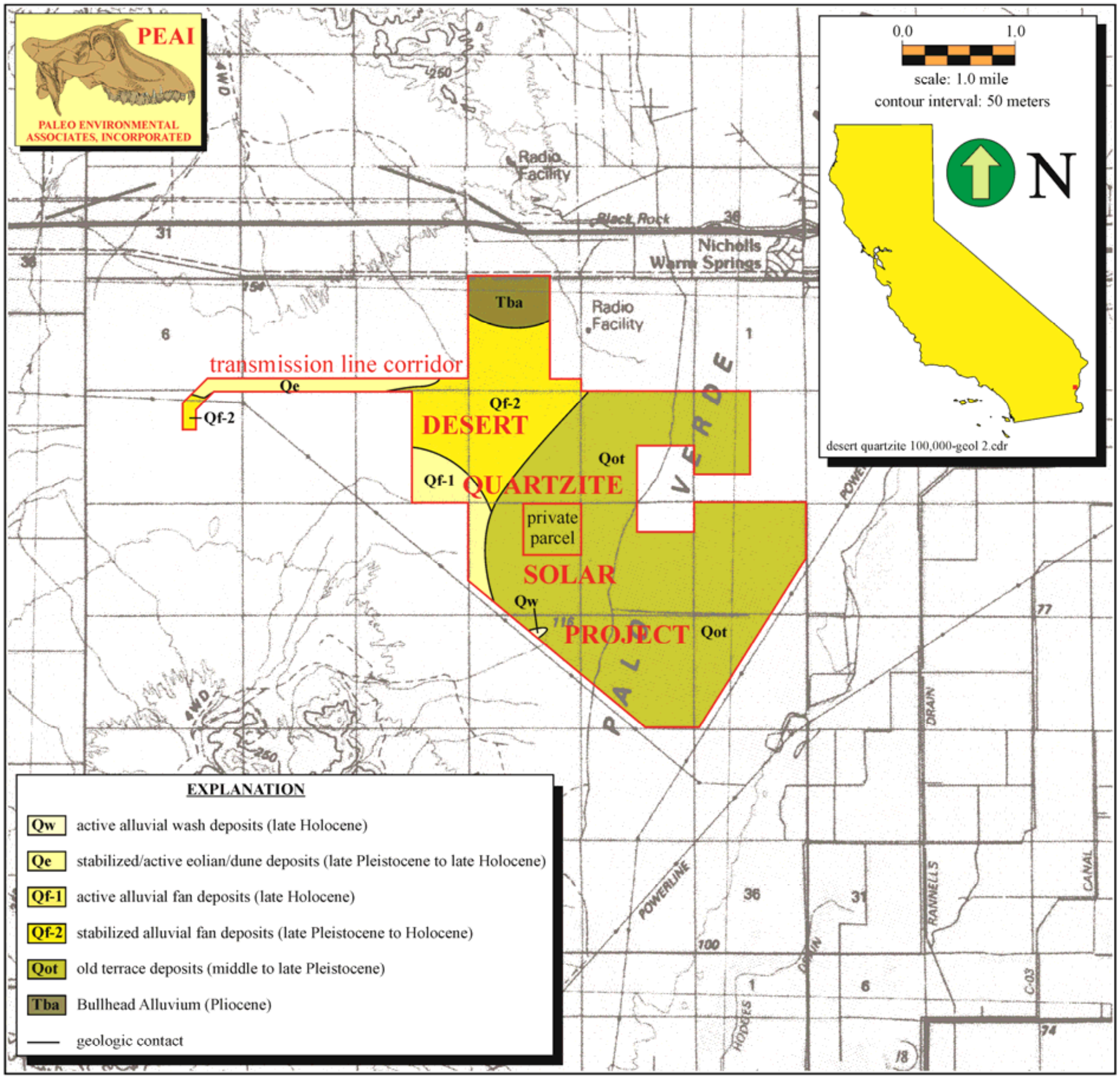


Figure 2.—Topographic and surficial geologic map, Desert Quartzite, LLC, Desert Quartzite Solar Project, northeastern Riverside County, California. Base map: United States Geological Survey Blythe 30 x 60 Minute Quadrangle (1986). Geology after Stone (2006) and Hayhurst and Bedrossian (2010), and based locally on photointerpretation of Google Earth satellite image covering Project site.

southwestern side of the Mule Mountains. The early Pliocene Bouse Formation is exposed southeast and southwest of Blythe along both sides of the Colorado River. The Bouse Formation contains the Lawlor Tuff, which has been dated at 4.83 million years (Ma) in age, and has produced fossil remains representing marine fishes and mollusks from a previous Gulf of California embayment. The Bouse Formation has not been mapped west of Blythe by Stone 1990, 2006) or Hayhurst and Bedrossian (2010).

Fanglomerates from the adjacent mountain ranges fringe their lower slopes and become progressively finer-grained towards the valley center, where they interfinger with sedimentary strata deposited by the ancestral Colorado River. Those strata have yielded scientifically important fossil remains that constrain the ages of river activity and terrain development in the Project region.

The oldest sedimentary deposit at the Project site is the Bullhead Alluvium, which crops out at the northern end of the Project site (K. A. Howard, 2015 personal communication to R. E. Reynolds, PEAI). These sediments were deposited between 3 and 4 Ma ago. The remainder of the Project site is underlain by four continental stratigraphic units of later Quaternary age, including (1) middle to late Pleistocene terrace deposits (unit Qot) laid down by the Colorado River, (2) late Pleistocene and Holocene alluvial fan deposits (units Qf-2, Qf-1, respectively), (3) late Holocene eolian and dune deposits (unit Qe), and (4) late Holocene active wash deposits (unit Qw) (Figure 2; see Stone 1990, 2006, Hayhurst and Bedrossian 2010).

The Bullhead Alluvium is distinguished by its well-rounded quartzite and chert pebbles, which were derived from sources on the Colorado Plateau. Its poorly constrained age is younger than the Pliocene Bouse Formation (4.83 Ma old) and older than the early Pleistocene Colorado River deposits (unit Qt), or between 3 and 4 Ma and Pliocene in age. Cross-bedding suggests that the gravels constituting the Bullhead Alluvium were deposited on the project by a southwestward meander of the Colorado River during the middle Pliocene Epoch (Reynolds et al. 2008). Northeast of the Project site, very old alluvial valley deposits (unit QTmw of Stone 2006 = unit Qvoa of Hayhurst and Bedrossian 2010) consist of gravels laid down by the Colorado River and might be laterally equivalent to the Bullhead Alluvium. At the northern end of the Project site, outcrops of Bullhead Alluvium have concordant summits, suggesting that erosion planed a terrace that is older than the upper terrace of Palo Verde Mesa.
Fluvial sediments deposited by the Colorado River and that include "...massive to thin-bedded pinkish silt and fine silty sand...interbedded locally with derived alluvial gravels" (Bell et al. 1978) are referred to as the Chemehuevi Formation by others (see Agenbroad et al. 1992). Near Blythe, the Chemehuevi Formation is exposed only on the Arizona side of the Colorado River. Although it was not recognized on the western side of the river by Stone (1990, 2006) or Hayhurst and Bedrossian (2010), it might underlie the middle to late Pleistocene, old terrace deposits (unit Qpv of Stone 2006 = unit Qot of Hayhurst and Bedrossian 2010) west of Blythe.

The ancestral Colorado River laid down old terrace deposits exposed at the Project site (unit Qpv of Stone, 2006 = unit Qot of Hayhurst and Bedrossian 2010) and cut into the older Bullhead Alluvium. The old terrace deposits, called the Upper Terrace of Palo Verde Mesa, extend to the south along the eastern flank of the Mule Mountains, where they underlie the Rio Mesa Project site. The Upper Terrace of Palo Verde Mesa is the oldest surface in the region, and underlies the southeastern two thirds of the Project area at elevations between 400 and 364 feet (Figure 2). Palo Verde Mesa and the Upper Terrace slope to the south to an elevation of about 335 feet near the Rio Mesa Project area.

Active late Holocene alluvial fan deposits (unit Qa-6 of Stone = unit Qf of Hayhurst and Bedrossian 2010) consist of gravels derived from the Big Maria and the Mule Mountains. Those alluvial fan deposits underlie the western edge of the Project area (Figure 2).

Active late Holocene eolian and dune deposits (unit Qs of Stone 2006 = unit Qe of Hayhurst and Bedrossian 2010) are composed of wind-blown sand derived from the playa to the west in Chuckwalla Valley. The lower and older stabilized dune deposits were laid down during the late Pleistocene Epoch, when westerly winds moved sand from the dry playa. This eolian process from Ford's Dry Lake continues today, covering the Project area with an unstable layer of mobile sand. The dune deposits cover most of the transmission line corridor (Figure 2). The Rositas and Orita Series of soils developed in locally thick sequences of aeolian sand west of the Project area from 35 to 25 thousand years (ky) (Rendell et al. 1994) ago. Lancaster and Tchakerian (2003) identified buried soils in the dunes that marked periods of non-deposition and stability 20 to 15, 14, and 4 ky years ago. A similar sequence might be present in the Project area. Eastward aeolian transport and fluvial erosion are stripping the surface of Palo Verde Mesa and exposing the underlying older sediments (units Tba, Qot, Qf2, Qe).

Late Holocene active alluvial wash deposits (unit Qw of Stone 2006, Hayhurst and Bedrossian 2010) are mapped in a small area along the southwestern margin of the Project site (Figure 2), and are expected to occur in other washes at the Project site.

The youngest sediments east of the Project area (between Palo Verde Mesa and Colorado River) are late Holocene alluvial valley deposits referred to as the Lower Terrace of the Colorado River (unit Qr of Stone 2006 = unit Qa of Hayhurst and Bedrossian 2010). The Lower Terrace lies at an elevation of 260 feet and represents sediments remaining from river meanders that cut through older sediments.

This mapped geologic sequence is supplemented with a soils map by Lerch et al. (2016) that defines five different soils and provides their relative ages (Figure 3, Table 1). Because soils develop on exposed surfaces of sedimentary units, soil ages are younger than the sediments on which they sit.

Table 1.—Soils underlying Desert Quartzite Solar Project site. Adapted from Lerch et al. (2016).

Soil	**Age**	**Developed On Unit (symbol in Figure 2)**	**Color in Figure 3**
Chuckawalla	Late Pleistocene	Tba	Dark gray
Aco	Late Pleistocene/early Holocene	Qot, Qf-2	Greenish gray
Orita	Late Holocene	Qot, Qf-2	Olive green
Rositas	Late Pleistocene	Qot, Qf-1,-2, Qe, Qw	Brown & green
Carrizo	Late Holocene	Tba, Qot	Tan

PALEONTOLOGICAL RESOURCES

The eastern portion of Riverside County has produced few fossil records older than 5 Ma in age. The older remains include petrified wood of Cretaceous age from the McCoy Mountains Formation (Stone 1990) and middle Miocene camel tracks from the western side of the Mule Mountains (R. E. Reynolds, personal observation 1997). The number of fossil occurrences increases with successively younger sediments whose deposition accompanied development of the Colorado River Trough and the embayment that extended northward from the Gulf of California about 5 Ma ago. Fossil fish and mollusk remains are recorded from the Bouse Formation to the northeast at Parker (Reynolds et al. 1992, 2007) and southeast of Blythe near Cibola, Arizona (Reynolds et al. 2008, Reynolds and Berry 2008). The Bouse Formation is not mapped at the Project site.

Early to middle Pleistocene, very old alluvial valley deposits (unit Tba of Figure 2 = unit QTmw of Stone 2006 and unit Qvoa of Hayhurst and Bedrossian 2010) are present as previously unmapped outcrops at the northern end of the Project site. Exposures of the unit at the Project site were established based on photointerpretation of a Google Earth satellite image covering the site. The gravels, referred to the Bullhead Alluvium by Reynolds (2008), have produced the fossilized rib of a horse south of Topock, Arizona (K. A. Howard, 2008 personal communication to R. E. Reynolds). The Bullhead Alluvium at the Project site has a moderate potential for containing significant vertebrate fossils.

Mammoth fossils from the Chemehuevi Formation are discussed by Agenbroad et al. (1992). They represent species of late Irvingtonian and early Rancholabrean age, ranging in age from at least 300 ky to just 102 ky, the latter based on a uranium-thorium radiometric age determination for a tusk from Ehrenberg, Arizona. The Chemehuevi Formation might underlie the old terrace deposits (unit Qot herein) in the Project area (see Figure 2).

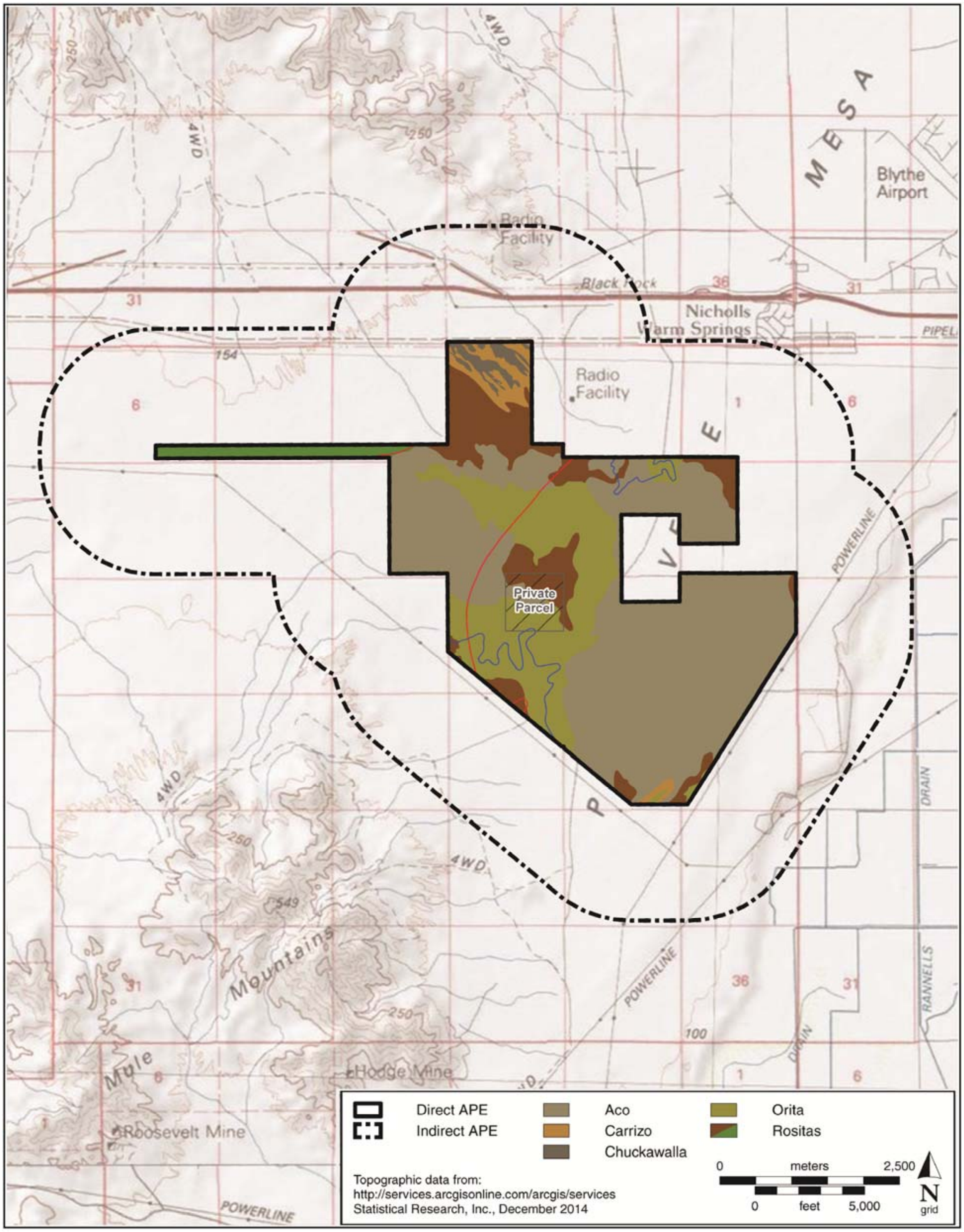


Figure 3.—Topographic and soils map, Desert Quartzite, LLC, Desert Quartzite Solar Project, northeastern Riverside County, California. Base map: United States Geological Survey Blythe 30 x 60 Minute Quadrangle (1986). Soils mapping after Lerch et al. (2016).

The most recent description of late Pleistocene vertebrate fossils near the Project area comes from studies at the Rio Mesa Project site (Stewart 2012, Stewart et al. 2012d), about 6 miles southeast of the Desert Quartzite Solar Project site. Vertebrate fossils from the Rio Mesa Project area were recovered from the same middle to late Pleistocene old terrace deposits (unit Qot herein = unit Qpv of Stone 2006 = unit Qot of Hayhurst and Bedrossian 2010) that underlie the current Project site. A 12-foot-thick paleosol (preserved soil horizon) is exposed at the Rio Mesa Project site (Stewart 2012). Fossils recovered from the "Palo Verde Mesa paleosol" include more than 800 vertebrate specimens representing birds, snakes, lizards, *Gopherus* (desert tortoise), *Sylvilagus* (cottontail), *Lepus* (jackrabbit), rodents, *Taxidea* (badger), bighorn sheep (?), *Odocoileus* (deer), *Equus* (horse), and *Mammuthus* (mammoth) (Table 2; Stewart 2012, Stewart et al. 2012). The mammoth provides an age constraint for the terrace deposits because it is restricted to the Irvingtonian and Rancholabrean NALMAs and the early to late Pleistocene Epoch in North America (Bell et al. 2004). The abundant fossil occurrences at the Rio Mesa Project site (one locality per 5 acres) demonstrates that the old terrace deposits with Pleistocene Chuckawalla and Aco soils in the Project area have a high potential for producing scientifically important vertebrate fossil remains of late Pleistocene age. The level of potential will be determined during the preconstruction field survey.
Stabilized eolian and dune deposits (unit Qe herein = unit Qs of Stone 2006 and unit Qe of Hayhurst and Bedrossian 2010) might be partly latest Pleistocene in age. Other portions of the dune field (also included in unit Qe herein) are remobilized by prevailing westerly winds. Similar Pleistocene stabilized dune fields deposited by winds from the west are found in Colton, on the western side of the Old Dad Mountain, west of Kelso at Flynn, and north of Baker at Silver Lake. Those dune fields have yielded vertebrate fossil remains from the end of the latest Pleistocene pluvial period, less than 17 ky ago (Reynolds 2004). Reworked Pleistocene fossil remains have been found in the eolian deposits of the Rio Mesa Project area (Stewart 2012). Such fossil occurrences suggest that the older, stabilized dune field in the Project area has a potential for producing scientifically important vertebrate fossil remains of latest Pleistocene age.

The active late Holocene alluvial fan deposits (unit Qf-1 herein = unit Qa-6 of Stone 2006 and unit Qf of Hayhurst and Bedrossian 2010) and alluvial wash deposits (unit Qw herein, Stone 2006, and Hayhurst and Bedrossian 2010) have produced no fossil remains in the region. However, fan deposits were being deposited for more than a million years and, consequently, older or stabilized alluvial fan deposits (unit Qf-2 herein) might produce fossils in the shallow subsurface, particularly where there is a deep B soil horizon as documented by Lerch et al. (2016).

This part of the paleontological resource inventory and impact assessment pertains to the privately owned parcel in the Project area. Development of the parcel would be subject to the California Environmental Quality Act (CEQA) and, therefore, the assessment follows Riverside County guidelines for determining the sensitivity of sedimentary units at a project site. The parcel is underlain by old terrace deposits (Figure 2). Based on its documented paleontological productivity (Stewart, 2012; Stewart et al., 2012), the old terrace deposits are reassigned High A and B productivity ratings from the previous Undetermined Potential, indicating that the unit has a high potential for containing fossil remains at the surface and in the subsurface.

Table 2.—Vertebrate taxonomic list, old terrace deposits Rio Mesa Project site. After Stewart (2012).

Higher-Level Taxon (common name)	Genus, Species	Common Name
Osteichthyes (fishes)	undet. fresh-water fishes	
Amphibia (amphibians)		
Bufonidae (toads)	undet.	toads
Reptilia (reptiles)		
Chelonia (turtles)		
Testudinidae (tortoises)	*Gopherus sp.*	desert tortoises
Lacertilia (lizards)		
Iguanidae (iguanids)	*Dipsosaurus*	desert iguana
	Phrynosoma platyrhinos	desert horned lizard
Serpentes (snakes)		

Colubridae (nonvenomous snakes)	*Phyllorhynchus decurtatus*	spotted leaf-nosed snake
Viparidae (vipers)	*Crotalus sp.*	rattlesnakes
Aves (birds)		
Fringillidae (seed-eating birds)	undet.	finches
Mammalia (mammals)		
Lagomorpha (rabbits/hares)	*Sylvilagus* sp. undet.	cottontails
	Sylvilagus bachmani	brush rabbit
	Lepus californicus	jack rabbit
Rodentia (rodents)	*Dipodomys deserti*	desert kangaroo rat
	Chaetodipus/*Perognathus*	pocket mouse
	Thomomys	pocket gophers
Carnivora (carnivores)		
Mustelidae	*Taxidea taxus*	badger
Perissodactyla (odd-toed ungulates)	*Equus*?	horse?
Artiodactyla(even-toed ungulates)	*Odocoileus*	deer
	Ovis canadensis	bighorn sheep
Proboscidea (proboscideans)		
Elephantidae (elephants)	*Mammuthus*	mammoth

PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT

INTRODUCTION

This preliminary paleontological resource assessment for the Project complies with the BLM PFYC system (Appendix C), which requires the preparation of an evaluation and an accompanying sensitivity map using the corresponding geologic base. The evaluation is based on the results of a literature review and an archival search.

The assessment found that the Project site is underlain by sediments with moderate to high potentials for containing fossil remains (e.g., Bullhead Alluvium, old terrace deposits, stabilized alluvial fan deposits, certain soils) as well as sediments with undetermined or low potential (e.g., active alluvial fan deposits, eolian and dune deposits, alluvial wash deposits). The PFYC rating of a sedimentary unit is based partly on the scientific importance or significance of the fossil specimens it has produced. All vertebrate fossils are considered significant. The BLM provides specimen-based and context-based criteria for evaluating the significance of a fossil specimen (Table 3).

Table 3.—Significance criteria for evaluating paleontological resources (BLM 2007; see Appendix C).

Criterion	**Significance**
Specimen based	• Represents an unknown or undescribed/unnamed taxon. • Represents rare taxon: either absolute rareness or contextual rareness. • Represents a vertebrate taxon (invertebrate specimen might also be significant).
Context based	• Is associated with other evidence of scientific interest, providing taphonomic, environmental, or evolutionary information. • Is evidence that extends and/or constrains the stratigraphic, chronologic, and/or geographic range of a species or higher-level taxonomic group.

The preliminary Project PFYC is presented by rock unit as a paleontological resource impact sensitivity map in Figure 4. The map is based on the most recent surficial geologic map covering the Project area by Hayhurst and Bedrossian (2010). The following discussion includes the Bullhead Alluvium at the northern end of the Project area (K. A. Howard, 2015 personal communication to R. E Reynolds) and adds an outcrop pattern for the Bullhead Alluvium (Figures 2, 4). Symbols in Figure 4 differentiate the distal, stabilized Pleistocene alluvial fans (unit Qf-2) from proximal active Holocene fans (unit Qf-1) near the bases of mountains.

Preliminary research suggests the central portion of the Project area is undergoing active deflation and erosion, thus exposing Pleistocene soils and sediments. The soils map in Figure 3 adds additional age constraints on the sedimentary units. The preliminary PFYC or impact sensitivity of each sedimentary unit exposed in the Project area is presented in Table 4 and Figure 4. The BLM PFYC system is presented in Appendix C.

Table 4.—PFYC of stratigraphic units in Desert Quartzite Solar Project area.

Stratigraphic Unit (age)	**PFYC**	**Description and Basis (BLM IM 2008-009; see Appendix C)**
Bullhead Alluvium (Tba) (Pliocene)	3 (Moderate to Undetermined)	Sediments contain vertebrate fossils, but occurrences are widely scattered.
Old terrace deposits (Qot) (middle to late Pleistocene)	5a (Very High)	Highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils, and that are at risk of human-caused adverse impacts or natural degradation. • Vertebrate fossils are known and documented to occur consistently, predictably, at one locality/five acres. • Unit is exposed. Paleontological resources are highly susceptible to adverse impacts from surface-disturbing actions.
Stabilized Alluvial Fan Deposits (Qf-2) (late Pleistocene to Holocene)	3b (Unknown)	Unit exhibits geologic (stratigraphic) features and preservational conditions that suggest significant fossils could be present.
Stabilized Eolian and Dune Deposits (Qe) (late Pleistocene to Holocene)	3b (Unknown)	Unit exhibits geologic (stratigraphic) features and preservational conditions that suggest significant fossils could be present.
Active Alluvial Fan Deposits (Qf-1) (late Holocene)	2 (Low)	Sedimentary geologic units not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils. • Units younger than 10,000 years before present.
Active Eolian and Dune Deposits (Qe) (late Holocene)	2 (Low)	Sedimentary geologic units that are not likely to contain vertebrate fossils. • Units younger than 10,000 years before present. • Recent aeolian deposits.
Active Alluvial Wash Deposits (Qw) (late Holocene)	2 (Low)	Sedimentary geologic units that are not likely to contain vertebrate fossils. • Units younger than 10,000 years before present.

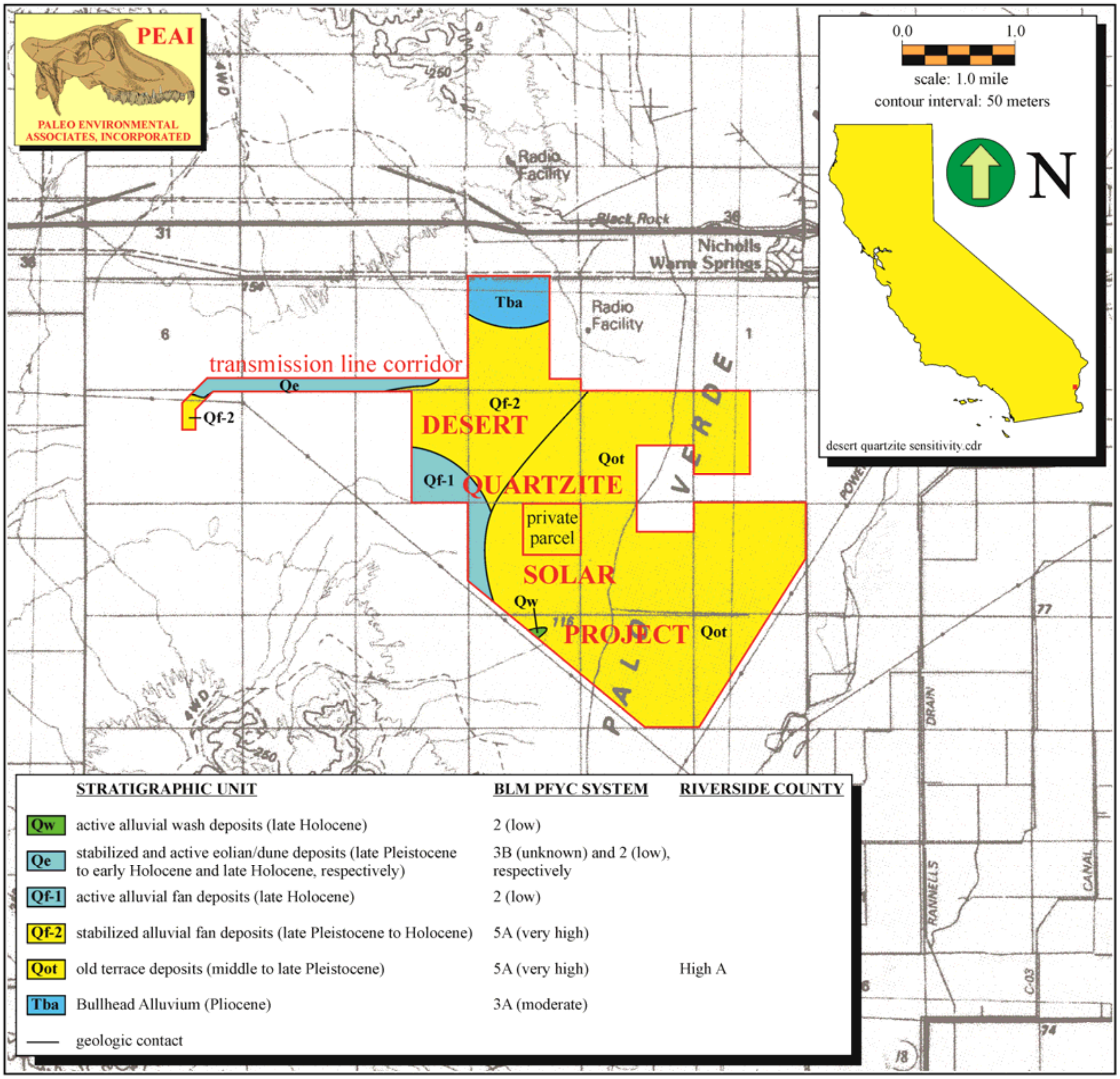


Figure 4.—Topographic and preliminary paleontological resource impact sensitivity map, Desert Quartzite, LLC, Desert Quartzite Solar Project, northeastern Riverside County, California. Base map: United States Geological Survey Blythe 30 x 60 Minute Quadrangle (1986). Geology after Stone (2006) and Hayhurst and Bedrossian (2010), and based locally on photointerpretation of Google Earth satellite image covering Project site. Sensitivities for stratigraphic units underlying most of Project site based on BLM PFYC System. Sensitivity for private parcel based on Riverside County paleontological sensitivity map. See Figure 2.

PFYC SYSTEM EVALUATIONS OF STRATIGRAPHIC UNITS IN PROJECT AREA

The Project area encompasses five continental stratigraphic units of Pliocene, Pleistocene, and Holocene age. The preliminary PFYC system class of each unit is discussed below and presented in Table 4 and Figure 4. Those assignments will be finalized after the preconstruction field survey.

Bullhead Alluvium (unit Tba) (Pliocene)
Previously unmapped outcrops at the north end of the Project have characteristics of the Pliocene Bullhead Alluvium. The presence of occasional vertebrate fossil remains allows it to considered to have a moderate to undetermined potential for containing fossil remains and therefore, as assigned to PFYC system Class 3.

Old Terrace Deposits (unit Qot) (middle to late Pleistocene)
As mapped by Stone (2006, unit Qpv) and Hayhurst and Bedrossian (2010, unit Qot), the old terrace deposits are the same as the fossiliferous sediments that underlie the Rio Mesa Project area, about 6 miles south of the Desert Quartzite Solar Project site. The "Palo Verde Mesa Paleosol" of the “old” or “Upper Terrace” deposits has produced over 800 fossil vertebrate specimens of Irvingtonian to Rancholabrean (Pleistocene) age (Stewart 2012). Because the fossil yield from the old terrace deposits is very high, they are considered to have a very high potential for containing fossil remains and, therefore, are assigned to PFYC system Class 5a.

Stabilized Alluvial Fan Deposits (unit Qf-2) (late Pleistocene to Holocene)
Stabilized Alluvial Fan Deposits interfinger with old terrace deposits (unit Qot) and, therefore, might contain a similar fossil vertebrate fauna. The alluvial fan deposits are considered to have an unknown potential for containing fossils and therefore, are assigned to PFYC system Class 3b of the PFYC system.

Stabilized and Active Eolian and Dune Deposits (unit Qe) (late Pleistocene to late Holocene)
Stabilized and active dune deposits in the Rio Mesa Project area to the south have yielded Pleistocene fossil remains (Stewart 2012). Therefore, the stabilized portions of the eolian and dune deposits (Qe) have an unknown potential for containing fossils, and, therefore, are assigned to PFYC system Class 3b.

Active eolian and dune deposits (not mapped separately in Figure 4) underlie the western portion of the Project area. Thicknesses of the sand sheets vary considerably (Lerch et al. 2016), but sometimes exceed 5 feet. The active deposits are too young to contain remains old enough to be considered fossilized. Any fossil remains would likely have been reworked and removed from their original stratigraphic context. These stratigraphic units have a low potential for producing fossils and are assigned to Class 2 of the PFYC system.

These preliminary PFY classifications will be finalized after the preconstruction field survey.

RECOMMENDATIONS

This preliminary paleontological resource impact assessment has determined that earth-moving activities at the Project site have the potential to impact fossil remains and associated specimen and locality data where the area is underlain by paleontologically sensitive deposits (Figure 4). The Project proponent has described construction-related earth-moving activities at the Project site. Such activities include grading, cut and fill, trenching for pipelines and construction of generator tie lines. Some excavation might reach depths of 10 feet. Therefore, a Project-specific paleontological resource impact mitigation plan/program (PRIMP) is recommended for all phases of construction-related earth-moving activities. The plan can be prepared after a paleontological resource preconstruction field survey has been completed.

A preconstruction field survey of the Project area is required to complete the BLM PFYC evaluation. The survey will provide ground truth verification of the preliminary PFYC assignment for each sedimentary unit exposed therein, or justification for changing such an assignment. The final assignments will be used in developing the PRIMP, which will be based on generic SVP (2010) measures (see Appendix D). When implemented, the PRIMP will reduce adverse construction-related impacts on paleontological resources of the Project site to a less-than-significant level.

During the preconstruction field survey, newly discovered fossil localities must be documented and the fossil remains recovered and fully treated (see below). Strata with a demonstrated potential for containing fossil remains (e.g., soils, paleosols, playa or lacustrine strata) should be noted.

Based on the results of this preliminary inventory and impact assessment, it is recommended that

1. a preconstruction field survey be conducted over the entire Project area to verify the PFYC assignment for each stratigraphic unit exposed therein, particularly with regard to eolian and dune deposits,
2. the survey include mapping of the Bullhead Alluvium to clarify its stratigraphic and outcrop relations to other sedimentary units,
3. a Project-specific PRIMP be prepared, based on this assessment, mapping, and preconstruction field survey results, and
4. fossil remains recovered during the survey, as well as those recovered during construction-related earth-moving activities, be dealt with as prescribed in the treatment plan presented below.
    a) the location of any larger fossil specimen will be documented using a hand-held GPS unit and recording NAD 83 UTM coordinates,
    b) the stratigraphic unit and level producing the specimen will be recorded,
    c) corresponding specimen data and geographic and geologic locality data will accompany the specimen during recovery, transport to a laboratory facility, and the treatment process,
    d) specimen stabilization, if necessary, will occur before removal and transport, and will include saturating the remains with hardening solution and enclosing them in protective plaster jacket,
    e) fine-grained sediment surrounding specimen will be test screened to allow for the recovery of smaller fossil remains that are too small to be observed in the field,
    f) larger fine-grained sediment or rock samples with volumes totaling amounts prescribed by SVP (2010) will be collected to allow for the recovery of additional small remains,
    g) each specimen recovered during the field survey or construction-related earth-moving activities will be prepared to point allowing identification to lowest taxonomic level possible,
    h) the skeletal element(s) represented by the specimen will be identified by a knowledgeable paleontologist, who will also identify the specimen to the lowest taxonomic level possible,
    i) the specimen will be catalogued with individual specimen and locality numbers provided by a designated museum repository,
    j) a fossil specimen catalog and a fossil locality inventory will be compiled, and
    k) the entire collection from the Project site will be transferred to the repository, where the collection will be permanently stored, maintained, and made available to qualified investigators for scientific research.

The treatment plan would be implemented under the PRIMP. A curation and storage agreement with the repository must be arranged prior to the preconstruction field survey. A suitable repository would be the Western Science Center in Hemet.

A preliminary PRIMP is being developed based on data from this assessment, and revisions to the PRIMP may occur after the proposed pre-construction survey. When the final PRIMP is completed, it must be approved by the BLM before any Project construction-related earth-moving activity begins and must be implemented during such construction activities when they might disturb potentially fossil-bearing sediments. It is recommended that the PRIMP include:

1. a worker environmental awareness training program to be presented by a Project paleontologist, who will discuss fossil recognition and procedures to be implemented by earth-moving equipment operators when remains are encountered, particularly when a trained paleontologic monitor is not on site (e.g., avoidance of fossil locality, notification of appropriate Project, agency staff, and PRIMP personnel), and who will provide an informational brochure and, as appropriate, a video recording,
2. paleontologic construction monitoring of earth-moving activities by a qualified (trained) monitor in portions of the Project area determined to have moderate or high sensitivity during the preconstruction field survey, thereby allowing for the discovery and recovery of any larger fossil remains exposed by such activities,
3. assignment of additional field staff to recover an unusually large fossil specimen, thereby avoiding any diversion of the monitor from their designated task,
4. collecting and processing fine-grained sediment samples to allow for the recovery of smaller remains,
5. recording of associated specimen data (element, preliminary taxonomic identification,/sample and locality data,

6. full treatment of any remains recovered as a result of monitoring or sample processing (e.g., specimen preparation, identification, curation, cataloging), and
7. preparation of a comprehensive final mitigation report of results and findings for submission to the BLM and the museum repository receiving the fossil collection.

The level of monitoring and the collection of sediment samples would be based on the PFYC assignment for the underling stratigraphic unit, and as determined appropriate based on preconstruction field survey results. The specific project activities requiring monitoring, as well as duration of monitoring in the event resources are not identified by monitoring activities, will be defined in the PRIMP. Acceptance of the final report by the BLM would signify completion of the PRIMP and would demonstrate Project compliance with CEQA, NEPA, BLM guidelines, and mitigation measures developed during the environmental impact review process for the Project.

LITERATURE CITED

Agenbroad, L.D., J.I. Mead, and R.E. Reynolds. 1992. Mammoths in the Colorado River corridor. J. Reynolds (editor). Old routes to the Colorado. *San Bernardino County Museum Association Special Publication* 92-2:104–106.

Bell, C.H., E.L. Lundelius Jr., A.D. Barnosky, R.W. Graham, E.H. Lindsay, D.R. Ruez Jr., H.A. Semken Jr., S.D. Webb, and R.J. Zakrzewski. 2004. The Blancan, Irvingtonian, and Rancholabrean Mammal Ages. Pages 232–314. *In* M.O. Woodburne (editor). Late Cretaceous and Cenozoic mammals of North America. Columbia University Press.

Bell, J.W., T.-L. Ku, and G.T. Kukla. 1978. The Chemehuevi Formation of Nevada, Arizona, and California: An examination of its distribution, facies, and age. *Geological Society of America Abstracts with Programs* 10(3):95.

Hayhurst, C.A., and T.L. Bedrossian. (compilers). West half of Blythe 30' by 60' Quadrangle. Plate 4. *In* T.L. Bedrossian, P. Roffers, and C.A. Hayhurst (compilers). Geologic compilation of Quaternary surficial deposits in southern California. *California Geological Survey Special Report* 217.

Jennings, C.W. (compiler). 1967. Salton Sea Sheet. *Geologic Map of California, Olaf P. Jenkins Edition*. California Division of Mines and Geology.

Lancaster, N., and V.P. Tchakerian. 2003. Late Quaternary aeolian dynamics in the Mojave Desert. *In* Y. Enzel, S.G. Wells, and N. Lancaster (editors). Paleoenvironments and paleohydrology of the Mojave and southern Great Basin desert. *Geological Society of America Special Paper* 368:231–249.

Lerch, M.K., P.B. Stanton, and K.K. Swope (editors). 2016. Class III Archaeological Survey of the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California. Statistical Research, Inc., Technical Report 15-36. Redlands, California. Prepared for First Solar Development, Inc. Submitted to BLM Palm Springs Field Office, Palm Springs, California.

Metzger, D.G., O.J. Loeltz, and B. Irelan. 1973. Geohydrology of the Parker-Blythe-Cibola area, Arizona and California. *United States Geological Survey Professional Paper* 486-G:1–130.

Rendell, H.M., N. Lancaster, and V.P. Tchakerian. 1994. Luminescence dating of late Quaternary aeolian deposits at Dale Lake and Cronese Mountains, Mojave Desert, California. *Quaternary Science Reviews (Quaternary Geochronology)* 13:417–422.

Reynolds, R.E., A.V. Buising, and, K.K. Beratan. 1992. Old routes to the Colorado: The 1992 Mojave Desert Quaternary Research Center field trip. *In* R.E. Reynolds (compiler). Old routes to the Colorado. *San Bernardino County Museum Association Special Publication* 92-2:5–27.

Reynolds, R.E. 2004. A latest Pleistocene (Rancholabrean) fossil assemblage from the Silver Lake Climbing Dune site, northeastern Mojave Desert, California. Pages 33–38. *In* R.E. Reynolds (editor). Breaking Up: The 2004 Desert Symposium field trip, with Abstracts from the 2004 Desert Symposium. California State University Desert Studies Consortium and LSA Associates, Inc.

Reynolds, R.E. 2007. Wild, scenic and rapid: A trip down the Colorado River Trough. 2007 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 116.

Reynolds, R.E., J. Faulds, P.K. House, K. Howard, D. Malmon, C.R. Miller, and P.A. Peachtree. 2007. Wild, scenic and rapid: A trip down the Colorado River Trough. Pages 5–32. *In* R.E. Reynolds (editor). 2007 Desert Symposium. California State University Desert Studies Consortium and LSA Associates, Inc.

Reynolds, R.E., and D.R. Berry. 2008. Preliminary review of invertebrate fossil localities in the Bouse Formation, Blythe basin, California. Pages 62–68. *In* R.E. Reynolds (editor). Trough to trough: The Colorado River and the Salton Sea. Proceedings of the 2008 Desert Symposium. California State University Desert Studies Consortium and

LSA Associates, Inc.

Reynolds, R.E., G.T. Jefferson, and D.K. Lynch. 2008. Trough to trough: The 2008 Desert Symposium field trip. Pages 5–25. *In* R.E. Reynolds (editor). Trough to trough: The Colorado River and the Salton Sea. Proceedings of the 2008 Desert Symposium. California State University Desert Studies Consortium and LSA Associates, Inc.

Stewart, J.D. 2012. Draft paleontological resources delineation work plan. URS, Project No. 27652105.00505. Prepared for Rio Mesa Solar I, LLC, and Rio Mesa Solar II, LLC.

Stewart, J.D., M. Williams, M. Hakel, and S. Musick. 2012. Was it washed in? New evidence for the genesis of Pleistocene fossil vertebrate remains in the Mojave Desert of southern California. Pages 140–143. *In* R.E. Reynolds (editor). Searching for the Pliocene: Southern exposures. The 2012 Desert Research Symposium. California State University Desert Studies Center.

Stone, P. 1990. Preliminary geologic map of the Blythe 30' by 60' Quadrangle, California and Arizona, United States Geological Survey Open-File Report 90-497.

Stone, P. 2006. Geologic map of the west half of the Blythe 30' by 60' Quadrangle, Riverside County, California and La Paz County, Arizona, United States Geological Survey Scientific Investigations Map 2922.

Society of Vertebrate Paleontology Impact Mitigation Guidelines Revision Committee. 2010. Standard procedures for assessment and mitigation of adverse impacts to paleontological resources.

United States Bureau of Land Management (BLM). 2007. Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands. BLM Instruction Memorandum No. 2008-009.

APPENDIX A

ACRONYMS, ABBREVIATIONS, AND INITIALISMS

BLM	United States Bureau of Land Management
CEQA	California Environmental Quality Act
Ma	million years
PEAI	Paleo Environmental Associates, Inc.
PFYC	Potential Fossil Yield Classification
PRIMP	paleontological resource impact mitigation plan/program
Project	Desert Quartzite Solar Project
Qe	eolian and dune deposits
Qf	alluvial fan deposits
Qot	old terrace deposits
Qw	alluvial wash deposits
Rio Mesa	Rio Mesa Solar Electric Generating Facility Project
SVP	Society of Vertebrate Paleontology
USGS	United States Geological Survey

APPENDIX B

RELEVANT FEDERAL AND STATE LEGISLATION REGARDING PALEONTOLOGICAL RESOURCES

A number of Federal statutes specifically address paleontological resources. Such statutes would apply to a specific project if that project were on Federal land or involved a Federal agency license, permit, approval, or funding. This section summarizes Federal regulations regarding paleontological resources and how those regulations might affect project development and operation. Policies and/or contact information for Federal land managing and regulatory agencies that have paleontological oversight and responsibilities are provided directly or by hotlink. If a project involves land owned or administered by another Federal or a State agency, that agency should be contacted in order to ascertain specific requirements they might impose with respect to paleontological resources.

Antiquities Act of 1906 (16 United States Code [USC] 431-433). The Antiquities Act of 1906 states, in part "That any person who shall appropriate, excavate, injure or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated, shall upon conviction, be fined in a sum of not more than five hundred dollars or be imprisoned for a period of not more than ninety days, or shall suffer both fine and imprisonment, in the discretion of the court." Although there is no specific mention of natural or paleontological resources in the Act itself or in the Act's uniform rules and regulations (Title 43 Part 3, Code of Federal Regulations [43 CFR 3]), "objects of antiquity" have been interpreted to include fossils by the National Park Service (NPS), the Bureau of Land Management (BLM), the Forest Service (FS), and other Federal agencies. Permits to collect fossils on lands administered by Federal agencies are authorized under this Act (see "Permit Requirements of Federal Agencies" section, below). Therefore, projects involving Federal land will require permits for both paleontological resource evaluation and mitigation efforts.

Archaeological and Paleontological Salvage (23 USC 305). Statute 23 USC 305 amends the Antiquities Act of 1906. Specifically, the Act states "Funds authorized to be appropriated to carry out this title to the extent approved as necessary, by the highway department of any State, may be used for archaeological and paleontological salvage in that state in compliance with the Act entitled 'An Act for the preservation of American Antiquities,' approved June 8, 1906 (PL 59-209; 16 USC 431-433), and State laws where applicable. This statute allows funding for mitigation of paleontological resources recovered pursuant to Federal aid highway projects, provided that excavated objects and information are to be used for public purposes without private gain to any individual or organization" (Federal Register [FR] 46(19): 9570; [also see FHWA policy section, below]).

National Registry of Natural Landmarks (16 USC 461-467). The National Natural Landmarks (NNL) program was established in 1962 and is administered under the Historic Sites Act of 1935. Implementing regulations were first published in 1980 under 36 CFR 1212 and the program was re-designated as 36 CFR 62 in 1981. A National Natural Landmark is defined as:

> "…an area designated by the Secretary of the Interior as being of national significance to the United States because it is an outstanding example(s) of major biological and geological features found within the boundaries of the United States or its Territories or on the Outer Continental Shelf (36 CFR 62.2)."

National significance describes

> "… an area that is one of the best examples of a biological community or geological feature within a natural region of the United States, including terrestrial communities, landforms, geological features and processes, habitats of native plant and animal species, or fossil evidence of the development of life (36 CFR 62.2)."

Federal agencies (e.g., FHWA) and their agents (e.g., Caltrans) should consider the existence and location of designated NNLs, and of areas found to meet the criteria for national significance, in assessing the effects of their activities on the environment under section 102(2)(c) of the National Environmental Policy Act (NEPA) (42 USC 4321). The NPS is responsible for providing requested information about the National Natural Landmarks Program for these assessments (36 CFR 62.6[f]). However, other than consideration under NEPA, NNLs are afforded no special protection. Furthermore, there is no requirement to evaluate a paleontological resource for listing as an NNL. Finally, project proponents (State and local) are not obligated to prepare an application for listing potential NNLs, should such a resource be encountered during project planning and delivery. For an up-to-date listing of NNLs, visit the National Natural Landmarks website.

National Environmental Policy Act of 1969 (42 USC 4321). The National Environmental Policy Act (NEPA) directs Federal agencies to use all practicable means to "…preserve important historic, cultural, and natural aspects of our national heritage…" (Section 101[b] [(])). Regulations for implementing the procedural provisions of NEPA are found in 40 CFR 1500 1508.

If the presence of a significant environmental resource is identified during the scoping process, Federal agencies and their agents must take the resource into consideration when evaluating project effects. Consideration of paleontological resources may be required under NEPA when a project is proposed for development on Federal land, or land under Federal jurisdiction. The level of consideration depends on the Federal agency involved (see "Identification of Regulatory/Management Agencies" section, below).

- **1872 Mining Law, amended 1988.** Excludes fossils (including petrified wood) from claim or patent. U.S. Forest Service and BLM regulates surface effects of development under this law. BLM regulations specifically state that operators may not knowingly disturb or destroy any scientifically important fossil remains on federal lands; that they notify an authorized officer of such finds; and that said officer shall take action to protect or remove the resource(s).
- **Mineral Leasing Act of 1920 (sec. 30).** Requires and provides for the protection of interest of the United States. Natural resources, including paleontological resources, are commonly regarded as such interests.
- **Executive Order 11593, May 31, 1971, Protection and Enhancement of the Cultural Environment (36 CFR 8921).** Requires Federal agencies to inventory and protect properties under their jurisdiction. National Park Service regulations under 36 CFR provide that fossil specimens may not be disturbed or removed without a permit.
- **Archaeological and Historic Data Preservation Act of 1974 (PL 86-253, as amended by PL 93-921, 16 USC 469), Act of May 24, 1974 (88 Stat 174, sec. 3 a0, 4a).** Provides for the survey, recovery, and preservation of significant scientific, prehistoric, historic, archaeological, or paleontological data when such data may be destroyed or irreparably lost due to a Federal, federally licensed, or federally funded project. A "Statement of Program Approach" was published in the *Federal Register* on March 26, 1979 (40 FR 18117) to advise the manner in which this law will be implemented.
- **Federal Land Management and Policy Act of 1976 (FLPMA, PL 94-579, 43 USC 1701–1782)**. Provides authority for BLM to regulate lands under its jurisdiction, managed in a manner to "protect the quality of scientific, scenic, historic, ecological, environmental...and archaeological values." Authority is given to establish areas of critical environmental concern (ACEC).
- **Surface Mining Control and Reclamation Act of 1977 (SMCRA, PL 95-87, 30 USC 1201–1328).** Regulates surface coal mining and provides designation as unsuitable for surface mining if mining would "...result in significant damage to important cultural, scientific, and esthetic values and natural systems..."
- **Paleontological Resource Management 1998, Bureau of Land Management Handbook H-8270-1** General Procedural Guidance for Paleontological Management.
- **Paleontological Resources Preservation Act, Section 291 of the Omnibus Public Land Management Act of 2009.** The proposed regulations would provide for the preservation, management, and protection of paleontological resources on Federal land.

State of California Legislation

- The following state laws and regulations are applicable or potentially applicable to projects crossing State lands.
- **California Environmental Quality Act of 1970 (CEQA, 13 PRC, 2100, et seq).** Requires identification of potential adverse impacts of a project to any object or site of scientific importance (Div. 1, PRC 5020.1(b)).

- The California Environmental Quality Act (Chapter 1, Section 21002) states that:
- it is the policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects, and that the procedures required are intended to assist public agencies in systematically identifying both the significant effects of proposed projects and the feasible alternatives or feasible mitigation measures which will avoid or substantially lessen such significant effects.
- Guidelines for the Implementation of the California Environmental Quality Act, as amended May 10, 1980 (14 Cal. Admin. Code: 15000, et seq). Requires mitigation of adverse impacts to a Paleontological site from development on public land by construction monitoring.
- The CEQA Guidelines (Article 1, Section 15002(a)(3)) state that CEQA is intended to: prevent significant, avoidable damage to the environment by requiring changes in projects through the use of alternatives or mitigation measures when the governmental agency finds the changes to be feasible.
- **Guidelines for the Implementation of CEQA, 1992, Appendix G, section J (Significant effects).** CEQA Guidelines, Appendix G, states, in part, that: A project will "normally" have a significant effect on the environment if it, among other things, will disrupt or adversely affect … a paleontological site except as part of a scientific study. If paleontological resources are identified during the Preliminary Environmental Analysis Report (PEAR), or other initial project scoping studies, as being within the proposed project area, the sponsoring agency must take those resources into consideration when evaluating project effects. The level of consideration may vary with the importance of the resource.
- Periodic review of CEQA-related court cases for decisions related to paleontology is also recommended. These cases can be found at the California Environmental Resources Evaluation System (CERES) web site.
- California Environmental Quality Act, State of California Public Resources Code, 2100-21177 as amended January 1, 1999, Appendix G Environmental Checklist Form. Impacts to known, important paleontological resources are specifically covered under CEQA as potentially significant effects, i.e., the project will have a significant effect on the environment. Specifically, each California project must answer the question: Cultural Resource - would the project directly or indirectly destroy a unique paleontological resource or site or unique geological feature? There are four possible answers: Potentially Significant Impact, Potentially Significant Unless Mitigation Incorporated, Less than Significant Impact, and No Impact.
- **California Coastal Act.** The California Coastal Act authorizes, in part, the California Coastal Commission (CCC) to review permit applications for development within the coastal zone and, where necessary, to require reasonable mitigation measures to offset effects of that development. Permits for development are issued with "special conditions" to ensure implementation of these mitigation measures.
- Section 30244 of the Act, "Archaeological or Paleontological Resources," states that: Where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required.
- If the CCC determines that a paleontological resource is present within an applicant's proposed project area, they generally look for evidence that the applicant has taken the resource into consideration, e.g., through formal survey by a professional paleontologist with implementation of resulting recommendations. If a paleontological site is present, special permit conditions may range from avoidance of the site to construction monitoring and/or salvage of significant fossils. This approach virtually parallels the level of protection afforded to paleontological resources by CEQA. Additionally, the CCC relies heavily on project sponsoring or permitting agencies to ensure compliance with CEQA (and consequently, the California Coastal Act).
- **Warren-Alquist Act (PRC 25000 et seq).** Requires the California Energy Commission to evaluate energy facility sitting in unique areas of scientific concern (Section 26627)
- **Public Resources Code, Section 5097.5 (State 1965, c. 1136, p. 2792).** Section 50987.5 of the California Public Code Section states: No person shall knowingly and willfully excavate upon, or remove, destroy, injure or deface any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands. Violation of this section is a misdemeanor.

- As used in this section, "public lands" means lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof. Consequently, Caltrans as well as local project proponents, are required to comply with PRC 5097.5 for their own activities, including construction and maintenance, as well as for permit actions (e.g., encroachment permits) undertaken by others.
- **Public Resources Code, Section 30244.** Requires reasonable mitigation of adverse impacts to paleontological resources from development on public land.
- **California Administrative Code.** Four sections of the California Administrative Code (Title 14, State Division of Beaches and Parks) administered by the California Department of Parks and Recreation CDPR) address paleontological resources. These include:
- Section 4306: Geological Features - "No person shall destroy, disturb, mutilate, or remove earth, sand, gravel, oil, minerals, rocks, or features of caves."
- Section 4307: Archaeological Features - "No person shall remove, injure, disfigure, deface, or destroy any object of paleontological, archaeological, or historical interest or value."
- Section 4308: Property - "No person shall disturb, destroy, remove, deface, or injure any property of the state park system. No person shall cut, carve, paint, mark, paste, or fasten on any tree, fence, wall, building, monument, or other property in the state parks, any bill, advertisement, or inscription."
- Section 4309: Special Permits - "Upon a finding that it will be for the best interest of the state park system and for state park purposes, the director may grant a permit to remove, treat, disturb, or destroy plants or animals or geological, historical, archaeological, or paleontological materials; and any person who has been properly granted such a permit shall to that extent not be liable for prosecution for violation of the foregoing."
- These sections of the California Administrative Code establish authority and processes to protect paleontological resources while allowing mitigation through the permit process.

Local Laws and Regulations

Various counties have passed ordinances and resolutions related to paleontological resources within their jurisdictions. Examples include the Counties of Orange, Riverside, and San Bernardino. These regulations generally provide additional guidance on assessment and treatment measures for projects subject to CEQA compliance. Project staff members should periodically coordinate with local entities to update their knowledge of local requirements.

APPENDIX C

BUREAU OF LAND MANAGEMENT
CRITERIA FOR EVALUATING PALEONTOLOGICAL RESOURCES
(INSTRUCTION MEMORANDUM NO. 2008-009)
(2007)

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Washington, D.C. 20240
October 15, 2007

In Reply Refer To:
1610, 8270 (240) P
EMS TRANSMISSION 10/18/2007
Instruction Memorandum No. 2008-009
Expires: 09/30/2009
To: All State Directors
From: Assistant Director, Renewable Resources and Planning

Subject: Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands

Program Areas: Paleontological Resources Management, Resource Management Planning, Lands and Realty Management, Minerals Management, Range

Purpose: This Instruction Memorandum (IM) transmits the Bureau of Land Management (BLM) classification system for paleontological resources on public lands. The classification system is based on the potential for the occurrence of significant paleontological resources in a geologic unit, and the associated risk for impacts to the resource based on Federal management actions. Copies of the classification system and implementation guidance are attached.

Policy/Action: The Potential Fossil Yield Classification (PFYC) system will be used to classify paleontological resource potential on public lands in order to assess possible resource impacts and mitigation needs for Federal actions involving surface disturbance, land tenure adjustments, and land-use planning. Implementation of the PFYC system will not mandate changes to existing land use plans, project plans, or other completed efforts. Integration into plans presently being developed is discretionary. All efforts subsequent to issuance of this IM should incorporate the PFYC system. This system will replace the current Condition Classification in the Handbook (H-8270-1) for Paleontological Resource Management.

Timeframe: This guidance is effective immediately for all BLM offices.

Background: This classification system for paleontological resources is intended to provide a more uniform tool to assess potential occurrences of paleontological resources and evaluate possible impacts. It uses geologic units as base data, which is more readily available to all users. It is intended to be applied in broad approach for planning efforts, and as an intermediate step in evaluating specific projects. This is part of a larger effort to update the Handbook H-8270-1 (General Procedural Guidance for Paleontological Resource Management) Chapter III (Assessment & Mitigation) and Chapter II.A.2 and will be incorporated into that Handbook update.

Impact on Budget: Costs for the initial classification of geologic units for those States that have not already determined the classification will be borne by each Office. Implementation of the PFYC system will have no additional costs.

Manual/Handbook Affected: Supersedes H-8270-1 (General Procedural Guidance for Paleontological Resource Management) Chapter II.A.2.

Coordination: The classification system is the product of the BLM's regional paleontologists, other BLM employees, and outside reviewers. This system is very similar to the Forest Service's Fossil Yield Potential Classification and will enable closer coordination of paleontological resource management between the agencies.

Contact: For questions regarding application of this policy and guidance, please contact Lucia Kuizon, National Paleontologist, at (202) 452-5107 or lkuizon@blm.gov.
Signed by: Authenticated by: IM 2008-009, Potential Fossil Yield Classification (PFYC) System for Paleontological Re... Page 1 of 2

http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national.1/18/2010

2 Attachments:
1 – The Potential Fossil Yield Classification (PFYC) System (4 pp)
2 – Guidance for Implementing the PFYC System (5 pp)

Todd S. Christensen	Robert M. Williams
Acting, Deputy Assistant Director	Division of IRM Governance
Renewable Resources and Planning	

Guidance for Implementing the Potential Fossil Yield Classification (PFYC) System

Introduction

The Potential Fossil Yield Classification (PFYC) system will aid in assessing the potential for discovery of significant paleontological resources or the impact of surface disturbing activities to these resources.

It is intended to assist in determining proper mitigation approaches for surface disturbing activities, disposal or acquisition actions, recreation possibilities or limitations, and other BLM-approved activities. It will provide consistent information for input and analysis during planning efforts. The PFYC system can also highlight the area's most likely to be a focus of paleontological research efforts or illegal collecting. It is hoped that this system will allow BLM to direct management efforts toward potentially significant areas and reduce efforts in areas of lower potential.

This classification system was originally developed by the Forest Service's Paleontology Center of Excellence and the Region 2 (FS) Paleontology Initiative in 1996. Modifications were made by the BLM's Paleontological Resources staff in subsequent years.

Paleontological resources are closely associated with the geologic rock units containing them; that is, fossils are found more frequently in some rock units than others. The management of paleontological resources can thus be tied to the geologic units present at or near the ground surface, with greater management emphasis aimed at higher potential geologic units.

Uses

This PFYC system is utilized for land use planning efforts and for the preliminary assessment of potential impacts and proper mitigation needs for specific projects. It is intended to provide a tool to assess potential occurrences of significant paleontological resources. It is meant to be applied in broad approach for planning efforts, and as an intermediate step in evaluating specific projects.

There are five Classes with Class 1 being Very Low Potential and Class 5 being Very High Potential. Although granite, lava beds, and other igneous or metamorphic rock types are usually considered to be void of any fossils, outcrops of these rocks may have fissure fillings, cave-like structures, sinkholes, and other features that may preserve significant paleontological resources or information, so the potential is not zero; therefore Class 1 is applied to these rock types usually considered not to contain fossil resources.

It is intended that this system replace the current Condition Classification in the Handbook (H-8270-1), for Paleontological Resource Management. In general, the following is a comparison of the Condition Classification rankings to the new PFYC

Classes: Condition (from H-8270-1)	PFYC Class (this Instruction Memorandum)
Condition 1 – Areas known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. (Note: this refers to known localities or groups of localities)	PFYC Class 4 (High) or Class 5 (Very High), based on geologic unit.
Condition 2 – Areas with exposures of geological units or settings that have high potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	PFYC Class 3 (Moderate), Class 4 (High), or Class 5 (Very High), based on geologic unit.
Condition 3 – Areas that are very unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	PFYC Class 1 (Very Low) or Class 2 (Low).

Assignment of Classes

A separate class ranking is assigned to each recognized geologic formation or member present at the surface. Deposits of young alluvium (post-Pleistocene) or thick soils can often be ignored. However, geologic mapping may not separate the older Pleistocene alluvium which, may contain significant vertebrate fossils, and thus these units need to be carefully considered. Available geologic mapping, depending on map scale, may combine multiple formations or units. In these cases, the assigned classification should use the highest class of those included units. For ease of application, the classifications should be integrated into a Geographic Information System (GIS) based geologic map.

The classification is initially determined by the Regional Paleontologist; the State Office Paleontology Lead in collaboration with the Regional Paleontologist; or by knowledgeable individuals from a paleontology museum, university paleontology department, or consulting firm working under a formal agreement. Several States have already completed an initial classification and are incorporating the system into new planning and mitigation efforts.

To maintain consistency in planning efforts, mitigation requirements, and other management approaches, the classification should be applied to each formation on a state-wide basis, and even across State boundaries. But in some situations, geologic characteristics within formations may change across the State or region and may alter the potential for fossil occurrence. These differences may be a characteristic of the formation, be variable in occurrence, and unmappable at a workable scale; or may indicate a regional gradient, where a formation is highly fossiliferous in one portion of the State, but has lowered potential in another area. A variable occurrence in potential may be included in the general information about the formation. A regional gradient can be addressed by assigning a different class for separate areas.

Multiple class assignments for an individual formation should be applied in consultation with the State Office to maintain consistency across Field Office boundaries.

Over time, additional information may be acquired or developed that may suggest that a change in the class assignment is appropriate, especially from the Unknown Class (3b) to a higher or lower class. The classification should reflect the most current information, and recent research or discoveries may indicate a change is warranted. However, any changes should be measured against existing applications or use of the current classification, such as usage in Resource Management Plans (RMPs) or other planning or management documents.

Application

In planning documents and other general applications, these classes allow for uniform discussion of the paleontologic resource, potential adverse impacts, and management approaches. Assessment of general conditions, such as acres or percentages of each class, or spatial identification of important areas can be determined and presented in simple manner. Identification of areas of potential concern with other resources can be identified using GIS mapping or explained in the text body in simple fashion.

The PFYC classes may also be utilized to assess the possibility of adverse or beneficial impacts from land tenure adjustment (disposal or acquisition) proposals prior to on-the-ground surveys.

A primary purpose of the PFYC is to assess the possible impacts from surface disturbing activities and help determine the need for pre-disturbance surveys and monitoring during construction. This assessment should be an intermediate step in the analysis process; and local conditions such as amount of exposed bedrock should be considered when final mitigation needs are determined. The determination should also be supplemented by occurrences of known fossil localities and local geologic and topographic knowledge.

Mitigation Needs Assessment

Impacts of most surface-disturbing activities, and the need for mitigation efforts, are addressed by the local Field Office. Some larger actions, such as major pipeline projects, may be handled by the State Office, or even as multi-State projects. In all these cases, the assessment of impacts to paleontological resources and need for mitigation can be addressed in similar fashion through a progression of steps. The following outlines the general steps used to apply the PFYC system to this mitigation process.

1. **Identify the proposed action and affected area.** Consider the area directly impacted by the action, as well as areas that may be impacted by vehicle drive ways, equipment parking, storage areas, and increased access. Also consider the depth of disturbance to determine possible subsurface impacts.

2. **Identify the potential impacts to paleontological resources.** Determine the geologic units that may be impacted and the associated PFYC classes, and consult other sources of information about known localities or paleontological research that may have been done previously.

   Based on the PFYC class and any additional resource information, determine the probability of impacting significant paleontological resources. If known localities are in the area of possible impact, determine if those localities can be avoided by altering the proposed action, such as repositioning a well pad location or rerouting a pipeline around a locality.

3. **Determine the need for field survey or other mitigation efforts.** On-the-ground field surveys, on-site

monitoring, spot-checking at key times during construction, or locality avoidance are all possible mitigation approaches to lessen adverse impacts.

- If the PFYC class for the impacted area is Class 1 or 2, and there are no known localities within the area, no further assessment is typically needed.
- If a Class 3a (Moderate Potential) unit underlies the area, the local geologic conditions should be considered, as well as any known localities in the region. It may be necessary to consult with the Regional Paleontologist or other qualified paleontologist to assess the local conditions.
- If a Class 3b (Unknown Potential) unit underlies the area, it may be appropriate to require an on-site preliminary assessment by a qualified paleontologist.
- If the area is a Class 4b (buried bedrock with High Potential) or Class 5b (buried bedrock with Very High Potential), an assessment of the possible impacts to bedrock units must be made. If the proposed action will not penetrate the protective soil or alluvial layer, a pre-work survey or monitoring during the activity may not be necessary. If the potential exists to remove the protective layer and impact the bedrock unit below, it may be prudent to require a pre-work field survey and/or on-site monitoring during disturbance or spot-checks at key times. Because the bedrock unit is typically buried for much of the area in question, a pre-work survey may not always be necessary, as the fossil material may not be visible. However, it may then be more important to have an on-site monitor during disturbance or spot-checks at key times.
- If it is a Class 4a (exposed bedrock with High Potential) or Class 5a (exposed bedrock with Very High Potential) area, it will be necessary in most (Class 4a) or almost all (Class 5a) situations to require a pre-activity field survey of the areas directly and indirectly impacted.

Larger projects may impact multiple geologic units with differing PFYC Classes. In those cases, field survey and monitoring may be applied at differing levels. For example, surveys may be appropriate only on the Class 4 and 5 formations and not the Class 2 formations along a pipeline project. Careful mapping and detailed field notes should reflect the differing survey/monitoring intensities, and should be included in the consultant's report to BLM.

Appendix B-1

Potential Fossil Yield Classification (PFYC) System

Occurrences of paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

Using the Potential Fossil Yield Classification (PFYC) system, geologic units are classified based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts, with a higher class number indicating a higher potential. This classification is applied to the geologic formation, member, or other distinguishable unit, preferably at the most detailed mappable level. It is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment.

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis, and should be used to assist in determining the need for further mitigation assessment or actions.

The descriptions for the classes below are written to serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual units or preservational conditions should be considered when determining the appropriate class assignment. Assignments are best made by collaboration between land managers and knowledgeable researchers.

Class 1 – **Very Low.** Geologic units that are not likely to contain recognizable fossil remains.

- Units that are igneous or metamorphic, excluding reworked volcanic ash units.

- Units that are Precambrian in age or older.

(1) Management concern for paleontological resources in Class 1 units is usually negligible or not applicable.

(2) Assessment or mitigation is usually unnecessary except in very rare or isolated circumstances.

The probability for impacting any fossils is negligible. Assessment or mitigation of paleontological resources is usually unnecessary. The occurrence of significant fossils is non-existent or extremely rare.

Class 2 – **Low.** Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.

- Vertebrate or significant invertebrate or plant fossils not present or very rare.
- Units that are generally younger than 10,000 years before present.
- Recent aeolian deposits.
- Sediments that exhibit significant physical and chemical changes (i.e., diagenetic alteration).

(1) Management concern for paleontological resources is generally low.

(2) Assessment or mitigation is usually unnecessary except in rare or isolated circumstances.

The probability for impacting vertebrate fossils or scientifically significant invertebrate or plant fossils is low. Assessment or mitigation of paleontological resources is not likely to be necessary. Localities containing important resources may exist, but would be rare and would not influence the classification. These important localities would be managed on a case-by-case basis.

Class 3 – **Moderate** or **Unknown.** Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence; or sedimentary units of unknown fossil potential.

- Often marine in origin with sporadic known occurrences of vertebrate fossils.
- Vertebrate fossils and scientifically significant invertebrate or plant fossils known to occur intermittently; predictability known to be low.

(or)

- Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.

Class 3a – **Moderate Potential.** Units are known to contain vertebrate fossils or scientifically significant nonvertebrate fossils, but these occurrences are widely scattered. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for hobby collecting. The potential for a project to be sited on or impact a significant fossil locality is low, but is somewhat higher for common fossils.

Class 3b – **Unknown Potential.** Units exhibit geologic features and preservational conditions that suggest significant fossils could be present, but little information about the paleontological resources of the unit or the area is known. This may indicate the unit or area is poorly studied, and field surveys may uncover significant finds. The units in this Class may eventually be placed in another Class when sufficient survey and research is performed. The unknown potential of the units in this Class should be carefully considered when developing any mitigation or management actions.

(1) Management concern for paleontological resources is moderate; or cannot be determined from existing data.

(2) Surface-disturbing activities may require field assessment to determine appropriate course of action.

This classification includes a broad range of paleontological potential. It includes geologic units of unknown potential, as well as units of moderate or infrequent occurrence of significant fossils. Management considerations cover a broad range of options as well, and could include pre-disturbance surveys, monitoring, or avoidance. Surface-disturbing activities will 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. These units may contain areas that would be appropriate to designate as hobby collection areas due to the higher occurrence of common fossils and a lower concern about affecting significant paleontological resources.

Class 4 – **High.** Geologic units containing a high occurrence of significant fossils. Vertebrate fossils or scientifically significant invertebrate or plant fossils are known to occur and have been documented, but may vary in occurrence and predictability. Surface disturbing activities may adversely affect paleontological resources in many cases.

> *Class 4a* – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two acres. Paleontological resources may be susceptible to adverse impacts from surface disturbing actions. Illegal collecting activities may impact some areas.
>
> *Class 4b* – These are areas underlain by geologic units with high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has high potential, but a protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.
>
> - Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.
> - Areas of exposed outcrop are smaller than two contiguous acres.
> - Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.
> - Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 4 is moderate to high, depending on the proposed action.

(2) A field survey by a qualified paleontologist is often needed to assess local conditions.

(3) Management prescriptions for resource preservation and conservation through controlled access or special management designation should be considered.

(4) Class 4 and Class 5 units may be combined as Class 5 for broad applications, such as planning efforts or preliminary assessments, when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations are similar at this level of analysis, and impacts and alternatives can be addressed at a level appropriate to the application.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation considerations must include assessment of the disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access resulting in greater looting potential. If impacts to significant fossils can be anticipated, on-the-ground surveys prior to authorizing the surface disturbing action will usually be necessary. On-site monitoring or spot-checking may be necessary during construction activities.

Class 5 – **Very High.** Highly fossiliferous geologic units that consistently and predictably produce vertebrate fossils or scientifically significant invertebrate or plant fossils, and that are at risk of human-caused adverse impacts or natural degradation.

> *Class 5a* – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two contiguous acres. Paleontological resources are highly susceptible to adverse impacts from surface disturbing actions. Unit is frequently the focus of illegal collecting activities.
>
> *Class 5b* – These are areas underlain by geologic units with very high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. The bedrock unit has very high potential, but a protective layer of soil, thin alluvial material, or other conditions may lessen or prevent potential impacts to the bedrock resulting from the activity.
>
> - Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted.
> - Areas of exposed outcrop are smaller than two contiguous acres.
> - Outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions.

- Other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

(1) Management concern for paleontological resources in Class 5 areas is high to very high.

(2) A field survey by a qualified paleontologist is usually necessary prior to surface disturbing activities or land tenure adjustments. Mitigation will often be necessary before and/or during these actions.

(3) Official designation of areas of avoidance, special interest, and concern may be appropriate.

The probability for impacting significant fossils is high. Vertebrate fossils or scientifically significant invertebrate fossils are known or can reasonably be expected to occur in the impacted area. On-the-ground surveys prior to authorizing any surface disturbing activities will usually be necessary. On-site monitoring may be necessary during construction activities.

4. Conduct Pre-work Field Survey. Field surveys are almost always needed for Class 4 and 5 units, especially exposed bedrock areas (Class 4a and 5a). Class 3 units may or may not require a survey. Local conditions, such as vegetated areas or pockets of bedrock exposure, may affect the need and intensity of field surveys.

The consultant is required to submit a report of findings after completion of the field survey. In addition to standard reporting information, the report should contain the consultants' recommendations for further mitigation, and this recommendation should be considered when determining the need for and type of on-site monitoring or locality avoidance.

5. Monitor during disturbance activities. Those areas that have been determined to have a Very High potential (Class 5) for adverse impacts should typically be monitored at all times when surface-disturbing activities are occurring. If the area has a High potential (Class 4), it may be appropriate to examine the exposed unit, including the spoil or storage piles, only at key times. These times are dependent on the activity, but typically are: when bedrock is initially exposed, occasionally during active excavation, and when the maximum exposure is reached and before backfilling has begun. This monitoring and spot-checking must be performed by a permitted paleontologist or their BLM-approved representative. The monitor has the authority to briefly pause any activity to inspect a possible find. These pauses are intended to allow for identification of possible fossil resources and should only last a few minutes to a couple hours.

6. Evaluate significant finds. If significant paleontological resources are discovered during surface disturbing actions or at any other time, the proponent or any of his agents must: (a) stop work immediately at that site; (b) contact the appropriate BLM representative, typically the project inspector or Authorized Officer, as soon as possible; and (c) make every effort to protect the site from further impacts, including looting, erosion, or other human or natural damage. The BLM or designated paleontologist will evaluate the discovery and take action to protect or remove the resource within 10 working days. Work may not resume at that location until approved by the official BLM representative. In some cases, such as recovery of a dinosaur, further activity at that site may be delayed until the discovered fossils are recovered, or until the project is modified to avoid impacting the find. Because of the potential for lengthy delays, the BLM should assure that the project proponent understands this possibility prior to approval to begin work.

These steps are included here to provide general guidance, and it may be appropriate to modify or skip them for various situations. However, a brief discussion of the background and reason for modification should be placed in the project file.

For all surface-disturbing activities occurring within Class 3 or higher units, a stipulation should be included in the permitting document.

Further Information

Detailed information on the geologic units and paleontological resources within a State can often be obtained from State geological surveys, geological or paleontological museums, geology departments at universities or colleges, paleontological permittees or other researchers or within the BLM from Regional Paleontologists or knowledgeable Geologists.

Scientific publications, such as professional journals or State geological survey reports, often contain general and detailed information about paleontological and geological resources relevant to fossil potential and occurrences for specific areas. Current and past paleontological permittee reports usually include precise locality data and maps, and often contain discussions of findings and their significance.

Appendix B-2

Significance Criteria for Paleontological Resources: Vertebrate, Invertebrate, Plant and Trace Fossils

The Forest Service paleontological resources program focuses its management activities on scientifically significant fossil resources. Scientific significance may be attributed to the fossil specimen or trace fossil itself, and to its context, i.e., its location in time and space, or association with other relevant evidence. As a general rule, fossil specimens that are scientifically significant are management-relevant resources. The scientific significance of a paleontological specimen or trace, and its context, is determined by meeting any one of the following criteria:

Specimen-based criteria:

- Represents an unknown or undescribed/unnamed taxon.
- Represents a rare taxon, or rare morphological/anatomical element or feature. The "rareness" criterion comprises either absolute rareness in the fossil record, or relative or contextual rareness as described below.
- Represents a vertebrate taxon (trace, Plant, and Invertebrate fossils may also be significant).
- Exhibits an exceptional type and/or quality of preservation.
- Exhibits remarkable or anomalous morphological/anatomical character(s) or taphonomic alteration.
- Represents "soft tissue" preservation or presence.
- Exhibits cultural affiliation, e.g., alteration or use by ancient humans. (Resources matching this criterion are protected under the Archaeological Resources Protection Act of 1979 and are not considered in the PFYC.)

Context-based criteria:

- Is associated in a relevant way with other evidence of scientific interest, providing taphonomic, ecologic, environmental, behavioral, or evolutionary information.
- Is evidence that extends and/or constrains the stratigraphic, chronologic and/or geographic range of a species or higher-level taxonomic group.

APPENDIX D

SOCIETY OF VERTEBRATE PALEONTOLOGY

STANDARD PROCEDURES FOR THE ASSESSMENT AND

MITIGATION OF ADVERSE IMPACTS TO PALEONTOLOGICAL RESOURCES

(2010)

SVP
OCIETY OF
VERTEBRATE
PALE TOLOGY

Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources

Society of Vertebrate Paleontology
Impact Mitigation Guidelines Revision Committee

Abstract
Fossils are nonrenewable paleontological resources that are subject to impacts from land development. Procedures are presented for evaluating the potential for impacts of a proposed action on paleontological resources and for mitigating those impacts. Impact mitigation includes pre-project survey and salvage, monitoring and screen washing during excavation to salvage fossils, conservation and inventory, and final reports and specimen curation. The objective of these procedures is to offer standard methods for assessing potential impacts to fossils and mitigating these impacts.

Introduction
Fossils are nonrenewable paleontological resources that are afforded protection by federal, state, and local environmental laws and regulations. The Paleontological Resources Preservation Act (PRPA) of 2009 calls for uniform policies and standards that apply to fossils on all federal public lands. All federal land management agencies are required to develop regulations that satisfy the stipulations of the PRPA. Section 6302 of the PRPA mandates that federal agencies "*shall manage and protect paleontological resources on Federal land using scientific principles and expertise.*" Thus, federal agencies need the help of the professional paleontological community in the formulation and implementation of these PRPA-mandated policies and regulations. The potential for destruction or degradation of paleontological resources on both public and private lands selected for development under the jurisdiction of various governmental planning agencies is recognized. The standard procedures below are intended to be applicable to both private and public lands under the jurisdiction of local, city, county, regional, state, and federal agencies. Protection of paleontological resources includes: (a) assessment of the potential for land to contain significant paleontological resources which could be directly or indirectly impacted, damaged, or destroyed by proposed development and (b) formulation and implementation of measures to mitigate these adverse impacts, including permanent preservation of the site and/or permanent preservation of salvaged fossils along with all contextual data in established institutions.

Assessment of the Paleontological Potential of Rock Units
Rock units are described as having (a) high, (b) undetermined, (c) low, or (d) no potential for containing significant paleontological resources.

High Potential
Rock units from which vertebrate or significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e. g., ashes or tephras), and some low-grade metamorphic rocks which contain significant paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils (e. g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous

and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones, etc.). Paleontological potential consists of both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units which contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, and rock units which may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.

Undetermined Potential
Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine if these rock units have high or low potential to contain significant paleontological resources. A field survey by a qualified professional paleontologist (see "definitions" section in this document) to specifically determine the paleontological resource potential of these rock units is required before a paleontological resource impact mitigation program can be developed. In cases where no subsurface data are available, paleontological potential can sometimes be determined by strategically located excavations into subsurface stratigraphy.

Low Potential
Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have low potential for yielding significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or based on general scientific consensus only preserve fossils in rare circumstances and the presence of fossils is the exception not the rule, e. g. basalt flows or Recent colluvium. Rock units with low potential typically will not require impact mitigation measures to protect fossils.

No Potential
Some rock units have no potential to contain significant paleontological resources, for instance high-grade metamorphic rocks (such as gneisses and schists) and plutonic igneous rocks (such as granites and diorites). Rock units with no potential require no protection nor impact mitigation measures relative to paleontological resources.

Discussion
It is extremely important to distinguish between archaeological and paleontological resources (see "definitions" section in this document) when discussing the paleontological potential of rock units. The boundaries of an archaeological resource site define the areal/geographic extent of an archaeological resource, which is generally independent from the rock unit on which it sits. However, paleontological sites indicate that the containing rock unit or formation is fossiliferous. Therefore, the limits of the entire rock unit, both areal and stratigraphic, define the extent of paleontological potential.

It is also important to ascertain if the paleontological resources are uniformly distributed throughout a rock unit or if they are confined as localized concentrations to specific members or facies. Using this information, paleontologists can develop maps which suggest areas that are likely to contain paleontological resources. These maps (Paleontological Resource Potential Maps) form the basis for preliminary planning decisions on which areas require a detailed paleontological resource impact assessment by a qualified professional paleontologist and which areas do not. Lead agency evaluation of a proposed project relative to such paleontological resource potential maps should trigger a "request for opinion" from a qualified professional paleontologist, state paleontological clearing house, or an accredited institution with an established paleontological repository housing paleontological resources from the region of interest.

The determination of the paleontological resource potential of an area proposed for development is first founded on a review of pertinent geological and paleontological literature, geological maps, and on records in fossil locality databases of paleontological specimens deposited in institutions (e. g., museums and universities). This preliminary review may clearly indicate that particular rock units have known high potential. If the paleontological resource potential of a rock unit cannot be delimited from the literature search and specimen records, a field survey by a qualified professional paleontologist will be necessary to determine the fossiliferous potential and the distribution or concentrations of fossils within the extent of the rock units present in a specific project area. The field survey may need to extend outside the defined project limits to areas where the relevant rock units are better exposed. If the rock units in an area are determined to have a high potential for containing paleontological resources, a program to mitigate impacts to fossil resources must be developed. In areas containing rock units with high potential, a preconstruction survey (intensive reconnaissance) may be necessary to locate surface concentrations of fossils which might require salvage in advance of excavations to avoid delays to construction schedules.

Measures to Mitigate Adverse Impacts from Development
Measures for adequate protection or salvage of significant paleontological resources are applied to areas determined to contain rock units that have either a high or undetermined potential for containing significant fossils. The Paleontological Resource Preservation Act of 2009 establishes a uniform code for decision-making on all federal lands. Specific mitigation measures generally need not be developed for areas of low paleontological potential. Developers (public and private) and contractors should be made aware, however, that if there is not an on-site monitor it will be necessary to contact a qualified professional paleontologist if fossils are unearthed in the course of excavation. This contingency should be planned for in advance. In order to save time and project delays, in the advance planning phases of a project the developer should contact a qualified professional paleontologist and arrange for the salvage of any unanticipated fossils. The paleontologist will then salvage the fossils and assess the necessity for further mitigation measures, if applicable. Decisions regarding the intensity of the paleontological resource impact mitigation program will be made by the project paleontologist on the basis of the significance of the paleontological resources, and their biostratigraphic, biochronologic, paleoecologic, taphonomic, and taxonomic attributes, not on the ability of a project proponent to fund the paleontological resource impact mitigation program.

In areas determined to have high or undetermined potential for significant paleontological resources, an adequate program for mitigating the impact of development must include:

1. an intensive field survey and surface salvage prior to earth moving, if applicable;
2. monitoring by a qualified paleontological resource monitor (see "definitions" section in this document) of excavations in previously undisturbed rock units;
3. salvage of unearthed fossil remains and/or traces (e. g., tracks, trails, burrows, etc.);
4. screen washing to recover small specimens, if applicable;

5. preparation of salvaged fossils to a point of being ready for curation (i. e., removal of enclosing matrix, stabilization and repair of specimens, and construction of reinforced support cradles where appropriate);

6. identification, cataloging, curation, and provision for repository storage of prepared fossil specimens; and

7. a final report of the finds and their significance.

All phases of mitigation must be supervised by a qualified professional paleontologist who maintains the necessary paleontological collecting permits and repository agreements. All field teams will be supervised by a paleontologist qualified to deal with the significant resources that might be encountered. The lead agency must assure compliance with the measures developed to mitigate impacts of excavation. To assure compliance at the start of the project, a statement that confirms the site's paleontological potential, confirms the repository agreement with an established public institution, and describes the program for impact mitigation, must be deposited with the lead agency and contractor(s) before any ground disturbance begins. In many cases, it will be necessary to conduct a salvage program prior to grading to prevent damage to known paleontological resources and to avoid delays to construction schedules. The impact mitigation program must include preparation, identification, cataloging, and curation of any salvaged specimens. All field notes, photographs, stratigraphic sections, and other data associated with the recovery of the specimens must be deposited with the institution receiving the specimens. Since it is not professionally acceptable to salvage specimens without preparation and curation of specimens and associated data, costs for this phase of the program must be included in the project budget. The mitigation program must be reviewed and accepted by the lead agency. If a mitigation program is initiated early during the course of project planning, construction delays due to paleontological salvage activities can be minimized or even completely avoided.

Standard Procedures
These standard procedures for paleontological resource impact assessment and mitigation are designed to apply to areas containing rock units with high, low, and undetermined paleontological resource potential.

Assessment before Construction Starts
An adequate preconstruction paleontological resource impact assessment is the key to developing an adequate paleontological resource impact mitigation program. Only a professional paleontologist is qualified to prepare a paleontological resource impact assessment. An adequate assessment of potential impacts typically includes all the following elements:

1. Literature Search—A review of the pertinent paleontological, geological, geotechnical, and environmental literature provides an information baseline for evaluating the extent of previous paleontological work in an area. Such a review also provides a fundamental basis for formulating mitigation plans and for understanding the significance of paleontological resources. The preconstruction assessment should also include examination of geotechnical reports, borehole logs, and geologic cross sections to address whether project excavations will impact rock units with high potential.

2. Records Search—A review of institutional localities and specimen records provides a means for determining the extent of previous fieldwork and fossil recovery in, and adjacent to, an area of interest. This task can be accomplished either by sending a written request for information to the relevant institution(s) or visiting the institution to review the records directly. A simple, on-line search of an institution's records is often incomplete and inadequate for determining the number and extent of known fossil localities in an area.

3. Consultation with Others—The preconstruction assessment should include consultation with geologists and paleontologists knowledgeable about the paleontological resource potential of rock units present in the vicinity of the proposed project.

4. Field Survey—The assessment should include a field survey by a qualified professional paleontologist and approved staff, as needed, to determine the paleontological potential of each rock unit, to re-examine any known fossil localities on or near the project, to search for unknown fossil localities, and to delimit the specific boundaries of rock units within the project area.

5. Reports—A paleontological resource impact assessment report and a project-specific paleontological resource impact mitigation program should be prepared based upon data gathered during the assessment.

6. Agency Confirmation—Prior to ground disturbance, the lead agency should review the paleontological resource impact assessment and proposed mitigation program to determine the adequacy of the proposed program.

7. Repository Agreement—The project paleontologist should have a repository agreement arranged prior to the start of earth-moving for the project.

8. Pre-excavation meetings—The project paleontologist should hold pre-excavation meetings with representatives of the lead agency, the developer or project proponent, and contractors to

explain the importance of fossils, the laws protecting fossils, the need for mitigation, the types of fossils that might be discovered during excavation work, and the procedures that should be followed if fossils are discovered. Defining the process of salvaging fossils will reduce project delays.

Paleontological Resource Mitigation Plan
Prior to any ground disturbance at the project site, a paleontological resource mitigation plan should be prepared by a qualified professional paleontologist, who then will implement the plan as the project paleontologist, program supervisor, and principal investigator. The paleontological resource mitigation plan establishes the ground rules for the entire paleontological resource mitigation program. Excavations at the project site may reveal conditions unanticipated when the paleontological resource mitigation plan was prepared. These conditions may require additional tasks not described in the previously prepared project impact mitigation plan. The project paleontologist should be the person who makes these project-specific modifications to the paleontological resource mitigation program in consultation with representatives of the lead agency and project proponent.

Adequate Monitoring
For excavations in rock units of known high potential, the project paleontologist or paleontological monitor will need to be present initially during 100% of the earth-moving activities. After 50% of excavations are complete in either an area or rock unit and no fossils of any kind have been discovered, the level of monitoring can be reduced or suspended entirely at the project paleontologist's discretion. For excavations in rock units with high or undetermined potential, it is never acceptable to have excavation monitoring done by construction workers, engineers, or persons who are not qualified paleontological resource monitors (see "definitions" section below). For excavations in rock units determined by a qualified professional paleontologist to have low potential, non-paleontologists may monitor for fossils. If potential paleontological resources are discovered during excavations in a rock unit with low potential, all ground disturbance in the vicinity of the find should stop immediately until a qualified professional paleontologist can assess the nature and importance of the find and recommend appropriate salvage, treatment, and future monitoring and mitigation.

Paleontologists who monitor excavations must be experienced in locating and salvaging fossils, and collecting necessary associated critical data. The paleontological resource monitor must be able to document the stratigraphic context of fossil discovery sites. Paleontological resource monitors must be properly equipped with tools and supplies to allow rapid removal of specimens. The monitor must be empowered to temporarily halt or redirect the excavation equipment away from fossils to be salvaged. Some lead agencies require that paleontological monitors be approved prior to performing any field work.

To reduce potential delays to excavation schedules, provision must be made in the mitigation program for additional assistants to monitor or help in removing large or abundant fossils. If many pieces of heavy equipment are in use simultaneously but at diverse locations, each location will need to be individually monitored.

Macrofossil Salvage
Many specimens recovered from excavations are readily visible to the eye and large enough to be easily recognized and removed. Upon discovery of such macrofossils, the monitor will flag the fossiliferous area for avoidance until the project paleontologist can evaluate the resource and develop plans for removal/salvage of these specimens. Some fossil specimens may be fragile and require consolidation

with archival quality media (e. g., Acryloid, Butvar, or Vinac) before moving. Others may require protection by encasing them within a plaster jacket before removal to a laboratory for later preparation and conservation. Occasionally specimens encompass all or much of a skeleton and will require moving either as a whole or in multiple blocks for later preparation. Such specimens require time to excavate and strengthen with a hardening solution before removal and the patience and understanding of the contractor to recover the specimens properly. It is thus important that contractors and developers are fully aware of the importance and fragility of fossils for their recovery to be undertaken with the optimum chances of successful extraction.

Avoidance and Site Protection
In exceptional instances the process of preconstruction assessment or construction monitoring itself may reveal a fossil occurrence of such importance that salvage or removal is unacceptable to all concerned parties. In such cases, the project design may need to be modified to avoid, protect and/or exhibit the fossil occurrence, e. g., in the floor or wall of a museum or as a basement exhibit in a mall. Under such circumstances, the site may be declared and dedicated as a protected resource of public value. Associated fossil fragments salvaged from such a site should be placed in an approved institutional repository. Federal land managers have the ability to set aside such exceptional areas providing documentation supports special management considerations.

Microfossil Salvage
Many significant vertebrate fossils (e. g., small mammal, bird, reptile, amphibian, or fish remains) are too small to be readily visible within the sedimentary matrix and are referred to as "microvertebrates". Small fossils also include non-vertebrate paleoenvironmental indicators (e. g., foraminifers, small gastropods, and plant seeds). Fine-grained sedimentary horizons (e. g., mudstones and paleosols) most often contain such fossils, which are typically recovered through a process of bulk matrix sampling followed by screen washing through 20 and/or 30 mesh screens. If indicators of potential microvertebrate fossils are found (e. g., plant debris, abundant mollusks, clay clasts, carbonate-rich paleosols, or mudstones) screening of a "test sample" (0.4 cubic yard/meter, ~600 lbs) may produce significant returns and indicate whether or not a larger sample needs to be screen washed. An adequate sample (standard sample) consists of approximately 4.0 cubic yards/meters (6,000 lbs or 2,500 kg) of matrix from each site, horizon, or paleosol. However, the uniqueness of the microvertebrate fossils recovered may justify screen washing even larger amounts. With this possibility in mind, two standard samples (~8.0 cubic yards/meters) or more as determined by the project paleontologist should be collected when the discovery is first made and set aside in case processing of a larger sample is later determined to be necessary. The developer must recognize that funding must be available to process these bulk matrix samples, thereby reducing volume to facilitate cost-effective storage of fossil specimens.

To avoid construction delays, samples of matrix may need to be removed from the project site and processed elsewhere. Chemicals (e. g., detergents, weak acids, orange oil, etc.) may be necessary to facilitate the breakdown of matrix. In some cases the concentrate will need to be further processed using heavy liquids (e. g., zinc bromide, polytungstate, or tetrabromide) to remove mineral grains and create a concentrate enriched with microvertebrate bones and teeth. The concentrate should be directly examined under a microscope to locate and remove individual microfossils.

Samples
To place fossils within a temporal context, dating of rock units may be necessary. If available, samples of volcanic ash and organic carbon should be collected for radiometric and/or thermoluminescence dating.

When appropriate, oriented samples should also be collected for paleomagnetic analysis. In addition, samples of fine-grained matrices should be collected from measured stratigraphic sections for microfossil (e. g., pollen, spores, dinoflagellates, ostracodes, diatoms, foraminifers, etc.) analyses. Other matrix samples may need to be collected and retained with the samples submitted to the repository institution for future analysis, for clast source analysis, or as witness to the source rock unit and possibly for procedures not yet envisioned. The project paleontologist should determine which of these samples should be immediately processed and which samples can be stored for later processing. Many museums will not accept such rock or sediment samples for curation and storage.

Preparation

Salvaged specimens must be prepared for identification and curation (not exhibition). This means removal of all or most of the enclosing sediment to reduce the specimen volume, increase surface area for the application of consolidants/preservatives, provide repairs and stabilization of fragile/damaged areas on a specimen, and allow identification of the fossils. Large specimens may require construction of reinforced plaster or fiberglass cradles. Removal of excess matrix from macrofossils during the preparation process will facilitate identification, reduce storage space, and reduce the cost of storage. Project paleontologists need to be aware that many museums will not accept specimens that are not fully prepared for permanent curation.

Identification and Cataloging

Specimens must be identified by competent qualified paleontological specialists to the lowest taxonomic level possible. Ideally, identification of individual specimens will be to genus and species and to skeletal element. Specimens must be cataloged and a complete list of specimens to be accessioned into the collections must be prepared for the curator of the repository institution. Batch identification and batch numbering (e. g., "mammals, 75 specimens") is unacceptable.

Analysis

Although academic research questions should dictate the field methods and types of data recorded, the overall goal of a paleontological resource mitigation program is not to conduct research but rather to discover and salvage significant fossil remains, record relevant stratigraphic and taphonomic data, and curate and permanently house the salvaged fossil remains for future study. However, before salvaged specimens are curated, either the project paleontologist or a competent qualified paleontological specialist should determine the significance and importance of the salvaged specimens and this information should be included in the final report.

Storage

Adequate curation and storage of salvaged specimens in an approved repository institution is an essential goal of the paleontological mitigation program. Adequate storage must include curation of individual specimens into the collections of a recognized, not-for-profit repository with a permanent curator, such as a museum or a university (institution). A complete set of GPS data, field notes, photographs, locality forms, and stratigraphic sections must accompany the fossil collections. Specimens must be stored in a fashion that allows retrieval of specific, individual specimens by future researchers.

Specific requirements of the designated repository must be established prior to the start of the project, field salvage work, and laboratory analysis. Adequate advance notice of funds required by the repository for curation is needed for the benefit of project funding. Costs of the project should cover the necessary curatorial supplies such as, but not limited to, trays, vials, foam, and storage cabinets or shelves to provide for the appropriate curation of the specimens.

Reporting

1) Interim report
At the close of the excavation phase of a project, an interim report should be prepared. This interim report should summarize exceptional fossil discoveries, note areas where monitoring occurred and fossils were collected, and list tasks remaining for preparation, identification, and curation of the salvaged specimens. In the interim report, the preconstruction repository agreement should be appended and any additional repository considerations and costs should be described.

2) Final report
After preparation, identification, analysis of significance, and curatorial inventory of the salvaged specimens is complete, a final report must be prepared by the project paleontologist including a summary of the field and laboratory methods, site geology and stratigraphy, faunal/floral list(s), and a brief statement of the significance and relationship of the fossils discovered to similar fossils found elsewhere The final report should emphasize the discovery of any new or rare taxa, or paleoecological or taphonomic significance. A complete set of field notes, geologic maps, stratigraphic sections, and a list of identified specimens must be included in or accompany the final report. This report should be finalized only after all aspects of the mitigation program are completed, including preparation, identification, cataloging, and curatorial inventory.

The final report (with any accompanying documents) and repository curation of specimens and samples constitute the goals of a successful paleontological resource mitigation program. Full copies of the final report should be deposited with both the lead agency and the repository institution with the request that all locality data remain confidential and not made available to the general public.

Compliance
From the beginning of the project, the lead agency should assure compliance with measures to protect fossil resources by:

1. requesting during initial planning phases an assessment and program for impact mitigation that is consistent with these SVP Standard Procedures;

2. ensuring the adequacy of the proposed mitigation measures;

3. acknowledging arrangements for salvaged specimens to be permanently housed in an institutional paleontological repository;

4. ensuring that the paleontological resource mitigation program is supervised by a qualified professional paleontologist;

5. ensuring that all monitoring for paleontological resources is performed by qualified paleontological resource monitors;

6. inspecting the monitoring program in the field periodically during project construction;

7. ensuring that specimens are prepared, identified, cataloged, and properly curated;

8. requiring an interim and final report before issuing final occupancy permits or equivalent documents; and

9. ensuring that the final report is complete and adequately describes the methods and results of the mitigation program.

The project paleontologist should be responsible for:

1. assessing potential impacts to paleontological resources and developing a program for impact mitigation during initial planning phases;

2. obtaining a repository agreement, and ensuring repository acceptance of specimens;

3. ensuring implementation of the mitigation measures; and

4. preparing the interim and final reports.

Acceptance of the final report by the lead agency signifies completion of the program of mitigation for the project. Review and approval of the final report by a qualified professional paleontologist designated by the lead agency will determine the effectiveness of the program and adequacy of the report. Inadequate performances in either area comprise noncompliance, and may result in the lead agency removing the project paleontologist from its list of qualified professional paleontological consultants.

Definitions

A QUALIFIED PROFESSIONAL PALEONTOLOGIST (Principal Investigator, Project Paleontologist) is a practicing scientist who is recognized in the paleontological community as a professional and can demonstrate familiarity and proficiency with paleontology in a stratigraphic context. A paleontological Principal Investigator shall have the equivalent of the following qualifications:

1. A graduate degree in paleontology or geology, and/or a publication record in peer reviewed journals; and demonstrated competence in field techniques, preparation, identification, curation, and reporting in the state or geologic province in which the project occurs. An advanced degree is less important than demonstrated competence and regional experience.
2. At least two full years professional experience as assistant to a Project Paleontologist with administration and project management experience; supported by a list of projects and referral contacts.
3. Proficiency in recognizing fossils in the field and determining their significance.
4. Expertise in local geology, stratigraphy, and biostratigraphy.
5. Experience collecting vertebrate fossils in the field.

PALEONTOLOGICAL RESOURCE MONITORS shall have the equivalent of the following qualifications:

1. BS or BA degree in geology or paleontology and one year experience monitoring in the state or geologic province of the specific project. An associate degree and/or demonstrated experience showing ability to recognize fossils in a biostratigraphic context and recover vertebrate fossils in the field may be substituted for a degree. An undergraduate degree in geology or paleontology is preferable, but is less important than documented experience performing paleontological monitoring, or
2. AS or AA in geology, paleontology, or biology and demonstrated two years experience collecting and salvaging fossil materials in the state or geologic province of the specific project, or
3. Enrollment in upper division classes pursuing a degree in the fields of geology or paleontology and two years of monitoring experience in the state or geologic province of the specific project.

4. Monitors must demonstrate proficiency in recognizing various types of fossils, in collection methods, and in other paleontological field techniques.

ASSOCIATED CRITICAL DATA includes adequate field notes, sketches of stratigraphic sections, geologic maps, and site and specimen photos. Associated critical data may also include samples of organic carbon and volcanic ash for radiometric dating, oriented samples for paleomagnetic analysis, samples for microfossil analysis, and samples for determining the sediment source.

A **PALEONTOLOGICAL REPOSITORY** is a not-for-profit museum or university approved by the lead agency and employing a permanent curator responsible for paleontological records and specimens. Such an institution assigns accession, locality, and/or catalog numbers to individual specimens that are stored and conserved to ensure their preservation under adequate security against theft, loss, damage, fire, pests, and adverse climate conditions. Specimens will be stored in a stable environment away from flammable liquids, corrosive chemicals, organic materials subject to mildew, and sources of potential water damage. Specimens must have all modifications, preparation techniques, etc. documented and linked with the specimen. The repository will also archive lists of collected specimens, and any associated field notes, maps, photographs, diagrams, or other data. The repository must have procedures for tracking specimens removed from storage for study, preparation, exhibit, or loan. The repository must make its collections of cataloged specimens available for study by qualified researchers.

ARCHAEOLOGICAL RESOURCES are human remains and items or artifacts associated with human cultures. If paleontological resources are determined to be in close stratigraphic association with human remains or human manufactured items, or if fossils can be demonstrated to be intentionally modified by humans, they are also considered archaeological resources.

SIGNIFICANT PALEONTOLOGICAL RESOURCES are fossils and fossiliferous deposits, here defined as consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded human history and/or older than middle Holocene (i. e., older than about 5,000 radiocarbon years).

A **LEAD AGENCY** is the agency responsible for addressing impacts to resources that a specific project might cause, and for ensuring compliance with approved mitigation measures.

PALEONTOLOGICAL POTENTIAL is the potential for the presence of significant paleontological resources. All sedimentary rocks, some volcanic rocks, and some low-grade metamorphic rocks have potential to yield significant paleontological resources. Paleontological potential is determined only after a field survey of a rock unit in conjunction with a review of available literature and relevant paleontological locality records.

APPENDIX E
RESUMES OF KEY PERSONNEL

Resume of

ROBERT E. REYNOLDS

Senior Vertebrate Paleontologist

Mr. Reynolds was Curator of Earth Science at the San Bernardino County Museum for 32 years. During that time he amassed collections of more than two million paleontological specimens from inland California stratigraphic sections, primarily in the Mojave Desert. Mr. Reynolds developed the Paleontologic Resource Guidelines for San Bernardino County, and sat on the Environmental Review Committee. He developed the initial (1985) Paleontological Resources Sensitivity Map for the County of San Bernardino. He also started and managed the Museum's Paleontological Resource Assessment Program for 18 years. Mr. Reynolds was chair of the Society of Vertebrate Paleontology's committee for Conformable Paleontological Resource Impact Mitigation between 1993 – 1996, which developed the guidelines that San Bernardino County has adopted and modified for local use.

Selected paleontological resource assessment and salvage projects in the Mojave Desert include the Intermountain Power Project (1978), All American Pipeline, Blythe to Ventura, (1985), Kern River Pipeline, Mesquite, Nevada via Barstow to Santa Barbara, (1990, 2003), Solar I (1981) and Luz Solar at Daggett (1984), Luz Solar at Kramer III-VII (1986) and Harper Lake VIII (1989), 37 commercial and residential assessments and salvages in the Helendale – Victorville - Hesperia area (1986-2008), and seven projects in Cajon Pass including the BNSF Triple Track Project (2007-2008). Mr. Reynolds worked for LSA Associates, Inc. in Riverside as Senior Paleontologist/Associate for 10 years bringing his professional work in the field of paleontology to 42 years. He has been involved with paleontological resources assessment reports for a number of specific plans in Riverside County, including the Riverside County Integrated Plan (RCIP – 1999-2003).

Selected Project Experience

Paleontological Resources Salvage for the SCE El Casco Substation
San Timoteo Canyon, west of Banning
Riverside County, California
Southern California Edison (SCE) new El Casco Substation required paleontological resource monitoring during construction excavation that lasted 13 months, from 2009-2010. Approximately 168 localities recovered produced 16,000 vertebrate, invertebrate and plant fossils consisting of more than 50 diagnostic taxa. The high number of taxa make this one of the most important early Pleistocene - Early Irvingtonian North American Land mammal Age faunas in California. The abundance of field localities and size of the collection involved extensive amounts of data management.

Needles Highway Improvement Project, San Bernardino County, CA., Caltrans District 8, FPN: STPL 5954 (085)
The Needles Highway Improvement Project (NHIP) consists of improvements to roadways that run northward from Needles, California, to Laughlin, Nevada, providing access to recreational areas between the two cities. The study focused only on Bureau of Land Management (BLM) land and private lands in California. The proposed alignments will cross sediments with potential to contain significant nonrenewable paleontological resources as defined by the California Environmental Quality Act (CEQA), the National Environmental Policy Act (NEPA), and guidelines of the BLM and County of San Bernardino which conform to recommendations of the Society of Vertebrate Paleontology (SVP). Published literature and records searches indicate that improvements will encounter sediments dating from the late Miocene (5 Ma) to the late Pleistocene (10 Ka) with potential to contain significant nonrenewable paleontological resources. Recommendations to reduce construction impacts to nonrenewable paleontological resources were proposed.

Alta East Wind Project, Horned Toad Hills, Mojave, Kern County, CA., BLM Permit No. CA-08-00-008P (Exp. 8/2011)
CH2M HILL, Inc., requested a paleontological resources assessment for the Alta East Wind Project northwest of the City of Mojave in southeastern Kern County, California. The project includes developing pads for wind generation turbines, turbine access and service roads, management facilities, and a transmission line running from the center of the project south to connect with an existing distribution grid.

The study area includes five sections of land that contain sediments that have potential for paleontological resources. The early Pliocene Horned Toad Formation contains the late Hemphillian Warren Local Fauna, with 24 fossil mammalian taxa. The literature review identified 34 fossil localities in the Horned Toad Formation, 12 of which were verified within project boundaries. The field survey located an additional 69 localities within project boundaries. Because of the potential for direct impacts to all paleontological resource localities, mitigation procedures are summarized. A project-specific paleontological resources impact mitigation program (PRIMP), including fossil salvage by qualified paleontologists, was recommended to accompany development of this project

Paleontological Resources Monitoring Program, Equilon Pipeline, McKittrick to Fellows
Kern County, California
RAM Environmental Engineering Services retained LSA to provide paleontological resource monitoring during excavation of the 33-mile pipeline between McKittrick and Fellows in Kern County. This paleontological resource excavation monitoring program recovered 61 fossil specimens from six localities along the right-of-way. Depending on locality, the fossils ranged from Pliocene to Pleistocene in age.

Paleontological Resources Assessment and Evaluation for the Barren Hills Geothermal Project
Lyon County, Nevada
Sierra Geothermal Power, Inc. proposed construction of the Barren Hills Geothermal Project in the Pine Grove Hills south of Yerington in Lyon County, west central Nevada. The paleontological resources study included proposed geotechnical studies along a series of proposed access roads from southern Mason Valley into the Pine Grove Hills. These roads provide access to proposed drill pads and well site reflection seismic lines. Also proposed are four magnetotelluric (geophysical) lines running east-west and north-south across the study area.

The study area included 18 sections of land and 40 miles of project routes. Project disturbances included vehicular travel within the road corridors, clearing of drill pads, cross-country vehicular placement, and coil burial of the geophysical lines. The U.S. Forest Service (USFS), Bridgeport District, recognized nonrenewable paleontological resources on the project situated on BLM holdings or on the Humboldt–Toiyabe National Forest. The report was prepared under BLM permit number N-82319 (Exp. 9/10). Fieldwork and report writing for the project was accomplished in fall and winter months of 2008. An impact mitigation program was prepared for all phases of the project.

Paleontological Resources Assessment for the Ely Energy Center Project in Eastern Nevada
Eastern Nevada Counties
Nevada Power Company and Sierra Pacific Power Company proposed construction of the Ely Energy Center in northeastern Nevada. The project included power plants, substations, utilities, and rail lines proposed for Elko, White Pine, Lincoln, and Clark Counties. Power plant sites north of Ely are 6,000 acres in size. The report (BLM Report No. 8270 (NV040) 2007-1) was prepared under BLM Permit No. N-82319 (Exp. 9/07). Fieldwork and report writing for the project was accomplished in fall, winter, and spring months of 2006–2007. An excavation impact mitigation program was prepared for all phases of the project.

Paleontological Monitoring, Kern River Pipeline Expansion
Wyoming, Utah, Nevada, and California
LSA contracted with Ecology and Environment, Inc. (E&E) to provide field assistance with paleontological monitoring and excavation needs on the Kern River Pipeline Expansion 2003 project in Wyoming, Utah, Nevada, and California. Mr. Reynolds managed and coordinated all the paleontological needs for project. LSA assisted E&E with the preparation and implementation of paleontological guidelines based on BLM of Wyoming, Nevada, and California rules and regulations. LSA provided paleontological awareness training for all Nevada and California construction crews. Agency requirements indicated excavation monitoring on Federal Lands was required in Wyoming, Nevada, and California, states where LSA provided experienced paleontological monitors. Monitors (as many as 10 concurrently) worked six, and sometimes seven days a week, often in dusty, inclement, and freezing weather. LSA paleontological staff was required to be in compliance with safety and environmental laws and agency conditions that were in effect. The five-month field project required managing paleontological resources at and recovered from 42 localities, some of which produced hundreds of fossil specimens.

Paleontological Resources Literature Review for the Oak Valley Reconductor Line
San Timoteo Canyon to Banning
Riverside County, California
Southern California Edison (SCE) proposed transmission line upgrades and the new El Casco Substation for the 22-

mile Oak Valley Reconductor line. The proposed reconductor right-of-way runs from central San Timoteo Canyon east to the center of the town of Banning. A literature review and records search in 2005 determined that the project area contained two fossiliferous sedimentary formations, the Plio-Pleistocene San Timoteo Formation and late Pleistocene alluvial terrace deposits that overlie the San Timoteo Formation. Twenty-three vertebrate fossil localities near the proposed line contain significant and diverse assemblages of small and large fossil mammals including mastodon, horse, and camel. Mr. Reynolds conducted excavation monitoring during construction in 2009.

Paleontological Records Search and Field Survey for the Chuckwalla Solar Energy Project
Desert Center, Riverside County, California
LSA conducted a paleontological resource records search and field survey for the proposed 3,800-acre Chuckwalla Solar Energy project, located east of Desert Center in north-central Riverside County, California. This project is north of the Chuckwalla Mountains and south of the Palen Mountains. LSA located Pleistocene sediments with the potential to contain paleontological resources.

Paleontological Resource Monitoring for Infrastructure Improvements, PRA-BADL 10(2), Badlands Loop Road
Pennington and Jackson Counties, South Dakota
LSA provided paleontological resources monitoring during landslide stabilization and construction of roads, sewer ponds, and visitor facilities for eight months that spanned summer and winter conditions in South Dakota. This project involved a minimum of four field monitors working 12-hour days. The program salvaged 424 fossil specimens of large mammals and rodents from 65 localities that were recovered from Oligocene and Pleistocene sediments. This is one of the more successful paleontological recovery programs in a National Park.

Paleontological Literature Review and Field Survey for the Badlands Landfill Expansion
Riverside County, California
Riverside County Waste Management Department proposed Badlands Landfill Expansion, and a paleontological literature review and field survey to consider impacts to paleontological resources. LSA conducted a field survey of the proposed 80-acre project and recommended project-specific measures to mitigate impacts to significant, nonrenewable paleontological resources.

Paleontological Resources Assessment, Mid County Parkway, Corona to San Jacinto
Riverside County Transportation and Land Management Services
Western Riverside County, California
LSA provided the paleontological resources assessment PIR/PER for the master-planned 32 miles of alternate routes. This paleontological resources assessment program literature search located 176 fossil localities in the 15 sedimentary formations crossed by the project. The environmental documents were prepared to meet Caltrans format for a PIR, PER, and PMP, and took 3.5 years to prepare. Applicable legislation was analyzed and programs for mitigation of impacts to significant, nonrenewable paleontological resources were prepared.

Paleontological Resources Assessment PIR/PER for the SR-91 Corridor Improvements Project
California Department of Transportation Districts 8 and 12
Cities of Anaheim, Yorba Linda, Corona, Norco, and Riverside
Counties of Orange and Riverside, California
LSA provided the paleontological resources assessment PIR/PER for 12 miles of improvements under consideration for the SR-91 Corridor Improvements Project in eastern Orange and western Riverside Counties. This paleontological resources assessment program literature search located 38 fossil localities in the 12 sedimentary formations crossed by the project. The environmental documents were prepared to meet Caltrans format for a PIR, PER, and PMP, and took nine months to prepare. Applicable legislation was analyzed and programs for mitigation of impacts to significant, nonrenewable paleontological resources were prepared.

Burlington Northern Santa Fe Main Third Track Project
Keenbrook to Summit, Cajon Pass
San Bernardino County, California
The BNSF Main Third Track (3MT) Project added a third rail through Cajon Pass. Widening existing rail cuts lasted from June 2007 to June 2008. Excavation for the project contacted Miocene sediments of the Cajon Valley Beds and the Crowder Formation, and Cretaceous Cosy Dell Formation, which have potential to contain significant, nonrenewable paleontological resources. There were no delays to project construction caused by identification and recovery of paleontological resources. LSA was retained by Tom Dodson Associates, Inc. to develop a

Paleontological Resources Monitoring and Mitigation Program (PRMMP) consistent with previous studies in fossiliferous sedimentary formations in Cajon Pass. Excavation monitoring and screen washing recovered small to microscopic fossils from 70 localities. 870 fossils were analyzed through the laboratory identification process. The BNSF 3MT project produced additional significant new "first" fossil records and fossils from sediments not previously known to contain fossils.

Centex Homes Paleontological Resources Monitoring Program
City of Bakersfield, Kern County, California
Centex Homes retained LSA to provide a paleontological resources monitoring and salvage program for the 215-acre Eagle Crest housing development on the south side of the Kern River in the eastern portion of the City of Bakersfield. This excavation and salvage program continued intermittently from 2005 to 2008, and recovered cultural resources and 3,675 paleontological resources. Two of the fossils will be described and named as new species. Many of the fossils were first time records for the early Miocene and also geographic range extensions. The project also recovered 24 taxa of Pleistocene fossils with approximately five range extensions, including bat and mole that are rare in any fossil fauna. Fossils were prepared and inventoried by LSA and curated into the Buena Vista Museum of Natural History.

SELECTED MAJOR PROJECTS IN SOUTHERN CALIFORNIA AND ARIZONA

California

Imperial County

1987 Imperial Irrigation District

Riverside County, Eastern

1985 All American Pipeline
1986 Mecca Hills, Indio
1989 Eagle Mountain Land Fill

Riverside County, North Central

1989 Denizen Heights, Hemet
1989 Portrero Ranch, Beaumont
1989 Landmark/ Oak Valley, Beaumont
1991 Shutt Ranch, Calimesa
1991 Olive Dell Ranch, El Casco
1991 De Anza Cycle Park
1990 Badlands Landfill Expansion
1995 Jackrabbit Trail Paleo Salvage

Riverside County, South Central

1987 Richmond American, Los Alamos, Murrieta
1987 Nutmeg, Temecula
1987 California Oaks, Murrieta
1988 Vail Lake Development
1988 Ynez Road, Temecula
1988 Country Walk, Temecula
1988 Woodview, Temecula
1988 Ynez Town Center, Murrieta
1988 Quail Springs, Murrieta
1988 Dane Development, Murrieta
1988 Dix Development, Murrieta
1988 Crowell-David, Murrieta
1988 BCI, Temecula
1988 Antelope Road, Murrieta
1988 Gibbs I, Murrieta
1988 Gibbs II, Murrieta
1989 Olsen, Murrieta

1989 Murrieta Horse Ranch
1989 Pulte Homes, Murrieta
1989 Gibbs III, Murrieta
1989 Murrieta Village Center
1989 S & G Homes, Murrieta
1989 Kraus Project, Murrieta
1989 Dix Development, II, Murrieta
1989 Pulte-Silverhawk, Murrieta
!990 Crowell-David, Murrieta
1990 Paragon Park
!990 Whitten Project, Temecula
1990 Toyota of Temecula
1990 Relco Homes, Temecula
1991 Rolling Ridge Plaza
1991 Bedford, Ynez Road, Murrieta
1991 Ynez Auto Plaza
1991 RanPac, Murrieta
1991 Murrieta Valley High School
1991 Dix Development III, Murrieta
1991 Murrieta Hospital
1991 J W Redwood, Murrieta
1991 Margarita Meadows, Murrieta
1991 Winchester Meadows Business Park
1991 Murrieta Gateway
1991 California Oaks Development, Murrieta
1991 Lakeview Hot Springs
1991 Morrison Homes, Murrieta
1992 Aguanga, Temecula Arkose

San Bernardino County, Eastern

1979 Lugo-Mira Loma T/L, SCE
1979 Solar One, SCE, Daggett
1981 Salvage, Barstow Fossil Beds
1981 Tower M7-T3, SCE, Cajon Pass
1981 Coolwater Coal Gasification Plant, SCE, Daggett
1982 Hackberry Mtn Salvage, Goffs
1983 Klein Camel Salvage, Barstow
1983 Solar Ponds, Daggett
1982 Hwy. 138 Alignment, Cajon Pass
1983 Santa Fe Widening, Cajon Pass
1983 Antelope Cave Salvage, Mescal Range
1984 Robbins Quarry, Barstow
1984 LUZ-Wismer & Becker Solar Trough Site, Daggett
1984 Calico Lakes, Yermo
1984 United Energy, Yermo
1984 Coolwater SCE Solid Waste Site, Daggett
1984 Intermountain Power Project, Stateline to Adelanto
1985 All American Pipeline, Blythe to Ventura
1985 IPP South Electrode, Coyote Lake
1985 Luz SEGS II, Daggett
1986 Luz SEGS I, Daggett
1986 Newberry Ballast, SPRR,
1986 MCI Fiber Optics, Cajon Pass
1986 Bitter Spring Playa Salvage, Ft. Irwin
1986 Luz Evaporation Ponds, Daggett
1986 WilTel Fiber Optics, Stateline to Cajon

1988 Ward Valley Low Level Repository
1988 Silurian Valley Low Level Repository
1989 Broadwell Lake Repository
1990 Mojave Pipeline, Blythe to Bakersfield
1990 Kern River Pipeline, Mesquite, Nev. to Santa Barbara
1990 Coolwater Texaco Syngas, Daggett
1990 Pacific Agriculture, Cadiz Land
1991 Hidden Valley Repository, Cady Mts.
1991 Railcycle, Amboy
1991 Las Vegas Truck Stop, Yermo
1991 Indian Trails, Oro Grande
1991 Campbell Hill, Twentynine Palms Gravel Pit
1992 Little Piute Mts Bonebed Quarry
1994 Old Woman Sandstone, Lucerne Valley
1995 Hackberry Wash Salvage
1997 Piute Valley Hazen Quarry, Needles
1998 Robbins Quarry, Barstow
2001 KRGT, Daggett Compressor Station
2006 Needles Highway Improvement Project

Arizona

1990 Mojave Pipeline, Bermuda City
1985 Wolf Ranch Salvage, Bisbee,
1985 Wikiup Salvage

PEER-REVIEWED PUBLICATIONS

Reynolds, R.E., 1967. Exploring the Calico Mining District: Bloomington, San Bernardino County Museum Association Quarterly, vol. XV, no. 2.

Reynolds, R.E., 1984. Miocene faunas in the lower Crowder Formation, Cajon Pass, California—a preliminary discussion, in Guidebook for the San Andreas fault—Cajon Pass to Wrightwood: Pacific Section, American Association of Petroleum Geologists.

Reynolds, R.E., ed., 1985. Geologic investigations along Interstate 15, Cajon Pass to Manix Lake: Redlands, San Bernardino County Museum.

Reynolds, R.E., 1985. Tertiary small mammals in the Cajon Valley, San Bernardino County, California, in Geologic investigations along Interstate 15, Cajon Pass to Manix Lake: Redlands, San Bernardino County Museum, p. 49-58.

Reynolds, R.E., 1985. Pleistocene fossils from SCE Coolwater area: Rosemead, Southern California Edison Company, Advanced Engineering Department Seminar Series, 16 July, abs.

Reynolds, R.E., 1986. California trackways from the lower Jurassic Aztec Sandstone, in Gillette, D.D., ed., First Annual Symposium on Dinosaur tracks and traces. Albuquerque, New Mexico Museum of Natural History: 24 (abs).

Reynolds, R.E., 1987. Biostratigraphic relationships in Cajon Valley, San Bernardino County, California. Journal of Vertebrate Paleontology 7(3): 24A.

Reynolds, R.E., 1987. On Daggett Pond: a late Pleistocene fauna suggests activity on the Calico Fault. San Bernardino County Museum Association Quarterly XXXIV (3, 4):55-56.

Reynolds, R.E., 1987. Shoshone Zoo—Natural traps in Pleistocene Tecopa Lake sediments. San Bernardino County Museum Association Quarterly XXXIV (3, 4):64-65.

Reynolds, R.E., editor, 1988. Cenozoic Tectonics in the Halloran Hills, in This Extended Land. Cordilleran Section, Geological Society of America, Field Trip Guidebook: 201-222.

Reynolds, R.E., 1988. Middle Miocene Vertebrates from Daggett Ridge, central Mojave Desert, San Bernardino County, California. Cordilleran Section, Geological Society of America, Abstracts with Programs.

Reynolds, R.E., 1988. Structural Evolution of the Shadow Valley Basin. Redlands, San Bernardino County Museum Association Quarterly XXXV (3, 4).

Reynolds, R.E., ed., 1989. Sequence of extensional tectonics in the Halloran Hills and Shadow Valley Basin, northeastern San Bernardino County, California: a field guide. Redlands, San Bernardino County Museum,

for Inland Geological Society.
Reynolds, R.E., ed., 1989. The west-central Mojave Desert: Quaternary studies between Kramer and Afton Canyon. Redlands, San Bernardino County Museum Association Special Publication.
Reynolds, R.E., 1989. Mid-Pleistocene faunas of the west-central Mojave Desert, in The west-central Mojave Desert: Quaternary studies between Kramer and Afton Canyon. Redlands, San Bernardino County Museum Association Special Publication.
Reynolds, R.E., 1990. Erosion, Deposition, and Detachment: the Halloran Hills Sequence. Redlands, San Bernardino County Museum Association Special Publication, MDQRC Guidebook.
Reynolds, R.E., 1991. Biostratigraphic relationships of Tertiary small vertebrates from Cajon Valley, San Bernardino County, California, in Inland southern California: the last 70 million years, M.O. Woodburne, R.E. Reynolds, and D.P. Whistler, ed. Redlands, San Bernardino County Museum Association Quarterly 38(3, 4):54-59.
Reynolds, R.E., 1991. The Cadiz Fauna: Possible Irvingtonian Land Mammal Age sediments in Bristol basin, San Bernardino County, California. San Bernardino County Museum Association Quarterly, 38(2):53-54.
Reynolds, R.E., 1991. Hemingfordian/Barstovian Land Mammal Age faunas in the central Mojave Desert, exclusive of the Barstow Fossil Beds, in Inland Southern California: the last 70 million years, M.O. Woodburne, R.E. Reynolds, and D.P. Whistler, ed. Redlands, San Bernardino County Museum Association Quarterly 38(3, 4):88-90.
Reynolds, R.E., 1991. Irvingtonian Land Mammal Age indicators in the west-central Mojave Desert. San Bernardino County Museum Association Quarterly, 38(3, 4):106-107.
Reynolds, R.E., 1992. Quaternary movement on the Calico Fault, Mojave Desert, California, in Deformation associated with the Neogene Eastern California Shear Zone, southeastern California and southwestern Arizona, S.M. Richards, ed. Redlands, San Bernardino County Museums Special Publication 92-1:64-65.
Reynolds, R.E., 1992. The Tertiary Pioneertown sequence, *in* Old routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:31-33.
Reynolds, R.E., (ed.) 1993. Landers: Earthquakes and aftershocks. San Bernardino County Museum Association Quarterly, 40(1): 72 p.
Reynolds, R.E., 1993. Road log through the 1992 Landers surface rupture, in Landers: Earthquakes and aftershocks, R.E. Reynolds (ed). San Bernardino County Museum Association Quarterly, 40(1): 3-39.
Reynolds, R.E., 1993. The Devil Peak Sloth, *in* Abstracts of Proceedings, the 1993 Desert Research Symposium, J. Reynolds, compiler. Redlands, San Bernardino County Museum Association Quarterly, 40(2):31.
Reynolds, R.E., 1993. Erosion, deposition, and detachment: the Halloran Hills area, California, p. 21-24, *in* Extended terranes, California, Arizona, Nevada, D.R. Sherrod and J.E. Nielson, eds. U.S. Geological Survey Bulletin, 2053: 250 p.
Reynolds, R.E. (ed.), 1994. Off limits in the Mojave Desert. Redlands, San Bernardino County Museum Association Special Publication, 94(1): 100 p.
Reynolds, R.E., 1995. The long outreach of the Devil Peak Sloth, *in* Abstracts from Proceedings, the 1995 Desert Research Symposium. Redlands, San Bernardino County Museum Association Quarterly, 42(2).
Reynolds, R.E., 1995. Grandview Gorge: research involving the Mid Hills tectonic block, *in* Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3): in prep.
Reynolds, R.E., 1995. Rhinoceros in Lanfair Valley *in* Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3): in prep.
Reynolds, R.E., 1995. Pack mule trails in the New York Mountains, East Mojave Desert *in* Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3): in prep.
Reynolds, R.E., 1995. New York Mountains Pegmatite in Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3).
Reynolds, R.E., 1998a. Flamingo egg from the Miocene sediments of the Calico Mountains, San Bernardino County, California, *in* Abstracts of Proceedings, 1998 Desert Research Symposium, J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 45(1, 2), p. 106.
Reynolds, R.E., 1998b. Paleontologic partners in the Mojave Desert. Journal of Vertebrate Paleontology, Abstracts of Papers, 18(3): 72A.
Reynolds, R.E., 1999. Fossil footprints. San Bernardino County Museum Association Quarterly, 46(2): 55p.
Reynolds, R.E., 1999. Pleistocene mammal tracks near Shoshone, southern Death Valley, *in* Reynolds, R.E., 1999. Fossil footprints. San Bernardino County Museum Association Quarterly, 46(2): 27-30

Reynolds, R.E., 1999. Gomphothere tracks in southern California, *in* Reynolds, R.E., 1999. Fossil footprints. San Bernardino County Museum Association Quarterly, 46(2): 31-32.
Reynolds, R.E., 2000. Marker units suggest correlation between the Calico Mountains and the Mud Hills, central Mojave Desert, California, *in* Reynolds, R.E. and Reynolds, J. (eds), Empty Basins, Vanished Lakes. San Bernardino County Museum Association Quarterly, 47(2): 3-20.
Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 76 p.
Reynolds, R.E., 2001. Wolves of Shoshone, southern Death Valley, *in* Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 58-60.
Reynolds, R.E., 2001. The changing face of the east Mojave Desert: field trip guide, *in* Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 3-14.
Reynolds, R.E., 2001. Tracking Big Game in the Mojave Desert: a partnership in education. Federal Millennium Conference, May, Barstow California.
Reynolds, R.E., 2001. Ancient lakes of the Mojave Desert: a field trip to Miocene and Pleistocene fossiliferous strata of the Central Mojave Desert. Federal Millennium Conference, May, Barstow California.
Reynolds, R.E. 2001. A billion years of life in the Amargosa Valley–Death Valley region. Interpretive trail text for Bureau of Land Management, August.
Reynolds, R.E. 2001. Marker bed correlations between the Mud Hills, Calico Mountains, and Daggett Ridge, central Mojave Desert, California. Geological Society of America Abstracts with Programs, Cordilleran section, GSA and Pacific Section 33(3):A-70.
Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 83 p.
Reynolds, R.E., 2002. Between the basins: field guide, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 3-14.
Reynolds, R.E., 2002. Impressions: Late Tertiary Mammalian Footprints in Various Substrates. Journal of Vertebrate Paleontology, Abstracts of Papers.
Reynolds, R.E., (ed), 2003. Land of Lost Lakes. California State University, Desert Studies Consortium: 68 p.
Reynolds, R.E., 2003. Fossil footprints in the Calico Mountains, *in* Guide to the Calicos: Calico Mining Camps and Scenic Areas, Bill Mann. Gem Books.
Reynolds, R.E., 2003. Reuniting the Barstow Basin. Western Association of Vertebrate Paleontologists Annual Meeting Field Trip Guide: 11 p.
Reynolds, R.E., 2003. Widespread early Miocene marker beds unite the Barstow Formation, central Mojave Desert. Western Association of Vertebrate Paleontologists, Abstracts and Program.
Reynolds, R.E., 2003. Miocene horse tracks in California and Nevada: morphology, motion, and tribes. Western Association of Vertebrate Paleontologists, Abstracts and Program.
Reynolds, R.E., 2003. Reunite Barstow. Presentation, Michael O. Woodburne convocation, University of California, Riverside.
Reynolds, R.E., 2004. A Latest Pleistocene (Rancholabrean) Fossil Assemblage from the Silver Lake Climbing Dune site, Northeastern Mojave Desert, California, California State University, Desert Studies Consortium: p. 33-38.
Reynolds, R.E., 2004. Miocene cat tracks in the Mojave Desert of California. Journal of Vertebrate Paleontology, Abstracts of Papers. V. 25, 104a.
Reynolds, R.E., 2005. Morphometric categorization of California's Jurassic quadruped tracks. Journal of Vertebrate Paleontology, Abstracts of Papers. V. 24, 103a.
Reynolds, R.E., 2005. Old Ores: Mining History in the eastern Mojave Desert. California State University, Desert Studies Consortium 92p.
Reynolds, R.E., and Ted Weasma, 2005. Old Ores: Mines and mineral marketing in the eastern Mojave Desert—a field trip guide. California State University, Desert Studies Consortium: 3-19.
Reynolds, R.E., 2005. Halloran turquoise: a thousand years of mining history. California State University, Desert Studies Consortium: 63-67.
Reynolds, R.E., 2006. Making Tracks across the Southwest. California State University, Desert Studies Consortium, 80p.
Reynolds, R.E., 2006. Jurassic Tracks in California. California State University, Desert Studies Consortium: 19-24.
Reynolds, R.E., 2006. Horse Hoof Prints in the Fossil Record. California State University, Desert Studies Consortium: 25-28.

Reynolds, R.E., 2006. Way out west: California's only dinosaur tracks. Presentation, 2006 Federal Fossil Conference, Albuquerque New Mexico.

Reynolds, R.E., 2006. Tracks missing: extinct camel tracks from the BLM Owl Canyon Campground, Miocene Barstow Formation, Mojave Desert, California. Presentation, 2006 Federal Fossil Conference, Albuquerque, New Mexico.

Reynolds, R.E., in press 2006. Preserving California's Fossil Heritage During Construction Excavation. CDMG Special Publication, Engineering Practice in Northern California.

Reynolds, R. E., in press 2006. Way out West: Jurassic tracks on the Continental Margin. New Mexico Museum of Natural History.

Reynolds, Robert E., 2007. Wild, scenic and rapid: a trip down the Colorado River Trough. 2007 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 116.

Reynolds, Robert E. (ed), 2008. Trough to Trough: the Colorado River and the Salton Sea. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 146.

Reynolds, Robert E., 2008. Review of freshwater mollusks from the Bouse Formation, Lake Havasu area, California. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 54-57.

Reynolds, Robert E., 2008. New Pleistocene records of the Tiger Salamander (Ambystoma tigrinum) in Riverside County, California. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 143-146.

Reynolds, Robert E., 2009. New Pleistocene faunas from Kern River Terrace Deposits. 2009 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 171-174.

Reynolds, Robert E., 2010. Camel Tracks from the Early Miocene Hector Formation, Cady Mountains, California; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 206-208.

Reynolds, Robert E., 2010. Early Pleistocene range extension for Microtus mexicanus in the southwestern Mojave Desert, California; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 248-252.

Reynolds, Robert E., 2011. The incredible shrinking Pliocene. 2011 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 136.

Reynolds, Robert E., 2011. A new Miocene flora from the Round Mountain Silt. 2011 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 114-118.

Reynolds, Robert E., 2012. Search for the Pliocene: the southern exposures. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 186.

Reynolds, Robert E., 2012. Ichnites in the Bouse Formation, Amboy, San Bernardino County, California. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 136-139.

Reynolds, Robert E., 2012. Searching for the Pliocene: Field trip guide to the southern exposures; Field trip day 1. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 5-18.

Reynolds, Robert E., 2012. Raising questions in the central Mojave: 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 234.

Reynolds, Robert E., 2013. The High Road to Borate. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 95-98.

Reynolds, Robert E., 2013. Non-vertebrate fossils in the Miocene Barstow Formation, central Mojave Desert, California. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 99-102.

Reynolds, Robert E., 2013. *Parapliohippus carrizoensis* (Perissodactyla: Equidae) from early Miocene (Hemingfordian NALMA) Barstow Formation outcrops in the southwestern Cady Mountains, Mojave Desert, California. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 114-116.

Reynolds, Robert E., 2013. New mammal tracks and invertebrate ichnites from Early Miocene Barstow Formation sediments on Daggett Ridge, Mojave Desert, California. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 117-120.

Senior Authored Publications

Reynolds, Robert E., and David R. Berry, 2008. Preliminary review of invertebrate fossil localities in the Bouse Formation, Blythe basin, California. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 62-68.

Reynolds, R.E., and Buffington, K., 2003. The Park Place fauna: a faunal assemblage from Irvine, Orange County, California, *in* Abstracts of the 2003 Desert Symposium. California State University Desert Studies Consortium:66-67.

Reynolds, R.E., and Buffington, K., 2003. The Park Place faunal assemblage (Irvine, Orange County, California). Western Association of Vertebrate Paleontologists, Abstracts and Program.

Reynolds, R.E., Buising, A.V., and Beratan, K.K., 1992. Old routes to the Colorado: the 1992 Mojave Desert Quaternary Research Center field trip, *in* Old routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:5-27.

Reynolds, R.E., and Calzia, James, 2001. Neogene erosional surfaces in the northeastern Mojave Desert, California, *in* Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 41-43.

Reynolds, R.E., and Conkling, Steven, 2001. Protecting our fossil heritage in Badlands National Park: preliminary report of paleontological monitoring at Interior, South Dakota. Partners in Paleontology, Grand Junction, Colorado.

Reynolds, R.E., and Cox, B.F., 1999. Tracks along the Mojave: a field guide form Cajon Pass to the Manix Basin and Coyote Lake. San Bernardino County Museum Association Quarterly, 46(3): 1-26.

Reynolds, R.E., and Fay, L.P., 1989. The Coon Canyon Fault Crevice Local Fauna: Preliminary evidence for recency of faulting in the Mud Hills, San Bernardino County, California, in The west-central Mojave Desert: Quaternary studies between Kramer and Afton Canyon. Redlands, San Bernardino County Museum Association Special Publication.

Reynolds, R.E., Fay, L.P., and Reynolds, R.L., 1990. California Oaks Road: an early-late Irvingtonian Land Mammal Age fauna from Murrieta, Riverside County, California. Redlands, San Bernardino County Museum Association Quarterly, 37(2).

Reynolds, R.E., Glazner, A.F., and Meek, N., 1989. Field trip road log, in The west-central Mojave Desert: Quaternary studies between Kramer and Afton Canyon. Redlands, San Bernardino County Museum Association Special Publication.

Reynolds, R.E., Hilburn, R., and Weasma, T., 2000. Tracks through time: a learning experience, in Reynolds, R.E. and Reynolds, J. (Eds), Empty Basins, Vanished Lakes. San Bernardino County Museum Association Quarterly, 47(2): 3-20.

Reynolds, R.E., Hunt, R., and Albright, B., 1995. Rhinoceros in Lanfair Valley *in* Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3): in prep.

Reynolds, R.E., and Jefferson, G.T., 1971, Late Pleistocene vertebrates from Valley Wells, Mojave Desert, California: Geological Society of America, 67th Annual Meeting Cordilleran Section, Abstracts with Programs.

Reynolds, R.E., and Jefferson, G.T., 1988. Timing of deposition and deformation in Pleistocene sediments at Valley Wells, eastern San Bernardino County, California. Cordilleran Section, Geological Society of America, Field Trip Guidebook.

Reynolds, R.E., and Jefferson, G.T., 1988. Timing of deposition and deformation in Pleistocene sediments at Valley Wells, eastern San Bernardino County, California. Cordilleran Section, Geological Society of America, Abstracts with Programs.

Reynolds, Robert E., G. T. Jefferson, and D. K. Lynch, 2008. Trough to Trough: The 2008 Desert Symposium field trip. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 5-25.

Reynolds, Robert E., and G. T. Jefferson, 2010. A brief comparison of central Mojave Desert lakes: Miocene Barstow Formation and Pleistocene Lake Manix, 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p.66-69.

Reynolds, R.E., Jefferson, G.T., and Reynolds, R.L., 1991. The sequence of vertebrates from Plio-Pleistocene sediments at Valley Wells, San Bernardino County, California, in Crossing the borders: Quaternary studies in eastern California and southwestern Nevada, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication MDQRC 1991:72-77.

Reynolds, R.E., and Jenkins, J.E., 1986, Secondary mineral assemblage, Copper Consolidated Lode, Copper Basin, San Bernardino County, California, in Geology around the margins of the eastern San Bernardino Mountains: Redlands, Publications of the Inland Geological Society, Vol. 1, p. 81-84.

Reynolds, Robert E., and David R. Jessey, 2009.Landscape Evolution at an active Plate Margin;. 2009 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 210.

Reynolds, R.E., and Kampf, A.R., 1984, Minerals of the Mohawk mine, San Bernardino County, California: Tucson, Friends of Mineralogy, Annual Meeting, abs.

Reynolds, R.E., and Knoll, M.A., 1992. Miocene vertebrate faunas of the Little Piute Mountains, southeastern Mojave Desert, *in* Old routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:92-94.

Reynolds, R.E., and Kooser, M.A., 1986, Road log, in Geology around the margins of the eastern San Bernardino Mountains: Redlands, Publications of the Inland Geological Society, Vol. 1, p. 7-50.

Reynolds, R.E., and Lander, E.B., 1985, Preliminary report on the Miocene Daggett Ridge local fauna, central Mojave Desert, California, in Geological investigations along Interstate 15, Cajon Pass to Manix Lake: Redlands, San Bernardino County Museum, p. 105-110.

Reynolds, R.E., Lemmer, B., and Jordan, F., 1994. The Landers Rupture Zone and other faults in the Central Mojave Desert Province, California, Field Trip 11 *in* Geological investigations of an active margin, S.F. McGill and T.M. Ross, eds. 27th Annual Meeting, Geological Society of America, Cordilleran Section Guidebook:258-271.

Reynolds, R.E., and Lindsay, E.H., 1999. Late Tertiary basins and vertebrate faunas along the Nevada–Utah border, *in* Gillette, D.D. (ed.), Vertebrate Paleontology in Utah. Utah Geological Survey Miscellaneous Publication 99-1: 469-478.

Reynolds, R.E., and McMackin, M.R., 1988. Field trip roadlog, Cenozoic tectonics in the Halloran Hills and Kingston Range. Cordilleran Section, Geological Society of America, Field Trip Guidebook.

Reynolds, R.E., Meek, Norman, McMackin, M.R., and Awramik, S.M., 2000. Empty basins, vanished lakes, the year 2000 desert symposium field guide, *in* Reynolds, R.E. and Reynolds, J. (Eds), Empty Basins, Vanished Lakes. San Bernardino County Museum Association Quarterly, 47(2): 3-20.

Reynolds, R. E., and Mickelson, Debra L., In press 2006. Way out West: preliminary description and comparison of Pterosaur ichnites from the Mescal Range, Mojave Desert, California. New Mexico Museum of Natural History.

Reynolds, Robert E., and David M. Miller, 2010.Overboard in the Mojave: 20 Million years of lakes and wetlands; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 292.

Reynolds, Robert E., David M. Miller, M. O. Woodburne, and L. B. Albright, 2010. Extending the boundaries of the Barstow Formation in the central Mojave Desert; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p.148-161.

Robert E. Reynolds and David M. Miller., 2011. The incredible shrinking Pliocene: Field Trip Guide, Day 3. 2011 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 136.

Reynolds, R.E., Miller, David, and Bishop, Kim, 2003. Land of lost lakes, the 2003 Desert Symposium field trip, *in* Land of Lost Lakes, R.E. Reynolds, ed. California State University Desert Studies Consortium: 3-26.

Reynolds, R.E., Miller, D.M. Nielson, J.E., and McCurry, M., 1995. Road log, *in* Ancient surfaces of the East Mojave Desert, Reynolds, R.E. (compiler) and J. Reynolds (ed). San Bernardino County Museum Association Quarterly, 42(3): in prep.

Reynolds, R. E., and David M. Miller and Jordon Bright, 2008. Possible Bouse Formation in the Bristol Lake basin, California. 2008 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 48-53.

Reynolds, R. E., Andrew R. C. Milner, Gary Hunt, Jared Brinton, 2007. Mammal Trackways from the Middle Miocene (Late Barstovian NALMA) volcaniclastic sediments in southwestern Utah. Abstract with proceedings. Jour. Vert. Paleo, Vol. 27, Suppl. to No. 3.

Reynolds, Robert E., and Andrew R. C. Milner, 2012. Early Neogene cat tracks from California and Utah. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 153-159.

Reynolds, R.E., and Nance, M.A., 1988. Shadow Valley Basin: late Tertiary deposition and Gravity Slides from the Mescal Range. Cordilleran Section, Geological Society of America, Field Trip Guidebook.

Reynolds, R.E., and Nance, M.A., 1988. Shadow Valley Basin: late Tertiary deposition and Gravity Slides from the Mescal Range. Cordilleran Section, Geological Society of America, Abstracts with Programs.

Reynolds, R.E., and Reeder, W.A., 1986. Age and fossil assemblage of the San Timoteo formation, Riverside County, California, in Geology around the margins of the eastern San Bernardino Mountains: Redlands, Publications of the Inland Geological Society, Vol. 1, p. 51-56.

Reynolds, R.E., and Reeder, W.A., 1991. The San Timoteo Formation, Riverside County, California. San Bernardino County Museum Association Quarterly, 38(3,4):44-48.

Reynolds, R.E., and Remeika, P., 1993. Ashes, faults and basins: the 1993 Mojave Desert Quaternary Research Center field trip, *in* Ashes, faults and basins. R.E. Reynolds and J. Reynolds, eds.. Redlands, San Bernardino County Museum Association Special Publication MDQRC 93-1: 3-33.

Reynolds, R.E., and Reynolds, J., 1991. Crossing the borders: the 1991 MDQRC field trip, *in* Crossing the borders:

Quaternary studies in eastern California and southwestern Nevada, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication MDQRC 91:5-35.

Reynolds, R.E. (compiler), and Reynolds, J. (ed), 1992. Old routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:106 p.

Reynolds, R.E., and Reynolds, J. (eds), 1993. Ashes, faults and basins. Redlands, San Bernardino County Museum Association Special Publication MDQRC 93-1: 107 p.

Reynolds, R.E. (compiler), and Reynolds, J. (ed), 1995. Ancient surfaces of the Eastern Mojave Desert. San Bernardino County Museum Association Quarterly, 42(3): 160 p.

Reynolds, R.E., and Reynolds, J. (eds), 1996. Punctuated chaos in the northeastern Mojave Desert. San Bernardino County Museum Association Quarterly, 43(1,2): 156 p.

Reynolds, R.E., and Reynolds, J. (eds), 1997. Death Valley: The Amargosa Route. San Bernardino County Museum Association Quarterly, 44(2): 106 p.

Reynolds, R.E., and Reynolds, J. (eds), 1999. Tracks along the Mojave. San Bernardino County Museum Association Quarterly, 46(3): 120 p.

Reynolds, R.E., and Reynolds, J. (eds), 2000. Empty Basins, Vanished Lakes. San Bernardino County Museum Association Quarterly, 47(2)): 88 p.

Reynolds, R.E., and Reynolds, R.L., 1985, Late Pleistocene faunas from Daggett and Yermo, San Bernardino County, California, in Geological investigations along Interstate 15, Cajon Pass to Manix Lake: Redlands, San Bernardino County Museum, p. 175-191.

Reynolds, R.E., and Reynolds, R.L., 1990. A new, late Blancan faunal assemblage from Murrieta, Riverside County, California. Redlands, San Bernardino County Museum Association Quarterly, 37(2).

Reynolds, R.E., and Reynolds, R.L., 1990. Irvingtonian? faunas from the Pauba Formation, Temecula, Riverside County, California. Redlands, San Bernardino County Museum Association Quarterly, 37(2).

Reynolds, R.E., and Reynolds, R.L., 1991. Structural implications of late Pleistocene faunas from the Mojave River Valley, California, *in* Inland southern California: the last 70 million years, M.O. Woodburne, R.E. Reynolds , and D.P. Whistler, ed. Redlands, San Bernardino County Museum Association Quarterly 38(3,4):100-105.

Reynolds, R.E., and Reynolds, R.L., 1992. Pleistocene Faunas in the Bristol-Danby Trough, *in* Old routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:83-86.

Reynolds, R.E., and Reynolds, R.L., 1993. Rodents and rabbits from the Temecula Arkose, *in* Ashes, faults and basins. Redlands, R.E. Reynolds and J. Reynolds, eds. San Bernardino County Museum Association Special Publication MDQRC 93-1: 98-100.

Reynolds, R.E., and Reynolds, R.L., 1994. The Victorville Fan and an occurrence of *Sigmodon*, *in* Off limits in the Mojave Desert, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication, 94(1): 31-33.

Reynolds, R.E., and Reynolds, R.L., 1994. The isolation of Harper Lake Basin, *in* Off limits in the Mojave Desert, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication, 94(1): 34-37.

Reynolds, R.E., and Reynolds, R.L., 1994. Depositional history of the Bitter Springs Playa paleontologic site, Tiefort Basin, Fort Irwin National Training Center, California, *in* Off limits in the Mojave Desert, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication, 94(1): 56-60.

Reynolds, R.E. and Reynolds, R.L., 1999. An early occurrence of woodrat (*Paraneotoma*: Hemphillian) from San Bernardino County, California. Journal of Vertebrate Paleontology, 19(3): 70A.

Reynolds, R.E., Reynolds, R.L., Bell, C.J., Czaplewski, N.J., Goodwin, H.T., Mead, J.I., and Roth, B., 1991. The Kokoweef Cave faunal assemblage, *in* Crossing the borders: Quaternary studies in eastern California and southwestern Nevada, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication MDQRC 91:97-103.

Reynolds, R.E., Reynolds, R.L., Bell, C.J., and B. Pitzer, 1991. Vertebrate remains from Antelope Cave, Mescal Range, San Bernardino County, California, *in* Crossing the borders: Quaternary studies in eastern California and southwestern Nevada, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication MDQRC 91:107-109.

Reynolds, R.E., Reynolds, R.L., and Lindsay, E.H., in press. Biostratigraphy of the Miocene Crowder Formation, Cajon Pass, southwestern Mojave Desert, California. Natural History Museum of Los Angeles County.

Reynolds, R.E., Reynolds, R.L., and Pajak III, A.F., 1991. Blancan, Irvingtonian, and Rancholabrean(?) Land Mammal Age faunas from western Riverside County, California. 38(3,4):37-40.

Reynolds, R.E., Schmidt, D., Harris, J. D., and Milner, A. R. C., 2006. Making Tracks – the field trip guide. California State University, Desert Studies Consortium: 3-18.

Reynolds, Robert E., and Thomas A. Schweich, 2013. The Rainbow Loop Flora from the Mud Hills, Mojave Desert, California. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 39-48.

Reynolds, R.E., and Turner, W.G., 1971. Petroglyph dating, in Three essays on petroglyphology: Bloomington, San Bernardino County Museum Association Quarterly, vol. XIX, no. 1, p. 28-34.

Reynolds, R.E., and Weasma, Ted, 2002. California dinosaur tracks: inventory and management [abs], *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 82.

Reynolds, R.E., and Weasma, Ted, 2002. California dinosaur tracks: inventory and management, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 15-18.

Reynolds, R.E., and Weasma, Ted, 2002. California dinosaur tracks: inventory and management, *in* National Park Service U.S. Department of the Interior Park Paleontology 6(2):5-7.

Reynolds, R.E., and Weasma, Ted, 2003. California dinosaur tracks: inventory and management. Western Association of Vertebrate Paleontologists, Abstracts and Program.

Reynolds, R.E., and Weldon, R.J., 1988. Vertebrate paleontologic investigation, DOSECC "Deep Hole" project, Cajon Pass, San Bernardino County, California. Geophysical Research Letters 15(9):1073-1076.

Reynolds, R.E., Wells, S.G., and Brady III, R.H., 1990. At the end of the Mojave: Quaternary studies in the eastern Mojave Desert. Redlands, San Bernardino County Museum Association Special Publication: 134 p.

Reynolds, R.E., and Whistler, D.E., 1990. Early Clarendonian Faunas of the Eastern Mojave Desert, San Bernardino County, California. Redlands, San Bernardino County Museum Association Special Publication, MDQRC Guidebook.

Reynolds, R.E., Whistler, D.P., and Woodburne, M.O., 1991. Road log: the 1991 SVP field trip to paleontologic localities in inland southern California. San Bernardino County Museum Association Quarterly, 38(3,4):5-36.

Reynolds, R.E., and Woodburne, M.O., 2001. Review of the Proboscidean datum within the Barstow Formation, Mojave Desert, California. Journal of Vertebrate Paleontology, Abstracts of Papers, 21(3): 93A.

Reynolds, R.E., and Woodburne, M.O., 2001. Marker bed correlations between the Mud Hills, Calico Mountains, and Daggett Ridge, central Mojave Desert, California. GSA Cordilleran section, 97th Annual Meeting, and Pacific Section, American Association of Petroleum Geologists, April.

Reynolds, R.E., and Woodburne, M.O., 2002. Review of the Proboscidean datum within the Barstow Formation, Mojave Desert, California [abs], *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 82-83.

Reynolds, R.E., and Woodburne, M.O., 2002. Marker bed correlations between the Mud Hills, Calico Mountains, and Daggett Ridge, central Mojave Desert, California [abs], *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 82.

Reynolds, R.E., and Woodburne, M.O., 2002. Review of the Proboscidean datum within the Barstow Formation, Mojave Desert, California [abs], *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 82-83.

Reynolds, R.E., and Woodburne, M.O., 2002. Marker bed correlations between the Mud Hills, Calico Mountains, and Daggett Ridge, central Mojave Desert, California [abs], *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 82.

Co-authored Publications

Agenbroad, L.D., Mead, J.I., and **Reynolds, R.E.,** 1992. Mammoths in the Colorado River Corridor, in Old Routes to the Colorado, J. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication 92-2:104-106.

Bell, Michael A., and Robert E. Reynolds, 2010. Miocene and Late Pleistocene stickleback spines from the Mojave Desert, California; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 162-168.

Calzia, J.P., and **Reynolds, R.E.,** 1998. Finding Faults in the Mojave Desert. San Bernardino County Museum Association Quarterly, 45(1,2), 112 p.

Conkling, S.W., and **Reynolds, R.E.,** 2001. Protecting our fossil heritage in a national park—preliminary report of paleontological monitoring at Badlands National Park, South Dakota. Partners in Paleontology, September, Grand Junction, Colorado.

Conkling, S.W., and **Reynolds, R.E.,** 2001. Protecting our fossil heritage in a national park – preliminary report of paleontological monitoring at Badlands National Park, South Dakota. Federal Millennium Conference, May, Barstow California.

Cooper, J.F. Jr., Dunning, G.E., Hadley, T.A., Moller, W.P., and **Reynolds, R.E.,** 2002. The Sulfur Hole, Calico District, San Bernardino County, California, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 29-36.

Davisson, Cole, and **Reynolds, R.E.,** 1999. Occurrence of fossil mammal tracks in the Diligencia Formation, Orocopia Mountains, southeast California, *in* Reynolds, R.E., 1999. Fossil footprints. San Bernardino County Museum Association Quarterly, 46(2): 33-36.

Goodwin, H.T., and **Reynolds, R.E.,** 1989. Late Quaternary Sciuridae from Kokoweef Cave, San Bernardino County, California. Bulletin, Southern California Academy of Sciences, 88(1):21-32.

Goodwin, H.T., and **Reynolds, R.E.,** 1989. Late Quaternary Sciuridae from low elevations in the Mojave Desert, California. The Southwestern Naturalist, 34(4):506-512.

Henderson, Zac, and **Reynolds, R.E.,** 2000. Digitizing paleontological sensitivity maps, *in* Reynolds, R.E. and Schneider, J., Abstracts from the Year 2000 Desert Symposium, San Bernardino County Museum Association Quarterly 47(2): 77.

Hilburn, Bob, and **Reynolds, R.E.,** 2002, Tracks through time: the fossil animal track replication project, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 77.

Hilburn, R.F., and **Reynolds, R.E.,** 2003. The Tracks through Time program at the Mojave River Valley Museum, *in* Abstracts from the 2003 Desert Symposium. California State University Desert Studies Consortium:64-65.

Housley, R.M., and **Reynolds, R.E.,** 2002. Mineralogical survey of the Mount General area, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 61-63.

Jefferson, George T., David Lynch, L. K. Murray, and R. E. Reynolds, 2012. Searching for the Pliocene: Field trip guide to the southern exposures; Field trip day 2. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 19-30.

Jessey, D.R., and **Reynolds, R.E., 2007**. Major and trace element geochemistry of the Neogene Halloran Hills andesites, San Bernardino County, California: implications for tectonic evolution of the eastern Mojave. 2007 Desert Symposium Volume, California State University, Fullerton, Desert Studies Consortium. p. 33-37.

Karnes, Kyle, and **Reynolds, R.E.,** 1995. *Marmota flaviventris* from Devil Peak Cave, southern Nevada, *in* Abstracts from Proceedings, the 1995 Desert Research Symposium. Redlands, San Bernardino County Museum Association Quarterly, 42(2).

Knott, Jeffrey R., John W. Hillhouse, David M. Miller, and **Robert E. Reynolds**, 2011. The incredible shrinking Pliocene: Field Trip Guide, Day 2. 2011 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 136.

Kooser, M.A., and **Reynolds, R.E.,** eds, 1986, Geology around the margins of the eastern San Bernardino Mountains: Publications of the Inland Geological Society, Vol. 1, 124 p.

Korth, W. W., and **Reynolds, R. E.,** 1994. A hypsodont gopher (Rodentia, Geomyidae) from the Clarendonian (Miocene) of California, Off limits in the Mojave Desert, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication, 94(1): 91-95.

Lange, F. W**. Reynolds, R. E.**, and Ewers, D. 2007. A cultural-geological analysis of quartz shatters from the Mesquite Regional Landfill, Imperial County, California. 2007 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 98-102.

Lange, F. W**. Reynolds, R. E.**, and Antonina Delu. 2008. An archaeological and geological view of cupule production in an area of western Riverside County, California. Desert Symposium Volume, California State University, Desert Studies Consortium. p. 119-121.

Lum, Maria, **Reynolds, R.E.,** and Sanders, Andrew, 2001. The hanging gardens of Amargosa Canyon, in Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 65-68.

Mende, Doug, and **Reynolds, R.E.,** 2000. Developing a paleontological sensitivity map and GIS database for the Mojave Desert, *in* Reynolds, R.E. and Schneider, J., Abstracts from the Year 2000 Desert Symposium, San Bernardino County Museum Association Quarterly 47(2): 81.

Miller, D. M., S. R. Leslie, J. W. Hillhouse, J. L. Wooden, J. A. Vazquez, and **R. E. Reynolds**, 2010. Reconnaissance geochronology of tuffs in the Miocene Barstow Formation: implications for basin evolution and tectonics in the central Mojave Desert; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 70-84.

Miller, David M., John W. Hillhouse, and **Robert E. Reynolds**, 2011. The incredible shrinking Pliocene: Field Trip Guide, Day 1. 2011 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 136.

Miller, David M., Peter Sadler, Kevin Schmidt, and **Robert E. Reynolds**, 2012. Raising questions in the central Mojave: the field trip. 2012 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 5-30.

Pagnac, D.C., and **Reynolds, R.E.,** 2006. The Fossil Mammals of the Barstow Formation. California State University, Desert Studies Consortium: 65-70.

Pagnac, Darrin C., and **Robert E. Reynolds**, 2010. A juvenile specimen of Archaeohippus mourningi (Perissodactyla: Equidae) from the Cajon Valley Formation (Middle Miocene) of California; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 241-247.

Roth, B., and **Reynolds, R.E.,** 1988. Late Pleistocene nonmarine Mollusca from Kokoweef Cave, Ivanpah Mountains, California. Redlands, San Bernardino County Museum Association Quarterly XXXV (3,4).

Roth, B., and **Reynolds, R.E.,** 1990. Late Quaternary nonmarine mollusca from Kokoweef Cave, Ivanpah Mountains, San Bernardino County, California. Bulletin, Southern California Academy of Sciences, 89(1):1-9.

Sarjeant, W.A.S., and **Reynolds, R.E.,** 1999. Camelid and horse footprints from the Miocene of California and Nevada *in* Reynolds, R.E., 1999. Fossil footprints. San Bernardino County Museum Association Quarterly, 46(2): 3-20.

Sarjeant, W.A.S., and **Reynolds, R.E.,** 2001. Bird footprints from the Miocene of California, *in* Reynolds, R.E. (ed.), 2001. The changing face of the east Mojave Desert. California State University, Desert Studies Center: 21-40.

Sarjeant, W.A.S., **Reynolds, R.E.,** and Kissell-Jones, M.M., 2002. Fossil creodont and carnivore footprints from California, Nevada, and Wyoming, *in* Reynolds, R.E., (ed), 2002. Between the basins: exploring the western Mojave and southern Basin and Range Province. California State University, Desert Studies Consortium: 37-50.

Simpson, R.D., Haenszel, A., **Reynolds, R.E.,** and Bowers, D., 1971. Rock Camp: Bloomington, San Bernardino County Museum Association Quarterly, vol. XIX, no. 1, p. 28-34.

Smith, Gerald R., Robert E. Reynolds, and Joseph D. Stewart, 2013. Hydrographic significance of fishes from the Early Pliocene White Narrows Beds, Clark County, Nevada. 2013 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 171-180.

Turner, W.G., and **Reynolds, R.E.,** 1977. Dating the Salton Sea petroglyphs: Science News, vol. 111, February.

Wagner, H.M., and **Reynolds, R.E.,** 1983. *Leptarctus ancipidens* (Carnivora: Mustelidae) from the Punchbowl formation, Cajon Pass, California: Bulletin of the Southern California Academy of Sciences.

Wells, S.G., and **Reynolds, R.E.,** 1990. Desert wind, water, and brimstone: Quaternary landscape evolution in the eastern Mojave Desert, *in* At the end of the Mojave, R.E. Reynolds, ed. Redlands, San Bernardino County Museum Association Special Publication:5-16.

Whistler, D.P., and **Reynolds, R.E.,** 1991. Recent revisions to the Clarendonian faunal assemblage from the Avawatz Formation. San Bernardino County Museum Association Quarterly, 38(3, 4):91-92.

Wilkerson, Gregg, **Reynolds, R.E.,** Lawlor, D., and Nafus, B., 1995. Fossil resources involving Federal Lands in California, *in* Abstracts from Proceedings, the 1995 Desert Research Symposium. Redlands, San Bernardino County Museum Association Quarterly, 42(2).

Wilkerson, Gregg, **Reynolds, R.E.,** Lawlor, D., and Nafus, B., 1995. Fossil resources and Federal Lands in California. Redlands, San Bernardino County Museum Association Quarterly, 42(2).

Woodburne, M.O., **Reynolds, R.E.,** and Whistler, D.P., eds. 1991. Inland Southern California: the last 70 million years, Redlands, San Bernardino County Museum Association Quarterly 38(3, 4):88-90.

Woodburne, Michael O. and Robert E. Reynolds, 2010. The mammalian litho- and biochronology of the Mojave

Desert Province; 2010 Desert Symposium Volume, California State University, Desert Studies Consortium. p. 124-147.

Resume of

E. BRUCE LANDER, Ph.D.

Principal Investigator

Experience Summary

Extensive paleontologic resource management experience conducting and managing paleontologic resource/impact assessments and impact mitigation programs for large construction projects in California, Nevada, Utah, Wyoming, Arizona, New Mexico, Texas, and Maryland. Projects include municipal solid waste landfills; aggregate quarries; dams and reservoirs; aqueducts; flood control and groundwater recharge facilities; irrigation systems; cogeneration plants; solar energy and electrical generating plants; oil refineries; water pipelines/tunnels; oil and natural gas pipelines; electrical transmission lines; freeways, tunnels, and other roadways; subways; tramways; waste water treatment facilities; housing developments; planned communities; hotels; office buildings/complexes; business and industrial parks; shopping centers; hospitals and medical centers; convention centers; movie studios; parking lots/structures; marinas and marine supply facilities; space vehicle launch facilities; landslide stabilization and lagoon enhancement projects; geotechnical drilling programs; land exchanges; regional overviews; and conditional use permit, specific plan, and general plan revisions. Clients include private industry, public utilities, and federal, state, county, city, and regional agencies. Paleontologic resource assessments entailed data searches (literature reviews, archival searches, field surveys, consultation with other paleontologists) to develop baseline inventories, evaluation of scientific importance of resources and potential for disturbance by adverse project-related impacts, and formulation of mitigation measures to reduce these impacts to an acceptable level. Paleontologic resource impact mitigation programs required monitoring of earth-moving activities, recovery of fossil remains and fossiliferous rock samples, supervision of field personnel, and preparation of progress and final reports. Projects involved extensive coordination and consultation with project proponents, other consulting firms, and permitting agencies; adherence to strict delivery schedules; and completion within specified budget limits. Over 35 years of professional experience as a paleontologist and 25 years as a paleontologic consultant involved in paleontologic resource management and NEPA/CEQA compliance. Extensive paleontologic research background in land mammal faunas and vertebrate biostratigraphy of Tertiary continental formations of the southeastern, central, and western United States. Research entailed literature reviews, archival searches, field surveys, and consultation with other paleontologists.

Experience Record

1988-Date Paleo Environmental Associates, Inc., Altadena, California. Principal Investigator. Developed and manages paleontologic resource management consulting program; prepared paleontologic resource assessments and corresponding EIR/EIS sections for numerous major earth-moving projects in California, including Puente Hills, Weldon Canyon, Marsh Canyon, Elsmere Canyon, and Altamont Landfill EIRs; Eastern Transportation Corridor EIR/EIS; Luz Solar Energy Generating System III to XII AFCs; Playa Vista EIR; Metropolitan Water District of Southern California Eastside Reservoir and Inland Feeder EIRs; Santa Monica Mountains National Recreation Area Land Exchange EIS; and City Ranch, West End Area, and Santa Fe Ranch Specific Plan EIRs; managed Simi Valley Landfill expansion, Santiago Canyon Landfill, Puente Hills Landfill expansion, Foothill Ranch, Shell Oil Company Wilmington Manufacturing Complex SCOT unit, Los Angeles Metro Red Line, Sutter Power Plant Project, Eastern Transportation Corridor, and Metropolitan Water District of Southern California Inland Feeder and Cajalco Creek Dam and Detention Basin Project paleontologic resource impact mitigation programs. Caltrans projects include assessments and/or mitigation programs for SR-14, SR-41, and SR-178, and assessment for SR-47/Terminal Island, I-10/McNaughton Parkway, and I-15/French Valley Parkway. City of Los Angeles projects include assessments and/or mitigation programs for Rampart Area Police Station replacement, Harbor Community Police Station and Jail Replacement, Police Headquarters Facility, Los Angeles Harbor West Basin China Shipping and Yang Ming, Venice Pumping Plant Dual Force Main, Silver Lake Improvement, South Region Middle School No. 6, and Emergency Operations Center.

1985-1990 Engineering-Science, Inc., Pasadena, California. Project Manager, Paleontologist/Geologist.

Developed and managed paleontologic resource management consulting program; prepared numerous paleontologic resource assessments for projects in California, Arizona, Utah, Wyoming, New Mexico, Texas, Nevada, and Maryland, including Simi Valley Landfill Expansion EIR, Pacific Texas Pipeline Project EIR/EIS, Mojave-Kern River-El Dorado Natural Gas Pipeline Projects EIR/EIS, Los Angeles Metro Rail MOS-2 EIR/EIS, and Orange County Foothill Transportation Corridor EIR; prepared paleontologic resource assessment overviews of southern Ventura County for Ventura County Resource Management Agency and City of Simi Valley sphere of influence for City of Simi Valley Department of Community Development; supervised Los Angeles Metro Rail MOS-1 and interim Simi Valley Landfill paleontologic resource impact mitigation programs; assisted in preparing public relations program for Waste Management of California; prepared geology/seismicity sections of environmental documents for numerous construction projects.

1984-1985 Wirth Environmental Services/Dames and Moore, San Diego and Santa Barbara, California. Paleontologic Consultant. Prepared paleontologic resource assessments for Mead/McCullough-Victorville/Adelanto Transmission Project ER, Argus Cogeneration Expansion Project AFC, and Midway-Sunset Cogeneration Project AFC.

1984-1985 San Bernardino County Museum, Redlands, California. Paleontologist. Identified vertebrate fossil remains; prepared educational fossil exhibits; assisted in docent training, preparation of technical reports regarding results of paleontologic resource impact mitigation program for Los Angeles Department of Water and Power Intermountain Power Project transmission line corridor and Western Association of Vertebrate Paleontologists 1985 Field Trip Guidebook and Volume.

1982-1985 Marine and Environmental Science Associates, Inc. ($MESA^2$, Inc.), La Crescenta, California. Project Manager, Paleontologist/Geologist. Developed and managed paleontologic resource management consulting program; prepared paleontologic resource assessments for projects throughout California, including Sacramento Municipal Utility District's Geothermal Public Power Line Project (NOI and AFC) and ARCO's Coal Oil Point Project EIS/EIR; assisted in preparing geologic reports and maps on southern California continental borderland; assisted in preparing expert testimony for presentation before California Energy Commission.

1980-1981 Woodward-Clyde Consultants, San Francisco, California. Paleontologic Consultant. Supervised paleontologic resource impact mitigation program for MAPCO pipeline in Wyoming; assisted in preparation of paleontologic resource assessment. Projects included MAPCO's Rocky Mountain high-pressure liquid hydrocarbon pipeline project and Public Service Company of New Mexico's New Mexico Generating Station project.

1980 Research Reports Center (division of William Kauffman, Inc.), Los Altos, California. Copy Editor. Edited and abstracted technical reports for EPRI (Electric Power Research Institute) Guide and Journal.

1977-1979 U.S. Geological Survey Paleontology/Stratigraphy Branch, Menlo Park, California. Physical Science Technician. Conducted paleontologic resource impact mitigation program at Stanford Linear Accelerator Positron Electron Project ring.

1970-1976 University of California Museum of Paleontology, Berkeley, California. Research Assistant. Supervised vertebrate fossil collections and curatorial assistants during summer, 1976. Other positions included Teaching Assistant and Senior Museum Preparator.

1965-1970 University of California Department of Geology, Los Angeles. Laboratory Assistant. Prepared, identified, and curated fossils.

Education

B.S., Geology, 1969, University of California, Los Angeles

M.A., Paleontology, 1972, University of California, Berkeley

Ph.D., Paleontology, 1977, University of California, Berkeley

Professional Registrations

Certified Paleontologic Consultant, County of Orange, California

Registered Paleontologic Consultant, County of Riverside, California

Registered Paleontologic Consultant, County of Ventura, California

Professional Societies

Paleontological Society

Society for Sedimentary Geology

Society of Vertebrate Paleontology

Western Association of Vertebrate Paleontologists

Geological Society of America

American Association for the Advancement of Science

Association of Environmental Professionals

Institutional Affiliations

Research Associate, Natural History Museum of Los Angeles County

Publications

Lander, E.B. 1972. A review of the John Day oreodonts. University of California, Berkeley, unpublished M.A. thesis.

Munthe, J., and Lander, E.B. 1973. A reevaluation of the age of the Split rock vertebrate fauna, Wyoming. Geological Society of America Abstracts with Programs 5(6):497.

Lander, E.B. 1977. A review of the Oreodonta (Mammalia, Artiodactyla), Parts I, II and III. University of California, Berkeley, unpublished Ph.D. dissertation.

Lander, E.B. 1978. A review of the Oreodonta (Mammalia, Artiodactyla), Parts I, II and III. Dissertation Abstracts International 38(8).

Lander, E.B. 1980. Marine-nonmarine tie-ins in the southern California coast ranges and recalibration of the earlier part of the Arikareean Land Mammal Age. Geological Society of America Abstracts with Programs 12(7):468.

Lander, E.B. 1983. Note [regarding publication of Ph.D. dissertation text without citation by Marshall and Corruccini, 1978]. Paleobiology 9(4):438.

Lander, E.B. 1983. Continental vertebrate faunas from the upper member of the Sespe Formation, Simi Valley, California, and the terminal Eocene event. Pages 142-153. *In* Squires, R.L., and Filewicz, M.V., editors. Cenozoic geology of the Simi Valley area, southern California. Society of Economic Paleontologists and Mineralogists Pacific Section Fall Field Trip Volume and Guidebook.

Lander, E.B. 1984. Biochronologic implications of climatically induced changes in mammalian adult body through time. Society of Economic Paleontologists and Mineralogists Abstracts, First Annual Midyear Meeting 1:47.

Lander, E.B, and Butcher, J.J. 1984. Late Paleogene regression, plate tectonics, and the terminal Eocene event, California continental margin. Society of Economic Paleontologists and Mineralogists Abstracts, First Annual Midyear Meeting 1:47.

Lander, E.B. 1985. Early and middle Miocene continental vertebrate assemblages, central Mojave Desert, San Bernardino County, California. Pages 127-144. *In* Reynolds, R.E., compiler. Geological Investigations Along Interstate 15, Cajon Pass to Manix Lake. San Bernardino County Museum.

Lander, E.B, and Reynolds, R.E. 1985. Fossil vertebrates from the Calico Mountains area, central Mojave Desert, San Bernardino County, California. Pages 156-153. *In* Reynolds, R.E., compiler. Geological Investigations Along

Interstate 15, Cajon Pass to Manix Lake. San Bernardino County Museum.

Reynolds, R.E., and Lander, E.B. 1985. Preliminary report on the Miocene Daggett Ridge Local Fauna, central Mojave Desert, San Bernardino County, California. Pages 105-110. *In* Reynolds, R.E., compiler. Geological Investigations Along Interstate 15, Cajon Pass to Manix Lake. San Bernardino County Museum.

Lander, E.B. 1988. Faunal events in the North American continental Tertiary mammalian herbivore record and their implications regarding the causes of extinction and diminishing average adult body size in late Quaternary mammalian herbivores. *In* Reynolds, J., compiler. Quaternary history of the Mojave Desert, Proceedings and Abstracts of the Mojave Desert Quaternary Research Center Second Annual Symposium, San Bernardino County Museum, Redlands, California, June 25-26, 1988. San Bernardino County Museum Association Quarterly 35(3&4):36-38.

Kelly, T.S., and Lander, E.B. 1988. Correlation of Hemingfordian and Barstovian land mammal assemblages, lower part of Caliente Formation, Cuyama Valley area, California. American Association of Petroleum Geologists Bulletin 72(3):384.

Kelly, T.S., and Lander, E.B. 1988. Biostratigraphy and correlation of Hemingfordian and Barstovian land mammal assemblages, Caliente Formation, Cuyama Valley area, California. *In* Bazeley, W.J.M., editor. Tertiary Tectonics and Sedimentation in the Cuyama Basin, San Luis Obispo, Santa Barbara, and Ventura Counties, California. Society of Economic Paleontologists and Mineralogists Pacific Section 59:1-19.

Lander, E.B. 1989. Climatically induced fluctuations in average adult body size through successive generations of Oligocene oreodonts (Mammalia, Artiodactyla, Oreodonta, Agriochoeridae and Oreodontidae). Geological Society of America Abstracts with Programs 21(6):A115.

Lander, E.B, and Swanson, D.A. 1989. Chadronian (early Oligocene) and early Arikareean (late Oligocene) land mammal assemblages from the Ohanapecosh Formation, Tieton Basin area, central Cascade Range, south-central Washington. Geological Society of America Abstracts with Programs 21(5):104.

Lander, E.B., and Kelly, T.S. 1989. Reassessment of the age and correlation of the type Barstow Formation in the Rainbow Basin area of southern California, based on changes in average adult body size through time in *Brachycrus laticeps* (Mammalia, Artiodactyla, Oreodontidae). *In* Reynolds, J., compiler. Abstracts of papers presented at the Mojave Desert Quaternary Research Center Third Annual Symposium. San Bernardino County Museum Association Quarterly 36(2):60-61.

Lander, E.B. 1990. Recorrelation of Chadronian (late Eocene) land mammal assemblages. Geological Society of America Abstracts with Programs 22(6):18.

Kelly, T.S., Lander, E.B., Roeder, M.A., Whistler, D.P., and Reynolds, R.E. 1991. Preliminary report on a paleontologic investigation of the lower and middle members, Sespe Formation, Simi Valley Landfill, Ventura County, California. PaleoBios 13(50):1-13.

Kelly, T.S., and Lander, E.B. 1992. Miocene land mammal faunas from the Caliente Formation, Cuyama Valley, California. PaleoBios 14(1):3-8.

Lander, E.B. 1994. Recalibration and causes of marine regressive-transgressive cycle recorded by middle Eocene to lower Miocene nonmarine Sespe Formation, southern California continental plate margin. *In* Fritsche, A.E., editor. Sedimentology and paleontology of Eocene rocks in the Sespe Creek area, Ventura County, California. Society for Sedimentary Geology Pacific Section 74:79-88.

Fisk, L. H., Spencer, L. A., Lander, E. B., Gustafson, E. P., and Wagner, H. M. 1994. Beneficial impacts of large construction projects on paleontologic resources: results from construction of the PGT-PG&E Pipeline Expansion Project, WA-OR-CA. *In* Proceedings of the Fourth Conference on Fossil Resources, "Partners in Paleontology: Protecting our Fossil Heritage."

Whistler, D.P., Lander, E.B., and Roeder, M.A. 1995. A diverse record of microfossils and fossil plants, invertebrates, and small vertebrates from the late Holocene Lake Cahuilla Beds, Riverside County, California. *In* Remeika, P., and Sturtz, A., editors. Paleontology and geology of the western Salton trough detachment, Anza-Borrego Desert State Park, California. San Diego Association of Geologist's field trip to Anza-Borrego Desert State Park, field trip guidebook and volume.

Whistler, D.P., Lander, E.B., and Roeder, M.A. 1995. First diverse record of small vertebrates from late Holocene sediments of Lake Cahuilla, Riverside County, California. *In* Reynolds, J., compiler. Abstracts from proceedings, The 1995 Desert Research Symposium. San Bernardino County Museum Association Quarterly 42(2):46.

Lander, E.B. 1997. Geology and vertebrate paleontology of Cenozoic nonmarine rock units, Simi Valley, Ventura County, California. Pages 302-319. *In* Havens, P., and Appleton, B., compilers. Simi Valley, a journey trough time. Simi Valley Historical Society and Museum.

Lander, E.B. 1998. Oreodontoidea. Pages 402-425. *In* Janis, C.M., Scott, K.M., and Jacobs, L.L., editors. Evolution of Tertiary mammals of North America, Volume 1: Terrestrial carnivores, ungulates, and ungulatelike mammals. Cambridge University Press.

Janis, C.M., Effinger, J.A., Harrison, J.A., Honey, J.G., Kron, D.G., Lander, E.B., Manning, E., Prothero, D.R., Stevens, M.S., Stucky, R.K., Webb, S.D., and Wright, D.B. 1998. Artiodactyla. Pages 337-357. *In* Janis, C.M., Scott, K.M., and Jacobs, L.L., editors. Evolution of Tertiary mammals of North America, Volume 1: Terrestrial carnivores, ungulates, and ungulatelike mammals. Cambridge University Press.

Lander, E.B., Whistler, D.P., Alderson, J.M., Anderson, E.S., Walker, S.I., and Anderson, C.B. 2001. Late Oligocene and early Miocene land mammal biostratigraphy, Piuma Member, Sespe Formation, and Fernwood Member, Topanga Canyon Formation, Saddle Peak area, central Santa Monica Mountains, Los Angeles County, California. Geological Society of America Abstracts with Programs 33(3):A-43.

Fisk, L.H., Lander, E.B., Alderson, J.M., Anderson, E.S., Walker, S.I., and Anderson, C.B. 2001. Late Oligocene and early to middle(?) Miocene land plants, upper Piuma Member, Sespe Formation, and Fernwood Member, Topanga Canyon Formation, Saddle Peak area, central Santa Monica Mountains, Los Angeles County, California. Geological Society of America Abstracts with Programs 33(3):A-43.

Lander, E.B., Whistler, D.P., Alderson, J.M., Fisk, L.H., Walker, S.I., Anderson, E.S., and Anderson, C.B. 2001. Late Oligocene to early or middle Miocene continental vertebrate, marine invertebrate, and land plant biostratigraphy of the Sespe, Vaqueros, and Topanga Canyon Formations, central Santa Monica Mountains, Los Angeles County, California. *In* CalPaleo 2001: A paleo odyssey. 2001 California Paleontology Conference Abstracts. PaleoBios 21(1 supplement):6-7.

Lander, E.B. 2002. Life near the edge—Sespia (Mammalia, Artiodactyla, Oreodontidae) from the continental Sespe and marine Alegria Formations, southern Santa Ynez Mountains, coastal Santa Barbara County, California. *In* 2002 California Paleontology Conference Abstracts. PaleoBios 22(1 supplement):6-7

Lander, E.B., and Fremd, T.J. 2001. Late Whitneyan, Arikareean, and earliest Hemingfordian oreodonts (Mammalia, Artiodactyla, Agriochoeridae and Oreodontidae) from the John Day Formation of central Oregon. *In* Paleontology in the new millennium. Program and abstracts, North American Paleontological Convention 2001. PaleoBios 21(2 supplement):82.

Lander, E.B. 2002. Early Orellan to late Arikareean hypertragulids (Mammalia, Artiodactyla, Hypertragulidae) from the Sespe, Otay, and Tecuya Formations of southern California, the John Day Formation of central Oregon, and the Ohanapecosh Formation of southwestern Washington. John Day Formation of central Oregon. The Western Association of Vertebrate Paleontologists Annual Meeting. Raymond M. Alf Museum of Paleontology.

Whistler, D.P., and Lander, E.B. 2003. New late Uintan to early Hemingfordian land mammal assemblages from the undifferentiated Sespe and Vaqueros formations, Orange County, and from the Sespe and equivalent marine formations in Los Angeles, Santa Barbara, and Ventura Counties, southern California. *In* Flynn, L.J., editor. Vertebrate fossils and their context: Contributions in honor of Richard H. Tedford. Bulletin of the American Museum of Natural History 278(11):234-268.

Lander, E.B.. 2003. Stratigraphically documented fluctuations in average adult body size through successive generations of *Brachycrus laticeps* (Mammalia, Artiodactyla, Oreodontidae) and a reevaluation of the Hemingfordian-Barstovian North American Land Mammal Age "boundary" in California and Nebraska. Western Association of Vertebrate Paleontologists Annual Meeting Abstracts and Program. Mojave River Valley Museum.

Calvano, G., Lander, E.B., Whistler, D.P., Roeder, M.A., Walsh, S.L., and Wagner, H.M. 2003. Recognition of a major unconformity in the middle Eocene to lower Miocene, nonmarine Sespe Formation, northern Santa Ana Mountains, Orange County, California. 2003 California Paleontology Conference Abstracts. PaleoBios 23(1, supplement):1.

Lander, E.B., Roeder, M.A., Calvano, G., Whistler, D.P., Alderson, J.M., and Hutchison, J.H. 2003. New records of late Cretaceous continental vertebrates from marine Ladd and Williams Formations, Eastern Transportation Corridor, northern Santa Ana Mountains, Orange County, southern California. 2003 California Paleontology Conference Abstracts. PaleoBios 23(1, supplement):4-5.

Calvano, G., Lander, E.B., Whistler, D.P., Roeder, M.A., Ludtke, J., Prothero, D.R., Walsh, S.L., and Wagner, H.M. 2003. Lithostratigraphic, biostratigraphic, and magnetostratigraphic documentation of a major unconformity in the middle Eocene to early Miocene continental Sespe Formation, northern Santa Ana Mountains, Orange County, southern California. Pages 56-57. *In* LA Basin 2003: Original urban oilfield legend. American Association of Petroleum Geologists Pacific Section and Society of Petroleum Engineers Western Region Conference Program and Abstracts.

Lander, E.B., Weigand, P.W., Fritsche, A.E., Alderson, J.M., and Iriondo, A. 2003. New 40Ar/39Ar age determinations for two tuffs in the Piuma (upper) Member of the continental Sespe Formation, central Santa Monica Mountains, California. Page 76. In LA Basin 2003: Original urban oilfield legend. American Association of Petroleum Geologists Pacific Section and Society of Petroleum Engineers Western Region Conference Program and Abstracts.

Lander, E.B., Whistler, D.P., Turner, R.D., Roeder, M.A., Shapiro, S.A., Calvano, G., Kennedy, C.L., Quinn, J.P., and Groves, L.T. 2004. Rancholabrean fossil land mammal and fresh-water molluscan assemblages and new radiocarbon age determination, older alluvium member c, Park La Brea Parcels A to C, the Farmers Market Expansion Phase II and III parcels, and The Grove at Farmers Market Phase I parcel, Los Angeles, California. Western Association of Vertebrate Paleontologists Annual Meeting, February 14, 2004, Occidental College, Los Angeles. Abstracts. Pages 3-4.

Lander, E.B. 2004. Re-evaluation of the Arikareean (Late Oligocene to Early Miocene) Tecuya Canyon land mammal local faunas, lower member, continental Tecuya Formation, San Emigdio Mountains, Kern County, California. Page A16. *In* More Energy from Proven Basins: Looking for more in 2004. American Association of Petroleum Geologists Pacific Section, Society for Sedimentary Geology Pacific Section, and Society of Exploration Geophysicists Pacific Section 2004 Pacific Section Convention Program and Abstracts.

Lander, E.B. 2004. Late middle to early late Miocene fossil land mammal assemblages, Lake Mathews Formation, Riverside County, California. 2004 California Paleontology Conference Abstracts. PaleoBios 24(1, supplement):5.

Foss, S.E., S.G. Lucas, T.J. Fremd, E.B. Lander, M.C. Mihlbachler, and C.B. Hanson. 2004. Reanalysis of the Hancock Mammal Quarry Local Fauna, Clarno Formation, Wheeler County, north-central Oregon. Journal of Vertebrate Paleontology 24(3 supplement):59A.

Lander, E.B. 2005. *Merychyus medius* Leidy and *M. major* Leidy (Mammalia, Artiodactyla, Oreodontidae, Ticholeptinae) from strata of late Clarendonian to earliest Hemphillian age, Dove Spring Formation, Red Rock Canyon, western Mojave Desert, Kern County, California. Pp. 5-6. *In* WAVP (Western Association of Vertebrates Paleontologists) 2005 Meeting Abstracts. Natural History Museum of Los Angeles County.

Lander, E.B. 2005. Revised correlation and age assignments of fossil land mammal assemblages of late Hemingfordian to earliest Hemphillian (early Middle to early Late Miocene) age in California, Nebraska, and Texas, based on occurrences of ticholeptine oreodonts (Mammalia, Artiodactyla, Oreodontidae, Ticholeptinae) and other land mammal taxa. *Bulletin of the Southern California Academy of Sciences* 104(2 supplement):29-30.

Turner, R.D., and Lander, E.B. 2005. *Mammut americanum* from part of the former Jungleland site, The Lakes parcel, Thousand Oaks, Ventura County, California. Pp. 10-11. *In* WAVP (Western Association of Vertebrates Paleontologists) 2005 Meeting Abstracts. Natural History Museum of Los Angeles County.

Lander, E.B., and Hanson, C.B. 2006. *Agriochoerus matthewi crassus* (Artiodactyla, Agriochoeridae) of the late middle Eocene Hancock Mammal Quarry Local Fauna, Clarno Formation, John Day Basin, north-central Oregon. PaleoBios 26(3):19-34.

Wagner, Hugh M., E. Bruce Lander, Mark A. Roeder, Donald R. Prothero, and George E. McDaniel, Jr.. 2007. A new Irvingtonian land mammal assemblage from the Saugus Formation, Moorpark, Ventura County, California. Bulletin of the Southern California Academy of Sciences 106(2):141.

Lander, E.B. 2008. Early Clarendonian (late middle Miocene) fossil land mammal assemblages from the Lake Mathews Formation, Riverside County, southern California; and a preliminary review of *Merychyus* (Mammalia, Artiodactyla, Oreodontidae). In X. Wang and L.G. Barnes (eds.). Geology and Vertebrate Paleontology of Western and Southern North America. Natural History Museum of Los Angeles County Science Series 41.181-212.

Calvano, G., D. R. Prothero, J. A. Ludtke, and E. B. Lander. 2008. Magnetic stratigraphy of the Eocene to Miocene Sespe-Vaqueros Formations, Los Angeles and Orange Counties, California; in X. Wang and L. G. Barnes (eds.), Geology and Vertebrate Paleontology of Western and Southern North America. Natural History Museum of Los Angeles County Science Series 41:43-61.

Morgan, G.S., E.B. Lander, D.W. Love, R.M. Chamberlin, and C. Cikoski. 2009a. A skull and partial skeleton of the oreodont *Merychyus major* (Mammalia: Artiodactyla: Merycoidontidae [*sic*]) from the Miocene Popotosa Formation, Bosque del Apache National Wildlife Refuge, Socorro County, New Mexico. Pp. 22-23 in New Mexico Geological Society Proceedings Volume, 2009 Annual Spring Meeting.

Morgan, G.S., E.B. Lander, D.W. Love, R.M. Chamberlin, and C. Cikoski. 2009b. A skull and partial skeleton of the oreodont *Merychyus major* (Mammalia: Artiodactyla: Oreodontidae) from the Miocene Popotosa Formation, Bosque del Apache National Wildlife Refuge, Socorro County, New Mexico. New Mexico Geology 31(2):48.

Morgan, G.S., E.B. Lander, C. Cikoski, R.M. Chamberlin, D.W. Love, and L. Peters. 2009. The oreodont *Merychyus major major* (Mammalia: Artiodactyla: Oreodontidae) from the Miocene Popotosa Formation, Bosque del Apache National Wildlife Refuge, Socorro County, central New Mexico. New Mexico Geology 31:91-103.

Wang, X., R.M. Hunt Jr., R.H. Tedford, and E.B. Lander. 2009. First record of immigrant *Phoberogale* (Mammalia, Ursidae, Carnivora) from southern California. In S. Peigné and G. Merceron (eds.). Louis de Bonis: 50 ans de recherches paléontologiques sur les mammifères. Geodiversitas 31(4):753-774.

Wernicke, B.P., Raub, T.D., Grover, J.A., and Lander, E.B. 2010. Possible clasts of Shinumo Quartzite (eastern Grand Canyon) in lower Miocene conglomerates of the Sespe Formation (coastal southern California), and implications for the uplift and erosion of the southwestern U.S. Geological Society of America Abstracts with Programs 42(5):185.

Lander, E.B., and E.H. Lindsay. 2011. *Merychyus calaminthus* (Mammalia, Artiodactyla, Oreodontidae) of probable early late Arikareean (late Oligocene to late early Miocene) age from the lower part of the Chalk Canyon Formation, Maricopa and Yavapai counties, central Arizona. Journal of Vertebrate Paleontology 31(1): 215-226.

Lander, E.B. 2011. A preliminary systematic review of the mammalian order Artiodactyla—The implications of geographic separation on phylogeny and convergent evolution. P. 7. *In* WAVP (Western Association of Vertebrates Paleontologists) 2011 Meeting Abstracts. Natural History Museum of Los Angeles County.

Lander, E.B. 2011. Western Association of Vertebrate Paleontologists 2011 annual meeting field trip guidebook and road log—Stratigraphy, biostratigraphy, biochronology, geochronology, magnetostratigraphy, and plate tectonic history of the early middle Eocene to late early Miocene Sespe, Vaqueros, and Lower Topanga Formation, east-central Santa Monica Mountains, Los Angeles County, southern California. *In* Lander, E.B. (compiler). Western Association of Vertebrate Paleontologists 2011 annual meeting field trip volume and guidebook—Stratigraphy, biostratigraphy, biochronology, geochronology, magnetostratigraphy, and plate tectonic history of the early middle Eocene to late early Miocene Sespe, Vaqueros, and Lower Topanga Formation, east-central Santa Monica Mountains, Los Angeles County, southern California. Natural History Museum of Los Angeles County Department of Vertebrate Paleontology and Paleo Environmental Associates, Inc.

Lander, E.B. (compiler). Western Association of Vertebrate Paleontologists 2011 annual meeting field trip volume and guidebook—Stratigraphy, biostratigraphy, biochronology, geochronology, magnetostratigraphy, and plate tectonic history of the early middle Eocene to late early Miocene Sespe, Vaqueros, and Lower Topanga Formation, east-central Santa Monica Mountains, Los Angeles County, southern California. Natural History Museum of Los Angeles County Department of Vertebrate Paleontology and Paleo Environmental Associates, Inc.

Wagner, H.M., L.H. Fisk, E.B. Lander, D.M. Haasl, and D.F. Maloney. 2011 Fossils salvaged from the late Miocene Orinda Formation during excavation of the Caldecott Tunnel 4th Bore, Contra Costa County, central California. P. 30 *in* L.H. Fisk and D.J. Lowenthal (eds.). CalPaleo 2011 abstracts with program. Sierra College, Rocklin, CA.

Wernicke, B., Raub, T.D., Lander, E.B., and Grover, J.A. 2012. Testing the Arizona River hypothesis: Detrital zircon spectra from orthoquartzite clasts in mid-Tertiary Sespe Formation of coastal southern California. Geological Society of America Abstracts with Programs 44(6):80.

Lander, E.B. 2012. Preliminary systematic overview of Agriochoeridae (Mammalia, Artiodactyla, Tylopoda, Oreodontoidea). Calpaleo 2012, April 14th, 2012, University of California, Riverside [abstracts and program]. University of California, Riverside, Department of Earth Sciences, p. 11.

Lander, E.B. 2013. Global warming and fluctuating adult body size in the oreodont *Brachycrus* (Mammalia, Artiodactyla, Oreodondontdae [*sic*]) during the Middle Miocene Climatic Optimum. Pp. 49–67. In Reynolds, R.E. (ed.). Raising questions in the central Mojave Desert. California State University Desert Studies Center 2013 Desert Symposium.

Reports

Lander, E.B., 1980, Paleontologic report on MAPCO pipeline: prepared for Woodward-Clyde Consultants and U.S. Bureau of Land Management.

Rowe, T., Knudson, R., Perman, R.C., and Lander, E.B., 1982, Paleontology, in U.S. Bureau of Land Management, Public Service Company of New Mexico's New Mexico Generating Station Environmental Impact Statement: Woodward-Clyde Consultants.

Lander, E.B., 1982, Summary of the geology of the Nigerian continental margin: prepared for MESA^2, Inc., and Nigerian Institute for Oceanography and Marine Research.

___, 1983, Bedrock geology of the shelf between Point Conception and Point Arguello, California (micropaleontology and lithologic descriptions of samples collected from Neogene units): MESA2, Inc.; prepared for Texaco, Inc.

___, 1983, Stratigraphy, in MESA2, Inc., Regional geology of the central offshore Santa Maria Basin from Point Arguello to Point San Luis, California.

___, 1983, Paleontologic resources assessment of the Sacramento Municipal Utility District's Geothermal Public Power Line Project, California: MESA2, Inc.; prepared for Wirth Environmental Services.

___, 1984, Paleontologic resources assessment of the Sacramento Utility District's Geothermal Public Power Line Project, California Supplement MESA2, Inc.; prepared for Wirth Environmental Services/Dames & Moore.

___, and Meyer, H.W., 1984, Paleontologic resources assessment of the Sacramento Utility District's Geothermal Public Power Line Project, California—Second supplement: MESA, Inc.; prepared for Wirth Environmental Services/Dames & Moore.

___, and C.M. Woods, 1984, Paleontological resources, pp. 23-25, in Woods, C.M., Cleland, J.H., Fredrickson, D.A., Lander, E.B., Meyer, H.W., Patterson, S., Quinn, J.P., and Smith, J.C., Geothermal Public Power Line Project collector system addendum to the cultural resources technical reports - archaeological resources, ethnographic resources, historical resources, paleontological resources: prepared for Wirth Environmental Services/Dames & Moore.

Gulliver, R., and Lander, E.B., 1984, Geologic hazards and geotechnical assessment of the Southern California Continental Borderland: MESA, Inc.; prepared for ARCO Oil and Gas Company.

Lander, E.B., 1984, in Cooper, J.D., Preliminary report on fossil remains from area of ARCO Coal Oil Point Project, Santa Barbara County, California: prepared for Chambers Consultants and Planners.
Lander, E.B., 1985, Geothermal Public Power Line Project paleontologic resources, Cache Formation—Results of second field survey: MESA2, Inc.; prepared for Wirth Environmental Services/Dames & Moore.

___, 1985, Paleontology, in U.S. Bureau of Land Management and Los Angeles Harbor Department, Proposed Pacific Texas Pipeline Project EIR/EIS: Engineering-Science, Inc.

___, 1985, Geothermal Public Power Line Project final paleontologic resource assessment of Mesozoic and Tertiary marine units, Williams North Route, California: MESA2, Inc.; prepared for Wirth Environmental Services/Dames & Moore.

___, 1985, Paleontologic resource investigation, proposed Pacific Texas Pipeline Project: U.S. Bureau of Land Management and Los Angeles Harbor Department; prepared by Engineering-Science, Inc.

___, and Woods, C.M., 1985, Paleontologic Resources, in Wirth Environmental Services/Dames & Moore, GPPL Project AFC technical reports.

___, and Alderson, J.M., 1985, Preliminary Paleontologic Resources Assessment, Victory Cogeneration Project, Kern County, California; prepared for Wirth Environmental Services/Dames & Moore.

Lander, E.B., 1985, Paleontology, in Sun Cogeneration Company and Southern Sierra Energy Company, Application for Certification, Midway-Sunset Cogeneration Project: Dames and Moore; prepared for California Energy Commission.

___, 1985, Paleontologic resource investigation, Argus Cogeneration Expansion (ACE) Project, Inyo and San Bernardino Counties, California: prepared for Dames and Moore.

___, 1985, Results of paleontologic resources preconstruction field survey, ACE Project, San Bernardino and Inyo Counties, California: prepared for Dames and Moore.

___, and Alderson, J.M., 1985, Paleontologic resource investigation for the proposed Mead/McCullough-Victorville/Adelanto Transmission Project, San Bernardino County, California, and Clark County, Nevada: Dames & Moore; prepared for U.S. Bureau of Land Management, Riverside District, and Los Angeles Department of Water and Power.

___, 1986, Summary of paleontologic resource investigation, Mead/McCullough-Victorville/Adelanto Transmission Project, San Bernardino County, California, and Clark County, Nevada, in U.S. Bureau of Land Management and Los Angeles Department of Water and Power, Mead/ McCullough-Victorville/Adelanto Transmission Project Final Environmental Report: Dames & Moore.

___, 1986, Paleontological resources, in Kerr-McGee Chemical Corporation, Application for Certification, Argus Cogeneration Expansion Project: Dames & Moore; prepared for California Energy Commission.

Lander, E.B., 1986, Paleontologic resource assessment of the Coastal Service Corporation's Cojo Supply Base, Point Conception, Santa Barbara County, California: Engineering-Science, Inc.; prepared for Coastal Service Corporation.

___, 1986, Paleontologic resources, in Federal Aviation Administration and U.S. Bureau of Land Management, Aerial tramway transportation system to and from the Mount Lewis Air Route Surveillance Site: Engineering-Science, Inc.

___, 1986, Paleontologic resource assessment overview, Simi Valley, California: Engineering-Science, Inc.; prepared for Cotton/Beland/Associates, Inc.

Morales, M.A., Lander, E.B., and Irby, G.V., 1986, Paleontological resources, in California State Lands Commission and Federal Energy Regulatory Commission, Proposed Mojave-Kern River-El Dorado Natural Gas Pipeline Projects EIR/EIS: Chambers Group.

___, 1986, Paleontologic resources technical report, Mojave-Kern River-El Dorado Natural Gas Pipeline Projects EIR/EIS: California State Lands Commission and Federal Energy Regulatory Commission; Chambers Group.

Lander, E.B., 1986, Paleontology, in Engineering-Science, Inc., Environmental Impact Report, Baldwin Hills Stocker Street/Valley Ridge housing development: prepared for Los Angeles County Department of Regional Planning.

___, 1986, Paleontologic resources, in City of Los Angeles Municipal Auditorium Department, Los Angeles Convention Center Expansion Project EIR: Engineering-Science, Inc.

___, 1986, Paleontology, in Mobil Oil Corporation, San Ardo Cogeneration Project Application for Certification: Dames & Moore; prepared for California Energy Commission.

___, 1986, Paleontology, in Imperial Irrigation District, Environmental Impact Report for the water conservation program and initial water transfer for the Imperial Irrigation District: Engineering-Science, Inc.

___, 1986, Paleontology, in San Bernardino County Flood Control District and U.S. Bureau of Reclamation, San Sevaine Creek Water Project Environmental Assessment: Engineering-Science, Inc.

___, 1986, Paleontologic resource assessment of the Day Creek Water Project, San Bernardino County, California: Engineering-Science, Inc.; prepared for San Bernardino County Flood Control District.

___, 1986, Paleontologic resource assessment of the Southern California Edison Company's BiCEP Project, California: Engineering-Science, Inc.; prepared for Dames & Moore.

___, 1986, Paleontologic resource assessment, San Ardo Cogeneration Project, Monterey County, California: Engineering-Science, Inc., prepared for Dames & Moore.

___, 1986, Paleontologic resource assessment, San Ardo Cogeneration Project Northern Alternative Transmission Line Corridor, Monterey County, California: Engineering-Science, Inc.; prepared for Dames & Moore.

___, 1986, Paleontologic resource assessment, San Ardo Cogeneration Project Southern Alternative Transmission Line Corridor, Monterey and San Luis Obispo Counties, California: Engineering-Science, Inc.; prepared for Dames & Moore.

___, 1986, Paleontologic resources, in Silver Strand Marina Association, Inc., Proposed Ballona Lagoon Improvement Project: Engineering-Science, Inc.

___, 1986, Paleontology, in Geothermal Public Power Line cultural and paleontological resources technical report: Wirth Environmental Services/Dames & Moore.

___, 1987, Paleontologic resources, in U.S. Air Force, Environmental Assessment, Titan II Space Launch Vehicle Modifications and Launch Operations Program, Vandenberg Air Force Base, California: Engineering-Science, Inc.

___, 1987, Paleontologic resources, in Elsinore Valley Municipal Water District, Environmental Impact Report/Environmental Assessment, Proposed Elsinore Lake Management Project: Engineering-Science, Inc.

___, 1987, Paleontologic resources, in U.S. Forest Service and Los Angeles County Department of Public Works, Environmental Assessment, San Gabriel Debris Management Plan: Engineering-Science, Inc.

___, 1987, Paleontologic resources, in SCS Engineers, Simi Valley Landfill Expansion Environmental Impact Report: prepared for Ventura County Resource Management Agency and Waste Management of North America, Inc.

___, 1987, Paleontologic resource technical report, proposed Simi Valley Landfill Expansion Project, Ventura County, California: Engineering-Science, Inc.; prepared for SCS Engineers, Ventura County Resource Management Agency, and Waste Management of North America, Inc.

___, 1987, Paleontologic resources technical report, Phases I and II, Tentative Tract 3302, City of Simi Valley, California: Engineering-Science, Inc.: prepared for Unocal Land & Development Company.

___, 1987, Paleontologic resource assessment, proposed Seven Oaks Dam Reservoir, San Bernardino Mountains, California, pp. 119-127 in Arnold, J.E., Duffield, A.Q., Greenwood, R.S., Hampson, R.P., and Van Bueren, T.M., Archaeological resources of the Seven Oaks Dam Project, Upper Santa Ana River locality: Greenwood and Associates, and Infotec Research Incorporated; prepared for U.S. Army Corps of Engineers, Los Angeles District.

___, 1987, Paleontologic resource assessment, Tract 13,469, East Highlands Ranch, San Bernardino County, California: Engineering-Science, Inc.; prepared for Mobil Land Development (California) Corporation/East Highlands Ranch, Inc.

___, 1987, Paleontologic resource assessment, proposed Simi Valley regional shopping center site, City of Simi Valley, California: Engineering-Science, Inc.; prepared for Planning Consultants Research.

___, 1987, Paleontologic Resources, in City of Los Angeles Planning Department and U.S. Army Corps of Engineers, Silver Strand Marina Association proposed Ballona Lagoon Improvement Project EIR/EIS: Engineering-Science, Inc.

___, 1987, Paleontological resource assessment, Victor Valley Wastewater Treatment Plant expansion, San Bernardino County, California: Engineering-Science, Inc.; prepared for Victor Valley Wastewater Reclamation Authority.

___, 1987, Paleontology, in Victor Valley Wastewater Reclamation Authority, Environmental Assessment, Victor Valley Wastewater Treatment Plant expansion, San Bernardino County, California: Engineering-Science, Inc.

___, 1987, Paleontology, in City of Coronado, Circulation Strategy Feasibility Study and General Plan Master EIR: Engineering-Science, Inc.

___, 1987, Paleontologic resource technical report, area of proposed major modification, Conditional Use Permit 1367, City of Simi Valley, California: Engineering-Science, Inc.; prepared for John W. Newton & Associates.

___, 1987, Paleontologic resource technical report, Los Angeles Rail Rapid Transit Project (Metro Rail) core study area, candidate alignments 1 to 5: Engineering-Science, Inc.; prepared for U.S. Department of Transportation Urban Mass Transportation Administration and Southern California Rapid Transit District.

___, 1987, Paleontology, in U.S. Department of Transportation Urban Mass Transportation Administration and Southern California Rapid Transit District, Final Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report, Los Angeles Rail Rapid Transit Project, Metro Rail.

___, 1987, Summary report, Los Angeles Metro Rail Project, Seventh/Flower Station utility line relocation, paleontologic mitigation program: Engineering-Science, Inc.; prepared for Southern California Rapid Transit District.

___, 1987, Paleontology, in U.S. Air Force, Environmental Assessment, Upgrade of electrical generation and distribution system, Onizuka Air Force Base, California: Engineering-Science, Inc.

___, 1987, Paleontology, in U.S. Air Force, Environmental Assessment, Titan IV Launch Vehicle Modifications and Launch Operations Program, Vandenberg Air Force Base, California: Engineering-Science, Inc.

___, 1987, Paleontologic resource assessment, Solar Energy Generating System (SEGS VIII), Harper Lake Area, San Bernardino County, California: Engineering-Science, Inc.; prepared For ERT.

___, 1988, Paleontologic resource assessment, Solar Energy Generating System (SEGS III-VII), Kramer Junction Area, Kern and San Bernardino Counties, California: Engineering-Science, Inc.; prepared for ERT.

___, 1988, Paleontologic resource technical report, Foothill Transportation Corridor, Orange and San Diego Counties, California: Engineering-Science, Inc.; prepared for Michael Brandman Associates.

___, 1988, Supplemental paleontologic resource technical report, Foothill Transportation Corridor (Northern and Central Segments), Orange and San Diego Counties, California: Engineering-Science, Inc.; prepared for Michael Brandman Associates.

___, 1988, Paleontologic resource assessment, North River Tract, Valencia, Los Angeles County, California: Engineering-Science, Inc.; prepared for Valencia Company, Sikand Engineering, and Los Angeles County Department of Regional Planning.

___, 1988, Paleontologic resources, in Los Angeles County Transportation Commission, Assessment of impacts of the Metro Rail Extension through the Northern Segment of the Santa Ana Corridor: Engineering-Science, Inc.

___, 1988, Paleontologic resource assessment overview, southern Ventura County, California: Engineering-Science, Inc.; prepared for Ventura County Resource Management Agency, Planning Division.

___, 1988, Paleontologic resources, in Calmark Commercial Development, Inc., Pacific Basin Plaza EIR: Engineering-Science, Inc.; prepared for Los Angeles Community Redevelopment Agency.

___, 1988, Paleontologic resource assessment, Batiquitos Lagoon Enhancement Project, San Diego County, California: Engineering-Science, Inc.; prepared for CH2M Hill.

___, 1988, Paleontologic Resources, in Los Angeles County Department of Public Works Planning Division, Environmental Impact Report, Malibu area wastewater management facilities: Ultrasystems, Inc., and Engineering-Science, Inc.

___, 1988, Paleontologic resource assessment, Solar Energy Generating System (SEGS VIII-XII), Harper Lake area, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 88-2; prepared for ERT.

___, 1988, Paleontologic resource assessment, Abalone Cove Landslide Stabilization Project, Palos Verdes Hills, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 88-3; prepared for Envirosphere Company.

___, 1988, Paleontologic resource assessment, City of Palmdale Vesting Tentative Tract 46391, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 88-4; prepared for EIP Associates and City of Palmdale Planning Department.

___, 1988, Paleontologic resource assessment, proposed Weldon Canyon Landfill site, Ventura County, California: Paleo Environmental Associates, Inc., project EBL 88-5; prepared for Brown and Caldwell, Ventura County Resource Management Agency, and Waste Management of California, Inc.

___, 1988, Paleontologic resource assessment for the southern part of the West End Community Development Area, City of Simi Valley, Ventura County, California: Paleo Environmental Associates, Inc., project EBL 88-6; prepared for McClelland Engineers, Inc., and City of Simi Valley Department of Community Development.

___, 1988, Paleontologic resource assessment, proposed Marsh Canyon Landfill site, Contra Costa County, California: Paleo Environmental Associates, Inc., project EBL 88-7; prepared for Golder Associates, Inc., and Waste Management of California, Inc.

___, 1988, Paleontologic resource assessment, Tentative Tracts 44857 and 44880, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 88-8, prepared for Planning Consultants Research, Howard Hughes Properties/Summa Corporation, and City of Los Angeles.

___, 1989, Paleontologic Resources in City of Palmdale Planning Department, City of Palmdale Vesting Tentative Tract 46391 and Zone Change Environmental Impact Report: EIP Associates; prepared for The Hammond Company.

___, 1989, Paleontologic resources, in Los Angeles County Department of Public Works, Environmental Impact Report, Abalone Cove Landslide Stabilization Project: Envirosphere Company.

___, 1989, Paleontologic resources, in South Coast Air Quality Management District Planning Division, Final Environmental Impact Report, Shell Oil Company Sulfur Reduction Project, Wilmington Manufacturing Complex, California: Engineering-Science, Inc.; prepared for Shell Oil Company.

___, 1989, Simi Valley Landfill interim paleontologic mitigation program final report: Paleo Environmental Associates, Inc., project EBL 89-3; prepared for Waste Management of California, Inc.

___, 1989, Paleontologic resource technical report, Eastern Transportation Corridor, northern Santa Ana Mountains, Orange County, California: Paleo Environmental Associates, Inc., project EBL 89-4; prepared for P & D Technologies, Inc.

___, 1989, Preliminary paleontologic resource assessment for the MWD feasibility study of a groundwater recharge basin in the Moorpark area, Ventura County, California: Paleo Environmental Associates, Inc., project EBL 89-6; prepared for McClelland Consultants (West), Inc., and Metropolitan Water District of Southern California.

___, 1989, Interim paleontologic resource technical report, Eastside Reservoir Project study--Phase 1, Riverside County, California, Paleo Environmental Associates, Inc., project EBL 89-7; prepared for Metropolitan Water District of Southern California.

___, 1989, Paleontologic resource assessment, Luz Solar Energy Generating System, Harper Lake area, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 89-8; prepared for Luz International Limited.

___, 1990, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, first progress report for period September 21 to December 31, 1989: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1990, Paleontologic resource assessment technical report, Vesting Tentative Tract 46619, Santa Clarita, Los Angeles County, California: Paleo Environmental Associates, Inc., project HMW 90-1; prepared for Archaeological Resource Management Corporation and City of Santa Clarita Department of Community Development.

___, 1990, Paleontologic resources, in City of Los Angeles Department of City Planning, Proposed Community Plan Revision Program Master Environmental Impact Report for the Northeast Los Angeles Subregion: Engineering-Science, Inc.

___, 1990, Paleontologic resource assessment technical report, proposed Community Plan Revision Program, Northeast Los Angeles Subregion, Los Angeles, California: Engineering-Science, Inc.; prepared for City of Los Angeles Department of City Planning.

___, 1990, Paleontologic mitigation program final report, Los Angeles Metro Rail Project, 7th/Flower Station, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 88-1; prepared for Southern California Rapid Transit District.

___, 1990, Paleontologic mitigation program final report, Los Angeles Metro Rail Project, Civic Center Station, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 89-1, prepared for Southern California Rapid Transit District.

___, 1990, Paleontologic mitigation program final report, Los Angeles Metro Rail Project, Wilshire/Alvarado Station, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 89-5; prepared for Southern California Rapid Transit District.

___, 1990, Draft/Final Paleontologic resource technical report, Eastside Reservoir Project study--Phase 2, Riverside County, California: Paleo Environmental Associates, Inc., project EBL 89-7; prepared for Metropolitan Water District of Southern California.

___, 1990, Paleontologic resource assessment technical report, proposed Elsmere Canyon Landfill Project, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 89-12; prepared for HDR Engineering, Inc., and Los Angeles County Department of Regional Planning.

___, 1990, Paleontologic resource assessment technical report, proposed Geotechnical Drilling Program, U.S. Forest Service property, Elsmere Canyon Landfill Project site, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 89-12; prepared for HDR Engineering, Inc., and U.S. Forest Service.

___, 1990, Paleontologic resource assessment technical report, proposed Owl Rock Products Star Quarry expansion, Orange County, California: Paleo Environmental Associates, Inc., project EBL 89-13; prepared for Owl Rock Products Co. and County of Orange Environmental Management Agency.

___, 1990, Paleontologic resource assessment technical report, proposed Sierra Rancho Estates, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project 90-1; prepared for The Janes Companies and City of Palmdale Planning Department.

___, 1990, Paleontologic resource assessment technical report, City Ranch Specific Plan area, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-3; prepared for Envicom Corporation and City of Palmdale Planning Department.

___, 1990, Paleontologic resource assessment, revised Playa Vista Plan, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 90-5; prepared for City of Los Angeles Department of City Planning, Planning Consultants Research, and Maguire Thomas Partners.

___, 1990, Paleontologic resource assessment, Hammond Canyon Landfill site, Ventura County, California: Paleo Environmental Associates, Inc., project EBL 90-7; prepared for Brown and Caldwell, and Ventura County Resource Management Agency.

___, 1990, Draft paleontologic resource technical report, Metropolitan Water District of Southern California Inland Feeder Project, San Bernardino and Riverside Counties, California: Paleo Environmental Associates, Inc., project EBL 90-8; prepared for P&D Technologies, Greenwood and Associates, and Metropolitan Water District of Southern California.

___, 1990, Supplement to Paleontologic resource assessment, Luz Solar Energy Generating System, Harper Lake area, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 90-9; prepared for Luz

International Limited, and California Energy Commission.

___, 1990, Paleontologic resource assessment, Ladera Heights Housing Tract Initial Study, Baldwin Hills, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-10; prepared for David E. Moss & Associates.

___, 1990, Paleontologic resource assessment, National Park Service proposed land exchange, Cheeseboro Canyon/Palo Comado Canyon, Santa Monica Mountains National Recreation Area, Los Angeles and Ventura Counties, California: Paleo Environmental Associates, Inc., project EBL 90-11; prepared for Envicom Corporation and National Park Service Santa Monica Mountains National Recreation Area.

___, 1990, Paleontologic resource assessment, Palmdale Trade and Commerce Center Specific Plan area, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-12; prepared for Rothbart Development Company and City of Palmdale Planning Department.

___, 1990, Paleontologic resource assessment, proposed 18.01-acre development, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-13; prepared for Antelope Valley Engineering, Inc., and City of Palmdale Planning Department.

___, 1990, Paleontologic resource assessment, proposed First Assembly of God Church Site, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-14; prepared for Palmdale First Assembly of God Church and City of Palmdale Planning Department.

___, 1990, Paleontologic resource assessment, Vesting Tentative Tract 46900, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-15; prepared for Civic Engineering Corporation and City of Palmdale Planning Department.

___, 1990, Paleontological resources, in U.S. Department of the Interior/National Park Service, Draft Environmental Impact Statement, National Park Service proposed land exchange, Cheeseboro Canyon/Palo Comado Canyon, Santa Monica Mountains, Santa Monica Mountains National Recreation Area/California: Envicom Corporation.

___, 1990, Paleontologic resource assessment, Santa Fe Ranch Specific Plan area, Santa Clarita, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-16; prepared for Envicom Corporation and City of Santa Clarita Department of Community Development.

___, 1990, Paleontologic resource assessment, Palmdale Hospital Medical Center Conditional Use Permit application, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-17; prepared for American Medical Enterprises and Bobrow/Thomas and Associates.

___, 1990, Paleontologic resource assessment, Valencia Commerce Center Channelization Project, Valencia, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 90-18; prepared for Valencia Company and U.S. Army Corps of Engineers.

___, 1990, Paleontological resources, in Alameda County Planning Department, Draft Environmental Impact Report, Altamont Sanitary Landfill expansion, Alameda County, California: Bryan A. Stirrat & Associates.

___, 1990, Paleontologic resource assessment, Twentieth Century Fox Film Corporation Studio Renovation and Expansion Project, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 90-21; prepared for Planning Consultants Research, Twentieth Century Fox Film Corporation, and Los Angeles Department of City Planning.

___, 1990, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, second progress report for period January 1 to June 30, 1990: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1991, First progress report, paleontologic resource impact mitigation program, El Toro Materials Company quarry expansion, County of Orange tentative tract 47118, Orange County, California: Paleo Environmental Associates, Inc., project MAR 89-2; prepared for El Toro Materials Company and Orange County Environmental Management Agency.

___, 1991, Paleontologic mitigation program final report, Los Angeles Metro Rail Project, 5th/Hill Station, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 89-2, prepared for Southern California

Rapid Transit District.

___, 1991, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, third progress report for period July 1 to December 31, 1990: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1991, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, fourth progress report for period January 1 to June 30, 1991: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1991, Paleontologic resource assessment in support of Ventura County Resource Management Agency Planning Division excavation permit for New Life Foundation basement: Paleo Environmental Associates, Inc., project EBL 91-1; prepared for Ventura County Resource Management Agency Planning Division and New Life Foundation.

___, 1991, Paleontologic resource inventory/assessment technical report, proposed Elsmere Canyon Landfill Project, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 91-3; prepared for Envicom Corporation and City of Santa Clarita.

___, 1991, Paleontologic resource assessment, Tentative Tract 47118, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 91-4; prepared for VTN West, Inc., and City of Palmdale Planning Department.

___, 1991, Paleontologic resource assessment, Vesting Tentative Tract 50616, Ladera Heights Housing Tract (Lot 2) Initial Study, Baldwin Hills, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 91-5; prepared for David E. Moss & Associates.

___, 1991, Paleontologic resource assessment, Fairfax Commerce Center, Tentative Tract 50594, Baldwin Hills, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 91-6; prepared for David E. Moss & Associates.

___, 1991, Paleontologic resource assessment, Vesting Tentative Tract 45218, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 91-7; prepared for Planning Consultants Research, Pardee Construction Company, and City of Palmdale Planning Department.

___, 1991, Paleontologic resource impact mitigation program final report, Sargent Canyon Cogeneration Project, Monterey County, California: Paleo Environmental Associates, Inc., project LAS 91-1; prepared for BioSystems Analysis, Inc., Sargent Canyon Cogeneration Company, and Monterey County Planning Department.

___, 1991, Draft Paleontologic resource technical appendix, Eastside Reservoir Project study--Phase 2, Riverside County, California, in Metropolitan Water District of Southern California, Eastside Reservoir Project Environmental Planning Technical Report.

___, 1991, Paleontologic resources, in Metropolitan Water District of Southern California, Eastside Reservoir Project Final Environmental Impact Report.

Spencer, L.A., and Lander, E.B., 1991, Preliminary evaluation of paleontologic resource management programs: Mojave and Kern River natural gas pipelines: Paleo Environmental Associates, Inc., project LAS 91-5; prepared for Chambers Group, Inc., Mojave Pipeline Company, Kern River Gas Transmission Company, California State Lands Commission, and Federal Energy Regulatory Commission.

Lander, E.B., 1991, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, fourth progress report for period January 1 to June 30, 1991: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1991, Paleontologic resource assessment in support of initial study for proposed 160-acre quarry site, Ventura County: Paleo Environmental Associates, Inc., project EBL 91-11; prepared for Hawks & Associates, Ventura County Resource Management Agency Planning Division.

Spencer, L.A., Lander, E.., Schorn, H.E., 1991, Paleontologic resource assessment/impact mitigation plan, PGT-PG&E Pipeline Expansion Project, Volume II, PG&E section, California: Paleo Environmental Associates, Inc., project LAS 91-2; prepared for Pacific Gas and Electric Company, Pacific Gas Transmission Company, California Public Utilities Commission, and Federal Energy Regulatory Commission.

Lander, E.B., 1992, Paleontologic resource assessment, West Bluffs site, Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 91-9; prepared for Planning Consultants Research, Howard Hughes Properties/Summa Corporation, and City of Los Angeles.

___, 1992, Preliminary paleontologic evaluation, proposed multiple family development, 960 Elkland Place, Venice, City of Los Angeles, California: Paleo Environmental Associates, Inc., project EBL 92-1; prepared for Planning Consultants Research.

___, 1992, Paleontologic resource evaluation, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-4; prepared for The KML Group and City of Palmdale Planning Department.

___, 1992, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, fifth progress report for period July 1 to December 31, 1991: Paleo Environmental Associates, Inc., project EBL 89-9; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1992, Simi Valley Landfill paleontologic resource impact mitigation program expansion phase, sixth progress report for period January 1 to June 30, 1992: Paleo Environmental Associates, Inc., project EBL 91-10; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1992, Preliminary paleontologic resource assessment, Continental Communities parcel, Vesting Tentative Tract Map No. 49159, Calabasas, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 92-2; prepared for Continental Communities, Inc., Engineering Service Corporation, and City of Calabasas.

___, 1992, Paleontologic resource assessment, proposed Puente Hills Landfill expansion, Los Angeles County, California: Paleo Environmental Associates, Inc., project EBL 92-3; prepared for Michael Brandman Associates and County Sanitation Districts of Los Angeles County, Solid Waste Management Department.

___, 1992, Paleontologic resource evaluation, Tentative Tract 46321, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-5; prepared for Anden Homes and City of Palmdale Planning Department.

___, 1992, Paleontologic resource evaluation, Tentative Tract 46757, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-6; prepared for West Venture Development Company and City of Palmdale Planning Department.

___, 1992, Paleontologic Resource Impact Mitigation Program Final Report of Findings for Meridian Oil Inc. 16-Inch Natural Gas Pipeline, Cool Water Generating Station, Daggett, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 92-7; prepared for Southern California Edison Company Environmental Affairs Division.

___, 1992, Paleontologic resource evaluation for parcel delineated in Los Angeles County Assessor's map book 3024, page 6, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-8; prepared for Crestview Development Partners and City of Palmdale Planning Department.

___, 1992, Paleontologic resource evaluation for parcels delineated in Los Angeles County Assessor's map book 3024, pages 7 and 13, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-9; prepared for The KML Group and City of Palmdale Planning Department.

___, 1992, Paleontologic resource evaluation for Tract 48034, Eastside General Plan Amendment, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 92-10; prepared for Cumorah Investments and City of Palmdale Planning Department.

___, 1992, Paleontologic resource assessment technical report, Pacific Pipeline Project, Santa Barbara, Ventura, and Los Angeles Counties, California: Paleo Environmental Associates, Inc., project EBL 92-11; prepared for Environmental Science Associates, Inc., California Public Utilities Commission, and Pacific Pipeline System, Inc.

___, 1992, Paleontologic resource assessment, City of Palmdale Tentative Tract 50871: Paleo Environmental

Associates, Inc., project EBL 92-12; prepared for Inco Development Company and City of Palmdale Planning Department.

___, 1992, Paleontologic resource assessment, Rancho Simi Recreation and Park District Handicapped Accessibility Project for Santa Susana Railroad Depot, Ventura County, California: Paleo Environmental Associates, Inc., project EBL 92-14; prepared for Ventura County Resource Management Agency Planning Division.

___, 1992, Paleontologic resource assessment, proposed Green River Golf Course Expansion Project, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 92-15; prepared for The Keith Companies.

___, 1992, Paleontologic resource assessment, proposed Molycorp, Inc., Mountain Pass Mine expansion, Mountain Pass, San Bernardino County, California: Paleo Environmental Associates, Inc., project EBL 92-16; prepared for U.S. Bureau of Land Management, San Bernardino County Land Management Department, and ENSR Consulting and Engineering.

___, 1992, Paleontologic resource assessment, proposed Sycamore Cogeneration Company Sycamore-Dexzel natural gas pipeline, Oildale, Kern County, California: Paleo Environmental Associates, Inc., project EBL 92-18; prepared for California Energy Commission, Sycamore Cogeneration Company, and BioSystems Analysis, Inc.

___, 1993, Simi Valley Landfill and Recycling Center paleontologic resource impact mitigation program expansion phase, seventh progress report for period July 1 to December 31, 1992: Paleo Environmental Associates, Inc., project EBL 91-10; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1993, Paleontologic resources, in ENSR Consulting and Engineering, Molycorp Mountain Pass Mine expansion EIR/EIS: prepared for U.S. Bureau of Land Management and San Bernardino County Land Management Department.

___, 1993, Paleontologic resource assessment, City of Costa Mesa tentative tract 14546: Paleo Environmental Associates, Inc., project EBL 93-1; prepared for City of Costa Mesa and Neke Homes, Inc.

___, 1993, Paleontologic resource impact mitigation program final report, Los Angeles Metro Red Line Segment 2 Wilshire/Normandie Station (B-221), Los Angeles, California: Paleo Environmental Associates, Inc., project no. EBL 91-8; prepared for Los Angeles County Transportation Commission, U.S. Department of Transportation Federal Transit Administration, State of California, and Greenwood and Associates.

___, 1993, Paleontologic resource impact mitigation program final report, Los Angeles Metro Red Line Segment 2 Wilshire/Western Station (B-231), Los Angeles, California: Paleo Environmental Associates, Inc., project no. EBL 91-8; prepared for Los Angeles County Transportation Commission, U.S. Department of Transportation Federal Transit Administration, State of California, and Greenwood and Associates.

___, 1993, Paleontologic/cultural resource impact mitigation program final report, Midway Sunset Cogeneration Company Midway/Mojave natural gas pipeline, Kern County, California: Paleo Environmental Associates, Inc., project no. EBL 92-17; prepared for California Energy Commission and Midway Sunset Cogeneration Company.

___, 1993, Paleontologic resource impact mitigation program final report--Sycamore Cogeneration Company Sycamore-Dexzel natural gas pipeline, Oildale, Kern County, California: Paleo Environmental Associates, Inc., project no. EBL 92-19; prepared for California Energy Commission, Sycamore Cogeneration Company, and BioSystems Analysis, Inc.

___, 1993, Paleontologic resource impact mitigation program final report, Sargent Canyon Cogeneration Company storage tank foundation, Monterey County, California: Paleo Environmental Associates, Inc., project no. EBL 93-3; prepared for California Energy Commission, Sargent Canyon Cogeneration Company, and BioSystems Analysis, Inc.

___, 1993, Paleontologic resource assessment, Southern California Gas Company gas pipeline no. 6902 southern segment, Imperial County, California: Paleo Environmental Associates, Inc., project no. EBL 93-4; prepared for U.S. Bureau of Land Management, Southern California Gas Company, and LSA Associates, Inc.

___, 1993, Paleontologic resources, in P&D Technologies, Badger Avenue Bridge Replacement DEIR/EIS; Paleo Environmental Associates, Inc., project no. EBL 93-5; prepared for Worldport LA.

___, 1993, Paleontologic resources, in ENSR Consulting and Engineering, Unocal Reformulated Gasoline Project DEIR; Paleo Environmental Associates, Inc., project no. EBL 93-6; prepared for South Coast Air Quality Management District and Unocal.

___, 1993, Simi Valley Landfill and Recycling Center paleontologic resource impact mitigation program expansion phase, ninth progress report for period January 1 to July 31, 1993: Paleo Environmental Associates, Inc., project EBL 91-10; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1993, Paleontologic resource assessment, Southern California Gas Company gas pipeline no. 6900, Riverside County, California: Paleo Environmental Associates, Inc., project no. EBL 93-9; prepared for U.S. Bureau of Land Management, Southern California Gas Company, and P&D Technologies.

___, 1993, PGT-PG&E Pipeline Expansion Project paleontologic resource impact mitigation program first annual progress report for period March 14 to December 31, 1992: Paleo Environmental Associates, Inc., project no. EBL 91-12; prepared for Federal Energy Regulatory Commission, California Public Utilities Commission, Pacific Gas Transmission Company, Pacific Gas and Electric Company, and Bechtel Corporation.

___, 1993, Paleontologic resources, in Alameda District Plan EIR: Cordoba Corporation; prepared for Catellus Development Corporation and Ratcovich-Villanueva Partnership.

___, 1993, Paleontologic resource evaluation, Vesting Tentative Tract 51505, Avenue P-8 at 20th Street West, Palmdale, California: Paleo Environmental Associates, Inc., project EBL 93-8; prepared for Epic Development Company One and City of Palmdale Planning Department.

___, 1993, Paleontologic resource inventory/impact assessment, Metropolitan Water District of Southern California headquarters site study: Paleo Environmental Associates, Inc., project EBL 93-11; prepared for Metropolitan Water District of Southern California and P&D Technologies, Inc.

___, 1994, Simi Valley Landfill and Recycling Center paleontologic resource impact mitigation program expansion phase, ninth progress report for period July 1 to December 31, 1993: Paleo Environmental Associates, Inc., project EBL 93-2; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1994, Results of initial paleontologic mitigation program, Tapo Rock & Sand Products Phase 1 (CUP-4609), Simi Valley, California, June to September 1994: Paleo Environmental Associates, Inc., project no. 94-1; prepared for Ventura County Resource Management Agency Planning Division and Tapo Rock & Sand Products.

___, 1994, Paleontologic resource assessment, Cellular One microcell excavation sites, Pacific Coast Highway, southeastern Ventura County, California: Paleo Environmental Associates, Inc., project 94-4; prepared for Cellular One and Ventura County Resource Management Agency Planning Division.

___, 1994, Paleontologic resource assessment, City of Simi Valley General Plan Amendment 18/Z-2-432, Ventura County, California: Paleo Environmental Associates, Inc., project no. EBL 94-5; prepared for City of Simi Valley Department of Community Development, and Environmental Science Associates, Inc.

___, 1994, Paleontologic resources, in U.S. Department of Transportation Federal Transit Administration and Los Angeles County Metropolitan Transportation Authority, Alternatives analysis/final environmental impact statement/final environmental impact report for the Los Angeles Eastside Corridor: Myra L. Frank and Associates.

___, 1994, Paleontologic resource impact mitigation program final report, Santiago Canyon Landfill southeast and southwest borrow, Orange County, California, July 1991 to April 1994: Paleo Environmental Associates, Inc., project no. MAR 91-1; prepared for Orange County Integrated Waste Management Department and Environmental Management Agency, and Chambers Group, Inc.

___, 1994, Paleontologic resource impact mitigation program final report, Foothill Ranch Planning Areas 3 and 4, Orange County, California: Paleo Environmental Associates, Inc., project no. MAR 92-3; prepared for Orange County Environmental Management Agency and Foothill Ranch Company.

___, 1994, Paleontologic resource impact mitigation program final report, Foothill Ranch Planning Area 6, Orange County, California: Paleo Environmental Associates, Inc., project no. MAR 93-1; prepared for Orange County Environmental Management Agency and Foothill Ranch Company.

___, 1994, Paleontologic resource impact mitigation program final report, Foothill Ranch Planning Area 15, Orange County, California: Paleo Environmental Associates, Inc., project no. MAR 93-2; prepared for Orange County Environmental Management Agency and Foothill Ranch Company.

___, 1994, Recovery of Pleistocene (Ice Age) fossil horse remains from alluvial fan deposits (older alluvium) in Vermont/Hollywood tunnel (B-251): Paleo Environmental Associates, Inc., project no. 94-6A; prepared for Los Angeles County Metropolitan Transportation Authority.

___, 1994, Recovery of additional Pleistocene (Ice Age) fossil horse remains from alluvial fan deposits (older alluvium) in Metro Red Line Vermont/Hollywood tunnel 1 (B-251): Paleo Environmental Associates, Inc., project no. 94-6A; prepared for Los Angeles County Metropolitan Transportation Authority.

___, 1994, Recovery of Pleistocene (Ice Age) fossil camel remains from alluvial fan deposits (older alluvium) in Metro Red Line Vermont/Hollywood tunnel 1 (B-251): Paleo Environmental Associates, Inc., project no. 94-6A; prepared for Los Angeles County Metropolitan Transportation Authority.

___, 1994, Paleontologic resource assessment, proposed Sycamore Ranch gravel quarry near Fillmore, Ventura County, California: Paleo Environmental Associates, Inc., project 94-8; prepared for Ventura County Resource Management Agency Planning Division and Southern Pacific Milling Company.

___, 1994, Evaluation of paleontologic characterization technical reports for Mojave northward expansion project: Paleo Environmental Associates, Inc., project 94-9; prepared for Ecology and Environment, Inc.

___, 1994, Paleontologic resources, in Ecology and Environment, Inc., Mojave Pipeline Northward Expansion Project Environmental Impact Report/Environmental Impact Statement: prepared for Federal Energy Regulatory Commission, California State Lands Commission, and Mojave Pipeline Company.

___, 1994, Paleontology, in Central Pool Augmentation and Water Quality Project Environmental Impact Report/Environmental Assessment: Paleo Environmental Associates, Inc., project 94-10; prepared for Metropolitan Water District of Southern California and Chambers Group, Inc.

___, 1994, Final report on paleontologic monitoring, Price Club site, Simi Valley, Ventura County, California: Paleo Environmental Associates, Inc., project no.94-15; prepared for City of Simi Valley and Kleinfelder, Inc.

___, 1994, Results of paleontologic resource field survey, Cellular One PCH microcell site #1 (CUP-4840) utility line right-of-way, Pacific Coast Highway, Point Mugu, Ventura County, California: Paleo Environmental Associates, Inc., project 94-19; prepared for Cellular One and Ventura County Resource Management Agency Planning Division.

___, 1994, Paleontologic resource assessment, 1.5-acre parcel, 3300 Palos Verdes Drive West, Rancho Palos Verdes, Los Angeles County, California: Paleo Environmental Associates, Inc., project 94-20; prepared for City of Rancho Palos Verdes, Burrell Design & Development, and Greenwood and Associates.

___, 1994, Paleontology, In County Sanitation Districts of Los Angeles County, Intermodal facility and waste-by-rail environmental impact report: Cordoba Corporation.

___, 1994, Final report of findings, paleontologic resource impact mitigation program, Cellular One PCH microcell site #1 utility line right-of-way (CUP-4850), Pacific Coast Highway, Point Mugu, southeastern Ventura County, California: Paleo Environmental Associates, Inc., project 94-19; prepared for Cellular One and Ventura County Resource Management Agency Planning Division.

___, 1994, Paleontologic resource impact mitigation program final report, Glenn Ranch Road right-of-way, Orange County, California: Paleo Environmental Associates, Inc., project no. 94-13; prepared for Orange County Environmental Management Agency and Foothill Ranch Company.

___, 1994, Paleontologic resource assessment, Owl Rock Products Sand Mining Project, Riverside County, California: Paleo Environmental Associates, Inc., project 94-21; prepared for Riverside County Planning Department and Owl Rock Products.

___, 1994, Paleontologic monitoring program (second phase), Foothill Ranch Planning area 15, supplemental final report: Paleo Environmental Associates, Inc., project no. 94-11; prepared for Orange County Environmental Management Agency and Foothill Ranch Company.

___, 1995, Paleontologic resource impact mitigation program interim report, Puente Hills Landfill expansion, Los

Angeles County, California: Paleo Environmental Associates, Inc., project 94-17; prepared for County Sanitation Districts of Los Angeles County Solid Waste Management Department.

___, 1995, Eastern Transportation Corridor paleontologic resource impact mitigation program and procedures: Paleo Environmental Associates, Inc., project 94-23; prepared for Foothill/Eastern Transportation Corridor Agency and Raytheon Infrastructure Services, Inc.

___, 1995, Paleontologic resources, in Christopher A. Joseph & Associates, Kaiser Permanente Los Angeles Medical Center EIR: prepared for City of Los Angeles and Kaiser Permanente.

___, and Whistler, D.P., 1995, Preliminary technical report of findings, paleontologic resource impact mitigation program, PGA West Tom Weiskopf Signature Course, La Qunita, Riverside County, California--results of paleontologic testing of two trenches: Paleo Environmental Associates, Inc., project no. 95-3; prepared for City of La Quinta Community Development Department and KSL Recreation Corporation.

___, 1995, Paleontologic resource impact mitigation program final report, PGA West Tom Weiskopf Signature Course, La Qunita, Riverside County, California: Paleo Environmental Associates, Inc., project no. 95-3; prepared for City of La Quinta Community Development Department and KSL Recreation Corporation.

Lander, E.B., 1996, Simi Valley Landfill and Recycling Center paleontologic resource impact mitigation program expansion phase, tenth progress report for period January 1, 1994, to December 31, 1995: Paleo Environmental Associates, Inc., project 94-3; prepared for Waste Management of California, Inc., Simi Valley Landfill, and Ventura County Resource Management Agency Planning Division.

___, 1996, Paleontologic resource inventory/impact assessment technical report prepared in support of Marine Corps Air Station El Toro Community Reuse Plan and Program Environmental Impact Report, Orange County, California: Paleo Environmental Associates, Inc., project 95-7; prepared for P&D Consultants, Inc.

___, 1996, Preliminary paleontologic resource assessment, MTA Crenshaw/Prairie corridor, Los Angeles County, California: Paleo Environmental Associates, Inc., project 96-4; prepared for DeLeuw, Cather & Company.

___, 1996, Final report of findings, paleontologic monitoring, Greystone Homes, Inc., parcel, Simi Valley, Ventura County, California: Paleo Environmental Associates, Inc., project 96-6; prepared for Greystone Homes, Inc.

___, 1996, Paleontologic resource inventory/impact assessment technical report prepared in support of The Villages of Madera, Madera County, California: Paleo Environmental Associates, Inc., project 96-7; prepared for Applied Earthworks, Inc.

___, 1996, Paleontologic resource inventory/impact assessment in support of proposed construction of BRJ ARCO AM/PM Mini-mart, Kramer Junction, San Bernardino County, California: Paleo Environmental Associates, Inc., project 96-13; prepared for BRJ, Inc.

___, 1996, Paleontologic resource inventory/impact assessment, UNOCAL service station #5961, Cajon Pass, San Bernardino County, California: Paleo Environmental Associates, Inc., project 96-8; prepared for 76 Products Company.

___, 1997, Final report on paleontologic monitoring, Prima Deshecha Sanitary Landfill Zone 1-Phase 1 Mass Excavation, Middle Ridge Excavation Area borrow site, Orange County, California. Paleo Environmental Associates, Inc., project 96-16. Prepared for County of Orange Integrated Waste Management Department and Chambers Group, Inc.

___, 1997, Final report on paleontologic construction monitoring in support of excavation associated with construction of BRJ ARCO AM/PM Mini-mart, Kramer Junction (Four Corners), San Bernardino County, California: Paleo Environmental Associates, Inc., project 96-17; prepared for BRJ, Inc.

___, 1996, Preliminary paleontologic resource baseline study in support of Lake Elsinore Storage Project, Riverside County, California: Paleo Environmental Associates, Inc., project 96-15; prepared for Ultrasystems Environmental, Inc.

___, 1996, Paleontologic resource/impact assessment in support of Price/Costco Retail Center, Culver City: Paleo Environmental Associates, Inc., project 96-18; prepared for Christopher A. Joseph and Associates.

___, 1997, Status report, paleontologic resource impact mitigation program conducted in support of Tapo Rock & Sand Products Phases 1 and 2 mining operations performed under CUP-4609, Simi Valley, Ventura County, California: Paleo Environmental Associates, Inc., project 94-1; prepared for Tapo Rock & Sand Products.

___, 1997, Paleontologic resource impact mitigation program second interim report, Puente Hills Landfill expansion, Los Angeles County, California: Paleo Environmental Associates, Inc., project 94-17; prepared for County Sanitation Districts of Los Angeles County Solid Waste Management Department.

Lander, E.B., 1997, Paleontologic resource impact mitigation program final report, Puente Hills Landfill expansion, Los Angeles County, California: Paleo Environmental Associates, Inc., project 94-17; prepared for County Sanitation Districts of Los Angeles County Solid Waste Management Department.

___, and Roeder, M.A., 1997, Hoag Hospital Cancer Center Lower Campus, Newport Beach, Orange County, California, paleontologic resource impact mitigation program final technical report of findings: Paleo Environmental Associates, Inc., project 95-8; prepared for Chambers Group, Inc., and Hoag Memorial Hospital Presbyterian.

Lander, E.B., 1997, The Metropolitan Water District of Southern California Headquarters Facility Project, Union Station, Los Angeles, California, paleontologic resource impact mitigation program final technical report of findings: Paleo Environmental Associates, Inc., project 96-3; prepared for Applied Earthworks, Inc., and The Metropolitan Water District of Southern California.

___, 1997, Paleontologic resource inventory/impact assessment, proposed 238-acre Oakmont residential development, Glendale, Los Angeles County, California: Paleo Environmental Associates, Inc., project 97-1; prepared for Rincon Consultants, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, Westport Homes parcel, Corona, Riverside County, California: Paleo Environmental Associates, Inc., project 97-2; prepared for L&L Environmental, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, Holliday Rock CUP 96-4 Quarry Expansion Project, Palmdale, Los Angeles County, California: Paleo Environmental Associates, Inc., project 97-4; prepared for L&L Environmental, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, Canyon Meadows parcel, Carbon Canyon, City of Chino Hills, San Bernardino County, California: Paleo Environmental Associates, Inc., project 97-6; prepared for Chambers Group, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, Forecast Homes parcel, French Valley, Riverside County, California: Paleo Environmental Associates, Inc., project 97-11; prepared for L&L Environmental, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, proposed tank site, Soboba Hot Springs, Riverside County, California: Paleo Environmental Associates, Inc., project 97-16; prepared for L&L Environmental, Inc.

___, 1997, Paleontologic resource inventory/impact assessment, Portuguese Bend Project, Rancho Palos Verdes, Los Angeles County, California: Paleo Environmental Associates, Inc., project 97-24; prepared for Chambers Group, Inc.

___, and Slawson, M.A., 1997, Report of findings, Class I and III historic architectural, archaeological, and paleontological surveys, Terminal Island Treatment Plant advance wastewater treatment facility Phase I distribution pipeline, Los Angeles harbor area, Los Angeles, California: Paleo Environmental Associates, Inc., project 97-28; prepared for City of Los Angeles Department of Public Works, Bureau of Engineering, Program Management Division.

Lander, E.B., 1997, Paleontologic resource inventory/impact assessment, Kaufmann and Broad of Southern California Mountain Gate parcel PA-3, Corona, Riverside County, California: Paleo Environmental Associates, Inc., project 97-30; prepared for L&L Environmental, Inc.

___, and Whistler, D.P., 1998, Paleontologic resource impact mitigation program final report, State Route 14 highway widening project, PM 42.0 to 46.2, immediately north of red Rock Canyon State Park, eastern Kern County, California: Paleo Environmental Associates, Inc., project 97-5; prepared for State of California Department of Transportation.

Lander, E.B., 1998, Paleontologic resource impact mitigation program final report, Chino Basin Municipal Water District Carbon Canyon Water Reclamation Project reclaimed water distribution system, Chino, San Bernardino County, California: Paleo Environmental Associates, Inc., project 97-7; prepared for prepared for L&L Environmental, Inc.

___, 1998, Simi Valley Landfill and Recycling Center landfill expansion, Ventura County, California, paleontologic resource impact mitigation program eleventh progress report for period January 1, 1996 to December 31, 1997: Paleo Environmental Associates, Inc., project 96-1; prepared for prepared for Waste Management of California, Inc., Simi Valley Landfill and Recycling Center, and Ventura County Resource Management Agency Planning Division.

___, 1998, Paleontologic resource impact mitigation program final report, Forecast Homes Group French Valley development, French Valley, Riverside County, California: Paleo Environmental Associates, Inc., project 97-11; prepared for prepared for L&L Environmental, Inc.

___, 1998, Paleontologic resource impact mitigation program final report, Mission Imports, Laguna Niguel, Orange County, California: Paleo Environmental Associates, Inc., project 97-20; prepared for prepared for L&L Environmental, Inc.

___, 1998, Paleontologic resource impact mitigation program final report, Alton Parkway extension, Orange County, California: Paleo Environmental Associates, Inc., project 97-23; prepared for prepared for Foothill Ranch Company.

___, 1998, Paleontologic resource inventory/impact assessment, LuxCore Studio development, Culver City, Los Angeles County, California: Paleo Environmental Associates, Inc., project 98-1; prepared for Rincon Consultants, Inc.

___, 1998, Paleontologic resource inventory/impact assessment, San Antonio Creek bridge, Los Angeles and San Bernardino Counties, California: Paleo Environmental Associates, Inc., project 98-3; prepared for Chambers Group, Inc.

___, 1998, Paleontologic resource inventory/impact assessment, Simi Valley Landfill and Recycling Center expansion, Simi Valley, Ventura County, California: Paleo Environmental Associates, Inc., project 98-4; prepared for TRC Environmental Solutions, Inc.

___, 1998, Paleontologic resource inventory/impact assessment, Chino Basin Municipal Water District regional wastewater treatment plant numbers 2 and 5, San Bernardino County, California: Paleo Environmental Associates, Inc., project 98-6; prepared for Albert A. Wood Associates.

Fisk, L.H., and Lander, E.B. 2001. Sutter Energy Center Project final paleontologic resource report on the results of the monitoring and mitigation program. Paleo Environmental Associates, Inc., project no. 99-4. Prepared for Calpine Corporation and California Energy Commission.

APPENDIX F

RESULTS OF PALEONTOLOGICAL RESOURCE ARCHIVAL SEARCHES

Natural History Museum
of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007

tel 213.763.DINO
www.nhm.org

Vertebrate Paleontology Section
Telephone: 213) 763-3325
FAX: 213 746-7431
e-mail: smc eo @nhm.org

5 September 2013

Paleo Environmental Associates
2248 Winrock Ave.
Altadena, CA 91001

Attn: Dr. E. Bruce Lander

re: Paleontological Resources Records Check for the proposed Desert Quartzite solar mirror Project, near the City of Blythe, Riverside County, project area

Dear Bruce:

I have thoroughly searched our paleontology collection records for the locality and specimen data for the proposed Desert Quartzite solar mirror Project, near the City of Blythe, Riverside County, project area as outlined on the portions of the Roosevelt Mine and Ripley USGS topographic quadrangle maps that you sent to me via e-mail on 26 August 2013. We do not have any vertebrate fossil localities that lie directly within the proposed project area, but we do have vertebrate fossil localities from sedimentary deposits similar to those that occur in the proposed project area, albeit at some distance.

In the far northwestern portion of the proposed project area there are some surface deposits of younger Quaternary aeolian sands. Otherwise the western portion of the proposed project area has surface deposits composed of younger Quaternary Alluvium, derived predominately as alluvial fan deposits from the McCoy Mountains to the north and northwest. These younger Quaternary deposits typically do not contain significant vertebrate fossils, at least in the uppermost layers and especially in the coarser fractions closer to the source material in the mountains. We do have a vertebrate fossil locality somewhat nearby from younger Quaternary deposits though, LACM 5977, to the west-northwest of the proposed project area between Interstate Highway 10 and Ford Dry Lake, so probably from fine-grained lacustrine deposits, that produced specimens of kangaroo rat, *Dipodomys*, and pocket mouse, *Perognathus*. Most of the proposed project area, the eastern nearly flat portion, has surface deposits of older Quaternary Alluvium, derived as alluvial deposits on the Palo Verde Mesa. Our closest vertebrate fossil localities from older Quaternary deposits, the Pinto Formation in this case, are LACM (CIT) 208 and LACM 3414, some distance to the northwest of the proposed project area between the Eagle Mountains and the Coxcomb Mountains, that produced fossil specimens of tortoise, *Gopherus*, horse, *Equus*, and camel, *Camelops* and *Tanupolama stevensi*.

Shallow excavations in the younger Quaternary aeolian and alluvial fan deposits exposed in the western portion of the proposed project area are unlikely to encounter significant vertebrate fossil remains. Deeper excavations in those areas that extend down into older Quaternary deposits, as well as any excavations in the older Quaternary deposits exposed in most of the proposed project area, however, may well uncover significant vertebrate fossils. Any substantial excavations in the sedimentary deposits in the proposed project area, therefore, should be monitored closely to quickly and professionally recover any fossil remains discovered while not impeding development. Any fossils recovered during mitigation should be deposited in an accredited and permanent scientific institution for the benefit of current and future generations.

This records search covers only the vertebrate paleontology records of the Natural History Museum of Los Angeles County. It is not intended to be a thorough paleontological survey of the proposed project area covering other institutional records, a literature survey, or any potential on-site survey.

Sincerely,

Samuel A. McLeod

Samuel A. McLeod, Ph.D.
Vertebrate Paleontology

enclosure: invoice

ACCREDITED by the AMERICAN ASSOCIATION OF MUSEUMS

SAN BERNARDINO COUNTY MUSEUM

2024 Orange Tree Lane ~ Redlands, California USA 92374-4560
(909) 798-8608 ~ Fax (909) 307-0539 www.sbcountymuseum.org

COUNTY OF SAN BERNARDINO

ROBERT L. McKERNAN
Director

6 September 2013

PaleoEnvironmental Associates, Inc.
attn: E. Bruce Lander, Ph.D.
2248 Winrock Avenue
Altadena, CA 91001

re: **PALEONTOLOGY LITERATURE AND RECORDS REVIEW, DESERT QUARTZITE SOLAR MIRROR PROJECT, RIVERSIDE COUNTY, CALIFORNIA**

Dear Dr. Lander,

The Division of Geological Sciences of the San Bernardino County Museum (SBCM) has completed a literature review and records search for the above-referenced development west of Blythe in Riverside County, California. The study area is located in portions of sections 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 22, 23, and 24, Township 7 South, Range 21 East, San Bernardino Base and Meridian, as seen on the Ripley, California (1952 edition, photorevised 1970) and the Roosevelt Mine, California (1983 provisional edition) 7.5' United States Geological Survey topographic quadrangle maps.

Geologic mapping by Jennings (1967) indicates that the proposed property is situated in part upon surficial Pleistocene nonmarine sediments (= unit **Qc**), particularly towards the southwestern part of the study area. To the north and east, these sediments are overlain by recent alluvium (= **Qal**) and dune sand (= **Qs**). The Pleistocene sediments may include both river gravels derived from the Colorado River and lake sediments of the Chemehuevi Formation, although these units were not differentiated by Jennings (1967). The Chemehuevi Formation and potentially the overlying river gravels have high potential to contain significant nonrenewable paleontologic resources subject to adverse impact by development-related excavation (Newberry, 1861; Longwell and others, 1965; Agenbroad and others, 1992). Similarly-mapped sediments in the Needles area (Bishop, 1963), for example, have yielded fossil remains of extinct mammoth (*Mammuthus* sp.). Additionally, Jefferson (1991) reported fossils (taxa not recorded) from Blythe (see below), as well as remains of extinct horse (*Equus* sp.) and camel (*Camelops* sp.) from the Needles area. These fossils were deposited during the Pleistocene Epoch, between approximately 2.6 million years ago and 11,000 years ago. Pleistocene sediments from throughout the eastern Mojave Desert have proven to be abundantly fossiliferous (Reynolds and Reynolds, 1992; Agenbroad and others, 1992; Scott and Cox, 2008).

For this report, I conducted a review of the Regional Paleontologic Locality Inventory (RPLI) at the SBCM. The results of this review indicate that no previously-known paleontologic resource localities are recorded by the SBCM from the site of the proposed solar mirror array, nor are any resource localities recorded from within several miles of the site. However, Jefferson (1991) listed one locality, UCMP V60004, from the Blythe area; unfortunately the precise location of this site and the nature of the fossils recovered were not discussed in that review.

Recommendations

The results of the literature review and the check of the RPLI at the SBCM demonstrate that excavation in conjunction with development is determined to have high potential to adversely impact significant nonrenewable paleontologic resources present within the boundaries of the proposed project property. A qualified vertebrate paleontologist must be retained to develop a program to mitigate impacts to such resources. This mitigation program should be consistent with the provisions of the California Environmental Quality Act (Scott and Springer, 2003), as well as with regulations currently implemented by the County of Riverside. This program should include, but not be limited to:

1. Monitoring of excavation in areas identified as likely to contain paleontologic resources by a qualified paleontologic monitor. Based upon the results of this review, areas of concern include any undisturbed surface or subsurface sediments of Pleistocene older alluvium. Paleontologic monitors should be equipped to salvage fossils as they are unearthed, to avoid construction delays, and to remove samples of sediments that are likely to contain the remains of small fossil invertebrates and vertebrates. Monitors must be empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens.

2. Preparation of recovered specimens to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates. Preparation and stabilization of all recovered fossils are essential in order to fully mitigate adverse impacts to the resources (Scott and others, 2004).

3. Identification and curation of specimens into an established, accredited museum repository with permanent retrievable paleontologic storage. These procedures are also essential steps in effective paleontologic mitigation (Scott and others, 2004) and CEQA compliance (Scott and Springer, 2003). The paleontologist must have a written repository agreement in hand prior to the initiation of mitigation activities. Mitigation of adverse impacts to significant paleontologic resources is not complete until such curation into an established museum repository has been fully completed and documented.

4. Preparation of a report of findings with an appended itemized inventory of specimens. It is recommended that this report incorporate the full results of this literature review. The report and inventory, when submitted to the appropriate Lead Agency along with confirmation of the curation of recovered specimens into an established, accredited museum repository, would signify completion of the program to mitigate impacts to paleontologic resources.

References

Agenbroad, L.D., J.I. Mead and R.E. Reynolds, 1992. Mammoths in the Colorado River Corridor. *In* J. Reynolds (ed.), Old routes to the Colorado. SBCM Association Special Publication 92-2, p. 104-106.

Bishop, C.C., 1963. Geologic map of California, Needles sheet, scale 1:250,000. California Division of Mines and Geology Regional Geologic Map Series.

Jefferson, G.T., 1991. A catalogue of late Quaternary vertebrates from California: Part Two, mammals. Natural History Museum of Los Angeles County Technical Reports, No. 7.

Jennings, C.W., 1967. Geologic map of California, Salton Sea sheet, 1:250,000. Division of Mines and Geology.

Longwell, C.R., E.H. Pampeyan, B. Bower and R.J. Roberts, 1965. Geology and mineral deposits of Clark County, Nevada. Nevada Bureau of Mines and Geology Bulletin 62. 218 p.

Newberry, J.S., 1861. Report upon the Colorado River of the West by J.C. Ives, Part III. Washington, D.C.: Government Printing Office.

Reynolds, S.F.B. and R.L. Reynolds, 1992. Pleistocene faunas in the Bristol-Danby trough. *In* J. Reynolds (ed.), Old routes to the Colorado. SBCM Association Special Publication 92-2, p. 83-86.

Scott, E. and S.M. Cox, 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) in the Mojave Desert of southern California and Nevada. *In* X. Wang and L.G. Barnes (eds.) Geology and Vertebrate Paleontology of Western and Southern North America, Contributions in Honor of David P. Whistler. Natural History Museum of Los Angeles County Science Series No. 41: 359 - 382.

Scott, E. and K. Springer, 2003. CEQA and fossil preservation in southern California. The Environmental Monitor, Fall 2003, p. 4-10, 17.

Scott, E., K. Springer and J.C. Sagebiel, 2004. Vertebrate paleontology in the Mojave Desert: the continuing importance of "follow-through" in preserving paleontologic resources. *In* M.W. Allen and J. Reed (eds.) The human journey and ancient life in California's deserts: Proceedings from the 2001 Millennium Conference. Ridgecrest: Maturango Museum Publication No. 15, p. 65-70.

Please do not hesitate to contact us with any further questions you may have.

Sincerely,

Eric Scott, Curator of Paleontology
Division of Geological Sciences
San Bernardino County Museum

X

Paleontological Survey of the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California

by Joseph J. El Adli

Prepared for
Jeffery Johnston, Geologist
United States Department of the Interior
Bureau of Land Management
Palm Springs–South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262

Technical Report 18-35
Statistical Research, Inc.
Redlands, California

Paleontological Survey of the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California

by Joseph J. El Adli

Prepared for
Jeffery Johnston, Geologist
United States Department of the Interior
Bureau of Land Management
Palm Springs–South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262

Technical Report 18-35
Statistical Research, Inc.
Redlands, California

September 2018

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Project: Desert Quartzite Solar Project, Bureau of Land Management (BLM) Project No. CACA 049397

Applicant: Desert Quartzite, LLC, A Wholly Owned Subsidiary of First Solar Development, Inc.

Agency: BLM, Renewable Energy Coordination Office, California Desert District

Permits: BLM Permit for Paleontological Investigations CA-18-01P, Fieldwork Authorization PFA-18-01

Project Location:

USGS 7.5-minute Quadrangle	Township/Range (BM)	Sections
Ripley, California	7 South/21 East (SBBM)	11–14, 23, 24
Roosevelt Mine, California	7 South/21 East (SBBM)	9–11, 14, 15, 22, 23

Key: BM = baseline and meridian; SBBM = San Bernardino Baseline and Meridian; USGS = United States Geological Survey.

Dates of Fieldwork: May14, 2018–June 1, 2018

Acreage of Direct Area of Potential Effects (APE): 4,969

Acreage of Indirect APE: 553

Total Acreage Surveyed: 5,522

Total Acreage Surveyed on Bureau of Land Management Land: 4,809; **Private Land:** 160

Results—Direct APE: In total, 37 fossil localities were recorded within the direct APE, including 31 vertebrate remains.

Results—Indirect APE: The indirect APE, defined as a 200-foot radius around the direct APE, included 1 locality containing vertebrate fossil remains.

Recommended Potential Fossil Yield Classification (PFYC) of Geologic Units within the APE: In total, 39 fossil localities were discovered within the project area (37 on public lands and 2 on private lands). Fossils discovered from these sites represent at least 5 taxa: tortoise, jackrabbit, horse, mammoth, and seed plant. Thirty-two fossil localities produced vertebrate remains, whereas 7 included petrified-wood fossils. Fossil tortoise remains were found nearly exclusively in the old terrace deposits, whereas petrified-wood fossils were more abundant in the stabilized alluvial deposits.

Geologic units within the project area were ranked based on paleontological resource potential using the PFYC and Society of Vertebrate Paleontology (SVP) classification systems. The old terrace deposits were assigned to PFYC Class 4 (high potential under SVP). Stabilized alluvial deposits in the northwest region of the project area were assigned to PFYC Class 3 (high potential under SVP). Ranking of active and stabilized aeolian dune deposits within the gen-tie corridor were split based on paleontological potential of the active and stabilized portions. Stabilized portions were assigned to PFYC Class 3 (high potential under SVP), and active portions were assigned to PFYC Class 2 (low potential under SVP). Active alluvial-fan deposits and alluvial-wash deposits were both assigned to PFYC Class 2 (low potential under SVP).

CHAPTER 1

Introduction

Desert Quartzite, LLC, a wholly owned subsidiary of First Solar Development, Inc. (First Solar), is proposing to develop, construct, and operate a 300-megawatt (MW) power-generating solar photovoltaic (PV) facility in eastern Riverside County, California—the Desert Quartzite Solar Project (DQSP). At the request of First Solar, Statistical Research, Inc. (SRI), conducted a paleontological survey of the project site to provide information for the U.S. Department of the Interior Bureau of Land Management (BLM) and the County of Riverside (County) to comply with federal and state environmental and historic-preservation laws and regulations.

The purpose of the study was to identify and evaluate paleontological resources within and around the project area in the context of the local geologic setting. These data will be used to classify each geologic unit occurring within the project vicinity based on its potential to yield significant paleontological discoveries. The field survey was preceded by a records search and a literature review, which are documented within this technical report. Management recommendations for mitigating adverse effects to paleontological resources are provided based on the results of the study.

Project Location

The proposed project area is located 0.8 km (½ mile) south of Interstate 10 and the community of Mesa Verde and about 13 km (8 miles) west of the city of Blythe, in eastern Riverside County, California (Figure 1.1). The DQSP area is located in Sections 11–14, 23, and 24 of Township 7 South, Range 21 East (San Bernardino Baseline and Meridian [SBBM]), on the Ripley, California, 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle and in Sections 9–11, 14, 15, 22, and 23 of Township 7 South, Range 21 East (SBBM), on the Roosevelt Mine, California, 7.5-minute USGS topographic quadrangle (Figure 1.2). The project site is situated on Palo Verde Mesa, in the Colorado Desert, with the McCoy Mountains to the north, the Mule Mountains to the southwest, Chuckwalla Valley to the west, and Palo Verde Valley and the Colorado River to the east.

The DQSP area is bounded on the southwest and southeast by existing electrical transmission lines and access roads, including Devers–Palo Verde Transmission Line Nos. 1 and 2. An existing 7.5-MW solar PV project, the NRG Blythe Solar Power Plant, is located on 200 acres adjacent to the northern boundary of the DQSP site. A portion of the Blythe Mesa Solar Project, a 485-MW, 3,660-acre PV project approved by the County in 2014 and by the BLM in 2015, is located on a keyhole-shaped parcel of land that is surrounded on three sides (the north, west, and south) by the DQSP site. The DQSP is located within the Riverside East Solar Energy Zone, identified as part of the BLM's comprehensive Solar Energy Program (the Western Solar Plan) for utility-scale solar-energy development on BLM-administered lands in six southwestern states, including California.

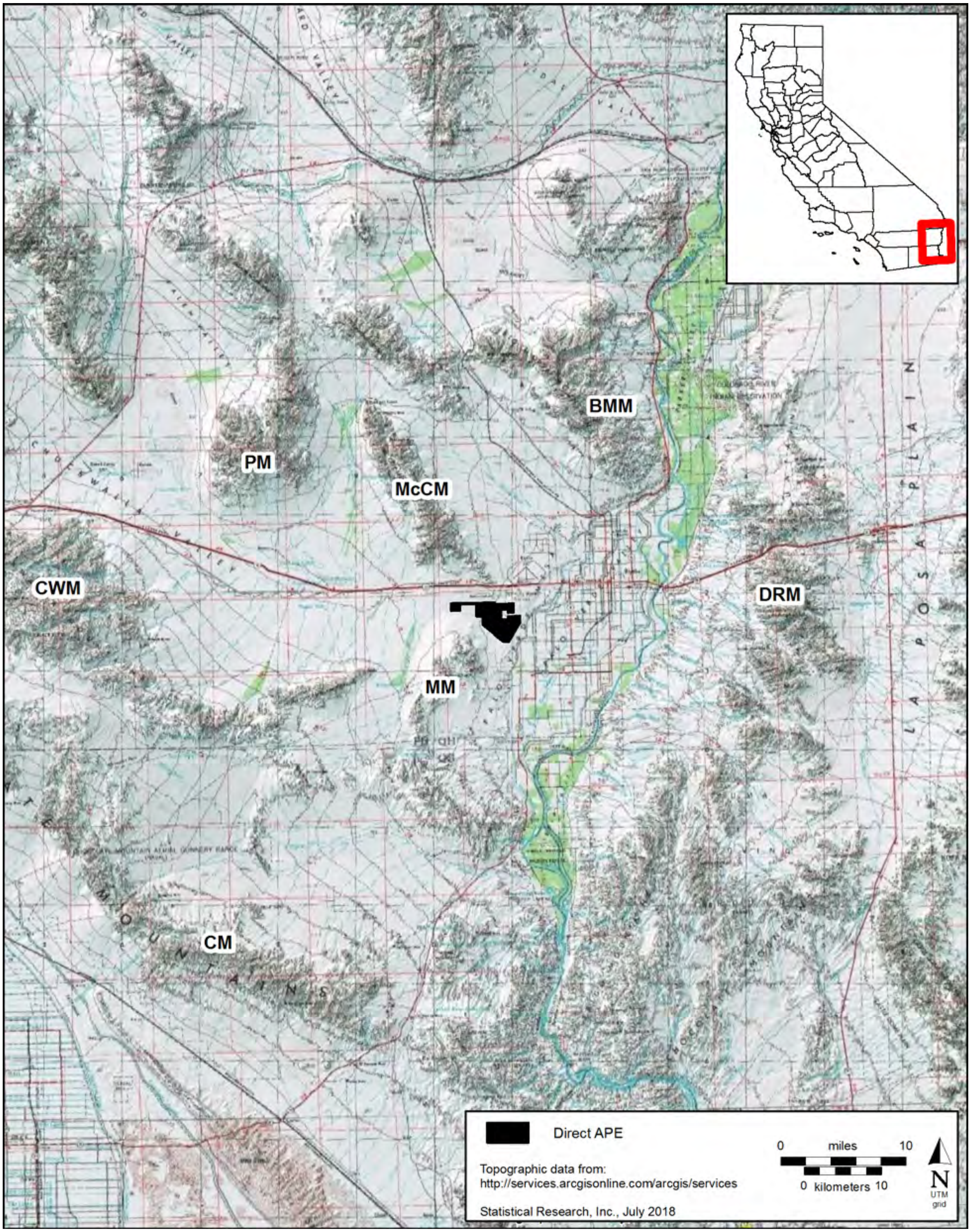


Figure 1.1. Vicinity map of the DQSP paleontological field survey area. BMM = Big Maria Mountains; CM = Chocolate Mountains; CWM = Chuckwalla Mountains; DRM = Dome Rock Mountains; McCM = McCoy Mountains; MM = Mule Mountains; and PM = Palen Mountains.

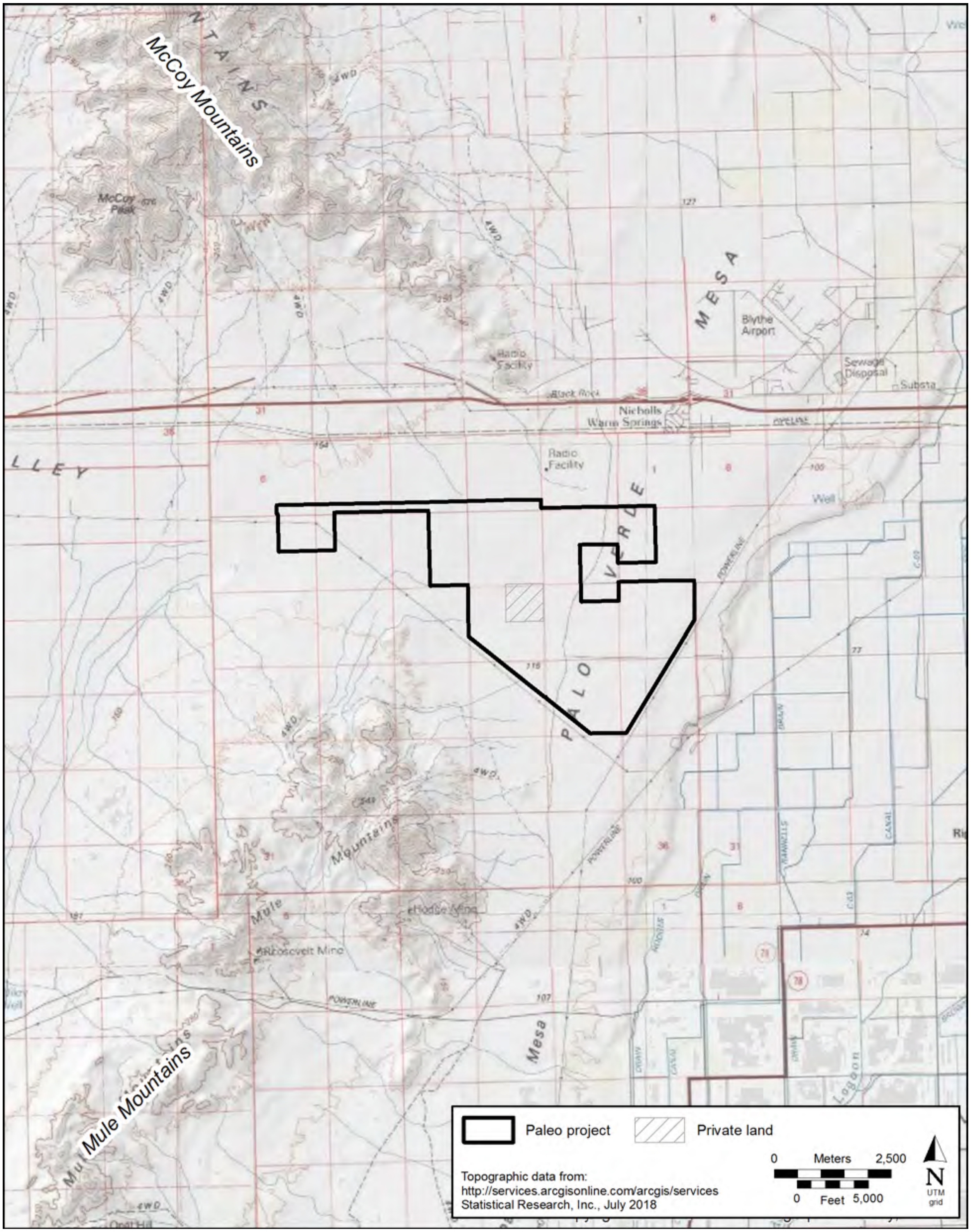


Figure 1.2. Location map of the DQSP paleontological field survey area.

Project Description

The DQSP includes a PV solar-facility site on approximately 3,560 acres of BLM land and 160 acres of private land, along with a corridor for generator tie lines (gen-tie lines) that extends for 3 miles and covers an area of 58 acres; this is all situated within a total project area of 5,010 acres. The total project area was initially defined on the basis of the right-of-way (ROW) grant application for a somewhat larger project footprint (and associated buffer areas) that was proposed in earlier versions of the DQSP Plan of Development (Desert Quartzite, LLC 2014).

The DQSP would consist of a single unit with a generating capacity of 300 MW. The proposed facilities on BLM-managed public land would include PV solar arrays, a gen-tie line, a 120-by-50-foot operations and maintenance building, an on-site substation, and ancillary facilities. The only facilities to be placed on the private land parcel would be solar arrays. The only linear facility extending out of the solar-plant site would be the gen-tie line. The DQSP would use existing access roads.

The DQSP would involve the installation of thin-film solar modules made by First Solar (or other PV technology) mounted on either single-axis horizontal tracker structures or fixed-tilt mounting systems, or a combination of these two mounting systems. The mounting system for the PV modules would consist of steel posts driven into the ground to depths between 1.2 and 2.1 m (4 and 7 feet); posts for single-axis tracking structures would need to be driven up to 3.7 m (12 feet) into the ground. The solar-module assemblies would be organized into arrays. Each array would be approximately 800 feet long and 500 feet wide. The exact placement of the arrays within the DQSP area would be based on topography, hydrology, and geotechnical conditions and could also be modified to avoid cultural resources.

Personnel

The personnel involved with the planning, implementation, and reporting of this survey have extensive training and knowledge in the fields of paleontology and geology and all meet the professional standards of the Society of Vertebrate Paleontology (SVP). As principal investigator on the Paleontological Resources Use Permit used for this study, Joseph J. El Adli, Ph.D., was responsible for management of the project and for writing the resulting report. Dr. El Adli designed the field methods used in this study and acted as field supervisor during the survey. Joshua Corrie, Paris Morgan, and Nichole Lohrke acted as field assistants to Dr. El Adli during the entirety of the survey. Jason Windingstad provided technical data and associated text regarding soils and paleosols for the report. Professional support staff from SRI's Cartography and Geospatial Technologies, Publications, and Accounting departments were utilized in conducting and reporting this paleontological field survey.

Organization of the Report

The research aspects of this report entailed three main phases: a literature review, a records search, and field survey. Data resulting from these phases are reported throughout this document as appropriate to convey a complete understanding of the paleontological resources found within the project area. Thus, this report is divided into multiple chapters designed to build an understanding of the project area in terms of the local geology and paleontology. Chapter 2 discusses paleontology and paleontological resources, the significance of fossils for science and education, and the criteria used to evaluate, assess, and classify the paleontological resource sensitivity of potential fossil-bearing geologic units. Chapter 3 presents background information on the environmental, cultural, geologic, and paleontological setting of the project area based on analysis of maps and literature. Chapter 4 provides information on the regulatory environment surrounding the DQSP at the federal, state, and local levels as it pertains to the preservation and management of paleontological resources. Chapter 5 discusses the overall research design and methods used for data collection in association with constructing this report, especially the methods used in conducting the paleontological field survey. Chapter 6 provides a discussion of the results of the literature review, records search, and field survey. Chapter 7 presents recommendations for the Potential Fossil Yield Classification (PFYC) of each geologic unit found within the project area based on the results of this study and discusses recommendations for managing adverse effects to paleontological resources during proposed project-associated construction. Finally, Chapter 8 produces citations for all literature discussed and utilized within this report. Following the body of the report are appendixes containing copies of records searches (Appendix A), the BLM Paleontological Resources Use Permit (Appendix B), and the BLM Field Authorization (Appendix C) used to conduct the field survey. Curricula vitae for project personnel are provided in Appendix D. A CD-ROM contains a separate, confidential volume with an appendix containing paleontological locality maps and BLM Paleontological Locality Forms (Form 8270-3) for all fossil remains discovered during the field survey (Appendix E). This confidential appendix contains sensitive information and is not intended for public distribution.

CHAPTER 2

Paleontological Resources

Paleontology is the study of past life on this planet. Its purview encompasses nearly 4 billion years of Earth's history (Ohtomo et al. 2014) and is tasked with understanding the biology of extinct and extant organisms. A multidisciplinary field, paleontology often combines different aspects of geology, biology, chemistry, physics, and mathematics in order to tease out information about prehistoric organisms and systems from a relatively incomplete fossil record. Inherently, paleontological investigations involve the study of fossil remains (i.e., paleontological resources).

Fossils are generally defined here as the remains or trace remains (both physical and chemical) of prehistoric organisms (i.e., animals, plants, and microorganisms). These resources can be preserved as body fossils, such as bones, teeth, shells, and plant matter, or as trace fossils, such as burrows and footprints. Geologic deposits make up the context in which these fossil remains were originally buried and provide information about the environment in which an organism lived. In the broadest sense, a fossil can be defined as any remains documenting past life. Typically, to be considered within the scope of paleontology, fossils must be at least 10,000 years in age (i.e., dating from before the beginning of the modern Holocene Epoch). However, some Holocene-age remains are also considered of paleontological interest, such as specimens of late-surviving woolly mammoths from Wrangel Island that survived until approximately 4,000 years before present. Such younger material is considered to be a paleontological resource because it contributes to our understanding of the record of past life. Alteration or replacement (e.g., permineralization, petrification, or "fossilization") of the original organic material is not required for determination of whether an object is a fossil or not.

In general, paleontological resources are preserved in sedimentary rocks; however, they can occasionally be preserved in low-grade metamorphic rocks and can, on rare occasions, be preserved in volcanic rocks. Beyond acting as a vessel for the preservation of fossil remains, sedimentary strata record telltale information reflecting the environment in which they were deposited (e.g., sedimentary structures, maturity, and lithology). For example, fossil remains found within the fine-grained sediments of a floodplain deposit represent organisms that died and were later buried on an ancient floodplain. Because of the interwoven relationship between fossil remains and their geologic contexts, for the purpose of this report, paleontological resources can be thought of as also including fossil-collecting localities and the geologic formations containing those localities.

Significant Paleontological Resources

With respect to paleontological resource management and for reasons discussed above, geologic units are often assigned a classification or rank based on the known or potential abundance of significant paleontological resources contained within that unit (see Chapter 4). The BLM considers a significant paleontological resource as a fossil that is considered to be of "scientific interest". This includes most vertebrate fossil remains and traces, as well as certain rare or unusual invertebrate and plant remains (BLM 2008). Paleontological resources may be considered to not be significant if they lack provenance or geologic context; lack physical integrity or are highly fragmentary; or are overly redundant, over-represented, or not useful for paleontological research. Significant paleontological resources are further defined by the SVP as identifiable vertebrate, invertebrate, plant, and trace fossils that provide taphonomic, taxonomic, phylogenetic, paleoecological, stratigraphic, or biochronological data (SVP 2010). A paleontological resource may by scientifically important because of its rarity, quality of preservation, unique anatomy, or educational value. These data are important for a multitude of scientific purposes, including examination of evolutionary relationships, understanding the development of biological communities and the interactions between organisms within them, as well as the establishment of chronologies for geologic units (Scott and Springer 2003). Fossils are considered important scientific and educational resources because they serve as direct and indirect evidence of prehistoric life and are used to understand the history of life on Earth, the nature of past environments and climates, the membership and structure of ancient ecosystems, and the pattern and process of organic evolution and extinction. Fossils are considered to be limited, nonrenewable resources, because they typically represent organisms that are now extinct or life in a context that no longer exists. Therefore, if destroyed, a particular fossil can never be replaced, and the information associated with it is forever lost.

Resource Assessment Criteria

In recognition that paleontological resources are considered to include not only actual fossil remains and traces but also the fossil collecting localities and the geologic units containing those fossils and localities, the BLM developed a procedure for evaluating the paleontological resource potential of individual geologic rock units (BLM 2007, 2016). This procedure uses the PFYC to classify rocks within units, based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and the sensitivity of these fossils to adverse impacts. The PFYC supersedes the Condition Classifications for paleontological resource management outlined in BLM Manual H-8270-1 (BLM 1998) (Table 2.1) and provides detailed guidelines for assignment of classes. Under the PFYC system, geologic formations, members, or other distinguishable units are assigned to a class between Classes 1 and 5, with higher numerical values representing increased potential to encounter significant paleontological resources. As such, the PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources on BLM lands.

Table 2.1. Comparative Frameworks for Assigning Paleontological Resource Significance under the Condition Classification and PFYC Systems

Condition[a]	PFYC Class[b]
1. Areas known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils[c]	4 (high) or 5 (very high), based on geologic unit
2. Areas with exposures of geological units or settings that have high potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	3 (moderate), 4 (high), or 5 (very high), based on geologic unit
3. Areas that are very unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	1 (very low) or 2 (low).

[a] Modified from BLM Manual H-8720-1 (BLM 1998).
[b] Modified from BLM Instruction Memorandum No. 2008-009 (BLM 2007).
[c] This refers to known localities or groups of localities.

The original version of the PFYC system was updated in 2016 by BLM Instruction Memorandum (IM) No. 2016-124 (BLM 2016). This update removed the previously used “a” and “b” subclassifications from PFYC Classes 3–5 in favor of the addition of Classes U, W, and I. Reference to this older scheme of classification will be necessary within this report in order to discuss PFYC assignments in older (pre-2016) paleontological assessments and surveys. However, all newly classified or reclassified geologic units will be discussed in reference to the updated PFYC system. In order to accurately reflect the intentions and definitions of the PFYC provided by the BLM, the below section is excerpted verbatim from BLM IM No. 2016-124.

> Occurrences of paleontological resources are known to be correlated with mapped geologic units (i.e., formations). The PFYC is created from available geologic maps and assigns a class value to each geological unit, representing the potential abundance and significance of paleontological resources that occur in that geological unit. PFYC assignments should be considered as only a first approximation of the potential presence of paleontological resources, subject to change based on ground verification.
>
> In the PFYC system, geologic units are assigned a class based on the relative abundance of significant paleontological resources and their sensitivity to adverse impacts. This classification is applied to the geologic formation, member, or other mapped unit. The classification is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit that has been assigned a lower PFYC classification, widely scattered important fossils or localities do not necessarily indicate a higher class assignment. Instead, the overall abundance of scientifically important localities is intended to be the major determinant for the assigned classification.
>
> The descriptions for the class assignments below serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual geological units are considered when developing PFYC assignments. These assignments must be developed using scientific expertise with input from a BLM paleontologist, but may include collaboration and peer review from outside researchers who are knowledgeable about both the geology and the nature of paleontological resources that may be found in each geological unit. Each state has unique geologic maps and so also has unique PFYC assignments. It is possible, and occasionally desirable, to have different assignments for a similar geologic unit across separate states.
>
> **Class 1 – Very Low.** Geologic units that are not likely to contain recognizable paleontological resources. Units assigned to Class 1 typically have one or more of the following characteristics:
>
> - Geologic units are igneous or metamorphic, excluding air-fall and reworked volcanic ash units.
> - Geologic Units are Precambrian in age.
>
> (1) Management concerns for paleontological resources in Class 1 units are usually negligible or not applicable.
>
> (2) Paleontological mitigation is unlikely to be necessary except in very rare or isolated circumstances that result in the unanticipated presence of paleontological resources, such as unmapped geology contained within a mapped geologic unit. For example, young fissure-fill deposits often contain fossils but are too limited in extent to be represented on a geological map; a lava flow that preserves evidence of past life, or caves that contain important paleontological resources. Such exceptions are the reason that no geologic unit is assigned a Class 0.

Overall, the probability of impacting significant paleontological resources is very low and further assessment of paleontological resources is usually unnecessary. An assignment of Class 1 normally does not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.

Class 2 – Low. Geologic units that are not likely to contain paleontological resources. Units assigned to Class 2 typically have one or more of the following characteristics:

- 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 aeolian deposits.
- Sediments exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely.

(1) Except where paleontological resources are known or found to exist, management concerns for paleontological resources are generally low and further assessment is usually unnecessary except in occasional or isolated circumstances.

(2) Paleontological mitigation is only necessary where paleontological resources are known or found to exist.

The probability of impacting significant paleontological resources is low. Localities containing important paleontological resources may exist, but are occasional and should be managed on a case-by-case basis. An assignment of Class 2 may not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate unanticipated discoveries.

Class 3 – Moderate. Sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Units assigned to Class 3 have some of the following characteristics:

- Marine in origin with sporadic known occurrences of paleontological resources.
- Paleontological resources may occur intermittently, but abundance is known to be low.
- Units may contain significant paleontological resources, but these occurrences are widely scattered.
- The potential for an authorized land use to impact a significant paleontological resource is known to be low-to-moderate.

(1) Management concerns for paleontological resources are moderate because the existence of significant paleontological resources is known to be low. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for casual collecting.

(2) Paleontological mitigation strategies will be proposed based on the nature of the proposed activity.

This classification includes units of moderate or infrequent occurrence of paleontological resources. Management considerations cover a broad range of options that may include record searches, pre-disturbance surveys, monitoring, mitigation, or avoidance. Surface-disturbing activities may require assessment by a qualified paleontologist to determine whether significant paleontological resources occur in the area of a proposed action, and whether the action could affect the paleontological resources.

Class 4 – High. Geologic units that are known to contain a high occurrence of paleontological resources. Units assigned to Class 4 typically have the following characteristics:

- 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.

(1) Management concerns for paleontological resources in Class 4 are moderate to high, depending on the proposed action.

(2) Paleontological mitigation strategies will depend on the nature of the proposed activity, but field assessment by a qualified paleontologist is normally needed to assess local conditions.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation plans must consider the nature of the proposed disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access that could result in looting. Detailed field assessment is normally required and on-site monitoring or spot-checking may be necessary during land disturbing activities. In some cases avoidance of known paleontological resources may be necessary.

Class 5 – Very High. Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources. Units assigned to Class 5 have some or all of the following characteristics:

- 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.

(1) Management concerns for paleontological resources in Class 5 areas are high to very high.

(2) A field survey by a qualified paleontologist is almost always needed. Paleontological mitigation may be necessary before or during surface disturbing activities.

The probability for impacting significant paleontological resources is high. The area should be assessed prior to land tenure adjustments. Pre-work surveys are usually needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designation of areas of avoidance, or special management designations should be considered.

Class U – Unknown Potential. Geologic units that cannot receive an informed PFYC assignment. Characteristics of Class U may include:

- 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 known.

- Geological 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.

(1) Until a provisional assignment is made, geologic units that have an unknown potential have medium to high management concerns.

(2) Lacking other information, field surveys are normally necessary, especially prior to authorizing a ground-disturbing activity.

An assignment of "Unknown" may indicate the unit or area is poorly studied, and field surveys are needed to verify the presence or absence of paleontological resources. Literature searches or consultation with professional colleagues may allow an unknown unit to be provisionally assigned to another Class, but the geological unit should be formally assigned to a Class after adequate survey and research is performed to make an informed determination.

Class W – Water. Includes any surface area that is mapped as water. Most bodies of water do not normally contain paleontological resources. However, shorelines should be carefully considered for uncovered or transported paleontological resources. Reservoirs are a special concern because important paleontological resources are often exposed during low water intervals. In karst areas sinkholes and cenotes may trap animals and contain paleontological resources. Dredging river systems may result in the disturbance of sediments that contain paleontological resources.

Class I – Ice. Includes any area that is mapped as ice or snow. Receding glaciers, including exposed lateral and terminal moraines should be considered for their potential to reveal recently exposed paleontological resources. Other considerations include melting snow fields that may contain paleontological resources with possible soft-tissue preservation.

Special Notes. When developing PFYC assignments, the following should be considered:

(1) Standard stipulations should always be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.

(2) Class 1 & 2 and Class 4 & 5 units may be combined for broad applications, such as largescale planning, programmatic assessments, or when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations will need to be addressed when actual land disturbing activities are proposed.

(3) Where large projects impact multiple geologic units with different PFYC Classes, field survey and monitoring should be applied appropriately. For example, the authorized officer may determine that on-the-ground (pedestrian) surveys are necessary for the Class

(4) 4 and 5 formations, but not for Class 2 formations along a specific project.

(5) Based on information gained by surveys, the BLM may adjust PFYC assignments appropriately. Actual survey and monitoring intensities, as well as the extent of discoveries, should be included in any assessment, mitigation, or permit report so the

(6) BLM may reevaluate PFYC assignments.

(7) A geologic unit may receive a higher or lower classification in specific areas where the occurrence of fossils is known to be higher or lower than in other areas where the unit is exposed.

(8) Some areas are difficult to evaluate, such as talus, colluvium, tailings, fill, borrow, and other mapped features. A PFYC assignment should be made for each area using available information, or the area should be assigned to Class U as appropriate.

(9) The BLM-wide PFYC assignments are maintained and periodically updated by the BLM paleontology team and may be obtained by contacting the BLM state or regional paleontologist assigned to an area."

Other criteria for assessing the paleontological resource significance of geologic units have been established by separate groups and agencies. One of the most widely used was created by the SVP within the "Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources" (SVP 2010). Under the SVP (2010) guidelines, geologic units are classified in one of four categories of paleontological resource sensitivity: no, low, undetermined, and high. The criteria for each of these sensitivity categories are presented in Table 2.2. Paleontological resource sensitivity will be assessed within this report using both the PFYC and SVP classification systems.

Table 2.2. SVP Classification for Paleontological Resource Sensitivity

Paleontological Potential	Criteria	Recommendations
High	Geologic formations that are known to yield vertebrate or significant invertebrate, plant, or trace fossils. Highly sensitive formations also may be those that are likely to produce new vertebrate materials, traces, or trackways.	A field survey as well as onsite construction monitoring is required. Any significant specimens discovered will require preparation, identification, and curation, as well as eventual accession into an appropriate museum collection. A final report documenting the significance of any finds is required.
Undetermined	Geologic formations for which available literature on paleontological resources is scarce, making it difficult to determine whether or not it is potentially fossiliferous. Under these circumstances, further study is needed to determine the unit's paleontological resource potential (i.e., field survey).	A field survey is required to further assess the unit's paleontological potential.
Low	Geologic formations that have yielded few fossils in the past, based upon review of available literature and museum collections records. Low potential also may include formations that yield fossils only under unusual circumstances. This also includes formations that, based on their relative youthful age or high-energy depositional history, are unlikely to produce important fossil remains	Mitigation is not typically required.
None	Geologic formations that are formed under or exposed to immense heat and pressure, such as high-grade metamorphic rocks and plutonic igneous rocks. Artificial fill materials also are assigned as having no potential because of the loss of stratigraphic context of any contained organic remains.	No mitigation required.

Note: Modified from Society of Vertebrate Paleontology (2010).

CHAPTER 3

Background Information

This chapter provides background information on the environmental, cultural, geologic, and paleontological setting of the study area. This information helped to inform the research questions and methods used to scope and implement the overall study.

Environmental Setting

The DQSP is located 17.5 km (10.9 miles) west of the present day Colorado River on the Palo Verde Mesa (see Figure 1.1). The project is situated in the northwestern portion of the Colorado Desert (a subdivision of the larger Sonoran Desert) near the southeastern border of the Mojave Desert (Jahns 1954; Shreve and Wiggins 1951). Temperature and precipitation data have been recorded 3 km (1.9 miles) to the northeast of the project area at the Blythe Airport by the National Oceanic and Atmospheric Administration (NOAA)—National Centers for Environmental Information (NOAA 2018). From 1981 to 2010, the annual average temperature recorded near the project site was 23.0°C (73.5°F), with precipitation averaging 9.7 cm (3.8 inches) per annum. Most precipitation occurs during the cooler winter months, whereas the summer months are hot and dry. However, single-event thunderstorms can occur during the summer months (especially August and September), producing rainfall of up to 15.2 cm (6.0 inches), which can alter normal drainage patterns and cause flash flooding. On average, over 110 days per year reach a high temperature of 37.8°C (100.0°F) or greater, and an average of nearly 175 days are over 32.2°C (90.0°F). Low temperatures below 0.0°C (32.0°F) are rare, only occurring on average 3 days per year.

Flora

The Colorado Desert, in general, is considerably more diverse in floral and faunal composition than the Mojave Desert to the north (Shreve 1951). This is, in part, due to a lack of freezing temperatures (allowing for the presence of some frost-sensitive taxa) and higher rainfall with occasional summer precipitation. Summer rainfall significantly increases from west to east across the Colorado Desert, which leads to large variation in floral communities.

Unlike eastern portions of the Sonoran Desert, the western portions of the Colorado Desert lack large succulent species and are largely composed of desert scrub. Plant growth in this region is typically open and broken as a result of competition for scarce water resources (Brown 1982). Vegetation patterns are frequently tied to drainages offset by interfluves. Many of the desert plants are herbaceous annuals that time germination with winter rains. In regions with higher aridity, perennial taxa may be largely absent and replaced by short-lived annual species. Arboreal taxa are mostly aphyllous or microphyllous, adaptations associated with living in a desert environment (Knight and Ackerly 2003). Overall, 124 plant taxa, representing 27 families, have been previously identified within the project area (Table 3.1).

Table 3.1. Plant Taxa Identified within the Project Area

Family	Taxon	Common Name	Abundance
Agavaceae	*Hesperocallis undulata*	desert lily	common
Amaranthaceae	*Tidestromia suffruticosa* var. *oblongifolia*	Arizona honeysweet	scarce
Apocynaceae	*Asclepias subulata*	desert milkweed	scarce
Apocynaceae	*Funastrum cynanchoides*	fringed twinevine	scarce
Apocynaceae	*Funastrum hirtellum*	hairy milkweed	scarce
Apocynaceae	*Funastrum utahense*	Utah swallow-wort	scarce
Asteraceae	*Ambrosia dumosa*	white bursage	common
Asteraceae	*Ambrosia salsola*	burrobrush	scarce
Asteraceae	*Baileya pauciradiata*	laxflower	occasional
Asteraceae	*Bebbia juncea*	sweetbush	scarce
Asteraceae	*Calycoseris wrightii*	white tackstem	occasional
Asteraceae	*Chaenactis carphoclinia*	pebble pincushion	occasional
Asteraceae	*Chaenactis stevioides*	Steve’s pincushion	abundant
Asteraceae	*Dicoria canescens*	desert twinbugs	occasional
Asteraceae	*Encelia farinosa*	white brittlebush	scarce
Asteraceae	*Encelia frutescens*	button brittlebush	scarce
Asteraceae	*Geraea canescens*	hairy desertsunflower	common
Asteraceae	*Malacothrix glabrata*	smooth desert dandelion	occasional
Asteraceae	*Monoptilon bellioides*	Mojave desertstar	occasional
Asteraceae	*Palafoxia arida*	desert needles	occasional
Asteraceae	*Pectis papposa*	manybristle cinchweed	common/locally abundant
Asteraceae	*Perityle emoryi*	Emory’s rockdaisy	scarce
Asteraceae	*Prenanthella exigua*	brightwhite	scarce
Asteraceae	*Psathyrotes ramosissima*	velvet turtleback	scarce
Asteraceae	*Rafinesquia neomexicana*	New Mexico plumeseed	common
Asteraceae	*Stephanomeria exigua*	wire lettuce	occasional
Asteraceae	*Stephanomeria pauciflora*	brownplume wirelettuce	occasional
Boraginaceae	*Cryptantha angustifolia*	Panamint catseye	abundant
Boraginaceae	*Cryptantha costata*	ribbed catseye	occasional
Boraginaceae	*Cryptantha maritima*	Guadalupe catseye	occasional
Boraginaceae	*Cryptantha micrantha*	redroot catseye	occasional
Boraginaceae	*Cryptantha nevadensis*	Nevada catseye	scarce
Boraginaceae	*Cryptantha pterocarya* var. *pterocarya*	wingnut catseye	scarce
Boraginaceae	*Nama demissum*	purplemat	scarce
Boraginaceae	*Pectocarya heterocarpa*	chuckwalla combseed	common
Boraginaceae	*Pectocarya platycarpa*	broadfruit combseed	common
Boraginaceae	*Pectocarya recurvata*	curvenut combseed	scarce
Boraginaceae	*Phacelia crenulata* var. *ambigua*	caterpillarweed	occasional
Boraginaceae	*Phacelia crenulata* var. *crenulata*	cleftleaf wildheliotrope	occasional
Boraginaceae	*Phacelia crenulata* var. *minutiflora*	smallflower scorpion-weed	occasional
Boraginaceae	*Phacelia ivesiana*	Ives’ scorpion-weed	scarce

Family	Taxon	Common Name	Abundance
Boraginaceae	*Plagiobothrys jonesii*	Mojave popcornflower	scarce
Boraginaceae	*Tiquilia palmeri*	Palmer's crinklemat	scarce
Boraginaceae	*Tiquilia plicata*	fanleaf crinklemat	locally common
Brassicaceae	*Brassica tournefortii*[a]	Tournefort's birdrape	common/locally abundant
Brassicaceae	*Caulanthus lasiophyllus*	California mustard	occasional
Brassicaceae	*Dithyrea californica*	California spectaclepod	occasional
Brassicaceae	*Lepidium lasiocarpum* ssp. *lasiocarpum*	hairypod pepperweed	common
Brassicaceae	*Streptanthella longirostris*	longbeak fiddle mustard	occasional
Cactaceae	*Cylindropuntia echinocarpa*	silver cholla	scarce
Cactaceae	*Ferocactus cylindraceus*	California barrel cactus	scarce
Cactaceae	*Mammillaria tetrancistra*	corkseed pincushion cactus	scarce
Caryophyllaceae	*Achyronychia cooperi*	Cooper's frostmat	occasional
Chenopodiaceae	*Atriplex canescens*	fourwing saltbush	scarce
Chenopodiaceae	*Atriplex polycarpa*	desert saltbush	scarce
Chenopodiaceae	*Chenopodium album*[a]	common lambsquarters	scarce
Chenopodiaceae	*Chenopodium murale*[a]	nettle-leaf goosefoot	scarce
Chenopodiaceae	*Salsola tragus*[a]	prickly Russian thistle	occasional/locally abundant
Euphorbiaceae	*Croton californicus*	California croton	scarce
Euphorbiaceae	*Ditaxis neomexicana*	New Mexico silverbush	scarce
Euphorbiaceae	*Euphorbia abramsiana*	Abrams' sandmat	scarce
Euphorbiaceae	*Euphorbia micromera*	Sonoran sandmat	common
Euphorbiaceae	*Euphorbia polycarpa*	smallseed sandmat	common
Euphorbiaceae	*Euphorbia setiloba*	Yuma sandmat	occasional
Euphorbiaceae	*Stillingia spinulosa*	annual toothleaf	scarce
Fabaceae	*Acmispon strigosus*	strigose bird's-foot trefoil	common
Fabaceae	*Astragalus aridus*	annual desert milkvetch	locally common
Fabaceae	*Astragalus didymocarpus*	dwarf white milkvetch	occasional
Fabaceae	*Astragalus insularis* var. *harwoodii*	Harwood's milkvetch	locally common
Fabaceae	*Astragalus nuttallianus* var. *imperfectus*	turkeypeas	locally abundant
Fabaceae	*Dalea mollis*	hairy prairie clover	occasional
Fabaceae	*Dalea mollissima*	soft prairie clover	occasional
Fabaceae	*Lupinus arizonicus*	Arizona lupine	scarce
Fabaceae	*Marina parryi*	Parry's indigobush	occasional
Fabaceae	*Olneya tesota*	ironwood	scarce
Fabaceae	*Parkinsonia florida*	blue palo verde	scarce
Fabaceae	*Prosopis glandulosa*	honey mesquite	scarce
Fabaceae	*Psorothamnus emoryi*	dyebush	occasional
Geraniaceae	*Erodium texanum*	Texas filaree	common
Krameriaceae	*Krameria bicolor*	white ratany	occasional
Loasaceae	*Mentzelia albicaulis*	whitestem blazingstar	occasional
Loasaceae	*Mentzelia longiloba*	Adonis blazingstar	occasional
Malvaceae	*Eremalche exilis*	white mallow	occasional

continued on next page

Family	Taxon	Common Name	Abundance
Malvaceae	*Eremalche rotundifolia*	desert fivespot	scarce
Malvaceae	*Sphaeralcea angustifolia*	copper globemallow	scarce
Martyniaceae	*Proboscidea althaeifolia*	straighttube devilsclaw	occasional
Myrtaceae	*Eucalyptus* sp.[a]	Eucalyptus	scarce
Nyctaginaceae	*Abronia villosa*	desert sand verbena	common
Nyctaginaceae	*Allionia incarnata*	trailing windmills	occasional
Nyctaginaceae	*Boerhavia triquetra* var. *intermedia*	fivewing spiderling	locally common
Nyctaginaceae	*Boerhavia wrightii*	large-bract spiderling	common
Onagraceae	*Chylismia brevipes*	yellow cups	scarce
Onagraceae	*Chylismia claviformis* ssp. *aurantiaca*	browneyes	common
Onagraceae	*Eremothera boothii*	Booth's evening primrose	occasional
Onagraceae	*Oenothera deltoides*	birdcage evening primrose	common/locally abundant
Onagraceae	*Oenothera primiveris*	desert evening primrose	scarce
Papaveraceae	*Eschscholzia minutiflora*	pygmy goldenpoppy	scarce
Papaveraceae	*Eschscholzia parishii*	Parish's poppy	scarce
Plantaginaceae	*Plantago ovata*	desert indianwheat	common
Poaceae	*Aristida adscensionis*	sixweeks threeawn	occasional
Poaceae	*Aristida oligantha*	prairie threeawn	scarce
Poaceae	*Bouteloua aristidoides*	needle grama	occasional
Poaceae	*Bouteloua barbata*	sixweeks grama	occasional
Poaceae	*Cynodon dactylon*[a]	common bermudagrass	scarce
Poaceae	*Hilaria rigida*	big galleta	locally common
Poaceae	*Schismus barbatus*[a]	Mediterranean grass	common/widespread
Poaceae	*Stipa hymenoides*	Indian ricegrass	occasional
Polemoniaceae	*Eriastrum harwoodii*	Harwood's woollystar	scarce
Polemoniaceae	*Langloisia setosissima* ssp. *setosissima*	Great Basin langloisia	scarce
Polemoniaceae	*Loeseliastrum schottii*	Schott's calico	occasional
Polygonaceae	*Chorizanthe brevicornu*	brittle spineflower	occasional
Polygonaceae	*Chorizanthe corrugata*	wrinkled spineflower	occasional
Polygonaceae	*Chorizanthe rigida*	devil's spineflower	occasional
Polygonaceae	*Eriogonum inflatum*	desert trumpet	scarce
Polygonaceae	*Eriogonum pusillum*	yellowturbans	scarce
Polygonaceae	*Eriogonum reniforme*	kidneyleaf buckwheat	scarce
Polygonaceae	*Eriogonum thomasii*	Thomas' buckwheat	occasional
Polygonaceae	*Eriogonum trichopes*	little desert trumpet	occasional
Polygonaceae	*Polygonum aviculare* ssp. *depressum*[a]	oval-leaf knotweed	scarce
Resedaceae	*Oligomeris linifolia*	lineleaf whitepuff	occasional
Tamaricaceae	*Tamarix ramosissima*[a]	salt cedar	scarce
Zygophyllaceae	*Kallstroemia californica*	California caltrop	common/locally abundant
Zygophyllaceae	*Larrea tridentata*	creosote bush	common/dominant shrub
Zygophyllaceae	*Tribulus terrestris*[a]	Mexican sandbur	scarce

Note: All nomenclature conforms to Baldwin et al. (2012). Modified from Lerch et al. (2016), which was a modification of Ironwood Consulting (2014).
[a] Nonnative taxa.

Fauna

The Colorado Desert supports a wide diversity of desert-adapted wildlife, including mammals, reptiles, birds, and various invertebrates. Large mammals include bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), kit fox (*Vulpes macrotis*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), mountain lion (*Puma concolor*), and gray fox (*Urocyon cinereoargenteus*) (Grinell et al. 1937). Small mammals include rodents (such as kangaroo rats and pocket mice [Heteromyidae], squirrels and chipmunks [Sciuridae], pocket gophers [Geomyidae], cricetids [Cricetidae], and murids [Muridae]) and lagomorphs (such as desert cottontail [*Sylvilagus audubonii*] and black-tailed hare [*Lepus californicus*]) (Laudenslayer et al. 1995) (Table 3.2). Reptiles of the Colorado Desert include desert tortoises (*Gopherus agassizii*), rattlesnakes (*Crotalus* spp.), and various species of lizards (such as *Crotaphytus* spp.*, Dipsosaurus* spp.*, Sceloporus* spp.*, Petrosaurus* spp.*,* and *Urosaurus* spp.). Avian taxa include quails (*Callipepla* spp.), greater roadrunners (*Geococcyx californianus*), ravens (*Corvus corax*), red-tailed hawks (*Buteo jamaicensis*), and turkey vultures (*Cathartes aura*). Many of these taxa have been present in the region since the Pleistocene (Jaeger 1965).

Table 3.2. Mammalian Taxa Identified from the Northwestern Colorado Desert Region

Order	Family	Taxon	Common Name
Insectivora	Soricidae	*Notiosorex crawfordi*	desert shrew
Chiroptera	Phyllostomidae	*Macrotus californicus*	California leaf-nosed bat
Chiroptera	Vespertilionidae	*Myotis lucifugus*	little brown bat
Chiroptera	Vespertilionidae	*Myotis yumanensis*	Yuma myotis
Chiroptera	Vespertilionidae	*Myotis velifer*	cave myotis
Chiroptera	Vespertilionidae	*Myotis evotis*	long-eared myotis
Chiroptera	Vespertilionidae	*Myotis thysanodes*	fringed myotis
Chiroptera	Vespertilionidae	*Myotis volans*	long-legged myotis
Chiroptera	Vespertilionidae	*Myotis californicus*	California myotis
Chiroptera	Vespertilionidae	*Pipistrellus hesperus*	western pipistrelle
Chiroptera	Vespertilionidae	*Eptesicus fuscus*	big brown bat
Chiroptera	Vespertilionidae	*Lasiurus cinereus*	hoary bat
Chiroptera	Vespertilionidae	*Euderma maculatum*	spotted bat
Chiroptera	Vespertilionidae	*Plecotus townsendii*	Townsend’s big-eared bat
Chiroptera	Vespertilionidae	*Antrozous pallidus*	pallid bat
Chiroptera	Molossidae	*Tadarida brasiliensis*	Brazilian free-tailed bat
Chiroptera	Molossidae	*Eumops perotis*	western mastiff bat
Lagomorpha	Leporidae	*Lepus californicus*	black-tailed hare
Lagomorpha	Leporidae	*Sylvilagus audubonii*	desert cottontail
Rodentia	Sciuridae	*Tamias panamintinus*	panamint chipmunk
Rodentia	Sciuridae	*Spermophilus variegatus*	rock squirrel
Rodentia	Sciuridae	*Ammospermophilus leucurus*	white-tailed antelope squirrel
Rodentia	Sciuridae	*Spermophilus mohavensis*	Mohave ground squirrel
Rodentia	Sciuridae	*Spermophilus tereticaudus*	round-tailed ground squirrel

continued on next page

Order	Family	Taxon	Common Name
Rodentia	Geomyidae	*Thomomys bottae*	Botta's pocket gopher
Rodentia	Heteromyidae	*Perognathus longimembris*	little pocket mouse
Rodentia	Heteromyidae	*Chaetodipus formosus*	long-tailed pocket mouse
Rodentia	Heteromyidae	*Dipodomys panamintinus*	panamint kangaroo rat
Rodentia	Heteromyidae	*Dipodomys deserti*	desert kangaroo rat
Rodentia	Heteromyidae	*Dipodomys merriami*	Merriam's kangaroo rat
Rodentia	Cricetidae	*Reithrodontomys megalotis*	western harvest mouse
Rodentia	Cricetidae	*Peromyscus eremicus*	cactus mouse
Rodentia	Cricetidae	*Peromyscus maniculatus*	deer mouse
Rodentia	Cricetidae	*Peromyscus crinitus*	canyon mouse
Rodentia	Cricetidae	*Peromyscus boylii*	brush mouse
Rodentia	Cricetidae	*Onychomys torridus*	southern grasshopper mouse
Rodentia	Cricetidae	*Sigmodon arizonae*	Arizona cotton rat
Rodentia	Cricetidae	*Sigmodon hispidus*	hispid cotton rat
Rodentia	Cricetidae	*Neotoma albigula*	white-throated woodrat
Rodentia	Cricetidae	*Neotoma lepida*	desert woodrat
Rodentia	Cricetidae	*Microtus californicus*	California vole
Rodentia	Cricetidae	*Ondatra zibethicus*	muskrat
Rodentia	Muridae	*Mus musculus*	house mouse
Carnivora	Canidae	*Canis latrans*	coyote
Carnivora	Canidae	*Vulpes macrotis*	kit fox
Carnivora	Canidae	*Urocyon cinereoargenteus*	gray fox
Carnivora	Procyonidae	*Bassariscus astutus*	ringtail
Carnivora	Procyonidae	*Procyon lotor*	raccoon
Carnivora	Mustelidae	*Taxidea taxus*	badger
Carnivora	Mustelidae	*Spilogale gracilis*	western spotted skunk
Carnivora	Mustelidae	*Mephitis mephitis*	striped skunk
Carnivora	Felidae	*Puma concolor*	mountain lion
Carnivora	Felidae	*Lynx rufus*	bobcat
Perissodactyla	Equidae	*Equus caballus*	horse
Perissodactyla	Equidae	*Equus asinus*	burro
Artiodactyla	Cervidae	*Odocoileus hemionus*	mule deer
Artiodactyla	Bovidae	*Ovis canadensis*	bighorn sheep

Note: Modified from Laudenslayer et al. 1995.

Geologic Setting

Regional Geologic History

The project area lies within the Mojave Desert geomorphic province (commonly referred to as the Mojave block), which is a broad region in southeastern California composed of isolated mountain ranges that are separated by relatively flat desert plains (Figure 3.1). The geomorphic province is bounded to the west and southwest by the San Andreas Fault, the San Gabriel Mountains, and the Western Transverse Ranges. To the north, the province is bounded by the approximately east–west-trending Garlock Fault, as well as the Tehachapi and El Paso Mountains. The Mojave Desert geomorphic province extends east and northeast into portions of Nevada and Arizona. Finally, the southern portion of the province is bounded irregularly by the San Andreas Fault and the northeastern edge of the Salton Trough.

Like much of southern California, the Mojave Desert geomorphic province is tectonically active. Extension occurs in a relatively east–west direction, along with a component of north–south shearing (Fuller et al. 2015). These tectonic activities operate similar to and parallel with the San Andreas Fault in connection with the opening of the Gulf of California that began in the Miocene.

The overall geologic history of the Mojave Desert geomorphic province can be traced back to the Proterozoic Eon, as the Mojave Desert geomorphic province contains some of the oldest exposed rocks in California (Fuller et al. 2015). Investigations of single zircons using isotopic age dating of $^{207}Pb/^{206}Pb$ revealed that magmatic intrusions of granitic rocks were occurring within the region as early as 1.7 billion years ago in the southern Marble Mountains (Wooden and Miller 1990). This period of magmatic intrusion co-occurred with a period of regional deformation known as the Ivanpah Orogeny (Strickland et al. 2013). Following this period of granitic intrusion and deformation, there was an extended interval of erosion and nondeposition coinciding with subsidence of the continental shelf and the breakup of the supercontinent of Rodinia (Hall 2007).

Deposition of sediments reinitiated near the end of the Neoproterozoic Era and continued into the Cambrian Period and throughout much of the Paleozoic Era. Sandstones, calcareous mudstones, limestones, and dolomites were deposited in shallow seas covering the Mojave Desert region during this interval (Glazner et al. 1994). Changing sea levels into the Triassic and Early Jurassic Periods allowed for further deposition of terrestrial sediments in lowlands within the region, as well as deposition of marine sediments within shallow seas. Several pulses of magmatism during the Early–Late Cretaceous Period intruded granitic rocks into older sedimentary and igneous rocks, metamorphosing them. At approximately the same time, the region west of Barstow was rifted away, establishing the typical north–south-oriented California coastline (Hall 2007).

A period of nondeposition and erosion followed the end of the Cretaceous and continued into the late Oligocene. Tectonic activity beginning in the Miocene Epoch led to the formation of extensive basins and ranges in the Mojave Desert geomorphic province, as well as in the adjacent Basin and Range geomorphic province. During the same period, volcanic activity in the southwestern United States deposited layers of ash and volcanic clasts. This volcanic activity continued throughout the late Miocene and into the Pliocene (Ferguson et al. 2013; McCurry 1988). Finally, the Pleistocene through the modern Holocene were marked within the region by deposition of sediments associated with alluvial fans, lakes, playas, rivers, and dune fields (Enzel et al. 1989; Shlemon 1978; Tchakerian and Lancaster 2002; Wells et al. 1987).

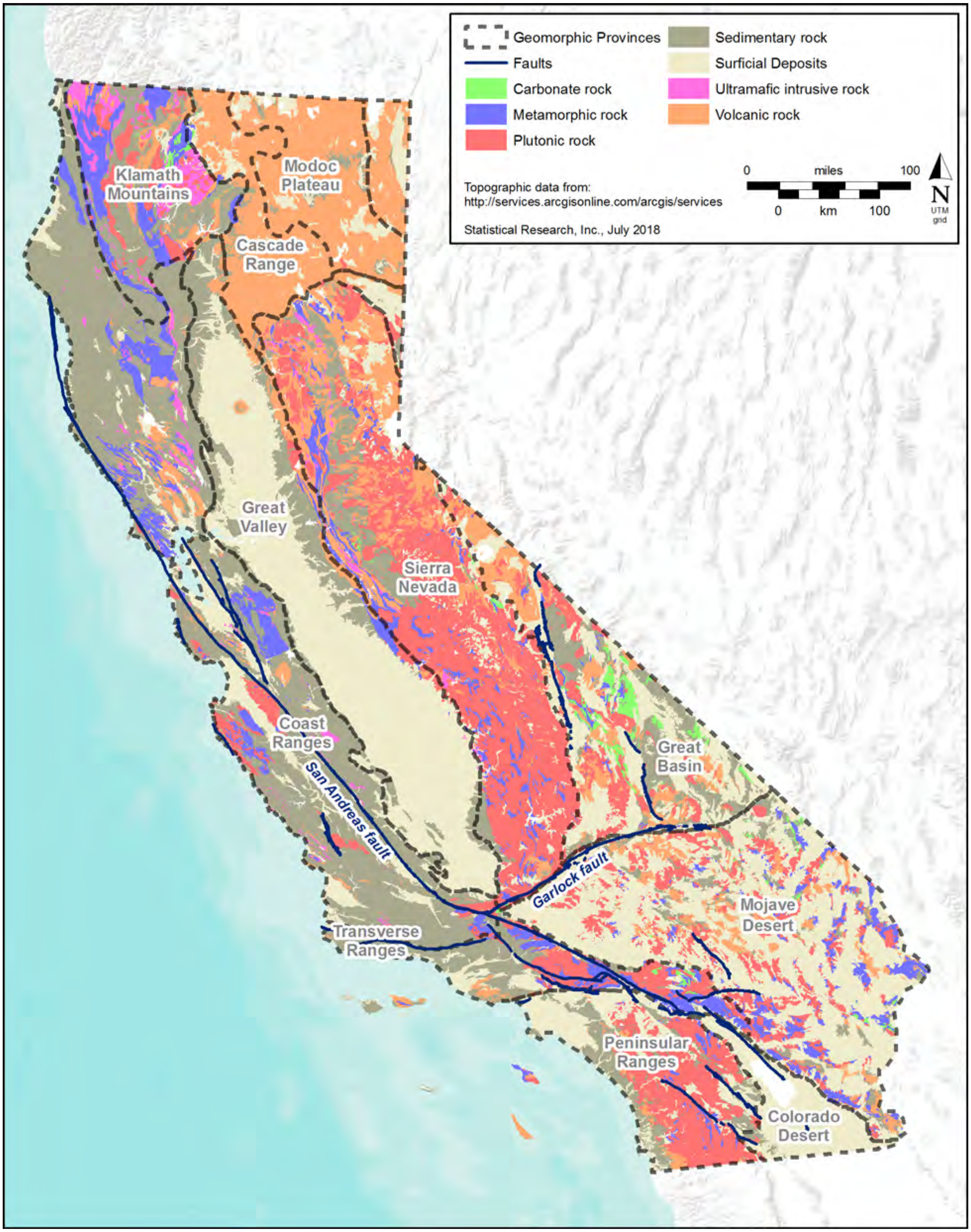


Figure 3.1. Map showing geomorphic provinces of California and their associated geology.

Local Geologic History

The project area lies within the Palo Verde Mesa, which is situated above and to the west of the Palo Verde Valley, adjacent to the western bank of the Colorado River. The portion of the Palo Verde Mesa containing the project area is located between the Big Maria Mountains to the north, the McCoy Mountains to the northwest (Figure 3.2), the Mule Mountains to the southwest (Figure 3.3), and the present-day path of the Colorado River to the east. The Palo Verde Mesa is a geomorphic terrace cut by the Colorado River that runs continuously from the Big Maria Mountains in the north to the Palo Verde Mountains in the south. In the most general sense, the sediments underlying the project area are a product of influence from the Colorado River, alluvial input from nearby topographic features, and soil formation during times of landscape stability (Fife and Brown 1980).

The geologic setting of the project area was extensively summarized in the paleontological assessment written by Reynolds and Lander (2016). Overall, the different geologic units within the vicinity of the project area have a complicated history with respect to their descriptions and nomenclatural use. For simplicity, discussion of geologic units within this report will follow the usage of Reynolds and Lander (2016) (Table 3.3). Below, we describe the relevant geologic units described within the project area and its vicinity. These descriptions are based off of geologic literature and will be expanded on in the discussion of results in Chapter 6.

Figure 3.2. The McCoy Mountains to the northwest of the DQSP paleontological field survey area.

Figure 3.3. The Mule Mountains to the southwest of the DQSP paleontological field survey area.

Table 3.3. Historical Nomenclatural Usage of Geologic Units Found within the Project Area

Unit	Age	Reynolds and Lander (2016)	Stone (2006)	Hayhurst and Bedrossian (2010)
Old terrace deposits	middle–late Pleistocene	Qot	Qpv	Qot
Stabilized aeolian and dune deposits	latest Pleistocene to Holocene	Qe	Qs	Qe
Active alluvial-fan deposits	Holocene	Qf-1	Qa-6	Qf
Alluvial-wash deposits	Holocene	Qw	Qw	Qw
Stabilized alluvial-fan deposits	Pleistocene	Qf-2	Qa-6	Qf

Paleozoic and Mesozoic Geology

The surrounding mountains provide a source for some of the sediments deposited within the project area and contain some of the oldest geologic units within the project's vicinity. The Big Maria Mountains to the north are a part of the Maria Fold and Thrust Belt that uplifted during orogenic (i.e., mountain-building) activity associated with the formation of the North American Cordillera near the end of the Mesozoic Era (especially the Cretaceous Period) (Spencer and Reynolds 1990). Geologically, the Big Maria Mountains are composed of a diverse suite of rocks of differing age and lithology. The oldest rocks contained within the range are Proterozoic granitic gneisses located in the northern portions of the mountains (Salem 2009). These Proterozoic basement rocks are overlain by Paleozoic metasedimentary rocks, including quartzite, schist, marble, metadolomite, metasandstone, and chert. Paleozoic rocks in the Big Maria Mountains are overlain by Mesozoic volcanic and sedimentary rocks, which are occasionally intruded by Jurassic plutonic rocks (Tosdal et al. 1989). Cenozoic rocks within the mountains are represented by rhyolite dykes, mafic dikes, and Quaternary surficial deposits (Salem 2009).

The McCoy Mountains to the northwest of the project area are an extensional fault-block mountain range containing metamorphosed sedimentary rocks of Mesozoic age (Pelka 1973). Many of these rocks have undergone relatively low-grade metamorphism and brittle deformation (unlike the geologic units of the Big Maria Mountains). The sequence of rocks exposed in the McCoy Mountains can be generalized as Jurassic volcanics in the northern part of the mountains that are unconformably overlain by the lithologically diverse Jurassic–Cretatceous-age McCoy Mountains Formation to the south (Salem 2009).

The Mule Mountains to the southwest are the closest major topographic feature to the project area. Compositionally, the Mule Mountains are made up largely of Proterozoic gneisses, Triassic plutonic rocks, and Jurassic volcanic and plutonic rocks (Stone 2006). Late Cretaceous deformation associated with the Mule Mountains Thrust has emplaced Proterozoic and Mesozoic rocks on top of younger Mesozoic volcanic rocks within the area (Tosdal 1990) (Figure 3.4). This tectonic activity resulted in low-grade greenschist facies metamorphism of many of the geologic units within the Mule Mountains (Figure 3.5).

Figure 3.4. Fault scarp along the northern margin of the Mule Mountains; evidence of tectonic history.

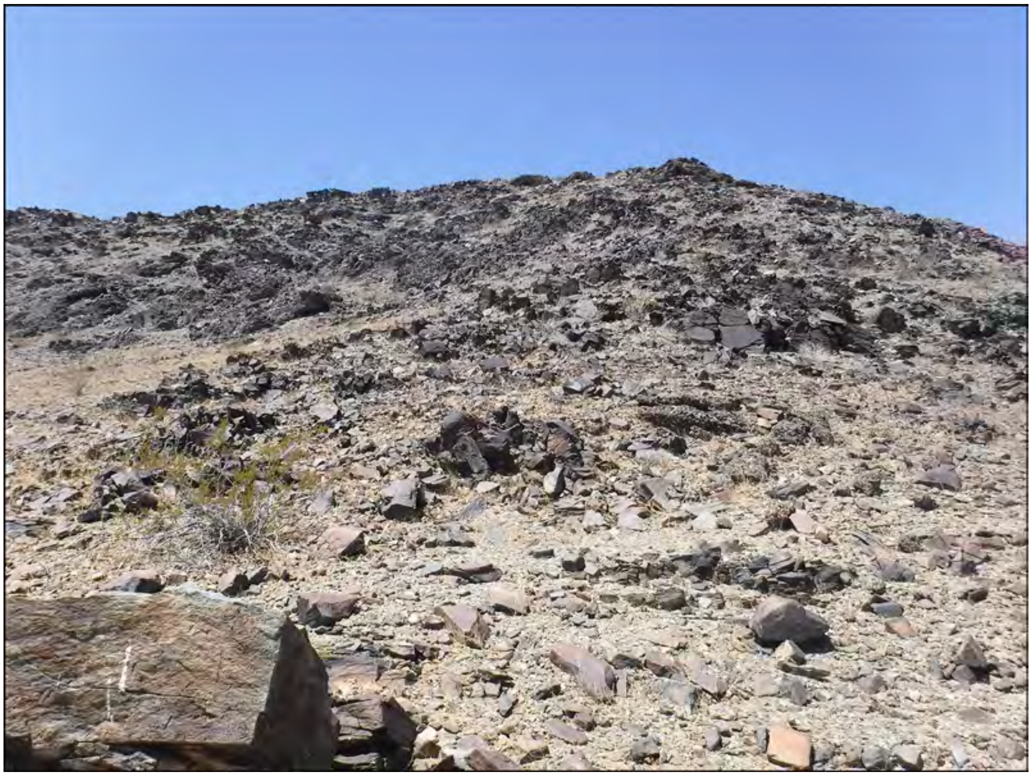


Figure 3.5. Metamorphosed Mesozoic igneous rocks on the northern slopes of the Mule Mountains.

Old Terrace Deposits (Qot)

The middle–late Pleistocene old terrace deposits represent sediments laid down in association with the Colorado River. Larger clasts within this unit consist of locally derived rocks mixed with rounded exotics deposited by the river (Stewart 2012). The old terrace deposits are generally composed of weakly consolidated sands, pebbly sands, silts, and clays (Stone 2006). The surface of these terrace deposits make up most of the surface of the Paleo Verde Mesa and lie approximately 20 m (65.6 feet) above the present-day Colorado River floodplain.

As part of a paleontological resource assessment survey for the Rio Mesa Solar project, Stewart (2012) identified a greater than 3.6-m- (12-feet-) thick fossiliferous paleosol developed on the sediments of the old terrace deposits. This paleosol, identified as an aridisol, often displayed a characteristic polygonal pattern at the surface interpreted as representing desiccation cracks. The base of the paleosol was found to contain moderate to high levels of carbonate (i.e., caliche) and rhizoliths (i.e., carbonate encrusted root traces).

Within the scope of the DQSP, the old terrace deposits have been mapped (Stone 2006) as being present across most of the project area (Figure 3.6a). These deposits are covered in the northwestern corner of the project area by stabilized alluvial-fan deposits (Qf-2) and active alluvial-fan deposits (Qf-1). Reynolds and Lander (2016) suggested that the "Palo Verde Mesa paleosol" of Stewart (2012) would likely be exposed within the old terrace deposits underlying the project area.

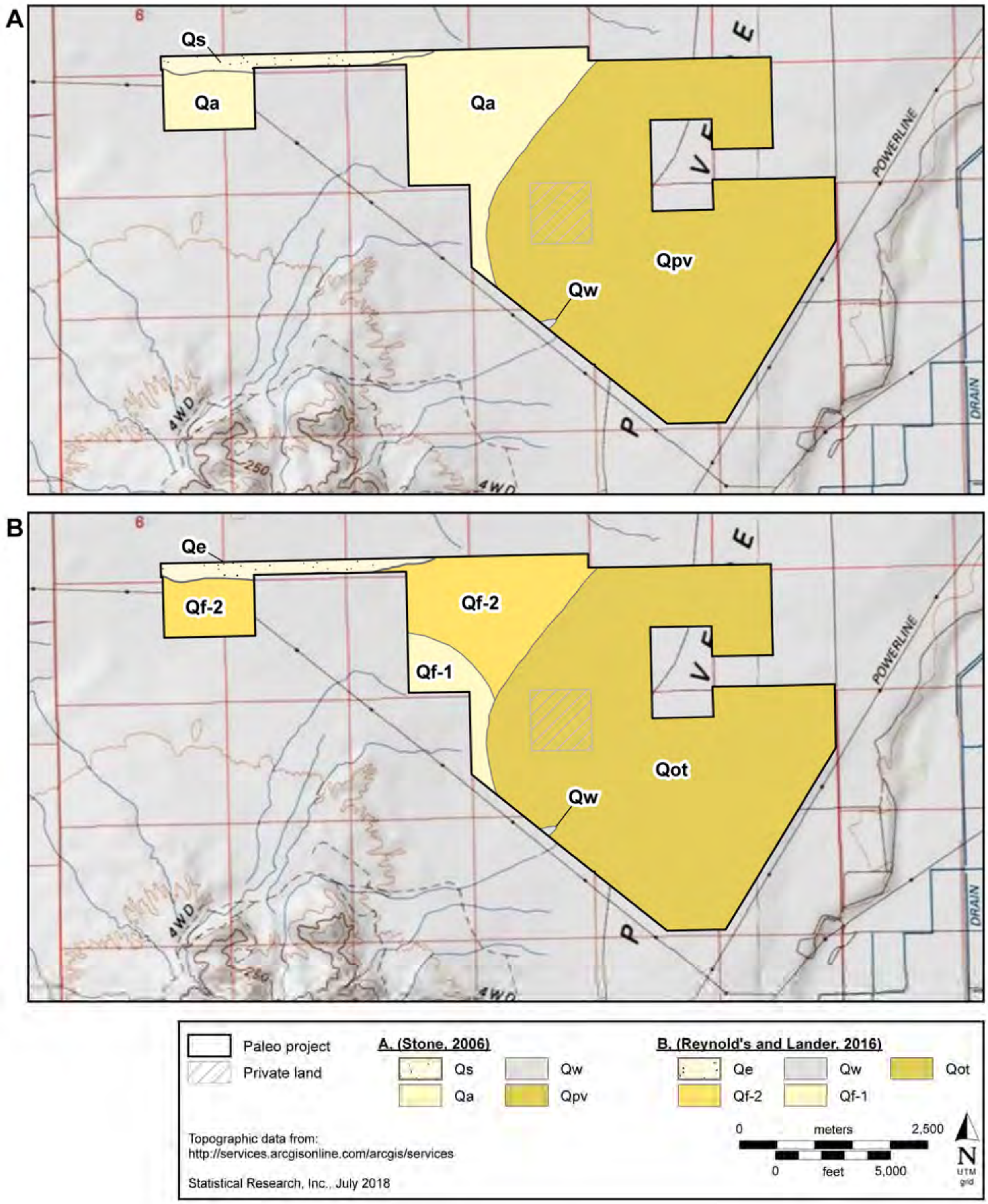


Figure 3.6. Geologic map of the DQSP paleontological field survey area as assessed by (*a*) Stone (2006) and (*b*) Reynolds and Lander (2016).

Stabilized Alluvial-Fan Deposits (Qf-2)

Alluvial fans are cone- or fan-shaped deposits of sediment that form at the boundaries between areas of high and low topography. The detrital sediments of the alluvial fan are transported and deposited by gravity, wind, and (most often) water. Such features are common in mountainous regions of the world and in tectonically active regions. Alluvial fans are potentially extensive features and can reach over 50 km (31 miles) in width and 60 km (37 miles) in length.

Both Stone (2006) and Hayhurst and Bedrossian (2010) mapped the sediments in the northwestern portion of the project area as young alluvial-fan and alluvial-valley deposits. These sediments were described as unconsolidated to weakly consolidated, angular to subangular gravels and sands derived from the local mountain ranges. Stone (2006) assigned a late Holocene age to these young alluvial deposits, based on similarity to units and geomorphic surfaces described by Bull (1991).

Reynolds and Lander (2016) departed from Stone (2006) and divided the young-alluvial-fan deposits into older "stabilized alluvial fan deposits" and younger "active alluvial fan deposits" (see Figure 3.6b). Using aerial and satellite images, they noted a difference in topography within young alluvial-fan deposits, which they suggested represents distinct active and stabilized alluvial-fan deposits. They also noted an interfingering of the stabilized alluvial-fan deposits with the old terrace deposits, which they considered to be evidence of older age. Given this, Reynolds and Lander (2016) assigned a late Pleistocene age to the stabilized alluvial-fan deposits, whereas the active alluvial-fan deposits retained the initial late Holocene–age assignment made by Stone (2006).

Stabilized and Active Aeolian and Dune Deposits (Qe)

The northern portion of the project area along the gen-tie corridor contains an area of exposed aeolian deposits (Jennings 1967; Stone 2006; Stone and Pelka 1989). These wind-deposited materials form small dunes and sheets across the landscape. Stewart (2012) suggested that these sediments are Holocene in age and are likely reworked from nearby Pleistocene deposits. Reynolds and Lander (2016) divided these deposits into active, Holocene dune fields overlying older, stabilized aeolian deposits of potentially Pleistocene age. SWCA Environmental Consultants (SWCA) (2011) similarly documented a shift from active to stabilized dune deposits with depth, corresponding to increased geologic age as well as paleontological potential.

Active Alluvial-Fan Deposits (Qf-1)

As discussed above for stabilized alluvial-fan deposits (Qf-2), the active alluvial-fan deposits within the project area are likely late Holocene in age. Gravels and sands within the unit are likely derived from the nearby Mule Mountains to the southwest but may have some minor input from the Big Maria and McCoy Mountains (Reynolds and Lander 2016). These deposits were separated from the stabilized alluvial-fan deposits by Reynolds and Lander (2016), based on apparent topographic differences visible on satellite and aerial images.

Active Alluvial-Wash Deposits (Qw)

Both Stone (2006) and Hayhurst and Bedrossian (2010) mapped a small area of active alluvial-wash deposits on the southwestern margin of the project area. The Southern California Mapping Project (2014) defined these types of deposits as unconsolidated sand-and-gravel deposits that are found in active channels of streams and rivers. These deposits typically have fresh flood scours, channel-and-bar morphology, and are present as (1) active deposits in steep-walled channels and arroyos incised into older alluvial units; (2) nonincised networks of active channels distributed across valley floors and alluvial fans; or (3) thin, active veneers that are present at the bottom of mountain canyons. The active alluvial-wash deposits within the project area are late Holocene in age (Stone 2006).

Surficial Geology

Soils and Surficial Geology

Soil developmental and geomorphic processes are often so closely interconnected in desert environments that the evolution of many desert landforms can be directly linked to soil-formation processes (Dixon 2009). The most significant of these processes include the development of surface crusts and pavements, the formation of vesicular A horizons, and the accumulation of clay and/or salts in the soil subsurface (Buol et al. 1997). In modern U.S. soil taxonomy, desert soils most commonly fall into two soil orders, aridisols and entisols. The aridisol order by definition includes soils in an aridic soil moisture regime (moist soil conditions are present less than 90 consecutive days with a soil temperature at 50 cmbs of 5°C or higher or the soil is dry in all parts more than half of the cumulative days in a year with a soil temperature at 50 cmbs of 8°C or higher) that have either a cambic, calcic, gypsic, petrocalcic, petrogypsic, salic, or duripan subsurface horizon (B horizon) (Buol et al. 1997; Schaetzl and Anderson 2005; Soil Survey Staff 2014). Put more simply, an aridisol is a desert soil with a diagnostic subsurface horizon (B horizon). Because the development of a subsurface horizon requires a fair amount of time, aridisols are commonly associated with desert landforms that have been stable for thousands to hundreds of thousands of years (Gile et al. 1981). Many of these soils developed under more-mesic conditions than today and could be considered relicts of the last full glacial climate.

Soils in an aridic soil moisture regime that do not have a subsurface horizon are classified as entisols (Soil Survey Staff 2014). These soils have an A horizon over pedogenically unaltered parent material (C horizons), most commonly stratified alluvium or aeolian sand. Entisols are generally considered to be "young" soils and are typically associated with deposits that aggraded during the latter half of the Holocene.

The County soil survey identifies five soil series within the project area (Figure 3.7; Table 3.4) (Soil Survey Staff 2018). Three of these soils are classified as aridisols (Aco, Chuckawalla, and Orita) with either an argillic and calcic or a cambic subsurface horizon. The remaining two soils (Carrizo and Rositas) are classified as entisols. The following summarizes the extent and basic characteristics of each individual soil series in the project area.

The Aco soil series is mapped over broad areas of the eastern and west-central project area and overlaps with both the Qot (early–middle Pleistocene Colorado River deposits) and the Qf (Holocene alluvium) geologic mapping units of Hayhurst and Bedrossian (2010) (see Figures 3.6 and 3.7; Table 3.4). The presence of a Bk subsurface horizon in this series indicates at least moderate levels of soil development/landform stability. Based on regional correlation with dated landforms, the Aco series likely represents Holocene (or older) fans (Harden et al. 1991; McFadden et al. 1989). Locally, this series may signify a mantle of younger alluvium over relict Pleistocene Colorado River deposits, where it overlaps with the Qot surface of Hayhurst and Bedrossian (2010).

The Carrizo series is mapped on recently abandoned late Holocene and active or recently active alluvial fans in the north-central project area, the Qf mapping unit of Hayhurst and Bedrossian (2010) (see Figure 3.6 and 3.7; Table 3.4). Carrizo soils are classified as entisols and have developed in stratified gravel and coarse sandy alluvium derived from mixed igneous rock types. This soil series is extensively mapped on floodplains, young alluvial fans, and basin floors across the Mojave, Sonoran, and southern Great Basin Deserts.

Chuckawalla soils are associated with older relict alluvial fans that extend southward from the McCoy Mountains into the northern part of the project area (see Figure 3.7). The Chuckawalla soil series is classified as an aridisol with calcic and argillic subsurface horizons developed in stratified silt loam and gravelly silty clay loam alluvial deposits (see Table 3.4). This series is commonly associated with piedmont surfaces characterized by well-developed desert pavement and dark-colored desert varnish in southwestern Arizona and southern California. The Chuckawalla series overlaps with the Qf geologic mapping unit of Hayhurst and Bedrossian (2010). Based on regional correlation with dated landforms, the areas mapped as the Chuckawalla series represent latest Pleistocene or older surfaces (Harden et al. 1991; McFadden et al. 1989).

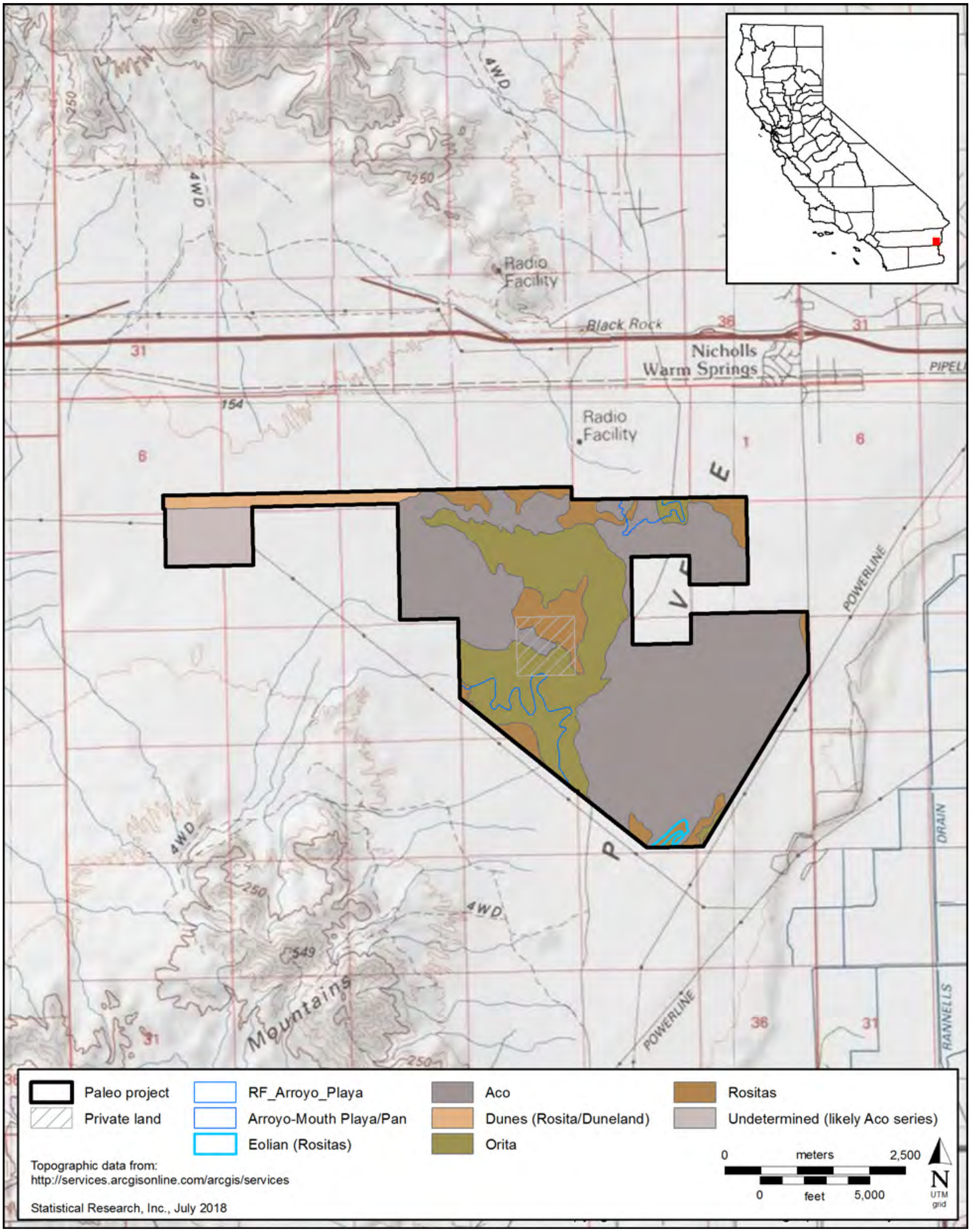


Figure 3.7. Soils map of the DQSP paleontological field survey area.

Table 3.4. Summary of Soil Types in the Project Area

Soil Series	Landform(s)	Geologic Mapping Unit[a]	B Horizon	Depth to B Horizon (cm)	Pavement/Varnish	Soil Texture	Regional Correlations[b]	Estimated Surface Age
Aco	distal fan/ alluvial plain	Qot and Qf (late Holocene and early–middle Pleistocene)	Bk	8	weak pavement/ weak varnish	sandy loam to coarse sandy loam	Holocene (or older) fans	Holocene (indeterminate)
Carrizo	incised channels and active fans	Qf (late Holocene	none	150+	none	gravelly sand	late Holocene fans	late Holocene
Chuckawalla	alluvial fan	Qf (late Holocene)	Bk and Btk	4	strong pavement/ moderate to strong varnish	silt loam and gravelly silty clay loam	late Pleistocene fans	late Pleistocene
Orita	distal fan/ alluvial plain	Qot and Qf (late Holocene and early–middle Pleistocene)	Bt and Btk	55	weak pavement/ absent to very weak varnish	gravelly fine sandy loam, gravelly clay loam	late Holocene over Pleistocene fans	late Holocene
Rositas	dunes, sand sheets, and blowouts	Qe, Qf, and Qot (late Holocene and early–middle Pleistocene)	none	150+	none	fine sand	Holocene and late Pleistocene aeolian deposits	late Holocene (dunes and sand sheets), older deposits (blowouts/ deflated areas)

[a] From Hayhurst and Bedrossian (2010).
[b] Based on Bacon et al. (2010), Harden (1982), McFadden et al. (1989), Miller et al. (2010), Rendell et al. (1994), and Lancaster and Tchakerian (2003).

The Orita soil series, mapped extensively in the west-central project area, is an aridisol developed in stratified alluvial-fan deposits derived from mixed bedrock sources (see Figure 3.7). The official soil series description for the Orita series identifies a well-developed buried soil mantled by 55 cm of late Holocene fan alluvium. The Orita series overlaps with the Qot and Qf geologic mapping unit of Hayhurst and Bedrossian (2010) (see Table 3.4). It is interesting to note that prior to the development of the modern soil classification system, Orita soils were simply identified as Red Desert soils (Soil Survey Staff 2018).

The Rositas soil series represents soils developed in locally thick sequences of late Pleistocene and Holocene aeolian sand (see Figure 3.7). Rositas soils are classified as entisols developed in dunes and sand sheets (see Table 3.4). The source of aeolian sand in the direct APE is linked to distal alluvial-fan and playa settings (Ford Dry Lake) immediately to the west in the Chuckwalla Valley. Regionally, aeolian deposition in the eastern Mojave Desert has been dated to 35–25 and 15–10 ka by Rendell et al. (1994) and from 7–4 ka by Smith (1967). Lancaster and Tchakerian further identified buried soils within the aeolian sand, marking periods of nondeposition and stability from 20–15, 14, and 4 ka. Rositas soils are extensively mapped in southern California, southwestern Arizona, and southern Nevada at elevations ranging from 83 m (270 feet) below mean sea level to 610 m (2,000 feet) above mean seal level. In the project area, the Rositas series overlaps with the Qe, Qf, and Qot geologic mapping units of Hayhurst and Bedrossian (2010).

Regulatory Environment

Applicable Regulations

The majority of the project area occupies public land managed by the BLM, which requires the issuance of a BLM ROW grant (ROW No. CACA 049397). The issuance of a ROW grant for the project is considered an undertaking, as defined by the National Historic Preservation Act (NHPA), and therefore, the project must comply with Section 106 of the NHPA, as amended (54 *U.S. Code* [USC] 300101 *et seq.*), and its implementing regulations, 36 *Code of Federal Regulations* (CFR) 800, as well as BLM policies regarding paleontological resources (BLM 2007, 2008, 2016). As required by the NHPA, as the federal agency that would approve the ROW grant, the BLM "shall take into account the effect of the undertaking on any historic property" (54 USC 306108). The BLM also must comply with the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (42 USC 4321 *et seq.*). The portion of the project on private land will require a Conditional Use Permit (CUP) from the County (Riverside County CUP No. 3721), along with review under the California Environmental Quality Act (CEQA), with the County as the lead CEQA agency. The BLM and the County will prepare a joint Environmental Impact Statement/Environmental Impact Report to meet the NEPA and CEQA requirements for the DQSP.

Federal Laws and Regulations

In general, management of paleontological resources on public lands is governed under multiple laws, regulations, and standards. These include NEPA, the Federal Land Management and Policy Act of 1976 (FLPMA), the Paleontological Resources Preservation Act of 2009 (PRPA) (16 USC 470aaa *et seq.*), and several BLM publications, including Manual H-8720-1 (BLM 1998) and IM Nos. 2008-009 (BLM 2007), 2009-011 (BLM 2008), and 2016-124 (BLM 2016). NEPA concerns paleontological resources as it recognizes the federal governments continued responsibility to "preserve important historic, cultural, and natural aspects of national heritage" (42 USC 4331). The FLPMA (43 USC 1701–1784) recognizes significant paleontological resources as scientific resources and requires federal agencies to manage public lands in a manner that protects the quality of such resources. For the purposes of FLPMA, a significant paleontological resource is considered

> a fossil which is unique, rare or particularly well-preserved; is an unusual assemblage of common fossils; is of high scientific interest; or provides important new data concerning:
>
> (1) Evolutionary trends;
>
> (2) Development of biological communities or interaction between organisms;
>
> (3) Unusual or spectacular circumstances in the history of life; or
>
> (4) Anatomical structure (47 *Federal Register* 35915 [August 17, 1982]).

In 2009, the PRPA was signed into law by President Barrack Obama under the Omnibus Public Lands Management Act (Public Law 111-11 [2009]). This act directed the Department of the Interior and Department of Agriculture to implement comprehensive paleontological resource management plans in order to protect paleontological resources on federal lands. The secretaries of both departments were instructed to use "scientific principles and expertise" in order to "develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources, in accordance with applicable agency laws, regulations, and policies. These plans shall emphasize interagency coordination and collaborative efforts where possible with non-Federal partners, the scientific community, and the general public" (16 USC 470aaa-1). Procedural guidelines for management of paleontological resources on BLM lands are discussed extensively in Manual H-8720-1 (BLM 1998) and BLM IM Nos. 2008-009, (BLM 2007), 2009-011 (BLM 2008), and 2016-124 (2016), and they provided the basis for the overall research design of the paleontological resource survey described in this report.

State Laws and Regulations

The proposed project is considered a "project" under the CEQA and is subject to compliance with the CEQA (*Public Resources Code* [PRC] 21000 *et seq.*) and CEQA guidelines (14 CCR 15000 *et seq.*), as amended. The County of Riverside is the CEQA lead agency. The CEQA mandates that lead agencies consider whether a proposed project will have an adverse effect on the environment and whether any such effect can be feasibly eliminated by pursuing an alternative course of action or can be mitigated to less-than-significant levels. CEQA recognizes that historical resources are part of the environment and that "a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment" (PRC 21084.1).

The State of California provides protection for paleontological resources as historical resources under the CEQA guidelines. Under these guidelines, the term "historical resource" is defined "as any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California" (14 CCR 15064.5[a][3]). Furthermore, for the purposes of the CEQA, a historical resource is any object, building, structure, site, area, place, record, or manuscript listed in or eligible for listing in the California Register of Historical Resources (CRHR) (PRC 21084.1). A resource is eligible for listing in the CRHR if it meets any of the following criteria (PRC 5024.1[c]):

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

Although paleontological resources are not eligible for listing in the CRHR, CEQA (14 CCR 15064.5[a][(4]) also states that eligibility for listing in the CRHR does not preclude a lead agency from determining that a resource may be a historical resource, as defined in PRC 5020.1(j) and 5024.1. Finally, the CEQA implementing guidelines (14 CCR 15000 *et seq.*) define the persons, agencies, activities, and procedures required to comply with CEQA. These guidelines include, as an issue to be addressed within the CEQA Environmental Checklist, the question, "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" (CEQA Guidelines, Appendix G, Section V[c]). These protections apply only to State of California land, and thus apply only to portions of the proposed project that are on state land.

Local Laws and Regulations

The County of Riverside General Plan sets forth the goals, policies, and programs the County uses to manage future growth and land uses. Although the General Plan usually only applies to portions of the County that are unincorporated, this section is being included for completeness. The following open space (OS) element policies contained in the General Plan (County of Riverside 2015) are designed to protect paleontological resources within the County:

OS 19.6 Whenever existing information indicates that a site proposed for development has high paleontological sensitivity. . . a paleontological resource impact mitigation program (PRIMP) shall be filed with the County Geologist prior to site grading. The PRIMP shall specify the steps to be taken to mitigate impacts to paleontological resources.

OS 19.7 Whenever existing information indicates that a site proposed for development has low paleontological sensitivity. . . no direct mitigation is required unless a fossil is encountered during site development. Should a fossil be encountered, the County Geologist shall be notified and a paleontologist shall be retained by the project proponent. The paleontologist shall document the extent and potential significance of the paleontological resources on the site and establish appropriate mitigation measures for further site development.

OS 19.8 Whenever existing information indicates that a site proposed for development has undetermined paleontological sensitivity. . . a report shall be filed with the County Geologist documenting the extent and potential significance of the paleontological resources on site and identifying mitigation measures for the fossil and for impacts to significant paleontological resources prior to approval of that department.

OS 19.9 Whenever paleontological resources are found, the County Geologist shall direct them to a facility within Riverside County for their curation, including the Western Science Center in the City of Hemet.

Permits and Approvals

This survey and report were conducted under BLM Paleontological Resources Use Permit No. CA-18-01P issued to Joseph El Adli, Ph.D., on March 27, 2018 (expiring April 27, 2019). All paleontological work on BLM land was approved and coordinated by the BLM Palm Springs South Coast Field Office. BLM Paleontological Fieldwork Authorization No. PFA-18-01 was issued to Dr. El Adli on May 10, 2018, for paleontological survey work related to the DQSP occurring from May 14 to June 8, 2018. Following BLM guidelines, all fossils collected from BLM land are required to be housed in a federally approved paleontological repository. Although no fossil remains were collected during the paleontological field survey, the repository designated for the above-listed permit number is the Western Science Center in Hemet, California.

CHAPTER 5

Research Design and Methods

The following chapter discusses the research questions and necessary data required to assess the paleontology and paleontological resource potential at the DQSP site. Data collected for this study included background and archival research, a paleontological records search of museum collections, and a paleontological field survey. Specific attention will be made to document the methods used during the field survey, as data recovered from this task will be the most informative in determining the paleontological significance of the project area.

The initial paleontological resource assessment for the project area, conducted by Reynolds and Lander (2016), recommended a preconstruction field survey be conducted over the entirety of the project area prior to the start of any earthmoving activities. This field survey was tasked with providing "ground truth verification" of the preliminary PFYC assignments made by Reynolds and Lander (2016) for each exposed geologic unit. At its core, this task forms the primary directive for this report, but other tasks are treated with equal significance. A second priority was the identification and documentation of any paleontological resources (i.e., fossils) located on the surface within the project area. Such fossil finds, especially those of scientific importance or significance, made during the field survey helped to inform the assignment of PFYC ranks for each geologic unit. Finally, the survey attempted to identify the location of contacts between the geologic units exposed in the project area. Geologic units were remapped in order to either confirm or modify those identified by previous authors (e.g., Stone 2006) at a coarser scale. This included an investigation into the validity of separating the alluvial deposits in the northwestern portion of the project area into separate active (Qf-1) and stabilized (Qf-2) units, as proposed by Reynolds and Lander (2016). The findings of the survey, as well as all other forms of data collection, are reported in Chapter 6.

Literature Review

Background and archival research was necessary to correctly interpret and evaluate the geologic and paleontological history of the area underlying the project. The findings of both published scientific literature and published and unpublished technical reports were examined. Some of these findings are summarized in Chapter 3, especially as they relate to the geologic history of the area at the regional and local scale. In our review of the literature, we identified three prior studies that documented the paleontology and geology within and around the project area; all related to proposed solar projects. The first is the paleontological resource assessment of the immediate project area conducted by Reynolds and Lander (2016) for the DQSP. The second report is a paleontological resource assessment and field survey associated with the McCoy Solar Energy Project conducted by SWCA (2011). This second report involved a paleontological survey of a project area located several miles to the north of the DQSP area but also included the entirety of the gen-tie corridor associated with the project area assessed in this report. Finally, the third report described the findings of a paleontological resource assessment and field survey of the Rio Mesa Solar Project conducted by Stewart (2012). The Rio Mesa Solar Project report documented an area located several miles to the south of the DQSP and identified hundreds of fossil remains within that project area. Secondary materials, including local and regional histories, government mining reports, and geologic maps provided further context and are cited herein, as appropriate.

Records Search

Records searches were conducted with the Natural History Museum of Los Angeles County Department of Vertebrate Paleontology (LACM) and with the San Bernardino County Museum (SBCM) during the initial paleontological assessment by Reynolds and Lander (2016). A further records search was requested from the San Diego Natural History Museum (SDNHM) for this report, as this institution holds many important fossil specimens of regional significance within its collections. In general, these reports summarized the geologic context of the project area and identified all known paleontological remains or localities within the project area and its surrounding vicinity. The search area for these reports was variable between institutions but usually encompassed at least a 1-mile-wide buffer area around the project area. The findings of these fossil locality reports is summarized in Chapter 6 and is used to assist in assignment of a PFYC ranking for each geologic unit underlying the project area.

Field Survey

A comprehensive pedestrian survey was conducted by SRI over the 3-week period between May 14 and June 1, 2018. The survey of the project area was conducted by a four-person team, which included the principal investigator and three field assistants. All survey methods followed the BLM guidelines outlined in BLM IM No. 2009-011 (BLM 2008).

The survey was conducted by walking straight-line transects at 30-m (98-foot) intervals. A 200-foot buffer zone outside of the project area also was surveyed per guidelines for paleontological field surveys laid out by the BLM (2008). The progress of the survey was monitored using Trimble Geo XT/XH Global Positioning System (GPS) units, as well as series of topographical, geologic, and aerial photographic base maps. The principal investigator used the GPS unit to record all identifiable paleontological resources encountered within each transect. Unidentifiable fossil remains and small pieces of petrified wood were noted within crewmember field notes (especially as to the frequency of occurrence in a given geologic unit) but were not given a waypoint or field number. Identifiable paleontological resources were assigned field numbers associated with a GPS waypoint, and relevant taphonomic and stratigraphic data were recorded in field notebooks. Field observations were made with regard to the context of a specimen in relation to the stratigraphy in which it was discovered, the aerial extent of the fossil-bearing strata, the density of fossils within the strata, recognition of the geologic unit within which the fossil was collected, and any additional pertinent information. Illustrations of specimens were made when appropriate. Field photographs were taken with a 16-megapixel Fujifilm PX90 camera. Photographs documented the fossil within its geologic context, as well as the surrounding area. Waypoints also were collected at identifiable boundaries between geologic units. Field notes, field photographs, and fossil-resource localities were keyed to GPS waypoints to provide comprehensive documentation of existing geologic and paleontological conditions. Where possible, attempts were made to detect the presence and nature of subsurface native sediments. No specimens were collected during the field survey, as was outlined in the BLM Fieldwork Authorization (see Appendix C). Therefore, a separate field program will be necessary to collect any significant fossil remains found within the project area during the field survey prior to any earthmoving activities.

CHAPTER 6

Results

The results of the DQSP paleontological field survey and assessment are presented in this chapter. The chapter begins with a review of the literature that is focused on previous paleontological assessments and field surveys conducted within the vicinity of the project area. Information collected during the paleontological records search at the SDNHM and those records previously reported in the initial DQSP paleontological assessment (Reynolds and Lander 2016) is also discussed. Finally, the results of the paleontological field survey of the project area are presented, with particular attention paid to paleontological and geological discoveries. The paleontological resource potential of each geologic unit, based on the findings presented in the results, will be discussed. A full concordance of all fossil localities is contained in Appendix E.

Literature Review

Paleontological resource assessments have been conducted for three proposed solar projects within and in the vicinity of the DQSP. Two of these reports (SWCA 2011; Stewart 2012) involved paleontological field surveys, and both found paleontological resources in similarly mapped geologic units to those underlying the DQSP area. The reports by SWCA (2011) and Reynolds and Lander (2016) both included an assessment of the paleontological resource potential of all (Reynolds and Lander 2016) or a portion (SWCA 2011) of the immediate project area. The findings of these reports are summarized below.

McCoy Solar Energy Project (SWCA 2011)

The paleontological assessment and field survey for the McCoy Solar Energy Project (MSEP) was conducted by SWCA in November of 2011. MSEP was a proposed 750-MW PV solar-energy-generating facility with related infrastructure. Most of the project was located north of Interstate 10 to the northwest of Blythe, California, but an associated gen-tie route was to extend south from the main Solar Plant site to accommodate construction of transmission lines. A portion of this gen-tie route associated with the MSEP overlaps with the entirety of the gen-tie corridor associated with the DQSP.

Pedestrian paleontological field survey of the MSEP project area revealed similar geologic units to those exposed under the DQSP area. Most of the MSEP project area was underlain by older and younger alluvial-fan deposits. The younger deposits (in the eastern portion of the project area) was characterized by tan, unconsolidated sands with some subrounded pebble-sized clasts scattered on the surface, whereas the older alluvium (in the western portion of the project area) was described as subrounded to subangular cobbles coated with desert varnish and cobble-sized clasts of quartzite that were not coated with desert varnish (SWCA 2011). Exposures of old terrace deposits were identified in the southeastern portion of the gen-tie route but were not described in any detail. Similarly, stabilized and active aeolian sand dune deposits were found in the western portion of the gen-tie route but were not thoroughly described.

During the survey, a single vertebrate fossil was recovered from the gen-tie route. This fossil, identified as a fragment of desert tortoise carapace, was found in a lag deposit on top of alluvial-fan sediments. The lack of clear provenance for the specimen and its fragmentary nature led those authors to classify the fossil as not scientifically significant.

The paleontological resource potential was assessed for each geologic unit within the MSEP project area using the criteria and classification system of SVP (1995). These rankings were based on the results of the survey, as well as information gathered from records and literature searches. SWCA (2011) assigned a high paleontological resource sensitivity to the older alluvial deposits and the old terrace deposits, based on known finds of significant terrestrial vertebrate fossils in similar deposits from the region. Younger alluvial deposits and the aeolian sand dune deposits were assigned a paleontological resource potential ranging from low to high. This range in resource sensitivity was meant to reflect the increased potential of these units for yielding significant fossil remains with depth. The authors suggested that the units assigned a "low to high" resource potential could produce scientifically important fossil remains as shallow as 1.5 m (5 feet) below the surface.

Rio Mesa Solar Electric Generating Facility Project (Stewart 2012)

A paleontological assessment and field survey was conducted for the proposed Rio Mesa Solar Electric Generating Facility (Rio Mesa) from March to June 2011 by URS Corporation (Stewart 2012). The Rio Mesa Project was proposed as three 250-MW solar concentrating thermal power plants located within a shared common area. The proposed project was located 21 km (13 miles) southwest of Blythe, California, immediately east of the Mule Mountains and several miles south of the DQSP.

The field survey component of Rio Mesa paleontological assessment was conducted within the project area and within 1 mile of its vicinity. Project paleontologists performed pedestrian survey of all geologic units underlying the project area, with the exception of the younger alluvium, which was considered too young to reasonably contain significant paleontological resources. The field survey discovered a widely distributed paleosol that was developed on the old terrace deposits (Stewart 2012). This paleosol was found to be at least 3.6 m (12 feet) thick and produced over 650 vertebrate fossil remains (see taxonomic list in Table 6.1). Stewart (2012) noted that fossils of large vertebrates from the paleosol are often incomplete as they are typically only preserved when smaller animals drag larger remains into their burrows. A fossil freshwater fish also was discovered from units equivalent to the Pleistocene Chemehuevi Formation (see Unit D of Metzger et al. [1973]), which the old terrace deposits likely incise into.

Table 6.1. Vertebrate Fossil Taxa Recovered from Palo Verde Mesa Paleosol at the Rio Mesa Solar Electric Generating Facility Project Site

Higher-level Taxon	Family	Taxonomic Name	Common Name
Lissamphibia	Bufonidae	gen. et sp. indet.	toad
Testudines	Testudinidae	*Gopherus* sp.	desert tortoise
Lacertilia	Iguanidae	*Dipsosaurus* sp.	desert iguana
		Phrynosoma platyrhinos	desert horned lizard
Serpentes	Colubridae	*Phyllorhynchus decurtatus*	spotted leaf-nosed snake
	Viperidae	*Crotalus* sp.	rattlesnake
Aves	Fringillidae	gen. et sp. indet.	finch
Lagomorpha	Leporidae	*Sylvilagus* sp.	cottontail
		Sylvilagus bachmani	brush rabbit
		Lepus californicus	jackrabbit
Rodentia	Heteromyidae	*Dipodomys deserti*	desert kangaroo rat
		Chaetodipus/Perognathus sp.	pocket mouse
	Geomyidae	*Thomomys* sp.	pocket gopher
Carnivora	Mustelidae	*Taxidea taxus*	badger
Perrisodactyla	Equidae	cf. *Equus*	horse
Artiodactyla	Cervidae	*Odocoileus* sp.	deer
	Bovidae	*Ovis canadensis*	bighorn sheep
Proboscidea	Elephantidae	*Mammuthus* sp.	mammoth

Note: Modified from Reynolds and Lander (2016); after Stewart (2012).

Paleontological resource potential was assessed and classified using the systems developed by SVP (1995) and the BLM (2008). As was the case for the assessment of the MSEP project, assignment of these rankings were based on the results of the survey, records searches, and review of the literature. The Chemehuevi Formation equivalents were assigned an SVP rank of high and PFYC Class 4b, based on known fossil occurrences from the literature and field survey. The silts, sands, and gravels of the old terrace deposits were assigned a high paleontological resource potential under the SVP guidelines and PFYC Class 3b. This assignment was based largely on the lithology and age of the sediments. The fossiliferous Palo Verde Mesa paleosol that developed on the old terrace deposits was assigned an SVP rank of high and PFYC Class 4a, based on the abundant fossil discoveries made during the field survey. Alluvial-fan and aeolian deposits all were designated as having a low paleontological resource potential under the SVP classification system and PFYC Class 2. It is not clear whether these surficial deposits were evaluated based on age, degree of consolidation, or subsurface resource potential as was done at MSEP by SWCA (2011).

DQSP (Reynolds and Lander 2016)

A paleontological assessment for the DQSP was conducted by Paleo Environmental Associates, Inc. (Reynolds and Lander 2016). This assessment concerned the same field area and project area as this report (see Chapter 1). However, the assessment by Reynolds and Lander (2016) included consideration of a northern extension of the project area north of the gen-tie corridor that is not relevant for this paleontological field survey report. The DQSP paleontological assessment was a desktop survey of the relevant geological and paleontological literature, as well as a records search of fossil localities contained within the collections of the SBCM and the LACM. The Reynolds and Lander (2016) assessment did not include a field component.

Reynolds and Lander (2016) identified several geologic units within the project area that had the potential to contain significant paleontological resources (see the section Local Geologic History in Chapter 3). They assigned paleontological resource potential to each geologic unit to a now-outdated BLM PFYC system (BLM 2008). Of those units classified by Reynolds and Lander (2016), only the Pliocene Bullhead Alluvium is not relevant to the scope of this study, as those deposits only outcrop north of the gen-tie corridor. Based on review of the available literature, those authors assigned the old terrace deposits (Qot) to PFYC Class 5a (very high). This classification was based on the multitude of fossil discoveries made from similar deposits associated with the Rio Mesa Project by Stewart (2012). The stabilized alluvial-fan deposits (Qf-2) also were assigned to PFYC Class 5a (very high), based partially on the stipulation that the paleosol discovered by Stewart (2012) may have been developed on this unit. Stabilized portions of the aeolian and dune deposits (Qe) were assigned to PFYC Class 3b (unknown), as these deposits were formed in conditions that have the potential to preserve significant fossils, but no such remains are known from the project area or vicinity. The active alluvial-fan deposits (Qf-1), active aeolian and dune deposits (Qe), and active alluvial-wash deposits (Qw) were each assigned to PFYC Class 2 (low). This classification was determined based on the young, Holocene age of these deposits, making it unlikely for these units to contain significant paleontological resources.

Records Search

Paleontological records searches provided valuable information on known fossil localities held in museum collections from in and around the project area. Such data helped to inform on the potential for disturbing significant paleontological resources during project-related construction activities. Three searches of museum records were conducted in relation to the DQSP. Two of these searches were made for the initial paleontological resource assessment of the project area (Reynolds and Lander 2016), and the third was requested in association with this report. The results of all three records searches are summarized below and are provided in full in Appendix A.

A records search of the collections at the LACM found no known fossil localities within the immediate project area (McCleod 2013). However, nearby fossil localities are known from deposits similar to the Quaternary alluvium found in the northwestern portion of the project area. These deposits produced specimens of small rodents such as kangaroo rats (*Dipodomys*) and pocket mice (*Perognathus*). Deposits of older Quaternary sediments (of similar age to the old terrace deposits underlying the project area) several miles to the northwest also were found to produce important fossil remains of tortoise (*Gopherus*), horse (*Equus*), camel (*Camelops*), and llama-like camel (*Tanupolama stevensi*). McCleod (2013) suggested that these results indicated that shallow excavations into younger aeolian and alluvial deposits may not encounter significant paleontological resources. However, deeper excavations into older deposits would have an increased likelihood of disturbing important fossil remains.

The SBCM completed a brief literature review and a records search of the Regional Paleontological Locality Inventory at the SBCM (Scott 2013). No SBCM fossil localities were found within the project area or its vicinity. However, several published scientific articles reported finding significant paleontological resources from sediments similar to those underlying the project area. Bishop (1963) reported remains of mammoth (*Mammuthus*) from similar sediments in the area. Jefferson (1991) documented fossil finds in the vicinity of Blythe (although no specific taxonomic information was reported and the precise location of the site was not provided), as well as remains of horse and camel found several miles to the north of the DQSP area. Scott (2013) suggested that the presence of known fossil localities reported from similar sediments near the project area indicated that there is a high potential for excavations associated with project development to negatively affect significant paleontological resources.

A paleontological records search of the collection at the SDNHM Department of Paleontology returned no known fossil localities within 1 mile of the project area (McComas 2018). However, McComas (2018) noted that a variety of important fossil resources have been recovered from deposits of similar lithologies and depositional histories in the region (especially Pleistocene alluvial-fan deposits; see Metzger et al. 1973). Given these data, McComas assigned a preliminary PFYC classification and SVP ranking for each mapped geology unit underlying the project area. The old terrace deposits are were assigned a high paleontological resource potential (SVP 2010) or assigned to PFYC Class 4 (BLM 2016). Older, stabilized alluvial-fan deposits were given an unknown (PFYC Class U) or undetermined paleontological resource potential because of regional variation in the concentration of fossil resources within these type of deposits. Active alluvial and aeolian deposits were assigned to a low paleontological resource potential or PFYC Class 2. These assignments are the same as those assigned to geologic units underlying the proposed Rio Mesa Solar Project by Stewart (2012) and similar to those assigned by Reynolds and Lander (2016) for the DQSP.

Field Survey

The paleontological field survey for the DQSP was conducted over 15 workdays by four SRI paleontologists. In the field, each paleontologist observed and documented the geology, stratigraphy (where visible), and paleontology of the project area. These observations resulted in minor changes to the boundaries of mapped geologic units (relative to those of Stone [2006] and Reynolds and Lander [2016]) and identification of a multiple paleontological resources (Figure 6.1; see Figure 3.6). The findings of the field survey as they relate to the paleontological and geological history of the project area are discussed in the following sections. Maps and locality records detailing the location of paleontological resources within the project area are presented in confidential Appendix E.

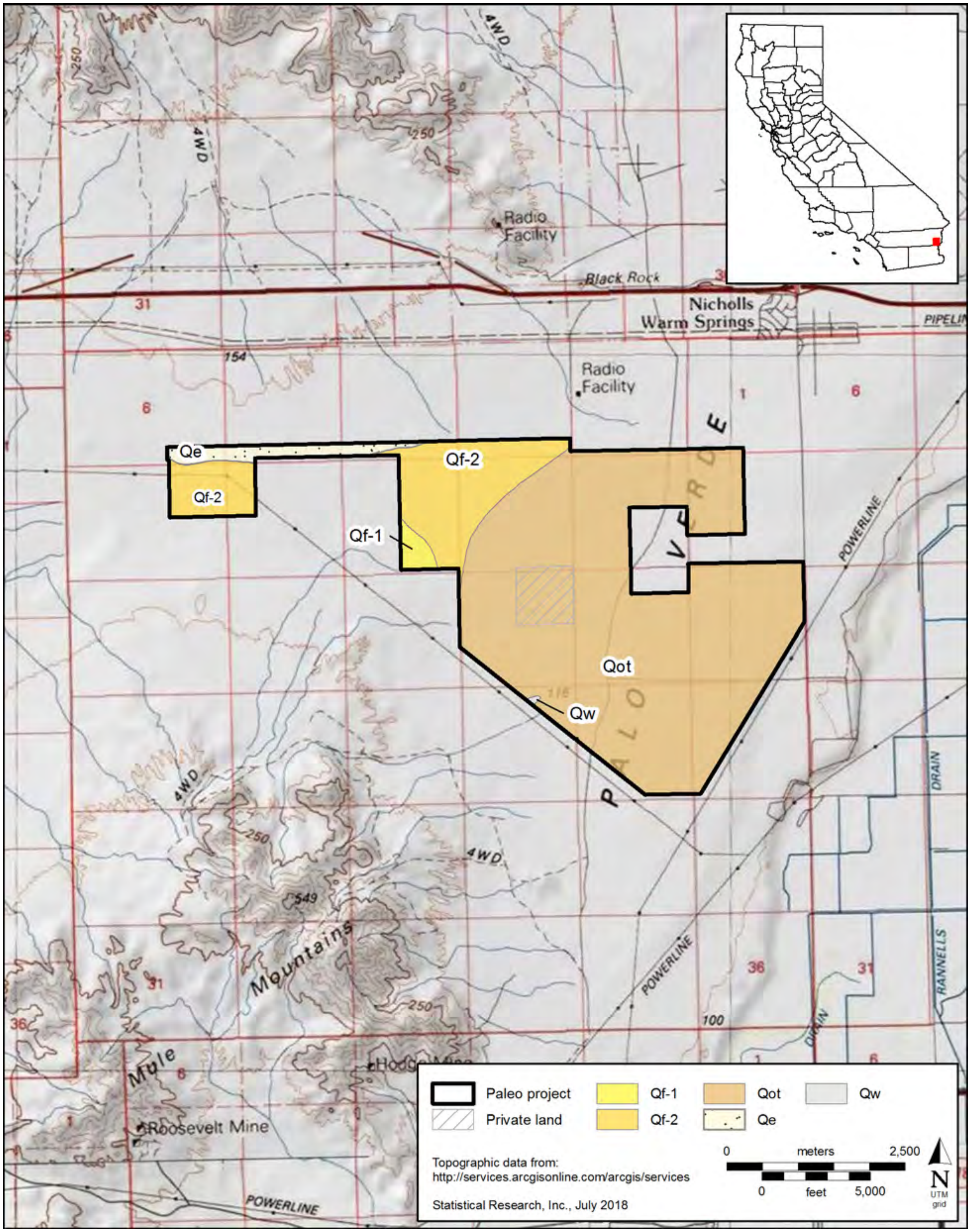


Figure 6.1. Current geologic map of the DQSP area as remapped during the paleontological field survey.

Overview of Results

In total, 39 localities containing paleontological resources were discovered during the field survey. All of these localities contained single specimens, usually preserved as single elements. These specimens represent members of at least four vertebrate taxa (Table 6.2). Of the localities documented, 32 contained remains of fossil vertebrates, whereas the other 7 contained isolated fragments of petrified wood. Three of these remains (two isolated horse teeth and a rabbit lower jaw; Localities SRI-VP-20180002, SRI-VP-20180008, and SRI-VP-20180024; see Appendix E) we consider to be scientifically significant based on the degree of preservation, identifiability, and relative rarity.

The nature of each geologic unit within the project area and the boundaries between units were noted where possible. The alluvial-fan deposits in the northwestern portion of the project area were found to have discernable active and stabilized portions, supporting the assertions of Reynolds and Lander (2016) that the Qf unit of Stone (2006) should be divided into a younger (Qf-1) unit and an older (Qf-2) unit within the DQSP area (see Figure 3.6). However, the exposure of the younger, active alluvial-fan deposits were found to be far less extensive within the project area than had been interpreted by Reynolds and Lander (2016), based on aerial and satellite photography (see Figure 6.1). The old terrace deposits make up most of the project area, as was expected. The northwest boundary between the stabilized alluvial-fan deposits (Qf-2) and the old terrace deposits was found to extend slightly farther northwest than was mapped by Stone (2006). This was determined based on surficial and subsurficial geology, as well as the presence or absence of certain fossil taxa within each unit (i.e., tortoise remains in Qot and abundant petrified wood in Qf-2). No significant differences were found in the extent and exposure of the other geologic units found within the project area compared to what was originally mapped by Stone (2006). The paleontological resource potential of each of these geologic units was assessed using the finds of the field survey, records searches, and literature survey, based on both the PFYC classification system (BLM 2016) and the SVP (1995) ranking system, as presented in Table 6.3 and Figure 6.2.

Table 6.2. Fossil Taxa Discovered during the DQSP Paleontological Field Survey

Higher-level Taxon	Family	Taxonomic Name	Common Name	Geologic Unit(s)	Soil Type				Total
					Aco	Orita	Aco/ Orita	Rositas	
Testudines	Testudinidae	cf. *Gopherus* sp.	desert tortoise	Qot; Qe(?)	24	4	—	—	28
Lagomorpha	Leporidae	*Lepus* sp.	jackrabbit	Qot	—	1	—	—	1
Perissodactyla	Equidae	*Equus* sp.	horse	Qot	1	—	—	1	2
Proboscidea	cf. Elephantidae	cf. *Mammuthus* sp.	mammoth	Qf-2	1	—	—	—	1
Spermatophyta	fam. indet.	gen. et sp. indet.	seed plant (petrified wood)	Qf-2; Qot	2	3	2	—	7

Table 6.3. Paleontological Resource Potential of Geologic Units Found within the Project Area Using the PFYC Classification and SVP Ranking Systems

Geologic Unit	Symbol	Age	PFYC Class[a]	SVP Rank[b]
Old terrace deposits	Qot	middle–late Pleistocene	4	high
Stabilized alluvial-fan deposits	Qf-2	Pleistocene	3	high
Active and stabilized aeolian and dune deposits	Qe	latest Pleistocene–Holocene	2 (active); 3 (stabilized)	low to high (with depth)
Active alluvial-fan deposits	Qf-1	Holocene	2	low
Alluvial-wash deposits	Qw	Holocene	2	low

Key: PFYC = Potential Fossil Yield Classification; SVP = Society of Vertebrate Paleontology.
[a] Classification according to BLM (2016).
[b] Ranking according to SVP (2010).

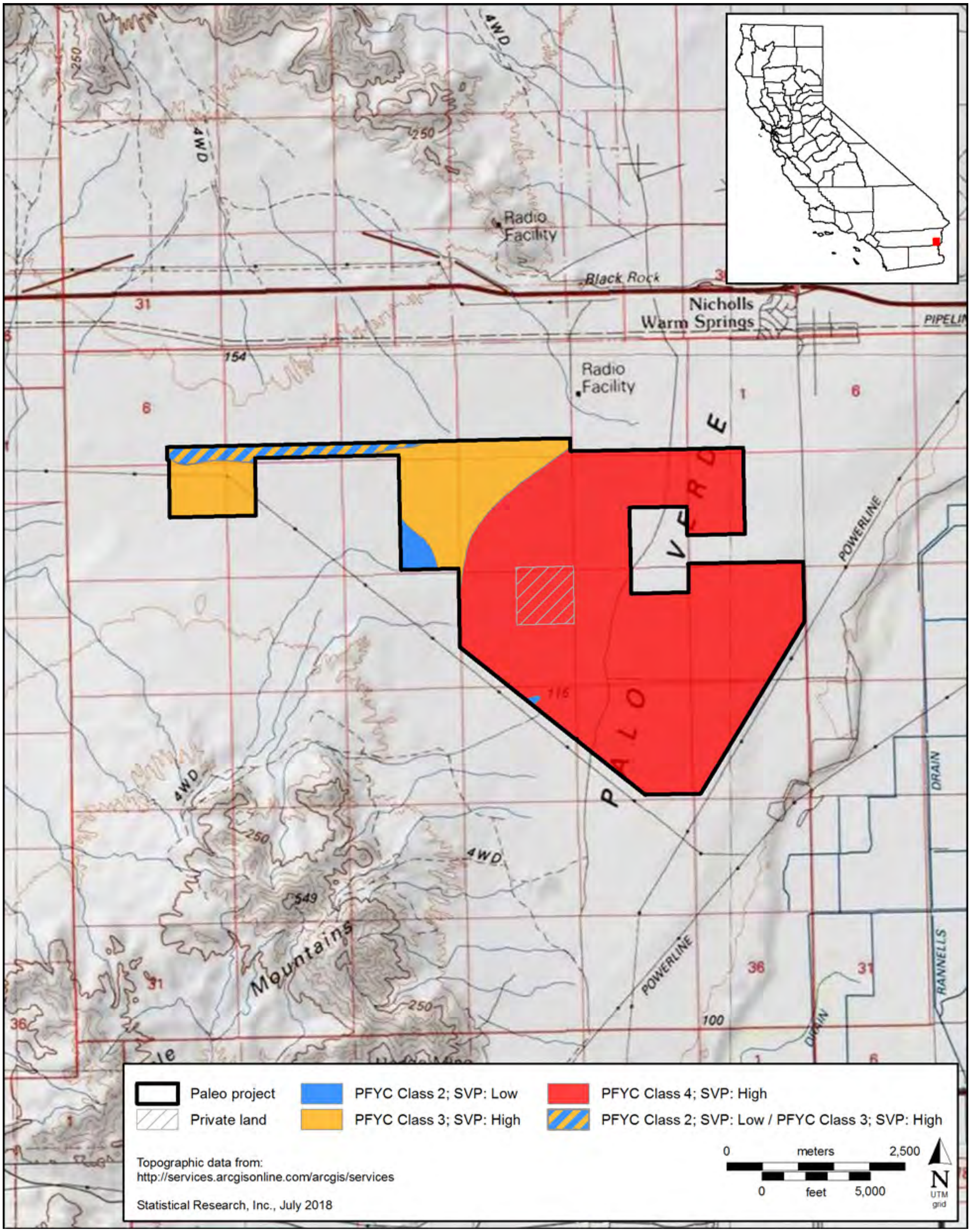


Figure 6.2. Map showing the paleontological resource potential of geologic units underlying the DQSP area.

Private and Public Lands in the Project Area

Public Lands

Most of the survey area consists of public lands (all except 160 acres). Consequently, all but two fossil localities (both containing tortoise remains) were discovered from public lands. All but one specimen (an isolated fragment of tortoise shell found outside of its geologic context) found within these public lands were discovered south of the gen-tie corridor. Portions of the project area on public lands are altogether underlain by all geologic units discussed in the below sections.

The gen-tie corridor was previously assessed for paleontological resource potential by SWCA (2011) during the paleontological field survey for MSEP. The methods used to analyze this portion of project area were adequate to gain an understanding of the paleontology and geology underlying the gen-tie corridor. However, the gen-tie corridor was still surveyed during the course of fieldwork associated with the results of this report, albeit with modified methods in order to confirm the findings of SWCA (2011). The entirety of the gen-tie corridor was observed by windshield survey along a transmission-line access road (Figure 6.3). Pedestrian survey was conducted where native sediments were exposed and not covered by active aeolian dunes. Changes in geology were noted, especially where sediments were undisturbed. The paleontological field survey conducted for this report confirms the findings of SWCA (2011) and assigns a similar paleontological resource potential to geologic units underlying the gen-tie corridor.

Figure 6.3. Access road along the gen-tie corridor showing active aeolian sands (Qe).

Private Lands

Private lands held within the project area consist of a single rectangular plot measuring 160 acres in area. These lands yielded two fossil localities (containing tortoise remains) during the paleontological field survey and were completely underlain by old terrace deposits. Unlike the public lands, the 160-acre parcel had relatively recently undergone some degree of earthmoving activity for apparent agricultural use. Evidence of tillage was observed throughout the private parcel as multiple north–south-oriented elongated rows of raised sediment divided by similarly elongated troughs (Figure 6.4). These raised rows contained several species of desert plants found within the project area but were also the only area within the project where jojoba (*Simmondsia chinensis*), a commercial crop endemic to the southwestern United States and Baja California, was observed. The southern edge of the parcel was bounded by an east–west-oriented elongated berm measuring 1.8 m or more in height that clearly represented spoils from earthmoving activities.

Because of the disturbed nature of the sediments, both of the fossil tortoise remains discovered within the private parcel were considered to be removed from their original context. However, these remains likely originated from within the private parcel, and their discovery points to a subsurface potential for finding other remains of paleontological significance. Therefore, the paleontological resource potential for the private parcel is the same as that of the old terrace deposits (see discussion below).

Figure 6.4. Evidence of agricultural usage in the private parcel.

Paleontology

The sediments underlying the project area represent late Pleistocene–Holocene deposits that record the geological and paleontological history of the project area. Analysis of these geologic units may reveal changes or stasis in the regional environment and local flora and fauna. In general, Pleistocene biotas are similar to those of the Holocene and contain many of the same taxa (Graham 1979). However, the end of the Pleistocene was marked by the extinction of multiple large-bodied vertebrate species (especially mammals), including mammoths, mastodons, ground sloths, and saber-toothed cats (Koch and Barnosky 2006). The paleontological field survey uncovered remains of fossil taxa that document this characteristic change in community between the Pleistocene and modern times. Three of the four vertebrate taxa discovered in the project area (i.e., tortoises, jackrabbits, and horses) are extant in the present-day Colorado Desert (see Tables 3.2 and 6.2). The fourth, a fragment of proboscidean tusk (i.e., elephants and their relatives), represents one of the many groups that went extinct in North America at the end of the Pleistocene. In fact, even the horse remains found within the project area represent a taxon that was eradicated in North America at the end of the Pleistocene but was later reintroduced in the sixteenth century by the Spanish (Azzaroli 1991; Luís et al. 2006).

Fossil bones found within the project area exhibited a distinctive texture that distinguished them in the field from modern bone. These fossils were also noticeably denser than the more recent remains. This difference in texture and density is likely due to partial remineralization of the specimens during diagenesis. Remineralization also was often visible on freshly broken surfaces of specimens when viewed under a 10× hand lens. Some specimens also were found partially encrusted in caliche, as was documented at Rio Mesa by Stewart (2012), but this was not the norm. Almost all specimens were found as isolated remains represented by (often) partial single elements. With few exceptions, fossil remains were found at the surface within lag deposits, although several specimens were found at least partially buried. No fossils were discovered in active dune deposits or units of Holocene age. Descriptions of the fossil taxa encountered during the field survey are given below.

Testudines

Testudines (synonym Chelonii) is a taxonomic order of amniotes containing turtles, tortoises, and terrapins. All living members of this group are characterized by a bony shell consisting of expanded and flattened ribs that act as a defensive shield. This shell is often covered by keratinous scales termed scutes that overlap the underlying ribs to give the shell further rigidity. Many members of this group are aquatic or semiaquatic, but some groups have adapted to desert habitats. One such family, Testudinidae (i.e., "tortoises"), has representatives currently living in the modern Colorado Desert.

Fossil tortoise remains are well known from the region and were found during both the MSEP and Rio Mesa Project paleontological field survey (SWCA 2011; Stewart 2012). The Rio Mesa Project, in particular, found multiple remains of the desert tortoise, *Gopherus* sp., including the partial skeleton of one individual within its burrow (Stewart 2012). Of the 39 fossil localities discovered on the project site during the field survey, 28 contained remains of fossil tortoise. All tortoise remains found were exoskeletal elements of the shell (Figure 6.5). Where possible, these elements were identified as either part of the carapace (i.e., the "upper shell") or the plastron (i.e., the "lower shell"). This determination often was based on the inside curvature of the element, where carapace fragments displayed a distinct curvature compared to the more planar plastron pieces. Most of the tortoise remains discovered on the project area were isolated fragments of shell found at the surface within desert pavement. However, several sites included associated fragments that were partially or completely buried within sediment. Based on morphology and the depositional environment where they were found, these fossils can all be confidently assigned to the family Testudinidae and are tentatively identified as cf. *Gopherus* sp.

Fossil tortoise remains within the project area were found almost exclusively in the old terrace deposits (Qot). The single tortoise fossil discovered outside of the old terrace deposits was a small fragment of plastron that was found in sediments of the active aeolian and dune deposits (Qe) within the gen-tie corridor. However, this specimen was found in loose sand and gravel associated with the transmission-line access road and had clearly been removed from its geologic context (Figure 6.6). Given the abundance of tortoise remains found otherwise only in the old terrace deposits and the dubious geologic context of the specimen, it is reasonable to assume that this specimen was transported from nearby old terrace deposits, perhaps during activities associated with installation of transmission lines within the gen-tie corridor.

Figure 6.5. Associated fossil tortoise carapace remains within the old terrace deposits (Qot).

Figure 6.6. Isolated fragment of fossil tortoise shell found ex situ in aeolian sands (Qe) on the gen-tie corridor.

Lagomorpha

Lagomorpha is a taxonomic order of mammals containing rabbits, hares, and pikas. The group consists of two extant families, Leporidae (rabbits and hares) and Ochotonidae (pikas), with at least one extinct family represented in the fossil record (Hoffman and Smith 2005). Lagomorphs currently have a wide distribution across the globe, with members present on all continents except for Antarctica. Two lagomorph genera (both leporids) are known from the Colorado Desert: *Sylvilagus* (i.e., cottontail rabbits) and *Lepus* (i.e., hares). Both genera were discovered within the sediments of the Palo Verde Mesa paleosol during the Rio Mesa Project paleontological field survey (Stewart 2012).

A single locality produced the remains of a fossil leporid during the DQSP paleontological field survey (Figure 6.7). The fossil is an isolated right dentary (lower jaw) containing a portion of the horizontal ramus and portions of five teeth. The third premolar through third molar are present within their alveoli. The anterior teeth are more complete than the posterior teeth, with the third premolar preserved as only a small fragment of dentin and enamel. Based on morphology, size of the specimen, and bone thickness, this specimen is identified as *Lepus* sp. This fossil was discovered partially buried within sediments of the old terrace deposits.

Perissodactyla

Perissodactyla is an order of mammals often referred to as odd-toed ungulates. In the fossil record, this group is fairly diverse but today is represented by three families: Equidae (e.g., horses, zebras, and asses), Rhinocerotidae (e.g., rhinoceroses), and Tapiridae (e.g., tapirs) (Graur et al. 1997). All three families have fossil representatives in Cenozoic deposits across North America. Although the last groups of North American rhinocerotids went extinct during the Pliocene, equids and tapirids survived until the end of the Pleistocene (Prothero 2009). All three groups, however, were extinct in North America by the Holocene, with equids being later reintroduced by humans from Europe. Having originally evolved in North America, equids (specifically those of the genus *Equus*) quickly spread across much of the continent after being reintroduced, with several species documented in the Colorado Desert (see Table 3.2). *Equus* is known from Pleistocene deposits in the vicinity of the DQSP, and remains of this genus were found in the Palo Verde Mesa paleosol during the Rio Mesa Project paleontological field survey (Stewart 2012).

Two fossil localities containing equid remains were discovered during the DQSP paleontological field survey. Both localities were found within sediments of the old terrace deposits. The first locality contained a single tooth that was broken into three pieces, likely because of desiccation (Figure 6.8). This specimen was found largely uncovered at the surface in desert pavement. No other equid remains were noted in the vicinity of the specimen. The second locality contained at least one tooth broken into five large fragments and multiple smaller fragments (Figure 6.9). This specimen was found partially buried within desert pavement and was spread out over several feet. Larger pieces were found clustered together, whereas smaller fragments were spread farther apart in an approximately north–south direction. This likely indicates that these fragments were transported by wind or water activity as the tooth eroded out of the desert pavement. Based on the degree of hypsodonty (i.e., high-crownedness) and the morphology of the enamel on the occlusal surface, both of these specimens were identified as *Equus* sp.

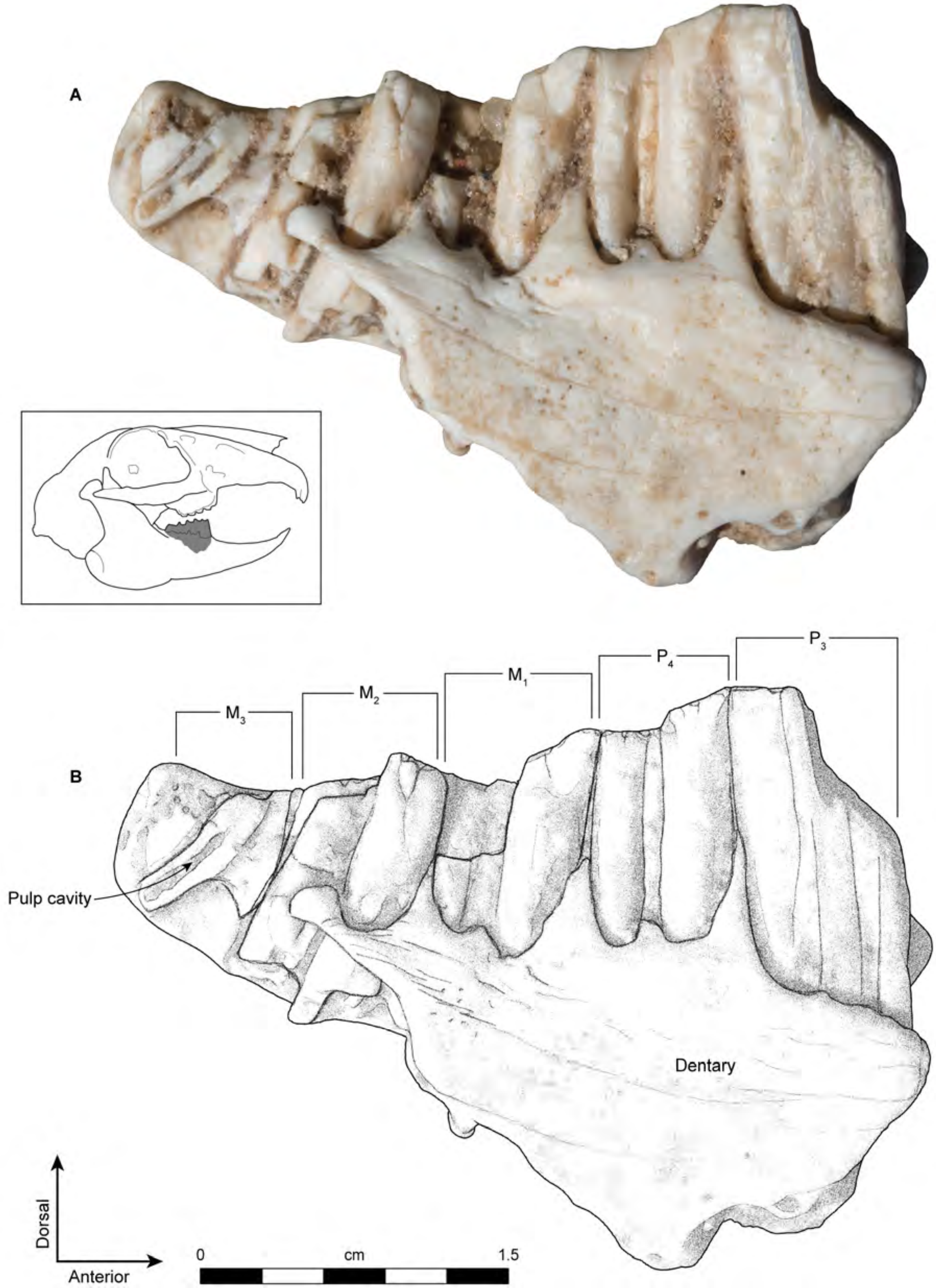


Figure 6.7. Partial right dentary of *Lepus* sp. in lateral view found within the old terrace deposits (Qot).

Figure 6.8. Isolated fossil horse tooth in occlusal view discovered within the old terrace deposits (Qot).

Figure 6.9. Fragments of fossil horse teeth discovered within the old terrace deposits (Qot).

Proboscidea

Proboscidea is an order of large-bodied mammals containing elephants and their relatives. This group is characterized by large, ever-growing incisor teeth, often referred to as tusks. Three families of proboscideans arrived in North America via Asia during the Miocene, Pliocene, and Pleistocene (Shoshani and Tassy 1996). The first, Gomphotheriidae, were widespread in North America during the Miocene and Pliocene but declined taxonomically and in geographic extent into the Pleistocene. The final two genera of gomphotheriids survived in Central and South America until the end of the Pleistocene. A single species of Mammutidae, the American mastodon (*Mammut americanum*) entered North America in the middle Miocene (ca. 11–16 million years ago [Ma]) (Fisher 2018). This species spread across North America and into Central America, inhabiting woodland and forest environments. The American mastodon would be the last species of mastodon to survive on the planet, going extinct in the early Holocene. Finally, two species of Elephantidae from the genus *Mammuthus* immigrated separately to North America during the Pleistocene (Lister 2017). The Columbian mammoth (*Mammuthus columbi*) arrived in North America around 2 Ma and established in the southern portions of the continent, and the woolly mammoth (*Mammuthus primigenius*), at approximately 100 thousand years ago (ka), occupied mostly northern latitudes. Both species became extinct in North America near the end of the Pleistocene. Today, proboscideans are relegated only to Africa and parts of Asia.

Proboscidean remains are known from the Pleistocene deposits throughout southern California and in the vicinity of the DQSP area. Agenbroad et al. (1992) noted mammoth fossils from the Chemehuevi Formation (which likely underlies the old terrace deposits) in nearby Arizona. Stewart (2012) recovered an abraded fragment of mammoth tusk during the Rio Mesa Project paleontological survey.

A single proboscidean fossil was discovered during the paleontological field survey for the DQSP (Figure 6.10). This fossil was a small (approximately 2-by-6-cm) piece of tusk dentin (one of the major tissues that form tusks and other teeth) that was found at the surface in the stabilized alluvial-fan deposits (Qf-2). Broken edges of the fragment of dentin revealed an observable but faint series of crossing lines identified as representing the Schreger pattern. This pattern is a visual artifact resulting from variations in underlying micromorphology associated with dentin formation by odontoblasts (Espinoza and Mann 1993). Fisher et al. (1998) studied the angle of intersecting Schreger lines in cross sections of proboscidean tusks and noted a difference between mastodons, mammoths, and elephants that would allow for discrimination between taxa based on dentin alone. The Schreger pattern on the tusk fragment from the DQSP is incomplete but appeared to show Schreger lines that would cross at less than 90°, indicating that the dentin was from a mammoth. Therefore, we tentatively identify this specimen as cf. *Mammuthus* sp.

A second proboscidean specimen was found at the DQSP by the archaeological field survey by Lerch et al. (2016) (Figure 6.11). They did not identify the specimen but noted that it was a fossil and presented its location to the BLM. This specimen was revisited during this paleontological survey to note its condition and attempt to better identify it. Like the fragment of mammoth dentin, this fossil also was discovered within sediments of the stabilized alluvial-fan deposits. The surface of the specimen is notably more worn and broken than when was previously noted, likely due to abrasive and erosional forces at the surface. Unlike the white- or cream-colored fossils discovered from the old terrace deposit, this specimen was dark brown to black in coloration. Based on its size and morphology, this specimen is tentatively identified as a broken neural spine from a proboscidean anterior thoracic vertebra. Though this likely represents a second specimen of *Mammuthus*, there are no morphological features present that would allow for a responsible identification to that taxonomic level.

Figure 6.10. Fragment of proboscidean (cf. *Mammuthus*) tusk dentin discovered within the stabilized alluvial-fan deposits (Qf-2).

Figure 6.11. Possible broken neural spine from a proboscidean thoracic vertebra discovered within the stabilized alluvial-fan deposits (Qf-2) during the DQSP Class III archaeological resource inventory.

Spermatophyta

Spermatophytes are an unranked group of plants that produce seeds during reproduction. They are the largest subgroup within the Embryophyta (“land plants”). Modern taxonomic models divide the spermatophytes into five smaller groups: Cycadophyta (e.g., cycads), Ginkgophyta (e.g., ginkos), Pinophyta (e.g., conifers), Gnetophyta (e.g., gnetophytes), and Magnoliophyta (e.g., flowering plants). Of these groups, several produce woody tissues, most notoriously members of Pinophyta and Magnoliophyta.

Wood is a porous and fibrous structural tissue found in the stems and roots of some plants. The oldest specimens of fossil wood date to the Early Devonian Period of France (Gerrienne et al. 2011). This material is often found permineralized and is fairly common in the fossil record, especially in certain depositional environments. Petrified wood specifically refers to woody plant remains that have had all organic materials replaced by other minerals (often silicates) during diagenesis. Such remains are known throughout the world, including in the vicinity of the DQSP.

Plant specimens found during the DQSP paleontological field survey were all petrified remains of woody tissue that had been replaced with silica (i.e., quartz). These specimens were most abundant in the stabilized alluvial-fan deposits (Qf-2) but were observed in the active alluvial-fan deposits (Qf-1) and old terrace deposits (Qot) within the project area. Specimens in the stabilized alluvial-fan deposits also were on average larger than those in the other units (Figure 6.12). No petrified wood was observed in the active alluvial-wash deposits (Qw) or the aeolian and dune deposits (Qe). Preservation was similar between specimens of petrified wood in all units where they were observed. This similar preservation, along with presence of these specimens in the both the active and stabilized alluvial-fan deposits and in the old terrace deposits, indicates that these remains may have been transported from the nearby mountains. If correct, the source of these specimens could be the McCoy Mountains which are known to contain petrified-wood fossils of Cretaceous age (Stone 2006). Although wood morphology can be diagnostic for some taxa, no such features were noted during the field survey. Therefore, petrified-wood specimens are conservatively identified to Spermatophyta, the group that contains all modern wood-bearing plants.

Figure 6.12. Piece of petrified wood found within the stabilized alluvial-fan deposits (Qf-2).

Geology

Old Terrace Deposits (Qot)

Description

The old terrace deposits are locally composed of sandy silts to gravelly sands. At the surface, the deposits are pinkish gray (7.5YR 7/2) to very pale brown (10YR 8/2) in color but are pink (5YR 8/3) to reddish yellow (7.5YR 7/6) on fresh surfaces. The sediments within the unit are often poorly sorted, with sand grains often ranging in size from fine to very coarse. The sand- and gravel-sized portion is generally subrounded to subangular. Sand-sized grains are mostly composed of quartz, with a minor component (<10 percent) of feldspar and lithics. Gravel-sized clasts are often a mixture of volcanics, granitoids, quartz, schist, limestone, or microcrystalline silica likely sourced from the nearby mountains. Reworked clasts contained transported Mesozoic and Paleozoic fossil remains (Figures 6.13–6.15). Although not observed subsurficially, well-rounded river pebbles and cobbles were observed at the surface within the desert pavement (Figure 6.16). The sediments of the deposits are generally dry and moderately to poorly consolidated.

Development of aridosols was noted in several places within the old terrace deposits (see section Distribution below). These paleosols contain a variably developed caliche layer or caliche nodules at 15 cm (6 inches) or more of depth. This is similar to portions of the fossiliferous Paleo Verde Mesa paleosol described by Stewart (2012) for the Rio Mesa Solar Project. However, the characteristic prismatic weathering profile documented by Stewart (2012) in the upper portions of the paleosol was not observed. Therefore, it is unclear whether these paleosols are equivalent, but given their development on the same geologic unit and the presence of abundant fossils representing similar taxa with similar preservation, it seems plausible.

Figure 6.13. Isolated fossil crinoid (sea lily) columnal found ex situ in the old terrace deposits.

Figure 6.14. Articulated series of 12 fossil crinoid (sea lily) columnals found ex situ in the old terrace deposits.

Figure 6.15. Fossil bivalves and corals discovered within an exotic clast in the old terrace deposits.

Figure 6.16. Desert pavement developed on the old terrace deposits (Qot).

Distribution

The old terrace deposits make up most of the area underlying the project. They are exposed everywhere except for the northwestern portion of the project area and along the gen-tie corridor. A small portion of the older terrace deposits in the southwest is overlain by a finger of the active alluvial-wash deposits (Qw) but are likely present at depth. In general, the old terrace deposits are covered either by desert pavement or by active aeolian dunes.

The extent of the old terrace deposits was found to be greater than was initially mapped by Stone (2006) (mapped at a coarser scale) and presented by Reynolds and Lander (2016). The northwestern boundary of the old terrace deposits extended farther north and west than indicated in these older maps (see Figures 3.2 and 6.1). The boundary between the old terrace deposits and the stabilized alluvial-fan deposits (Qf-2) was not a distinct contact, but transitions in lithology and sedimentological composition were observed that allowed the location of this boundary to be approximated.

Paleontology

Identifiable fossils found within the old terrace deposits include remains of tortoise, horse, and rabbit (see Figures 6.5–6.9). Unidentifiable fragments of fossil bone and small pieces of petrified wood also were occasionally observed throughout the unit during the survey. Nearly all of the specimens observed are represented by isolated elements or fragments of elements. However, the presence of abundant, identifiable vertebrate fossil remains at the surface indicates that significant paleontological remains are likely present in the subsurface. For this reason, the old terrace deposits are given a paleontological potential of PFYC Class 4 (high) (high potential under SVP [1995]).

Stabilized Alluvial-Fan Deposits (Qf-2)

Description

The stabilized alluvial-fan deposits are composed of silty sands and sandy silts where observed. Surficially, these sediments are pinkish gray (7.5YR 7/2) in color but are reddish yellow (5YR 6/6) below the surface and where unweathered. Sand-sized particles are very fine to fine grained, subangular to subrounded, and are moderately sorted. Compositionally, these sand grains are 60–70 percent quartz, with the remaining portion composed of lithics and other minerals. Subangular gravel to pebble-sized clasts were sparsely observed below the surface, but within the overlying desert pavement, there was a wide range of subrounded to angular gravel to cobble-sized clasts. These larger clasts were made of microcrystalline silica, volcanics, gneiss, quartzite, schist, limestone, and quartz. Unlike in the desert pavement on the surface of the old terrace deposits, granitoids were not common. The sediments of this unit were poorly to moderately consolidated. Field observations of this unit supports the findings of Reynolds and Lander (2016) that the alluvial deposits within the project area should be divided into an older, stabilized unit and a younger, active unit (see section Description under Active Alluvial-Fan Deposits [Qf-1] below). Observations of fossil taxa and soil types present within the stabilized alluvial-fan deposits indicate that this unit is likely Pleistocene in age.

Distribution

The stabilized alluvial-fan deposits are the second-most extensively distributed unit within the project area (behind the old terrace deposits). They are observed in the northwestern portion of the main project area and the eastern and southwestern portions of the gen-tie corridor (see Figure 6.1). These deposits are overlain by active alluvial-fan deposits (Qf-1) in the northwest portion of the main project area and active aeolian and dune deposits (Qe) in the central portion of the gen-tie corridor.

Paleontology

Only one vertebrate fossil taxon, represented by fragmentary remains of mammoth, was discovered within the stabilized alluvial-fan deposits (see Figure 6.10). Medium–large-sized pieces of petrified wood also were observed in abundance throughout the unit (see Figure 6.12). Significant vertebrate fossils are also known from similar Pleistocene alluvial-fan deposits throughout the region. Given the discovery of vertebrate fossil materials during the field survey and the known paleontological sensitivity of units of similar lithology, the stabilized alluvial-fan deposits are assigned a paleontological potential of PFYC Class 3 (moderate) (high potential under SVP [1995]).

Stabilized and Active Aeolian and Dune Deposits (Qe)

Description

The stabilized and active aeolian and dune deposits consist of relatively thick covering of unconsolidated wind-blown sand dunes overlying poorly consolidated sandy sediments (Figure 6.17). Both the active and stabilized portions of dune deposits are composed of well sorted, rounded to well rounded, medium to coarse sand. Compositionally, they are composed mainly of quartz (>95 percent), along with a minor lithic component. No frosted grains were observed upon inspection. The active aeolian and dune deposits made up most of the surface where observed, but exposures of stabilized aeolian deposits were occasionally visible, especially near the access road for transmission lines along the gen-tie corridor. These stabilized deposits displayed high-angle tabular crossbedding and some examples of inverse grading, which is indicative of sediments deposited in an aeolian dune environment. Unlike the overlying active portion, these sediments are somewhat consolidated and form short (<1-foot) vertical surfaces along portions of the access road. Reynolds and Lander (2016) postulated that these stabilized dune deposits are likely Pleistocene in age.

Figure 6.17. Active aeolian dune deposits on top of stabilized aeolian and dune deposits (Qe) within the gen-tie corridor.

Distribution

The stabilized and active aeolian and dune deposits only were observed in the western two-thirds of the gen-tie corridor (see Figure 6.1). These deposits differ from the active aeolian sands that cover large portions of the main project area (especially to the northeast). It is likely that the dune deposits overlie portions of the stabilized alluvial-fan deposits (Qf-2) in this region.

Paleontology

A single tortoise carapace fragment was found in these deposits, within loose sand near the transmission-line access road along the gen-tie corridor (see Figure 6.6). However, because of the lack of context for this specimen, it is unclear whether it has been transported from another unit, especially given that all other tortoise remains were recovered solely from the old terrace deposits. No other fossil remains are known from these deposits. Given the clear difference in age and consolidation between the active and stabilized portions of these deposits, it is reasonable to assign a different paleontological resource potential classification or rank to each portion. The overlying active portion of the aeolian and dune deposits is assigned a paleontological potential of PFYC Class 2 (low) (low potential under SVP [1995]), as any remains discovered from these deposits would either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. Conversely, the underlying stabilized dune deposits represent sediments that are old enough to preserve fossils and are composed of a lithology known to produce fossil remains. Therefore, the stabilized dune deposits are assigned a paleontological potential of PFYC Class 3 (moderate) (high potential under SVP [1995]).

Active Alluvial-Fan Deposits (Qf-1)

Description

The active alluvial-fan deposits are composed of silty sands and gravelly sands. At the surface, these deposits are pinkish gray (5YR 7/2) in color but are light brown (7.5YR 6/4) below the surface and where unweathered. Sand-sized particles are very fine to medium grained, angular to rounded, and poorly to moderately sorted. Compositionally, the deposits are made up of approximately 70 percent quartz sand grains, approximately 20 percent clay/silt particles, and approximately 10 percent sand- to pebble-sized lithics. Larger clasts are composed of quartz, microcrystalline silica, sandstone, volcanics, granitoids, and angular fragments of caliche. Sediments are generally poorly to very poorly consolidated, although small caliche nodules were observed greater than 23 cm (9 inches) below the surface. Rootlets were observed within the unit, and the deposits had a noticeably higher moisture content than other units within the project area (perhaps because of higher porosity).

The active alluvial-fan deposits (Qf-1) differed from the stabilized alluvial-fan deposits (Qf-2) in several ways. First, the active alluvial-fan deposits formed areas of slightly higher topography above the flatter lying region containing the stabilized alluvial-fan deposits. Second, the stabilized deposits were more consolidated and had a lower moisture content than the active alluvial-fan deposits. Third, the active alluvial-fan deposits contained sediments with a higher degree of angularity and a lower degree of sorting than was observed for the stabilized alluvial-fan deposits. For these reasons, the argument to split the alluvial-fan deposits within the project area into an older, stabilized unit and a younger, active unit made by Reynolds and Lander (2016) appears to have merit and is adopted here. However, the active alluvial-fan deposits were found to be far less extensive than suggested by Reynolds and Lander (2016) (see Figures 3.2 and 6.1).

Distribution

The active alluvial-fan deposits were observed in a small portion of the northwest region of the project area. These deposits extend southwest out of the project area toward the Mule Mountains. The active alluvial-fan deposits overlie the stabilized alluvial-fan deposits within the project area and decrease in thickness toward the northeast.

Paleontology

No significant paleontological remains were noted within the active alluvial-fan deposits. However, a single small fragment of petrified wood was observed at the surface near the approximate boundary between the stabilized and active alluvial-fan deposits. This piece of petrified wood was likely transported from elsewhere or was reworked from the stabilized alluvial-fan deposits. Given the Holocene age of the active alluvial-fan deposits, any remains discovered from these deposits would likely either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. Therefore, the active alluvial-fan deposits are assigned a paleontological potential of PFYC Class 2 (low) (low potential under SVP [1995]).

Active Alluvial-Wash Deposits (Qw)

Description

The active alluvial-wash deposits were not documented in as great of detail as were the other units within the project area. This was because of their young, Holocene age and to their minimal coverage within the area surveyed. These alluvial-wash deposits were topographically raised above the old terrace deposits which they overlay. As with the active alluvial-fan deposits, the alluvial-wash deposits are generally very poorly sorted and have angular to subrounded grains and clasts. These deposits are poorly consolidated and readily crumbled when minimal pressure was applied.

Distribution

The active alluvial-wash deposits are located near the southwestern boundary of the project area. These deposits are exposed as a thin finger of slightly higher topography overlying the old terrace deposits. The active alluvial-wash deposits noticeably increase in thickness toward their sediment source (the Mule Mountains) in the southwest.

Paleontology

No paleontological remains were discovered within the active alluvial-wash deposits, and no remains are known from similar deposits in the vicinity of the project area. Given the Holocene age of the active alluvial-wash deposits, any remains discovered from these deposits would likely either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. Therefore, the active alluvial-wash deposits are assigned a paleontological potential of PFYC Class 2 (low) (low potential under SVP [1995]).

Correlation of Paleontological Discoveries with Soil Type

With the exception of one horse tooth, all paleontological remains were found in association with either the Aco or Orita soil series (see Table 6.2). Both soils are associated with the stable basin-floor/distal piedmont geomorphic surfaces that predominate across a significant portion of the project area. The Aco soil has developed in sandy alluvial-fan deposits and is classified as an aridisol with calcic subsurface horizons (see Table 3.4). The level of pedogenic carbonate accumulation in this soil suggests at least an early Holocene to latest Pleistocene age. Based on test pits excavated during the paleontological survey, some areas mapped as the Aco series are mantled with a thin cover of more-recent aeolian or alluvial sediments.

Similar to the Aco soil series, the Orita series is classified as an aridisol but also contains subsurface soil horizons enriched in both calcium carbonate and translocated silicate clays. These horizons are commonly capped or buried by a thin mantle of coarse-textured (gravelly sand) late Holocene alluvium. Based on the soil horizons exposed in test pits excavated during paleontological survey, this young alluvial mantle ranges from less than 15–30+ cm (6–12+ inches) in depth across the project area. The strong level of soil development in the buried soil component of the Orita series suggests it dates to the late–middle Pleistocene (see Table 3.4).

A single horse tooth was recovered in an area mapped as the Rosita soil series, a weakly developed soil (entisol) formed in late Quaternary aeolian sand (see Tables 3.4 and 6.2). Based on correlation with dated aeolian deposits in the eastern Mojave Desert, these sands could either be late Pleistocene (35–25 or 15–10 ka) or Holocene (7–4 ka) in age (Lancaster and Tchakerian 2003; Rendell et al. 1994; Smith 1967). During paleontological survey, it was discovered that some areas mapped as the Rosita series contain a gravel lag or desert pavement in the deflated areas between dunes. This suggests that at least some locations mapped as the Rosita series contain gravelly alluvial deposits that have been locally reworked by wind. If the horse tooth is Pleistocene in age (rather than modern), then the aeolian parent materials for the Rosita series in the southern project area are likely similar in age to the late Pleistocene aeolian sand units identified by Rendell et al. (1994).

Evaluations and Recommendations

This chapter provides discussion of the paleontological resource potential of each geologic unit within the project area and the potential impacts to significant paleontological resources posed by project related construction. The paleontological resource potential for each unit (see Chapter 6) is discussed in relation to those assigned to the same or similar units by other authors during studies conducted in the vicinity of the DQSP. Mitigation measures are also recommended to reduce the adverse effects of earthmoving activities to paleontological resources to a less than significant level.

Potential Impacts to Paleontological Resources

As discussed in Chapter 2, paleontological resource potential was evaluated for each geologic formation or unit based on lithology, preservation potential, known occurrences of significant fossils from geologically similar units, and/or known significant fossil occurrences within the given unit. Based on these criteria and the data presented in this report, the paleontological resource potential for each geologic unit underlying the DQSP was assessed and was assigned to a PFYC class (BLM 2016) or SVP (1995) rank (see Table 6.3). These are summarized and discussed here in relation to the findings of the paleontological resource assessment by Reynolds and Lander (2016), as well as those of SWCA (2011) and Stewart (2012).

Both Stewart (2012) and Reynolds and Lander (2016) assessed the paleontological resource potential of the old terrace deposits or soils developed on that unit. Stewart (2012) assigned this unit to PFYC Class 4a (BLM 2008), based on the discovery of hundreds of fossil remains within the Rio Mesa Solar Project area during a paleontological field survey. Reynolds and Lander (2016), based on a literature review and records searches, determined that soils developed on the old terrace deposits underlying the DQSP were likely equivalent to the Palo Verde Mesa paleosol discussed by Stewart (2012). Based on the units "very high potential for containing fossil remains," Reynolds and Lander (2016:12) assigned the old terrace deposits to PFYC Class 5a (BLM 2008). The field survey associated with this report was not able to confirm that any of the paleosols developed on the old terrace deposits within the DQSP corresponded to the Palo Verde Mesa paleosol of Stewart (2012). However, the survey did encounter widespread Pleistocene paleosols containing numerous vertebrate taxa from in the old terrace deposits, all of which were among the faunal list presented by Stewart (2012) (see Tables 6.1 and 6.2). These findings speak to a high potential to discover scientifically significant paleontological resources below the surface during project-related construction. Therefore, the old terrace deposits underlying the DQSP are here assigned to PFYC Class 4 (BLM 2016). This assignment is in line with the findings of Stewart (2012) and differs from that of Reynolds and Lander (2016). The findings of this study do not suggest that the old terrace deposits contain abundant enough significant paleontological resources to warrant being assigned to PFYC Class 5; PFYC Class 5 should be reserved for units with extraordinary paleontological resource potential. All of the studies assigned a high paleontological resource potential to the old terrace deposits under the SVP (1995) ranking system.

Stabilized and active alluvial-fan deposits were directly or indirectly assessed by SWCA (2011) and Reynolds and Lander (2016). SWCA (2011) adopted the geologic nomenclature of Stone (2006) and assigned alluvial deposits to older, Holocene to Pleistocene deposits (Qa3) and younger, Holocene deposits (Qa6). Of these deposits, only those mapped as Qa6 by Stone (2006) are exposed within the DQSP area.

Based on the results of a literature review, records search, and field survey, SWCA (2011) assigned these deposits a paleontological resource potential of "low to high (increasing with depth)" (SWCA 2011:E-21) using the SVP (1995) ranking system; this includes those alluvial-fan deposits underlying portions of the gen-tie corridor. Reynolds and Lander (2016) split the alluvial-fan deposits within the DQSP area into younger, active deposits (Qf-1) and older, stabilized deposits (Qf-2). With respect to the older, stabilized alluvial-fan deposits (Qf-2), the paleontological resource potential assigned by Reynolds and Lander (2016) is ambiguous within their assessment: Qf-2 is assigned to PFYC Class 3b (BLM 2008) within the text but is assigned to PFYC Class 5a within the associated figures (see Reynolds and Lander 2016:Figure 4). Qf-1 is unambiguously assigned to PFYC Class 2. The data presented within this study support the division of Qa6 into two distinct units (Qf-1 and Qf-2), as suggested by Reynolds and Lander (2016). These findings support an assignment of PFYC Class 3 (BLM 2016) to the older, stabilized alluvial-fan deposits (Qf-2) and an assignment of PFYC Class 2 for the younger, active alluvial-fan deposits (Qf-1). These classifications are in line with the findings of SWCA (2011), assuming both stabilized and active alluvial-fan deposits were observed during that field survey, and also match the findings of Reynolds and Lander (2016), assuming the assignment of Qf-2 to PFYC Class 5a within report figures is erroneous.

Active and stabilized aeolian and dune deposits are exposed along the gen-tie corridor and were assessed by both SWCA (2011) and Reynolds and Lander (2016). As with the alluvial-fan deposits (Qa6), SWCA (2011) assigned the aeolian sands (Qs of Stone [2006]) along the gen-tie corridor a "low to high (increased with depth)" (SWCA 2011:E-21) paleontological resource potential under the SVP (1995) ranking system. These findings were based mainly on the results of literature review, as well as a records search and field survey. Similarly, Reynolds and Lander (2016) assigned the older, stabilized portions of the aeolian deposits to PFYC Class 3b (BLM 2008) and the younger, active portions to PFYC Class 2. The paleontological field survey and literature review conducted for this report support the findings of both SWCA (2011) and Reynolds and Lander (2016). Thus, the stabilized portions of the aeolian and dune deposits (Qe) are assigned to PFYC Class 3 (BLM 2016) and the active aeolian and dune deposits (Qe) are assigned to PFYC Class 2. Regions of the DQSP area that have exposed active aeolian deposits are likely underlain by stabilized deposits at depth and thus should be considered as having the potential to produce significant paleontological resources at depth.

Late Holocene to modern active alluvial-wash deposits (Qw of Stone [2006]) were considered by SWCA (2011), Stewart (2012), and Reynolds and Lander (2016). All agreed that these deposits have low potential for containing significant paleontological remains, based on their young age. Both Stewart (2012) and Reynolds and Lander (2016) assigned these deposits to PFYC Class 2 (BLM 2008), whereas SWCA (2011) determined that paleontological resource potential was low under the SVP (1995) ranking system. The findings of this report concur with those authors, and therefore, the active alluvial-wash deposits are here assigned to PFYC Class 2 (BLM 2016).

Mitigation Recommendations

The results of this paleontological field survey and assessment indicate that geologic units underlying the DQSP area have the potential to contain significant paleontological resources. Sediments associated with old terrace deposits and stabilized alluvial-fan deposits were found to produce important fossil discoveries, and thus proposed construction activities associated with the project have a great potential to negatively affect paleontological resources. Fossil remains found in the project area could provide important information about the prehistory of the region.

The project area is underlain by several geologic units with varying paleontological resource potential under the PFYC (BLM 2016) and SVP (1995) systems (see above; Table 6.3). Especially where Pleistocene soils are developed, significant paleontological remains could be discovered at the surface or immediately below the surface. In some areas, Holocene deposits cover older Pleistocene deposits that may contain significant paleontological resources.

The collected data indicate that there is a potential to encounter paleontologically significant remains during project construction. This section provides mitigation measures designed to reduce the potential for adverse impacts to such paleontological resources to a less than significant level. The following recommendations, developed in accordance with SVP (2010) guidelines, satisfy the requirements for mitigating damage to paleontological resources under federal and state laws.

Mitigation Measures

Preconstruction Phase Measures

Mitigation Measure 1

The services of a qualified professional paleontologist shall be retained prior to earthmoving activities associated with construction in order to carry out an appropriate mitigation program (a qualified paleontologist is defined by SVP [2010] as an individual with an M.S. or Ph.D. in paleontology or geology who is familiar with paleontological procedures and techniques and techniques, is knowledgeable in the geology and paleontology of the region, and who has worked as a paleontological mitigation project supervisor in the region for at least 1 year). The qualified professional paleontologist shall develop a site-specific Paleontological Resource Mitigation and Monitoring Plan for review and approval before implementation during construction activities. The plan shall specify the level and types of mitigation efforts, based on the types and depths of earthmoving activities and the geological and paleontological settings of the project area. The paleontological resource mitigation plan will provide a research design that will guide any testing programs and proposed field and laboratory methods, as well outline reporting methods, plans for preparation and curation of collected materials, and a schedule for completing the proposed work. The plan should include the professional qualifications required of key staff, monitoring protocols, provisions for evaluating and treating sites discovered during earthmoving activities, and reporting requirements. If artificial fill, significantly disturbed deposits, or younger deposits (too recent to contain paleontological resources) are encountered during construction, the project paleontologist may reduce or curtail monitoring in the affected areas after consultation with the project proponent, BLM, and the County, as applicable.

Prior to the start of construction, the qualified professional paleontologist shall develop and present a paleontological sensitivity training program. This training program will be provided to all project-related workers and will address the significance and importance of paleontological resources, the potential to encounter paleontological remains during earthmoving activities, and the legal obligations related to preservation and protection of fossil resources. Reporting procedures for discovery of unexpected paleontological resources during project activities also will be provided during worker paleontological resource sensitivity training.

The qualified professional paleontologist should also attend any preconstruction meetings to consult with grading and excavation contractors concerning excavation schedules, paleontological field techniques, and safety issues. Communication protocols will be established to ensure that all relevant earthmoving activities are monitored and assessed to comply with the paleontological resource mitigation plan.

Mitigation Measure 2

A short preconstruction survey will be required before earthmoving activities to recover all scientifically significant paleontological remains discovered within the project area during the paleontological field survey discussed within this report. These include the fossil horse teeth and *Lepus* dentary (Localities SRI-VP-20180002, SRI-VP-20180008, and SRI-VP-20180024; see Chapter 6 and Appendix E). Upon collection, these paleontological resources will be prepared to the level required for acceptance at an appropriate public, nonprofit scientific institution with permanent paleontological collections (e.g., The Western Science Center). The specimens will then be curated and deposited within the repository, along with any relevant field notes, photographs, and reports.

Construction Phase Measures

Mitigation Measure 3

A qualified professional paleontologist or paleontological monitor should be onsite at all times during the original cutting of previously undisturbed deposits of high paleontological resource potential (SVP 2010) or PFYC Class 3 or higher (e.g., old terrace deposits, stabilized alluvial-fan deposits, and stabilized aeolian and dune deposits) to inspect exposures for contained fossils. Units assigned to PFYC Class 3 or higher require full-time monitoring during all earthmoving activities. A paleontological monitor is defined as an individual who has experience in the collection and salvage of fossil materials. The paleontological monitor will work under the direction of a qualified professional paleontologist. Monitoring will entail visual inspection of active or recently active construction areas. Because of the potential for recovering small fossil remains (isolated small mammal teeth, foraminifera, otoliths, etc.), onsite screen washing may be required at the discretion of the paleontological monitor or qualified professional paleontologist.

If paleontological resources are discovered during construction, the monitor will have the authority to temporarily divert or direct earthmoving activities in the immediate vicinity around the find until they are assessed for scientific significance and recovered (i.e., collected). Often, fossil salvage will be completed relatively quickly. However, some fossil specimens (e.g., large skeletons) may require an extended salvage period. Such extended salvage activities rarely (if ever) stop construction activities at a project site but may require some period during which construction activities in the immediate area are redirected.

Paleontological resources collected during monitoring will be prepared in a properly equipped fossil-preparation laboratory. Preparation will include the removal of rock matrix from fossil materials, as well as the stabilization, consolidation, and repair of specimens, as necessary. Fossil preparation will be done to the point that specimens are ready for curation. Specimens will be identified to the finest taxonomic level that is reasonably possible before being sorted and cataloged as part of the mitigation program.

Once prepared, fossils should be deposited (as a donation) in an appropriate public, nonprofit scientific institution with permanent paleontological collections, along with copies of all pertinent field notes, photographs, and maps. The cost of curation and accession of fossil specimens into such a repository will be the responsibility of the project owner and is required for compliance with the mitigation program.

Postconstruction Phase Measures

Mitigation Measure 4

Following the conclusion of all monitoring, laboratory work, and curation, a final summary report will be completed that describes the results of the paleontological resource mitigation program. This report will include an overview of the methods and procedures used during the mitigation program, will describe the stratigraphy exposed and fossils collected during construction activities, and will discuss the significance of recovered fossil finds. If monitoring efforts during the monitoring program produced fossil remains, then a copy of the final report will be provided to the designated scientific institution where the fossil specimens were deposited.

REFERENCES CITED

Agenbroad, L. D., J. I. Mead, and R. E. Reynolds

1992 Mammoths in the Colorado River Corridor. *San Bernardino County Museum Association Special Publication* 92:104–106.

Azzaroli, Augusto

1991 Ascent and Decline of Monodactyl Equids: A Case for Prehistoric Overkill. *Annales Zoologici Fennici* 28(3–4):151–163.

Bacon, Steven N., Eric V. McDonald, Todd G. Caldwell, Graham K. Dalldorf

2010 Timing and Distribution of Alluvial Fan Sedimentation in Response to Strengthening of Late Holocene ENSO Variability in the Sonoran Desert, Southwestern Arizona, USA. *Quaternary Research* 73:425–438.

Baldwin, Bruce G., Douglas H. Goldman, David J. Keil, Robert Patterson, Thomas J. Rosatti, and Dieter H. Wilken (editors)

2012 *The Jepson Manual: Vascular Plants of California*. 2nd ed. University of California Press, Berkeley.

Bishop, Charles C.

1963 *Geologic Atlas of California–Needles Sheet*. Scale 1:250,000. Geology Regional Geologic Map Series. California Division of Mines, Sacramento.

Brown, David E. (editor)

1982 Biotic Communities of the American Southwest—United States and Mexico. Special issue, *Desert Plants* 4(1–4).

Bull, William B.

1991 *Geomorphic Responses to Climatic Change*. Oxford University Press, Oxford.

Buol, Stanley W., Francis D. Hole, Ralph J. McCracken, and Randal J. Southard

1997 *Soil Genesis and Classification*. 4th ed. Iowa State University Press, Ames.

Bureau of Land Management (BLM)

1998 *General Procedural Guidance for Paleontological Resource Management*. Manual H-8270-1. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2007 *Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands*. Instruction Memorandum No. 2008-009. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2008 *Assessment and Mitigation of Potential Impacts to Paleontological Resources*. Instruction Memorandum No. 2009-011. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2016 *Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands*. Instruction Memorandum No. 2016-124. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

County of Riverside

2015 Multipurpose Open Space Element. In *County of Riverside General Plan*, pp. OS-i–OS-56. County of Riverside, California. Available online at http://planning.rctlma.org/Portals/0/genplan/general_Plan_2017/elements/OCT17/Ch05_MOSE_120815.pdf?ver=2017-10-11-102103-833.

Desert Quartzite, LLC

2014 *Plan of Development: Desert Quartzite Solar Project*. Rev. May 23. Desert Quartzite, San Francisco. Submitted to the U.S. Department of the Interior Bureau of Land Management, California Desert District, Riverside County, California. Project No. CACA 049397. Available online, http://www.blm.gov/style/medialib/blm/ca/pdf/palmsprings/desert_quartzite_solar.Par.44609.File.dat/FSE%20DQSP%20Updated%20POD_CACA%20049397_052314.pdf, accessed November 5, 2015.

Dixon, John C.

2009 Aridic Soils, Patterned Ground, and Desert Pavements. In *Geomorphology of Desert Environments*, edited by A. J. Parsons and A. D. Abrahams, pp. 101–122. Springer, Dordrecht.

Enzel, Yehouda, Daniel R. Cayan, Roger Y. Anderson, and Stephen G. Wells

1989 Atmospheric Circulation During Holocene Lake Stands in the Mojave Desert: Evidence of Regional Climate Change. *Nature* 341(6237):44–47.

Espinoza, Edgard O'Niel, and Mary-Jacque Mann

1993 The History and Significance of the Schreger Pattern in Proboscidean Ivory Characterization. *Journal of the American Institute for Conservation* 32(3):241–248.

Ferguson, C. A., W. C. McIntosh, and C. F. Miller

2013 Silver Creek Caldera—The Tectonically Dismembered Source of the Peach Spring Tuff. *Geology* 41(1):3–6.

Fife, Donald L., and Arthur R. Brown (editors)

1980 *Geology and Mineral Wealth of the California Desert.* Annual Field Trip Guidebook No. 8. South Coast Geological Society, Santa Ana, California.

Fisher, Daniel C.

2018 Paleobiology of Pleistocene Proboscideans. *Annual Review of Earth and Planetary Sciences* 46:229–260.

Fisher, D. C., J. Trapani, J. Shoshani, and M. S. Woodford

1998 Schreger Angles in Mammoth and Mastodon Tusk Dentin. *Current Research in the Pleistocene* 15:105–107.

Fuller, M., S. Brown, C. Willis, and W. Short (editors)

2015 Mojave Desert Geomorphic Province. In *Geological Gems of California State Parks*. Geogem Note 43. Special Report 230. California Geological Survey, Department of Conservation, Sacramento. Prepared for California State Parks under Interagency Agreement C01718011.

Gerrienne, P., P. G. Gensel, C. Strullu-Derrien, H. Lardeux, P. Steemans, and C. Prestianni
2011 A Simple Type of Wood in Two Early Devonian Plants. *Science* 333(6044):837–837.

Gile, Leland H., John W. Hawley, and Robert B. Grossman
1981 *Soils and Geomorphology in the Basin and Range Area of Southern New Mexico: Guidebook to the Desert Project*. Memoir No. 39. New Mexico Bureau of Mines and Mineral Resources, Socorro.

Glazner, A. F., J. D. Walker, J. M. Bartley, J. M. Fletcher, M. W. Martin, E. R. Schermer, and J. K. Linn
1994 Reconstruction of the Mojave Block. In *Guidebook for the Annual Meeting*, pp. 273–330. Geological Society of America, Cordilleran Section. Death Valley Publishing, Boulder, Colorado.

Graham, Russell W.
1979 Paleoclimates and Late Pleistocene Faunal Provinces in North America. In *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities*, edited by Robert L. Humphrey and Dennis J. Stanford, pp. 49–69. Anthropological Society of Washington, Washington, D.C.

Graur, D., M. Gouy, and L. Duret
1997 Evolutionary Affinities of the Order Perissodactyla and the Phylogenetic Status of the Superordinal Taxa Ungulata and Altungulata. *Molecular Phylogenetics and Evolution* 7(2):195–200.

Grinnell, Joseph, Joseph S. Dixon, and Jean M. Linsdale
1937 *Fur-Bearing Mammals of California: Their Natural History, Systematic Status and Relations to Man*. Vol. 1. University of California Press, Berkeley.

Hall, Clarence A., Jr.
2007 *Introduction to the Geology of Southern California and Its Native Plants*. University of California Press, Berkeley.

Harden, Jennifer W.
1982 A Quantitative Index of Soil Development from Field Descriptions: Examples from a Chronosequence in Central California. *Geoderma* 28(1):1–28.

Harden, J. W., E. Taylor, M. Reheis, and L. D. McFadden
1991 *Calcic, Gypsic, and Siliceous Soil Chronosequences in Arid and Semiarid Environments*. Special Publication 26. Soil Science Society of America, Madison, Wisconsin.

Hayhurst, Cheryl A., and Trinda L. Bedrossian (compilers)
2010 West Half of Blythe 30' by 60' Quadrangle. In *Geologic Compilation of Quaternary Surficial Deposits in Southern California*, edited by T. L. Bedrossian, P. Roffers, and C. A. Hayhurst, Plate 4. Special Report 217. California Geological Survey, Sacramento.

Hoffman, Robert S., and Andrew T. Smith
2005 Order Lagomorpha. In *Mammal Species of the World: A Taxonomic and Geographic Reference*, vol. 1., edited by Donn E. Wilson and DeeAnn M. Reeder, pp. 185–211. 3rd ed. Johns Hopkins University Press, Baltimore, Maryland.

Jaeger, Edmund C.
1965 *The California Deserts*. 4th ed. Stanford University Press, Palo Alto, California.

Jahns, Richard H. (editor)
1954 *Geology of Southern California*, vol. 170. California Department of Natural Resources, Division of Mines, Sacramento.

Jefferson, George T.
1991 *A Catalogue of Late Quaternary Vertebrates from California*. Technical Reports Nos. 5 and 7. Natural History Museum of Los Angeles County, Los Angeles.

Jennings, C. W.
1967 *Geologic Map of California: Salton Sea Sheet*. Scale 1:250,000. California Division of Mines and Geology, Sacramento.

Knight, C. A., and D. D. Ackerly
2003 Evolution and Plasticity of Photosynthetic Thermal Tolerance, Specific Leaf Area and Leaf Size: Congeneric Species from Desert and Coastal Environments. *New Phytologist* 160(2):337–347.

Koch, Paul L., and Anthony D. Barnosky
2006 Late Quaternary Extinctions: State of the Debate. *Annual Review of Ecology, Evolution, and Systematics* 37:215–250.

Lancaster, N., and V. P. Tchakerian
2003 Late Quaternary Eolian Dynamics, Mojave Desert, California. In *Paleoenvironments and Paleohydrology of the Mojave and Southern Great Basin Deserts,* edited by Y. Enzel, S. G. Wells, and N. Lancaster, pp. 231–249. Special Paper 368. Geological Society of America, Boulder, Colorado.

Laudenslayer, W. F., Jr., K. B. Buckingham, and T. A. Rado
1995 Mammals of the California Desert. In *The California Desert: An Introduction to Natural Resources and Man's Impact*, edited by June Latting and Peter G. Rowlands, p. 665. June Latting Books, Riverside, California.

Lerch, Michael K., Patrick B. Stanton, and Karen K. Swope (editors)
2016 *Class III Archaeological Survey of the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California*. Technical Report 15-36. Statistical Research, Redlands, California.

Lister, A. M.
2017 On the Type Material and Evolution of North American Mammoths. *Quaternary International* 443:14–31.

Luís, C., C. Bastos-Silveira, E. G. Cothran, and M. D. M. Oom
2006 Iberian Origins of New World Horse Breeds. *Journal of Heredity* 97(2):107–113.

McComas, K.
2018 *Paleontological Records Search–Desert Quartzite Solar Project*. Department of Paleontology, San Diego Natural History Museum, San Diego.

McCurry, M.
1988 Geology and Petrology of the Woods Mountains Volcanic Center, Southeastern California: Implications for the Genesis of Peralkaline Rhyolite Ash Flow Tuffs. *Journal of Geophysical Research: Solid Earth* 93(B12):14835–14855.

McFadden, Leslie D., John B. Ritter, and Stephen G. Wells
1989 Use of Multiparameter Relative-Age Methods for Age Estimation and Correlation of Alluvial Fan Surfaces on a Desert Piedmont, Eastern Mojave Desert, California. *Quaternary Research* 32:276–290.

McLeod, S. A.
2013 *Paleontological Resource Records Check for the Proposed Desert Quartzite Solar Mirror Project, near the City of Blythe, Riverside County, Project Area*. Vertebrate Paleontology Section, Natural History Museum of Los Angeles County, Los Angeles.

Metzger, D. G., O. J. Loeltz, and B. Irelan
1973 G*eohydrology of the Parker-Blythe-Cibola Area, Arizona and California*. Professional Paper 486-G. U.S. Geological Survey, Washington, D.C.

Miller, David M., Kevin M. Schmidt, Shannon A. Mahan, John P. McGeehin, Lewis A. Owen, John A. Barron, Frank Lehmkuhl, and Rene Löhrer
2010 Holocene Landscape Response to Seasonality of Storms in the Mohave Desert. *Quaternary International* 215(1–2):45–61.

National Centers for Environmental Information, National Oceanic and Atmospheric Administration (NOAA)
2018 https://www.ncdc.noaa.gov/cdo-web/datasets/NORMAL_MLY/stations/GHCND:USW00023158/detail, accessed June 20, 2018.

Ohtomo, Yoko, Takeshi Kakegawa, Akizumi Ishida, Toshiro Nagase, and Minik T. Rosing
2014 Evidence for Biogenic Graphite in Early Archaean Isua Metasedimentary Rocks. *Nature Geoscience* 7:25–28.

Pelka, Gary Jerome
1973 *Geology of the McCoy and Palen Mountains, Southeastern California*. Ph.D. dissertation, University of California, Santa Barbara. University Microfilms, Ann Arbor, Michigan.

Prothero, D. R.
2009 Evolutionary Transitions in the Fossil Record of Terrestrial Hoofed Mammals. *Evolution: Education and Outreach* 2(2):289–302.

Rendell, H., N. Lancaster, and V. P. Tchakerian
1994 Luminescence Dating of Late Pleistocene Aeolian Deposits at Dale Lake and Cronese Mountains, Mojave Desert, California. *Quaternary Science Reviews* 13:417–422.

Reynolds, R. E., and E. B. Lander
2016 *Preliminary Paleontological Resource Assessment Technical Report Prepared in Support of Desert Quartzite Solar Project Southeastern Riverside County, California*. Prepared for First Solar, LLC.

Salem, Anthony C.
2009 Mesozoic Tectonics of the Maria Fold and Thrust Belt and McCoy Basin: An Examination of Polyphase Deformation and Synorogenic Response. Unpublished Ph.D. dissertation, Department of Earth and Planetary Sciences, University of New Mexico.

Schaetzl, Randall J., and Sharon Anderson
2005 *Soils Genesis and Geomorphology*. Cambridge University Press, New York.

Scott, E.
2013 *Paleontology Literature and Records Review, Desert Quartzite Solar Mirror Project, Riverside County, California*. Division of Geological Sciences, San Bernardino County Museum, Redlands, California.

Scott, Eric, and Kathleen Springer
2003 CEQA and Fossil Preservation in California. *Environmental Monitor* Fall 2003:4–10. Association of Environmental Professionals, Sacramento, California.

Shlemon, R. J.
1978 Quaternary Soil-Geomorphic Relationships, Southeastern Mojave Desert, California and Arizona. *Quaternary Soils* 187–207.

Shoshani, J., and P. Tassy
1996 *The Proboscidea. Evolution and Palaeoecology of Elephants and Their Relatives*. Oxford University Press, Oxford.

Shreve, Forrest
1951 *Vegetation of the Sonoran Desert.* Vegetation and Flora of the Sonoran Desert, vol. 1. Publication 591. Carnegie Institution, Washington, D.C.

Shreve, Forrest, and Ira L. Wiggins
1951 *Vegetation of the Sonoran Desert*. Vegetation and Flora of the Sonoran Desert, vol. 2. Publication 591. Carnegie Institution, Washington, D.C.

Smith, H. T. U.
1967 *Past versus Present Wind Action in the Mojave Desert Region, California*. Publication AFCRL-67-0683. U.S. Air Force Cambridge Research Laboratories, Office of Aerospace Research, Bedford, Massachusetts, and University of Massachusetts, Amherst.

Society of Vertebrate Paleontology (SVP)
1995 Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources Standard Guidelines. *SVP News Bulletin* 163:22–27.

2010 Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Electronic document, http://vertpaleo.org/Membership/Member-Ethics/SVP_Impact_Mitigation_Guidelines.aspx, accessed June 2018.

Soil Survey Staff
2014 *Keys to Soil Taxonomy*. 12th ed. U.S. Department of Agriculture, Natural Resources Conservation Service, U.S. Government Printing Office, Washington, D.C.

2018 Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.sc.egov.usda.gov/, accessed June 2018.

Spencer, J. E., and S. J. Reynolds
1990 Relationship between Mesozoic and Cenozoic Tectonic Features in West Central Arizona and Adjacent Southeastern California. *Journal of Geophysical Research: Solid Earth* 95(B1):539–555.

Stewart, J. D.
2012 *Draft Paleontological Resources Delineation Work Plan*. URS, Project No. 27652105.00505. Prepared for Rio Mesa Solar I, LLC, and Rio Mesa Solar II, LLC.

Stone, P.

2006 *Geologic Map of the West Half of the Blythe 30' By 60' Quadrangle, Riverside County, California, and La Paz County, Arizona*. Scientific Investigations Map 2922. U.S. Geological Survey, Menlo Park, California.

Stone, Paul, and G. J. Pelka

1989 *Geologic Map of the Palen-Mccoy Wilderness Study Area and Vicinity, Riverside County, California*. Miscellaneous Field Studies Map No. 2092. Scale 1:62,500. U.S. Geological Survey, Washington, D.C.

Strickland, A., J. L. Wooden, C. G. Mattinson, T. Ushikubo, D. M. Miller, and J. W. Valley

2013 Proterozoic Evolution of the Mojave Crustal Province as Preserved in the Ivanpah Mountains, Southeastern California. *Precambrian Research* 224:222–241.

SWCA Environmental Consultants (SWCA)

2011 *Paleontological Resource Assessment for the McCoy Solar Energy Project, Riverside County, California*. SWCA Environmental Consultants, Pasadena, California. Prepared for AECOM and McCoy Solar, LLC.

Tchakerian, V. P., and N. Lancaster

2002 Late Quaternary Arid/Humid Cycles in the Mojave Desert and Western Great Basin of North America. *Quaternary Science Reviews* 21(7):799–810.

Tosdal, R. M.

1990 Constraints on the Tectonics of the Mule Mountains Thrust System, Southeast California and Southwest Arizona. *Journal of Geophysical Research: Solid Earth* 95(B12):20025–20048.

Tosdal, R. M., G. B. Haxel, J. E. Wright, J. P. Jenney, and S. J. Reynolds

1989 Jurassic Geology of the Sonoran Desert Region, Southern Arizona, Southeastern California, and Northernmost Sonora: Construction of a Continental-Margin Magmatic Arc. *Geologic Evolution of Arizona: Arizona Geological Society Digest* 17:397–434.

Wells, Stephen G., Leslie D. McFadden, and John C. Dohrenwend

1987 Influence of Late Quaternary Climatic Changes on Geomorphic and Pedogenic Processes on a Desert Piedmont, Eastern Mojave Desert, California. *Quaternary Research* 27(2):130–146.

Wooden, J. L., and D. M. Miller

1990 Chronologic and Isotopic Framework for Early Proterozoic Crustal Evolution in the Eastern Mojave Desert Region, SE California. *Journal of Geophysical Research: Solid Earth* 95(B12):20133–20146.

APPENDIX A

Records-Search Results

20 June 2018

Dr. Joseph El Adli
Statistical Research, Inc.
21 West Stuart Avenue
Redlands, CA 92374

RE: Paleontological Records Search – Desert Quartzite Solar Project

Dear Dr. El Adli:

This letter presents the results of a paleontological records search conducted for the Desert Quartzite Solar Project (Project), located in southeastern Riverside County, CA. The Project site lies south of Interstate 10, approximately 9 miles west of the City of Blythe.

A review of published geological maps covering the Project site and surrounding area was conducted to determine the specific geologic units underlying the Project. Each geologic unit was subsequently assigned a paleontological resource potential following guidelines developed by the Bureau of Land Management (BLM, 2016) and Society of Vertebrate Paleontology (SVP, 2010). Published geological reports (e.g., Stone, 2006) covering the Project area indicate that construction of the proposed Project will impact Holocene-age surficial sediments, Holocene- and Pleistocene-age alluvial-fan deposits, and middle to late Pleistocene-age alluvial deposits of Palo Verde Mesa. These geologic units and their paleontological sensitivity are summarized in detail in the following section.

In addition, a search of the paleontological collection records housed at the San Diego Natural History Museum (SDNHM) was conducted in order to determine if any documented fossil collection localities occur at the Project site or within the immediate surrounding area (Figure 1). The SDNHM does not have any recorded fossil localities within one mile of the Project site.

Geologic Rock Units Underlying the Project Area

Holocene surficial sediments (wash deposits, eolian sand, and alluvial deposits) – Holocene surficial sediments underlie the northern and western portions of the Project site. In general, these surficial deposits range in thickness from less than one foot to over 300 feet, are undeformed by faulting, are largely undissected by modern drainages, and are probably entirely Holocene in age (i.e., younger than ~11,000 years old). As mapped by Stone (2006), the Holocene surficial sediments underlying the Project site include: alluvium of modern washes (Qw), consisting of unconsolidated gravel and sand derived from local mountain ranges); eolian sand (Qs), consisting of unconsolidated sand dunes and sheets; and alluvial-fan and alluvial-valley deposits, unit 6 (Qa_6), consisting of unvarnished, fine-grained sand, pebbly sand, and sandy pebble-gravel. The SDNHM does not have any localities from these deposits within a 1-mile radius of the Project site. Holocene surficial sediments are typically not considered to possess the potential to yield significant fossils because of their relatively young age, and are assigned a low paleontological potential (SVP, 2010) or PFYC Class 2 rating (BLM, 2016).

Holocene and Pleistocene alluvial-fan deposits – Holocene and Pleistocene-age (approximately 730,000 to 8,000 years old) alluvial deposits (mapped by Stone, 2006, as alluvial-fan and alluvial-valley deposits, unit 3; Qa3) underlie the northern portion of the Project site. These deposits generally consist of gravel and sand with dissected surfaces characterized by varnished desert pavement. The SDNHM does not have any localities from these deposits within a 1-mile radius of the Project site. Alluvial deposits are highly variable in composition, and fossils within alluvial deposits are most likely to be preserved within low-energy, fine-grained deposits and paleosols, rather than in high-energy conglomerates and fanglomerates. Fossils recovered from Pleistocene-age alluvial deposits include a large diversity of terrestrial vertebrates and occasionally freshwater vertebrates (e.g., fish, amphibians) and invertebrates (e.g., ostracods, barnacles). Recovered terrestrial vertebrates include reptiles (e.g., tortoise, snakes, lizards), birds (e.g., hawk, owl, song birds), small mammals (e.g., rabbits and hares, pocket mice, kangaroo rats, geomyid rodents, gopher, shrews, bats), and large mammals (e.g., mammoth, mastodon, camel, pronghorn, bison, deer, horse, ground sloth, mountain lion, saber-toothed cat, fox, wolf, bear). The Holocene and Pleistocene alluvial-fan deposits underlying the Project site are assigned an unknown potential (PFYC Class U; BLM, 2016) or undetermined potential (SVP, 2010) due to the variation in the concentration of fossil resources in these deposits, and the lack of precise grain size mapping of sediments.

Alluvial deposits of Palo Verde Mesa – The middle to late Pleistocene-age (approximately 780,000 to 11,000 years old) alluvial deposits of Palo Verde Mesa underlie the eastern and southern portions of the Project site. These deposits were laid down by the ancestral Colorado River, and are generally composed of unconsolidated to weakly consolidated sand, pebbly sand, silt, and clay. The SDNHM does not have any localities from these deposits within a 1-mile radius of the Project site. The alluvial deposits of Palo Verde Mesa are equivalent to units D and E of Metzger et al. (1973), which yielded fossil remains of turtle, snake, lizard, bird, and proboscidians near Ehrenberg, Arizona. Based on the prior recovery of vertebrate fossils from these sediments, the alluvial deposits of Palo Verde Mesa are assigned a high paleontological potential (SVP, 2010) or PFYC Class 4 rating (BLM, 2016).

Summary and Recommendations

The high paleontological potential (PFYC Class 4) of the alluvial deposits of Palo Verde Mesa and undetermined or unknown paleontological potential (PFYC Class U) of Holocene and Pleistocene alluvial-fan deposits (BLM, 2016; SVP, 2010) suggest the potential for construction of the proposed Project to result in impacts to paleontological resources. Any proposed excavation activities that extend deep enough to encounter previously undisturbed deposits of these geologic units have the potential to impact the paleontological resources preserved therein. For these reasons, implementation of a complete paleontological resource mitigation program during ground-disturbing activities is recommended.

If you have any questions concerning these findings please feel free to contact me at 619-255-0321 or kmccomas@sdnhm.org.

Sincerely,

Katie McComas
Paleontology Collections Assistant
Department of Paleontology

Enc: Figure 1: Project map

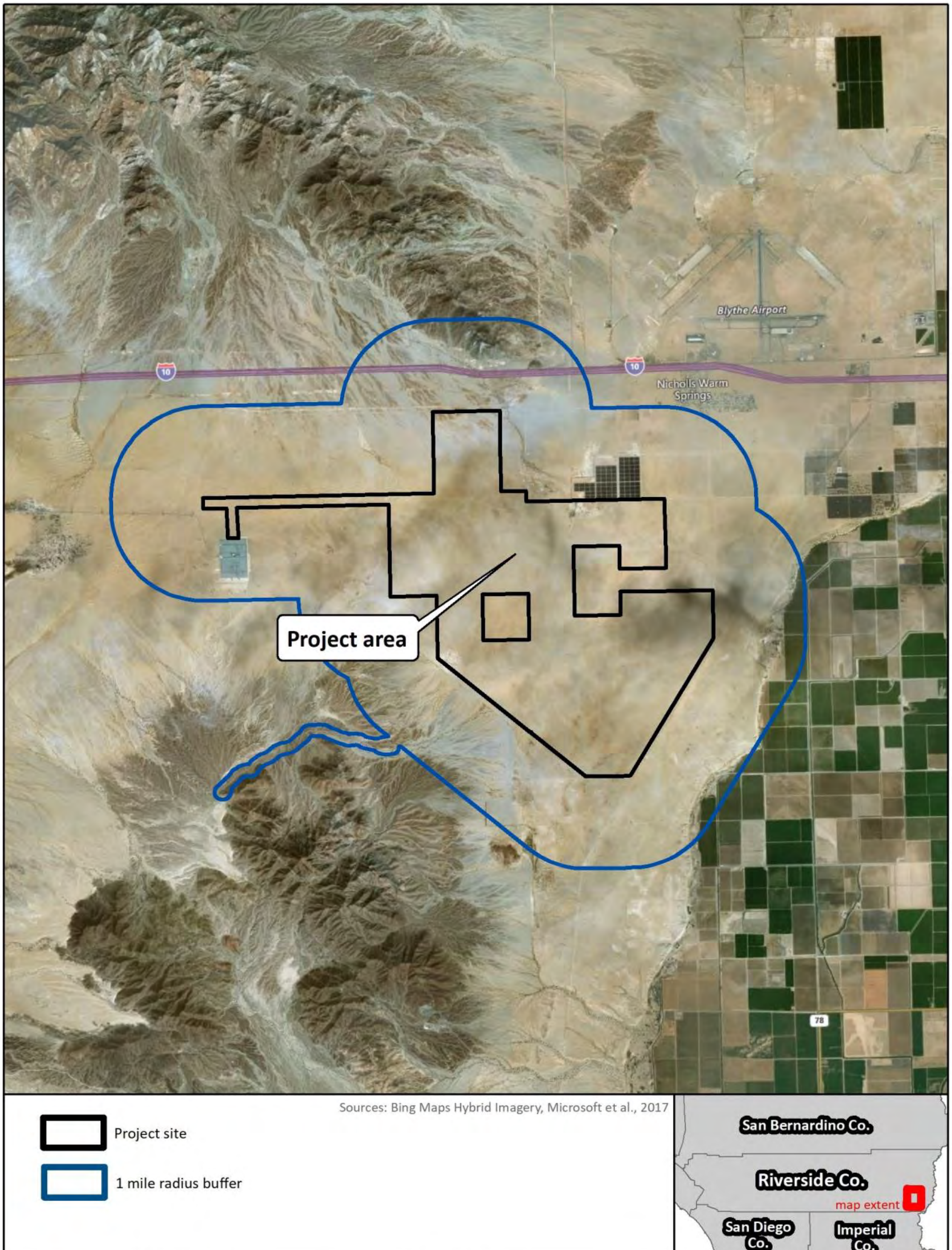
Literature Cited

Bureau of Land Management (BLM). 2016. Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands. Instruction Memorandum No. 2016-124, released July 20, 2016.

Metzger, D.G., O.J. Loeltz, and R. Irelna. 1973. Geohydrology of the Parker-Blythe-Cibola area, Arizona and California: U.S. Geological Survey Professional Paper 486-G, 130 p.

Society of Vertebrate Paleontology (SVP). 2010. Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Society of Vertebrate Paleontology, p. 1-11.

Stone, P. (compiler). 2006. Geological Map of the West Half of the Blythe 30' by 60' Quadrangle, Riverside County, California and La Paz County, Arizona. United States Geological Survey Scientific Investigations Map 2922.



PALEOSERVICES

FIGURE 1

Project Map
Desert Quartzite Solar Project
Riverside County, California

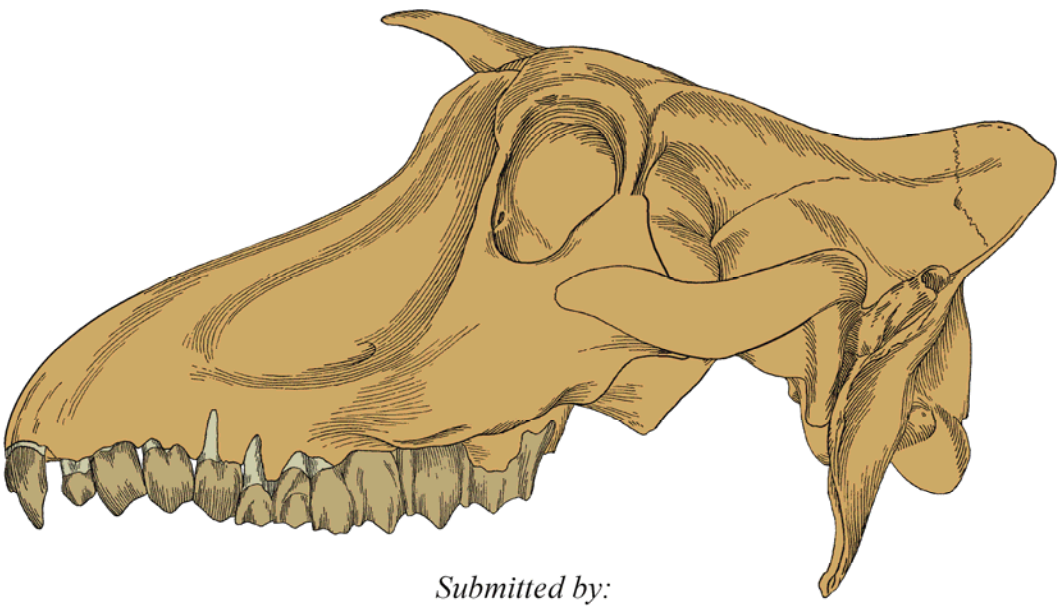
PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT TECHNICAL REPORT
prepared in support of
DESERT QUARTZITE SOLAR PROJECT
Southeastern Riverside County, California

Submitted to:

Statistical Research, Inc.
21 West Stuart Avenue
Post Office Box 390
Redlands, California 92373-0123

On behalf of:

Desert Quartzite, LLC
135 Main Street, 6th Floor
San Francisco, California 94105



Submitted by:

Robert E. Reynolds
&
E. Bruce Lander, Ph.D.
Paleo Environmental Associates, Inc.
2248 Winrock Avenue
Altadena, California 91001-3205

626/797-9895
paleo@earthlink.net

PEAI
PALEO ENVIRONMENTAL ASSOCIATES, INCORPORATED

March 2016

2013-13
desert quartzite.doc

PALEO ENVIRONMENTAL ASSOCIATES

PRELIMINARY PALEONTOLOGICAL RESOURCE ASSESSMENT TECHNICAL REPORT
prepared in support of
DESERT QUARTZITE SOLAR PROJECT
Southeastern Riverside County, California

submitted to:

Statistical Research, Inc.
21 West Stuart Avenue
Post Office Box 390
Redlands, California 92373-0123

on behalf of:

Desert Quartzite, LLC
135 Main Street, 6th Floor
San Francisco, California 94105

Submitted by:

Robert E. Reynolds
&
E. Bruce Lander, Ph.D.
Paleo Environmental Associates, Inc.
2248 Winrock Avenue
Altadena, California 91001-3205

626/797-9895
paleo@earthlink.net

March 2016

EXCERPTED MATERIAL

APPENDIX F

RESULTS OF PALEONTOLOGICAL RESOURCE ARCHIVAL SEARCHES

Natural History Museum
of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007

tel 213.763.DINO
www.nhm.org

NATURAL HISTORY MUSEUM
LOS ANGELES COUNTY

Vertebrate Paleontology Section
Telephone: (213) 763-3325
FAX: (213) 746-7431
e-mail: smcleod@nhm.org

5 September 2013

Paleo Environmental Associates
2248 Winrock Ave.
Altadena, CA 91001

Attn: Dr. E. Bruce Lander

re: Paleontological Resources Records Check for the proposed Desert Quartzite solar mirror Project, near the City of Blythe, Riverside County, project area

Dear Bruce:

I have thoroughly searched our paleontology collection records for the locality and specimen data for the proposed Desert Quartzite solar mirror Project, near the City of Blythe, Riverside County, project area as outlined on the portions of the Roosevelt Mine and Ripley USGS topographic quadrangle maps that you sent to me via e-mail on 26 August 2013. We do not have any vertebrate fossil localities that lie directly within the proposed project area, but we do have vertebrate fossil localities from sedimentary deposits similar to those that occur in the proposed project area, albeit at some distance.

In the far northwestern portion of the proposed project area there are some surface deposits of younger Quaternary aeolian sands. Otherwise the western portion of the proposed project area has surface deposits composed of younger Quaternary Alluvium, derived predominately as alluvial fan deposits from the McCoy Mountains to the north and northwest. These younger Quaternary deposits typically do not contain significant vertebrate fossils, at least in the uppermost layers and especially in the coarser fractions closer to the source material in the mountains. We do have a vertebrate fossil locality somewhat nearby from younger Quaternary deposits though, LACM 5977, to the west-northwest of the proposed project area between Interstate Highway 10 and Ford Dry Lake, so probably from fine-grained lacustrine deposits, that produced specimens of kangaroo rat, *Dipodomys*, and pocket mouse, *Perognathus*. Most of the proposed project area, the eastern nearly flat portion, has surface deposits of older Quaternary Alluvium, derived as alluvial deposits on the Palo Verde Mesa. Our closest vertebrate fossil localities from older Quaternary deposits, the Pinto Formation in this case, are LACM (CIT) 208 and LACM 3414, some distance to the northwest of the proposed project area between the Eagle Mountains and the Coxcomb Mountains, that produced fossil specimens of tortoise, *Gopherus*, horse, *Equus*, and camel, *Camelops* and *Tanupolama stevensi*.

Shallow excavations in the younger Quaternary aeolian and alluvial fan deposits exposed in the western portion of the proposed project area are unlikely to encounter significant vertebrate fossil remains. Deeper excavations in those areas that extend down into older Quaternary deposits, as well as any excavations in the older Quaternary deposits exposed in most of the proposed project area, however, may well uncover significant vertebrate fossils. Any substantial excavations in the sedimentary deposits in the proposed project area, therefore, should be monitored closely to quickly and professionally recover any fossil remains discovered while not impeding development. Any fossils recovered during mitigation should be deposited in an accredited and permanent scientific institution for the benefit of current and future generations.

This records search covers only the vertebrate paleontology records of the Natural History Museum of Los Angeles County. It is not intended to be a thorough paleontological survey of the proposed project area covering other institutional records, a literature survey, or any potential on-site survey.

Sincerely,

Samuel A. McLeod

Samuel A. McLeod, Ph.D.
Vertebrate Paleontology

enclosure: invoice

ACCREDITED by the AMERICAN ASSOCIATION OF MUSEUMS

SAN BERNARDINO COUNTY MUSEUM

2024 Orange Tree Lane ~ Redlands, California USA 92374-4560
(909) 798-8608 ~ Fax (909) 307-0539 www.sbcountymuseum.org

COUNTY OF SAN BERNARDINO

ROBERT L. McKERNAN
Director

6 September 2013

PaleoEnvironmental Associates, Inc.
attn: E. Bruce Lander, Ph.D.
2248 Winrock Avenue
Altadena, CA 91001

re: **PALEONTOLOGY LITERATURE AND RECORDS REVIEW, DESERT QUARTZITE SOLAR MIRROR PROJECT, RIVERSIDE COUNTY, CALIFORNIA**

Dear Dr. Lander,

The Division of Geological Sciences of the San Bernardino County Museum (SBCM) has completed a literature review and records search for the above-referenced development west of Blythe in Riverside County, California. The study area is located in portions of sections 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 22, 23, and 24, Township 7 South, Range 21 East, San Bernardino Base and Meridian, as seen on the Ripley, California (1952 edition, photorevised 1970) and the Roosevelt Mine, California (1983 provisional edition) 7.5' United States Geological Survey topographic quadrangle maps.

Geologic mapping by Jennings (1967) indicates that the proposed property is situated in part upon surficial Pleistocene nonmarine sediments (= unit **Qc**), particularly towards the southwestern part of the study area. To the north and east, these sediments are overlain by recent alluvium (= **Qal**) and dune sand (= **Qs**). The Pleistocene sediments may include both river gravels derived from the Colorado River and lake sediments of the Chemehuevi Formation, although these units were not differentiated by Jennings (1967). The Chemehuevi Formation and potentially the overlying river gravels have high potential to contain significant nonrenewable paleontologic resources subject to adverse impact by development-related excavation (Newberry, 1861; Longwell and others, 1965; Agenbroad and others, 1992). Similarly-mapped sediments in the Needles area (Bishop, 1963), for example, have yielded fossil remains of extinct mammoth (*Mammuthus* sp.). Additionally, Jefferson (1991) reported fossils (taxa not recorded) from Blythe (see below), as well as remains of extinct horse (*Equus* sp.) and camel (*Camelops* sp.) from the Needles area. These fossils were deposited during the Pleistocene Epoch, between approximately 2.6 million years ago and 11,000 years ago. Pleistocene sediments from throughout the eastern Mojave Desert have proven to be abundantly fossiliferous (Reynolds and Reynolds, 1992; Agenbroad and others, 1992; Scott and Cox, 2008).

For this report, I conducted a review of the Regional Paleontologic Locality Inventory (RPLI) at the SBCM. The results of this review indicate that no previously-known paleontologic resource localities are recorded by the SBCM from the site of the proposed solar mirror array, nor are any resource localities recorded from within several miles of the site. However, Jefferson (1991) listed one locality, UCMP V60004, from the Blythe area; unfortunately the precise location of this site and the nature of the fossils recovered were not discussed in that review.

Recommendations

The results of the literature review and the check of the RPLI at the SBCM demonstrate that excavation in conjunction with development is determined to have high potential to adversely impact significant nonrenewable paleontologic resources present within the boundaries of the proposed project property. A qualified vertebrate paleontologist must be retained to develop a program to mitigate impacts to such resources. This mitigation program should be consistent with the provisions of the California Environmental Quality Act (Scott and Springer, 2003), as well as with regulations currently implemented by the County of Riverside. This program should include, but not be limited to:

1. Monitoring of excavation in areas identified as likely to contain paleontologic resources by a qualified paleontologic monitor. Based upon the results of this review, areas of concern include any undisturbed surface or subsurface sediments of Pleistocene older alluvium. Paleontologic monitors should be equipped to salvage fossils as they are unearthed, to avoid construction delays, and to remove samples of sediments that are likely to contain the remains of small fossil invertebrates and vertebrates. Monitors must be empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens.

2. Preparation of recovered specimens to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates. Preparation and stabilization of all recovered fossils are essential in order to fully mitigate adverse impacts to the resources (Scott and others, 2004).

3. Identification and curation of specimens into an established, accredited museum repository with permanent retrievable paleontologic storage. These procedures are also essential steps in effective paleontologic mitigation (Scott and others, 2004) and CEQA compliance (Scott and Springer, 2003). The paleontologist must have a written repository agreement in hand prior to the initiation of mitigation activities. Mitigation of adverse impacts to significant paleontologic resources is not complete until such curation into an established museum repository has been fully completed and documented.

4. Preparation of a report of findings with an appended itemized inventory of specimens. It is recommended that this report incorporate the full results of this literature review. The report and inventory, when submitted to the appropriate Lead Agency along with confirmation of the curation of recovered specimens into an established, accredited museum repository, would signify completion of the program to mitigate impacts to paleontologic resources.

References

Agenbroad, L.D., J.I. Mead and R.E. Reynolds, 1992. Mammoths in the Colorado River Corridor. *In* J. Reynolds (ed.), Old routes to the Colorado. SBCM Association Special Publication 92-2, p. 104-106.

Bishop, C.C., 1963. Geologic map of California, Needles sheet, scale 1:250,000. California Division of Mines and Geology Regional Geologic Map Series.

Jefferson, G.T., 1991. A catalogue of late Quaternary vertebrates from California: Part Two, mammals. Natural History Museum of Los Angeles County Technical Reports, No. 7.

Jennings, C.W., 1967. Geologic map of California, Salton Sea sheet, 1:250,000. Division of Mines and Geology.

Longwell, C.R., E.H. Pampeyan, B. Bower and R.J. Roberts, 1965. Geology and mineral deposits of Clark County, Nevada. Nevada Bureau of Mines and Geology Bulletin 62. 218 p.

Newberry, J.S., 1861. Report upon the Colorado River of the West by J.C. Ives, Part III. Washington, D.C.: Government Printing Office.

Reynolds, S.F.B. and R.L. Reynolds, 1992. Pleistocene faunas in the Bristol-Danby trough. *In* J. Reynolds (ed.), Old routes to the Colorado. SBCM Association Special Publication 92-2, p. 83-86.

Scott, E. and S.M. Cox, 2008. Late Pleistocene distribution of *Bison* (Mammalia; Artiodactyla) in the Mojave Desert of southern California and Nevada. *In* X. Wang and L.G. Barnes (eds.) Geology and Vertebrate Paleontology of Western and Southern North America, Contributions in Honor of David P. Whistler. Natural History Museum of Los Angeles County Science Series No. 41: 359 - 382.

Scott, E. and K. Springer, 2003. CEQA and fossil preservation in southern California. The Environmental Monitor, Fall 2003, p. 4-10, 17.

Scott, E., K. Springer and J.C. Sagebiel, 2004. Vertebrate paleontology in the Mojave Desert: the continuing importance of "follow-through" in preserving paleontologic resources. *In* M.W. Allen and J. Reed (eds.) The human journey and ancient life in California's deserts: Proceedings from the 2001 Millennium Conference. Ridgecrest: Maturango Museum Publication No. 15, p. 65-70.

Please do not hesitate to contact us with any further questions you may have.

Sincerely,

Eric Scott, Curator of Paleontology
Division of Geological Sciences
San Bernardino County Museum

X

U.S. Department of the Interior Bureau of Land Management Paleontological Resource Use Permit

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
California State Office
2800 Cottage Way, Suite W1623
Sacramento, CA 95825
www.blm.gov/california

MAR 2 7 2018

In Reply Refer To:
8151(CA-930) P

Joseph J. El Adli, Ph.D.
Statistical Research, Inc.
21 W. Stuart Ave.
Redlands, CA 92374

Dear Dr. El Adli:

The Bureau of Land Management (BLM) is pleased to issue a Scientific Paleontological Permit (*CA-18-01P*) to Statistical Research, Inc. for use on Public Lands managed by California BLM as specified in your permit. This permit is issued under the authority of the Federal Land Policy and Management Act (FLPMA) and the Antiquities Act of 1906. Keep a copy with you at all times in the field.

This permit authorizes the permit holder to conduct and collect paleontological resources pertaining to both scientific research and commercial projects. BLM would like to emphasize a few points. First, this permit assigns to your firm the responsibility to submit reports and other documents in a timely fashion and such submittal will be a major point of review of your firm's performance under this permit. Second, you are required to contact the appropriate Field Office to obtain a Field Use Authorization before you begin any fieldwork. Please allow the Field Office sufficient lead-time to process your application for a Field Use Authorization. The Field Office may impose additional conditions and stipulations at that time. Third, please be mindful that it is your firm's responsibility to ensure assignment of supervisory field personnel (crew chiefs) to projects that have at least four months' local experience and who otherwise meet the standards of the Bureau.

Our office is enclosing a map of California BLM Field Offices with phone numbers of cultural heritage staff and a copy of your permit with attached National special permit conditions. BLM draws your attention to these stipulations and encourages you to read and understand them. Please sign page 5, as indicated, and **return a copy of this signature page to the California BLM State Office within 30 days of your receipt of the permit**. Your permit will be valid after your signature is received.

Should you have any questions contact James Barnes at email jjbarnes@blm.gov or by phone 916-978-4676.

Sincerely,

Danielle Chi
Deputy State Director

Enclosures as stated

DI Form 1991 (Rev Sept 2004)
OMB No. 1024-0037
Exp. Date (01/31/2008)

United States Department of the Interior

PERMIT FOR PALEONTOLOGICAL INVESTIGATIONS

To conduct archeological work on Department of the Interior lands and Indian lands under the authority of:

☐ The Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-mm) and its regulations (43 CFR 7).
☒ The Antiquities Act of 1906 (P.L. 59-209; 34 Stat. 225, 16 U.S.C. 431-433) and its regulations (43 CFR 3).
☐ Supplemental regulations (25 CFR 262) pertaining to Indian lands.
☒ Bureau-specific statutory and/or regulatory authority: Federal Land Policy and Management Act of 1976 (Public Law 94-570), and Section 302 of Public Law 94-4579

Please use this number when referring to this permit
No.: **CA-18-01P**

1. Permit issued to Statistical Research, Inc.	2. Under application dated February 14, 2018
3. Address 21 W. Stuart Ave., Redlands, CA 92374	4. Telephone number(s) (909) 335-1896 5. E-mail address(es) jeladli@sricrm.com
6. Name of Permit Administrator Joseph J. El Adli Telephone number(s): (909) 335-1896 Email address(es): jeladli@sricrm.com	7. Name of Principal Investigator(s): Joseph J. El Adli Telephone number(s): (909) 335-1896 Email address(es): jeladli@sricrm.com
8. Name of Field Director(s) authorized to carry out field projects:	Telephone number(s):

9. Activity authorized
Survey and limited surface collection

10. On lands described as follows
All public lands managed by the Bureau of Land Management-California Desert District

11. During the duration of the project From April 28, 2018 To April 27, 2019

12. Name and address of the curatorial facility in which collections, records, data, photographs, and other documents resulting from work under this permit shall be deposited for permanent preservation on behalf of the United States Government.
Western Science Center, 2345 Searl Pkwy, Hemet, CA 92543

13. Permittee is required to observe the listed standard permit conditions and the special permit conditions attached to this permit.

14. Signature and title of approving official *Danielle Chi* Danielle Chi, Deputy State Director, Natural Resources Division	15. Date 3/27/18

15. Standard Permit Conditions

a. This permit is subject to all applicable provisions of 43 CFR Part 3, 43 CFR 7, and 25 CFR 262, and applicable departmental and bureau policies and procedures, which are made a part hereof.

b. The permittee and this permit are subject to all other Federal, State, and local laws and regulations applicable to the public lands and resources.

c. This permit shall not be exclusive in character, and shall not affect the ability of the land managing bureau to use, lease or permit the use of lands subject to this permit for any purpose.

d. This permit may not be assigned.

e. This permit may be suspended or terminated for breach of any condition or for management purposes at the discretion of the approving official, upon written notice.

f. This permit is issued for the term specified in 11 above.

g. Permits issued for a duration of more than one year must be reviewed annually by the agency official and the permittee.

h. The permittee shall obtain all other required permit(s) to conduct the specified project.

i. Archeological project design, literature review, development of the regional historic context framework, site evaluation, and recommendations for subsequent investigations must be developed with direct involvement of an archeologist who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation; fieldwork must be generally overseen by an individual who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation.

j. Permittee shall immediately request that the approving official (14. above) make a modification to accommodate any change in an essential condition of the permit, including individuals named and the nature, location, purpose, and time of authorized work, and shall without delay notify the approving official of any other changes affecting the permit or regarding information submitted as part of the application for the permit. Failure to do so may result in permit suspension or revocation.

k. Permittee may request permit extension, in writing, at any time prior to expiration of the term of the permit, specifying a limited, definite amount of time required to complete permitted work.

l. Any correspondence about this permit or work conducted under its authority must cite the permit number. Any publication of results of work conducted under the authority of this permit must cite the approving bureau and the permit number.

m. Permittee shall submit a copy of any published journal article and any published or unpublished report, paper, and manuscript resulting from the permitted work (apart from those required in items q. and s., below), to the approving official and the appropriate official of the approved curatorial facility (item 12 above).

n. Prior to beginning any fieldwork under the authority of this permit, the permittee, following the affected bureau's policies and procedures, shall contact the field office manager responsible for administering the lands involved to obtain further instructions.

o. Permittee may request a review, in writing to the official concerned, of any disputed decision regarding inclusion of specific terms and conditions or the modification, suspension, or revocation of this permit, setting out reasons for believing that the decision should be reconsidered.

p. Permittee shall not be released from requirements of this permit until all outstanding obligations have been satisfied, whether or not the term of the permit has expired. Permittee may be subject to civil penalties for violation of any term or condition of this permit.

15. Standard Permit Conditions (continued)

q. Permittee shall submit a preliminary report to the approving official within a timeframe established by the approving official, which shall be no later than 6 weeks after the completion of any episode of fieldwork, setting out what was done, how it was done, by whom, specifically where, and with what results, including maps, GPS data, an approved site form for each newly recorded archeological site, and the permittee's professional recommendations, as results require. If other than 6 weeks, the timeframe shall be specified in Special Permit Condition p. Depending on the scope, duration, and nature of the work, the approving official may require progress reports, during or after the fieldwork period or both, and as specified in Special Permit Condition r.

r. Permittee shall submit a clean, edited draft final report to the agency official for review to insure conformance with standards, guidelines, regulations, and all stipulations of the permit. The schedule for submitting the draft shall be determined by the agency official.

s. Permittee shall submit a final report to the approving official not later than 180 days after completion of fieldwork. Where a fieldwork episode involved only minor work and/or minor findings, a final report may be submitted in place of the preliminary report. If the size or nature of fieldwork merits, the approving official may authorize a longer timeframe for the submission of the final report as specified in Special Permit Condition q.

t. Two copies of the final report, a completed NTIS Report Documentation Page (SF-298), available at http://www.ntis.gov/pdf/rdpform.pdf, and a completed NADB-Reports Citation Form, available at http://www.cr.nps.gov/aad/tools/nadbform_update.doc, will be submitted to the office issuing the permit.

u. The permittee agrees to keep the specific location of sensitive resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

v. Permittee shall deposit all artifacts, samples and collections, as applicable, and original or clear copies of all records, data, photographs, and other documents, resulting from work conducted under this permit, with the curatorial facility named in item 12, above, not later than 90 days after the date the final report is submitted to the approving official. Not later than 180 days after the final report is submitted, permittee shall provide the approving official with a catalog and evaluation of all materials deposited with the curatorial facility, including the facility's accession and/or catalog numbers.

w. Permittee shall provide the approving official with a confirmation that museum collections described in v. above were deposited with the approved curatorial facility, signed by an authorized curatorial facility official, stating the date materials were deposited, and the type, number and condition of the collected museum objects deposited at the facility.

x. Permittee shall not publish, without the approving official's prior permission, any locational or other identifying archeological site information that could compromise the Government's protection and management of archeological sites.

y. For excavations, permittee shall consult the OSHA excavation standards which are contained in 29 CFR §1926.650, §1926.651 and §1926.652. For questions regarding these standards contact the local area OSHA office, OSHA at 1-800-321-OSHA, or the OSHA website at http://www.osha.gov.

z. Special permit conditions attached to this permit are made a part hereof.

16. Special Permit Conditions

☒ a. Permittee shall allow the approving official and bureau field officials, or their representatives, full access to the work area specified in this permit at any time the permittee is in the field, for purposes of examining the work area and any recovered materials and related records.

☒ b. Permittee shall cease work upon discovering any human remains and shall immediately notify the approving official or bureau field official. Work in the vicinity of the discovery may not resume until the authorized official has given permission.

☒ c. Permittee shall backfill all subsurface test exposures and excavation units as soon as possible after recording the results, and shall restore them as closely as reasonable to the original contour.

☒ d. Permittee shall not use mechanized equipment in designated, proposed, or potential wilderness areas unless authorized by the agency official or a designee in additional specific conditions associated with this permit.

☒ e. Permittee shall take precautions to protect livestock, wildlife, the public, or other users of the public lands from accidental injury in any excavation unit.

☒ f. Permittee shall not conduct any flint knapping or lithic replication experiments at any archeological site, aboriginal quarry source, or non-site location that might be mistaken for an archeological site as a result of such experiments.

☒ g. Permittee shall perform the fieldwork authorized in this permit in a way that does not impede or interfere with other legitimate uses of the public lands, except when the authorized officer specifically provides otherwise.

☒ h. Permittee shall restrict vehicular activity to existing roads and trails unless the authorized officer provides otherwise.

☒ i. Permittee shall keep disturbance to the minimum area consistent with the nature and purpose of the fieldwork.

☒ j. Permittee shall not cut or otherwise damage living trees unless the authorized officer gives permission.

☒ k. Permittee shall take precautions at all times to prevent wildfire. Permittee shall be held responsible for suppression costs for any fires on public lands caused by the permittee's negligence. Permittee may not burn debris without the authorized officer's specific permission.

☒ l. Permittee shall conduct all operations in such a manner as to prevent or minimize scarring and erosion of the land, pollution of the water resources, and damage to the watershed.

☒ m. Permittee shall not disturb resource management facilities within the permit area, such as fences, reservoirs, and other improvements, without the authorized officer's approval. Where disturbance is necessary, permittee shall return the facility to its prior condition, as determined by the authorized officer.

☒ n. Permittee shall remove temporary stakes and/or flagging, which the permittee has installed, upon completion of fieldwork.

☒ o. Permittee shall clean all camp and work areas before leaving the permit area. Permittee shall take precautions to prevent littering or pollution on public lands, waterways, and adjoining properties. Refuse shall be carried out and deposited in approved disposal areas.

☐ p. Permittee shall submit the preliminary report within ____________ days/weeks of completion of any episode of fieldwork..

☐ q. Permittee shall submit the final report within ____________ days/weeks/months after completion of fieldwork..

☐ r. Permittee shall submit progress reports every ____________ months over the duration of the project.

☒ s. California special permit conditions are attached.

Special Permit Conditions Continuation Sheet: California Conditions

- a. Work under this permit is limited to specific service approved for each permit. This may consist of non-collection survey, limited testing to determine site content and limits or extensive testing emergency excavation and/or salvage projects. Testing/ excavation projects may be conducted under the authority of this permit only upon completion of ARPA consultation with Native American Groups and written approval from the Bureau for such work. (CARIDAPs for the purpose of the identification of archaeological resources are authorized under a FLPMA/ARPA Permit).
- b. Permittees shall verbally and subsequently in writing contact the appropriate BLM Field Manager prior to the beginning of each of his field operations (with follow-up written notification) to inform the BLM of specific work to be conducted. At this time, the BLM Field Manager may impose additional stipulation as deemed necessary to provide for the protection and management of resource values in the general site or project area.
- c. All cultural artifacts and other related materials such as notes, photographs, etc., acquired under the provisions of this permit **remain the property of the United States Government and may be recalled at any time for the use of the Department of the interior or other agencies of the Federal Government.** Cultural materials collected under the provisions of this permit must be curated at a repository approved by the BLM. Curation shall be at a local qualified repository, if feasible, and an approved curation facility shall be designated prior to all field projects. An itemized list of all materials with accession numbers, curated at the repository will be submitted to the State Office and to the appropriate Field Office within 180 days of the completion of individual field projects. A copy of a receipt from the curation facility must be submitted with the list or catalogue.
- d. Permittees shall acquire a primary number from the appropriate Information Center for each cultural resource documented while undertaking work authorized by this permit.
- e. The BLM Field Manager or authorized representative may require a monthly letter progress report outlining what was accomplished. This report, if required, is due by the fifth day of the following month, unless different arrangements are approved.
- f. The individual(s) in direct charge must be academically qualified and possess adequate field experience. At least two weeks prior to initiation field work, the permittees must provide the BLM Field Manager with the vitae of individuals proposed to be in direct charge if not approved at the time of permit issuance. A list of field crew members should be submitted at the same time. Only the individual(s) listed in Item No. 8 of the permit is/are authorized to be in direct charge of field work conducted under this permit.
- g. The person(s) in direct charge of field work, shall be on site at all times when work is in progress. Failure to comply with permit stipulations will result in removal of subject's name(s) from the approved list of person-in-direct-charge.
- h. Care should be exercised to avoid directly or indirectly increasing access or potential vandalism to sensitive sites.
- i. All National Permit Stipulations are binding. The authority for issuing permits in the Bureau of Land Management rests solely with the State Director as Delegated by the Secretary of the Interior and all further delegation is prohibited by Secretarial Order. No Modification of National Permit Conditions 8 or 9 or of the California Special Permit Conditions may occur except by written decision of the State Director.
- j. The Bureau of Land Management shall be cited in any report of work done under this permit, including publications such as books, news articles and scientific publications, as well as oral reports, films, television programs, and presentations in other media.

By signing below, I, the Principal Investigator, acknowledge that I have read and understand the Permit for Archeological Investigations and agree to its terms and conditions as evidenced by my signature below and initiation of work or other activities under the authority of this permit.

Signature and title:	Date:

Paperwork Reduction Act and Estimated Burden Statement: This information is being collected pursuant to 16 U.S.C. 470cc and 470mm, to provide the necessary facts to enable the Federal land manager (1) to evaluate the applicant's professional qualifications and organizational capability to conduct the proposed archeological work; (2) to determine whether the proposed work would be in the public interest; (3) to verify the adequacy of arrangements for permanent curatorial preservation, as United States property, of specimens and records resulting from the proposed work; (4) to ensure that the proposed activities would not be inconsistent with any management plan applicable to the public lands involved; (5) to provide the necessary information needed to complete the Secretary's Report to Congress on Federal Archeology Programs; and (6) to allow the National Park Service to evaluate Federal archeological protection programs and assess compliance with the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470). Submission of the information is required before the applicant may enjoy the benefit of using publicly owned archeological resources. To conduct such activities without a permit is punishable by felony-level criminal penalties, civil penalties, and forfeiture of property. A federal agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Departmental Consulting Archeologist; NPS; 1849 C Street, NW (2275); Washington, DC 20240-0001.

U.S. Department of the Interior Bureau of Land Management Paleontological Survey Fieldwork Authorization

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Palm Springs South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262
www.blm.gov/california

In Reply Refer To:
2800 (P)
8270
CACA049397
CAD060.65

MAY 1 0 2018

Statistical Research, Inc.
21 W. Stuart Avenue,
Redlands, CA 92374
Attention: Mr Joseph J. El Adli, PhD

Dear Mr. El Adli

Enclosed is your Paleontological Field Authorization (PFA), #18-01, for your paleontological survey of the Desert Quartzite Solar Project located just southwest of Blythe and north of the Mule Mountains of eastern Riverside County, California (see attached location and site index maps).

As noted on your application, the proposed study area exists on a variety of federal lands under the jurisdiction of the Bureau of Land Management (BLM) as well as private and other ownership lands. This authorization applies only to the paleontological monitoring which will be conducted on the project area within public federal lands under the jurisdiction of the BLM.

The authorized activities include: (1) broad ranging survey/reconnaissance work; (2) locate, but not collect, vertebrate fossil localities for inventory or planning purposes; and (3) identify in advance of development projects which areas may threaten resource localities.

The following stipulations apply:

1. All standard and special conditions of Permit For Paleontological Investigations No. CA-18-01P issued will remain in effect and in force. A copy of this permit and associated authorizations must be carried by the individual in charge of fieldwork during the duration of onsite inventory.

2. Please note that only the individual(s) listed in Item No. 7 of the permit is/are authorized to be in direct charge of field work conducted under this permit.

3. A "Field Contact Representative" (FCR) is defined as a person designated by the project proponent who is responsible for overseeing compliance with desert tortoise protective measures and for coordination with the agency compliance officer. The FCR must be on-site during all project activities. The FCR shall have the authority to halt all project activities that are in violation of these measures. The FCR shall have a copy of all tortoise protective measures when work is being conducted on the site.

4. Limit the collection of materials to easily collectible vertebrate fossils which result in very little or no significant surface disturbance. Isolated gar scales, chelonid (turtle) carapace or plastron fragments, crocodile and and fish teeth are not to be collected. However, if these fragments are seen, the location of these fragments must be recorded and a description of the fossil material noted in the field notes and on a

MAY 1 0 2018

BLM Locality Form as part of the report. A separate notification will be required for the collection of vertebrate paleontological resources that are not easily collectable and/or will require surface disturbanceYou must notify this field office prior to making any collections which result in excavations and/or significant surface disturbance.

5. Motor vehicle access shall be limited to maintained roads and designated routes. Vehicle speed on non paved highways within a project area shall not exceed 20 miles per hour. Vehicles parked in desert tortoise habitat shall be inspected immediately prior to being moved. If a tortoise is found beneath a vehicle, the BLM Authorized Biologist shall be contacted to move the animal from harm's way, or the vehicle shall not be moved until the desert tortoise leaves of its own accord. Should any desert tortoise be injured or killed, all activities shall be halted, and the BLM Authorized Biologist immediately contacted. The biologist shall have the responsibility for determining whether the animal should be transported to a veterinarian for care, which is paid for by the project proponent, if involved. If the animal recovers, USFWS is to be contacted to determine the final disposition of the animal; few injured desert tortoises are returned to the wild.

6. All trash and food items shall be promptly contained and regularly removed from the project site to reduce the attractiveness of the area to common ravens and other desert predators.

7. The presence of dogs on the site should be discouraged within tortoise habitat zones. Any dogs on the project site must be restrained either by enclosure in a kennel or on a 6-foot maximum length leach under the immediate control of the field party.

8. You must notify the BLM Palm Springs South Coast field office when fieldwork has been completed.

9. Reports of the general findings and the background information must be submitted to the BLM project manager or Authorized Officer no later than 180 days after completion of fieldwork. Reports must include the following details, as applicable. Items (a) and (b) should appear at the beginning of the report and may be presented as a title page in multi-page reports. Some of these categories may be combined.

- a.) Name, affiliation, address, date of report, and permit number (if consultant) of paleontologist doing the survey.
- b.) Project name and number (if used), name of proponent, and general location of project.
- c.) Date(s) of survey and names of any personnel assisting with the survey.
- d.) Brief description of the proposed project, emphasizing potential impacts to paleontological resources.
- e.) Descriptions of background research conducted. (Include overview of known paleontological information, institutions consulted, previous surveys in the area, previous projects of similar nature in the area, and general description of survey techniques employed).
- f.) Summary of regional and local geology. May reference earlier projects for relevant information.
- g.) Summary of regional and local paleontology. May reference earlier projects for relevant information.
- h.) Summary of the survey results.
- i.) Significance of findings.
- j.) Potential impacts to paleontological resources resulting from the project.
- k.) Detailed mitigation recommendations that may lessen potential adverse impacts.
- l.) Potential fossiliferous areas to allow for future assessment of sites if applicable.
- m.) Cited and other pertinent references.
- n.) Map of project area, indicating areas surveyed, known localities, and new discoveries.

MAY 1 0 2018

o.) Relevant photos, diagrams, tables to aid in explaining, clarifying, or understanding the findings.

p.) Listing of collected material, including field numbers, field identifications, and elements, cross-referenced to locality field numbers. This list may be submitted in electronic format, preferably in spreadsheet format.

q.) BLM locality form (8270-3) or equivalent for each new locality (including localities where fossils were observed but not collected) with a 1:24000 scale map showing the localities (not reduced in scale during photocopying) (see items 2 and 3 below).

Thank you for your assistance. Should you have questions, please don't hesitate to call our BLM Palm Springs Field Office Geologist, Mr. Jeffrey Johnston at (760) 833-7134.

Sincerely,

Janet E Clark acting for

Douglas Herrema
Field Manager

Enclosure (3):
1. PFA 2018-1
2. Paleontological Fieldwork Authorization Application
3. Detailed work area maps

Form 8151-3

United States
Department of the Interior
Bureau of Land Management

INFORMATION
REQUIREMENT
APPROVED
OMB NO. 1024-0037

FIELDWORK AUTHORIZATION REQUEST

For BLM Use Only

PFA-18-01

[redacted]

MAY 10 2018

To Conduct Specific Cultural Resource Work under the Authority of a
Cultural Resource Use Permit Issued by the Bureau of Land Management
Pursuant to Sec. 302 (b) of P. L. 94-579, October 21, 1976, 43 USC 1732
Sec. 4 of P. L. 96-95, October 31, 1979, 16 USC, 470cc

1. Permit Number and Date Issued **CA-18-01P** **Issued: 03/27/2018**	2. Name of Permittee **Joseph El Adli**
3. Mailing Address and Telephone Number Address: **Statistical Research, Inc.** **21 W. Stuart Ave.** **Redlands, CA 92374 USA**	Telephone [(xxx) xxx-xxxx]: **(909) 335-1896**
4. Nature of Cultural Resources Work Proposed (if Consultation Work, Identify Client and Project) **Paleontological Resource Field Survey; Consultation Work** **Client: First Solar** **Project: Desert Quartzite Solar Project** **See attached description of proposed work**	
5. Location of Proposed Work (Include Map) a. Description of Public Lands Involved **All or parts of sections 9–15 and 22–24, Township 7 South, Range 21 East, San Bernardino Base and Meridian. See attached map and description.**	b. Identification of Cultural Resource(s) Involved (if applicable) **None known. Pliocene and Quaternary, fossil vertebrate-bearing and potentially fossil bearing units.**
6. Period During Which Work Will Be Conducted From [mm/dd/yy]: **5/14/18**	To [mm/dd/yy]: **6/8/18**
7. Name of Individual(s) Responsible for Planning and Supervising Fieldwork and Approving Report, Evaluations, and Recommendations **Joseph J. El Adli, PhD will be responsible for planning and supervising all fieldwork, and writing/approving all aspects of report (see attached resume).**	
8. Signature [signature]	9. Date [mm/dd/yy]: **4/27/18**
10. Approved Janet L. Cheek (Authorized Officer)	11. Date [mm/dd/yy]: 05/10/2018

Submit one copy of each request, by mail, FAX, or in person to the Field Office Manager in the BLM Field Office with administrative jurisdiction over the public lands involved.

4. Nature of Work Proposed

The proposed work involves a comprehensive paleontological resource survey of the proposed Desert Quartzite Solar Project area planned by First Solar. The Desert Quartzite Solar Project consists of a 4,448 acre main project area and the 521 acre gen-tie corridor area (see attached map). The project area is primarily composed of public lands, with the exception of a 160-acre privately owned parcel (also to be surveyed). This work will be a pedestrian survey of the 4,448 acre main project area (the gen-tie corridor was previously surveyed for paleontological resources in 2011 by SWCA Environmental Consultants and AECOM for the McCoy Solar Energy Project proposed by McCoy Solar, LLC). The pedestrian survey will be conducted by walking straight-line transects at 30-m intervals across the main project area. A buffer of 200 feet will be included in the scope of the survey, as required by Instruction Memorandum Number 2009-011 (see subsection B-3 in Attachment 1-7 of IM2009-011). The survey will document the geology of the project area and any paleontological resources discovered within in order to verify the potential for fossil remains being encountered by project construction (as was assessed in a 2016 paleontological resource assessment of the project area by Reynolds and Landers submitted to Statistical Research Inc. on behalf of Desert Quartzite, LLC [see attached assessment]). Paleontological resources discovered during the survey will not be collected at the time of survey, but will be thoroughly documented. A report of the survey's findings, including discovery of any paleontological resources in the project area, will be submitted to the BLM.

5. Location of Proposed Work

a. Description of Public Lands Involved

The proposed project area is located 0.8 km (1/2 mile) south of Interstate 10 and the community of Mesa Verde and about 13 km (8 miles) west of the city of Blythe in eastern Riverside County, California. All or parts of sections 9–15, 22–24, Township 7 South, Range 21 East, San Bernardino Base and Meridian (includes 160-acre, privately owned parcel under jurisdiction of Riverside County Planning Department). As described in Section 4 (above), the Desert Quartzite Solar Project consists of a 4,448 acre main project area and the 521 acre gen-tie corridor area (see attached map). The project area is primarily composed of public lands, with the exception of the 160-acre privately owned parcel (also to be surveyed). The project site is situated on Palo Verde Mesa in the Colorado Desert, with the McCoy Mountains to the north, the Mule Mountains to the southwest, Chuckwalla Valley to the west, and Palo Verde Valley and the Colorado River to the east.

The DQSP area is bounded on the southwest and southeast by existing electrical transmission lines and access roads, including the Devers–Palo Verde Transmission Lines Number 1 and Number 2. An existing 7.5-MW solar PV project, the NRG Blythe Solar Power Plant, is located on 200 acres adjacent to the northern boundary of the DQSP site. A portion of the Blythe Mesa Solar Project, a 485-MW, 3,660- acre PV project approved by the County in 2014 and by the BLM in 2015, is located on a keyhole-shaped parcel of land that is surrounded on three sides (the north, west, and south) by the DQSP site. The DQSP is located within the Riverside East Solar Energy Zone (SEZ), identified as part of BLM's comprehensive Solar Energy Program (the Western Solar Plan) for utility-scale solar energy development on BLM administered lands in six southwestern states, including California.

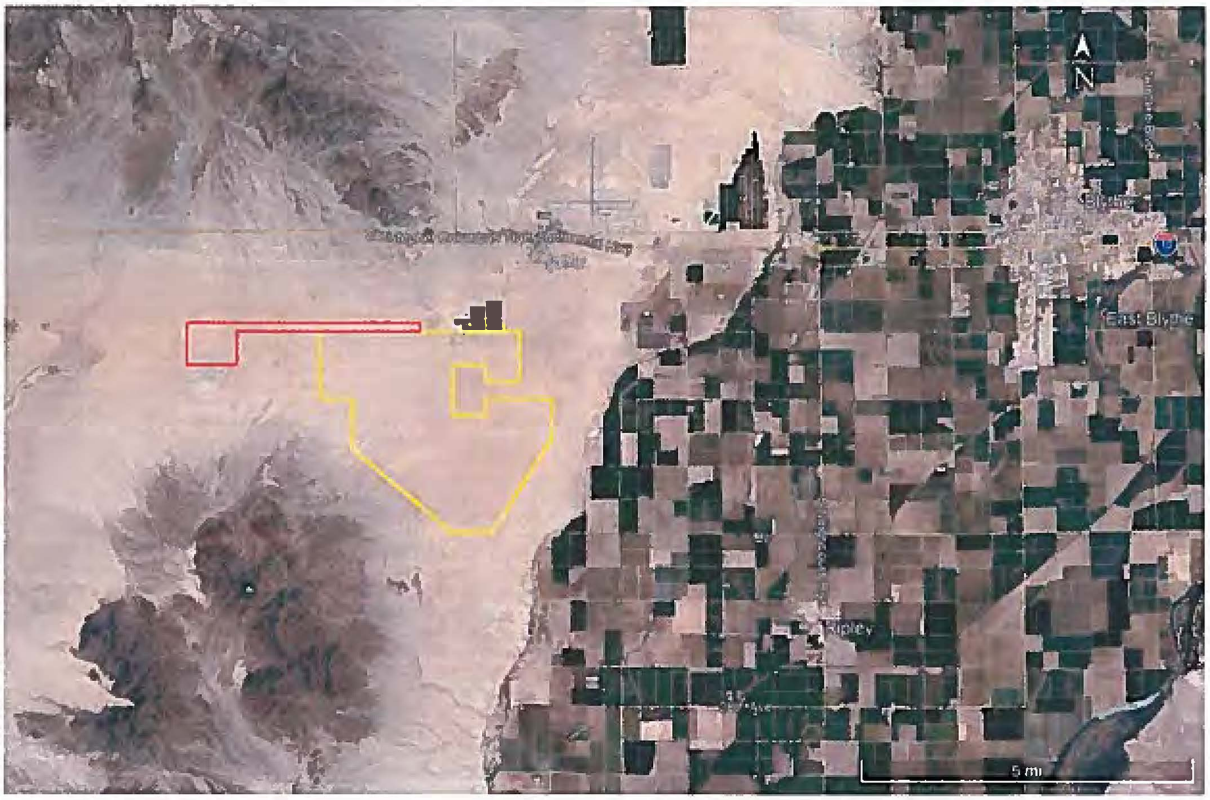


Figure 1. Vicinity map of the proposed Desert Quartzite Solar Project area (red and yellow polygons) and the surrounding region. The red polygon outlines the gen-tie corridor area, while the yellow polygon outlines the main project area.

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
California State Office
2800 Cottage Way, Suite W1623
Sacramento, CA 95825
www.blm.gov/california

MAR 2 7 2018

In Reply Refer To:
8151(CA-930) P

Joseph J. El Adli, Ph.D.
Statistical Research, Inc.
21 W. Stuart Ave.
Redlands, CA 92374

Dear Dr. El Adli:

The Bureau of Land Management (BLM) is pleased to issue a Scientific Paleontological Permit (*CA-18-01P*) to Statistical Research, Inc. for use on Public Lands managed by California BLM as specified in your permit. This permit is issued under the authority of the Federal Land Policy and Management Act (FLPMA) and the Antiquities Act of 1906. Keep a copy with you at all times in the field.

This permit authorizes the permit holder to conduct and collect paleontological resources pertaining to both scientific research and commercial projects. BLM would like to emphasize a few points. First, this permit assigns to your firm the responsibility to submit reports and other documents in a timely fashion and such submittal will be a major point of review of your firm's performance under this permit. Second, you are required to contact the appropriate Field Office to obtain a Field Use Authorization before you begin any fieldwork. Please allow the Field Office sufficient lead-time to process your application for a Field Use Authorization. The Field Office may impose additional conditions and stipulations at that time. Third, please be mindful that it is your firm's responsibility to ensure assignment of supervisory field personnel (crew chiefs) to projects that have at least four months' local experience and who otherwise meet the standards of the Bureau.

Our office is enclosing a map of California BLM Field Offices with phone numbers of cultural heritage staff and a copy of your permit with attached National special permit conditions. BLM draws your attention to these stipulations and encourages you to read and understand them. Please sign page 5, as indicated, and **return a copy of this signature page to the California BLM State Office within 30 days of your receipt of the permit**. Your permit will be valid after your signature is received.

Should you have any questions contact James Barnes at email jjbarnes@blm.gov or by phone 916-978-4676.

Sincerely,

Danielle Chi
Deputy State Director

Enclosures as stated

DI Form 1991 (Rev Sept 2004)
OMB No. 1024-0037
Exp. Date (01/31/2008)

United States Department of the Interior

PERMIT FOR PALEONTOLOGICAL INVESTIGATIONS

To conduct archeological work on Department of the Interior lands and Indian lands under the authority of:

- ☐ The Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-mm) and its regulations (43 CFR 7).
- ☒ The Antiquities Act of 1906 (P.L. 59-209; 34 Stat. 225, 16 U.S.C. 431-433) and its regulations (43 CFR 3).
- ☐ Supplemental regulations (25 CFR 262) pertaining to Indian lands.
- ☒ Bureau-specific statutory and/or regulatory authority: Federal Land Policy and Management Act of 1976 (Public Law 94-570), and Section 302 of Public Law 94-4579

Please use this number when referring to this permit
No.: **CA-18-01P**

1. Permit issued to Statistical Research, Inc.	2. Under application dated February 14, 2018
3. Address 21 W. Stuart Ave., Redlands, CA 92374	4. Telephone number(s) (909) 335-1896 5. E-mail address(es) jeladli@sricrm.com
6. Name of Permit Administrator Joseph J. El Adli Telephone number(s): (909) 335-1896 Email address(es): jeladli@sricrm.com	7. Name of Principal Investigator(s): Joseph J. El Adli Telephone number(s): (909) 335-1896 Email address(es): jeladli@sricrm.com
8. Name of Field Director(s) authorized to carry out field projects:	Telephone number(s):

9. Activity authorized
Survey and limited surface collection

10. On lands described as follows
All public lands managed by the Bureau of Land Management-California Desert District

11. During the duration of the project From April 28, 2018 To April 27, 2019

12. Name and address of the curatorial facility in which collections, records, data, photographs, and other documents resulting from work under this permit shall be deposited for permanent preservation on behalf of the United States Government.
Western Science Center, 2345 Searl Pkwy, Hemet, CA 92543

13. Permittee is required to observe the listed standard permit conditions and the special permit conditions attached to this permit.

14. Signature and title of approving official Danielle Chi Danielle Chi, Deputy State Director, Natural Resources Division	15. Date 3/27/18

15. Standard Permit Conditions

a. This permit is subject to all applicable provisions of 43 CFR Part 3, 43 CFR 7, and 25 CFR 262, and applicable departmental and bureau policies and procedures, which are made a part hereof.

b. The permittee and this permit are subject to all other Federal, State, and local laws and regulations applicable to the public lands and resources.

c. This permit shall not be exclusive in character, and shall not affect the ability of the land managing bureau to use, lease or permit the use of lands subject to this permit for any purpose.

d. This permit may not be assigned.

e. This permit may be suspended or terminated for breach of any condition or for management purposes at the discretion of the approving official, upon written notice.

f. This permit is issued for the term specified in 11 above.

g. Permits issued for a duration of more than one year must be reviewed annually by the agency official and the permittee.

h. The permittee shall obtain all other required permit(s) to conduct the specified project.

i. Archeological project design, literature review, development of the regional historic context framework, site evaluation, and recommendations for subsequent investigations must be developed with direct involvement of an archeologist who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation; fieldwork must be generally overseen by an individual who meets the Secretary of the Interior's Standards for Archeology and Historic Preservation.

j. Permittee shall immediately request that the approving official (14. above) make a modification to accommodate any change in an essential condition of the permit, including individuals named and the nature, location, purpose, and time of authorized work, and shall without delay notify the approving official of any other changes affecting the permit or regarding information submitted as part of the application for the permit. Failure to do so may result in permit suspension or revocation.

k. Permittee may request permit extension, in writing, at any time prior to expiration of the term of the permit, specifying a limited, definite amount of time required to complete permitted work.

l. Any correspondence about this permit or work conducted under its authority must cite the permit number. Any publication of results of work conducted under the authority of this permit must cite the approving bureau and the permit number.

m. Permittee shall submit a copy of any published journal article and any published or unpublished report, paper, and manuscript resulting from the permitted work (apart from those required in items q. and s., below), to the approving official and the appropriate official of the approved curatorial facility (item 12 above).

n. Prior to beginning any fieldwork under the authority of this permit, the permittee, following the affected bureau's policies and procedures, shall contact the field office manager responsible for administering the lands involved to obtain further instructions.

o. Permittee may request a review, in writing to the official concerned, of any disputed decision regarding inclusion of specific terms and conditions or the modification, suspension, or revocation of this permit, setting out reasons for believing that the decision should be reconsidered.

p. Permittee shall not be released from requirements of this permit until all outstanding obligations have been satisfied, whether or not the term of the permit has expired. Permittee may be subject to civil penalties for violation of any term or condition of this permit.

15. Standard Permit Conditions (continued)

q. Permittee shall submit a preliminary report to the approving official within a timeframe established by the approving official, which shall be no later than 6 weeks after the completion of any episode of fieldwork, setting out what was done, how it was done, by whom, specifically where, and with what results, including maps, GPS data, an approved site form for each newly recorded archeological site, and the permittee's professional recommendations, as results require. If other than 6 weeks, the timeframe shall be specified in Special Permit Condition p. Depending on the scope, duration, and nature of the work, the approving official may require progress reports, during or after the fieldwork period or both, and as specified in Special Permit Condition r.

r. Permittee shall submit a clean, edited draft final report to the agency official for review to insure conformance with standards, guidelines, regulations, and all stipulations of the permit. The schedule for submitting the draft shall be determined by the agency official.

s. Permittee shall submit a final report to the approving official not later than 180 days after completion of fieldwork. Where a fieldwork episode involved only minor work and/or minor findings, a final report may be submitted in place of the preliminary report. If the size or nature of fieldwork merits, the approving official may authorize a longer timeframe for the submission of the final report as specified in Special Permit Condition q.

t. Two copies of the final report, a completed NTIS Report Documentation Page (SF-298), available at http://www.ntis.gov/pdf/rdpform.pdf, and a completed NADB-Reports Citation Form, available at http://www.cr.nps.gov/aad/tools/nadbform_update.doc, will be submitted to the office issuing the permit.

u. The permittee agrees to keep the specific location of sensitive resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

v. Permittee shall deposit all artifacts, samples and collections, as applicable, and original or clear copies of all records, data, photographs, and other documents, resulting from work conducted under this permit, with the curatorial facility named in item 12, above, not later than 90 days after the date the final report is submitted to the approving official. Not later than 180 days after the final report is submitted, permittee shall provide the approving official with a catalog and evaluation of all materials deposited with the curatorial facility, including the facility's accession and/or catalog numbers.

w. Permittee shall provide the approving official with a confirmation that museum collections described in v. above were deposited with the approved curatorial facility, signed by an authorized curatorial facility official, stating the date materials were deposited, and the type, number and condition of the collected museum objects deposited at the facility.

x. Permittee shall not publish, without the approving official's prior permission, any locational or other identifying archeological site information that could compromise the Government's protection and management of archeological sites.

y. For excavations, permittee shall consult the OSHA excavation standards which are contained in 29 CFR §1926.650, §1926.651 and §1926.652. For questions regarding these standards contact the local area OSHA office, OSHA at 1-800-321-OSHA, or the OSHA website at http://www.osha.gov.

z. Special permit conditions attached to this permit are made a part hereof.

16. Special Permit Conditions

☒ a. Permittee shall allow the approving official and bureau field officials, or their representatives, full access to the work area specified in this permit at any time the permittee is in the field, for purposes of examining the work area and any recovered materials and related records.

☒ b. Permittee shall cease work upon discovering any human remains and shall immediately notify the approving official or bureau field official. Work in the vicinity of the discovery may not resume until the authorized official has given permission.

☒ c. Permittee shall backfill all subsurface test exposures and excavation units as soon as possible after recording the results, and shall restore them as closely as reasonable to the original contour.

☒ d. Permittee shall not use mechanized equipment in designated, proposed, or potential wilderness areas unless authorized by the agency official or a designee in additional specific conditions associated with this permit.

☒ e. Permittee shall take precautions to protect livestock, wildlife, the public, or other users of the public lands from accidental injury in any excavation unit.

☒ f. Permittee shall not conduct any flint knapping or lithic replication experiments at any archeological site, aboriginal quarry source, or non-site location that might be mistaken for an archeological site as a result of such experiments.

☒ g. Permittee shall perform the fieldwork authorized in this permit in a way that does not impede or interfere with other legitimate uses of the public lands, except when the authorized officer specifically provides otherwise.

☒ h. Permittee shall restrict vehicular activity to existing roads and trails unless the authorized officer provides otherwise.

☒ i. Permittee shall keep disturbance to the minimum area consistent with the nature and purpose of the fieldwork.

☒ j. Permittee shall not cut or otherwise damage living trees unless the authorized officer gives permission.

☒ k. Permittee shall take precautions at all times to prevent wildfire. Permittee shall be held responsible for suppression costs for any fires on public lands caused by the permittee's negligence. Permittee may not burn debris without the authorized officer's specific permission.

☒ l. Permittee shall conduct all operations in such a manner as to prevent or minimize scarring and erosion of the land, pollution of the water resources, and damage to the watershed.

☒ m. Permittee shall not disturb resource management facilities within the permit area, such as fences, reservoirs, and other improvements, without the authorized officer's approval. Where disturbance is necessary, permittee shall return the facility to its prior condition, as determined by the authorized officer.

☒ n. Permittee shall remove temporary stakes and/or flagging, which the permittee has installed, upon completion of fieldwork.

☒ o. Permittee shall clean all camp and work areas before leaving the permit area. Permittee shall take precautions to prevent littering or pollution on public lands, waterways, and adjoining properties. Refuse shall be carried out and deposited in approved disposal areas.

☐ p. Permittee shall submit the preliminary report within ____________ days/weeks of completion of any episode of fieldwork..

☐ q. Permittee shall submit the final report within ____________ days/weeks/months after completion of fieldwork..

☐ r. Permittee shall submit progress reports every ____________ months over the duration of the project.

☒ s. California special permit conditions are attached.

Special Permit Conditions Continuation Sheet: California Conditions

- a. Work under this permit is limited to specific service approved for each permit. This may consist of non-collection survey, limited testing to determine site content and limits or extensive testing emergency excavation and/or salvage projects. Testing/ excavation projects may be conducted under the authority of this permit only upon completion of ARPA consultation with Native American Groups and written approval from the Bureau for such work. (CARIDAPs for the purpose of the identification of archaeological resources are authorized under a FLPMA/ARPA Permit).
- b. Permittees shall verbally and subsequently in writing contact the appropriate BLM Field Manager prior to the beginning of each of his field operations (with follow-up written notification) to inform the BLM of specific work to be conducted. At this time, the BLM Field Manager may impose additional stipulation as deemed necessary to provide for the protection and management of resource values in the general site or project area.
- c. All cultural artifacts and other related materials such as notes, photographs, etc., acquired under the provisions of this permit **remain the property of the United States Government and may be recalled at any time for the use of the Department of the interior or other agencies of the Federal Government.** Cultural materials collected under the provisions of this permit must be curated at a repository approved by the BLM. Curation shall be at a local qualified repository, if feasible, and an approved curation facility shall be designated prior to all field projects. An itemized list of all materials with accession numbers, curated at the repository will be submitted to the State Office and to the appropriate Field Office within 180 days of the completion of individual field projects. A copy of a receipt from the curation facility must be submitted with the list or catalogue.
- d. Permittees shall acquire a primary number from the appropriate Information Center for each cultural resource documented while undertaking work authorized by this permit.
- e. The BLM Field Manager or authorized representative may require a monthly letter progress report outlining what was accomplished. This report, if required, is due by the fifth day of the following month, unless different arrangements are approved.
- f. The individual(s) in direct charge must be academically qualified and possess adequate field experience. At least two weeks prior to initiation field work, the permittees must provide the BLM Field Manager with the vitae of individuals proposed to be in direct charge if not approved at the time of permit issuance. A list of field crew members should be submitted at the same time. Only the individual(s) listed in Item No. 8 of the permit is/are authorized to be in direct charge of field work conducted under this permit.
- g. The person(s) in direct charge of field work, shall be on site at all times when work is in progress. Failure to comply with permit stipulations will result in removal of subject's name(s) from the approved list of person-in-direct-charge.
- h. Care should be exercised to avoid directly or indirectly increasing access or potential vandalism to sensitive sites.
- i. All National Permit Stipulations are binding. The authority for issuing permits in the Bureau of Land Management rests solely with the State Director as Delegated by the Secretary of the Interior and all further delegation is prohibited by Secretarial Order. No Modification of National Permit Conditions 8 or 9 or of the California Special Permit Conditions may occur except by written decision of the State Director.
- j. The Bureau of Land Management shall be cited in any report of work done under this permit, including publications such as books, news articles and scientific publications, as well as oral reports, films, television programs, and presentations in other media.

By signing below, I, the Principal Investigator, acknowledge that I have read and understand the Permit for Archeological Investigations and agree to its terms and conditions as evidenced by my signature below and initiation of work or other activities under the authority of this permit.

Signature and title:	Date:

Paperwork Reduction Act and Estimated Burden Statement: This information is being collected pursuant to 16 U.S.C. 470cc and 470mm, to provide the necessary facts to enable the Federal land manager (1) to evaluate the applicant's professional qualifications and organizational capability to conduct the proposed archeological work; (2) to determine whether the proposed work would be in the public interest; (3) to verify the adequacy of arrangements for permanent curatorial preservation, as United States property, of specimens and records resulting from the proposed work; (4) to ensure that the proposed activities would not be inconsistent with any management plan applicable to the public lands involved; (5) to provide the necessary information needed to complete the Secretary's Report to Congress on Federal Archeology Programs; and (6) to allow the National Park Service to evaluate Federal archeological protection programs and assess compliance with the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470). Submission of the information is required before the applicant may enjoy the benefit of using publicly owned archeological resources. To conduct such activities without a permit is punishable by felony-level criminal penalties, civil penalties, and forfeiture of property. A federal agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Departmental Consulting Archeologist; NPS; 1849 C Street, NW (2275); Washington, DC 20240-0001.

APPENDIX D

Personnel Curricula Vitae

Joseph J. El Adli

PRINCIPAL INVESTIGATOR, PALEONTOLOGY

EDUCATION

Ph.D., Earth and Environmental Sciences, University of Michigan, Ann Arbor, 2018
M.S., Earth and Environmental Sciences, University of Michigan, Ann Arbor, 2017
B.S. (summa cum laude), Geological Sciences, San Diego State University, San Diego, 2010

PROFESSIONAL EXPERIENCE

2018–present, Principal Investigator, Paleontology Program, Statistical Research, Inc.
2015–2017, Chemical Safety Lab Coordinator, CC Little 5004A, University of Michigan
2013–2017, Museum Assistant, Museum of Paleontology, University of Michigan
2012, Guest Curator: The Horse Exhibition, San Diego Natural History Museum
2011, Co-host: Sixth Triennial Conference on Secondary Adaptation of Tetrapods to Life in Water, San Diego Natural History Museum
2010–2012, Fossil Preparation Laboratory Manager (Formerly Paleontological Specialist I and Paleontological Specialist II), Department of Paleontology, Department of PaleoServices, San Diego Natural History Museum
2009, Research Assistant (NSF REU Fellowship), Department of Paleontology, San Diego Natural History Museum
2008–2010, Volunteer, Department of Paleontology, San Diego Natural History Museum

RELEVANT TEACHING EXPERIENCE

2017 (Fall), University of Michigan, EARTH 437: Evolution of Vertebrates
2016 (Winter), University of Michigan, EARTH 418/419: Paleontology
2015 (Summer), University of Michigan, Camp Davis Field Station, EARTH 441: Field Geology Project—Paleoclimate and Paleoenvironment
2015 (Summer), University of Michigan, Camp Davis Field Station, EARTH 440: Geology Field Course
2015 (Winter), University of Michigan, EARTH 437: Evolution of Vertebrates
2013 (Summer), University of Michigan, Camp Davis Field Station, EARTH 341: Environmental Sciences in the Rockies

PROFESSIONAL AFFILIATIONS

American Association of Anatomists
Society of Vertebrate Paleontology

SELECTED FIELD AND RESEARCH EXPERIENCE

2010–present, CT and MicroCT analyses of fossil whale and proboscidean specimens
2008–present, Paleontological curation, collections management, and fossil preparation
2017, MicroCT scanner operation and analysis (Nikon XT H 225 ST)
2013–2017, 3D modelling of paleontological specimens for the University of Michigan Online Repository of Fossils (UMORF)
2013–2017, Paleontological fieldwork and fossil salvage in southern Michigan
2012–2017, Stable isotope analyses of structural carbonate and collagen in proboscidean tusk dentin
2015, Geological and paleontological fieldwork and mapping in Idaho, Montana, and Wyoming
2015, Humpback whale necropsy and dissection
2014, Paleontological fieldwork in northeastern Siberia, Russian Federation
2012, Neonate gray whale dissection
2008–2012, Paleontological fieldwork and fossil salvage in San Diego County
2006–2012, Geologic fieldwork and mapping in southern California
2011, Fin whale necropsy and dissection
2011, Paleontological field survey of Bureau of Land Management land in San Diego
2011, Paleontological field survey of the Ocotillo Wells State Vehicular Recreation Area
2010, Large-scale excavation of a fossil whale skeleton at the San Diego Zoo
2008, Geologic fieldwork and mapping in central Queensland, Australia

PALEONTOLOGY PUBLICATIONS

2017 Season of Death of the Bowser Road Mastodon (with D. C. Fisher, L. C. DeLancey, and S. G. Beld). *Archaeological Recovery of the Bowser Road Mastodon, Orange County, New York*, edited by R. M. Gramly, Appendix IV. R.M. Persimmon Press, Massachusetts.

2017 First Analysis of Life History and Season of Death of a South American Gomphothere (with D. C. Fisher, M. D. Cherney, R. Labarca, and F. Lacombat). *Quaternary International* 443:180–188, https://doi.org/10.1016/j.quaint.2017.03.016.

2016 Final Years of Life and Seasons of Death of Woolly Mammoths from Wrangel Island and Mainland Chukotka, Russian Federation (with D. C. Fisher, S. L. Vartanyan, and A. N. Tikhonov). *Quaternary International* 445:135–145, https://doi.org/10.1016/j.quaint.2016.07.017.

2015 Last Years of Life and Season of Death of a Columbian Mammoth from Rancho La Brea (with M. D. Cherney, D. C. Fisher, J. M. Harris, A. B. Farrell, and S. M. Cox). *Science Series* 42:65–80.

2015 On the Anatomy of the Temporomandibular Joint and the Muscles That Act upon It: Observations on the Gray Whale, *Eschrichtius robustus* (with T. A. Deméré). *The Anatomical Record* 298:680–690.

2014 *Herpetocetus morrowi* (Cetacea: Mysticeti): A New Species of Diminutive Baleen Whale from the Upper Pliocene (Piacenzian) of California, USA, with Observations on the Evolution and Relationships of the Cetotheriidae (with T. A. Deméré and R. W. Boessenecker). *Zoological Journal of the Linnean Society* 170:400–466.

CONFERENCE AND POSTER PRESENTATIONS

2017 Life History Analyses of Whole Female Woolly Mammoth Tusks Using X-ray Computed Tomography (with D. C. Fisher, S. Vartanyan, A. N. Tikhonov, and B. Buigues). Presented at the VII International Conference on Mammoths and their Relatives, Taichung, Taiwan.

2016 Life History Analyses of Woolly Mammoths from Wrangel Island and Chukotka (with D. C. Fisher, S. Vartanyan, and A. N. Tikhonov). Presented at the 76th Annual Meeting of the Society of Vertebrate Paleontology, Salt Lake City, Utah.

2016 Proboscidean Life Histories from Analyses of Tusks. Presented to the faculty of the Department of Paleontology, University of Michigan.

2015 First Analysis of Tusk Growth Rate and Season of Death of a South American Gomphothere (with D. C. Fisher, M. D. Cherney, R. Labarca, and F. Lacombat). Presented at the 75th Annual Meeting of the Society of Vertebrate Paleontology, Dallas, Texas.

2015 The Lives and Deaths of Mammoths. Presented to the faculty of the Department of Paleontology, University of Michigan.

2015 Lunar Entrainment of Circadian Rhythms in the Woolly Mammoth, *Mammuthus primigenius* (with D. C. Fisher). Presented to the Michigan Geophysical Union.

2014 Final Years of Life and Seasons of Death of Woolly Mammoths from Wrangel Island (with D. C. Fisher, S. Vartanyan, A. Tikhonov, and B. Buigues). Presented at the VI International Conference on Mammoths and their Relatives, Grevena & Siatista, Greece.

2014 3D Models of Proboscidean Osteology (with D. C. Fisher, M. D. Cherney, and A. N. Rountrey). Presented at the VI International Conference on Mammoths and their Relatives, Grevena & Siatista, Greece.

2014 Forever Young: Life after Death for a Baby Gray Whale. Presented to the faculty of the Department of Paleontology, University of Michigan.

2013 Last Years of Life and Season of Death of a Columbian Mammoth from Rancho La Brea (with M. Cherney, D. C. Fisher, J. Harris, and A. Farrell). Presented at the 73rd Annual Meeting of the Society of Vertebrate Paleontology, Los Angeles.

2013 3D Osteology of the American Mastodon (with D. C. Fisher and Z. Calamari). Presented at the 73rd Annual Meeting of the Society of Vertebrate Paleontology, Los Angeles.

2013 *Benedenopsis morrowi*, a New Species of Diminutive Cetotheriid from the Pliocene of California: Discussions on Form, Function, Phylogeny, and the Genus Herpetocetus. Presented to the faculty of the Department of Paleontology, University of Michigan.

2011 The Musculature of the Temporomandibular Region in the Mio-Pliocene Baleen Whale Genus Herpetocetus and Its Inference for Feeding Strategy (with R. W. Boessenecker). Presented at the 71st Annual Meeting of the Society of Vertebrate Paleontology, Las Vegas, Nevada.

2011 Taxonomic Problems of and Relationships among Species of the Fossil Baleen Whale Genus Herpetocetus (with R. W. Boessenecker and J. H. Geisler). Presented at the Sixth Triennial Conference on Secondary Adaptation of Tetrapods to Life in Water, San Diego.

2011 ‘Supermorphomatrices’ and You: Proposal for Collaborative Research on Baleen Whale Evolution Using an Online Database (with E. G. Ekdale, T. A. Deméré, and A. Berta). Presented at the Sixth Triennial Conference on Secondary Adaptation of Tetrapods to Life in Water, San Diego.

2010 A New Species of the Extinct Baleen Whale Genus Herpetocetus (Cetacea, Mysticeti) from the San Diego Formation of San Diego, California. Presented to the faculty of the Department of Geological Sciences, San Diego State University, in requirement of the Bachelor of Sciences degree in Geological Sciences and published in the San Diego State University Love Library.

HONORS AND AWARDS

Rackham Graduate Student Research Grant, 2017
Earth and Environmental Sciences Outstanding Graduate Student Instructor, 2017
Scott Turner Award, 2017
Rackham Predoctoral Fellow, 2016
Society of Vertebrate Paleontology, Nominee for Colbert Prize, 2015
Scott Turner Award, 2015
Michigan Geophysical Union, Research Poster Award (First Prize), 2015
Ermine Cowles Case Student Research Award, 2014
Russell C. Hussey Scholarship, 2012
Earth and Environmental Sciences Departmental Fellowship, 2012
Dean's Honor List, San Diego State University (8 semesters), 2006–2010
Phi Eta Sigma National Honor Society, 2009
The Honor Society of Phi Kappa Phi, 2008
Golden Key International Honour Society, 2008
San Diego State University Education Abroad awardee, 2007

Josh Corrie

FIELD ASSISTANT

EDUCATION

Ph.D., Geology, University of Otago (OU), Dunedin, New Zealand, pending
M.S., Biological Sciences, Marshall University, Huntington, West Virginia, 2013
B.S. (with distinction), Earth and Environmental Sciences, University of Illinois, Chicago, 2010

AREAS OF INTEREST AND EXPERTISE

Morphological evolution of Cetacea, evolution of feeding ecology in fossil Cetacea, mammalian vertebrate paleobiology, aquatic locomotion biomechanics (particularly involving the vertebral column), systematics and phylogenetics of marine mammals (namely Cetacea), and 3D morphometrics of stem vs. crown Cetacea

LABORATORY AND TECHNICAL EXPERIENCE

Fossil Preparatory Laboratory (2013–2016), learned techniques in preparation of fossil specimens used for Ph.D. that included the utilization of pneumatic drills and dental tools to remove matrix from specimens; additional skills learned included the making of field jackets, molds, and the casts of fossil elements using polyester resin.

Laboratory Assistant, Paleontology Laboratory, University of Illinois at Chicago (2009–2010), assisted in experimental setup that included construction of crinoid models and setup of soft substrate environments; collected quantitative data.

FIELD EXPERIENCE

Fossil Prospecting in North and South Otago, South Island, New Zealand (2013–2016), multiple trips to outcrops of marine Oligocene rocks (Chattian) in search of fossil Cetacea and penguins; multiple trips were carried out to Wangaloa Beach, Otago, South Island, New Zealand, in search of marine vertebrates in the Paleocene Wangaloa Formation; gained experience using Pionjar rock drill and a diamond-bladed hand saw.

Big Bend National Park, Texas, Field Excursion, Marshall University, 1-week field trip to prospect Big Bend National and State Parks in search of Eocene and Late Cretaceous fossils, namely Mosasauridae.

Ireland Field Geology Course, James Madison University (2010), 6-week field geology course in western and Northern Ireland involving analysis of the structural, petrological, sedimentological, mineralogical, and geomorphological aspects of the surrounding geology; learned proper methods in taking field notes; gained experience using a Brunton Compass, a Jacob's Staff, and ArcGIS software.

RELEVANT TEACHING EXPERIENCE

2017–present, Lecturer, San Diego State University, BIOL 212: Human Anatomy
2015–2016, Demonstrator, OU, GEOL 252: Field Studies and New Zealand Geology
2015, Demonstrator, OU, GEOL 272/372: Evolution of New Zealand Biota
2015–2016, Demonstrator, OU, EAOS 111: Introductory Geology
2010–2013, Laboratory Instructor, OU, BSC 227: Human Anatomy

PROFESSIONAL AFFILIATIONS

Geosciences Society of New Zealand
The Paleontological Society
Society for Vertebrate Paleontology
Society for Marine Mammalogy

PALEONTOLOGY PUBLICATION

2013 The Orientation of Strophomenid Brachiopods on Soft Substrates (with R. E. Plotnick, B. F. Dattilo, D. Piquard, and J. E. Bauer). *Journal of Paleontology* 87(5):818–825, https://doi.org/10.1666/12-152.

CONFERENCE AND POSTER PRESENTATIONS

2016 Heterodont Confusion: A Late Oligocene Putative Kekenodontid from New Zealand with Comments on the Taxonomy of '*Squalodon*' *gambierensis* (with R. E. Fordyce). Paper presented at the 76th Annual Meeting of the Society for Vertebrate Paleontology, Salt Lake City, Utah.

2015 Heterodont Confusion: A Late Oligocene Putative Kekenodontid from New Zealand and '*Squalodon*' *gambierensis* (with R. E. Fordyce). Annual Conference of the Geoscience Society of New Zealand, Wellington, New Zealand.

2015 A New Oligocene Kekenodontid Archaeocete (Mammalia: Cetacea) from New Zealand, with Implications for Cetacean Ontogeny (with R. E. Fordyce). Poster presented at the 21st Biennial Conference on the Biology of Marine Mammals, San Francisco.

2014 Survivors: A Clade of Archaeocetes from the Late Oligocene of New Zealand (with R. E. Fordyce). Paper presented at Secondary Adaptations of Tetrapods to Life in Water, Washington, D.C.

2014 The Ecomorphology of New Zealand Kekenodontids and Their Implications for Niche Partitioning with Early Neoceti (with R. E. Fordyce). Paper presented at the 74th Annual Meeting Society for Vertebrate Paleontology; 2014 November 5 – 8; Berlin, Germany.

2014 The Morphology and Phylogeny of the Most Complete Kekenodontid, OU 22294, with Observations on the Feeding Ecology of Late Oligocene Archaeocetes (with R. E. Fordyce). Paper presented at the Annual Conference of the Geoscience Society of New Zealand, New Plymouth, New Zealand.

2013 Swimming Mode of the Enigmatic Archaeocete *Basilosaurus cetoides* (Mammalia, Cetacea) (with F. R. O'Keefe). Paper presented at the 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

2012 Functional Morphology of Vertebrae in *Basilosaurus* and Cetacea (with F. R. O'Keefe). Poster presented at the 72nd Annual Meeting of the Society for Vertebrate Paleontology, Raleigh, North Carolina.

2011 Push me–pull you: experimental biomechanics of immobile suspension feeders on soft substrates (with R. E. Plotnick, B. F. Dattilo, D. Piquard, and J. E. Bauer). Poster presented at the Annual Meeting of the Geological Society of America, Minneapolis, Minnesota.

RESEACH GRANTS AND AWARDS

Graduate Assistantship, Marshall University, 2010–present
Doctoral Scholarship, UO, 2013–2016
The Doris O. and Samuel P. Welles Research Fund, University of California Museum of Paleontology, 2015
The Otago Museum Linnaeus Taxonomy Fellowship, 2014
Summer Thesis Award, Marshall University, 2012
Lerner Gray Memorial Fund, American Museum of Natural History, 2012
Distinction in Earth and Environmental Sciences, University of Illinois, Chicago, 2010

Jason Dean Windingstad

GEOARCHAEOLOGIST

EDUCATION

M.S., Soil Science (emphasis in Pedology and Geoarchaeology), University of Tennessee, Knoxville, 2005
B.S., Geology and Environmental Science (magna cum laude), Southwest Minnesota State University, Marshall, 2002

QUALIFICATIONS

Meets the Secretary of the Interior's Professional Qualifications Standards for prehistoric archaeology; is skilled in field interpretation and laboratory analysis of soil and sediment within an archaeological context; has worked on cultural resource management projects across the United States, since 2005; has conducted geoarchaeological research in Eastern Europe

AREAS OF INTEREST AND EXPERTISE

Alluvial and aeolian geomorphology and soils; southwestern U.S. Quaternary environments and paleoclimate; archaeological site formation processes; soil geomorphology, geochronology and stratigraphy; environmental reconstruction; aeolian sediments; anthropogenic influences on soil properties

PROFESSIONAL EXPERIENCE

2017–present, Senior Geoarchaelogist and Project Director, Statistical Research, Inc., Tucson, Arizona
2008–2017, Geoarchaeologist, Statistical Research, Inc., Tucson, Arizona
2005–2008, Geoarchaeologist, Archaeological Research Laboratory, University of Tennessee, Knoxville
2003–2005, Graduate Teaching Assistant, Biosystems Engineering and Soil Science, University of Tennessee, Knoxville
2000–2003, Geotechnical Engineering Technician, American Engineering, Marshall, Minnesota

PROFESSIONAL AFFILIATIONS

Arizona Archaeological and Historical Society
Geological Society of America
Register of Professional Archaeologists (No. 38953274)
Society for American Archaeology

SELECTED CULTURAL RESOURCE MANAGEMENT PROJECTS

Geoarchaeologist, Barry M. Goldwater Range (BMGR) East Emergency Manned Range 1 Road Data Recovery, Pima County, Arizona (data recovery at the HTH site), for the 56th Range Management Office (56 RMO), Luke Air Force Base, 2017

Geoarchaeologist, BMGR Range Wide project (survey, evaluation of NRHP eligibility), BMGR East, Maricopa, Pima, and Yuma Counties, Arizona, for the 56 RMO, Luke Air Force Base, 2014–2016

Geoarchaeologist, Gila Bend Air Force Auxiliary Field Archaeological Data Recovery at Five Sites and One Isolate within the Airfield Flight-Line Clear Zone, BMGR East, Arizona, project, Maricopa County, Arizona, for the 56 RMO, Luke Air Force Base, 2015

Geoarchaeologist and archaeological project director, Luke Solar Interconnect testing and construction monitoring project, Maricopa County, Arizona, for Luke Air Force Base and Arizona Public Service Company (APS), 2014–2015

Geoarchaeologist and archaeological project director, Luke Air Force Base solar-power-array archaeological data recovery project, Maricopa County, Arizona, for Luke Air Force Base and Aerostar SES, LLC, 2014

Geoarchaeologist, stratigraphy and geomorphology of the Luke Solar site mitigation, Glendale, Arizona, for Luke Air Force Base and Aerostar SES, LLC, 2013

Geoarchaeologist, geomorphic assessment of Auxiliary Field 8, Manned Range 1, BMGR East, Pima and Maricopa Counties, for the 56 RMO, Luke Air Force Base, 2012

Geoarchaeologist, alluvial reconstruction of San Cristobal Wash/Stoval Airfield, BMGR East, Dateland, Arizona, for the 56 RMO, Luke Air Force Base, 2012

Geoarchaeologist, geoarchaeological evaluation of moderately to extremely eroded archaeological sites on East Range, Fort Huachuca, Sierra Vista, Arizona, for U.S. Army Garrison, Fort Huachuca, 2012

CULTURAL RESOURCE MANAGEMENT PUBLICATIONS

2017 Geoarchaeology and Archaeological Chronology (with S. Lengyel, J. D. Hall, M. C. Pailes, J. A. Homburg, and R. M. Wegener). In *Analyses and Interpretations*, edited by R. M. Wegener and J. D. Hall, pp. 19–90. 5,000 Years of Aboriginal Land Use in the Western Phoenix Basin: The Luke Air Force Base Solar Project, vol. 2. Technical Series 95. Statistical Research, Tucson, Arizona.

2016 Geoarchaeology and Radiocarbon Chronology. In *Gila Bend Air Force Auxiliary Field: Archaeological Data Recovery at Five Sites and One Isolate within the Airfield Flight-Line Clear Zone, Barry M. Goldwater Range East*, *Arizona*, edited by R. Vanderpot, J. L. Griffitts, N. M. Hlatky, M.A. Keur, J. Knighton-Wisor, A. Natoli, R. M. Wegener, and J. D. Windingstad, pp. 123–149. BMGR East Cultural Resource Management Program, Cultural Resource Studies in the Western Papaguería 30. Statistical Research, Tucson, Arizona.

2016 Environment (with R. Vanderpot, M. P. Heilen, and J. H. Homburg). In *Project Background and Setting*, edited by R. Vanderpot. Range Wide: Intensive Archaeological Survey of 154 Miles (6,209 Acres) of Road Segments and 2,837 Acres in Other Parcels Distributed across the Barry M. Goldwater Range East, Arizona, vol. 2. Technical Report 16-109. Statistical Research, Tucson, Arizona.

2016 *Results of Archaeological Testing and Geomorphological Investigations in Support of the Luke Air Force Base F-35 Bomb Build-Up Pad, Maricopa County, Arizona* (with J. D. Hall and R. M. Wegener). Technical Report 16-07. Statistical Research, Tucson, Arizona.

2015 *Archaeological Testing in Support of the Luke Air Force Base Solar Power Array Interconnect, Maricopa County, Arizona* (with J. D. Hall and R. M. Wegener). Technical Report 14-66. Statistical Research, Tucson, Arizona.

2014 Geoarchaeological Results. In *Mitigation of Archaeological Site FB 8431 (LA 123631)/FB 16733 (LA 115029), along Range 80, in Training Area 32, Otero County, New Mexico*, edited by J. J. Vasquez, C. G. Ward, and B. J. Vierra, pp. 63–73. Fort Bliss Project No. 13-21.Technical Report 14-32. Statistical Research, El Paso, Texas.

2013 *Murray Springs Clovis Site National Historic Landmark Archaeological and Paleoenvironmental Condition Assessment, San Pedro Riparian National Conservation Area, Cochise County, Arizona* (with J. A. M. Ballenger, H. Miljour, N. Aydin, and R. Sulkosky). Technical Report 13-14. Statistical Research, Tucson, Arizona.

2013 *The GPS Site (AZ Z:5:55 [ASM]): Archaeological Survey and Condition Assessment, Barry M. Goldwater Range East, Arizona* (with J. A. M. Ballenger, L. E. Jelinek, C. S. Daughtrey, J. L. Griffitts, K. L. Blake, and R. M. Wegener). Barry M. Goldwater East Cultural Resource Management Program, Cultural Resource Studies in the Western Papaguería 27. Statistical Research, Tucson, Arizona.

2012 Environmental Setting and Its Influence on the Preservation Potential of Historical-Period Burials and Features (with J. D. Hall). In *The History, Archaeology, and Skeletal Biology of the Alameda-Stone Cemetery*, edited by M. Heilen, J. T. Hefner, and M. A. Keur, pp. 81–100. Deathways and Lifeways in the American Southwest; Tucson's Historic Alameda-Stone Cemetery and the Transformation of a Remote Outpost into an Urban City, vol. 2, M. Heilen and M. Gray, series editors. Technical Report 10-96. Statistical Research, Tucson, Arizona.

2011 *Stoval Airfield Resurvey, Stoval Additional Survey, and Stoval Airfield Testing: Archaeological Investigations in the San Cristobal Valley, Barry M. Goldwater Range East, Arizona* (with M. D. Tagg, J. A. M. Ballenger, K. L. Sagebiel, and J. Minor). Technical Report 11-17. Statistical Research, Tucson, Arizona.

2011 *Excavations of Prehistoric Sites in the Queen Valley to Queen Creek Area*, edited by R. M. Wegener and R. Ciolek-Torello (contributor; provided stratigraphic and geomorphological analysis for 10 project sites). The U.S. 60 Archaeological Project; Early Agricultural, Formative, and Historical-Period Use of the Upper Queen Creek Region, vol. 2. Technical Series 92. Statistical Research, Tucson, Arizona.

2011 Environmental Setting, Culture History, and the Research Design (with R. M. Wegener, R. Ciolek-Torello, J. D. Hall, H. J. Miljour, J. A. M. Ballenger, A. Natoli, and W. M. Graves). In *Excavations of Prehistoric Sites in the Queen Valley to Queen Creek Area*, edited by R. M. Wegener and R. Ciolek-Torello, pp. 15–47. The U.S. 60 Archaeological Project; Early Agricultural, Formative, and Historical-Period Use of the Upper Queen Creek Region, vol. 2. Technical Series 92. Statistical Research, Tucson, Arizona.

2010 *The Removal of Human Remains and Evaluation of Geomorphological Processes at AZ EE:2:577 (ASM) in Lower Matty Wash, Las Cienegas National Conservation Area, Arizona* (with J. D. Hall, J. T. Hefner, and R. M. Wegener). Technical Report 10-29. Statistical Research, Tucson, Arizona.

2009 Christiansen Wash Geomorphology (with J. Ballenger). In *Data Recovery at Christiansen Border Village: Nonriverine Late Archaic/Early Agricultural and Formative Period Archaeology in the Borderlands of Southeastern Arizona*, edited by R. M. Wegener, K. L. Blake, and R. Ciolek-Torrello, pp. 91–124. Technical Report 09-31. Statistical Research, Tucson, Arizona.

Paris Morgan

FIELD ASSISTANT

EDUCATION

B.S., Geoscience (geology emphasis), University of Utah, 2014
Integrated Certificate in Sustainability, University of Utah, 2014
A.S., General Studies, Utah Valley University, 2010

FIELD EXPERIENCE

Field Geologist/Paleontologist, Panama City, Panama (surveyed and assessed excavation sites along the Panama Canal for paleontological resources; excavated, collected, transported and documented fossil specimens; measured geological sections and constructed geological stratigraphic columns to document fossil/sample location; hiked rivers in tropical forest for sample collection and documentation; created geological maps of the Azuero peninsula; screenwashed matrix for microfossil analysis; field leader for elementary school paleontological fieldtrip; field leader for teacher's workshop in Panama City, Panama, and Fort Robinson, Nebraska), for Smithsonian Tropical Research Institute-Calle Gorgas, 262, Panama City, Panama /University of Florida, Florida Natural History Museum, 2015–2016

Field Camp, University of Utah (hiked/camped for 3 weeks in field areas Parowan Gap in central Utah and Raft River Mountains at the Utah-Idaho border and used geological observation methods and field equipment to create maps, stratigraphic columns, and scientific reports), 2014

Field Methods, University of Utah (instructed in field equipment and safety; made geological field observations at different scales; sampled and recorded features of different rocks; constructed maps and stratigraphic columns; communicated findings in professional written scientific reports), 2014

Hydrology Field Assistant, University of Utah (compiled sample kits and collect water and sediment samples on the Great Salt Lake), 2012 and 2013

Geomorphology of the Alps Field Trip with Dr. Anke Friedrich, Ludwig Maximilian University of Munich (studied the geomorphology of the Alps for 3 weeks, hiking in Germany, Austria, Switzerland; evaluated geological maps and physical evidence to explain the geomorphology of the Alps), 2013

Hydrology/Geoscience Study Abroad with Dr. William Johnson, University of Utah (studied mining and environmental contamination in Ecuador; collected and analyzed water, soil, hair samples for contamination from corporate and artesian mining practices; created written report for local communities and governments), 2012

Paleoecological study with Dr. Tony Ekdale, University of Utah (9-day study along Gulf of California in Mexico; collected and logged fossils and created a written comparative analysis of paleontological vs. present-day tidal flat environment), 2011

Paleobiological study with Dr. Tony Ekdale, University of Utah (collected and categorized fossils in the House Range and Confusion Range, Southern Utah), 2011

PRACTICAL SCIENCE COMMUNICATION EXPERIENCE

Science Communication Fellow/Scientist in the Spotlight, Natural History Museum of Utah (developed skills in communicating with the general public about science concepts, created a hands-on activity for museum patrons, presented "Not So Buried Treasure of Utah" activity, educate the general public on geological processes of Utah, and researched and developed project for presentation), 2014

Tutor, Introduction to Geology (expanded on geological concepts)

PROFESSIONAL AFFILIATIONS

Association for Women Geoscientists, Utah Chapter
Geological Society of America

POSTER PRESENTATIONS

2016 PCP-PIRE Program: Promoting Research and Outreach on Panama's Geological History, Smithsonian Tropical Research Institute Fellow Symposium.

2016 The Panama Canal Project: Geological Internships in International Settings, Annual Meeting of the Geological Society of America, Denver, Colorado.

SCHOLARSHIPS

Association of Women Geologists-Ekdale Field Camp
Marta L. Weeks Legacy
Questar
Ricardo Presnell (2 years)
University of Utah Geoscience Department-Field Camp

Nichole J. Lohrke

FIELD ASSISTANT

EDUCATION

B.S., Evolutionary Anthropology (honors) and German, with minor in Paleontology, University of Michigan, Ann Arbor, 2017

PROFESSIONAL EXPERIENCE

2017–present, General Educator, Ann Arbor Hands-On Museum
2016–present, Laboratory Assistant, University of Michigan Museum of Paleontology
2017, Conservation Intern, The Mammoth Site of Hot Springs, South Dakota

PROFESSIONAL AFFILIATION

Society of Vertebrate Paleontology

FIELD AND RESEARCH EXPERIENCE

2017–present, Photogrammetry and 3-D rendering of paleontological specimens
2017–present, Identification and inventory of paleontological specimens in collection
2016–present, Fossil preparation and cleaning
2018, Photographing and use of Photoshop to render detailed images of slides
2017, 3-D printing of paleontological specimens
2017, Jacketing and removal of paleontological specimens
2017, In-situ paleontological site excavation and preservation
2017, Survey and excavation of paleontological sites for private landowner associated with South Dakota School of Mines
2017, Screen washing sediments for microfossils
2017, Picking and sorting of microfossils
2017, Analysis of stable carbon and oxygen isotopes
2017, Preparation of fossil enamel for isotope-ratio mass spectrometry
2016–2017, Paleontological surveying and salvage work in Michigan
2016–2017, Molding and casting of paleontological specimens
2016–2017, Piecing and consolidation of broken paleontological specimens

CONFERENCE PRESENTATION

2017 African Deinothere Isotopic Paleoecology: Developing a Diet and Habitat Proxy for an Extinct Proboscidean (with J. Kingston and W. Sanders). 1st Great Lakes Student Paleoconference, Univresity of Michigan, Ann Arbor.

ADDITIONAL SKILLS AND CERTIFICATIONS

Familiarity with geological surveying instruments
CPR and AED certified
Certificate in General Laboratory Safety
Proficient in German

HONORS AND AWARDS

Honors in Evolutionary Anthropology, 2017
LSA Honors Program, 2016–2017
University Honors (4 semesters), University of Michigan, Ann Arbor, 2014–2017

Paleontological Resource Mitigation and Monitoring Plan for the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California

Joseph J. El Adli

Prepared for
Jeffery Johnston, Geologist
U.S. Department of the Interior
Bureau of Land Management
Palm Springs–South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262

Technical Report 18-36
Statistical Research, Inc.
Redlands, California

Paleontological Resource Mitigation and Monitoring Plan for the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California

Joseph J. El Adli

Prepared for
Jeffery Johnston, Geologist
U.S. Department of the Interior
Bureau of Land Management
Palm Springs–South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262

Technical Report 18-36
Statistical Research, Inc.
Redlands, California

September 2018

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

Project Background

At request of Desert Quartzite, LLC, a wholly owned subsidiary of First Solar Development, Inc. (First Solar), and on behalf of the Bureau of Land Management (BLM) Desert District Office and Palm Springs–South Coast Field Office, Statistical Research Inc., has been retained to prepare a Paleontological Resources Mitigation and Monitoring Plan (PMMP) for the Desert Quartzite Solar Project (DQSP). In accordance with the initial paleontological assessment for the project conducted by Reynolds and Lander (2016) and the results of the paleontological field survey and assessment conducted by El Adli (2018), portions of the project area are determined to be underlain by geologic units containing a moderate–high potential to encounter paleontological resources. In the event that a project will potentially impact significant nonrenewable paleontological resources, the BLM requires that a PMMP be developed and implemented prior to the start of the construction phase. This PMMP takes into consideration mitigation measures recommended by El Adli (2018) (see Appendix A) and incorporates them pursuant to BLM, California, and Riverside County (County) requirements.

Project Location and Description

The proposed project area is located 0.8 km (1/2 mile) south of Interstate 10 and the community of Mesa Verde and about 13 km (8 miles) west of the city of Blythe, in eastern Riverside County, California (Figure 1). The DQSP area is located in Sections 11–14, 23, and 24 of Township 7 South, Range 21 East (San Bernardino Baseline and Meridian [SBBM]), on the Ripley, California, 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle and in Sections 9–11, 14, 15, 22, and 23 of Township 7 South, Range 21 East (SBBM), on the Roosevelt Mine, California, 7.5-minute USGS topographic quadrangle (Figure 2). The project site is situated on Palo Verde Mesa, in the Colorado Desert, with the McCoy Mountains to the north, the Mule Mountains to the southwest, Chuckwalla Valley to the west, and Palo Verde Valley and the Colorado River to the east.

The DQSP area is bounded on the southwest and southeast by existing electrical transmission lines and access roads, including Devers–Palo Verde Transmission Line Nos. 1 and 2. An existing 7.5-megawatt (MW) solar photovoltaic (PV) project, the NRG Blythe Solar Power Plant, is located on 200 acres adjacent to the northern boundary of the DQSP site. A portion of the Blythe Mesa Solar Project, a 485-MW, 3,660-acre PV project approved by the County in 2014 and by the BLM in 2015, is located on a keyhole-shaped parcel of land that is surrounded on three sides (the north, west, and south) by the DQSP site. The DQSP is located within the Riverside East Solar Energy Zone, identified as part of the BLM's comprehensive Solar Energy Program (the Western Solar Plan) for utility-scale solar-energy development on BLM-administered lands in six southwestern states, including California.

The DQSP includes a PV solar-facility site on approximately 3,560 acres of BLM land and 160 acres of private land, along with a corridor for generator tie lines (gen-tie lines) that extends for 3 miles and covers an area of 58 acres; this is all situated within a total project area of 5,010 acres. The total project area was initially defined on the basis of the right-of-way (ROW) grant application for a somewhat larger project footprint (and associated buffer areas) that was proposed in earlier versions of the DQSP Plan of Development (Desert Quartzite 2014).

The DQSP would consist of a single unit with a generating capacity of 300 MW. The proposed facilities on BLM-managed public land would include PV solar arrays, a gen-tie line, a 120-by-50-foot operations and maintenance building, an on-site substation, and ancillary facilities. The only facilities to be placed on the private land parcel would be solar arrays. The only linear facility extending out of the solar-plant site would be the gen-tie line. The DQSP would use existing access roads.

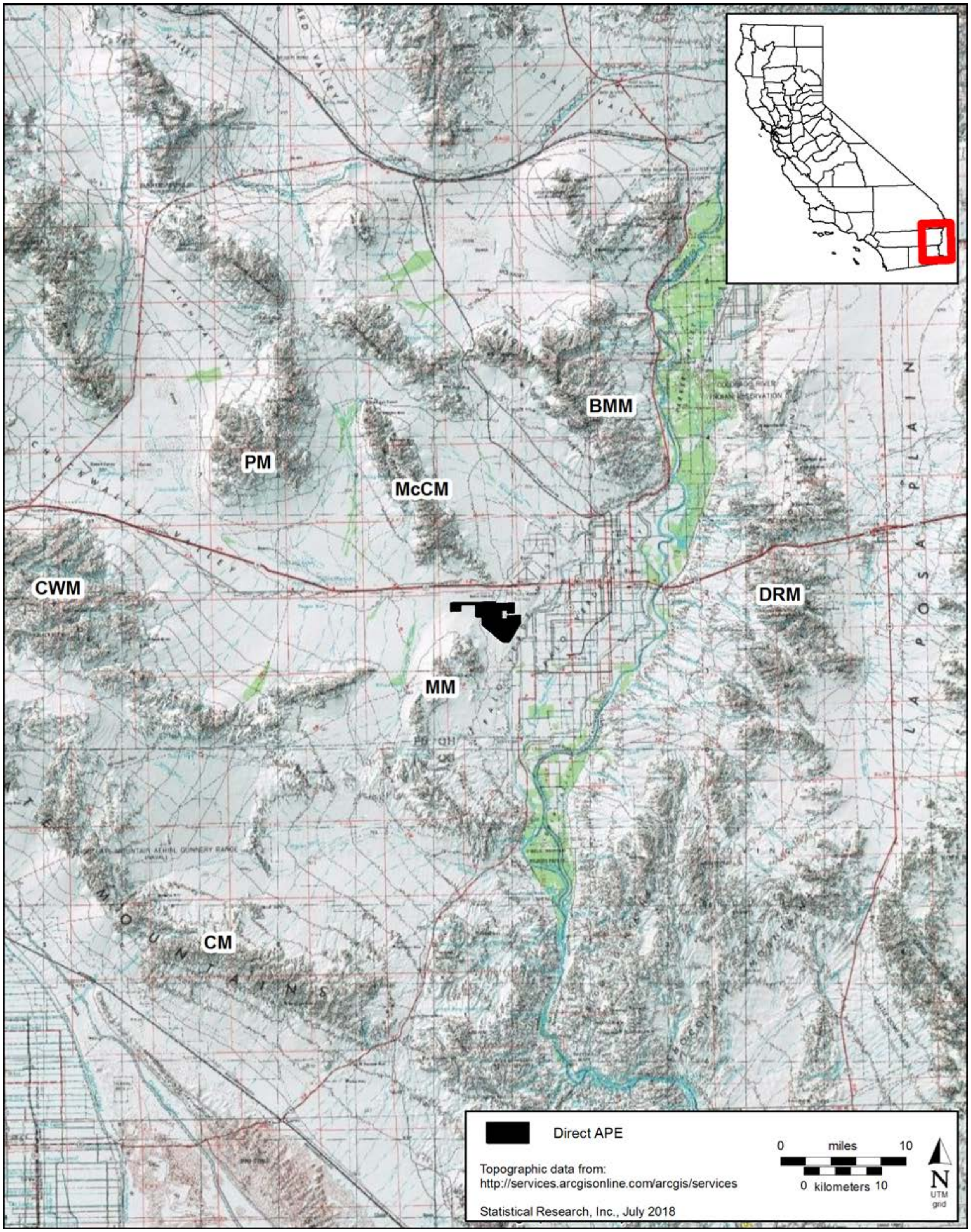


Figure 1. Vicinity map of the DQSP paleontological field survey area. BMM = Big Maria Mountains; CM = Chocolate Mountains; CWM = Chuckwalla Mountains; DRM = Dome Rock Mountains; McCM = McCoy Mountains; MM = Mule Mountains; and PM = Palen Mountains.

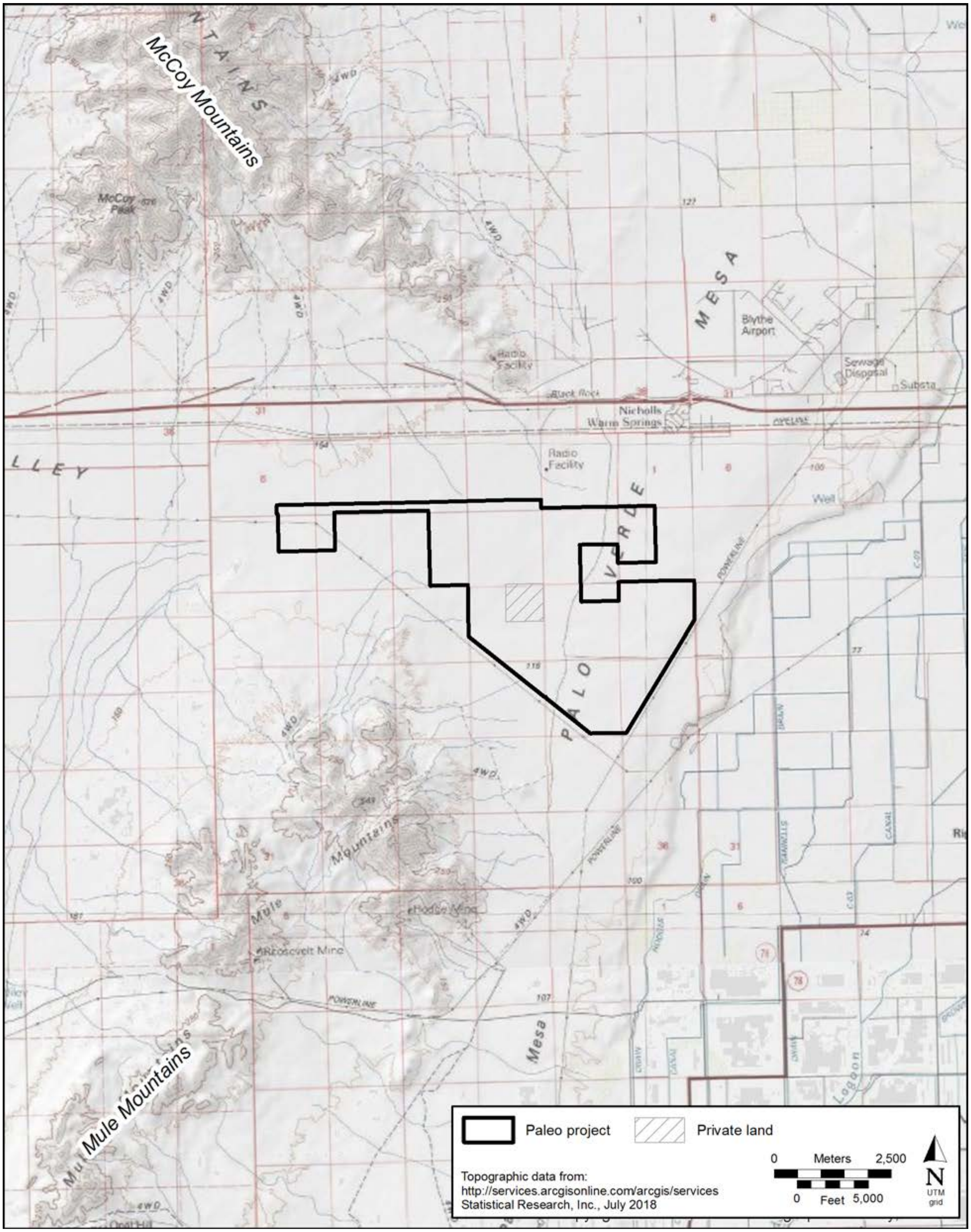


Figure 2. Location map of the DQSP paleontological field survey area.

The DQSP would involve the installation of thin-film solar modules made by First Solar (or other PV technology) mounted on either single-axis horizontal tracker structures or fixed-tilt mounting systems, or a combination of these two mounting systems. The mounting system for the PV modules would consist of steel posts driven into the ground to depths between 1.2 and 2.1 m (4 and 7 feet); posts for single-axis tracking structures would need to be driven up to 3.7 m (12 feet) into the ground. The solar-module assemblies would be organized into arrays. Each array would be approximately 800 feet long and 500 feet wide. The exact placement of the arrays within the DQSP area would be based on topography, hydrology, and geotechnical conditions and could also be modified to avoid cultural resources.

Regulatory Context

The majority of the project area occupies public land managed by the BLM, which requires the issuance of a BLM ROW grant (ROW No. CACA 049397). The issuance of a ROW grant for the project is considered an undertaking, as defined by the National Historic Preservation Act (NHPA), and therefore, the project must comply with Section 106 of the NHPA, as amended (54 *U.S. Code* [USC] 300101 *et seq.*), and its implementing regulations, 36 *Code of Federal Regulations* (CFR) 800, as well as BLM policies regarding paleontological resources (BLM 2007, 2008, 2016). As required by the NHPA, as the federal agency that would approve the ROW grant, the BLM "shall take into account the effect of the undertaking on any historic property" (54 USC 306108). The BLM also must comply with the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (42 USC 4321 *et seq.*). The portion of the project on private land will require a Conditional Use Permit (CUP) from the County (Riverside County CUP No. 3721), along with review under the California Environmental Quality Act (CEQA), with the County as the lead CEQA agency. The BLM and the County will prepare a joint Environmental Impact Statement/Environmental Impact Report to meet the NEPA and CEQA requirements for the DQSP.

In general, management of paleontological resources on public lands is governed under multiple laws, regulations, and standards. These include NEPA, the Federal Land Management and Policy Act of 1976 (FLPMA), the Paleontological Resources Preservation Act of 2009 (PRPA) (16 USC 470aaa *et seq.*), and several BLM publications, including Manual H-8720-1 (BLM 1998) and Instruction Memoranda (IM) Nos. 2008-009 (BLM 2007), 2009-011 (BLM 2008), and 2016-124 (BLM 2016). NEPA concerns paleontological resources as it recognizes the federal governments continued responsibility to "preserve important historic, cultural, and natural aspects of national heritage" (42 USC 4331). The FLPMA (43 USC 1701–1784) recognizes significant paleontological resources as scientific resources and requires federal agencies to manage public lands in a manner that protects the quality of such resources. For the purposes of FLPMA, a significant paleontological resource is considered

> a fossil which is unique, rare or particularly well-preserved; is an unusual assemblage of common fossils; is of high scientific interest; or provides important new data concerning:
>
> (1) Evolutionary trends;
>
> (2) Development of biological communities or interaction between organisms;
>
> (3) Unusual or spectacular circumstances in the history of life; or
>
> (4) Anatomical structure (47 *Federal Register* 35915 [August 17, 1982]).

In 2009, the PRPA was signed into law by President Barrack Obama under the Omnibus Public Lands Management Act (Public Law 111-11 [2009]). This act directed the Department of the Interior and Department of Agriculture to implement comprehensive paleontological resource management plans in order to protect paleontological resources on federal lands. The secretaries of both departments were instructed to use "scientific principles and expertise" in order to "develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources, in accordance with applicable agency laws, regulations, and policies. These plans shall emphasize interagency coordination and collaborative efforts where possible with non-Federal partners, the scientific community, and the general public" (16 USC 470aaa-1). Procedural guidelines for management of paleontological resources on BLM lands are discussed extensively in Manual H-8720-1 (BLM 1998) and BLM IM Nos. 2008-009, (BLM 2007), 2009-011 (BLM 2008), and 2016-124 (2016), and they provided the basis for the overall research design of the paleontological resource survey described in this report.

State Laws and Regulations

The proposed project is considered a "project" under the CEQA and is subject to compliance with the CEQA (*Public Resources Code* [PRC] 21000 *et seq.*) and CEQA guidelines (14 *California Code of Regulations* [CCR] 15000 *et seq.*), as amended. The County of Riverside is the CEQA lead agency. The CEQA mandates that lead agencies consider whether a proposed project will have an adverse effect on the environment and whether any such effect can be feasibly eliminated by pursuing an alternative course of action or can be mitigated to less-than-significant levels. CEQA recognizes that historical resources are part of the environment and that "a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment" (PRC 21084.1).

The State of California provides protection for paleontological resources as historical resources under the CEQA guidelines. Under these guidelines, the term "historical resource" is defined "as any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California" (14 CCR 15064.5[a][3]). Furthermore, for the purposes of the CEQA, a historical resource is any object, building, structure, site, area, place, record, or manuscript listed in or eligible for listing in the California Register of Historical Resources (CRHR) (PRC 21084.1). A resource is eligible for listing in the CRHR if it meets any of the following criteria (PRC 5024.1[c]):

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

Although paleontological resources are not eligible for listing in the CRHR, CEQA (14 CCR 15064.5[a][(4]) also states that eligibility for listing in the CRHR does not preclude a lead agency from determining that a resource may be a historical resource, as defined in PRC 5020.1(j) and 5024.1. Finally, the CEQA implementing guidelines (14 CCR 15000 *et seq.*) define the persons, agencies, activities, and procedures required to comply with CEQA. These guidelines include, as an issue to be addressed within the CEQA Environmental Checklist, the question, "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" (CEQA Guidelines, Appendix G, Section V[c]). These protections apply only to State of California land, and thus apply only to portions of the proposed project that are on state land.

Local Laws and Regulations

The County of Riverside General Plan sets forth the goals, policies, and programs the County uses to manage future growth and land uses. Although the General Plan usually only applies to portions of the County that are unincorporated, this section is being included for completeness. The following open space (OS) element policies contained in the General Plan (County of Riverside 2015) are designed to protect paleontological resources within the County:

OS 19.6 Whenever existing information indicates that a site proposed for development has high paleontological sensitivity. . . a paleontological resource impact mitigation program (PRIMP) shall be filed with the County Geologist prior to site grading. The PRIMP shall specify the steps to be taken to mitigate impacts to paleontological resources.

OS 19.7 Whenever existing information indicates that a site proposed for development has low paleontological sensitivity. . . no direct mitigation is required unless a fossil is encountered during site development. Should a fossil be encountered, the County Geologist shall be notified and a paleontologist shall be retained by the project proponent. The paleontologist shall document the extent and potential significance of the paleontological resources on the site and establish appropriate mitigation measures for further site development.

OS 19.8 Whenever existing information indicates that a site proposed for development has undetermined paleontological sensitivity. . . a report shall be filed with the County Geologist documenting the extent and potential significance of the paleontological resources on site and identifying mitigation measures for the fossil and for impacts to significant paleontological resources prior to approval of that department.

OS 19.9 Whenever paleontological resources are found, the County Geologist shall direct them to a facility within Riverside County for their curation, including the Western Science Center in the City of Hemet.

Purpose of Plan

The purpose of this plan is to establish procedures to mitigate adverse effects to significant, nonrenewable paleontological resources during project-related construction activities. This plan will outline the timing, location, and levels of mitigation monitoring, develop discovery procedures for paleontological resources exposed during ground-disturbing activities, and provide a reporting schedule for documenting results of the PMMP. This plan first discusses the paleontological resources in general and then documents the geology and paleontology of the project area, with emphasis on the paleontological resource potential of each geologic unit. Mitigation and monitoring procedures within this PMMP are broken into three sections based on major phases in the project timeline: preconstruction, during construction, and postconstruction. Each section outlines paleontology-related tasks to be completed before the start of the following phase in the project timeline. By implementing this plan, adverse effects to paleontological resources as a result of project-related construction would be reduced to a less than significant level, in accordance with NEPA and CEQA.

Paleontological Resources

Paleontology is the study of past life on this planet. Its purview encompasses nearly 4 billion years of Earth's history (Ohtomo et al. 2014) and is tasked with understanding the biology of extinct and extant organisms. A multidisciplinary field, paleontology often combines different aspects of geology, biology, chemistry, physics, and mathematics in order to tease out information about prehistoric organisms and systems from a relatively incomplete fossil record. Inherently, paleontological investigations involve the study of fossil remains (i.e., paleontological resources).

Fossils are generally defined here as the remains or trace remains (both physical and chemical) of prehistoric organisms (i.e., animals, plants, and microorganisms). These resources can be preserved as body fossils, such as bones, teeth, shells, and plant matter, or as trace fossils, such as burrows and footprints. Geologic deposits make up the context in which these fossil remains were originally buried and provide information about the environment in which an organism lived. In the broadest sense, a fossil can be defined as any remains documenting past life. Typically, to be considered within the scope of paleontology, fossils must be at least 10,000 years in age (i.e., dating from before the beginning of the modern Holocene Epoch). However, some Holocene-age remains are also considered of paleontological interest, such as specimens of late-surviving woolly mammoths from Wrangel Island that survived until approximately 4,000 years before present. Such younger material is considered to be a paleontological resource because it contributes to our understanding of the record of past life. Alteration or replacement (e.g., permineralization, petrification, or "fossilization") of the original organic material is not required for determination of whether an object is a fossil or not.

In general, paleontological resources are preserved in sedimentary rocks; however, they can occasionally be preserved in low-grade metamorphic rocks and can, on rare occasions, be preserved in volcanic rocks. Beyond acting as a vessel for the preservation of fossil remains, sedimentary strata record telltale information reflecting the environment in which they were deposited (e.g., sedimentary structures, maturity, and lithology). For example, fossil remains found within the fine-grained sediments of a floodplain deposit represent organisms that died and were later buried on an ancient floodplain. Because of the interwoven relationship between fossil remains and their geologic contexts, for the purpose of this report, paleontological resources can be thought of as also including fossil-collecting localities and the geologic formations containing those localities.

Significance Criteria

With respect to paleontological resource management and for reasons discussed above, geologic units are often assigned a classification or rank based on the known or potential abundance of significant paleontological resources contained within that unit. The BLM considers a significant paleontological resource as a fossil that is considered to be of "scientific interest". This includes most vertebrate fossil remains and traces, as well as certain rare or unusual invertebrate and plant remains (BLM 2008). Paleontological resources may be considered to not be significant if they lack provenance or geologic context; lack physical integrity or are highly fragmentary; or are overly redundant, over-represented, or not useful for paleontological research. Significant paleontological resources are further defined by the Society of Vertebrate Paleontology (SVP) as identifiable vertebrate, invertebrate, plant, and trace fossils that provide taphonomic, taxonomic, phylogenetic, paleoecological, stratigraphic, or biochronological data (SVP 2010). A paleontological resource may by scientifically important because of its rarity, quality of preservation, unique anatomy, or educational value. These data are important for a multitude of scientific purposes, including examination of evolutionary relationships, understanding the development of biological communities and the interactions between organisms within them, as well as the establishment of chronologies for geologic units (Scott and Springer 2003). Fossils are considered important scientific and educational resources because they serve as direct and indirect evidence of prehistoric life and are used to understand the history of life on Earth, the nature of past environments and climates, the membership and structure of ancient ecosystems, and the pattern and process of organic evolution and extinction. Fossils are considered to be limited, nonrenewable resources, because they typically represent organisms that are now extinct or life in a context that no longer exists. Therefore, if destroyed, a particular fossil can never be replaced, and the information associated with it is forever lost.

Paleontological Resource Potential

In recognition that paleontological resources are considered to include not only actual fossil remains and traces but also the fossil collecting localities and the geologic units containing those fossils and localities, the BLM developed a procedure for evaluating the paleontological resource potential of individual geologic rock units (BLM 2007, 2016). This procedure uses the Potential Fossil Yield Classification (PFYC) to classify rocks within units, based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and the sensitivity of these fossils to adverse impacts. The PFYC supersedes the Condition Classifications for paleontological resource management outlined in BLM Manual H-8270-1 (BLM 1998) (Table 1) and provides detailed guidelines for assignment of classes. Under the PFYC system, geologic formations, members, or other distinguishable units are assigned to a class between Classes 1 and 5, with higher numerical values representing increased potential to encounter significant paleontological resources. As such, the PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources on BLM lands.

Table 1. Comparative Frameworks for Assigning Paleontological Resource Significance under the Condition Classification and PFYC Systems

Condition[a]	PFYC Class[b]
1. Areas known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.[c]	4 (high) or 5 (very high), based on geologic unit
2. Areas with exposures of geological units or settings that have high potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	3 (moderate), 4 (high), or 5 (very high), based on geologic unit
3. Areas that are very unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.	1 (very low) or 2 (low).

[a] Modified from BLM Manual H-8720-1 (BLM 1998).
[b] Modified from BLM Instruction Memorandum No. 2008-009 (BLM 2007).
[c] This refers to known localities or groups of localities.

The original version of the PFYC system was updated in 2016 by BLM IM No. 2016-124 (BLM 2016). This update removed the previously used "a" and "b" subclassifications from PFYC Classes 3–5 in favor of the addition of Classes U, W, and I. Reference to this older scheme of classification will be necessary within this report in order to discuss PFYC assignments in older (pre-2016) paleontological assessments and surveys. However, all newly classified or reclassified geologic units will be discussed in reference to the updated PFYC system. In order to accurately reflect the intentions and definitions of the PFYC provided by the BLM, the below section is excerpted verbatim from BLM IM No. 2016-124.

> Occurrences of paleontological resources are known to be correlated with mapped geologic units (i.e., formations). The PFYC is created from available geologic maps and assigns a class value to each geological unit, representing the potential abundance and significance of paleontological resources that occur in that geological unit. PFYC assignments should be considered as only a first approximation of the potential presence of paleontological resources, subject to change based on ground verification.
>
> In the PFYC system, geologic units are assigned a class based on the relative abundance of significant paleontological resources and their sensitivity to adverse impacts. This classification is applied to the geologic formation, member, or other mapped unit. The classification is not intended to be applied to specific paleontological localities or small areas

within units. Although significant localities may occasionally occur in a geologic unit that has been assigned a lower PFYC classification, widely scattered important fossils or localities do not necessarily indicate a higher class assignment. Instead, the overall abundance of scientifically important localities is intended to be the major determinant for the assigned classification.

The descriptions for the class assignments below serve as guidelines rather than as strict definitions. Knowledge of the geology and the paleontological potential for individual geological units are considered when developing PFYC assignments. These assignments must be developed using scientific expertise with input from a BLM paleontologist, but may include collaboration and peer review from outside researchers who are knowledgeable about both the geology and the nature of paleontological resources that may be found in each geological unit. Each state has unique geologic maps and so also has unique PFYC assignments. It is possible, and occasionally desirable, to have different assignments for a similar geologic unit across separate states.

Class 1 – Very Low. Geologic units that are not likely to contain recognizable paleontological resources. Units assigned to Class 1 typically have one or more of the following characteristics:

- Geologic units are igneous or metamorphic, excluding air-fall and reworked volcanic ash units.
- Geologic Units are Precambrian in age.

(1) Management concerns for paleontological resources in Class 1 units are usually negligible or not applicable.

(2) Paleontological mitigation is unlikely to be necessary except in very rare or isolated circumstances that result in the unanticipated presence of paleontological resources, such as unmapped geology contained within a mapped geologic unit. For example, young fissure-fill deposits often contain fossils but are too limited in extent to be represented on a geological map; a lava flow that preserves evidence of past life, or caves that contain important paleontological resources. Such exceptions are the reason that no geologic unit is assigned a Class 0.

Overall, the probability of impacting significant paleontological resources is very low and further assessment of paleontological resources is usually unnecessary. An assignment of Class 1 normally does not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.

Class 2 – Low. Geologic units that are not likely to contain paleontological resources. Units assigned to Class 2 typically have one or more of the following characteristics:

- 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 aeolian deposits.
- Sediments exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely.

(1) Except where paleontological resources are known or found to exist, management concerns for paleontological resources are generally low and further assessment is usually unnecessary except in occasional or isolated circumstances.

(2) Paleontological mitigation is only necessary where paleontological resources are known or found to exist.

The probability of impacting significant paleontological resources is low. Localities containing important paleontological resources may exist, but are occasional and should be managed on a case-by-case basis. An assignment of Class 2 may not trigger further analysis unless paleontological resources are known or found to exist. However, standard stipulations should be put in place prior to authorizing any land use action in order to accommodate unanticipated discoveries.

Class 3 – Moderate. Sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Units assigned to Class 3 have some of the following characteristics:

- Marine in origin with sporadic known occurrences of paleontological resources.
- Paleontological resources may occur intermittently, but abundance is known to be low.
- Units may contain significant paleontological resources, but these occurrences are widely scattered.
- The potential for an authorized land use to impact a significant paleontological resource is known to be low-to-moderate.

(1) Management concerns for paleontological resources are moderate because the existence of significant paleontological resources is known to be low. Common invertebrate or plant fossils may be found in the area, and opportunities may exist for casual collecting.

(2) Paleontological mitigation strategies will be proposed based on the nature of the proposed activity.

This classification includes units of moderate or infrequent occurrence of paleontological resources. Management considerations cover a broad range of options that may include record searches, pre-disturbance surveys, monitoring, mitigation, or avoidance. Surface-disturbing activities may require assessment by a qualified paleontologist to determine whether significant paleontological resources occur in the area of a proposed action, and whether the action could affect the paleontological resources.

Class 4 – High. Geologic units that are known to contain a high occurrence of paleontological resources. Units assigned to Class 4 typically have the following characteristics:

- 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.

(1) Management concerns for paleontological resources in Class 4 are moderate to high, depending on the proposed action.

(2) Paleontological mitigation strategies will depend on the nature of the proposed activity, but field assessment by a qualified paleontologist is normally needed to assess local conditions.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action. Mitigation plans must consider the nature of the proposed disturbance, such as removal or penetration of protective surface alluvium or soils, potential for future accelerated erosion, or increased ease of access that could result in looting. Detailed field assessment is normally required and on-site monitoring or spot-checking may be necessary during land disturbing activities. In some cases avoidance of known paleontological resources may be necessary.

Class 5 – Very High. Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources. Units assigned to Class 5 have some or all of the following characteristics:

- 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.

(1) Management concerns for paleontological resources in Class 5 areas are high to very high.

(2) A field survey by a qualified paleontologist is almost always needed. Paleontological mitigation may be necessary before or during surface disturbing activities.

The probability for impacting significant paleontological resources is high. The area should be assessed prior to land tenure adjustments. Pre-work surveys are usually needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designation of areas of avoidance, or special management designations should be considered.

Class U – Unknown Potential. Geologic units that cannot receive an informed PFYC assignment. Characteristics of Class U may include:

- 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 known.
- Geological 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.

(1) Until a provisional assignment is made, geologic units that have an unknown potential have medium to high management concerns.

(2) Lacking other information, field surveys are normally necessary, especially prior to authorizing a ground-disturbing activity.

An assignment of "Unknown" may indicate the unit or area is poorly studied, and field surveys are needed to verify the presence or absence of paleontological resources. Literature searches or consultation with professional colleagues may allow an unknown unit to be provisionally assigned to another Class, but the geological unit should be formally assigned to a Class after adequate survey and research is performed to make an informed determination.

Class W – Water. Includes any surface area that is mapped as water. Most bodies of water do not normally contain paleontological resources. However, shorelines should be carefully considered for uncovered or transported paleontological resources. Reservoirs are a special concern because important paleontological resources are often exposed during low water intervals. In karst areas sinkholes and cenotes may trap animals and contain paleontological resources. Dredging river systems may result in the disturbance of sediments that contain paleontological resources.

Class I – Ice. Includes any area that is mapped as ice or snow. Receding glaciers, including exposed lateral and terminal moraines should be considered for their potential to reveal recently exposed paleontological resources. Other considerations include melting snow fields that may contain paleontological resources with possible soft-tissue preservation.

Special Notes. When developing PFYC assignments, the following should be considered:

(1) Standard stipulations should always be put in place prior to authorizing any land use action in order to accommodate an unanticipated discovery.

(2) Class 1 & 2 and Class 4 & 5 units may be combined for broad applications, such as largescale planning, programmatic assessments, or when geologic mapping at an appropriate scale is not available. Resource assessment, mitigation, and other management considerations will need to be addressed when actual land disturbing activities are proposed.

(3) Where large projects impact multiple geologic units with different PFYC Classes, field survey and monitoring should be applied appropriately. For example, the authorized officer may determine that on-the-ground (pedestrian) surveys are necessary for the Class

(4) 4 and 5 formations, but not for Class 2 formations along a specific project.

(5) Based on information gained by surveys, the BLM may adjust PFYC assignments appropriately. Actual survey and monitoring intensities, as well as the extent of discoveries, should be included in any assessment, mitigation, or permit report so the

(6) BLM may reevaluate PFYC assignments.

(7) A geologic unit may receive a higher or lower classification in specific areas where the occurrence of fossils is known to be higher or lower than in other areas where the unit is exposed.

(8) Some areas are difficult to evaluate, such as talus, colluvium, tailings, fill, borrow, and other mapped features. A PFYC assignment should be made for each area using available information, or the area should be assigned to Class U as appropriate.

(9) The BLM-wide PFYC assignments are maintained and periodically updated by the BLM paleontology team and may be obtained by contacting the BLM state or regional paleontologist assigned to an area."

Other criteria for assessing the paleontological resource significance of geologic units have been established by separate groups and agencies. One of the most widely used was created by the SVP within the "Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources" (SVP 2010). Under the SVP (2010) guidelines, geologic units are classified in one of four categories of paleontological resource sensitivity: no, low, undetermined, and high. The criteria for each of these sensitivity categories are presented in Table 2. Paleontological resource sensitivity will be assessed within this report using both the PFYC and SVP classification systems.

Table 2. SVP Classification for Paleontological Resource Sensitivity

Paleontological Potential	Criteria	Recommendations
High	Geologic formations that are known to yield vertebrate or significant invertebrate, plant, or trace fossils. Highly sensitive formations also may be those that are likely to produce new vertebrate materials, traces, or trackways.	A field survey as well as onsite construction monitoring is required. Any significant specimens discovered will require preparation, identification, and curation, as well as eventual accession into an appropriate museum collection. A final report documenting the significance of any finds is required.
Undetermined	Geologic formations for which available literature on paleontological resources is scarce, making it difficult to determine whether or not it is potentially fossiliferous. Under these circumstances, further study is needed to determine the unit's paleontological resource potential (i.e., field survey).	A field survey is required to further assess the unit's paleontological potential.
Low	Geologic formations that have yielded few fossils in the past, based upon review of available literature and museum collections records. Low potential also may include formations that yield fossils only under unusual circumstances. This also includes formations that, based on their relative youthful age or high-energy depositional history, are unlikely to produce important fossil remains	Mitigation is not typically required.
None	Geologic formations that are formed under or exposed to immense heat and pressure, such as high-grade metamorphic rocks and plutonic igneous rocks. Artificial fill materials also are assigned as having no potential because of the loss of stratigraphic context of any contained organic remains.	No mitigation required.

Note: Modified from Society of Vertebrate Paleontology (2010).

Paleontological and Geological Context

Paleontology

The sediments underlying the project area represent late Pleistocene–Holocene deposits that have recorded the geological and paleontological history of the project area. In general, Pleistocene biotas are similar to those of the Holocene and contain many of the same taxa (Graham 1979). However, the end of the Pleistocene was marked by the extinction of multiple, large-bodied vertebrate species (especially mammals), including mammoths, mastodons, ground sloths, and saber-toothed cats (Koch and Barnosky 2006). The paleontological field survey uncovered remains of fossil taxa that document this characteristic change in community between the Pleistocene and present day (El Adli 2018).

Fossil remains found within the project area during the field survey included those of tortoise, jackrabbit, horse, mammoth, and seed plant. Almost all specimens were found as isolated remains represented by (often) partial single elements. With few exceptions, the fossil remains were found at the surface within lag deposits, although several specimens were found at least partially buried. No fossils were discovered in active dune deposits or units of Holocene age. Given the abundance of fossil remains found at the surface within some deposits (especially the old terrace deposits), there is potential to find significant paleontological remains in the subsurface during construction-related activities. As paleontological resource potential is assigned to geologic formations or units, the assigned PFYC classifications and SVP rankings will be discussed for each geologic unit below.

Geology

The project area lies within the Palo Verde Mesa, which is situated above and to the west of the Palo Verde Valley, adjacent to the western bank of the Colorado River. The portion of the Palo Verde Mesa containing the project area is located between the Big Maria Mountains to the north, the McCoy Mountains to the northwest, the Mule Mountains to the southwest, and the present-day path of the Colorado River to the east. The Palo Verde Mesa is a geomorphic terrace cut by the Colorado River that runs continuously from the Big Maria Mountains in the north to the Palo Verde Mountains in the south. In the most general sense, the sediments underlying the project area are a product of influence from the Colorado River, alluvial input from nearby topographic features, and soil formation during times of landscape stability (Fife and Brown 1980).

The geologic setting of the project area was extensively summarized in the paleontological assessment of the project area written by Reynolds and Lander (2016) and the paleontological field survey and assessment by El Adli (2018). The geologic units underlying the project area as reported by those authors are discussed below and summarized in Figures 3 and 4 and Table 3:

Old Terrace Deposits (Qot)

The middle–late Pleistocene old terrace deposits represent sediments laid down in association with the Colorado River. Larger clasts within this unit consist of locally derived rocks mixed with rounded exotics deposited by the river (Stewart 2012). The old terrace deposits are generally composed of weakly consolidated sands, pebbly sands, silts, and clays (Stone 2006). The surface of these terrace deposits make up most of the surface of the Paleo Verde Mesa and lie approximately 20 m (65.6 feet) above the present-day Colorado River floodplain.

Within the scope of the DQSP, the old terrace deposits make up most of the area underlying the project (see Figure 3). El Adli (2018) documented exposures of these deposits across much of the project area, except for the northwestern portion of the project area and along the gen-tie corridor. A small portion of the older terrace deposits in the southwest is overlain by a finger of the active alluvial wash deposits (Qw), but are likely present at depth. In general, the old terrace deposits are covered either by desert pavement or by active aeolian dunes.

The paleontological field survey conducted by El Adli (2018) found fossil remains of tortoise, horse, and rabbit within the old terrace deposits. Because of the presence of abundant, identifiable vertebrate fossil remains at the surface, El Adli (2008) concluded that significant paleontological remains were likely present in the subsurface. For this reason, the old terrace deposits were assigned a paleontological potential of PFYC Class 4 (high) (high under SVP [2010]).

Stabilized Alluvial-Fan Deposits (Qf-2)

Alluvial fans are cone- or fan-shaped deposits of sediment that form at the boundaries between areas of high and low topography. The detrital sediments of the alluvial fan are transported and deposited by gravity, wind, and (most often) water. Such features are common in mountainous regions of the world and in tectonically active regions. Alluvial fans are potentially extensive features and can reach over 50 km (31 miles) in width and 60 km (37 miles) in length.

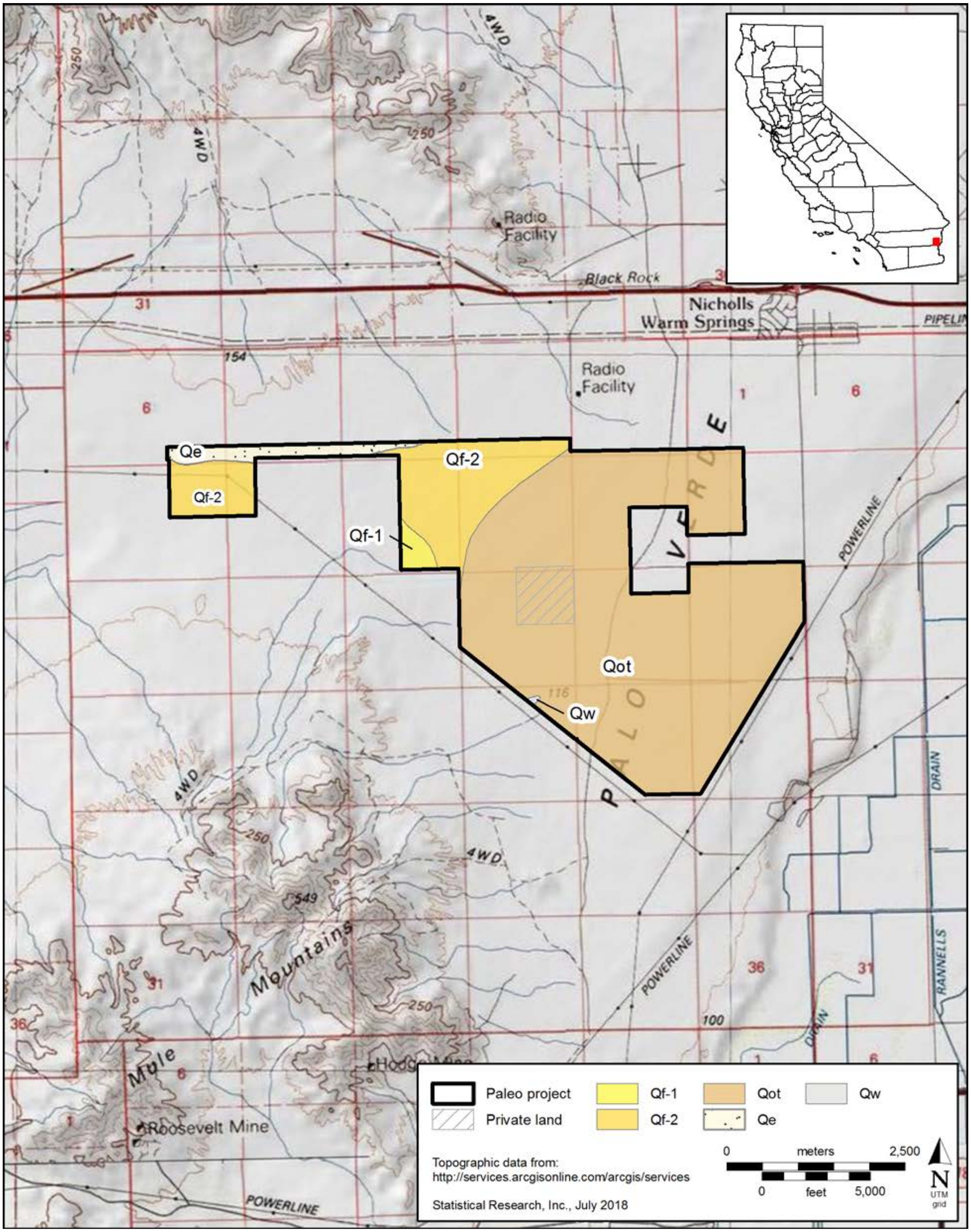


Figure 3. Current geologic map of the DQSP area as remapped during the paleontological field survey.

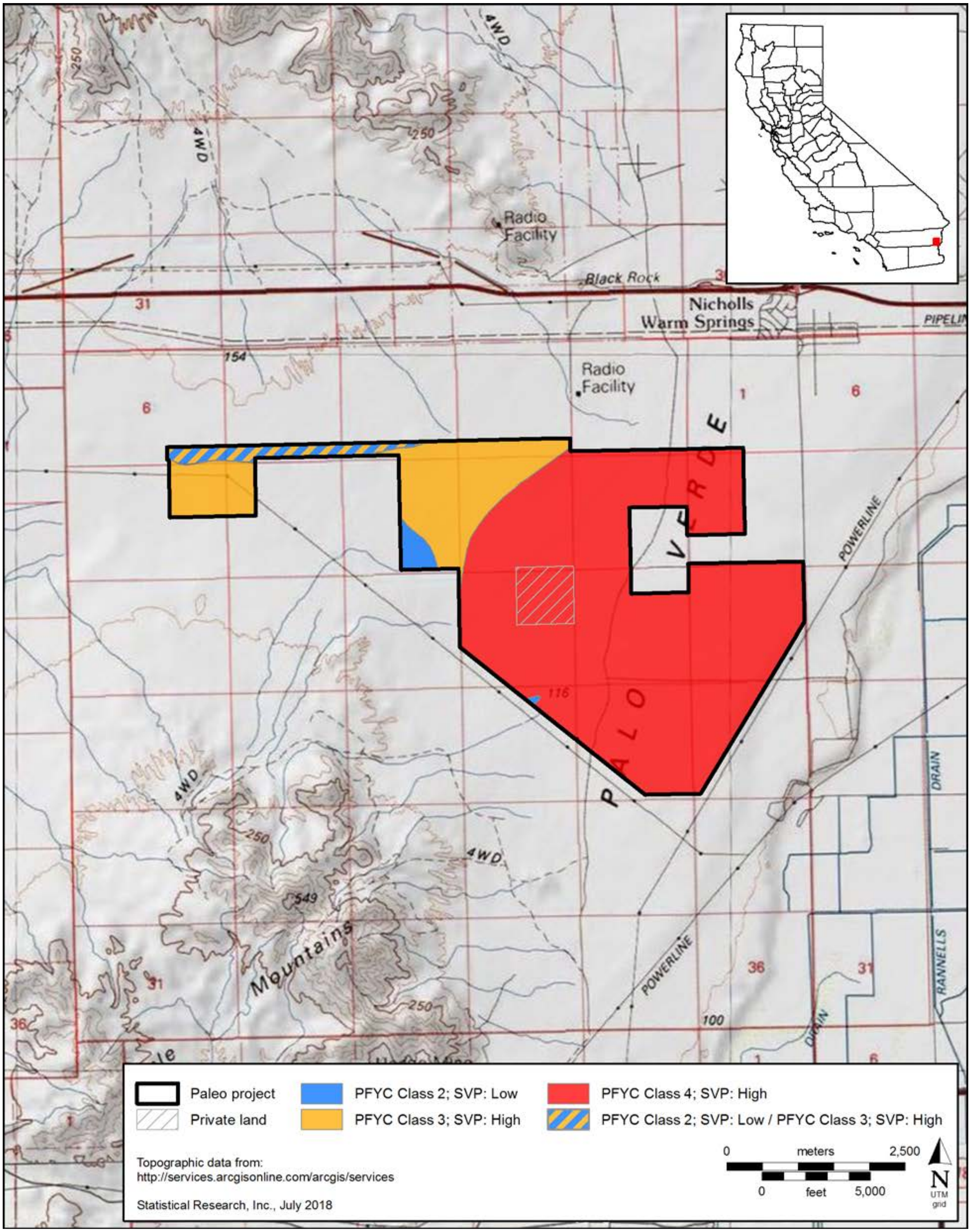


Figure 4. Map showing the paleontological resource potential of geologic units underlying the DQSP area.

Table 3. Paleontological Resource Potential of Geologic Units Found within the Project Area Using the PFYC Classification and SVP Ranking Systems

Geologic Unit	Symbol	Age	PFYC Class[a]	SVP Rank[b]
Old terrace deposits	Qot	middle–late Pleistocene	4	high
Stabilized alluvial-fan deposits	Qf-2	Pleistocene	3	high
Active and stabilized aeolian and dune deposits	Qe	latest Pleistocene–Holocene	2 (active); 3 (stabilized)	low to high (with depth)
Active alluvial-fan deposits	Qf-1	Holocene	2	low
Alluvial-wash deposits	Qw	Holocene	2	low

Key: PFYC = Potential Fossil Yield Classification; SVP = Society of Vertebrate Paleontology.
[a] Classification according to BLM (2016).
[b] Ranking according to SVP (2010).

Reynolds and Lander (2016) proposed dividing the alluvial fan deposits within the project area into younger, active alluvial-fan deposits (Qf-1) and older, stabilized alluvial-fan deposits (Qf-2). This hypothesis was supported by the data recovered during the paleontological field survey (El Adli 2018). The stabilized alluvial-fan deposits were interpreted to be late Pleistocene in age, whereas the active alluvial-fan deposits retained the initial late Holocene–age assignment made by Stone (2006). These sediments were described as unconsolidated to weakly consolidated, angular to subangular gravels and sands derived from the local mountain ranges.

The stabilized alluvial fan deposits are the second-most extensively distributed unit within the project area (behind the old terrace deposits). They were observed by El Adli (2018) in the northwestern portion of the main project area and the eastern and southwestern portions of the gen-tie corridor. These deposits are overlain by active alluvial-fan deposits (Qf-1) in the northwest portion of the main project area and active aeolian and dune deposits (Qe) in the central portion of the gen-tie corridor.

El Adli (2018) discovered fragmentary remains of mammoth and pieces of petrified wood within the stabilized alluvial-fan deposits. Significant vertebrate fossils are also known from similar alluvial-fan deposits of Pleistocene age throughout the region. Given these data, the stabilized alluvial-fan deposits were assigned a paleontological resource potential of PFYC Class 3 (moderate) (high under SVP [2010]).

Stabilized and Active Aeolian and Dune Deposits (Qe)

The northern portion of the project area along the gen-tie corridor contains an area of exposed aeolian deposits (Jennings 1967; Stone 2006; Stone and Pelka 1989). These wind-deposited materials form small dunes and sheets across the landscape. Stewart (2012) suggested that these sediments are Holocene in age and are likely reworked from nearby Pleistocene deposits. Reynolds and Lander (2016) divided these deposits into active, Holocene dune fields overlying older, stabilized aeolian deposits of potentially Pleistocene age. SWCA Environmental Consultants (SWCA) (2011) similarly documented a shift from active to stabilized dune deposits with depth, corresponding to increased geologic age as well as paleontological potential. The field observations from the paleontological survey by El Adli (2018) further supported this division.

The paleontological field survey (El Adli 2018) discovered a single isolated tortoise remain from loose sand associated with the aeolian and dune deposits. However, because of lack of context for that specimen, it was unclear whether it has been transported from another unit. Based on the differences in age between the active and stabilized portions of the aeolian and dune deposits, each portion was assigned a different paleontological resource potential. The overlying active portion of the aeolian and dune deposits were assigned a paleontological potential of PFYC Class 2 (low) (low under SVP [2010]), as any remains discovered from these deposits would either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. Conversely, the underlying stabilized dune deposits represented sediments that were old enough to preserve fossils and were found to be composed of a lithology known to produce fossil remains. Therefore, the stabilized dune deposits were assigned a paleontological significance of PFYC Class 3 (moderate) (high under SVP [2010]). Because the active portion of these deposits likely overlies the stabilized portions, this unit should effectively be treated as having an increased paleontological resource potential with depth.

Active Alluvial-Fan Deposits (Qf-1)

As discussed above for stabilized alluvial-fan deposits (Qf-2), the active alluvial-fan deposits within the project area are likely late Holocene in age. Gravels and sands within the unit are likely derived from the nearby Mule Mountains to the southwest but may have some minor input from the Big Maria and McCoy Mountains (Reynolds and Lander 2016). These deposits were separated from the stabilized alluvial-fan deposits by Reynolds and Lander (2016), based on apparent topographic differences visible on satellite and aerial images. El Adli (2018) found lithologic and topographic differences between the stabilized and active alluvial-fan deposits, supporting the division made by Reynolds and Lander (2016).

The active alluvial-fan deposits were observed by El Adli (2018) in a small portion of the northwest region of the project area. These deposits extend southwest out of the project area toward the Mule Mountains. The active alluvial fan deposits overlie the stabilized alluvial fan deposits within the project area and decrease in thickness toward the northeast.

No significant paleontological remains were noted within the active alluvial-fan deposits during the paleontological field survey (El Adli 2018). Given the Holocene age of the active alluvial fan deposits, any remains discovered from these deposits would likely either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. Therefore, the active alluvial-fan deposits were assigned a paleontological potential of PFYC Class 2 (low) (low potential under SVP [2010]).

Active Alluvial-Wash Deposits (Qw)

Both Stone (2006) and Hayhurst and Bedrossian (2010) mapped a small area of active alluvial-wash deposits on the southwestern margin of the project area. The Southern California Mapping Project (2014) defined these types of deposits as unconsolidated sand-and-gravel deposits that are found in active channels of streams and rivers. These deposits typically have fresh flood scours, channel-and-bar morphology, and are present as (1) active deposits in steep-walled channels and arroyos incised into older alluvial units; (2) nonincised networks of active channels distributed across valley floors and alluvial fans; or (3) thin, active veneers that are present at the bottom of mountain canyons. The active alluvial-wash deposits within the project area are late Holocene in age (Stone 2006). These deposits were noted by El Adli (2018) as poorly consolidated and generally very poorly sorted with angular to subrounded grains and clasts.

Within the project area, the active alluvial-wash deposits are located near the southwestern boundary of the project area. These deposits are exposed as a thin finger of slightly higher topography overlying the old terrace deposits. The active alluvial-wash deposits noticeably increase in thickness toward their sediment source (the Mule Mountains) to the southwest.

As with the active alluvial-fan deposits, no paleontological remains were discovered within the active alluvial-wash deposits, and none is known from similar deposits in the vicinity of the project area. Given the young, Holocene age of the active alluvial-wash deposits, any remains discovered from these deposits would likely either be too young to represent fossil remains or would represent fossil remains that had been removed from their original context. For these reasons, the active alluvial-wash deposits were assigned a paleontological potential of PFYC Class 2 (low) (low under SVP [2010]).

Monitoring Plan

Personnel Qualifications

Definitions and qualifications for project personnel associated with paleontological resources are outlined by SVP (2010). These guidelines meet or exceed those set forth by the BLM in IM No. 2009-011 (BLM 2008). Definitions for both qualified professional paleontologist (i.e., qualified paleontologist) and paleontological resource monitor (i.e., field monitor) are shown below verbatim from SVP (2010:10–11):

> **A QUALIFIED PROFESSIONAL PALEONTOLOGIST (Principal Investigator, Project Paleontologist)** is a practicing scientist who is recognized in the paleontological community as a professional and can demonstrate familiarity and proficiency with paleontology in a stratigraphic context. A paleontological Principal Investigator shall have the equivalent of the following qualifications:
>
> 1. A graduate degree in paleontology or geology, and/or a publication record in peer reviewed journals; and demonstrated competence in field techniques, preparation, identification, curation, and reporting in the state or geologic province in which the project occurs. An advanced degree is less important than demonstrated competence and regional experience.
> 2. At least two full years professional experience as assistant to a Project Paleontologist with administration and project management experience; supported by a list of projects and referral contacts.
> 3. Proficiency in recognizing fossils in the field and determining their significance.
> 4. Expertise in local geology, stratigraphy, and biostratigraphy.
> 5. Experience collecting vertebrate fossils in the field.
>
> **PALEONTOLOGICAL RESOURCE MONITORS** shall have the equivalent of the following qualifications:
>
> 1. BS or BA degree in geology or paleontology and one year experience monitoring in the state or geologic province of the specific project. An associate degree and/or demonstrated experience showing ability to recognize fossils in a biostratigraphic context and recover vertebrate fossils in the field may be substituted for a degree. An undergraduate degree in geology or paleontology is preferable, but is less important than documented experience performing paleontological monitoring, or
> 2. AS or AA in geology, paleontology, or biology and demonstrated two years experience collecting and salvaging fossil materials in the state or geologic province of the specific project, or
> 3. Enrollment in upper division classes pursuing a degree in the fields of geology or paleontology and two years of monitoring experience in the state or geologic province of the specific project.
> 4. Monitors must demonstrate proficiency in recognizing various types of fossils, in collection methods, and in other paleontological field techniques.

Pre-construction

Paleontological-Resource Salvage

An extensive pedestrian paleontological field survey of the project area was conducted by El Adli (2018) during the earlier assessment phase of the project evaluation. This survey was deemed sufficient to evaluate paleontological resource potential and to document known fossil occurrences on the surface of the project area. However, no paleontological remains were recovered during this survey. Therefore, all paleontological resources discovered during the field survey and deemed significant or potentially significant by the BLM will need to be collected by a qualified paleontologist or paleontological monitor prior to any construction-related activities. Following collection, these fossil remains will be prepared and curated before being deposited in an adequate fossil repository. Copies of field notes, data, and reports will be submitted to the official fossil repository with the collected material. A report must be written documenting the recovery and indicating that no further mitigation efforts are required for those remains. This report will be approved and signed by the authorized officer and/or project leader.

Alternative mitigation, such as avoidance and rerouting of the project in the vicinity of significant paleontological resources, is also an option. However, rerouting must be far enough away such that access roads do not lead directly to the fossil discovery site. If avoidance is the selected mitigation, then the discovery must be stabilized and buried, as necessary, and appropriate measures taken to reduce human-caused or natural adverse effects (e.g., erosion) (BLM 2008).

Worker Education Training

Prior to the start of any ground-disturbing activities, a preconstruction meeting shall take place during which the qualified paleontologist shall provide all construction personnel with paleontological sensitivity training. This training program will provide information regarding the potential to encounter subsurficial paleontological resources during earthmoving activities and the need to protect such resources. The training will inform construction personnel of the location and boundary of any areas with a moderate–very high paleontological resource potential. Instructions will be provided as to the appropriate procedures and notifications to be undergone should paleontological resources be discovered during project construction. The training will also emphasize that unauthorized collections or disturbances of protected fossils within or outside the project area are prohibited and may result in criminal penalties and fines. The qualified paleontologist or qualified paleontological monitor may attend tailgate meetings to brief the construction crew on paleontological monitoring protocols.

Permits and Agreements

The BLM has formal permitting policies and procedures governing survey work and fossil collecting on lands under their management. It is required that qualified paleontologists obtain a Paleontological Resource Use Permit (e.g., Survey and Limited Surface Collection Permits) for the area prior to the start of work on BLM property. Before start of work, the qualified paleontologist must also obtain a Fieldwork Authorization from the appropriate BLM field office.

Prior to issuance of a grading permit by the County of Riverside and the start of any construction activities, a qualified paleontologist approved by the County and BLM must be retained to implement the monitoring and reporting services outlined in this PMMP. A signed contract must be provided to the County and BLM to fulfill this requirement. Furthermore, a repository and curation agreement with an appropriate fossil repository approved by the BLM and the County must be acquired prior to the start of construction. Pursuant to the County's Safeguard Artifacts Being Excavated in Riverside County (SABER) Policy, the preferred fossil repository is the Western Science Center in the City of Hemet.

During Construction

Excavation Monitoring

Qualified paleontological resource monitor(s) will be present at all times during grading or excavation into native geologic units that have been assigned a high paleontological resource potential under the SVP (2010) classification system or PFYC Class 3 or higher. In areas where a paleontological monitor is required, the monitor will be present to visually observe ground disturbance where previously undisturbed sediments are excavated. The opportunity to observe fossil-bearing sedimentary units is ideal during trenching, foundation, and access-road excavation work. It is the construction manager's responsibility to keep the qualified paleontologist and paleontological monitor(s) informed with current plans and any construction or scheduling changes. The monitor(s) will coordinate with construction management to determine the timing for monitoring in the identified areas of concern. It will be the qualified paleontologist's responsibility to maintain communication and coordination with the construction team. The BLM approving official will be notified via E-mail at the start of monitoring. If a monitoring hiatus occurs, the BLM approving officer will be notified via E-mail at the cessation and restart of monitoring. Areas of PFYC Class 3 and higher geologic units are indicated in Figure 4.

Some geologic units may require spot-checking because of their moderate potential to contain significant paleontological remains. The qualified paleontological resource monitor(s) will determine (with the guidance of the qualified professional paleontologist) an appropriate frequency to check spoils piles and vertical exposures of sediment. Such spot-checking requires close coordination between the project proponent, construction personnel, and the paleontologist. Communication protocols will therefore need to be developed between these groups prior to excavation into geologic units requiring spot checking. No geologic units requiring spot checking are identified in this report.

No monitoring will be required in geologic units assigned to PFYC Class 2 because of their low potential to produce significant paleontological resources. Areas underlain by PFYC Class 2 geologic units are indicated in Figure 4. Project areas that will require paleontological monitoring or spot-checking may be altered at any time at the discretion of the BLM and in consultation with the qualified professional paleontologist.

Monitoring Locations

The exact monitoring locations are based on the results of the preconstruction paleontological field survey conducted by El Adli (2018) and in consultation with the local BLM field office. Given that large portions of the project area are underlain by geologic units assigned PFYC Classes 3 and 4 (see Figure 4), any areas where excavations penetrating surficial exposures of these rock units or any areas within 500 feet of surficial exposures of these rock units will require paleontological monitoring by a qualified paleontologist or qualified paleontological monitor(s). This includes units mapped by El Adli (2018) as old terrace deposits (Qot), stabilized alluvial deposits (Qf-2), and stabilized and active aeolian and dune deposits (Qe). Some of these units (e.g., stabilized and active aeolian and dune deposits) are often covered with a layer of younger, surficial deposits that have low paleontological resource potential. Monitoring of these units will not be required during initial excavation activities but will be required 3 feet or more below grade or when native sediments are encountered. If geologic units assigned to PFYC Classes 3 or higher are unexpectedly exposed during construction-related activities, the qualified professional paleontologist and paleontological resource monitor(s) are to be notified immediately, and excavations in that area must cease until inspected by a monitors. The project proponent must notify the qualified professional paleontologist at least 72 hours prior to ground-disturbing activities that may impact paleontologically sensitive geologic units.

Discovery of Paleontological Resources

In the event of the discovery of paleontological remains, the paleontological resource monitor will immediately report the find to the construction supervisor and the qualified professional paleontologist, who will in turn notify the BLM. On private property within Riverside County, the professional paleontologist will instead report the discovery to the property owner, who will immediately notify the County geologist. The paleontological resource monitor or qualified professional paleontologist has the authority to temporarily stop construction or grading work at the discovery location. When work is stopped, the qualified professional paleontologist shall be contacted immediately. The paleontological monitor, under direction of the qualified professional paleontologist, will divert, direct, or temporarily halt ground-disturbing activities in the area of discovery to allow for preliminary evaluation of potentially significant paleontological resources and to determine if additional mitigation (i.e., collection and curation) is required.

The significance of discovered paleontological remains will be determined by the qualified professional paleontologist in consultation with the BLM field office. For large, significant paleontological resources, a data recovery plan will be developed for BLM review within five business days. Once approved, the data recovery plan will be implemented as soon as is feasibly possible. The recovery methods used will vary depending on the types of paleontological remains encountered (e.g., large fossil remains, microfossils, or plants fossils).

In general, paleontological resources will be collected and placed in bags or trays for transport to an equipped paleontology laboratory. Larger specimens may require further excavation and removal inside of a plaster jacket. Consolidants (e.g., Paraloid, polyvinyl butyral, or polyvinyl acetate) may be used to stabilize paleontological remains in the field, as necessary. Matrix samples may be collected at the discretion of the qualified paleontologist for subsequent laboratory studies (i.e., microfossil analysis). All fossil localities will be documented using Global Positioning System (GPS) units meeting or exceeding BLM standards for data collection (BLM 2008). Detailed stratigraphic, lithologic, and taphonomic data will be documented in order to understand the context in which the fossil was recovered. A camera will be use to photographically document the locality and any fossil remains encountered. Finally, each fossil locality will be recorded using BLM Form H-8270-1.

Screenwashing

Some lithologies and depositional environments are more conducive to the preservation of small paleontological remains (microfossils). The qualified professional paleontologist (with concurrence from the BLM authorized officer) may identify sediments that should be screened for microvertebrate remains. This process involves the breaking down of larger sediment blocks with water and manual agitation. The resulting sediment slurry is then sent through a series of metal sieves that sort out the desired grain size fraction. Screened materials are transferred to plastic sample bags and are later sorted and assessed under a microscope for presence of microfossil remains.

Sediment test samples may be collected accompanying the discovery of any identifiable macro-vertebrate fossils. Test samples will be collected using 5-gallon buckets and screened for presence of microvertebrate remains. If such remains are identified within the test sample, a bulk matrix sample will be collected for offsite screenwashing. Per SVP guidelines, a standard bulk sample is 4.0 cubic yards (or 6,000 pounds) of sediment for each fossiliferous horizon or paleosol (SVP 2010). All sediment samples will be collected with pertinent field data, especially those related to stratigraphy, lithology, and geography.

Reporting

All paleontological work will be reported on a daily monitoring summary form, with additional data recorded within a field notebook. This form will report monitoring activities, stratigraphy, geology, and any paleontological remains encountered. These daily monitoring forms will be summarized in a brief weekly report of paleontological monitoring activities by the qualified professional paleontologist, who will then provide it to a project supervisor designated by the project proponent. A monthly progress report summarizing all fieldwork and laboratory activities also will be created by the qualified professional paleontologist and provided to the BLM and the project supervisor.

Postconstruction

Fossil Preparation

Fossils collected during field survey, salvage, and/or monitoring activities will require consolidation, repair, and cleaning prior to deposit in an appropriate fossil repository. This preparation will involve the removal of sedimentary matrix that may be obscuring important morphology present on fossil specimens. Such preparation can be done either mechanically (e.g., with pneumatic chisels, air abrasion, pin vises, dental picks, or brushes) or chemically (e.g., with glacial acetic acid or formic acid), depending on the condition of the specimen and the encapsulating matrix. Smaller remains, such as microvertebrates, will likely need to be prepared under a microscope with fine tools. Weak, damaged, or porous specimens will be consolidated using specialized media such as thermoplastic resins (e.g., Paraloid), polyvinyl butyral, or polyvinyl acetate dissolved in acetone. Repair to damaged specimens will require adhesives such as cyanoacrylate glue (if unavoidable) or concentrated thermoplastic resins (e.g., Paraloid), polyvinyl butyral, or dissolved polyvinyl acetate.

Fossil Curation

Following fossil preparation, salvaged paleontological remains will be sorted, identified, cataloged, and placed in an appropriate storage vessel. Specimens will be sorted so that specimens of same taxon from the same stratigraphic horizon (i.e., taxonomic lots) are grouped together. Once sorted, the taxa will be identified to the lowest practical taxonomic level, given the available morphology. Identified specimens will be assigned a unique specimen number, which will be stored in an electronic catalog database. These catalog numbers are to be written on the specimens in a morphologically indistinct region using India ink over white acrylic paint. Specimens will then be placed in archival storage trays with curatorial labels, as appropriate. Large specimens may require the building of a storage cradle to allow for movement and transportation of the specimen. Storage cradles are typically composed of fiberglass embedded in Hydrocal (e.g., FGR-95) with metal conduit or wood being used for reinforcement. Smaller specimens (especially microvertebrates) may be pin-mounted using museum wax. The pins will then be attached to a cork and placed in a glass vial with relevant curatorial information.

Fossil Storage

All fossils collected under a BLM Paleontological Resource Use Permit remain property of the federal government and must be stored in an approved fossil repository. This fossil repository is identified on the consulting paleontologist's BLM Paleontological Resource Use Permit, as a repository agreement with an appropriate fossil repository is a precondition for permit approval. Fossil remains are to be placed within the approved repository no later than 60 days after all fieldwork is completed. Written approval from the BLM authorized officer is required if additional time is needed to transfer specimens. All paleontological remains will be accompanied by appropriate field notes, photographs, maps, GPS coordinates, and other field data. A copy of the final report will be submitted to the fossil repository upon completion and final approval.

Fossils collected from private lands will be given clear and unconditional title to the fossil repository by the landowner via a signed deed of gift. If no such agreement is reached, the property owner will be informed of the required professional and financial responsibilities associated with professional curation and storage of recovered paleontological resources. However, upon placement in an approved fossil repository, all such responsibilities will be assumed by the repository in perpetuity. Therefore, the assumption of responsibility for the curation of these paleontological resource by the approved repository generally removes any notion of retaining ownership by the property owner. The cost of curation and permanent storage is assessed by the repository and is the responsibility of the project proponent. Pursuant to the County SABER Policy, a signed curation and repository agreement with an appropriate fossil repository (with preference to the Western Science Center) must be provided to the County prior to issuance of a grading permit.

Final Report

Following the completion of all field-related work, the qualified professional paleontologist will write a final summary report presenting the results of the PMMP. This report will comply with the guidelines provided by the BLM in IM No. 2009-011 (BLM 2008) and must be submitted to the BLM and approved repository within 30 days of completion of fieldwork. The report will discuss the methods used during mitigation and monitoring, research themes, stratigraphy and geology at the project site, fossils collected and observed, and significance of any recovered fossils. An inventory of salvaged, prepared, and curated fossils will be provided with the final report. Pertinent information related to each discovery of paleontological resources must be recorded on BLM Form 8270-3 and included within a confidential appendix that is submitted to the BLM. These locality forms will be accompanied by 1:24,000 scale map(s) depicting the location of fossil localities throughout the project area. This confidential information cannot be provided to the project proponent. The final report will be reviewed and approved by the BLM no later than 180 days following completion of fieldwork, unless the size or nature of the project merits an extended timeframe. Such an extension must be approved by the BLM as early as possible before or following the completion of fieldwork.

All reports submitted to the County of Riverside must be signed by the project paleontologist and all professionals responsible for the report's contents. The County geologist must receive an original, signed copy of the report, as well as a copy of associated conditions and grading plans. These documents should not be submitted to any other County office besides that of the County geologist.

Bureau of Land Management (BLM)

1998 *General Procedural Guidance for Paleontological Resource Management*. Manual H-8270-1. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2007 *Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands*. Instruction Memorandum No. 2008-009. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2008 *Assessment and Mitigation of Potential Impacts to Paleontological Resources*. Instruction Memorandum No. 2009-011. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

2016 *Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands*. Instruction Memorandum No. 2016-124. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C.

County of Riverside

2015 Multipurpose Open Space Element. In *County of Riverside General Plan*, pp. OS-i–OS-56. County of Riverside, California. Available online at http://planning.rctlma.org/Portals/0/genplan/general_Plan_2017/elements/OCT17/Ch05_MOSE_120815.pdf?ver=2017-10-11-102103-833.

Desert Quartzite, LLC

2014 *Plan of Development: Desert Quartzite Solar Project*. Rev. May 23. Desert Quartzite, San Francisco. Submitted to the U.S. Department of the Interior Bureau of Land Management, California Desert District, Riverside County, California. Project No. CACA 049397. Available online, http://www.blm.gov/style/medialib/blm/ca/pdf/palmsprings/desert_quartzite_solar.Par.44609.File.dat/FSE%20DQSP%20Updated%20POD_CACA%20049397_052314.pdf, accessed November 5, 2015.

El Adli, Joseph J.

2018 *Paleontological Survey of the Desert Quartzite Solar Project, Palo Verde Mesa, Riverside County, California*. Technical Report 18-35. Statistical Research, Redlands, California.

Fife, Donald L., and Arthur R. Brown (editors)

1980 *Geology and Mineral Wealth of the California Desert.* Annual Field Trip Guidebook No. 8. South Coast Geological Society, Santa Ana, California.

Graham, Russell W.

1979 Paleoclimates and Late Pleistocene Faunal Provinces in North America. In *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities*, edited by Robert L. Humphrey and Dennis J. Stanford, pp. 49–69. Anthropological Society of Washington, Washington, D.C.

Hayhurst, Cheryl A., and Trinda L. Bedrossian (compilers)

2010 West Half of Blythe 30’ by 60’ Quadrangle. In *Geologic Compilation of Quaternary Surficial Deposits in Southern California*, edited by T. L. Bedrossian, P. Roffers, and C. A. Hayhurst, Plate 4. Special Report 217. California Geological Survey, Sacramento.

Jennings, C. W.
1967 *Geologic Map of California: Salton Sea Sheet*. Scale 1:250,000. California Division of Mines and Geology, Sacramento.

Koch, Paul L., and Anthony D. Barnosky
2006 Late Quaternary Extinctions: State of the Debate. *Annual Review of Ecology, Evolution, and Systematics* 37:215–250.

Ohtomo, Yoko, Takeshi Kakegawa, Akizumi Ishida, Toshiro Nagase, and Minik T. Rosing
2014 Evidence for Biogenic Graphite in Early Archaean Isua Metasedimentary Rocks. *Nature Geoscience* 7:25–28.

Reynolds, R. E., and E. B. Lander
2016 *Preliminary Paleontological Resource Assessment Technical Report Prepared in Support of Desert Quartzite Solar Project Southeastern Riverside County, California*. Prepared for First Solar, LLC.

Scott, Eric, and Kathleen Springer
2003 CEQA and Fossil Preservation in California. *Environmental Monitor* Fall 2003:4–10. Association of Environmental Professionals, Sacramento, California.

Society of Vertebrate Paleontology (SVP)
2010 Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources. Electronic document, http://vertpaleo.org/Membership/Member-Ethics/SVP_Impact_Mitigation_Guidelines.aspx, accessed June 2018.

Southern California Mapping Project (SCAMP)
2014 Surficial Geologic Materials in Southern California: Alluvial Deposits. U.S. Geologic Survey. Electronic document, http://geomaps.wr.usgs.gov/archive/scamp/html/scg_surf_alluv.html, accessed June 20, 2018.

Stewart, J. D.
2012 *Draft Paleontological Resources Delineation Work Plan*. URS, Project No. 27652105.00505. Prepared for Rio Mesa Solar I, LLC, and Rio Mesa Solar II, LLC.

Stone, P.
2006 *Geologic Map of the West Half of the Blythe 30' By 60' Quadrangle, Riverside County, California, and La Paz County, Arizona*. Scientific Investigations Map 2922. U.S. Geological Survey, Menlo Park, California.

Stone, Paul, and G. J. Pelka
1989 *Geologic Map of the Palen-Mccoy Wilderness Study Area and Vicinity, Riverside County, California*. Miscellaneous Field Studies Map No. 2092. Scale 1:62,500. U.S. Geological Survey, Washington, D.C.

SWCA Environmental Consultants (SWCA)
2011 *Paleontological Resource Assessment for the McCoy Solar Energy Project, Riverside County, California*. SWCA Environmental Consultants, Pasadena, California. Prepared for AECOM and McCoy Solar, LLC.

Mitigation Measures

Preconstruction Phase Measures

Mitigation Measure 1

The services of a qualified professional paleontologist shall be retained prior to earthmoving activities associated with construction in order to carry out an appropriate mitigation program (a qualified paleontologist is defined by SVP [2010] as an individual with an M.S. or Ph.D. in paleontology or geology who is familiar with paleontological procedures and techniques and techniques, is knowledgeable in the geology and paleontology of the region, and who has worked as a paleontological mitigation project supervisor in the region for at least 1 year). The qualified professional paleontologist shall develop a site-specific Paleontological Resource Mitigation and Monitoring Plan for review and approval before implementation during construction activities. The plan shall specify the level and types of mitigation efforts, based on the types and depths of earthmoving activities and the geological and paleontological settings of the project area. The paleontological resource mitigation plan will provide a research design that will guide any testing programs and proposed field and laboratory methods, as well outline reporting methods, plans for preparation and curation of collected materials, and a schedule for completing the proposed work. The plan should include the professional qualifications required of key staff, monitoring protocols, provisions for evaluating and treating sites discovered during earthmoving activities, and reporting requirements. If artificial fill, significantly disturbed deposits, or younger deposits (too recent to contain paleontological resources) are encountered during construction, the project paleontologist may reduce or curtail monitoring in the affected areas after consultation with the project proponent, BLM, and the County, as applicable.

Prior to the start of construction, the qualified professional paleontologist shall develop and present a paleontological sensitivity training program. This training program will be provided to all project-related workers and will address the significance and importance of paleontological resources, the potential to encounter paleontological remains during earthmoving activities, and the legal obligations related to preservation and protection of fossil resources. Reporting procedures for discovery of unexpected paleontological resources during project activities also will be provided during worker paleontological resource sensitivity training.

The qualified professional paleontologist should also attend any preconstruction meetings to consult with grading and excavation contractors concerning excavation schedules, paleontological field techniques, and safety issues. Communication protocols will be established to ensure that all relevant earthmoving activities are monitored and assessed to comply with the paleontological resource mitigation plan.

Mitigation Measure 2

A short preconstruction survey will be required before earthmoving activities to recover all scientifically significant paleontological remains discovered within the project area during the paleontological field survey discussed within this report. These include the fossil horse teeth and *Lepus* dentary (Localities SRI-VP-20180002, SRI-VP-20180008, and SRI-VP-20180024; see Chapter 6 and Appendix E). Upon collection, these paleontological resources will be prepared to the level required for acceptance at an appropriate public, nonprofit scientific institution with permanent paleontological collections (e.g., The Western Science Center). The specimens will then be curated and deposited within the repository, along with any relevant field notes, photographs, and reports.

Construction Phase Measures

Mitigation Measure 3

A qualified professional paleontologist or paleontological monitor should be onsite at all times during the original cutting of previously undisturbed deposits of high paleontological resource potential (SVP 2010) or PFYC Class 3 or higher (e.g., old terrace deposits, stabilized alluvial-fan deposits, and stabilized aeolian and dune deposits) to inspect exposures for contained fossils. Units assigned to PFYC Class 3 may be spot checked, whereas those assigned to PFYC Class 4 or higher require full-time monitoring during all earthmoving activities. A paleontological monitor is defined as an individual who has experience in the collection and salvage of fossil materials. The paleontological monitor will work under the direction of a qualified professional paleontologist. Monitoring will entail visual inspection of active or recently active construction areas. Because of the potential for recovering small fossil remains (isolated small mammal teeth, foraminifera, otoliths, etc.), onsite screen washing may be required at the discretion of the paleontological monitor or qualified professional paleontologist.

If paleontological resources are discovered during construction, the monitor will have the authority to temporarily divert or direct earthmoving activities in the immediate vicinity around the find until they are assessed for scientific significance and recovered (i.e., collected). Often, fossil salvage will be completed relatively quickly. However, some fossil specimens (e.g., large skeletons) may require an extended salvage period. Such extended salvage activities rarely (if ever) stop construction activities at a project site but may require some period during which construction activities in the immediate area are redirected.

Paleontological resources collected during monitoring will be prepared in a properly equipped fossil-preparation laboratory. Preparation will include the removal of rock matrix from fossil materials, as well as the stabilization, consolidation, and repair of specimens, as necessary. Fossil preparation will be done to the point that specimens are ready for curation. Specimens will be identified to the finest taxonomic level that is reasonably possible before being sorted and cataloged as part of the mitigation program.

Once prepared, fossils should be deposited (as a donation) in an appropriate public, nonprofit scientific institution with permanent paleontological collections, along with copies of all pertinent field notes, photographs, and maps. The cost of curation and accession of fossil specimens into such a repository will be the responsibility of the project owner and is required for compliance with the mitigation program.

Postconstruction Phase Measures

Mitigation Measure 4

Following the conclusion of all monitoring, laboratory work, and curation, a final summary report will be completed that describes the results of the paleontological resource mitigation program. This report will include an overview of the methods and procedures used during the mitigation program, will describe the stratigraphy exposed and fossils collected during construction activities, and will discuss the significance of recovered fossil finds. If monitoring efforts during the monitoring program produced fossil remains, then a copy of the final report will be provided to the designated scientific institution where the fossil specimens were deposited.