CONFIDENTIAL

BURIED SITE SENSITIVITY STUDY FOR THE PHASE 1 AREA OF THE TAPESTRY PROJECT, HESPERIA, SAN BERNARDINO COUNTY, CALIFORNIA

USGS Hesperia, CA 7.5' Quadrangle
USGS Silverwood Lake, CA 7.5' Quadrangle

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INTRODUCTION

This report describes the sensitivity for buried prehistoric resources within the Phase 1 portion of the Proposed Tapestry Specific Plan Project (Project) in the City of Hesperia, San Bernardino County, California. The result of this study is a model delineating sensitivity units within the Project that describe the potential for finding buried prehistoric archaeological sites. This model is based on available geologic literature, geologic maps, soils maps, aerial images, known prehistoric sites, and USGS 7.5-minute quadrangles. No fieldwork or subsurface testing was conducted to improve the accuracy of or validate the conclusions of the model. As such, the conclusions are solely derived from and as accurate as boundaries on available soils data and geologic map products. However, the results of the Phase I archaeological survey and Phase II evaluation were incorporated into this analysis.

SOURCES CONSULTED

Sources consulted for this study include the Geologic Map of the San Bernardino and Santa Ana 30 x 60' quadrangles produced by the U.S. Geologic Survey (Miller and Morton 2006). Soils data include geographic information system data downloaded from the Web Soils Survey Website (http://websoilsurvey.sc.egov.usda.gov/App/ HomePage.htm). Soil description data were obtained from the Online Soil Description website (OSD) (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053587). Topographic and geographic data depicted on the Hesperia (1956-photorevised 1984) and Silverwood Lake (1956-photorevised 1988) 7.5' USGS quadrangles were also consulted. Archaeological data were obtained from the Phase I survey (Clark and McDougall 2014) and Phase II testing and evaluation report (Potter et al. 2014).

GEOLOGIC AND ENVIRONMENTAL SETTING

The Project site is located along the northern front of the San Bernardino Mountains southwest of the confluence of the West Fork of the Mojave River (West Fork) and Deep Creek. Specifically, it is located on a geologic formation informally known as the Victorville fan. The Victorville Fan is a northeast-sloping alluvial fan that formed between 1.7 and 0.5 Mega annum (Ma) (Early to Middle Pleistocene) (Miller and Morton 2006). The original sediment source for the fan was in the San Gabriel Mountains, but due to movement along the San Andreas Fault, the fan is now located north of the San Bernardino Mountains. Unlike most alluvial fans, the Victorville Fan was cut off from its mountain headwaters sometime between 0.78 and 0.5 Ma (Enzel et al. 2003). At this point, deposition of new sediment on the fan ceased and a regime of sediment recycling and down-cutting ensued (Enzel et al. 2003).

As discussed in Waters (1992), alluvial fans form at the point where streams emerge from mountain valleys. In arid regions, such as the Project area, deposition is spasmodic instead of continuous due to the pattern of brief intense precipitation events. They typically form through two processes, including gravity induced mass-wasting and streamflow in gullies. Mass wasting occurs in catastrophic flow events where water-saturated debris moves rapidly downslope depositing several meters of material in a matter of minutes. Streamflow consists of gully channels entrenched into the upper and middle segments of a fan where coarse sand and gravel deposition is common. Gully-mouth sheet flow deposits form at the mouth of these gullies on the lower portions of the fan, depositing finer sediments. The locus of deposition on a fan is constantly shifting, leaving large areas stable for thousands of years and permitting the development of lag deposits through deflation and the formation of soils.

The Project site is bounded on the south by the West Fork, on the east by the Mojave River, on the north by Antelope Valley, and several miles to the west by Summit Valley as depicted on the Baldy Mesa and Cajon, 7.5-minute USGS quadrangles. The landform generally consists of a series of flat-topped hills separated by a series of streams and their associated drainage networks. The landform becomes much more dissected to the west. Within the Project area, two major higher order washes are cut into the fan surface about 25 to 45 meters (80 to 150 feet) deep. The stream bottoms are between 70 and 170 meters (230 to 550 feet) wide and the active channels meander through the valleys. Abandoned channels and braided networks of channels are present in the valleys, indicating active stream processes.

Geologic Formations

Three geologic units are mapped within the Project area (Figure 1) consisting of very old alluvial-fan deposits, younger alluvial-fan deposits and younger reworked wash sediments derived mainly from the fan. The very old alluvial-fan deposits are consolidated silt, sand, gravel and conglomerate. Sediments typically are medium to dark reddish-brown sandstone moderately to well-consolidated in places. The surface of this unit is moderately deflated and dissected by small washes draining into the two main east-northeast trending streams. Coppice dunes and small sand sheets are present where sources of sand are available. Cobbles outcrop on side slopes where the fan is incised. Very old alluvial-fan deposits are primarily found in the southern part of the Project area in sections 9, 10, 11, 15 and 16, as seen on Figure 1; however, they do extend to near the northern extent of the Project in sections 2 and 3.

The young wash deposits (Unit 1) described by Morton and Miller (2006) date to the early Holocene and late Pleistocene and are unconsolidated to slightly consolidated silt, sand, and coarse-grained sand to cobble alluvium. Well-defined terrace rises are commonly formed within in the unit, and are often truncated. Unmapped very young to active wash deposits make up the axis of the stream valley. These deposits are found in the two east-northeast trending streams.

The young alluvial-fan deposits (Unit 3) date to the middle Holocene and are relatively uniform medium-brown silt and sand containing sparse granule and pebble lenses and scattered, matrix-supported, pebble-sized clasts. Fan surfaces are slightly to moderately dissected and, in places, show low amplitude rolling surfaces having swales and ridges parallel to axes of fans (Morton and Miller 2006).

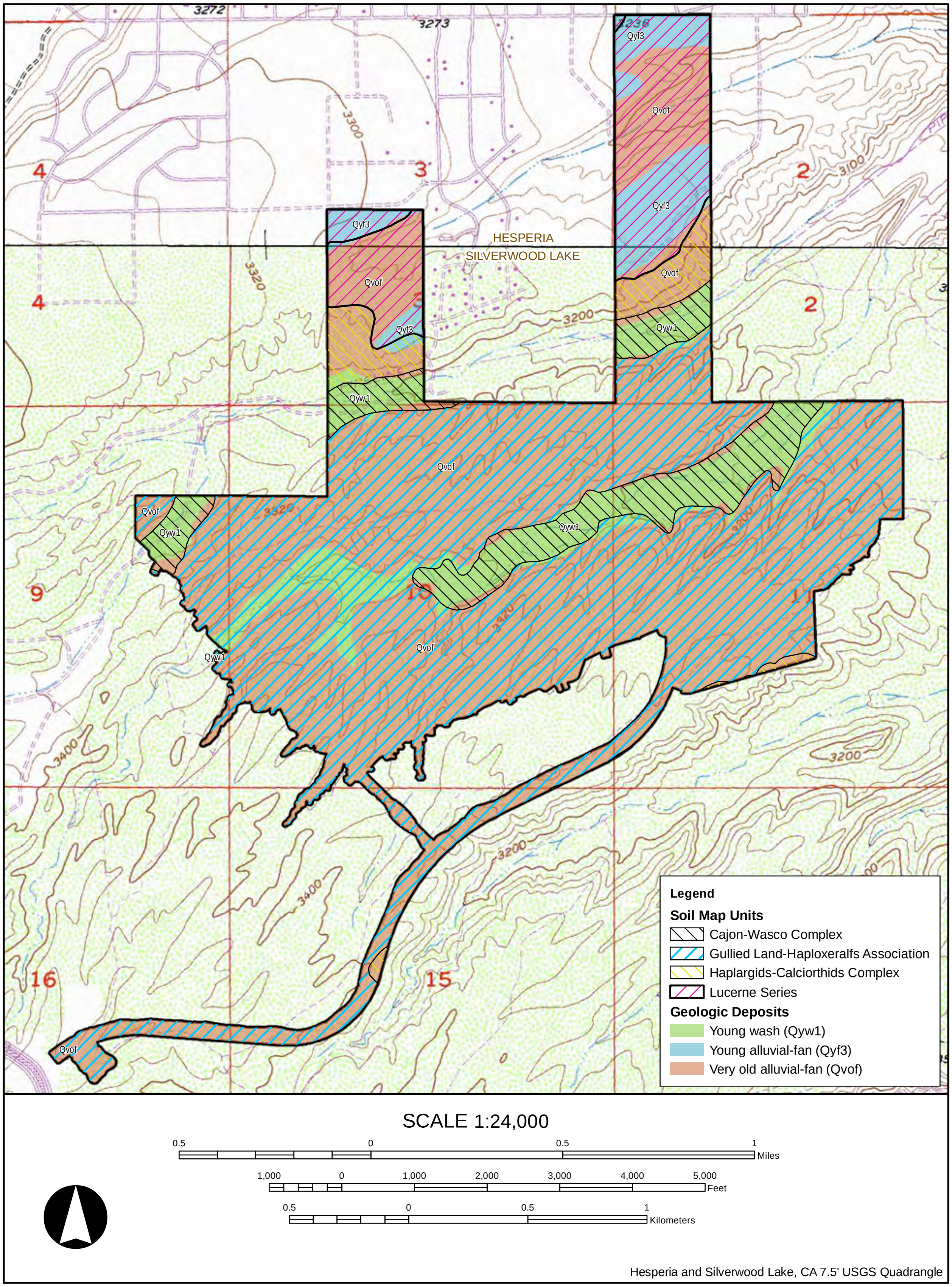

Figure 1 Geologic and soils map units within the Project area.

The northern portion of the Project area, in Sections 2 and 3 (see Figure 1), is mapped geologically as bands of young alluvial-fan deposits and old fan sediments. The young alluvial-fan deposits seem to be sourced from the ancestral course of Antelope Creek and were deposited on top of the very old alluvial-fan deposits. These young alluvial-fan deposits were laid-down on top of the very old alluvial-fan deposits as gully-mouth sheet flow consisting of large lobes and are part of middle Holocene fan building processes. After deposition of the young alluvial-fan deposits, the down-cutting of Antelope Creek cut off the source of new sediment for this area leaving the young fan sediments as exposed deflating hills. Very old alluvial-fan deposits are exposed on the side-slopes of washes cut into the young fan sediments in this area.

Soil Types

The use of soils in developing the buried site sensitivity model is important in that soils generally take a long time to form, especially in arid regions such as the Project area, and this data can be used to infer the stability of the landscape and age of strata. However, it is important to note that soils will form faster in optimal climactic conditions, which include increased moisture, and more slowly in poor climactic conditions (Birkland 1984). With inconsistent weather altering soil formation conditions, the level of soils development can only be used as a relative dating method. Soil features in aridic climates used to estimate relative age include argillic horizons, which are accumulations of clay within a specific layer, the presence and thickness of rinds on cobbles, level of rubification (accumulation of iron oxides on stone surfaces or in soil causing a red color), and accumulations of calcium carbonates. Argillic horizons, commonly observed in the Project area, may take as little as several thousand years to form, but may take much longer (Birkland 1984).

There are four soil units that have formed within the geologic strata deposited within the Project area. In addition to geology, Figure 1 also depicts the location of soils within the Project area. Soils present include a unit classified as a Gullied Land-Haploxeralf Association, the Lucerne Series, the Cajon-Wasco Complex, and Haplargids-Calciorthids Complex (Soils Survey Staff 2014) (Figure 1). A series is a group of soils that have horizons similar in arrangement and a relatively narrow range of properties. Soil complexes and associations generally consist of two or more dissimilar components, such as a series, that occur at regular repeating patterns throughout a map unit. Major components are sufficiently different in characteristics that they cannot be singly classed as one soil series. Associations differ from complexes in that the components of an association are typically larger in area than those of soil complexes (Soil Survey Staff 1993).

The soil formed on the southern part of the Project area, which includes portions of sections 9, 10, 11, 15 and 16, is classified as a Gullied Land-Haploxeralf Association. Thus, as an association, large patches of area consist of dissected gullied land or areas classified as Haploxeralf. Haplozeralf is a soil that formed in a xeric moisture regime with an argillic horizon usually in sediments deposited during the Pleistocene (Soil Survey Staff 1999). This classification suggests stability of the surface within this unit as argillic horizons take a long time to form.

Soils formed in the two areas that were mapped by Morton and Miller (2006) as young wash deposits are classified as the Cajon-Wasco soil complex. As a complex, characteristics of both soil series are present in the mapped unit as a mosaic of small repeating patches (Soil Survey Staff 1993). Both series within this complex form in sediments derived from igneous and sedimentary rock sources and form on flood plains and washes within alluvial fans (Soils Survey Staff 2013). This complex is classified as a combination of Torripsamments (Cajon Series) and Torriorthents (Wasco Series). Torripsamments are sandy soils derived from granitic sources and form on stable surfaces, sand dunes, and moving surfaces and are found in the stream bottoms. Torriorthents form in dry arid regions, are slightly calcareous, are found on the side-slopes of streams where there is little accumulation of organic carbon. As classified, the soils in the stream are moderately young to older and generally lack stability while soils on the slopes have accumulated minerals and are older and more stable (Soil Survey Staff 1999). In the case of the Project area, a pattern exists in which Wasco makes up the side slopes of the two washes and Cajon makes up the wash bottoms and wash terraces. The base of the wash, therefore, typically consists of a less stable environment, while the slopes are more stable allowing for the formation of precipitated minerals.

Most of northernmost extent of the Project area, located in Sections 2 and 3, is mapped as Lucerne soil series, which are commonly found throughout the Mojave Desert geomorphic province. This series forms in alluvium derived primarily from granitic sources. Geologic maps (Morton and Miller 2006) indicate that the underlying geologic source materials are very old alluvial-fan deposits dating to the middle Pleistocene and young alluvial-fan (Unit 3) deposits dating to the middle Holocene. Lucerne soils support Joshua tree, Mormon tea, buckwheat, cholla, annual grasses, and forbs. Older buried horizons are commonly found within this series (Soils Survey Staff 2014).

Lucerne soils are Aridisols, which are soils that form in dry climates where water is generally not available during seasons when plant growth occurs and, therefore, they lack the formation of accumulated organic matter (Soils Survey Staff 1999). Lucerne soils are further defined as Argids, which characterizes the soils as having an accumulation of clay. In this case, clay films and bridges can be observed in the interstices of structural units, on cobble and pebble faces, and on sand grains (Soils Survey Staff 2013). The accumulation of clay in this manner indicates a reasonable level of stability within the soil unit.

The Haplagid-Calciorthid complex soils are found on sloping surfaces associated with the wash transecting the northern part of the Project area and they occupy a small percentage of the total Project surface area. They are associated with very old alluvial-fan sediments. Haplagids have an argillic horizon and commonly have calcium carbonate accumulations within or below the argillic horizon and form on late Pleistocene surfaces. They occur only in desert environments and are very old (Soil Survey Staff 1999). Calciorthids are deep soils with no groundwater, have a calcic horizon and a high salt level. They are typically found on steep slopes and are associated with side slopes of the wash.

Geomorphic Processes

A number of geomorphic processes have been occurring throughout the Holocene period on the upper fan surface. Deflation is a process by which the wind removes smaller particles from the surface leaving larger ones behind and is most effective on sand grains. Smaller particles such as clay require great velocities to break the cohesive forces aggregating particles, while larger particles require greater force to move their higher mass (Huggett 2003). This process is augmented by sheet wash and the down cutting of small gullies where water aggregates and, combined, these processes are actively lowering the upper fan surface. Sediments are actively moving from the upper portions of the fan into the higher order streams and ultimately the Mojave River. This process is also occurring in the northern part of the Project in Sections 2 and 3, but to a lesser extent. The resultant surface at the higher elevations of the Project area is a series of small parallel gullies dissecting the landscape separated by low interfluvial ridges.

RESULTS

Sensitivity was derived by examining the age of sediments based on geologic map and soils map units, stability based on soils map units, and geomorphic processes as inferred from areal images, topographic maps, geologic map units and soils data. Landform data, specifically related to the conditions on the Victorville fan, were also used to construct the model. Combining these data, three general sensitivity units were defined for the Project area. Defined units include *Low to No*, *Low*, and *Moderate* sensitivity. No areas of high sensitivity for buried prehistoric sites were identified in the Project area. Sensitivity units are defined in Table 1. Figure 2 shows the location of sensitivity units in the Project area.

Table 1 Sensitivity Units in the Phase I study area.

Sensitivity	Description
Low to No	Underlying sediment deposited prior to human occupation of the area. Actively eroding surface. Only potential for buried sites limited to shallow eolian surficial deposits. Found throughout the Project area. Depicted as Areas 1 and 3 on Figure 2.
Low	Located in the northern-most area of the Project area. Underlying sediment deposited mid-Holocene then stabilized and eroded. There is potential for buried sites but they may be deeper than Project impacts, in secondary context, or too sparse to detect. Depicted as Area 4 on Figure 2.
Moderate	Located in the central part of the Project area. Younger stream valley sediments with active wash and terraces. Active sedimentary system transporting sediment from highlands to Mojave River. Geomorphic processes may cause the burial and preservation of sites as easily as they may cause the erosion of them. Depicted as Area 2 on Figure 2.

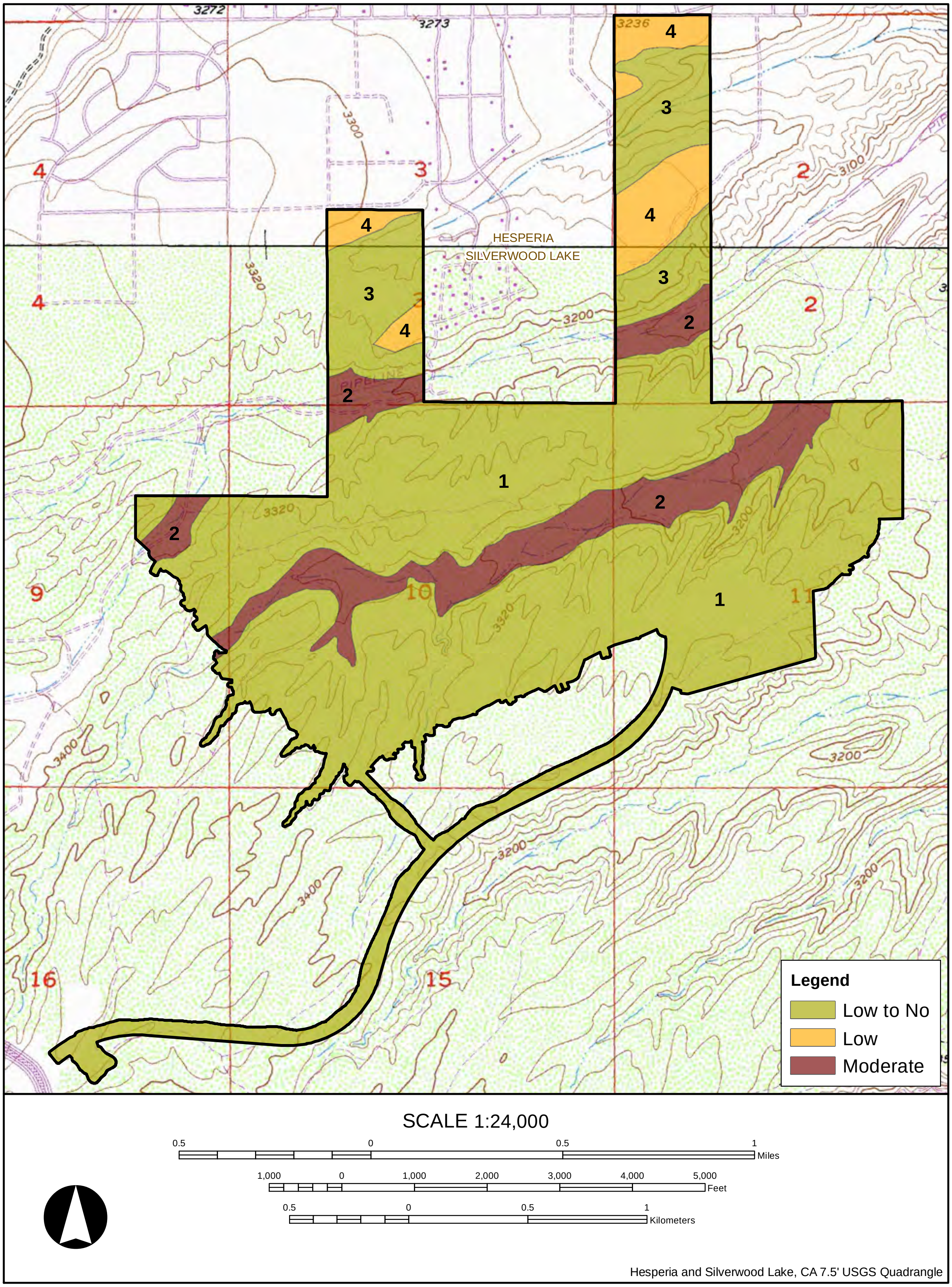

Figure 2 **Buried archaeological sensitivity.**

Low to No Sensitivity

Areas of low to no sensitivity are located in the higher elevations of the Project area (depicted as Area 1 on Figure 2). In this area, there is very little accumulation of new sediments. Active geomorphic processes have been deflating the area throughout the Holocene. Therefore, the likelihood of buried sites in the upper portions of the Project area is very low. Bioturbation and localized deposition of gully sediments may shallowly bury artifacts or portions of archaeological sites, including those dating to the historic period. Also, eolian processes may bury small portions of surface scatters of artifacts. However, due the age of sediments making up the landform and the stability of the soils that have formed here, there is nearly no potential for buried prehistoric archaeological sites.

The Phase I archaeological survey of the area resulted in the documentation of numerous surface scatters of lithic artifacts and a few small possible campsites in the higher elevations of the Project area (Clark and McDougall 2014). Phase II archaeological testing, consisting of the excavation of shovel probes, was undertaken at a sample of these sites (Potter et al. 2014). In most cases, excavation was shallow and was terminated at argillic horizons consisting of hard and compact red sediments. All artifacts discovered were on or near the surface corroborating the above assertion of nearly no potential for buried sites.

There is very low to no likelihood of finding buried prehistoric resources in the very old alluvial-fan sediments in the northern Project area (depicted as Areas 3 on Figure 2). The deposits are generally actively eroding into the creek and out to the Mojave River although to a lesser degree than in the southern part of the Project area. Bioturbation and eolian processes may bury artifacts, but in most cases cultural deposits would be shallow.

Low Sensitivity

As discussed above, the young alluvial-fan sediments in the northern part of the Project area (Sections 2 and 3) overlie very old alluvial-fan deposits. The very old alluvial-fan surface was exposed for several thousand years during the early Holocene. It is possible that this surface was used by prehistoric peoples. During the middle Holocene, this area became a locus of deposition, burying this former surface. However, it is not possible based on geologic and soils data to infer the condition of the buried surface. It is possible that many meters of this surface were scoured away at the time of deposition and sites present (if any) were translocated into the Mojave River.

Once Antelope Creek down-cut deep into the fan, this area ceased to receive new sediment and became stable. Soils formed and the surface began deflating. As such there is the possibility for finding buried prehistoric sites at the contact between the two geologic units and buried within the young alluvial-fan deposits. However, because the conditions of the buried contact are unknown, the sensitivity for this area is low. Further, the young fan sediments are classified as low sensitivity because sites may have been washed away during deposition of the fan sediments, and the depth of the young alluvial-fan sediments is unknown and may exceed the depth of the Project excavations.

The surface of the young fan deposits, located in Sections 2 and 3 (depicted on Figure 2 as Area 4), appears to be less susceptible to ongoing geomorphic processes observed further south and at higher elevations (Sections 9, 10, 11, 15, and 16). The surface of this area is less dissected by small creeks exposing fewer cobble outcrops along the shoulder slopes that flank gullies. Instead, the surface consists of low amplitude rolling surfaces having swales and ridges parallel to the axis of the fan. Soils data indicate that argillic horizons have formed in both geologic units indicating some surface stability for several thousand years further affirming the low potential for buried sites.

Surface site density in this area is much lower than the higher elevations farther south, most likely due to fewer exposures of cobbles. Also, according to Morton and Miller (2006) the young fan deposits contain fewer cobbles and other raw lithic materials. Bioturbation and eolian processes may bury artifacts or small portions of sites. However, these processes are unlikely to have resulted in deeply buried prehistoric site in this area.

Moderate Sensitivity

The most active section of the Project area is the two streams incised into the fan carrying sediments from the upper fan surfaces into the Mojave River (depicted as Area 2 on Figure 2). A narrow active wash meanders through the valley and small terraces are situated on the side. The actively eroding upper surfaces are constantly providing new sediment to the active washes and floodplains of these streams. As a result some surfaces in the stream valley are aggrading. Likewise, portions of the valley are also down-cutting as the stream is actively moving sediments out to the Mojave River. When channels become entrenched, higher terraces become stable offering protected locations for habitation by prehistoric people. Some of these terraces may be stable for thousands of years and then could be buried by sediments moving down the slopes into the stream system. The depositional system in the stream valleys is largely controlled by conditions in the Mojave River over that last several thousand years. As the elevation of the Mojave River changes, portions of the stream valley will switch from deposition to erosional environment. As such, this area is the most likely section to find buried prehistoric sites and is moderately sensitive for buried prehistoric sites. The active processes occurring in this area may cause disturbance to sites as well.

CONCLUSION AND RECOMMENDATIONS

When developing buried site sensitivity models for a particular area, a number of factors need to be considered to determine sensitivity. These include the geomorphological factors of energy of deposition and age of deposition, and the cultural factor of suitability or attractiveness. Current surface and environmental conditions and the results of previous survey work indicate that recent (or late) prehistoric exploitation and use of the southern two-thirds of the Project area was extensive. This area was exploited as a lithic procurement and processing area for the cobbles found outcropping on drainage slopes. Several short term occupation sites were also identified. Since the geomorphic environment mostly precludes the accumulation of sediments, the entirety of cultural deposits in this area will be found on the surface.

In the stream valleys, which transect this region, sediments from the highlands are actively being transported to the Mojave River. Here, processes supporting both the accumulation and erosion of sediments are occurring. As a result of this system, there is the possibility of buried sites in the landform; however, these processes can also wash away and damage site integrity. Because site density in the local region is high, there is a strong possibility of prehistoric use of the stream valleys. However, this area is only classified as moderate sensitivity for buried resources because the geomorphic processes can preserve or be destructive of cultural deposits.

In the northernmost portion of the Project there are very old sediments that are actively eroding; however, not all sediments were deposited prior to the humans entering the region. These sections, deposited in the mid-Holocene period may have the potential to bury early Holocene period cultural deposits. However, these areas are classified as low sensitivity because few sites have been identified in the area during the Phase I archaeological survey and the depth of the deposits most likely exceeds the depth of Project impacts. Also, these deposits are higher energy deposits and surface cultural deposits may have been transported into secondary contexts during deposition.

A buried site testing (BST) program is recommended within Project impact areas classified as moderately sensitive prior to Project construction. BST is a means of determining the presence or absence of subsurface prehistoric sites. Proper implementation of a BST program may reduce the need for monitoring and prevent costly delays caused by discoveries during Project construction. BST involves the excavation of trenches to the depth of proposed Project impacts or the underlying very old fan sediments. A sample from each trench will be screened and examined for the presence of prehistoric artifacts and a qualified archaeologist will monitor trench excavation for the presence of cultural features, buried soils, and other indicators of archaeological sites.

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