Journal of California and Great Basin Anthropology | Vol. 38, No. 1 (2018) | pp. 31–49

Water and Infrastructure as Resources for Native Californians within the Mission Landscape at San Luis Obispo

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Recent archaeological investigations near Mission San Luis Obispo encountered a zanja *(irrigation ditch) and associated terracing within the larger mission landscape. Native Californian practices persisted through the mission period—incorporating new technologies and new food sources—and using those new technologies to build upon existing social structures. In the process, native groups and individuals actively controlled some of the land use within the mission setting, as well as the products of that land use. Previous investigations of this and other California missions acknowledge the importance of native labor, but typically frame discussion of the infrastructure as part of the larger colonial institution. Recent findings have prompted the authors to reconsider water and infrastructure as part of the native landscape within the mission system at San Luis Obispo.*

Many historical and archaeological studies have looked at the water systems at California's missions, but typically have done so within the Spanish colonial framework. The role of water systems is generally highlighted for their significance in providing drinking water to mission residents and delivering water to feed ditches for the agricultural fields, orchards, and industries (e.g., Allen and Felton 1998). From this point of view, the missions are considered primarily as agricultural and industrial complexes. Historian Edith Webb (1952, republished in 1982) astutely observed that while mission fathers and artisans may have designed the various components of the mission landscapes, it was Native Californian labor that constructed the buildings, industrial areas, agricultural fields, and orchards. She also noted that the water system made it all possible. Native residents of the missions provided agricultural labor, and in the process, learned to be adept farmers.

Recent archaeological findings in San Luis Obispo expand this view, by considering native influences on the creation of native living and work spaces within the mission system, as people adapted part of the mission's water conveyance infrastructure for their own uses. Allen (1998) posited that a native economy and value system actively operated within the larger colonial mission, and noted the persistence of many native cultural traditions. Recent publications by Panich and Schneider (2014; 2015) expand upon this idea, and encourage scholars to reconsider California's early historic-period settlements as places of native occupation rather than simply as colonial spaces. Most missions were built near (or in some cases on) pre-mission-period village sites, which in turn were built near convenient sources of water. With their knowledge of locale, topography, and natural waterways, Native Californians of course had a profound effect and influence on how spaces within each mission landscape were used and shaped.

Hauser (2017) recently published an article on water systems at two eighteenth-century Caribbean plantations. His focus on these and on the role of "water ways" combines the archaeological and documentary record of objects used to control and transform water, and shows how that relates to the social structure and politics of enslaved laborers. Hauser notes that the documentary record focuses on the use of water as infrastructure for the industry of the plantations. The documentary record reflects "those who had the power and means to shape it." Archaeological evidence, although incomplete and fragmentary, teases out the uses of those who labored in the fields. Hauser (2017:253) envisions turning the documentary statements around, and using the "messy" archaeological fragments to seek new information and ask new questions about how water was used in a colonial setting.

Consideration of the "water ways" at Mission San Luis Obispo raises many of the same queries. As the text below demonstrates, the water system at the mission was of primary importance to the colonial settlement, and it was critical to the functioning of the mission as an agricultural landscape. At the same time, the redirection of water and its effect on the larger mission landscape also offered native laborers and residents a known but transformed resource for continuing native food and medicinal traditions. As archaeological evidence of water conveyance is often ephemeral, intermittent, and "messy," we also describe the methodology used to discover, describe, and record the overall system.

DOCUMENTED CALIFORNIA MISSION WATER SYSTEMS

The control of water sources, and the ability to direct and redirect water, made possible the construction of all twenty-one of the Franciscan missions in Alta California. Table 1 summarizes many of the comparative water-system studies completed at other California mission sites, which were reviewed to better describe the structure and purpose of the water conveyance system found at the site in San Luis Obispo. For the purposes of this study, a manuscript written by Edna Kimbro (1997) as part of the larger documentation of the Mission San Antonio water system provided the most historically researched Spanish terms used for irrigation. Many of these archaeological reports also contain the dimensions and physical attributes of the various parts of the water systems—the dams, aqueducts, and irrigation ditches.

Mission documentary records (such as mission annual reports, priests' letters to one another, and visitor accounts) do not typically detail how water moved from one place to another within each mission, but such records often remark upon dams (*presas*), mill buildings (*molinos*), and main aqueducts. *Acueducto* is the Spanish term for aqueduct, generally meaning a long, narrow stone channel for conveying water, often elevated, and supported by columns and/or arches. The term *acueducto* generally refers to the main canal present, and the primary source of drinking water. Within the California mission layout, *acueductos* also characteristically lead to the area of the *lavanderia* (laundry, wash basin), fountains, and living quarters for the mission priests. The construction of the main aqueduct, along with their reservoirs and settling tanks (for drinking water), was an important component in the building of the mission infrastructure.

While the construction of the dam(s) and the main aqueduct is typically noted in the documentary record, discussions of the extensive networks of lateral and sub-lateral water conveyance features that reached the fields and orchards do not often appear, although there are exceptions. At Mission San Antonio, for example, the mission fathers discussed the construction of a *zanja* (irrigation ditch) in one of their annual reports (Kimbro 1997:1–2). In California, the Spanish term *zanja* generally seems to refer to a ditch, which can be simply an earthen channel dug into the ground or a low-profile stone-walled and tile-lined feature. *Zanjas* tend to be wider, for carrying more water to suit agricultural needs, or for channeling water to mills. (Note that the term *acequia* is similar to *zanja*, but seems to specifically mean a ditch for irrigation to orchards and agricultural fields; this term is even less frequently used in California documentary records, but is used more often in New Mexico and Arizona.) The trajectories of lateral ditch systems from the main aqueduct are often unclear in both the documentary and archaeological record, mostly appearing as ephemeral and intermittent features in both sources of information.

Table 1

HISTORICAL AND ARCHAEOLOGICAL DESCRIPTIONS OF WATER SYSTEMS AT OTHER MISSION SITES IN CALIFORNIA

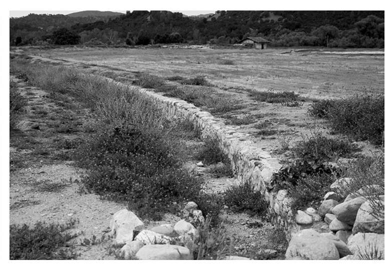
Mission	Reference	Topics of Study
La Purisima	Guy F. Warren (1934). Excavation Notes of Water Lines, handwritten manuscript.	Contains details of main aqueduct line leading from reservoir. Includes map of reservoirs and water conveyance, drawings of flat quarried rock and mortar aqueduct, with tile-lined floor, distribution box, tile pipes, settling tank, round and square reservoirs.
	Fred Hageman (1940)	Architect's memo on reconstruction recommendations. Overview of the water source, reservoirs, aqueduct, spring house, tile piping, fountains.
	William Kenyon (1946)	Memo on reservoir construction. Circular cistern, 31 ft. diameter. Height, 7 ft. Rocks, stones, broken brick [tile?], lime mortar. "Lime plaster coat to smooth the sides, with another coast of a red plaster on top of this." Refers to red plaster as "of a more durable nature."
	California Division of Beaches and Parks (1963)	Use of inmate labor to uncover approximately a half-mile of main aqueduct line from reservoir to Mission area. Following notes from earlier CCC report. Restoration occurred. Tile pipeline leading from reservoir/settling tank. Aqueduct rock and mortar sidewalls, with tile-lined bottom. Portion of the aqueduct line was a flume made of redwood planks to carry the aqueduct over the flood channel.
	Hageman and Ewing (1991)	Short discussion of the "Important Structures of the Water System," (124-125). Includes mention of fountain, masonry aqueduct, reservoir. Figures include fountain, *lavanderia* (laundry, wash basin), aqueduct, spring house, and "open irrigation aqueduct."
San Antonio	Smith (1932)	Historic account of Mission, and its many buildings.
	Jones et al. (1997)	Historical and archaeological evaluation of water system. Overview of water system, including aqueduct and irrigation ditches, with detailed documentation of specific components. Review of historical and previous archaeological documentation. Appendix I, compiled by Edna Kimbro, notes use of term *zanja* for irrigation ditch. Appendix II by PHR Consultants also differentiates between irrigation ditches and aqueduct. Currently, the mill and mill race (below left), portions of the aqueduct, and ditches (below, right) are still visible today. Note the use of cobbles, and flat-bottom channels, with incorporation of tiling and tile fragments. (Photos by R. Allen.)  
Santa Barbara	Imwalle (1996)	Overview of Mission Canyon Dam (CA-SBA-1963H) and Mission Canyon Aqueduct (CA-SBA-1852H). System complex, with two aqueducts, several reservoirs, filter, fountain, *lavanderia*. Two water sources and dams, associated with Mission Canyon and Rattlesnake Canyon.
	Allen and Felton (1998)	Water system overview of Santa Barbara Mission, including review of historic documentation of the water system. Discussion and documentation of the main components of the water system, including dams, filter houses, fountain, *lavanderia*, lined irrigation ditches, tanning vats, grist mill, reservoirs, raised masonry aqueduct.
San Buenaventura	Foster and Greenwood (1989); Greenwood and Gesler (1968)	Portions of the Mission San Buenaventura aqueduct in Weldon Canyon and closer to the church and quadrangle.
San Diego	Green (1933)	Manuscript on dam and irrigation system.
	Snell (1964)	The dam associated with this mission is a National Historic Landmark. The National Register nomination (Snell 1964; updated in 1983) notes that vandals destroyed the "ruins of the aqueduct."
San Gabriel	Dietler et al. (2015)	Discussion of water system, including earth ditches and aqueduct. The focus was on the mission's garden area, mill and millrace, reservoirs, and a possible granary.
Santa Ines	Hoover (1992)	Discussion of the mill complex and associated water feeds.
	Costello et al. (1998)	National Historic Landmark nomination of the larger Mission Santa Ines landscape.
	EAST (2003)	Environmental and Spatial Technologies (EAST) class at Santa Ynez Valley Union High School, directed by historians and assisted by archaeologists. This was an effort to map the water system at Mission Santa Ines.

Table 1 (*Continued*)

HISTORICAL AND ARCHAEOLOGICAL DESCRIPTIONS OF WATER SYSTEMS AT OTHER MISSION SITES IN CALIFORNIA

Mission	Reference	Topics of Study
San Jose	Thompson and Galvan (2007) (Image courtesy of A. Galvan)	Excavations at St. Joseph's Rectory draft report includes short discussion of aqueduct segments found in archaeological contexts, and archaeologically documented mission dam. Described as a linear alignment of two courses of mortared locally obtained sandstone and limestone cobbles, with the channel of the aqueduct lined with rectangular mission period tiles, the top of which was capped with larger sandstone and limestone cobbles. Note the narrow channel and capping of aqueduct. 
	Allen et al. (2018)	Primarily an overview of Mission-related Native American housing, but includes mapping of the overall Mission landscape as partial mitigation.
San Luis Rey de Francia	Soto (1961)	Soto described the *lavanderias* and the aqueducts that fed them, as well as the some of the restoration efforts of Father O'Keefe, beginning in 1893, as well as the research of Edith Webb. Currently, much of the water system at Mission San Luis Rey is available for visitor viewing, including a cobble and tile aqueduct that fed the *lavanderia*, and cobble and tile ditches with arched walkways over the open narrow ditch that continued from the *lavanderia* to provide irrigation. (Photo by R. Allen.) 
Soledad	Mendoza (2014)	Summary article of work near native adobe housing and quadrangle. Mapping of *zanja* between the quadrangle and L-shaped native adobe housing to the east. Paralleled a section of El Camino Real, and "traversed the mission compound at the north perimeter of the neophyte housing area, thereby separating the resident indigenous population from the path of the Camino Real. Mendoza interprets this separation as "safeguarding the health" of the European population.

COLONIAL USE OF WATER WITHIN MISSION SAN LUIS OBISPO

In the fall of 1772, the missionaries founded Mission San Luis Obispo, the fifth mission within the chain of such establishments in Alta California. Father Junípero Serra was one of the founding missionaries. After the founding ceremony, Serra left this new mission in the charge of Father José Cavaller, five soldiers, and two converted natives brought up from Baja California. Among the first buildings constructed were a chapel and priest's dwelling, soldier barracks, and a stockade (Englehardt 1933:17, quoting Fr. Francisco Palóu, Serra's biographer). Temporary shelters for the converted natives were not noted in the historical record, but were likely also constructed. As with all California missions, the complex of buildings associated with Mission San Luis Obispo went through several iterations. The buildings and structures associated with the mission dominated the landscape and the lives of local colonizers and Native Californians alike.

The water system at Mission San Luis Obispo had three primary purposes: (1) to provide drinking and washing water for the mission fathers, soldiers, and native residents; (2) to channel water to the agricultural fields and orchards; and (3) to produce power to run mills. Understanding the use and trajectory of the water system is important, involving such details as elevations and the location of gates and interconnecting lateral channels. Using gravity and the surface flow of water was essential to the success of the mission hydraulic systems: "The padres could not lead water to upper slopes successfully until they had worked hard and long on hydraulic projects such as dams, reservoirs, and conduits. Hence the great importance attached to the presence of low, irrigable ground that would lend itself readily to cultivation" (Raup 1959:60).

Construction of the main aqueduct at San Luis Obispo was completed in 1776, four years after the mission was founded. Several historians of the area have noted the importance of water to the mission. According to Ballard (1922:161), Serra selected a site for the main chapel on a gentle, sloping area, "at the foot of which ran the San Luis creek, a stream of sufficient size to supply drinking water to the settlers and irrigation for the mission lands." Fr. Englehardt (1933:16) noted much the same: "After surveying the locality, it was determined to found the Mission about a half a league before reaching the Cañada de los Osos, yet in sight of it, on a level plot, which to all appeared most suitable for the Mission on account of two little arroyos which contained water with sufficient lands that with but little trouble could be irrigated from them. For the site of the Mission a slight elevation below which ran the two arroyos was designated." Edith Webb also noted the importance of water to the new settlement, and detailed the construction of the aqueduct:

> …Mission San Obispo was located on a hill at whose foot ran a stream with a flow of water sufficient not only for domestic use but for irrigation of a field as well. Near by was another arroyo with water enough to irrigate another field. These two streams, the San Luis and Stenner creeks, were both below the level of the mission buildings. Consequently, for domestic purposes, it was necessary to tap the former stream at a point up near its source in La Cuesta (the Pass), and to conduct the water by dug ditch, or aqueduct, down the slope to the mission premises. Legend says that this work was done by Ignacio Vicente Vallejo in the early years of the mission's existence. And it may well be true that Vallejo did superintend this work for, in 1776, he was employed at San Luis Obispo as carpenter, and the carpenter's trade in those days included many others. Moreover, according to Bancroft, Vallejo was often called upon to oversee such undertakings. But it was, of course, the Indians who did the actual work [1982:65].

Documentary evidence of *zanja* construction at Mission San Luis Obispo comes from an account written when the military governor Pedro Fages visited in November, 1773. Fages observed the early palisade chapel, soldiers' barracks, and a few native style houses, and noted that "an irrigation ditch was already bringing abundant water to the sown fields" (Schuetz-Miller 1994:171). *Zanjas* also served as feeders to mills. According to Schuetz-Miller (1994:172), the first grist mill at Mission San Luis Obispo was built in 1795, although other sources (including Webb 1938:117) state its construction occurred in 1798; the latter seems more likely. Webb notes that this was the second water-powered mill in Alta California; the first had been built earlier at Mission Santa Cruz. Regardless of which year the mill was built, the construction of a grist mill implies the existence of a fully functioning water system that would not only bring drinking water but would have a sufficient flow in a secondary ditch system to power a mill.

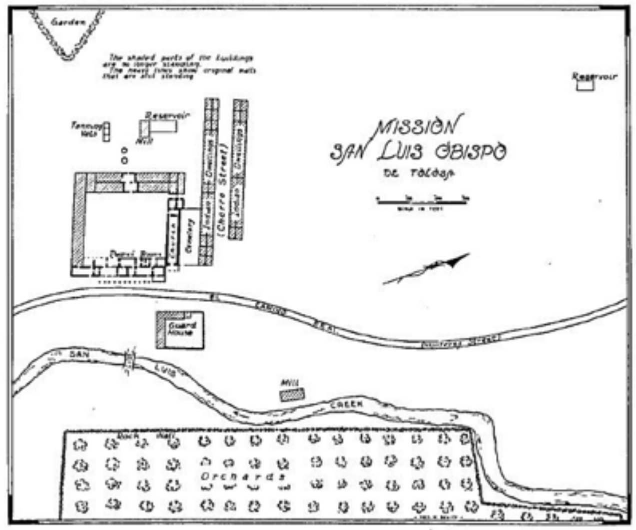


Figure 1. Mission San Luis Obispo Layout and Water System (Webb 1938).

Francis J. Weber (1985:169–70) compiled several early accounts of Mission San Luis Obispo, including one from *The Monitor* describing the grist mill as being "further up Monterey Street from the large reservoir, to the left of the road and by the side of San Luis Creek." A 1937 brochure reprinted by Weber (1985:162–163) noted that remains of the mill had been uncovered, including a mill stone and stone floor (this area is one block south of where our recent archaeological investigations occurred). In 1805, another mill and a second reservoir were built, this time in back of the church and adjacent quadrangle. Englehardt (1933:56) noted that repairs to a water-powered grist mill were undertaken in 1812, although he does not specify which mill was involved. In her 1938 publication, Webb drew a map (Fig. 1) showing the features that she knew about from the documentary record and from discussions with locals; she included some of the standing adobe buildings that once served as "Indian Dwellings," and showed the locations of two reservoirs and two mills. This was a hand-drawn map, and the locations of some features were approximate.

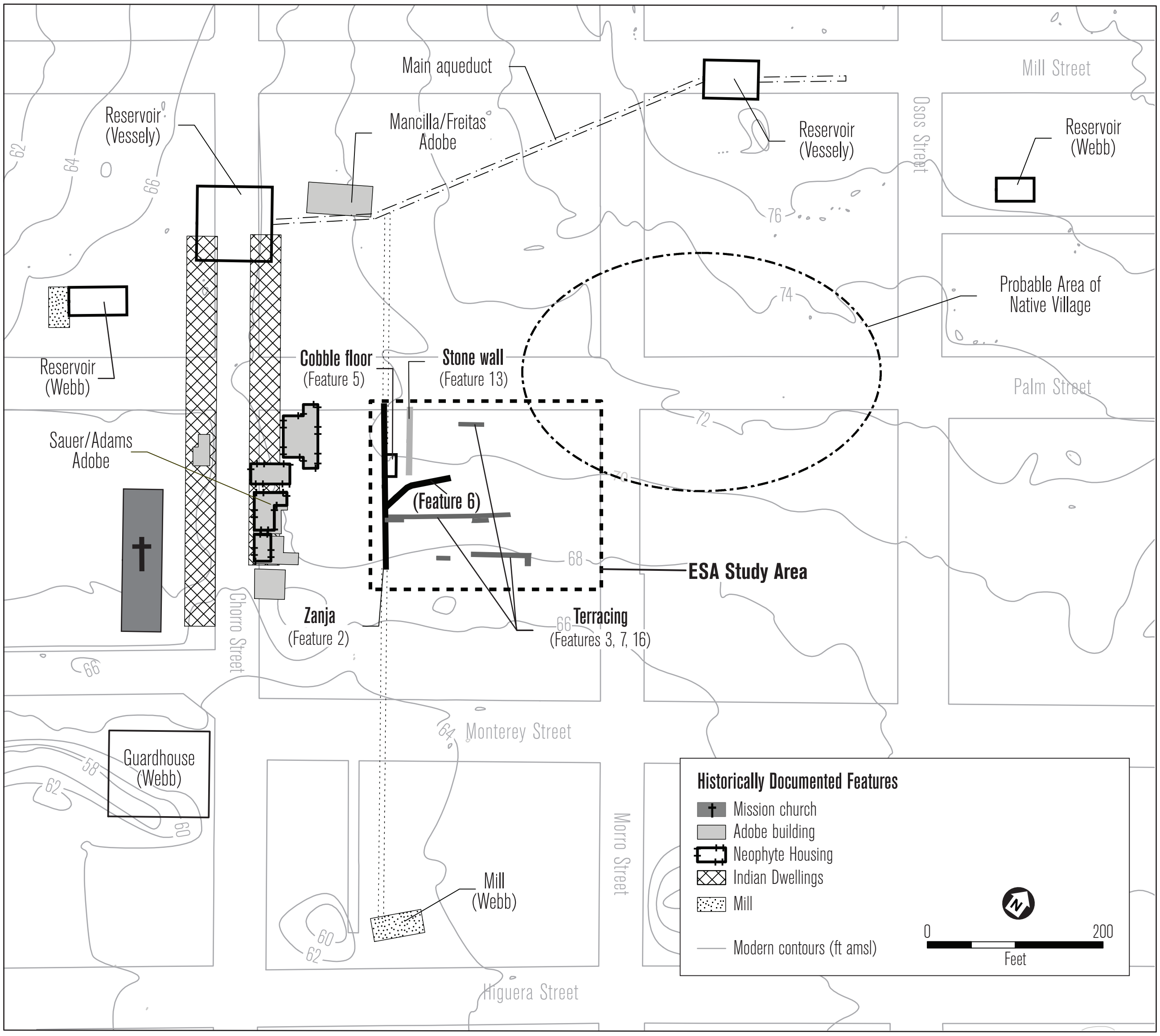


Figure 2. Reconstructed mission layout and water conveyance features (map by R. Vessely and P. Zimmer).

DISCOVERY OF THE *ZANJA* AND OTHER FEATURES

In 2016, ESA excavated a study area that is part of the archaeological site designated as CA-SLO-1419H, roughly bounded by Mill, Chorro, Monterey, and Osos streets (see Fig. 2 for street locales). Site boundaries have not yet been fully defined, but they extend beyond the current study boundaries. CA-SLO-1419H is a large site associated with several layers of historic occupation, including the San Luis Obispo Chinatown. It was first discovered in 1986 during the construction of the Palm Street parking structure (north of Palm Street, between Chorro and Morro streets). Artifacts dating to the mission period that were associated with the native residential occupation, as well as materials from the late nineteenth century associated with the Euromerican occupation, have been documented within this site. Based on the kinds of native artifacts found, excavators within the "Kozak lot" portion of the project site—in the northeast corner, south of Palm Street and adjacent to Morro (Conway 1995)—suggested that the "Kozak lot" was part of CA-SLO-1419H, and represented an area of native residence during the mission period. Additional data recovery in this area in 2016 found a persistent occurrence of artifacts such as shell beads, glass beads, and lithics, although no specific features; this area of the project was highly disturbed, as was the northern portion of the site in general.

Area exposure and excavation strategies uncovered a long linear feature (Fig. 3) along the western side of the study area. As part of the data recovery effort, the feature was exposed through hand excavation, and several test units were excavated on top of and adjacent to the feature. We exposed the sidewall of what was labeled Feature 2. This wall, constructed of locally occurring cobbles, was made up of two courses of rock; it was 15 in. (0.38 m.) high and about 33 in. (0.84 m., or one *vara*) wide. The feature ran the length of the entire project area, was 188 ft. or 57.3 m. in length, and appeared to continue in both directions. Broken fragments of roof tile and floor tile covered the top of the wall. Soil found on top of the feature (within the site's overburden) contained a mix of mission period and American period artifacts; some of the latter reflected the Chinatown occupation of this city block. Test Unit 1 was placed on top of and adjacent to Feature 2 in order to get a better sense of its construction and to recover any associated artifacts.

Retired engineer Robert Vessely (P.E.) has studied the Mission San Luis Obispo water system, and has projected the likely location of the various system parts, taking into consideration topography, historically-mapped features, known archaeological resources such as the Mancilla-Freitas adobe (constructed circa 1850), and known standing structures. Numerous discussions between Allen and Vessely—as well as with Mark Rawson (the project architect who understands the area's topography) and Paul Zimmer (geoarchaeologist)—proved critical for understanding the significance and function of archaeological features that were encountered within the ESA study area (Fig. 2). We used archaeological evidence, coupled with documentary evidence, to piece everything together; not all of the parts have been noted or described, and even fewer survived once the mission system collapsed in the 1830s. To quote Larry Felton (Allen and Felton 1998:2), as we were reconstructing the water system at Mission Santa Barbara, "The situation is perhaps analogous to trying to comprehend the workings of a complex piece of machinery (e.g., an automobile) from which the wiring, fuel lines, and connecting rods have been removed."

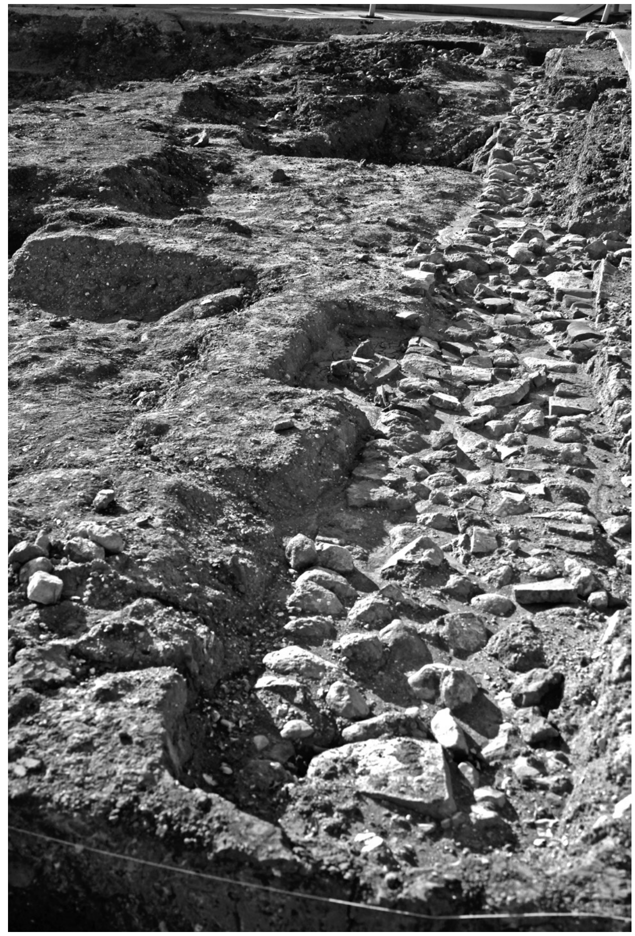


Figure 3. Top of the east wall of the *zanja*, Feature 2. (Photo by C. McClellan, 2016.)

By plotting the feature location on the map created by Vessely, and adding Webb's map of the mission, the purpose of Feature 2 became almost immediately apparent (Fig. 2). Vessely had projected the location of the mission's higher reservoir with the main aqueduct heading southwest, with a bend near the southeast corner of the Mancilla-Freitas adobe. This varied from the reservoir localtion roughly drawn by Webb, but makes more topographical sense. The linear Feature 2 was in direct alignment with this bend; it served as a *zanja* that would carry water to the mill that Webb (Fig. 1) had plotted southeast of the mission church, and south of what became Monterey Street. Other historic maps of the mission also show the presence of orchards south of this mill. The *zanja* would have continued south to feed those crops. The 2016 excavation exposed the east wall of the *zanja*. The ditch bed and its western wall remain under the present sidewalk. Earlier archaeological test

Figure 4. Overview of Feature 6, the secondary water conveyance ditch. (Photo by C. McClellan.)

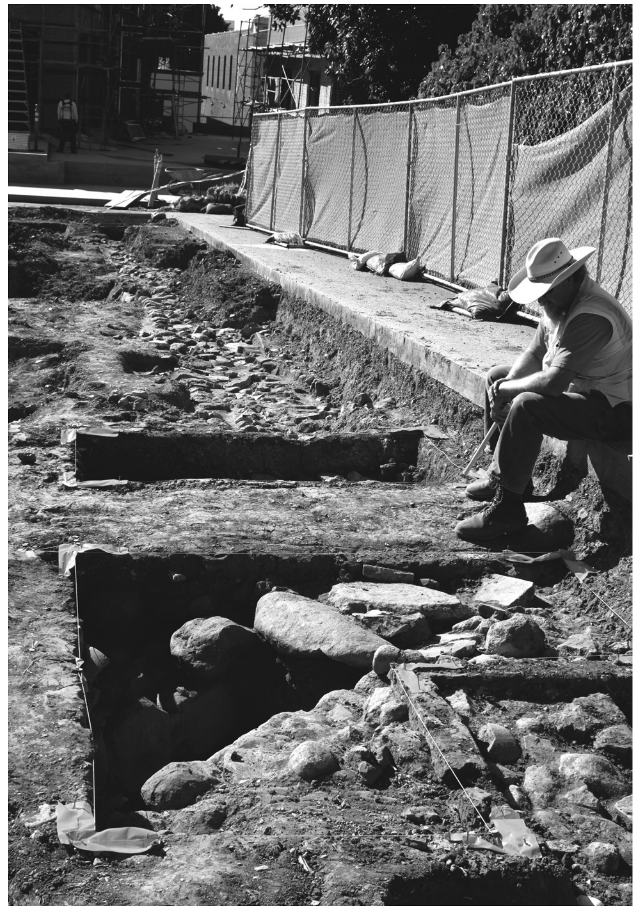


Figure 5. R. Scott Baxter, looking at the intersection of Feature 6 lateral with the main zanja, Feature 2. (Photo by C. McClellan.)

excavations had also encountered the eastern wall of the *zanja*, in an area to the south of the ESA study area (M. Rawson, personal observations; see also Hamilton 2017).

The excavation of Test Unit 1 also uncovered a water conveyance lateral (labeled Feature 6) that fed into the main *zanja*. The lateral (Feature 6; Fig. 4) was a narrow, U-shaped ditch with a flat bottom, vertical sides, and square corners, constructed of a mix of siltstone and repurposed floor tile fragments. The floor tiles were used primarily on the floor of the ditch. Large flat stones were set into the walls on edge, with the broadest dimensions running vertically. The walls and floor were mortared together. Further area exposure of the project site showed that a concrete driveway, constructed no later than 1926 (according to Sanborn Insurance maps), destroyed the eastern extension of Feature 6.

We placed an additional test unit to intersect and investigate the *zanja* and its lateral feeder. Excavation exposed the width of the feature (Fig. 5), which consisted of parallel rock walls, with a ditch in between. Roof tiles and cobbles covered the bottom of the ditch, which was about 24 inches (0.6 m.) wide. The rock walls along the sides of the ditch were two courses high, and about 16 inches (0.4 m.) in height. Test units exposed the western terminus of Feature 6, where it intersected with the main *zanja*. These units revealed the construction methods and materials used in the construction of both features, and exposed a flat area on top of the features that may have been used as a walkway over the *zanja*. Grooves in the rock construction could be seen at this intersection of channels; a wooden sluice gate was likely used to control the flow of water.

Excavation also uncovered a series of rock-lined terraces extending from the *zanja* east towards Morro Street (Fig. 2) in the southern portion of the ESA study area. Prior excavations in the area to the south also showed terracing and low rock foundations or walls that appear to have been associated with features discovered in 2016. In the northern part of the ESA study area, we also exposed a rock cobble floor partially covered with a pinkish hydraulic cement, and a wall segment that paralleled the main *zanja* (Fig. 2).

Distinct archaeological strata (also called contexts) characterized the soils above and within all of these landscape features. Above the ditches, contexts contained a mix of mission period and later American period artifacts, representing the overburden present throughout the site. Within the ditch beds, contexts represented fill with mission period artifacts, which would have been deposited after the ditch was abandoned. The artifact assemblage in this fill included Mexican-made earthenware, majolica, and locally made earthenware ceramic fragments, glass beads, shell beads, ground stone, faunal materials (including shell and animal bone), and roof and floor tile fragments. The assemblage represents extensive domestic refuse, and resembles that of other native mission occupations (see Panich et al., this volume, for other examples of Native Californian residential refuse). Stratigraphic data and artifacts suggest that the ditches were most likely abandoned sometime during the late mission period. Given the land disturbance during the American period, particularly in the northern end of the *zanja* segment, the ditches were likely filled with adjacent soil and artifacts that represented nearby mission-period residential land use.

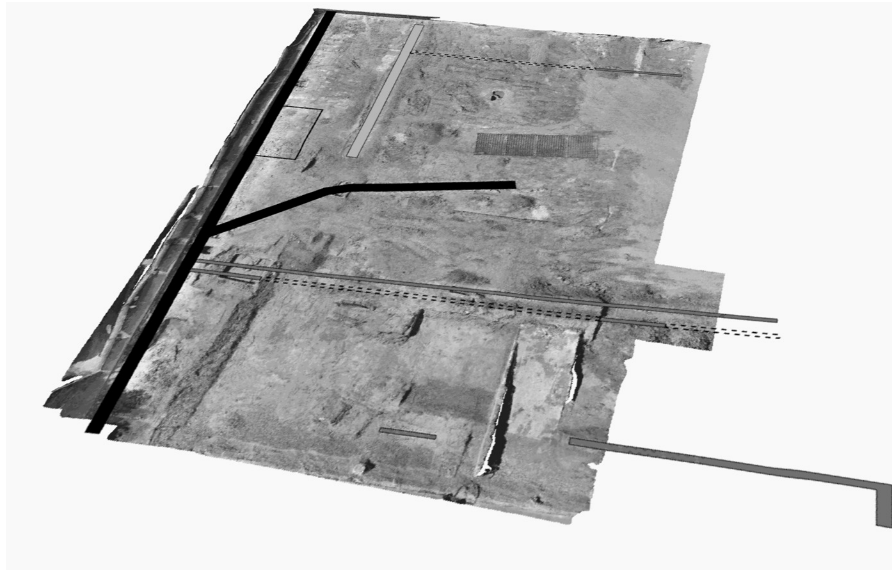


Figure 6. CHEI-produced model of a portion of the archaeological project site, with features drawn in. (CHEI, University of California San Diego; adapted by P. Zimmer.)

UNDERSTANDING AND MAPPING THE MISSION LAYOUT

David Hurst Thomas (1991:145–146) noted that archaeological evidence of California's missions can be found underneath many streets, buildings, and parking lots. Early archaeological excavations focused on mission churches and quadrangles; later excavations expanded into residential and industrial areas, although they tended to focus on buildings and structures. While these are often good places to begin archaeological investigations and plans for preservation if possible, investigating the potential for archaeological features of everyday life in areas between and surrounding mission buildings should not be so constrained (Allen 2010a). Use of extensive area excavation becomes critical to finding both apparent and more ephemeral features, and for understanding how the features of everyday life and more substantial infrastructure and buildings relate to one another. Expansive area excavation also presents challenges as to how to record these often complex mission sites and features.

During the entire 2016 field excavation, Field Director R. Scott Baxter maintained a hand-drawn map of the features, trench locations, excavation areas, and findings. As the several-weeks-long excavation progressed, this interim map helped us to interpret the many layers of mission, Chinese American, and Euromerican land use that existed within this city half-block. Near the end of the excavation, Dominque Rissolo led a team of specialists from the Cultural Heritage Engineering Initiative (CHEI) at the University of California, San Diego, in documenting site elements using aerial and terrestrial Structure-from-Motion (SfM) photogrammetry, creating a photorealistic 3D-modeling of all features (Fig. 6) and elements associated with the site, particularly the water-conveyance features. This also helped us create a digital elevation model. An ortho-rectified photo mosaic assisted with identifying the spatial and functional relationships of project features to standing mission buildings (church and quadrangle) in adjacent blocks. Using three levels of photography and photogrammetry to accomplish this, CHEI specialists took photographs from an aerial platform (camera attached to a mini-van-sized balloon), mid-level photography accomplished with a long pole, and close-up, near-ground-level photography of site features. The end result was a 3D-model of the site that could be turned in all directions, adjusted for elevation, and viewed in the office as the site report was being written (Fig. 6). Effectively, we could virtually re-walk the site, and revisit aspects of the features, topography, and land use over time.

Understanding the area's slope, and how the various features relate to one another, has important implications for reconstructing how native residents within the mission system would have used land adjacent to the *zanja*, as well as used water as a resource. As an example, being able to look from south to north, along the eastern wall of the *zanja*, helped us to better understand how this feature functioned, and how land use that occurred after the mission period, when the *zanja* was no longer in use, impacted it. This methodology also helped us to understand the function of the secondary (or lateral) ditch (labeled Feature 6). During the mission period, the western side of the study area along the route of the *zanja* changed about 10 ft. in elevation from Palm Street south to Monterey Street (see Fig. 2). The natural slope of the site has been disturbed by the subsequent construction and demolition of a building at the northern end of the site, adjacent to Palm Street. While in use, Feature 6 was likely intermittently fed by a stream during periods of heavy rains.

Figure 2 shows the blocks of native residential housing, constructed of adobe. At the majority of California missions, adobe houses for native families were constructed in rows, and are often referred to as mission barracks. One of these adobe buildings is still standing, and is today known as the Sauer/Adams adobe. Housing for priests and young unmarried girls was constructed as part of the mission quadrangle. As there was never enough housing for native residents, native-style houses were built on the peripheries of the mission landscape (Allen 2010a; see also Panich et al. in this volume). At Mission San Luis Obispo, historic maps and documentary records show that the adobe houses constructed for native residents were placed east of the mission church. The eastern half of the area south of Palm Street and closer to Morro Street is not as sloping as the western side closer to the *zanja*. This would have been an ideal location for native-style residential housing during the mission period (Fig. 2).

The *zanja* at that time would have been in the "backyard" of Mission San Luis Obispo's native residences, between the rows of adobe houses and the village of native-style housing. A consideration of the overall layout of the study area in relationship to other known mission features helped us to understand the perpendicular terracing that appeared within the study area (Fig. 7), as well as the cobble floor adjacent to the *zanja* and the parallel rock wall. If these features were all within the backyard of the native residential area, and were all constructed by Native Californians, then their interpretation has to consider what function these features would have had.

NATIVE USE OF WATER WITHIN MISSION SAN LUIS OBISPO

The term *tribal cultural resources* generally refers to sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a Native California tribe. The area that is now the city of San Luis Obispo lies within the area historically occupied by the Chumash people usually referred to as the Obispeño (Greenwood 1978; Kroeber 1976). Their territory is generally considered to have extended from the Pacific Ocean east to the Coast Ranges, and from the Santa Maria River north to approximately Point Estero. Today, it is generally understood that Native Californians never saw themselves as members of the larger cultural groups described by anthropologists. Instead, they viewed themselves as being affiliated with specific villages, and perhaps related to others by marriage or kinship ties. The village was the primary reference point for self-identification, with many variations in culture and ideology existing within and between villages, and sometimes within and between families. The traditional anthropological literature utilizes a "static" descriptive framework to distinguish between native cultures, and to make it easier for ethnographers to describe past behaviors

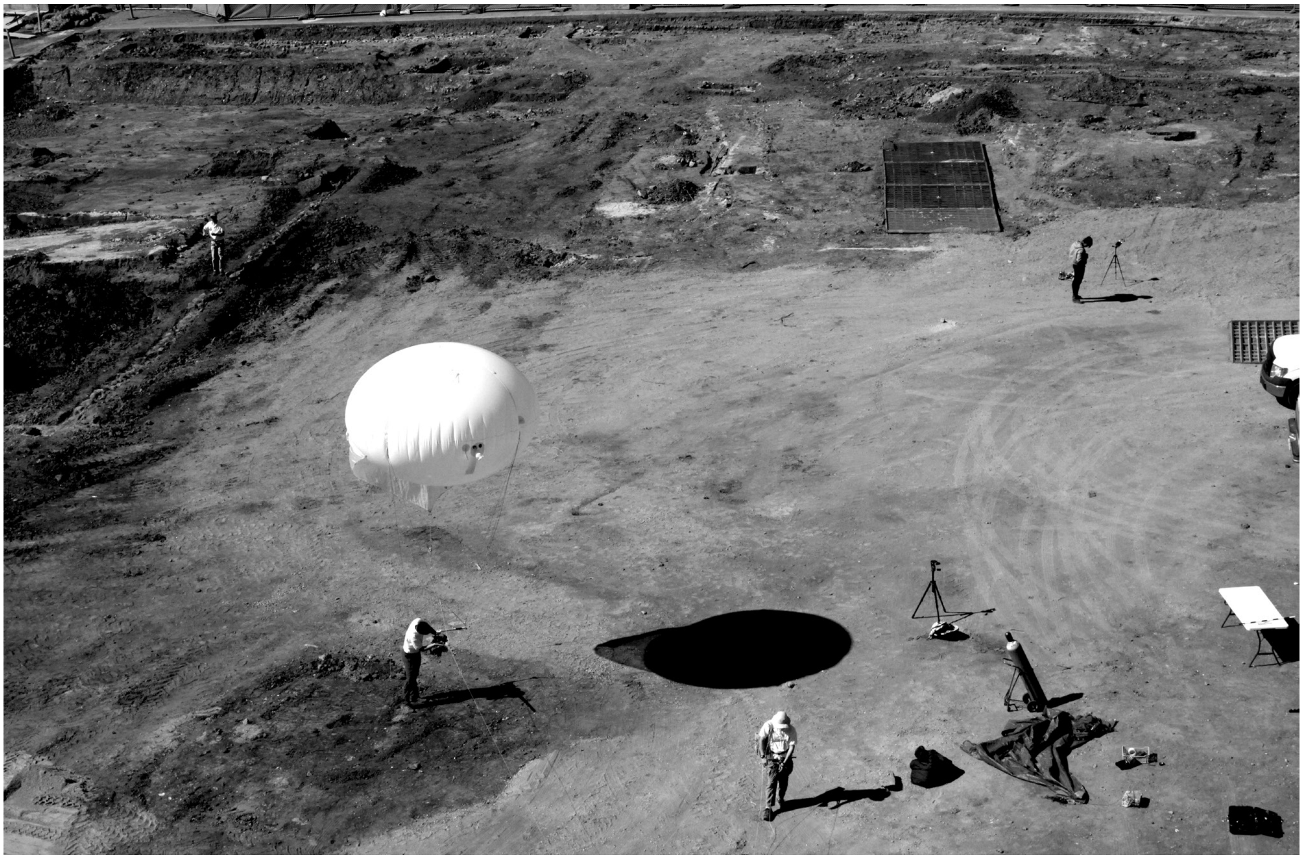


Figure 7. Overview of site during photogrammetry recordation. At the upper left, Dominique Rissolo is standing on Feature 7, a line of terracing across the project site. (Photo by C. McClellan.)

in specific locales. This system of categorization masked native adaptability, self-identity, mobility, and cultural interest in landscapes outside of "traditional" territories.

Spanish exploration profoundly affected Alta California's populations, including those in territories within and near what is today called San Luis Obispo. Among the consequences of this exploration was a disruption of social and political hierarchies, and a devastating reduction in population (Preston 2002). The founding of Mission San Luis Obispo, as well as later historic events, compounded the negative effects on native villages in the area. During the early nineteenth century, Salinans and Yokuts were brought into the Mission San Luis Obispo compound, and into what had traditionally been Chumash territory. Despite this, tribal peoples and native identities endured and persisted, and today have an active presence in San Luis Obispo County. Many native groups—in addition to the Obispeño—have an interest in the study area.

Native American consultation was a critical part of the current archaeological effort. It was quite evident that tribal elders and Native American monitors viewed the mission-period *zanja*, the terracing and other features, and all native-related mission-era artifacts, as tribal cultural resources. In other words, these objects and features have meaning beyond their archaeological and historical value. The *zanja*, for example, was seen as the very embodiment of Chumash labor and value. For this reason, at least one Native American monitor was always present on site during excavation, and a monitor was also present at the off-site water-screening area.

The following discussion focuses on native uses of components of the mission water system, and on the importance of water as a resource for the native community within Mission San Luis Obispo.

Terracing the Landscape

Features 3, 7, and 16, adjacent to the ditch, are constructions that form terraces trending eastwards across the site (Figs. 2, 6, and 7). These terraces would have made flat, shallow areas in the southern portion of the ESA study area, as the areas sloped downward in elevation from north to south towards what is now Monterey Street. This change in elevation is still visible on lands below the existing mission church, across Chorro Street; recently, the area below the church has been terraced and steps installed.

Feature 7 consisted of two long, parallel linear rock alignments that extended horizontally from the *zanja* across the site towards Morro Street. The two parallel rows of rocks (one above the other) created a terrace that was slightly less than 3 ft. (1 m., or 1 *vara*) wide. The rock alignments were in a relatively straight line and were composed of a single layer of dry-laid local siltstone. There was no evidence of mortar. Feature 3 was a long, L-shaped segment of rock alignment, perpendicular to and below Feature 7. Truncated by later American period land use, Feature 3 is not as long as Feature 7. It begins east of (and not adjacent to) the *zanja*, and extends for 101 ft. (30.8 meters), with a 9 ft. (2.7 meter) shorter leg that heads towards the south. Construction of a concrete driveway and a twentieth-century building that was on site prior to archaeological investigation truncated the eastern extent. Feature 3 was set deeper than Feature 7. Including the terrace and the rock alignment, Feature 3 is about 1 ft. (0.3 m.) high, and the platform that the terrace created is about 2 ft. (0.6 m.) wide at its widest extent. The eastern end of the rock alignment is wider than the much narrower west end. We exposed the extent and top of Feature 3 with hand excavation. Soil from the feature was not excavated or screened, as it was determined to be from disturbed (mixed) contexts.

Feature 16 was a short segment of rock alignment, found in the northern portion of the project site in a highly disturbed area. Construction of the twentieth-century concrete driveway and utility lines truncated the alignment, which was parallel to features 7 and 3 (Fig. 6) and was similarly constructed of dry-laid siltstone cobbles. Bone and shell that was mostly fragmentary was adjacent to and on top of the feature. Artifacts were noted on field forms but were not collected, as this feature was in such a highly disturbed area.

To further tease out the purpose of the terracing, Test Unit 5 was excavated as a 3 × 3 m. unit adjacent to the *zanja* (Fig. 8). The unit was intended to further expose the rock alignment and terrace area, and to identify associated artifacts. Test Unit 5 encountered mission-period deposits with a variety of materials suggestive of Native American land use. Stratigraphic layers that were clearly from the mission period contained ceramics, faunal remains, shellfish remains, *Olivella* shell beads, flaked chert, glass beads, and fragments of roof tiles. A mixed deposit that directly overlaid the rock alignment contained American-period ceramics, but (interestingly) two projectile points, a Desert side-notch and a Cottonwood triangular point, as well.

Figure 8. Test Unit 5, showing the terracing adjacent to the *zanja*, with small ceramic jar in situ. (Photo by R. Allen.)

During the excavation, Allen and Rawson, in collaboration with several archaeological community members, searched for information on the use of terracing within the missions. Citing several documentary sources, Edith Webb (1982:59) noted that "[n]ot only did the Indians perform the work in the fields, garden, and orchards of the mission community, but…those who desired them had gardens of their own to care for. They were encouraged to plant various seeds and cuts and were allowed to dispose of the produce as they chose." Archaeological evidence of garden areas created within the native residential space has also been found at Mission San Antonio (Bertrando 1997; Robert Hoover, personal communication 2017). Given this evidence, the authors posited the use of the terraces as gardens. In order to confirm this, soil samples were taken from three contexts (strata), and were sent to PaleoResearch Institute, Inc. for identification.

Evidence from Pollen, Macrofloral, and Phytolith Remains

Previous pollen and macrofloral studies from California mission sites have been shown to be useful in recon-

Table 2

MACROFLORAL REMAINS FROM MISSION PERIOD CONTEXTS

Sample	Identification	Common Name	Part	Charred	Uncharred	Weight (g.)
Feature 6, Context 18	Asteraceae, cf. *Helianthus*	Sunflower family	Seed	1 frag.		0.0005
	Cyperaceae	Sedge family	Seed	1 whole		0.0003
	Erodium	Filaree	Seed	1 whole		0.0003
	Erodium/Poaceae	Filaree/grass family	Awn	4 frag.		<.0001
	Fabaceae	Pea or bean family	Seed	1 whole		0.0009
	cf. *Lepidium*	Mustard family, pepperweed	Seed	1 whole		0.0002
	Malva	Cheeseweed	Seed	1 whole		0.0015
	Poaceae A	Grass family	Caryopsis	1 frag.		0.0008
	Zea mays	Corn	Cupule	1 frag.		0.0009
	Unidentified		Seed	1 frag.		0.0009
	Parenchymous tissue ≥ 2 mm.	Unid. tissue		10 frag.		0.1332
	Chara	Stonewort	Oogonia		3 whole, 4 frag	
	Malva	Cheeseweed	Seed		1 whole	
Test Unit 5, Feature 31	Amaranthaceae	Amaranth	Perisperm	1 whole		0.0001
	Erodium/Poaceae	Filaree/grass family	Awn	3 frag.		
	Amaranthaceae	Amaranth			4 frag	
	Malva	Cheeseweed	Seed		1 frag	
Test Unit 5, small jar, Context 33	Amaranthaceae	Amaranth	Perisperm	1 whole		<.0001
	cf. *Erodium*	Filaree	Seed	1 frag.		0.0003
	Erodium/Poaceae	Filaree/grass family	Awn	3 frag.		0.0003
	Juglandaceae	Walnut family	Nutshell	1 frag.		0.0097
	Malva	Cheeseweed	Seed	1 whole, 2 frag.		0.0015
	Poaceae	Grass family	Caryopsis	2 frag.		0.0003
	Zea mays	Corn	Kernel	1 frag.		0.0040
	Unidentified		Seed/Nut	3 frag.		0.0663
	Malva	Cheeseweed	Seed		1 whole	

structing local environmental conditions (Allen 2010b). Within the ESA study area, we sampled fill from Context 18, near the bottom of the Feature 6 ditch, to process for pollen, phytolith, and macrofloral analysis. We also took a soil sample from an area associated with the terracing of Feature 7 (Context 31), and from soil matrix taken from a small Mission-ware jar found *in situ* during excavation (Fig. 8; Context 33). Table 2 highlights and summarizes the macrofloral remains; evidence from pollen, phytoliths, and charcoal are discussed below.

High-spine Asteraceae pollen, representing plants in the sunflower family, dominated the sample from the bottom of the lateral ditch (Feature 6). Small quantities of other pollens indicated a local growth of hickory, gum, pine, and oak trees. Other local weeds and plants included sagebrush or wormwood, ragweed/marshelder, dandelion or another plant in the chicory tribe of the sunflower family, a member of the mustard family, a member of the bindweed family, weedy spurge, prairie clover, red clover, a member of the evening primrose family, prickly pear cactus, grasses, a member of the buckthorn family, cattails, and local ferns. Only small amounts of pollen represented any vegetal remains related to food, but pollen from corn, (probably) wheat, and mint was present. Phytolith evidence suggests the presence of local grasses. Macrofloral evidence (Table 2) suggests weedy plants likely grew in the vicinity of this secondary ditch, including *Erodium*, plants in the sunflower family, cheeseweed, and grasses; there was also some charcoal from hardwoods.

The pollen sample from Context 31 resembles that found in Feature 6: high-spine Asteraceae pollen dominated the sample, representing plants in the sunflower family, followed by smaller amounts of pollen representing alder, juniper, pine, and oak trees, and low-growing plants including ragweed/marshelder, plants like dandelion in the chicory tribe of the sunflower family, mustard family plants, wild buckwheat, prairie clover, and grasses. Small quantities of shrubby chamise and cattails are suggestive of an area of wetland or plants associated with the nearby *zanja*. The phytolith record suggests the presence of local grasses, but no food-related vegetation. Macrofloral results (Table 2) included one charred and four uncharred Amaranthaceae perisperm fragments, or processed seeds from members of the amaranth and goosefoot family. Three charred Erodium/Poaceae awn fragments and a single Malva seed indicate the presence of weedy plants like filaree or grasses, and cheeseweed (mallow). Many oak charcoal fragments were also found.

Context 33, soil from inside the small jar, was found to have a smaller quantity of high-spine Asteraceae pollen than the other contexts, as well as small quantities of Cyperaceae (sedge) and *Plantago* (plantain) pollen. The amount of Poaceae pollen was slightly elevated and it was also accompanied by aggregates, suggesting the possibility that the jar held grass seeds. A few phytoliths also suggested grasses. A small quantity of Apiaceae pollen might reflect the presence of dill. Macrofloral samples (Table 2) included Amaranthaceae perisperm, a walnut or hickory nutshell, and a single corn kernel fragment. Poaceae and cheeseweed were also present. Small amounts of burned sycamore, cottonwood, oak, sunflower, sagebrush, pine, and laurel were also found, along with non-floral remains of small bone fragments (likely rodent), shell fragments, and a few insect chitin fragments.

Previous data recovery from areas associated with native residence in adobe buildings (Allen 1998; Allen et al. 2018; Panich et al., this volume) or mission period native-style residences typically indicate a dominant presence of cereals, primarily wheat and corn. Phytolith data from these residential areas also indicate the presence and threshing of wheat (Allen 2010b; Allen et al. 2010). Evidence from many missions with native residential-area archaeological contexts also includes features and artifacts associated with food preparation, such as fire hearths and fire-cracked rocks, accompanied by groundstone tools, metal tools, and containers. Identifications from soil samples from the 2016 excavations associated with Mission San Luis Obispo are atypical, in that evidence of European-introduced cereals was much sparser than at other mission residential sites. Many more indigenous species were found than is typical of a site or feature associated with native residential use (cf. Panich et al., this volume), a fact that is important for understanding land use adjacent to and near the *zanja*.

Timbrook's *Chumash Ethnobotany* (2007) suggests many native uses for the plants found within the soil contexts (Table 3). For example, findings from Test Unit 5, within the flat, terraced areas, suggest the growing of such native foods as amaranth, grasses or clover, and corn, a New World species introduced to California and adapted as an important food source. The native walnuts were a source of food, and their shells were used as dice in games. Introduced species known as cheeseweed were known to be used for medicinal purposes (Mead 1972:129–130; Timbrook 2007:121–2). Native plants in the Asteraceae (sunflower) family were also used for medicine. Some of the grasses may have been valuable for basketry, thatching, and making arrow shafts. All of these would be useful plants to the native residents of Mission San Luis Obispo.

Additional Evidence of Food Processing

In the northern part of the ESA study area, excavations also uncovered a cobble floor covered with a pinkish plaster, recorded as Feature 5 (Figs. 2 and 6). The feature was parallel to the *zanja* and was approximately 15 ft. long by 10 ft. wide (4.6 × 3 m.). Subsequent nineteenth-century construction (pier and post cement foundations), a twentieth-century waterline, and a recent irrigation pipe and prior archaeology had disturbed the cobble floor and removed much of the plaster that would have once covered it. In areas that were not disturbed, the layer of pinkish hydraulic cement could be seen to have once covered the cobbles, evening out the uneven surface, and making the surface more usable. Webb (1982:74) noted the use of

Table 3

KNOWN NATIVE USES FOR PLANTS FROM MISSION PERIOD CONTEXTS

Plant (Common Name)	Timbrook (1997) Suggested Uses
Amaranthaceae (Amaranth)	Seeds of *Amaranthus californicus* were ground and eaten, although not as important to Chumash as to other California groups.
Asteraceae, cf. *Helianthus* (Sunflower family)	Many plants within this family: common yarrow used as medicinal herb for toothaches, and poultice for cuts and sores; coastal sagebrush used for arrow shafts, barricade construction, and medicinal use; mugwort had medicinal uses; horseweed had medicinal uses, etc.
Chara (Stonewort algae)	None reported.
Cyperaceae (Sedge family)	Tule used for thatching houses and constructing mats; Yellow Nutgrass possibly used as food.
Erodium (Filaree)	None reported; common European weed that was one of the first to spread.
Fabaceae (Pea or Bean Family)	California broom used as basketry material; Clover used as food.
Juglandaceae (Walnut family)	Walnuts used as food, and shells as dice in games.
cf. *Lepidium* (Mustard family, pepperweed)	Seeds had medicinal use for dysentery or diarrhea.
Malva (Cheeseweed)	European weed, but adapted by Chumash for medicinal purposes for inflammation, or used as food.
Poaceae A (Grass family)	Many species in this family, such as: *Arundo* used as living hedges or windbreaks; *Aveno* wild oats a European species but used as food and/or livestock fodder; Giant rye grass used for arrow shaft and/or house thatching; Deer grass used for basketry; European introduced Carrizo grass used for arrow shafts.
Zea mays (Corn)	New World species but introduced to California; used as food.

"pinkish cement" for water-related features. Hageman and Ewing (1991:94–95), likely building on Webb's research, discuss the use of "colored lime mortars" and note that "use of this pink plaster invariably occurs in water structures, such as reservoirs, aqueducts, fountain, lavatories, etc. It was also used to line the large vats of the tallow works, and the drainage flume leading from it." Hageman and Ewing also note the use of pinkish or ochre plaster on the *corredor* columns outside of the priests' residence at Mission La Purisima, and in the finish of the floors of the residence, church, and exterior walks in the cemetery, all surfaces associated with the main quadrangle. In contrast, both documentary and archaeological evidence shows that the first temporary buildings and native adobe residential areas typically had compacted earthen floors (Allen 1998; Farris 1991; Webb 1982:107–17).

With the cooperation of the City of San Luis Obispo and the San Luis Obispo County Archaeological Society, excavations were carried out in 1987—although just recently published (Konzak 2016)—across Palm Street (see Fig. 2) from the ESA study area. Excavations in this area also encountered traces of pink plaster over cobble floors, associated with a rectangular stone foundation. The portion of the structure excavated was roughly 10 m. × 20 m. (32.8 ft. × 65.6 ft., or 12 × 24 *varas*). Excavations showed that the stone wall associated with the cobble floor continued east and west of the excavated rectangle. Given the size of this feature, and the use of pink plaster for the floor, this area was likely part of the industrial complex of the mission, although fill associated with this area also contained a mix of native and European artifacts.

Cobble floors can be indicative of threshing areas (such as the threshing floor still visible at Mission San Antonio today). They have also been noted as floors used as outdoor surfaces for butchering, such as the one that appears in front of the Bolcoff Adobe at Wilder Ranch State Historic Park. It has been suggested that the Bolcoff Adobe initially served as a cookhouse rather than a residence (Reinoehl et al. 1986:5). Excavations in the area in front of the Bolcoff Adobe consistently returned large amounts of butchered cattle bone (Curry 2017). The same is true of the area of the cobble floor found in the ESA study area at San Luis Obispo (Fig. 2). Preliminary analysis of faunal remains from areas around the *zanja* suggest a heavy predominance of cattle, along with remains of pigs, horses, wild native birds, and shellfish. The faunal remains had been intensively processed, and the presence of many small bone fragments is consistent with the commonly observed pre-contact butchering style;

many fragments are also burned and calcined, suggesting processing for bone marrow and grease. This evidence supports the idea that the cobble area was likely used for food and animal processing. The pinkish hydraulic cement surface would have been useful for keeping the area clean, using water from the adjacent *zanja*.

Just east of the cobble floor, data recovery encountered Feature 13 (see Figs. 2 and 6), a long, linear rock wall, approximately 33 in. (0.8 m., or one vara) wide, that ran parallel to Feature 2, the long *zanja*. The north end of the wall appeared to extend into Palm Street but was truncated roughly at the south end of the cobble floor designated as Feature 5. A later nineteenth-century brick foundation was constructed on top of this wall but did not disturb its overall course. Excavation of a 50 by 50 cm. test unit in the area (Hamilton 2017; Hamilton and Abdo-Hintzman 2014) had previously encountered the top of this rock wall; at the time it was labeled a "cobble floor." Area excavation during the 2016 data recovery showed this cobble surface to be the top of a segment of rock wall. The rock wall (Feature 13) does not appear to constitute part of a room or building, but rather is a long, single wall, and one that extended into what is now Palm Street. In other mission settings, such walls have been associated with boundary landscaping or corrals. Previous excavations just to the south of the ESA study area also encountered what appear to be long rock walls that may have been associated with animal husbandry.

CONCLUSIONS

A block away from the Mission San Luis Obispo church and quadrangle, recent excavations that emphasized the exposure of large areas uncovered evidence of the larger agricultural landscape and water delivery system, and focused particularly on a long, linear *zanja* that irrigated agricultural areas and fed a water-powered mill to the south. Archaeological, pollen, and macrofloral evidence suggests that rock-lined terraces that ran perpendicular to the *zanja* were used as garden areas. A cobble floor used as a possible food processing area and a linear rock wall are suggestive of native agricultural and animal husbandry practices. These areas were found behind a row of native adobe houses, and near what was likely to have been an area of native housing, in what could be called the "backyard" of the mission native community.

At Mission San Luis Obispo, water, and the conveyance of water, was one of the focal points of native life within the colonial mission system. Previous documentation at mission sites has shown that Native Californians continued traditional practices of engaging and using indigenous vegetation, just as they had for millennia before the missionaries arrived. The recently found *zanja*, garden terracing, and associated features are indicative of this pattern. From the priests' perspective, the *zanja* was built as part of the irrigation system, and to power the mill (Figs. 1 and 2). From the native perspective, this resource of diverted and channeled water could be used in traditional ways, to grow useful indigenous plants, and to create personal gardens and a useful food processing area. Water within the mission system became a resource for native residents to use as they saw fit, outside the purview of the colonial mission influence and for their own daily purposes.

Although the colonial form of agricultural resource use and European foods such as wheat were new concepts to the native population, native Californians already had many traditional ways of making use of local vegetation, including sowing seeds, transplanting shrubs, pruning, weeding, setting fires to promote growth and reseeding, and irrigation in some California cultural areas (Blackburn and Anderson 1993:19). Indigenous plants that appear in the pollen and macrofloral assemblages associated with native residence are typically scarcer in number than introduced vegetation but are often suggestive evidence of native persistence in the use of traditional foods and medicines (Allen 1998; Cuthrell et al. 2016; Panich et al., this volume; Popper 2016). Coombs and Plog (1974) first suggested that missionaries seasonally sent out native groups on *paseos* (leaves of absence) to gather vegetal materials and hunt game to supplement their mission diet. More recently, Panich and Schneider (2014) discuss the concept and use of the *paseo*. Archaeological evidence also suggests that even without the *paseo*, native residents in many contexts are known to have supplemented their diet by following traditional patterns, exploiting sources of nearby native plants and shellfish, and hunting native species (Allen 1998, 2010a; Lightfoot 2005; Panich et al., this volume). Recent findings near Mission San Luis Obispo further illuminate this persistence of native foodways. Within the mission grounds themselves, native residents cultivated native vegetal species grown on site, and processed both introduced domestic animals and wild native species in pre-contact ways.

Allen (1998:97) noted that native residents within the mission system used and produced artifacts that were only of value to themselves, creating a separate economic system with values controlled only by natives, and outside the realm of the colonial missionaries. This is evidence of the native persistence and the creation of native spaces highlighted by Panich and Schneider (2014, 2015). Access to resources, including water at Mission San Luis Obispo, enabled the persistence of native cultural traditions. The study of these patterns of persistence expands our view of everyday life for the native residents. Before archaeological excavations are undertaken, a consideration of the kinds of archaeological features and artifacts of everyday life potentially present is critical for better understanding the mission as a native space. Archaeological methods that will capture native land use, especially of ephemeral resources and expansive systems such as water systems, requires investigations that stretch the planning as to where excavations should occur, and how those excavations should be conducted and documented.

ACKNOWLEDGMENTS

This study would not have been possible without the support of Hotel SLO, LLC and Copeland Properties. The authors would like to especially thank Micah Bycel, who kept the project on track while understanding the need to better understand and interpret this historic site. Michael Codron, Brian Leveille, and Xzandrea Fowler offered responsive and thoughtful project oversight for the City of San Luis Obispo. R. Scott Baxter led an exceptional field crew, which included Josh Garr, Graham Rogers, Matt Gonzalez, Doug Alexander, Alicia Valentino, Heather Atherton, Robin Hoffman, Paul Zimmer, Kaya Wiggins, Jesse Shelmire, Julie Elsey, and Kurt McLean. Tom Ostrander provided a preliminary study of faunal remains. The participation of Northern Chumash *yak tityu tityu* monitors Mona Olivas Tucker, Kelsey Shaffer, Lorie Laguna, Lisa Dignan, Haylee Bautista, and other tribal representatives was an important element in the archaeological effort. Conversations with and the encouragement of Robert Vessely, P.E., especially helped and honed site interpretation, and our knowledge of the larger water system. The San Luis Obispo archaeological and historical community graciously offered their knowledge of SLO's archaeological and Native American past, in particular Robert Hoover, Christina MacDonald, John Johnson, Elise and Tom Wheeler, Val Levulett, Luther and Betsy Bertrando, and Hilliard Wood, although there were certainly many others. Dominique Rissolo, Eric Lo, Dominique Meyer, and Emily Zheng from the Cultural Heritage Engineering Institute gave us a new perspective on how to record and document archaeological sites. Peer review by Mark Hauser and an anonymous reviewer strengthened the data and interpretations presented here. Adie Whitaker, *JCGBA* editor, provided encouragement and patience during the writing and revision process ably assisted by Victoria Kline and Kathleen Wise.

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