Surveying the Southern California Coast

PART 1

Retracing the Thirty-Ninth Parallel to United States-Mexico Boundary Arc of Primary Triangulation

During 2011, the California Department of Transportation (Caltrans) District 7 in Los Angeles completed several GNSS densification surveys to upgrade the geodetic control system in Los Angeles and Ventura Counties, along with nearby surrounding areas. These surveys are a part of the regional transportation program to support ongoing project delivery throughout District 7. During these surveys, the District also sought to perpetuate the positions of the oldest triangulation stations in the region.

This article is a brief history of four historic triangulation stations established in the 1800s and occupied by Caltrans during the 2011 densification surveys. Two of the stations (CONEJO RESET and SANTA CLARA) are located in Ventura County while the others (SAN JUAN and LOS ANGELES SE BASE) are located in the County of Orange. All four control stations played an important role during the ‘Thirty-Ninth Parallel to United States-Mexico Boundary Arc’ of primary triangulation. Completed during the late 1800s, this arc of triangulation was the primary horizontal control survey that connected most of California to the United States until the end of the classical era of geodetic surveying.

CONEJO RESET (NGS PID EW7504)

First established in 1857 by Mr. William E. Greenwell of the United States Coast Survey (USCS) shortly after California statehood, CONEJO RESET was first positioned during the earliest triangulation surveys completed by the Federal government in California. This triangulation station was established to support coastal charting and navigation in southern California during the mid-1800s and was part of a local system, the Channel Islands Datum, which pre-dates any national horizontal control system in California. Although CONEJO RESET was initially used for the network of coastal triangulation, it later became a supplemental triangulation station supporting the primary arc of triangulation along the California coast.

*Conejo* is the Spanish word for “rabbit” and hikers in the hills surrounding this triangulation station can still see rabbits hopping along these hillsides during springtime. Caltrans

>> By Jay Satalich, PS
District 7 occupied CONEJO RESET during a previous GNSS survey in 1991, so it was a familiar station.

CONEJO RESET is located in the community of Newbury Park, just north of U.S. Highway 101. Although this station has been in continuous existence since 1857, there have been three different station marks over the years, along with numerous reference marks. CONEJO RESET was the first geodetic station established by the USCS in the County of Ventura and is quite possibly the oldest geodetic station in continuous existence located in southern California.

The original station mark set by Assistant Greenwell in 1857 was a “…granite slab, 5 inches square sunk into the ground. Top of stone was marked with two intersecting lines and letters U.S.C.S. Four live oak stubs, 6 inches in diameter, with nails in center were driven into the ground. Those to the north, south, and east were distant 4 feet 5 inches. And one to the west, 3 feet 10 inches.”

In 1948, Mr. C.L. Pitt, a surveyor from the U.S. Geological Survey (USGS), recovered the station mark set by Greenwell in 1857. Pitt observed that the “… original station mark was a piece of granite buried in the ground and found in poor condition. The piece of granite was removed and replaced with standard tablet by C.L. Pitt, 1948.” Pitt tells us that he set a “…standard tablet stamped ‘CONEJO 1948’ set in solid rock buried in the ground.” Pitt also admitted that he stamped the mark in error and that the monument should have been stamped “CONEJO 1857 1948”, the standard naming convention used in geodetic surveying when remarking a horizontal control station located in the same position.

No mention was made by Pitt of the live oak stubs set by Greenwell in 1857. Pitt also set reference marks 1 and 2 at that time. It does not appear that USGS formally notified the U.S. Coast and Geodetic Survey (USC&GS) that the original station mark was replaced by that agency in 1948.

The station was next recovered in 1959 by the USC&GS with reference mark 4 set at that time. In 1959, no mention was made by the USC&GS of setting reference mark 3 or of recovering reference mark 1. During the 1959 recovery, the USC&GS corroborated Pitt’s statement from 1948 that “…the station mark is a U.S. Geological Survey bronze disk stamped ‘CONEJO 1948’ set in cement in a drill hole in a buried boulder.” A side comment made at the time by the USC&GS verifies the position of the USGS mark: “office note—computations indicated that station is the same as ‘CONEJO 1857’.”

In 1976, the Ventura County Surveyor’s Office recovered the station and reported that all the marks had been vandalized. The Ventura County Surveyor noted that the “…station mark has been pried from drill hole in buried boulder. Reference mark 2 has had the brass disk broken off its shank. Reference mark 4 has been pried from drill hole in boulder. The station mark was reset by tie distances from the center of the shank and drill hole.” It is in 1976 that the County of Ventura set a bronze benchmark stamped “CONEJO RESET 1976”, which was “…set into an irregular mass of concrete in the place of the buried boulder.” This is the mark used by Caltrans District 7 during the 2011 GNSS densification survey.
Two years later in 1978, the County of Ventura returned to CONEJO RESET and set two new reference marks; reference mark 4 was reset using a new disk stamped ‘CONEJO R.M. NO. 4 RESET 1978’ located in the same drill hole as ‘CONEJO NO 4 1959’ set by the USC&GS in 1959. At that time, the Ventura County Surveyor’s Office also set ‘CONEJO RESET R.M. NO. 5 1978’.

During the Caltrans densification survey in 2011, a reference mark had once again been vandalized. ‘CONEJO R.M. NO. 4 RESET 1978’ had been removed from the boulder from where it was set. ‘CONEJO RESET R.M. NO. 5’ was recovered in good condition, the shank of ‘CONEJO RM 2’ was recovered, and the station mark—CONEJO RESET—was of course recovered in good condition.

SANTA CLARA (NGS PID EW7718)
Station SANTA CLARA is located on South Mountain, about two miles south of the City of Santa Paula. The station is located near the top of the mountain on land owned by the Richardson Family of Santa Paula. The Richardson Family first homesteaded the mountain during the 1860s and is still well established in the area. The family leases the land to an energy company who extracts crude oil from the mountain and the company maintains a service road leading to the peak.

During the initial triangulation along the southern California coast to support nautical charting, Mr. William E Greenwell of the USCS established a triangulation station on the top of South Mountain, SANTA CLARA OLD 1857 (NGS PID EW7719). Assistant Greenwell reported that the station is “… marked by four live oak stubs, 2 feet from center to north, south, east, and west.” Like several other triangulation stations he set during the 1850s, Greenwell did not set a station mark at SANTA CLARA OLD 1857.

After Greenwell’s original 1857 description, there are no station recoveries for SANTA CLARA OLD 1857 in any publication by the USCS or its successor agencies. In USC&GS Special Publication No. 202 First and Second Order Triangulation in California published in 1936 as part of the rollout for the “new” NAD 27 adjustment, SANTA CLARA OLD 1857 and SANTA CLARA are identified as different stations. This is confirmed in Plate 31 of Special Publication No. 202 that shows both stations on a sketch of primary triangulation in southern California.

An original station description for SANTA CLARA, written by Mr. A.T. Mosman of the USC&GS in 1898 does not appear to exist. Station SANTA CLARA was first described by the USC&GS in 1932, or thirty-four years after the station mark was first set by Mosman during his 1898 survey.

The original SANTA CLARA station description, first written by an
anonymous USC&GS author in 1932 states that

“… in 1898 underground mark was bottle sunk mouth up 2.3 feet below the surface. Surface mark was copper bolt in tile pipe, 4 inches in diameter by 2 feet long, filled with concrete. Upper part of pipe was encased in concrete triangle, at apexes of which three marble blocks, 6 by 6 by 4 inches, were set in cement. Four tile pipes, 4 inches in diameter by 2 feet long, were filled with concrete and iron nail placed in the upper surface.”

Besides the concrete-filled clay tile pipes set by Mosman in 1898, the USC&GS field party established reference marks 1 and 2 in 1932.

In 1952, the USC&GS once again recovered station SANTA CLARA noting that “… reference marks numbers 1 and 2 were destroyed by road building operations in 1932. Two additional marks, stamped 3 and 4, were set.” The USC&GS field party also set an unstamped reference mark 0.45 feet east of the station mark in the base of the concrete triangle surrounding the station mark, a punched copper rod.

In January 1969, the USC&GS published a 1:500,000 scale triangulation diagram of southern California that shows both SANTA CLARA OLD 1857 and SANTA CLARA. Shortly thereafter in December 1971, the National Geodetic Survey (NGS) published a 1:250,000 scale geodetic control diagram for the Los Angeles quadrangle showing the County of Ventura in its entirety; both SANTA CLARA OLD 1857 and SANTA CLARA are shown on the 1971 NGS diagram.

What is most significant in the analysis of the 1932 USC&GS description for SANTA CLARA is what was left unsaid. The 1932 description by the anonymous USC&GS author makes no mention of the live oak stubs set by Assistant Greenwell as SANTA CLARA OLD 1857. A geodetic inverse between these two triangulation stations places SANTA CLARA distant 2.66 feet along a north azimuth of 30° 41’ 12” from SANTA CLARA OLD 1857.

The station mark (and concrete-filled clay tile pipes) first described by the USC&GS in 1932 and set by Mosman in 1898 are in substantial agreement with what was recovered in 2011 and is what was used during the Caltrans densification survey. No evidence of Greenwell’s live oak stubs have been found during several visits over the last twenty-two years at South Mountain of Caltrans GNSS surveys at this station.

During the time of the 2011 Caltrans survey, the station mark, reference mark 3, and the unstamped reference mark were all recovered in good condition.

SAN JUAN (NGS PID DX4280)
The word “monument” conjures certain images. For a surveyor, a monument could mean anything from a wooden stake to a CORS site, but put plainly it is a survey marker. Anecdotally (and with good humor), it has been suggested by some that larger monuments are more important that smaller ones. Perhaps this has more to do with human psychology than anything, but occasionally as surveyors, we come

Below: The GNSS setup located at station SAN JUAN, located in Chino Hills State Park. Please note one of two remaining tripod stands located to the left of the triangulation pier. Above right: A tarantula during its mating season in the Chino Hills. Images courtesy of Mr. Jeffrey Stevens, P.S.
across a monument that can only be described as special. These special monuments could be an initial point in the public lands survey system or an important geodetic station—they are monuments of pedigree. Whether one calls it ‘station,’ ‘mark,’ or ‘monument’ its history is so impressive that the monument itself commands respect. These types of monuments are located in all parts of the world and become part of the fabric of surveying in that location. SAN JUAN is one such monument because of its historic significance earned as the basis for many horizontal control surveys in southern California.

Located in Chino Hills State Park near the boundary between Orange and San Bernardino Counties, SAN JUAN has the distinction of being one of a few geodetic stations located in southern California dating from the 1800s that remains in its original condition. Originally set as a primary triangulation station in the ‘Thirty-Ninth Parallel to United States-Mexico Boundary Arc’ survey, SAN JUAN once served as an important hub for horizontal geodetic surveys located in Los Angeles, Orange, Riverside, and San Bernardino Counties. During the classical era of geodetic surveying, SAN JUAN was used during no fewer than nineteen horizontal control surveys identified in the NGS database including several Caltrans surveys.

Station SAN JUAN shares several similarities with its Ventura County counterpart, SANTA CLARA, one being that we do not have a description of the original station mark from those who first set it. First described by an anonymous USC&GS author in 1933, the

“… station pier can be seen on highest hill some distance before reaching it. In 1886 underground mark was cross in copper bolt leaded into drill hole 2 ½ feet below surface. Surface mark was probably large stone. In 1896 hexagonal concrete pier, 26 inches across and projecting 3.1 feet above surface, was erected, and copper bolt with cross was placed in top.”

Although some of the reference marks have been lost, the station mark itself remains essentially the same as it did from the 1896 triangulation survey by the USC&GS. As recovered during the 2011 Caltrans densification survey, SAN JUAN is described as a

“… ¾ inch diameter, center-punched, bronze bolt set flush atop a finished concrete pier. The concrete pier is 2.1 feet wide and hexagonal-shaped, projecting 3.3 feet above the ground. The concrete pier has ‘SAN JUAN 1896’ inscribed on its north face and ‘US CG (SUR) VEY’ inscribed on its south face. Reference marks 5 and 6 were recovered in good condition.”

Although there are never guarantees when it comes to the permanence of survey monuments, it is likely that SAN JUAN will exist for a very long time because it is located on an isolated hilltop in a state park.

In the next installment, we will discuss Los Angeles Base SE…

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