

SADLER SUPP_2

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Pre-1905 Discharge of Select Springs, Diamond Valley, Eureka County, Nevada



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Purpose and Overview

The flow rate of 7.02 cfs given to Big Shipley Spring in the Proposed Order is based on discharge measurements in made in the mid-1960s. There is a difference between the earliest reported spring discharge from Big Shipley Spring (1912-1940) and historical discharge measurements commencing in the mid-1960s (Figure 1). The purpose of this report is to compile available information to relate early reported discharge with later reported discharge, for the purpose of determining a pre-1905 spring discharge. The pre-1905 discharge is important to establish for the duty of vested rights to spring flow from the Big Shipley Spring source, as the spring was deemed to be fully appropriated in early 1900s.

As will be demonstrated herein, it is unlikely that discharge measurements from the mid- to late-1960s are representative of pre-1905 discharge. Artesian and pumped wells were drilled in the 1940s to mid-1960s both to the north and south of the spring. Drawdown propagates readily through the aquifers on the west side of the playa based on present-day observations. Principles of hydraulics of well discharge, dictate that well discharge produced some potentiometric head lowering at the spring. When taking into account the physical changes to the spring environment, discharges observed in the mid to late-1960s are concluded to have been less than pre-1905 discharges.

Reported Big Shipley Spring discharges from several sources from 1912 to 1940 range from 8 to 15 cfs, and average approximately 12 cfs. The most reliable source of reported discharge near to the time frame of pre-1905 is 12.5 to 15 cfs, made by an irrigation engineer that spent several days on the farm mapping the Big Shipley Spring source and routing of flows (Nickerson, 1912). H.N Payne, an engineering staff from the State Engineer's office also visited the spring in 1912, but appears to have only made a brief inspection of the Sadler Ranch and Big Shipley Spring along with other ranches over a 20-mile distance on the west side of the playa. His estimate of 8 cfs, or a little more, has low reliability, in part due to the nature of the reported inspection. Several other sources reporting Big Shipley Spring discharge corroborate the irrigation engineer estimate of discharge, ranging from 11 to 15 cfs.

Springs north and south of Big Shipley Spring were also affected by early development of artesian and pumped wells, prior to discharge measurements by Harrill in 1965 and 1966. A well was drilled near Eva Spring in 1960, and was both pumped and produced a significant artesian flow. Indian Camp Spring located south of Big Shipley Spring was also affected by well drilling, but trenching at the spring makes it less clear as to how flow observations in 1961 and 1965-66 compared with pre-1905 conditions.

This report reviews data and information available from which the above conclusions are drawn.

Introduction

Sadler Ranch is located on the northwestern side of Diamond Valley, west of the extensive playa that occupies the northern valley floor (Figure 2). The history of well drilling in Diamond Valley dates back to the 1940s with the drilling of artesian wells on the west side of the playa on the Romano Ranch (Figure 3).

The perennial yield of Diamond Valley is estimated at 30,000 acre-feet per year (af/yr). In the late 1950s and early 1960s, a major agricultural center was established in southern Diamond Valley through Desert Land Act claims (Figure 2). As a result, Diamond Valley became significantly over-appropriated, and pumping has been greater than the defined perennial yield for the basin for about 45 years. Approximately 134,000 af/yr of underground water rights are currently permitted, with consumptive use by agriculture estimated at approximately 76,000 af/yr (see Nevada State Engineer Order 1302, January 11, 2019, adopting the Diamond Valley groundwater management plan). Drawdown from the pumping encroached into northern Diamond Valley and has captured all spring discharge that previously existed (in abundance) in northern Diamond Valley at historic ranches (Figure 3).

The degree of drawdown stemming from the southern Diamond Valley agricultural area is extensive, and has exceeded 100 feet in the center of the agricultural area. Drawdown encroached along the west side of playa as early as the mid-1960s to early 1970s. The trend of drawdown continues to present day, as illustrated by the water level data collected by Eureka County at the Bailey Ranch, located approximately 2.5 miles south of Big Shipley Spring (Figure 4).

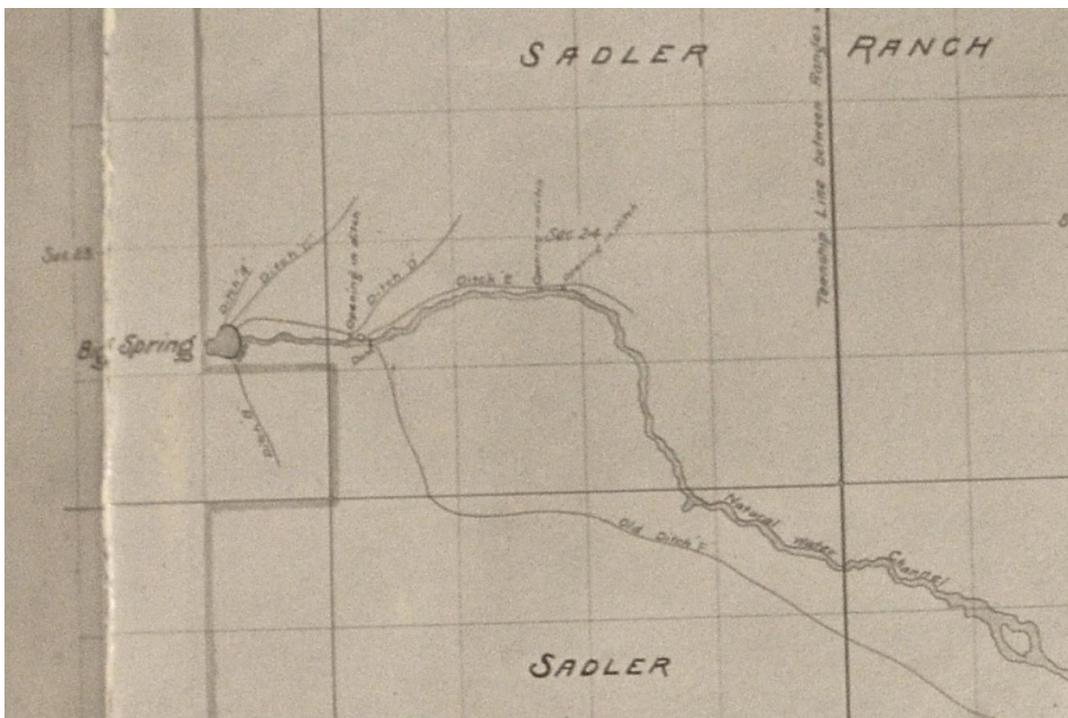
Documentation regarding the development of groundwater in Diamond Valley, the degree of pumping and over-appropriation of groundwater rights, and drawdown impacts stemming from the southern agricultural center have been provided to the Nevada State Engineer (see Interflow, 2013b) in the mitigation water right hearing for the Sadler Ranch and Big Shipley Spring (applications 81719, 81720, and 82268). Big Shipley Spring has been granted a mitigation right to pump groundwater totaling approximately 5,100 af/yr, with a diversion rate of 7 cfs. Additional information on hydrogeologic conditions in Diamond Valley may be found in a number of reports published by the U.S. Geological Survey (USGS) (Harrill, 1968; Artega, 1995; Tumbusch, et al, 2006; Knochenmus, et al, 2011; and Berger, et al, 2016).

Claim V-03289 Big Shipley Spring

1912 to 1940 Reported Big Shipley Spring Discharge

Early spring discharge, representative of pre-1905 conditions, is reported over a wide range, between 8 to 15 cubic feet per second (cfs). Cubic feet per second is also referred to as second-feet, and is equal to 448.9 gallons per minute (gpm). The following archives of reported discharge from Big Shipley Spring have been identified.

1. On March 1-3, 1912, George B. Nickerson, irrigation engineer and surveyor with 25 years of experience, made inspections and surveys of Big Shipley Spring, conveyance ditches and diversion works extending down to the lower Romano field (under litigation at the time). In a signed affidavit dated March 7, 1912, Mr. Nickerson reports observing an estimated flow from Big Shipley Spring ("*Big Spring*") of 12.5 to 15 cfs, reported as "*500 to 600 miners inches of water, on a basis of 40 miners inches being equal to one second-foot of water.*" The surveyed map prepared by Mr. Nickerson depicts the Big Shipley Spring pond to be similar in geographic configuration as present day, except that four diversions were present (labeled A-D, see below), and only two pond outlets exist today.



Portion of Nickerson (1912) map

2. In November 1912, H.M. Payne from the Nevada State Engineer's office visited the Sadler Ranch. Mr. Payne's visit appears brief as compared to Nickerson's multi-day effort. Mr. Payne's field notes of November 18, 1912 indicate he inspected all the ranches on the west side of the Diamond Valley playa, spanning from the Romano Ranch at south end of the playa to the Flynn Ranch, north of the Brown Ranch approximately 7 miles (Figure 2). Mr. Payne stated in his field notes: *Two and one half miles beyond Bailey's is the Sadler Ranch, which is irrigated from a large spring know as Big Shipley Spring. I intended to take an accurate measurement of the source, but was unable to do so on account of there being a break in the dam at the reservoir, and the water not confined to any one channel. By an estimate, I should place the flow of this spring at about 8 sec. ft. or a little more.*
3. Court proceedings in 1913 and 1917 between Romano and Sadler, and Eccles and Sadler,

respectively, made determinations of 1/3 of the Big Shipley Spring discharge being allocated to the parties other than Sadler, quantifying 1/3 of the flow as 5 cfs. These court rulings relied upon a determination of the total spring discharge being 15 cfs, the upper value of the range reported by Nickerson in March of 1912.

4. Alfred Sadler stated in 1931 correspondence regarding a ranch inventory that *“the springs supply 13 second feet of water, which runs in the reservoirs and ditches”* (within the Sadler vs. Sadler, 1947 litigation, U.S. Court of Appeals 9th Circuit No. 11715).
5. The USGS reported Big Shipley Spring discharge at approximately 11.1 cfs (5000 gallons per minute – gpm) in the publication Thermal Springs of the United States, by Stearns, Stearns, and Waring (1937), citing a source for the reported discharge as an 1875 USGS report, an 1886 USGS bulletin, and “data in the files of the USGS.”
6. Floyd Slagowski who worked on the Sadler Ranch from 1937 to 1940 reported that Big Shipley Spring discharge was *“about 12 second feet”* (McCracken, 1993).

The average of the reported discharge cited above is 12 cfs. The Nickerson (1912) estimate of discharge from the Big Shipley Spring is the most thoroughly documented in the available early records.

History of Diamond Valley Artesian Well Drilling in the 1940s – 1965

Development of wells along the west side of the playa in the 1940s-1960s impacted the discharge of Big Shipley Spring along with discharge from other springs in the vicinity. There is a hydraulic connection of aquifers and springs along the west side of the playa. Drawdown by discharge from wells reduced the differential head driving spring flow, and thus decreased spring discharge. The process of drawdown reducing potentiometric head and decreasing spring discharge is generally termed spring flow capture.

Hydraulic connection in the aquifer is demonstrated by the progressive lowering of water levels in observation wells along the west side of the playa as a result of encroaching drawdown from the southern agricultural pumping center. No pre-existing spring along the southern half of the Diamond Valley playa has been spared from spring flow capture, demonstrating that there was no spring occurring from a hydraulically isolated flow system. Figure 4 shows water levels at the Bailey Ranch. The regional drawdown trend from southern agriculture pumping is observed as a long-term declining trend of water levels of about 0.5 ft/yr.

Drawdown response through the aquifer on the west side of the playa is also observed to be a rapid traveling phenomenon, based on pumping tests at the Big Shipley Spring mitigation well (Interflow 2013a), and observed pumping responses to the use of the mitigation well observed at the Bailey Ranch (Figure 4). The rapid travel of drawdown and significant magnitude indicates a confined aquifer with high transmissivity. Similar to current observations, the drawdown response to drilling

of artesian wells and early pumping of wells in the time frame of the 1940s – mid-1960s would have also produced at drawdown signal at Big Shipley Spring.

Harrill (1968) reported a total of seventeen (17) flowing wells on the western side of northern Diamond Valley, fifteen (15) of which were located on the Romano Ranch, in field inspection notes made on November 18, 1965. The documented artesian wells were located approximately 1 to 4.5 miles from Big Shipley Spring. The history of this early well drilling is examined below. Two (2) additional artesian wells were located approximately 10 miles north of Big Shipley Spring on the Flynn Ranch, but are likely too far away to have had measurable drawdown effect at Big Shipley Spring.

Wells at the Romano Ranch

In the 1940s, several artesian wells were drilled on the Romano Ranch, approximately 4 miles south of Big Shipley Spring (Figure 2). The artesian wells were used to augment flow from springs on the northern portion of the ranch that had been used for many decades, including Siri Spring, Romano Springs, House Springs, and a number of unnamed springs south of the ranch house and north of Tule Spring (springs identified in the 1983 affidavit of Dante Siri included with proof filings V04471-V04480). Tule (or Tule Dam) Spring and Sulphur (or Sulphur Station) Spring were additional large spring sources used for irrigation and stockwatering on the southern part of the Romano Ranch, south of the artesian wells. The history of drilling of the artesian wells is incomplete, with available information summarized below. Figure 2 shows the location of referenced ranches and wells.

1. Eakin (1962) reported that several artesian wells were drilled in about 1943, with initial discharge of 600 gpm, later diminishing to about 200 gpm.
2. Artesian flows measured by the USGS in October 1947 totaled 250 gpm from three (3) wells at the time owned by Florio (Romano Ranch) (USGS fieldwork notes on file in Carson City, NV).
3. Nevada Division of Water Resources (NDWR) well logs filed in 1948 and 1949 for A.C. Florio (Romano Ranch) indicate artesian well discharges from 0.5 to 1.5 cfs, and totaling 4 cfs (1,800 gpm) (NDWR Well Logs #509, 625, 626, 627, and 1037; note 1.5 cfm on well log 1037 is assumed to be cfs, a common unit for rate of discharge, rather than cubic feet per minute, a rarely-used unit for rate of discharge).
4. The supporting map for water right application 17273, filed July 29, 1957, shows ten (10) wells on the Romano Ranch, which were later documented by the USGS to be artesian wells (see next bullet), and also indicates that one of the wells was being pumped on the ranch at that time. No information regarding the magnitude of pumping is provided.
5. On November 18, 1965, Jim Harrill with the USGS measured a total combined discharge from fifteen (15) artesian wells on the Romano Ranch at 521 gpm (1.2 cfs) (USGS fieldwork notes on file in Carson City, NV). Four (4) of the wells documented by Harrill were located

on the northern-most part of the ranch, just south of the Bailey Ranch, and approximately 3 miles south of Big Shipley Spring (Figure 1).

It is likely that the majority of the potentiometric drawdown caused by the artesian wells drilled in the 1940s and 1950s on the Romano Ranch established equilibrium with reduced spring discharges at closer proximity springs. However, the hydraulic connection of the western aquifer suggests that some associated drawdown also extended to Big Shipley Spring. The drawdown would have traveled through the aquifer rapidly, and equilibrated with spring flow capture rapidly, within a matter of months to a couple years, based on degree of hydraulic connection and aquifer properties. Ultimately, due to progressive regional drawdown that encroached from the southern Diamond Valley agricultural center, all artesian wells and all springs on the Romano Ranch ceased to flow between the time frame of 1965 to 1972 (see vested claim proofs V04471-V04480). A reduced scale of agriculture has continued on the Romano Ranch using pumped wells and transferred underground water rights granted in 1987 and 1988 (Permits 50961-50963).

Wells at the Sadler Ranch

One flowing well is reported on the northern part of the Sadler Ranch (“Middle Well”, see Figure 2) drilled in May 1960, and located approximately 1 mile north of Big Shipley Spring. This well was drilled to 135 feet in alluvium (sands, clays and gravels that make up the main basin-fill aquifer) with a screened interval from 70 to 135 feet. The well had a reported artesian discharge of 400 gpm (0.9 cfs) when it was drilled, and a pressure head of 14 feet above land surface, as noted on the driller’s well log (NDWR Well Log #5526). Reported flow from the Middle Well had decreased to 100 gpm (0.2 cfs) in November of 1965 (Harrill fieldwork notes). There is no known history of pumping from this well.

Additionally, a small artesian well was drilled in December 1958 (NDWR Well Log #4438) on the eastern portion of the Sadler Ranch (see Figure 1, near the playa edge) for stockwater supply, with a reported artesian discharge of 10 gpm. This well is not documented in Harrill (1968).

Wells at the Brown Ranch

One flowing well is reported in Harrill (1968) on the Brown Ranch (Harrill ID 24/53 – 6BDAB). The well was drilled in May of 1960, completed with 14-inch diameter casing, and produced an initial artesian discharge of 400 gpm (NDWR Well Log #5527). The well was drilled to 190 feet in depth and terminated at the top of limestone bedrock. The well screens alluvium between 30 to 172 feet. Water produced from the well is mildly geothermal at 80° F. Harrill (1968) reported artesian discharge from this well in December 1965 at 200 gpm (0.45 cfs), and noted that the well was pumped at 800 gpm (1.8 cfs) during the irrigation season. It is not precisely known when pumping began from the well, but it is assumed it may have been in the summer of 1960, following well drilling. A water right for irrigation was not issued at this well until 1967 (Permit 22885, abrogated by 50581).

Development of wells on the Brown Ranch likely captured some flow from Eva Spring, the historical

source of water to the Brown Ranch (V02658 indicates historical discharge of 2.1 cfs; Harrill measured discharge in December 1965 at 0.56 cfs). Artesian discharge (and probably pumping) from the Brown Ranch well commenced in 1960, and also produced some drawdown at Big Shipley Spring, located 3.5 miles to the south (Figure 2), based on hydraulic connection of the aquifer.

Summary of 1940s to 1965 Well Drilling and Discharges on the West Side of the Playa

Figure 5 plots a reconstructed time-line of cumulative well discharge from 1943-1965. Figure 6 annotates the time-line of well discharges with the data sources. Discharge from known wells ranged from 0.5 to 4.5 cfs during this time period. In 1965, the estimated discharge from wells on the west side of the playa is approximately 3.5 cfs.

Claim V03290 Indian Camp Spring

Indian Camp Spring is located about 1 mile south of Big Shipley Spring (Figures 2 and 4). Indian Camp Spring was also a historically significant source of irrigation water on the Sadler Ranch. Aerial photography from 1946 illustrates that the spring was comprised of over a dozen springs and seeps emanating along a fault scarp.

Thomas Eakin, in September 1961, observed that the spring had been developed via a north-south trench cut parallel to contour and was producing an estimated flow of 1.5 to 2 cfs (USGS field notes at Carson City). Harrill (1968) reports discharge from Indian Camp Spring as 0.66 cfs in December 1965, and 0.82 cfs in April 1966 (Table 9, 24/52-26d "Unnamed"). Discharge is believed to have been warm, about 80°F, similar in temperature to Sulphur Spring to the south and Eva Spring on the Brown Ranch to the north.

Similar to Big Shipley Spring, the drilling of wells along the west side of the playa in the 1940s to mid-1960s time frame is predicted to have had some initial impact to spring discharge, latter followed by regional drawdown encroachment from the southern Diamond Valley agricultural center. Indian Spring appears in aerial photography to have been impacted in the 1970s and dry by the mid-1980s. Depth to groundwater near Indian Camp Spring (Indian Camp Cistern, Figure 2) was observed to be 13 feet below land surface in 2013.

Pre-1905 spring discharge was probably greater than observed by Harrill in 1965-66, due to the effects of wells developed along the western playa. However, it is unclear if earlier trenching development of the spring source augmented the flow, resulting in Eakins 1.5 – 2 cfs observed discharge. Discharge from the spring if not being diverted to irrigation to fields directly east of the spring, would have flowed down to the lower southern field irrigated by Big Shipley Spring water, becoming a comingled source of water.

Claim V10918 Shipley Spring #2

A spring historically existed about 1000 feet south of Big Shipley Spring (Figure 8), which is actually

labeled on USGS topographic maps as Big Shipley Spring. Today, this spring feature is a dry depression of approximately 150 feet in diameter. Remnants of a collection system (vertical pipe) and water distribution piping from this southern spring source are still present. This spring is referred to in this document as Shipley Spring #2. This spring source is not included in historical Big Shipley Spring discharge measurements made by the USGS, as USGS protocol is to assign a separate site ID number to separate spring sources.

Aerial photography indicates that this spring began going dry by the early 1970s (1973 photography shows the spring notably drier than the 1967 photography) and appears completely dry by the mid-1980s. Observations at this spring support the interpretation that drawdown impacts from the southern agricultural center had extended to the Sadler Ranch by the 1970s.

An unnamed spring also of apparent significance was also situated 1500 feet south-southeast of Big Shipley Spring and appears to have provided a source of water to adjacent fields irrigated by Big Shipley Spring along irrigation Ditch B (Figure 7). This spring also appears to progressively dry in the 1970s and 1980s.

Discharge quantities from these springs are unknown, but under natural and developed conditions would have produced flow to the down-gradient lands, comingled with Big Shipley Spring water conveyed in irrigation Ditch B. Piping from the #2 spring suggests the flow rate may have been perhaps ½ cfs, or greater.

Claim V02658 Eva Spring

Development of a well on the Brown Ranch located approximately 2,000 feet north of Eva Spring captured a portion of spring discharge by the time of the 1965 measurement by Harrill (0.56 cfs). In 1965, Harrill reported that the well was pumped at 1.8 cfs, with an artesian flow of 0.45 cfs. Spring flow capture was occurring, the magnitude of which is unknown, but may have mid-range of the pumped and artesian flows. Therefore, a pre-1905 discharge of approximately 1.5 cfs is estimated and generally compares with the V02658 claim of 2.1 cfs.

Conclusions

Spring discharge measurements in 1965 and 1966 do not represent pre-1905 conditions for Big Shipley Spring, and other springs on the west side of the Diamond Valley playa. Drilling of artesian wells and pumped wells from the 1940s to mid-1960s caused drawdown along the western side of the playa, though a hydraulically connected high-transmissivity and confined aquifer system. Drawdown from large-scale pumping in southern Diamond Valley, commencing in the late-1950s and early 1960s may also have begun encroaching along the west side of the playa by the time of the 1965-1966 measurements.

For Big Shipley Spring, historical reports of spring discharge from Big Shipley Spring prior to 1940

average approximately 12 cfs. The most reliable estimate to associate with pre-1905 flow of Big Shipley Spring is the 12.5-15 cfs reported by Nickerson in 1912. Mr. Nickerson was a highly qualified irrigation engineer, spent a significant amount of time at the ranch, and attested to the estimate under penalty of perjury. His reported flow rate range also correlates with all but one of the pre-1940 reported values, including estimates published in official United States government publications.

Springs south of Big Shipley Spring, were smaller sources, but contributed water to the Sadler Ranch. No measurements of flows are available from these sources, but based on remnants of a collection system and piping at Shipley Spring #2 may have provided about 0.5 cfs. Discharge from Indian Camp Spring was observed in 1961 and 1965-66, ranging from 0.66 to 2 cfs, and while used for irrigation of a field directly to the east of the spring, historically would have produced discharge down to the lower southern fields of the Sadler Ranch. Discharges from Indian Camp Spring observed in the 1960s were also affected by trenching to collect flows, the effects of which are unknown as contrasted with pre-1905 conditions.

Discharge from Eva Spring on the Brown Ranch was affected by an artesian and seasonally pumped well near the spring, by the time that Harrill made a discharge measurement of 0.56 cfs in 1965. The nearby well was pumped at 1.8 cfs, and had an artesian flow of 0.45 cfs, which at the time had to have been resulting in a degree of spring flow capture. A pre-1905 discharge of 1.5 cfs is estimated.

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Historical Big Shipley Spring Discharge

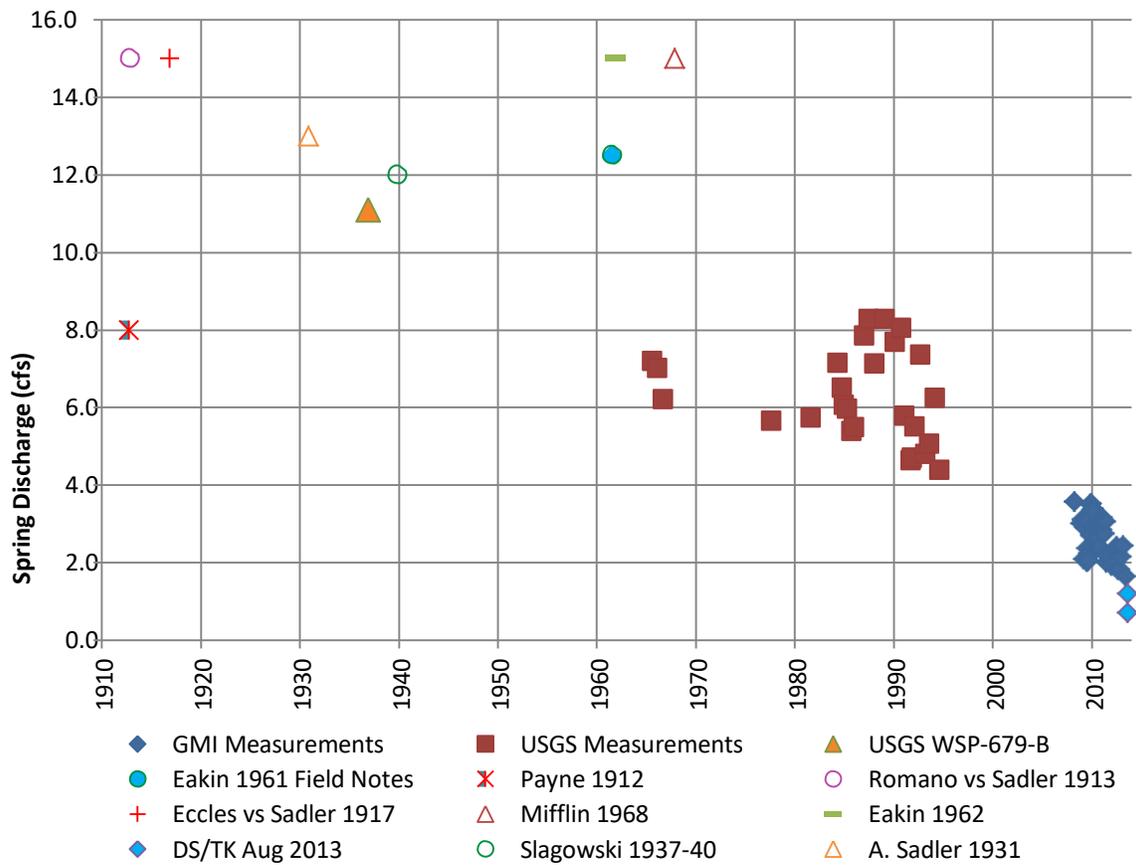


Figure 1 – Big Shipley Spring Discharge Measurements and Reported Discharge, 1912 to 2013

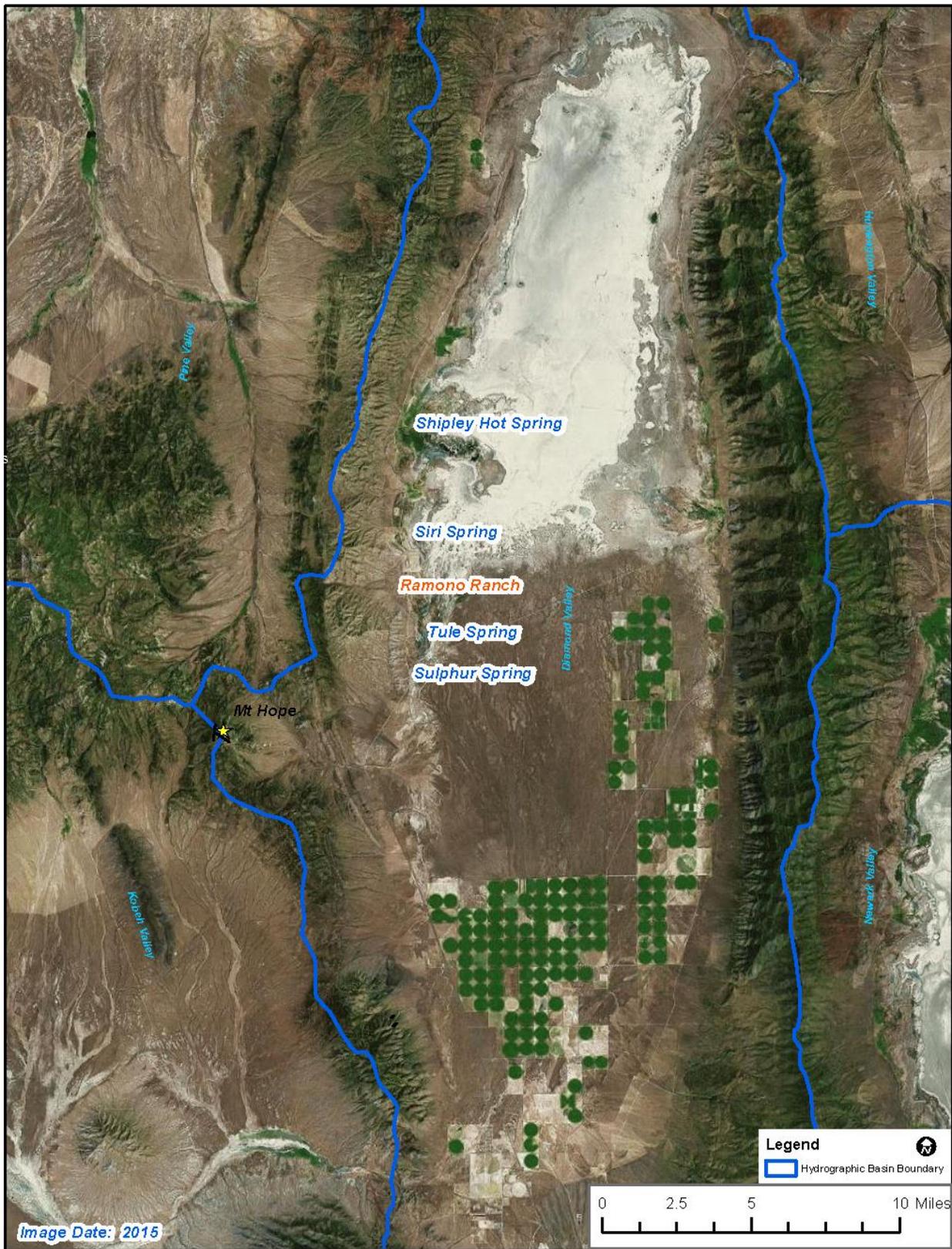


Figure 2 – Satellite image of Diamond Valley, Eureka County, Nevada

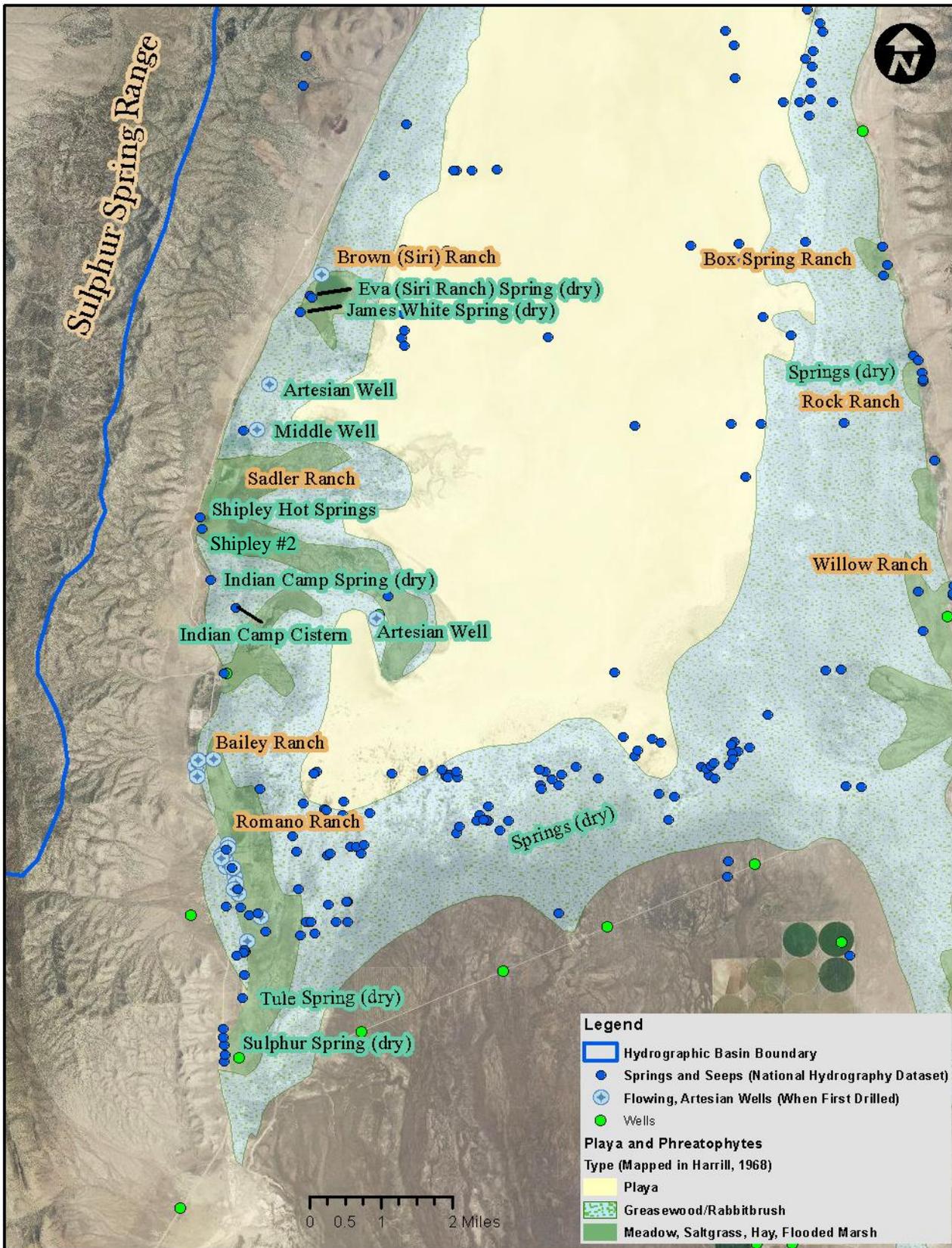


Figure 3 – Big Shipley Spring Location Map, Diamond Valley, Eureka County, NV

Bailey Stockwater Well

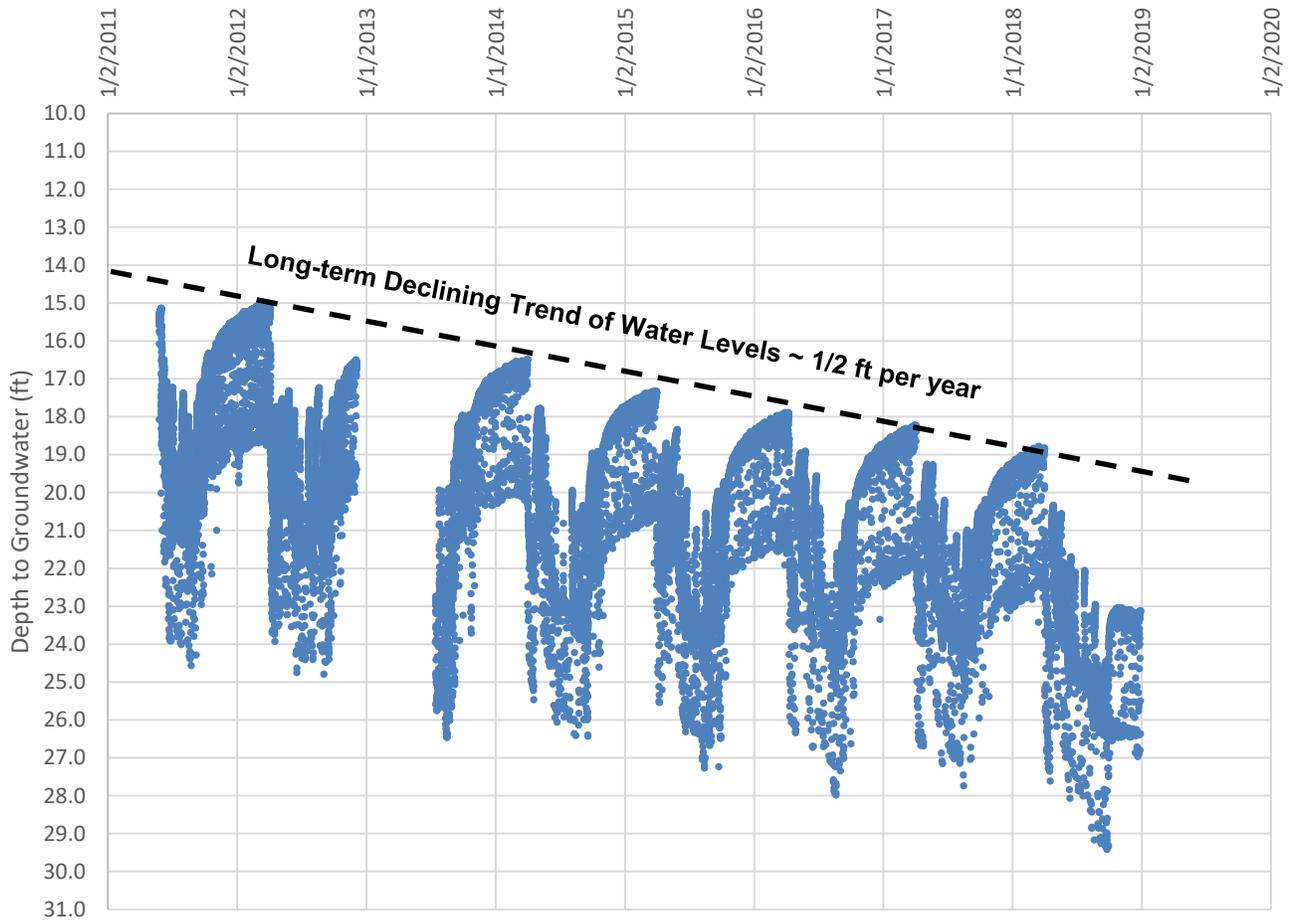


Figure 4 - Water Level Monitoring Data at the Bailey Stockwater Well – Data Collected by Eureka County

**Cumulative Groundwater Development - West Side of Diamond Valley near Big Shipley Spring
1943 - 1965**

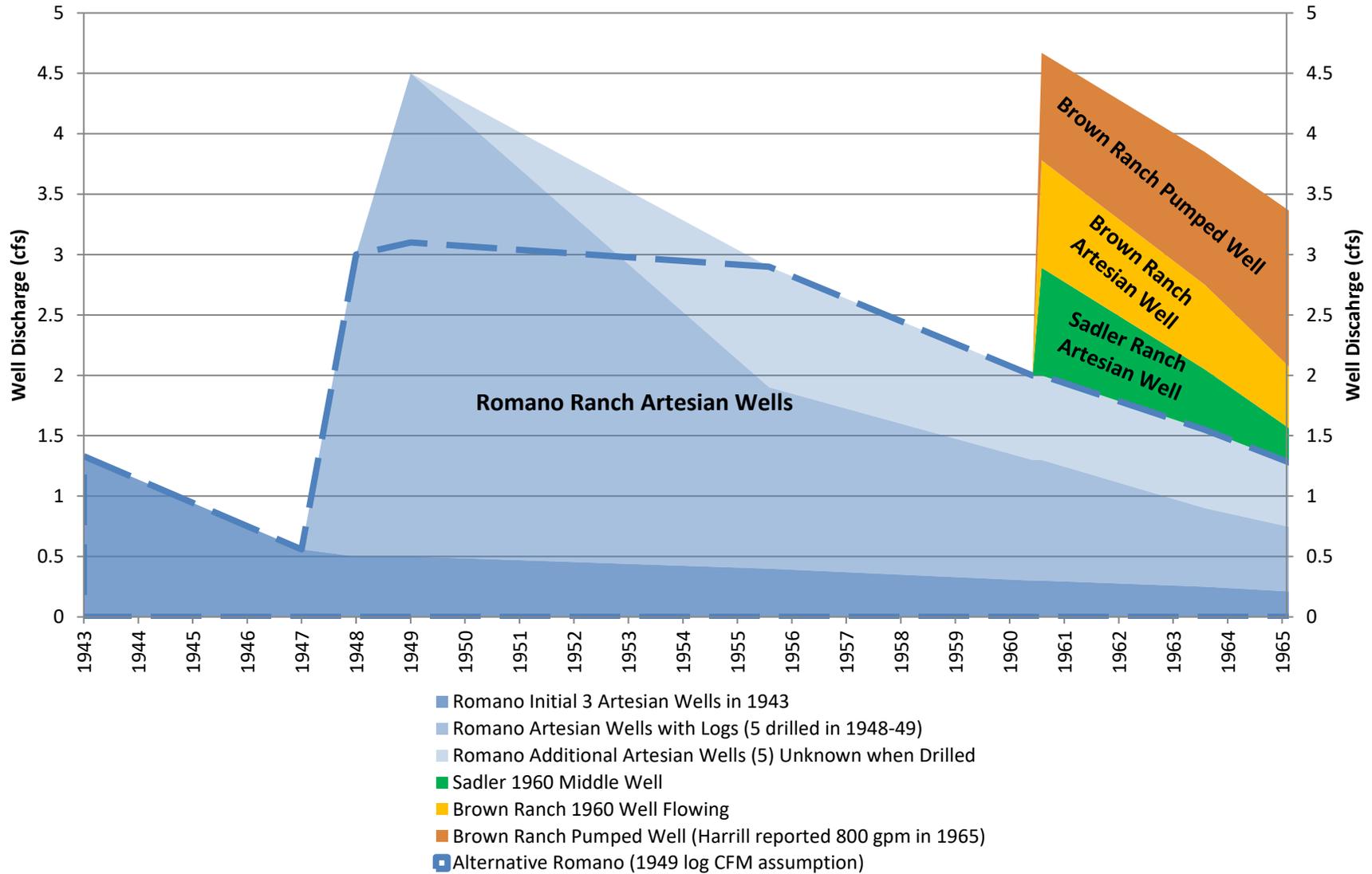
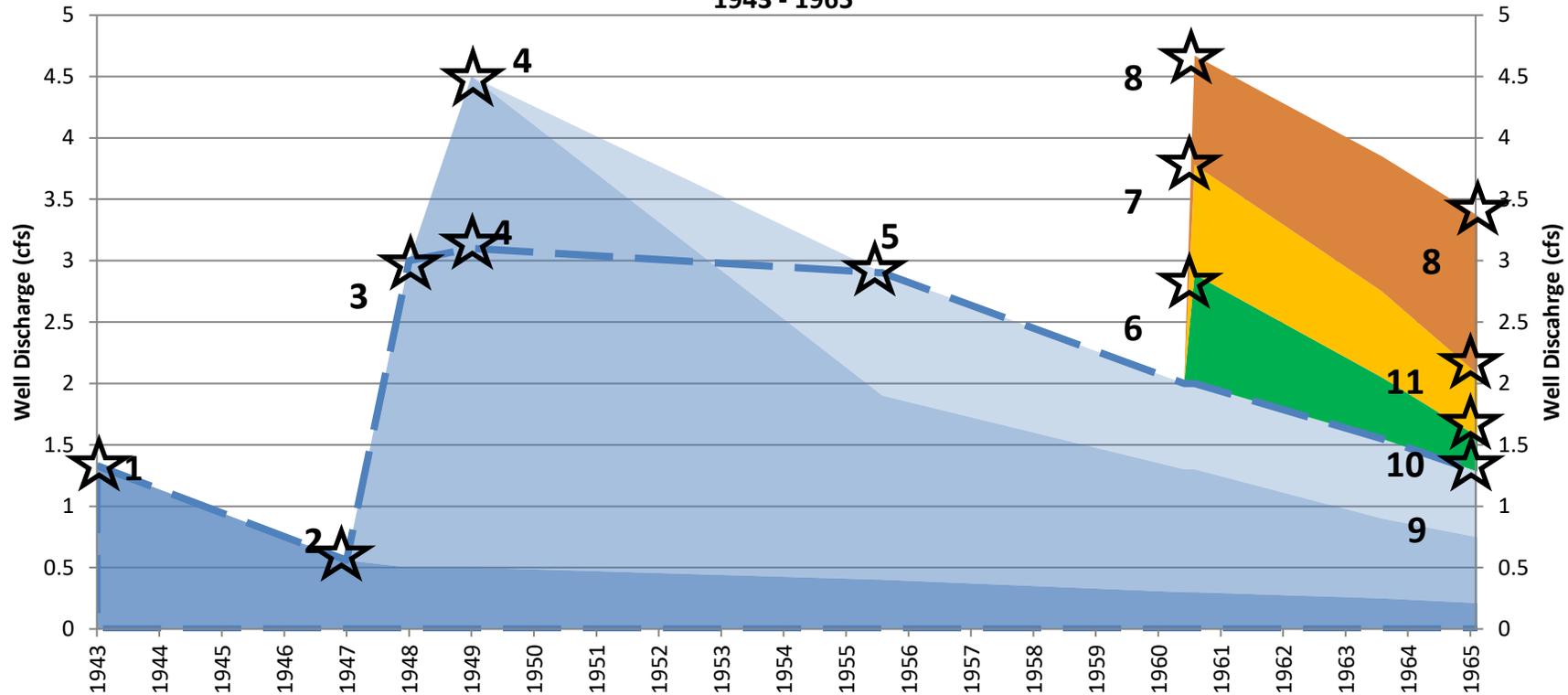


Figure 5 – Reconstructed Historical Flow from Wells near Big Shipley Spring, 1943-1965

Cumulative Groundwater Development - West Side of Diamond Valley near Big Shipley Spring 1943 - 1965



- 1.) Eakin (1962) reports artesian wells first drilled on Romano Ranch in 1943 with initial discharge of 600 gpm
- 2.) USGS Field Notes from October 1947 document 3 artesian wells on Romano Ranch discharging 250 gpm
- 3.) NDWR well drillers logs filed in 1948 for 4 artesian wells on Romano Ranch with reported combined discharge of 2.5 cfs
- 4.) NDWR well drillers log filed in 1949 for 1 artesian well on Romano Ranch with report discharge 1.5 "cfm" (possible error, cfs, both shown)
- 5.) Five additional artesian wells drilled on Romano Ranch – no documentation of dates or initial discharge – assumed drilled in the 1950s (Supporting Map for water right application 17273 filed in 1957 shows ten total wells, Harrill in 1965 documented 13 artesian wells)
- 6.) NDWR well drillers logs filed in 1959 and 1960 for Sadler Ranch "Middle" well (initial discharge 400 gpm) and eastern stock well (10 gpm)
- 7.) NDWR well drillers log filed in May 1960 for one artesian well (14-inch diameter) on the Brown Ranch (initial discharge 400 gpm)
- 8.) Harrill (1968) in fieldwork notes from 1965 reports the Brown Ranch artesian well is additionally pumped at 800 gpm (assumed commenced in 1960)
- 9.) Harrill (1968) in fieldwork notes from 1965 measured 521 gpm discharging from 13 artesian wells on the Romano Ranch
- 10.) Harrill (1968) in fieldwork notes from 1965 measured 100 gpm discharging from the Sadler Ranch "Middle" well
- 11.) Harrill (1968) in fieldwork notes from 1965 measured 200 gpm discharging from the Brown Ranch artesian well

Figure 6 – Annotated Historical Well Discharge Plot

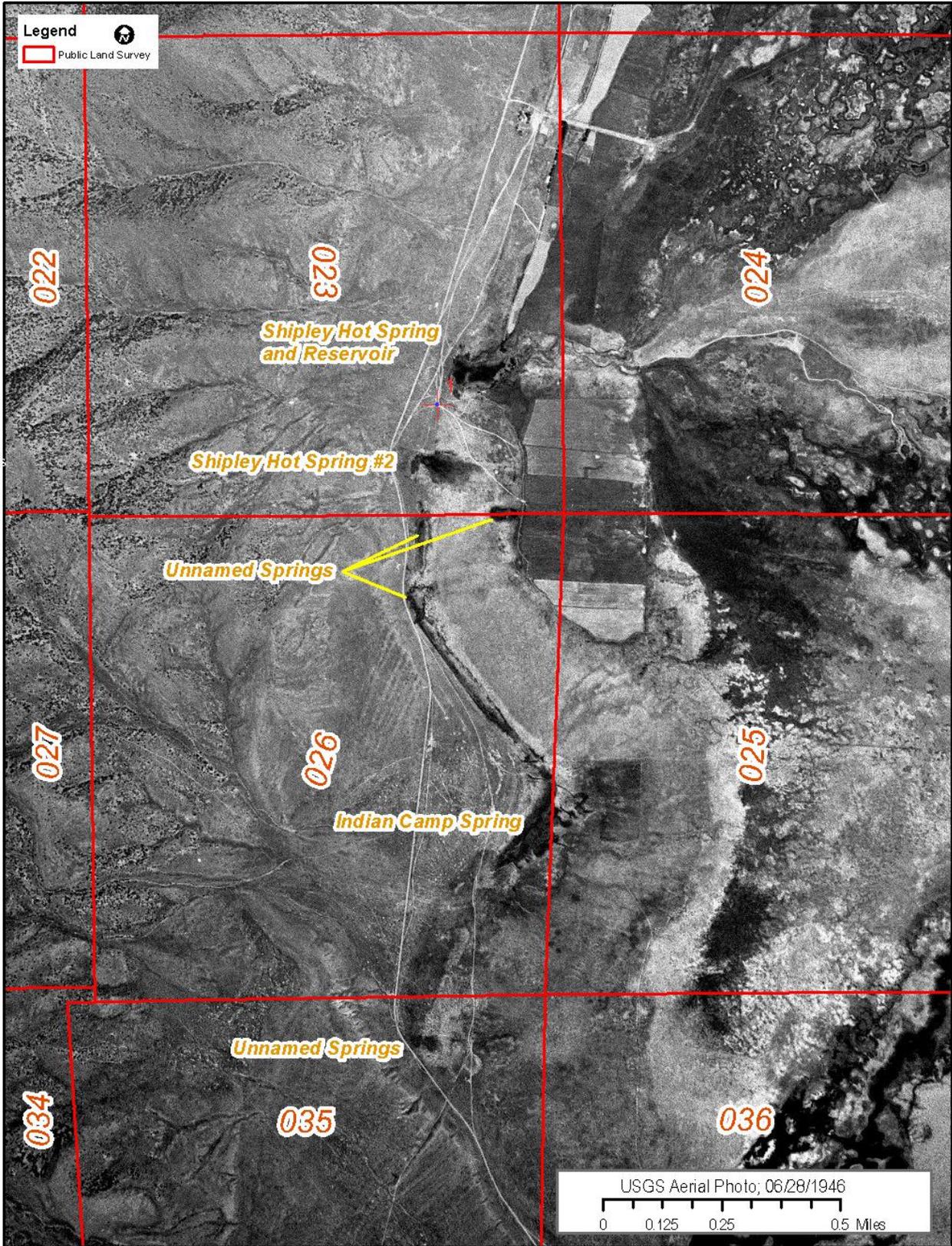


Figure 7 – 1946 Aerial Photograph of the Big Shipley Spring and Indian Camp Spring areas.