

**Hydrology and hydrogeology of the water-supply well at
Capulin Volcano National Monument, New Mexico**
Summary

The pump in the well at Capulin Volcano National Monument (CAVO) failed in July 2015. Subsequent investigations revealed that the water level in the well has declined about 18 feet since the well was constructed in 1962. Additionally, the bottom 26 feet of the well had filled with sediment, likely contributing to the failure of the pump. These events caused staff at NPS Water Resources Division (WRD) to investigate hydrologic conditions related to the well to determine the causes of these problems.

A review of previous hydrogeologic investigations in the area suggests that the well at CAVO draws water from the Capulin aquifer which extends to the south and west of CAVO. There are several irrigation wells completed in the Capulin aquifer. However, groundwater level monitoring data from two USGS observation wells do not show the same degree of water level decline as has been observed at the CAVO well. This suggests that the aquifer (cinders) from which the CAVO well draws water is not well-connected with the Capulin aquifer near the town of Capulin and the area west of town where the large-volume irrigation wells are located. We do not know the extent of the aquifer that is tapped by the CAVO well, nor do we know the source of recharge, the discharge area, the water budget, or very little else about the aquifer.

We have very little groundwater level data for the CAVO well. We do know that the water level declined 8 feet from when the well was constructed in 1962 to 1977 and an additional 10 feet from 1977-2014. If the water level decline continues, the park will need to plan for an alternative source within a few decades. Most likely that would be drilling a new, deeper well. The geologic log from the current well will be useful in planning the construction of a new well.

A video log of the well was conducted when the pump was pulled in July 2014. The log showed that the bottom 26 feet of the well had filled with sediment. Attempts to remove the sediment by jetting only succeeded in blowing the sediment back into the formation. No sediment was removed from the well. The sediment will likely migrate slowly back into the well, eventually filling the well to the level of the pump and causing another pump failure.

If the water level in the well stabilizes, we can follow a routine of jetting the well every 5 years to remove the sediment from the well to protect the pump and maintain production. The cost of removing the pump and jetting the well is a small fraction of the amount to construct a new well. It's unlikely that the existing well could be fixed to prevent continuing influx of sediment because of its diameter, depth, and the need to place the pump in the perforated interval to keep the pump intake below the water level.

Larry Martin
NPS Water Resources Division
Ft. Collins, CO, March 2015

Capulin Volcano National Monument, New Mexico

Including discussion of declining water levels in the well, sediment filling the bottom of the well, and repair/rehab of the well in July 2011.

Introduction

In July 2014, the pump failed in the water-supply well at Capulin Volcano National Monument (CAVO) (Figure 1). Subsequently it was learned that there had been a significant water level decline (18 feet) in the well from when it was constructed in 1962. Additionally, the bottom 26 feet of the well had filled with sediment. This report was written to compile all the formation that could be found regarding the hydrology and hydrogeology of the well and aquifer in one place.



Figure 1. Location of Capulin Volcano National Monument in northeastern New Mexico.

Previous investigators (Hart and Smith, 1979; Trauger and Kelly, 1987) described the Capulin aquifer as including the cinder aquifer at CAVO and the alluvial deposits to the west of the town of Capulin. Analysis of water level data in the area (described later in this report) suggests that the cinder aquifer might not be hydraulically connected with the alluvial aquifer. In the future, comparison of geochemical analyses of groundwater from the CAVO well completed in the cinder aquifer with groundwater from wells completed in the alluvial aquifer will further aid in the determination of hydraulic connection.

Hydrogeology

The origin of the Capulin aquifer and the occurrence of groundwater in the alluvial and volcanic sediments is a result of the Quaternary volcanic activity in the Raton basin. Two episodes of volcanic activity in the early Quaternary covered the underlying bedrock formations with a blanket of basalt flows and cinders. The area was then deeply eroded by a drainage system similar to the present day Pinabete Creek drainage. The third episode of volcanic activity occurred in the late-Quaternary. A major eruption of basalt from Capulin Mountain filled the valley of Pinabete Creek, flowing northeast toward the present location of Folsom and blocked the surface drainage, creating a closed basin upstream (south and west) of Capulin Mountain. The thickest accumulation of sediments in the closed basin (greater than 125 feet) is centered under the town of Capulin. Hart and Smith (1979) opined that groundwater in the alluvial sediments in the Capulin basin is hydraulically connected with groundwater in the cinder aquifer at Capulin Volcano, but there appears to be no evidence to support that statement. The approximate surficial extent of the Capulin alluvial aquifer, as mapped by Hart and Smith (1979), is shown in Figure 2.

The alluvium that underlies most of the valley is relatively fine-grained in its upper portions, but consists of fine-to-medium grained sand and well-sorted gravel deeper in the valley. Scoria and cinders occur deeper in the sequence near the cinder cones. The deeper sediments (well-sorted gravel, cinders, and scoria) are very porous and transmissive and will yield large quantities of water to wells with minimal drawdown. The alluvium, cinders, and scoria constitute the principal aquifer of the Capulin groundwater basin. (Trauger and Kelly, 1987)

The bedrock formations that underlie the volcanic rocks and alluvium are sandstone, shale, and limestone of late Cretaceous age. These formations have a combined thickness exceeding 1,200 feet. They are mostly dense and relatively impermeable, except for the sandstone comprising the Dakota Sandstone which reportedly will yield as much as 25 gpm to a well. (Trauger and Kelly, 1987)

The geologic map of the area from Hart and Smith (1979) is included in this report as Figure 3. It shows the Capulin basalt flow (Qbc) filling the ancestral valley of Pinabete Creek between the towns of Capulin and Folsom. The trace of Cross-Section A-A' is highlighted on the map. Cross-section A-A' shows the relation of the water-supply well at Capulin Mountain to wells in the alluvial aquifer in the vicinity of Capulin and along the main axis of the aquifer from Capulin toward the west (Figure 4).

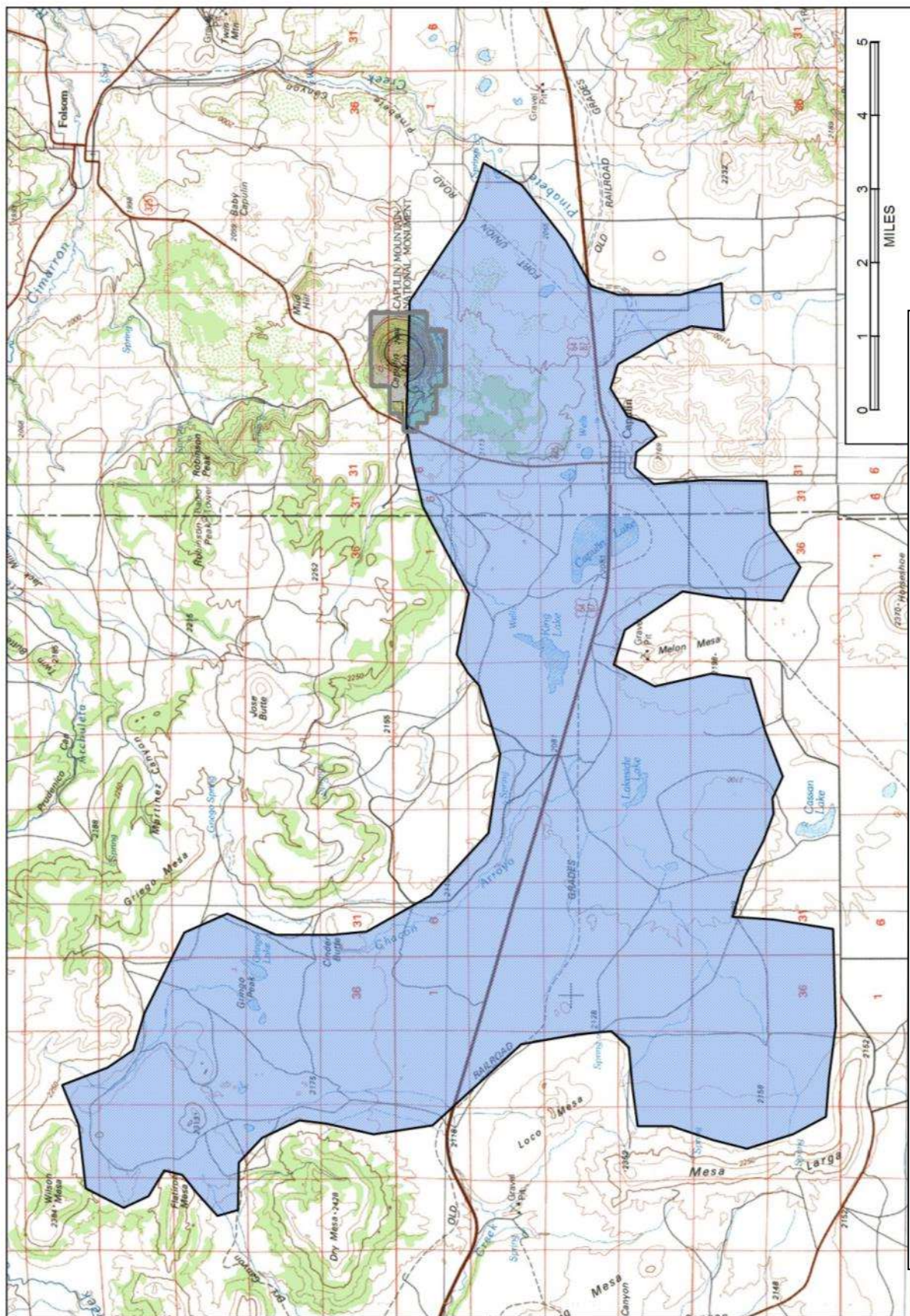


Figure 2. Approximate extent of the Capulin alluvial aquifer, from Hart and Smith (1979).

(from Hart and Smith, 1979).

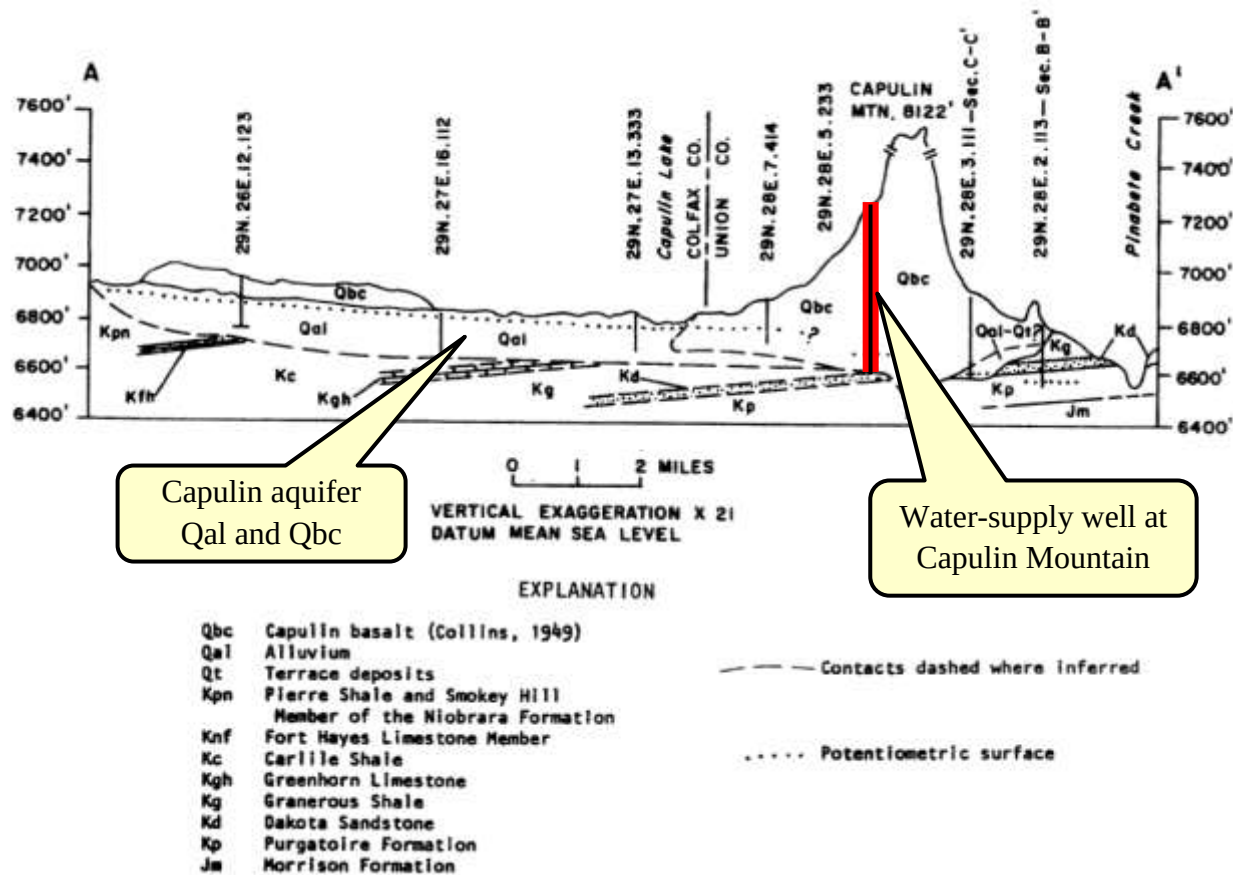


Figure 4. Cross-section A-A' through the Capulin aquifer, showing the relation of the water-supply well at Capulin Mountain to the alluvial aquifer in the Capulin area. Groundwater flow is from left to right in this cross section. (from Hart and Smith, 1979).

There are no existing geologic data to determine the potential hydraulic connection between shallow groundwater in the Capulin aquifer near the town of Capulin and groundwater in the cinder unit that has been tapped by the NPS water-supply well at Capulin Volcano. Water level monitoring data from wells near the town of Capulin and at Capulin Volcano suggest that the two aquifers might not be hydraulically connected.

Rawling (2013) conducted a hydrogeologic investigation of east-central Union County, approximately 40 miles east of Capulin Volcano. Rawling determined that there was very little local recharge from ground surface to the underlying aquifers. There were too many low-permeability layers in the geologic strata, preventing percolation of water to the underlying aquifers. Rawling hypothesized that most of the groundwater recharge occurred many tens of miles west of his study area, west of Capulin. He cited multiple lines of geologic, hydrologic, and chemical evidence to support his hypothesis.

It is possible that a similar recharge scenario is occurring at Capulin Volcano, where the deep cinder unit tapped by the NPS water-supply well (Figure 4) has limited hydraulic connection with the shallow Capulin aquifer in the vicinity of the town of Capulin. The geologic log of the NPS well shows several thick malpais layers (lava flows) which are often nearly impermeable. Multiple layers of lava flows overlying the cinders could greatly inhibit recharge to the cinder aquifer. If the aquifer is of some limited areal extent, it could be that groundwater pumping from the NPS well is slowly dewatering the aquifer. Regular monitoring of water levels in the NPS well may help determine the cause of the observed water level decline, or at least provide the park ample warning before the water supply is completely exhausted. Sampling and analysis of water chemistry and stable isotope from the NPS well and wells near the town of Capulin may allow age-dating the groundwater and help determine the hydraulic interconnectivity of the shallow Capulin aquifer and the deeper cinder aquifer.

Groundwater Flow

The direction of groundwater flow in the alluvial aquifer can be inferred from the potentiometric surface map (i.e., the water table map). Hart and Smith (1979) produced a potentiometric map based on water level measurements in January 1978. Blue arrows were added to the map to show the direction of groundwater flow (Figure 5).

Water in the alluvial deposits and the Capulin basalt are hydrologically connected. Groundwater flow is generally eastward, turning toward the northeast at the town of Capulin. The potentiometric surface map from Hart and Smith (1979) appears to show continuation of groundwater flow to the northeast in Cretaceous and Jurassic formations toward the Dry Cimarron River. However, the aforementioned groundwater might not be hydraulically connected with groundwater in the cinder aquifer at Capulin Volcano. Groundwater flow directions appear to roughly follow surface topography of the buried ancestral valley.

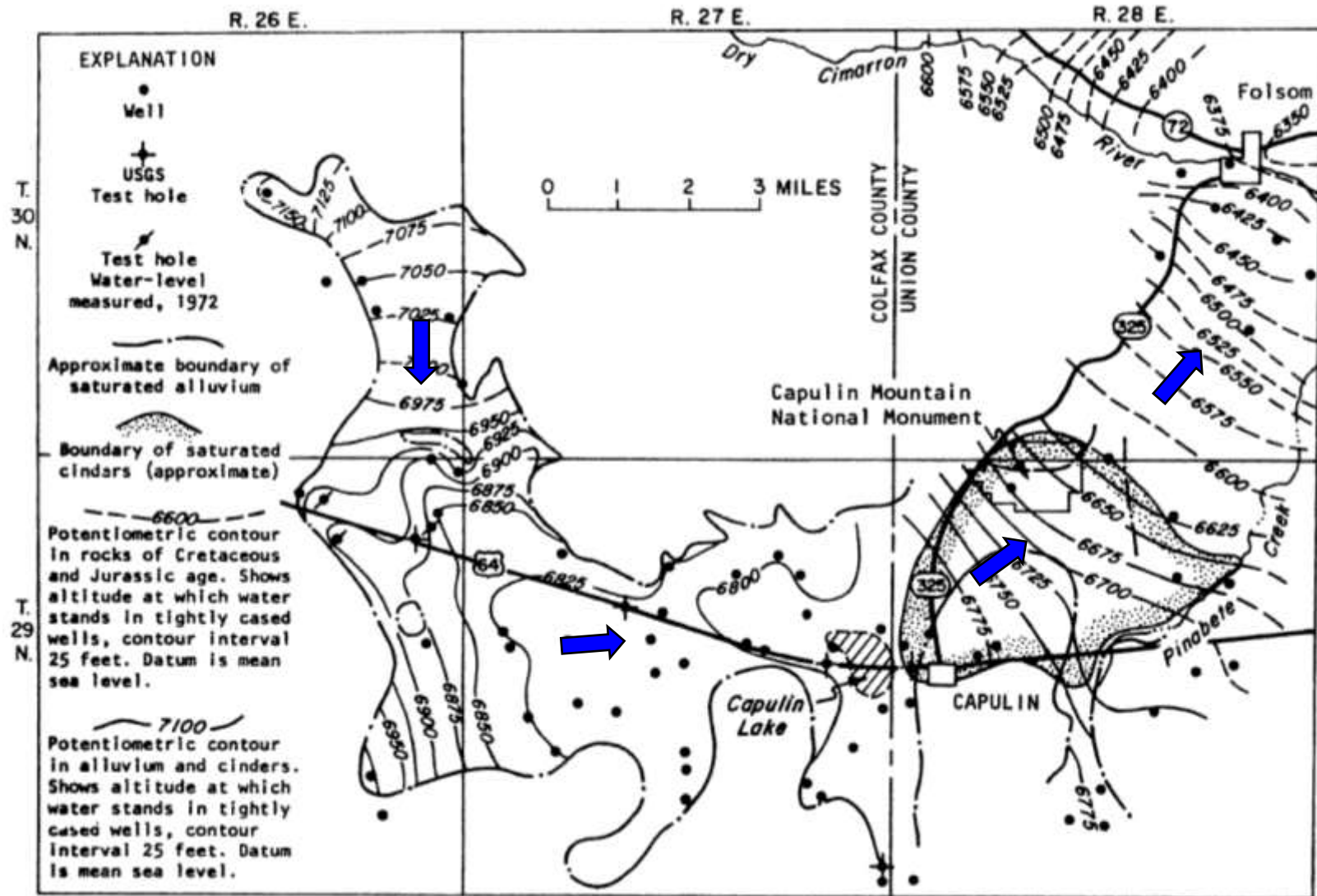


Figure 5. Potentiometric surface map of the Capulin alluvial aquifer and cinders at Capulin Volcano, January 1978 (Hart and Smith, 1979). The potentiometric surface mapped northeast of Capulin Volcano is in Cretaceous and Jurassic formations. Blue arrows show the general direction of groundwater flow.

Well construction and testing

The water-supply well at Capulin Volcano National Monument was completed in June 1962 and drilled to a depth of 680 feet. The primary source of water is a bed of cinders (porous volcanic rock) from 662-671 feet. The well was constructed with 6-inch steel casing with perforations in the bottom 20 feet (approximately 660-680 feet). The WR File Number for the well is CT-00574 (New Mexico Office of the State Engineer) and the well number is 29N.28E.05.234 (see appendix A for explanation of New Mexico well numbering scheme).

<http://nmwrrs.ose.state.nm.us/nmwrrs/ReportDispatcher?type=WR&name=WaterRightSummary.jrxml&basin=CT&nbr=00574&suffix=>

Test pumping occurred after completion at several pumping rates and for various durations, all showing very little (less than one foot) of drawdown. The cumulative result of the tests was an estimation of the specific capacity of 65 gallons per minute (gpm)/foot of drawdown.

A general description of the stratigraphy encountered during drilling the well is provided in a memo (July 3, 1962) from the USGS to the NPS regional office in Santa Fe. (It was common practice in those days for the local USGS office to provide oversight and testing of water-supply wells for parks.) The first 550 feet of drilling were through alternating beds of volcanic cinders and lava flows (Figure 6). From about 550-662 feet drilling was through an olivine-basalt lava flow. The main water bearing zone composed of cinders occurs between 662-671 feet. Fine sand and clay were encountered from 671-680 feet. A drawing of the well log and lithology are provided in Figure 6. It is unclear what type of material would be encountered if a well was drilled deeper at this location. Hart and Smith (1979, Figure 6) show that deeper drilling at this location would likely encounter sandstone beds within the Dakota Group (Figure 4 in this report).

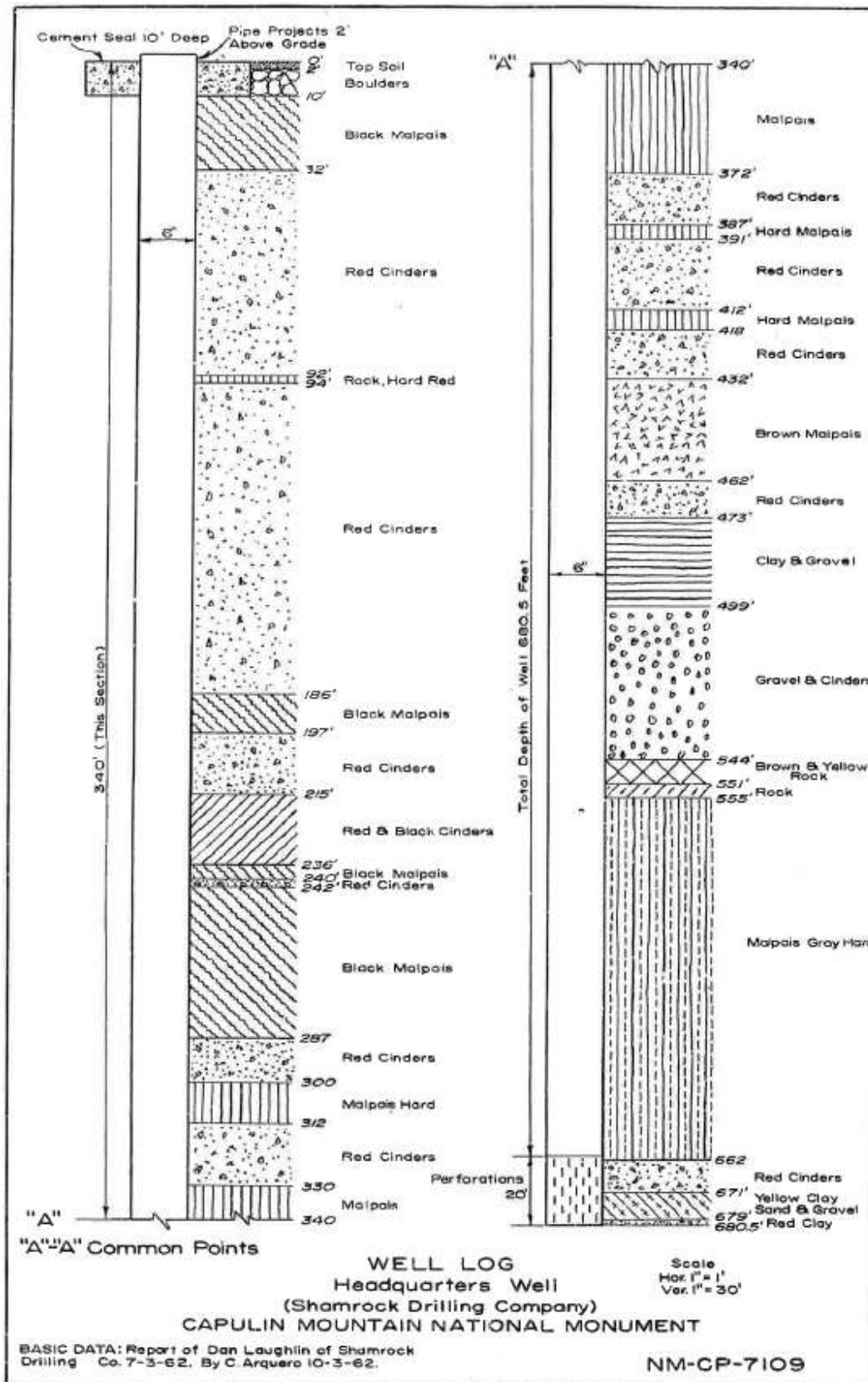


Figure 6. Well log for the water-supply well at Capulin Volcano National Monument.

Water Level Measurements

There has not been a regular schedule of water level measurements in the well at CAVO. There are two measurements made by USGS personnel that specifically state that the measurement was corrected to reflect the depth to water below ground surface (BGS).

Prior to the initial pumping test June 26, 1962 634.4 ft BGS (static water level)
July 29, 1977 642.5 ft BGS (Hart & Smith, 1979)

Additionally, a recent measurement by NPS personnel is known to have been made from the top of the well casing. The measurement was 654.3 feet from the top of the casing, or about 652 feet below ground surface. This measurement is known to be a good measure of the static water level in the well because no pumping had occurred for at least two days.

July 15, 2014 652 ft BGS

The two water level measurements by USGS (1962 and 1977) and the recent measurement by NPS are known to be corrected to land surface datum and provide a general indication of the long-term water level change over a 52-year period (Figure 7). The water level in July 2014 is approximately 18 feet lower than when the well was constructed in June 1962.

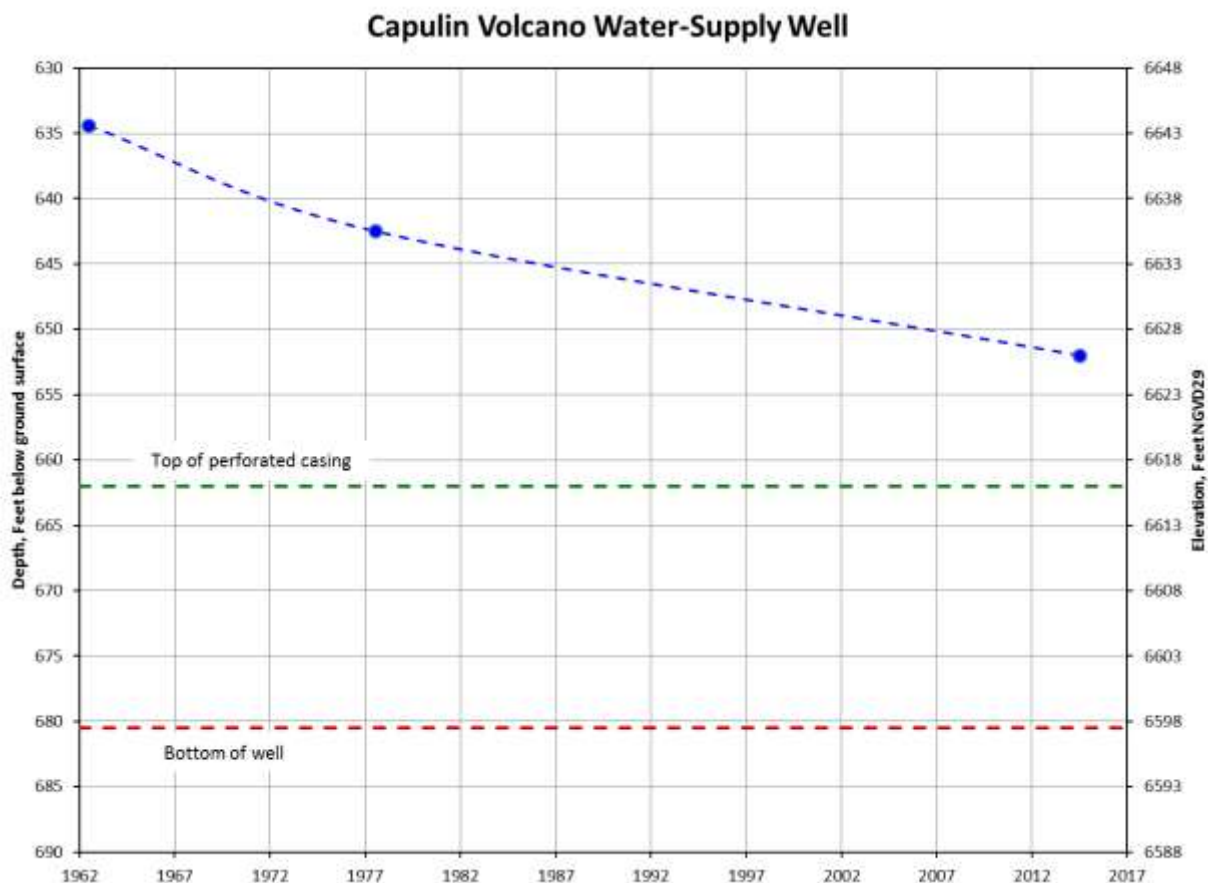


Figure 7. Water level measurements known to be corrected to land surface datum.

Park staff made measurements of the depth to water in the well from 1977-80 (Figure 8). Although we suspect that more water level measurements have been made, we could only find records of 12 measurements. There is no indication whether these data have been corrected for casing stickup and we are uncertain as to whether the datum is the top of the well casing or ground surface, or whether these data are affected by pumping of the well. We include these data in the report to provide a complete record of water level measurements at the well. We don't know exactly how to compare these data to the water level measurements shown in Figure 7, which we know to be corrected to depth below ground surface.

June 1977	647.1 feet
June 1978	647.1 feet
June 1979	647.9 feet
June 1980	647.9 feet
July 24, 1980	648.9 feet
July 30, 1980	648.1 feet
August 4, 1980	649.4 feet
August 7, 1980	649.4 feet
August 10, 1980	649.8 feet
August 15, 1980	649.2 feet
August 18, 1980	649.3 feet
August 25, 1980	650.0 feet

It is difficult to draw any meaningful conclusions from the limited data set from 1977-80. There was only one measurement per year in 1977, 1978, and 1979, which doesn't provide enough information to determine a long-term trend or to separate daily or seasonal fluctuation from a long-term trend. More frequent measurements were made in the summer of 1980 and show the amount of variability that is observed from weekly measurements. The 1980 measurements might also be indicative of the typical water level decline in the summer, but without additional measurements in the fall and winter, we don't know if the water elevation rebounded completely or to what extent the observed measurements are a function of increased pumping in the summer and how much of the variation is due to seasonal precipitation variation.

In July 1992, William Werrell and Gary Smillie (NPS Water Resources Division) visited the park to investigate erosion problems along the road to the top of the volcano and to discuss concerns regarding the aquifer supplying water for the park. They learned that the conductor pipe had been removed when the pump was replaced in 1987. The only water level data that could be found were for 14 measurements between when the well was constructed in 1962 and 1980. Werrell suggested three hypotheses to explain the apparent water level decline: (1) additional groundwater pumping for irrigation near the park, (2) the effects of an exceptionally dry summer, and (3) inconsistencies in the manner that the water level data were reported, i.e. making the

measurement from the top of the well casing rather than correcting the measurement to feet below ground surface.

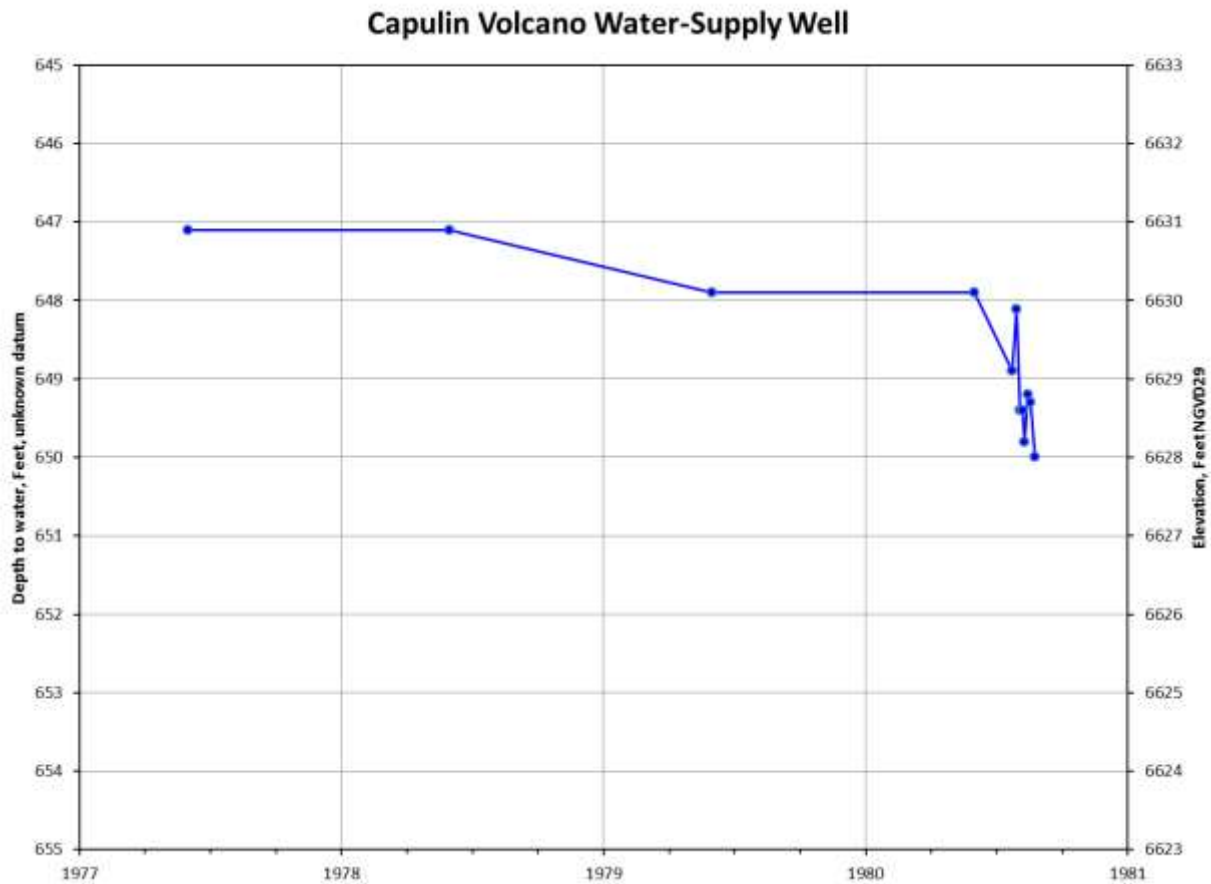


Figure 8. Water level measurements by park staff, 1977-80.

USGS Groundwater level monitoring

USGS personnel have made regular (mostly biannual) water-level measurements in two wells near Capulin (Figure 9, Table 1). For purposes of discussion herein these wells are arbitrarily assigned the descriptive names; Capulin Town Well and West of Capulin Well. The Capulin Town Well, having a state ID number of 29N.28E.18.341 is about ¼ mile WNW of the town of Capulin and is 78 feet deep. The West of Capulin Well, having a state ID number of 29N.27E.16.222 is about 4 miles west of Capulin and is 120 feet deep. Both wells are completed in Capulin aquifer as defined by Hart and Smith (1979).

Table 1. Records of selected wells near Capulin Volcano National Monument

Well name	State ID/USGS#	Location	Depth	Aquifer
CAVO Well	29N.28E.5.233 364643103583701	Capulin Volcano National Monument	680 feet	cinders
Capulin Town Well	29N.28E.18.341 364444014000201	¼ mile WNW of the town of Capulin	78 feet	alluvium
West of Capulin Well	29N.27E.16.222 364522104034501	4 miles west of Capulin	120 feet	alluvium

The West of Capulin Well (29N.27E.16.222) is about 1½ miles NW of the three center-pivot irrigated fields. The water level in this well has been fairly stable between 6825-6830 feet NGVD29 from 1957-2002. Since 2002 there has been a gradual decline of the water level of about ½ foot per year (Figure 10).

The Capulin Town Well (29N.28E.18.341) is about ¼ mile WNW of the town of Capulin. There are no large irrigated fields nearby that are observable on Google Earth. There are a couple of small fields, perhaps 5 acres in total, about ½ mile south of the monitoring well. The water level in the well was stable at around 6810 feet NGVD29 from 1958-2010. It appears that the well has been actively pumped since 2010 (Figure 11) and most of the recent measurements are affected by pumping at the well.

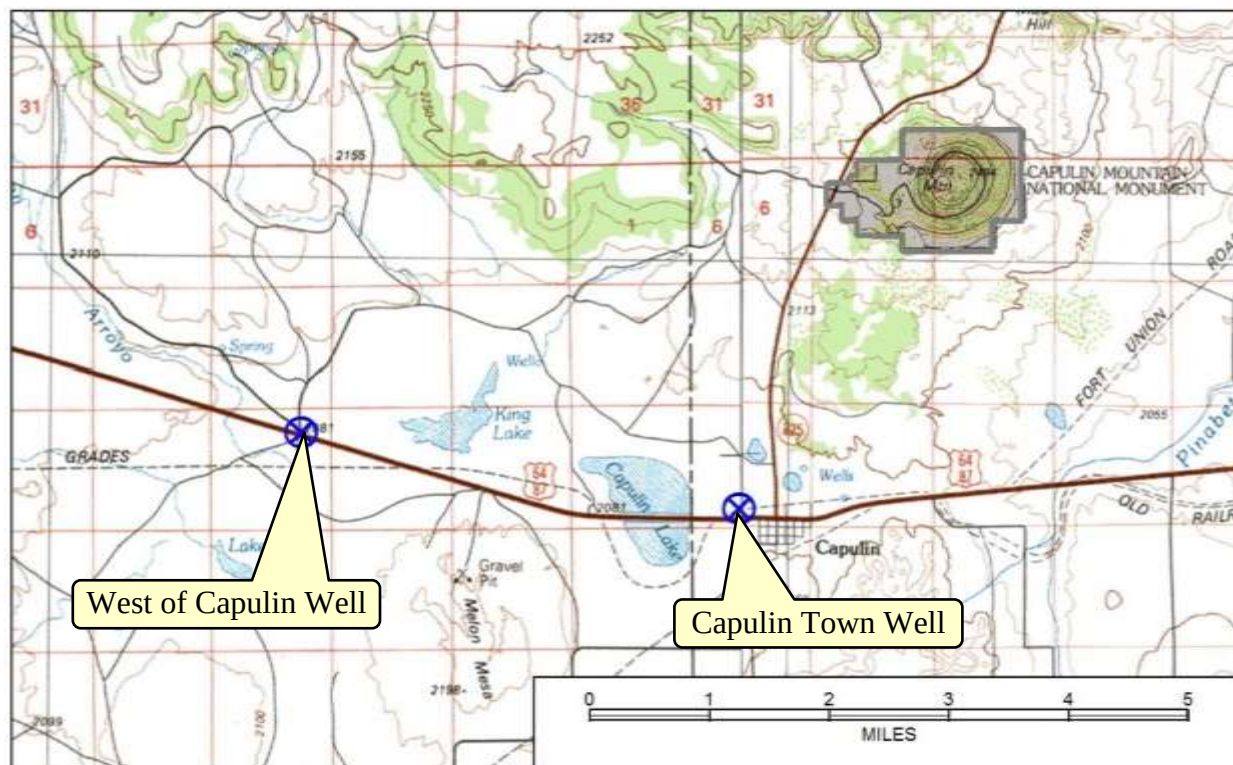


Figure 9. Location of two long-term water-level monitoring wells near Capulin, New Mexico.

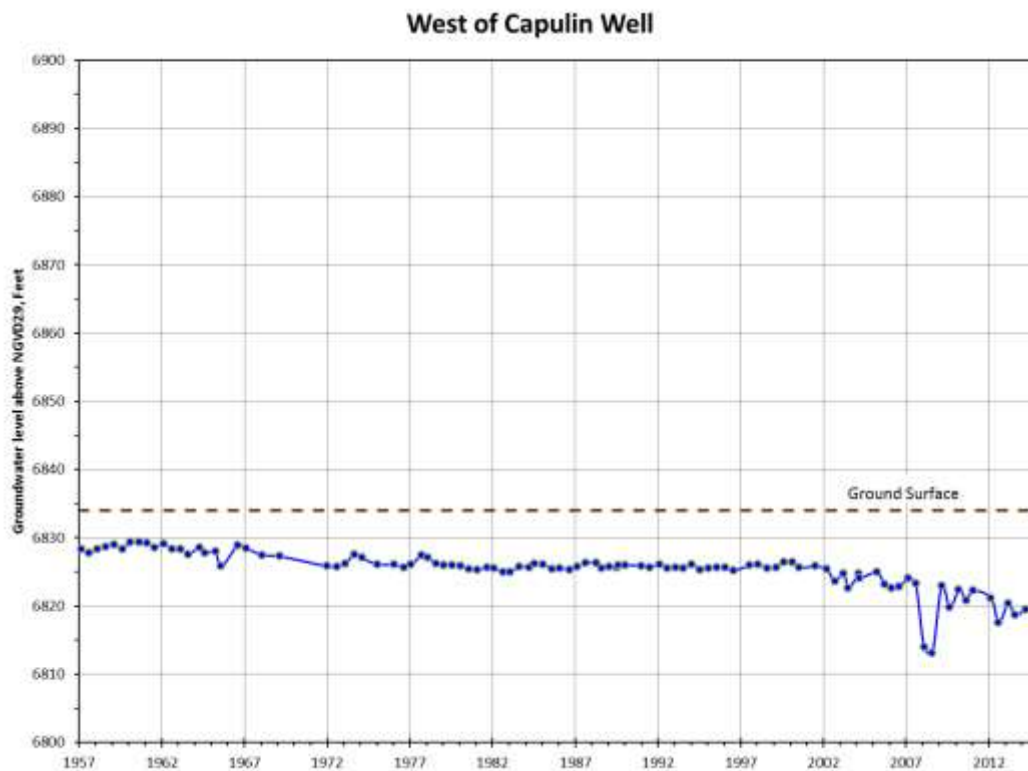


Figure 10. Water levels in a well 4 miles west of Capulin, New Mexico.

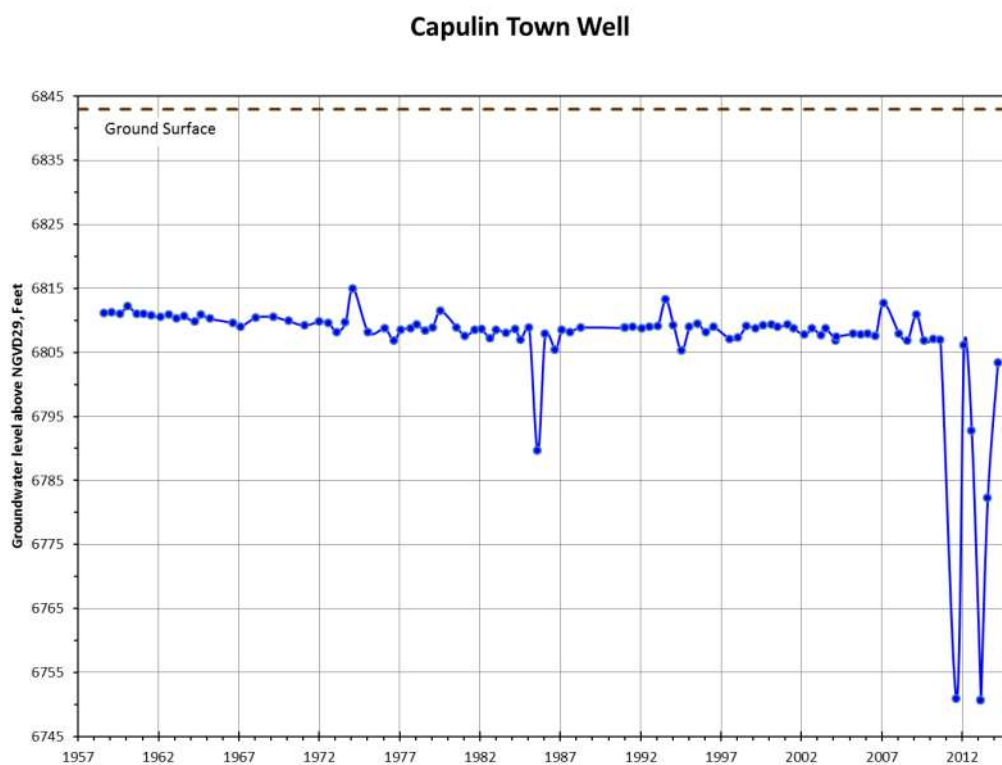


Figure 11. Water levels in a well ¼ mile WNW of Capulin, New Mexico.

Additionally, there are limited data sets from USGS for two other wells (18.322 and 17.331) near the town of Capulin. Well locations are shown on the map (Figure 12). Water level data for these wells do not show any significant decline over the 50+ years of record. Recent data for Well 17.331 is about 10 feet higher than data from 1957-96 (Figure 13). Water level data for wells 18.322 and 17.331 are graphed on Figure 13, along with the data for the long-term USGS monitoring well 18.341, aka Capulin Town Well, which was discussed in the preceding paragraphs.

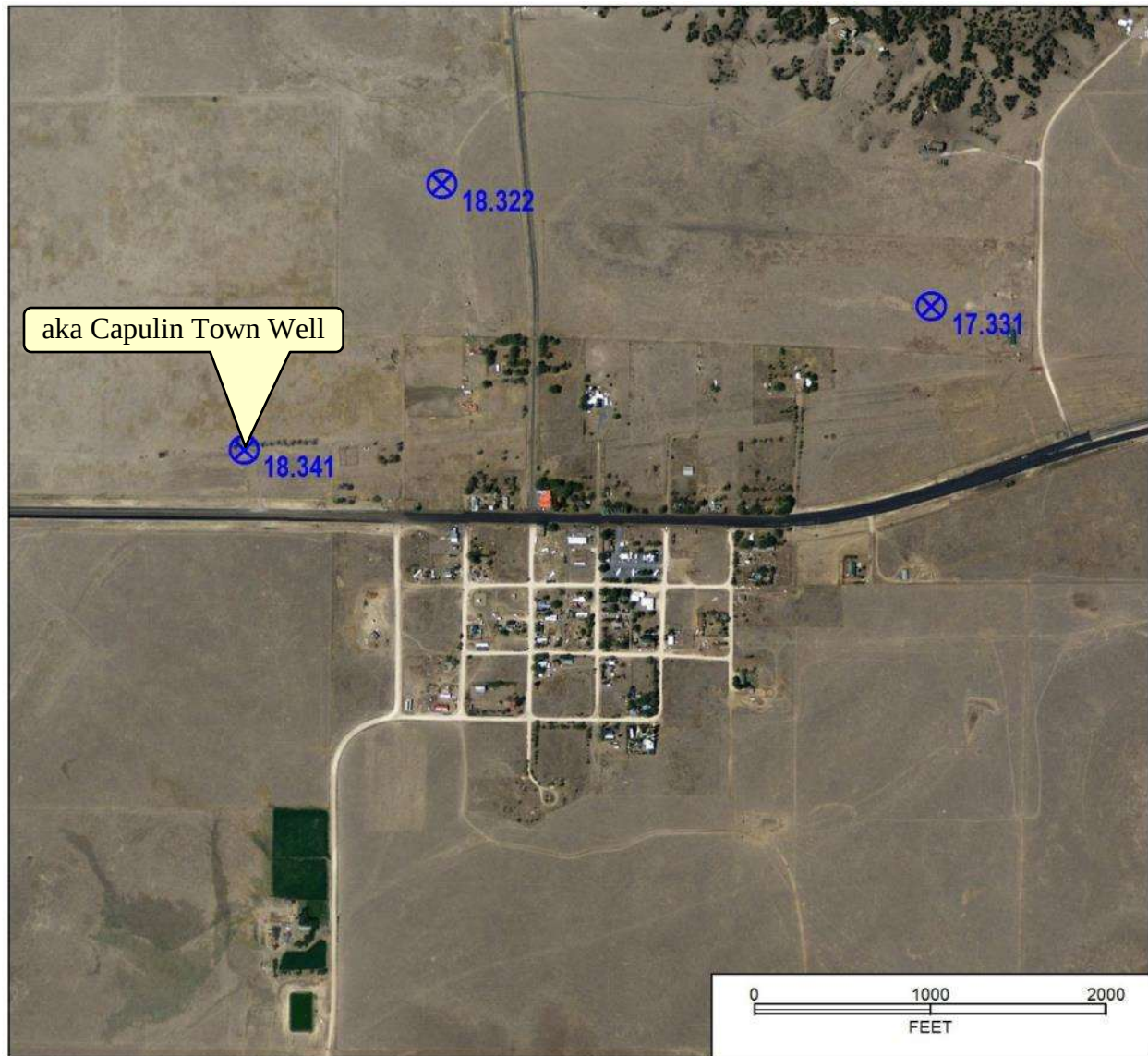


Figure 12. Location of three monitoring wells near Capulin, New Mexico.
Base image: Google Earth, 7/24/11

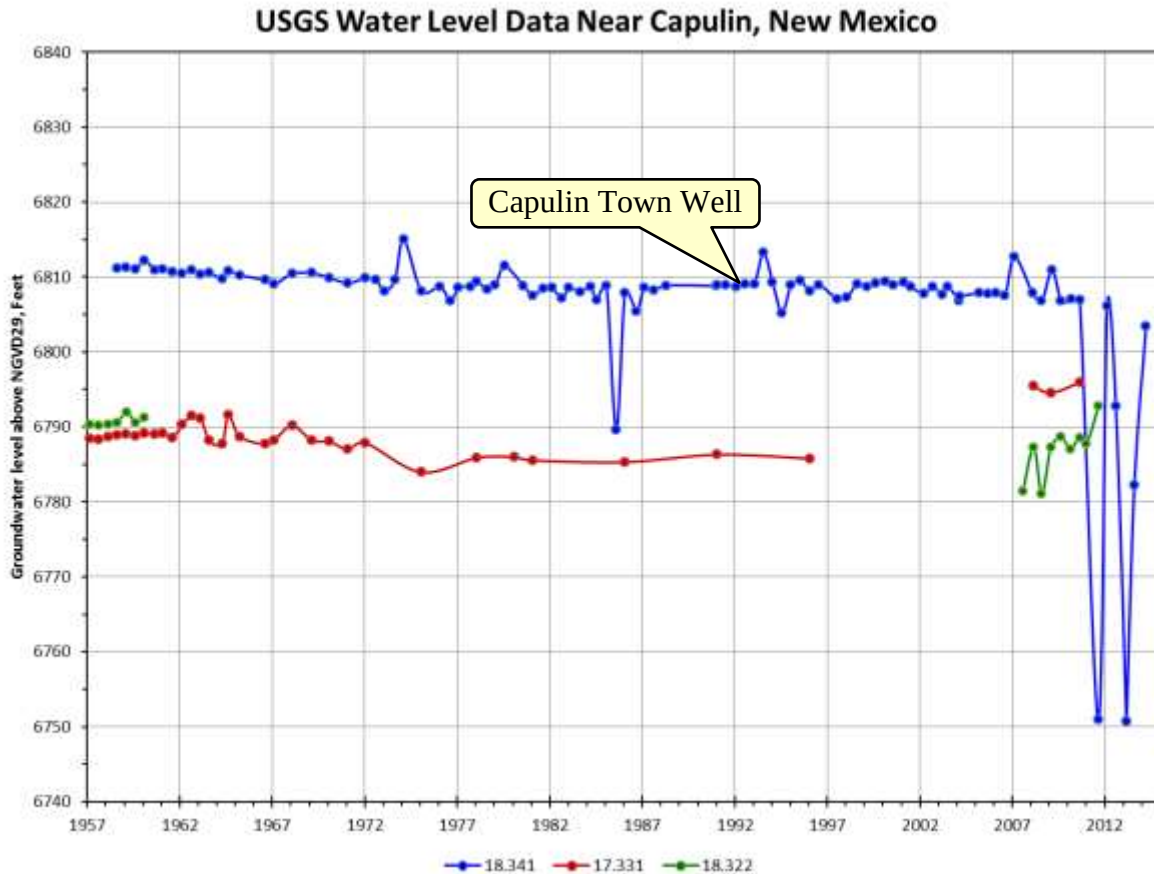


Figure 13. Water levels in three monitoring wells near Capulin, New Mexico.
Water level data from USGS NWIS

Since there is no apparent change in the water levels near the town of Capulin, it would seem that the water level decline at Capulin Volcano is probably not caused by excessive pumping from the Capulin aquifer near the town of Capulin or the irrigation wells 4 miles west of town. It is somewhat problematic to correlate the observed water level decline at Capulin Volcano (approximately 18 feet) with a decline of only a few feet near the town of Capulin.

Groundwater Use

The water rights records of the New Mexico Office of the State Engineer (http://www.ose.state.nm.us/waters_db_index.html) were searched to identify high-production wells in the Capulin aquifer that could be responsible for overdrafting the aquifer and a resultant decline of the groundwater level elevation. An arbitrary volume of 20 acre-feet/year (afy) was selected as the cutoff for identifying large-yield wells. Eight wells were identified by this criterion (Table 2 and Figure 14). We do not have information regarding which of these wells are actually being used, or the annual production rate of these wells, but some inferences can be made by examining Google Earth images for evidence of irrigated cropland.

Irrigated farmland can be identified by looking at aerial imagery in Google Earth (Figure 15). The only areas in the Capulin basin that appear to be irrigated are three large center pivots about 6 miles west of Capulin (totaling approximately 520 acres) and several small fields, that total about 5 acres, on the southwest side of Capulin.

The number of large-yield wells in the basin is fairly small and they are dispersed over a large area. It doesn't seem that there are enough wells to cause a lot of water table drawdown over a large area. Also, if we look at the irrigated farmland over time in Google Earth, we don't see a significant increase in the amount of irrigated area in the basin. Water levels at the long-term monitoring wells in the basin have been fairly stable until the past few years. All of these factors suggest that there has been no increase in groundwater pumping in the basin, and the amount of groundwater pumping has not been large enough to cause water level declines throughout the basin. It appears that only the NPS well at Capulin Volcano has experienced significant water level decline.

Table 2. Groundwater wells completed in the Capulin Aquifer that are permitted for more than 20 acre-feet/year. New Mexico Office of the State Engineer, <http://nmwrrs.ose.state.nm.us/nmwrrs/wellSurfaceDiversiion.html>

Water Right File Number	Use	Acre-feet/year	Owner	Q64	Q16	Q4	Sec	Twp	Rng	Comments
CT 00574	MUN	20	CAPULIN MT. NATIONAL MONUMENT	4	3	2	05	29N	28E	CAVO water-supply well, TD 680', priority date 8/9/1916
CT 00884	IRR	175	MARK/LORI VAN BUSKIRK	2	4	1	19	29N	28E	¼ mile S of Capulin, TD 235', irrigate 80 acres, priority 8/1/2004
CT 01182	IRR	75	GEORGE N SNEED			3	17	29N	28E	shallow well ¼ mile ENE of Capulin, hand dug TD 40', irrigate 50 acres, priority 6/1/1950
CT 01184	IRR	165	R A PACHTA	3	2	3	18	29N	28E	shallow well ¼ mile NW of Capulin, TD 48', irrigate 82 acres, priority 10/1/1948
CT 01435	IRR	1000	KING FAMILY LAND COMPANY LLC	3	2	3	10	29N	27E	4 miles E of Capulin, King Well #1, TD 127', 3 wells irrigate 500 acres, priority 12/29/1978
CT 01436	IRR	1000	KING FAMILY LAND COMPANY LLC	3	4	1	16	29N	27E	4 miles E of Capulin, King Well #2, TD 138', 3 wells irrigate 500 acres, priority 12/22/1978
CT 01437	IRR	1000	KING FAMILY LAND COMPANY LLC	2	4	3	09	29N	27E	4 miles E of Capulin, King Well #3, TD 148', 3 wells irrigate 500 acres, priority 12/27/1978
CT 00020	IRR	140	T.O. RANCH SILVER SPUR LAND & CATTLE CO.	2	4	1	12	29N	26E	8 miles E of Capulin, TD 159', irrigate 100 acres in Sec 12, priority 6/2/1980

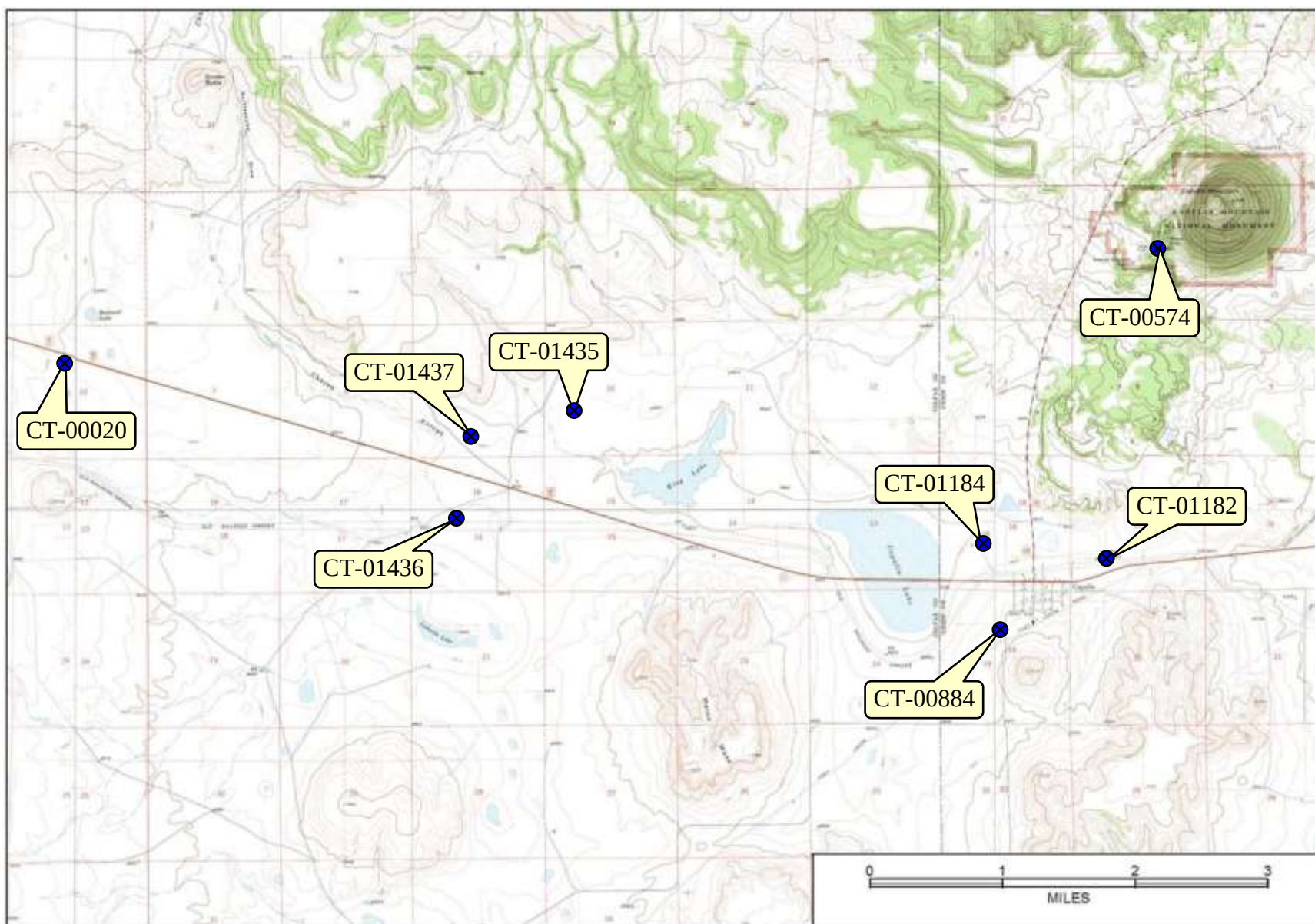


Figure 14. Wells permitted for more than 20 AFY in the Capulin aquifer. Labels are the water right file number from Table 1.



Figure 15. Irrigated farmland from wells completed in the Capulin aquifer. Base image: Google Earth, 7/24/11

Water Use at Capulin Volcano National Monument

Park staff record the meter reading at the wellhead when they check on the chlorination system. This usually occurs 4-5 days per week. Pumping data were obtained for 2012-14 and are presented as average daily use in Figure 16. Average daily use generally ranges from 3,000 to 6,000 gallons per day.

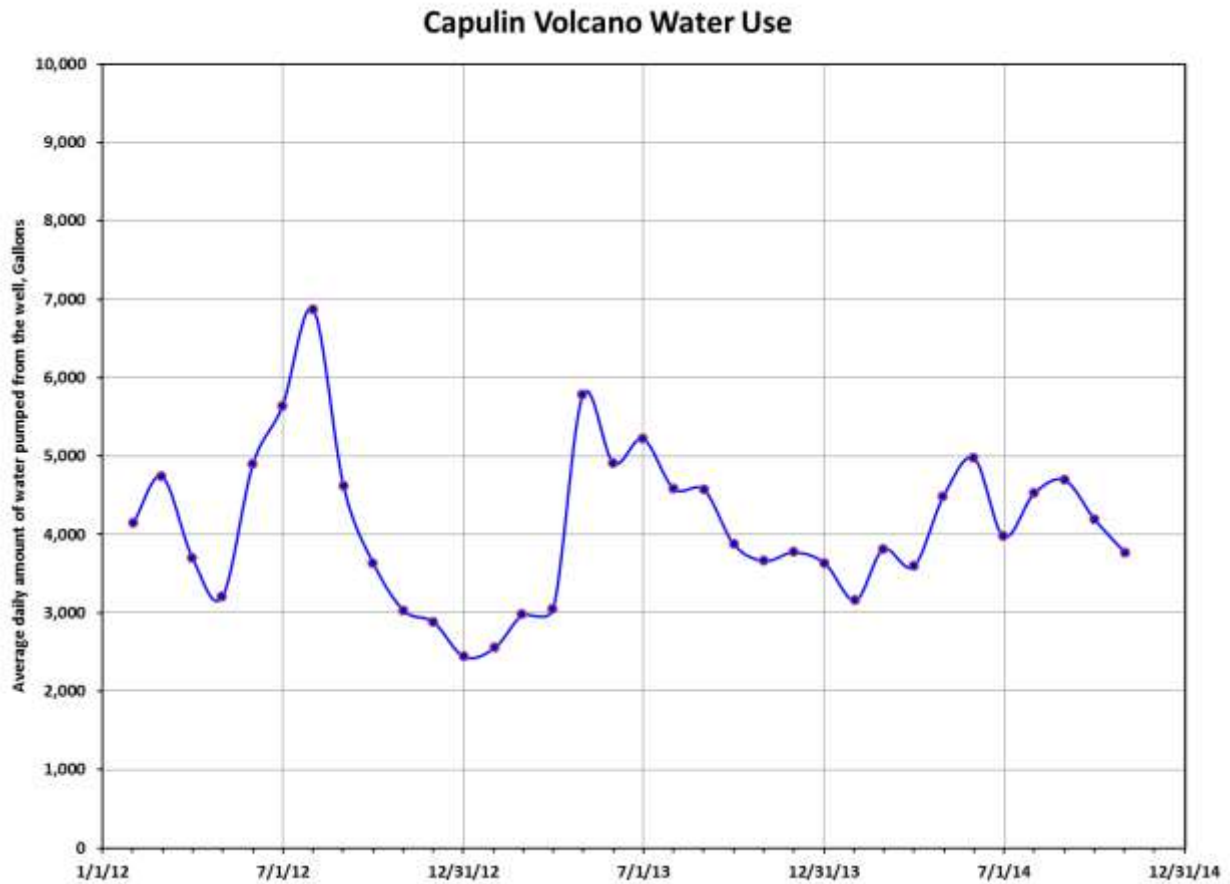


Figure 16. Average daily water use at Capulin Volcano.

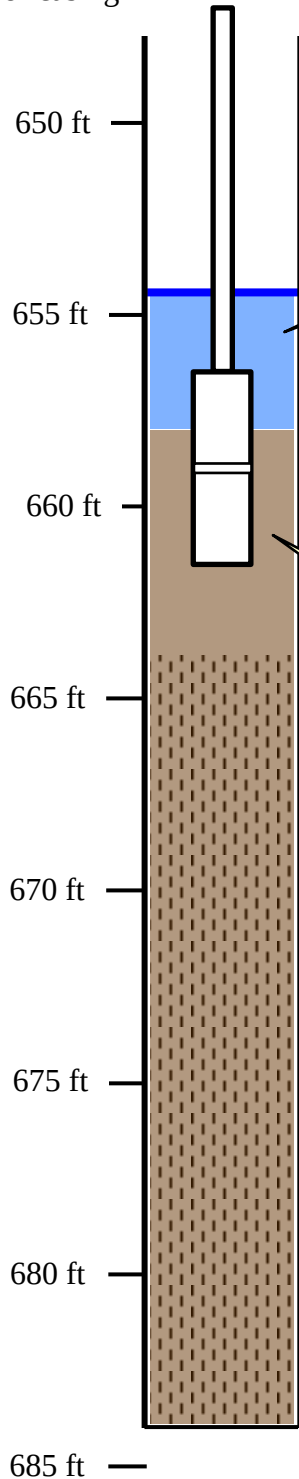
Water well problems, July 2014

Staff at Capulin Volcano and regional office began making plans in spring 2014 for a cyclic maintenance project to replace the pump in the well and make some associated improvements of the water-supply system. The age of the pump was uncertain and thought to be more than 10 years old. As more research was conducted, the last record of pump replacement that could be found was in 1997.

In July 2014, the pump failed. The pump was removed from the well and a contractor inspected the interior of the well with a borehole camera. While making the video inspection of the well, it was discovered the lower 26 feet of the well had filled in with sediment, or some other obstruction existed, preventing the inspection camera from being lowered further. The bottom of the well was at a depth of 658 feet from the top of the casing, or about 654 feet below ground surface (Figure 17). It was calculated that the intake of the removed pump was at the level of the sediment, this may explain the abrupt pump failure. It was also calculated that only 4' of water depth existed in the well, precluding the installation of a new pump and another reason for the pump failure.

The well was cleaned by air jetting. However, no water or sediment was blown out the top of the well during the process. Apparently all of the sediment was blown back through the perforations in the casing and into the aquifer. A video inspection of the well was performed the next day. Unfortunately the water in the well was so turbid from the jetting process that visibility was minimal. Despite the low visibility, the perforated casing was determined to be intact. A new pump was installed lower in the well to compensate for the lower water level in the well. The pump is set with the intake at 679 feet below ground surface, about 5 feet from the bottom of the well (Figure 18). A 1" PVC pipe was installed next to the drop pipe to function as a sounding tube to accommodate future water level monitoring in the well. A water level recorder was installed in the well in November 2014 to monitor the water level in the well.

Depth from
top of casing



This drawing shows the condition of the well prior to the repair/rehab work that was conducted in July 2014. Measurements might be off by a couple feet, depending on whether measurements were recorded from the top of the well casing or corrected to ground surface. Regardless, the basic concepts remain the same.

Water

The original static water level in the well when it was constructed in 1962 was reported as 634.4 feet below ground surface. The drawing of the well from that time shows the well casing rising 2 feet above grade. That would put the static water level at 636.4 feet below the top of the well casing.

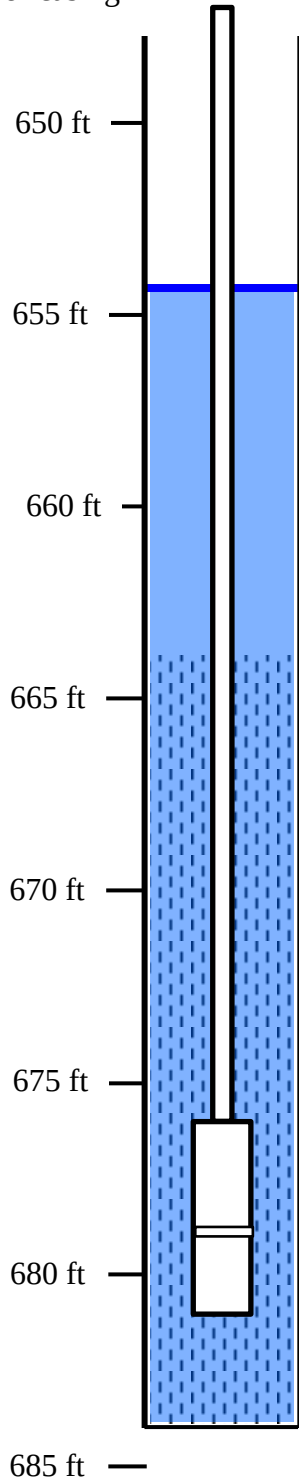
Sediment

When the well was videologged on July 15, 2014, the water level was 654.33 feet below the top of the casing. (That would be about 652 feet below ground surface.) Static water level has apparently declined 18 feet from 1962 to 2014. We have only a few measurements from the intervening period, so it's difficult to determine the cause of the water level decline.

It was found that the sediment had filled the bottom 26 feet of the well, completely filling the perforated interval of the well casing. It's difficult to comprehend that the well was still able to produce any water with so much sediment blocking the perforated interval. The pump and motor were partially buried. It's likely that the pump failed from overheating of the motor because there was not enough water flowing past the motor to cool it.

Figure 17. Schematic drawing of the water-supply well at Capulin Volcano prior to repair/rehabilitation in July 2014.

Depth from
top of casing



The well was air-jetted on July 16, 2014 in an attempt to remove the accumulated sediment. The process was partially successful in that the full depth of the well was restored (684 feet from the top of the casing). However, no sediment or water was blown out of the top of the well. We assume that the cinders and scoria comprising the aquifer are so permeable that the air pressure pushed the sediments back into the geologic formation. Those sediments will likely migrate toward the well as it is pumped in the future and eventually cover the pump. We may, or may not, notice sediment entrained in the pumped water in the future. That would be our early warning signal that we need to pull the pump and jet the well again. However, it is possible that there wouldn't be enough sediment in the pumped water to be noticeable until we pass some critical point and the pump gets covered by sediment and can't be pulled out of the well.

Figure 18. Schematic drawing of the water-supply well at Capulin Volcano after the repair/rehab in July 2014

Recommendations

Water level in the well should be measured regularly to provide data regarding how much water is available and to help determine the cause of the gradual, long-term water level decline.

Personnel from the Sonoran Desert I&M Network installed a water level recorder in the well in November 2014 and plan to leave it there for at least 6 months. The park has purchased a water level meter and will be able to make manual measurements weekly indefinitely into the future until the seasonal variation and long-term water level trend is better understood. WRD staff in Ft. Collins are available to analyze and interpret the data.

Sampling and analysis of water chemistry and stable isotope from the NPS well and wells near the town of Capulin may allow age-dating the groundwater and help determine the hydraulic interconnectivity of the shallow Capulin aquifer and the deeper cinder aquifer.

The sediment that had accumulated in the well was apparently blown back into the formation during the jetting operation. It was not removed from the well. We would presume that it will eventually move back into the well during normal pumping operations. Whether it will take a couple of months or many years is unknown and it will be difficult or impossible to monitor this until the pump fails again and is pulled from the well. Our only potential early warning might be if the well consistently produces a small pulse of sediment every time it is pumped. If we find this to be a problem, we might need to construct a new well.

If a new well needs to be constructed, we should consider two modifications to the present design: drilling deeper and installing a pre-packed well screen.

If the water level continues to decline, it will be necessary to drill deeper. Even if the water level remains stable, it would be prudent to drill deeper when a new well is constructed to at least explore what might be available in the next 50-100 feet. We might find another permeable zone at greater depth that will provide abundant water, or we might discover that there is no additional water at greater depth. Either outcome is worth knowing and if we don't like the results, we can always plug the bottom part of the borehole with cement.

A pre-packed well screen is essentially two concentric well screens with a sand filter between them. The well screen and sand can be sized to allow water to flow through but prevent sand, silt, and clay from entering. That would eliminate the current problem of sediment filling the well. We could not retrofit the existing well with a pre-packed screen because the well casing has 6-inch diameter and pre-packed screen with an outside diameter of 6 inches would have an inside diameter of 3 inches, which would be too small for a pump to fit into.

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Appendix A

New Mexico Well Numbering System

In New Mexico, to provide an additional means of identification and a cross reference to records in older reports, most wells and springs have been assigned a local identifier based on the system of public land surveys. In areas covered by such surveys, the local identifier consists of a series of numbers and letters separated by periods, giving the township, range, section, and tract within a section, in that order. The letters N or S locate the township north or south of the New Mexico base line. The letters E or W locate the range east or west of the New Mexico principal meridian. A zero in a tract number indicates that the well or spring is centrally positioned or has not been located accurately enough to be placed within a tract or quarter section. One digit in a tract number will locate a well or spring to a 64-acre tract, two digits will locate the well to a 16-acre tract, and three digits will locate a well to a 4-acre tract. This numbering system is illustrated in the following figure.

