# Rehabilitation and Testing of 3 Water Supply Wells in the Castolon Area, Big Bend National Park

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Introduction

Three water supply wells in the Castolon area (Figure 1) were redeveloped and new pumps, wire, drop pipe, etc. were installed during the period of April 22-30, 2002. The wells were then tested to determine the potential yield of each well. Redevelopment and installation of new pumps was done by Skinner Well Drilling (Walt Skinner) of Alpine, Texas. Drawdown and yield testing was conducted by Larry Martin, NPS Water Resources Division.

Well numbers used in this report may not match well numbers in older NPS files. The well numbers used in this report match the current naming system used by park maintenance staff at Castolon.

Well No. 1

Well No. 1 is located at the southwest corner of the intersection between the main Castolon Road and the entrance to the Campground. The Texas State ID number for this well is BK-73-52-9-08. Western Well and Pump from Colby, Kansas, constructed the well in August 1983. The well was completed by installing 30 feet of plain casing and 20 feet of well screen.

The well was test pumped at several rates in March 1984 (Figure 2). The static water level was 22 feet below ground surface. Pumping at 10 gpm resulted in 4 feet of drawdown. Pumping at 15 gpm resulted in 10 feet of drawdown. Park staff stated that the well was never put into production because the water pumped from it always had a rusty color. Even after pumping continuously for two weeks, the water remained rusty.

The old pump was pulled from the well on April 23, 2002. The measured depth of the well was 42 feet below ground surface. The static water level was 26 feet below ground surface. The bottom part of the pump motor appeared to have been covered by sediments filling the bottom part of the well. There was a hole in the discharge pipe a few inches above the pump. High and low water level electrodes were in the well, but were not connected to the control panel.

The well was redeveloped by jetting, using a high-volume, high-pressure air compressor for several hours. Approximately 5 $ft^3$ of sand, gravel, and cobbles was removed from the well. The gravel appeared to be native material from the alluvial deposits rather than gravel purchased for use as a gravel pack. Cobbles up to 3-inches in diameter were removed during the jetting process. The well would consistently refill with sediments to a depth of about 48 feet. After 4-5 attempts to clear this material, we allowed the well to have a final depth of 48 feet. We were concerned that continuing to remove sediments might result in creating a large cavity that would eventually result in surface subsidence. It is also possible that the original drillers report was misinterpreted. The report states that the well was completed with 30 feet of plain casing and 20 feet of screen. Since the measured stickup of casing above ground surface is about 2 feet, the bottom of the well screen might be at 48 feet below ground surface.

Many of the rocks and gravel that were removed from the well had an unidentified black coating. This may be some type of sulfide deposit, as the water has a high sulfate concentration. The zone around 40 feet below ground surface continued to produce fine-grained black sediments for a long time when jetting that area. Eventually, it cleared up after repeatedly jetting that zone.

Yield from the well was estimated to be 25-30 gpm during the jetting operation. Following completion of the jetting operation, the static water level was 25.8 feet below ground surface and the total depth of the well was 47.8 feet below ground surface.

A new pump was installed in the well, including new electrical cable, drop pipe, airline, torque arrestors, etc. The pump is a Grundfos 25S30-15 with a Franklin 3hp motor. This is a “25 gpm” pump. The top of the pump is about 41 feet below ground surface and the pump intake is about 42½ feet below ground surface. The bottom of the airline is at the top of the pump. Figure 3 shows the completed well and a scale for converting the psi reading of the airline to depth below ground surface.

After installation of the new pump and equipment, the well was disinfected by pouring 2 gallons of bleach into the well and recirculating water pumped from the well back into the top of the well to completely coat the inside of the well with chlorinated water. The chlorine solution was allowed to remain in the well for 24 hours and was then pumped out on the ground as part of the test pumping.

Test pumping the well at full discharge of about 30 gpm would result in drawing the water level down to the pump intake and sucking air after about 5 minutes of pumping. The water level would fully recover within 2 minutes after the pump was turned off. The well was cycled like this 10 times on April 27 and 5 times on April 28 to flush any sediments into the well. This pumping showed that the well would not sustain a pumping rate of 30 gpm.

A step-drawdown test was conducted on the well to determine the optimal and maximum sustainable pumping rates. The well was pumped at 3, 10, 15, 17, 20, and 27 gpm (Figure 4). It was difficult to adjust pumping rates as a very small turn on the valve at the wellhead resulted in a large change in discharge. It is recommended that the control valves at the wellhead be adjusted so the well is pumped at 15-20 gpm. Higher pumping rates cause the water level to be drawn down too far.

The pump installed in this well was originally intended for Well No. 2, but initial testing at Well No. 2 showed that it could not sustain a pumping rate of 30 gpm. Since Well No. 1 had produced 30 gpm during the jetting phase of redevelopment, we moved the larger pump to Well No. 1. Subsequent testing showed that Well No. 1 would not sustain a pumping rate of 30 gpm. The pumping rate can be controlled by partially closing the valve at the wellhead to create more backpressure against the pump. The next time the pump is replaced a 20 gpm pump should be installed.

Use of PVC drop pipe instead of the galvanized steel would eliminate the corrosion problems at the contact between the drop pipe and the pump.

Well No. 2

Well No. 2 is located about 250 feet west of the intersection of the main Castolon Road and the entrance to the campground. It is about 100 feet south of the main road. The Texas State ID number for this well is BK-73-52-9-09. Killingsworth Well Service from Terlingua, Texas constructed the well in July 1985. The well was completed with 6-inch casing to a depth of 48 feet and 6-inch well screen (Houston Well Screen Co., 0.016" slot size) from 48-68 feet. At the time of construction and initial testing of the well, it was reported to have produced 30 gpm for 44 hours with no drawdown.

The old pump was pulled from the well on April 23, 2002. The measured depth of the well was 62 feet below ground surface. The static water level was 24½ feet below ground surface. The pump and drop pipe appeared to be in good shape. The pump had been replaced in January 1999 and the drop pipe was in good shape at that time. This is the only one of the three wells in the area that had been functional in recent years. It operated at about 16 gpm. The old pump was a Webtrol 102S711B with a Franklin 3 hp motor. This pump can be stored for use as a backup or replacement pump for either Well No. 1 or No. 2 in the future.

The well was redeveloped by jetting, using a high-volume, high-pressure air compressor for several hours. A small amount of rust and corroded casing material was removed from the well. The well appeared to have a very solid bottom, probably a plate welded on the bottom to prevent sediment from entering the well. At the completion of jetting the well measured 68 feet deep from ground surface.

Yield from the well was estimated to be 12-15 gpm during the jetting operation. Following completion of the jetting operation, the static water level was 24.65 feet below ground surface.

Since this well had reportedly produced 30 gpm with no drawdown when it was constructed, and we had hoped to restore the well to near that capacity, we had ordered a 25-gpm pump for the well. During jetting of the well, it appeared that it would not produce 25 gpm. Nevertheless, we installed the 25-gpm pump to provide a good test of the well. The pump would draw the water level down to the pump intake within about 2 minutes. The water level would recover completely within 5 minutes. The well was cycled through complete drawdown and recovery 10 times with no discernable change in capacity.

The 25 gpm pump was removed from Well No. 2 and later placed in Well No. 1, because we already knew from jetting Well No. 1 that it appeared to be a better producer than Well No. 2. The 10-gpm pump, originally planned for installation in Well No. 1 was installed in Well No. 2. This pump is a Grundfos 10S05-9 with a ½ hp Grundfos motor. It is a “10 gpm” pump. The top of the pump is about 62 feet below ground surface and the pump intake is 63 feet below ground surface. All new equipment was placed in the well including a new pump, electrical cable, drop pipe, airline, torque arrestors, etc. The bottom of the airline is at the top of the pump. Figure 5 shows the completed well and a scale for converting the psi reading of the airline to depth below ground surface.

After installation of the new pump and equipment, the well was disinfected by pouring 2 gallons of bleach into the well and recirculating water pumped from the well back into the top of the well to completely cover the inside of the well with chlorinated water. The chlorine solution was allowed to remain in the well for 24 hours and was then pumped out on the ground as part of the test pumping.

The well was test pumped at the maximum pumping rate for the pump, 14 gpm for 4 hours resulting in about ½ foot of drawdown (Figure 6). This well will produce more water. A 20-gpm pump could safely be installed in Well No. 2.

<u>Well No. 3</u>

Well No. 3 is located in the middle of the loop of the gravel road east of the water treatment building. It is about 500 feet north of the intersection of the main Castolon Road and the entrance to the campground. The Texas State ID number for this well is BK-73-52-9-11. According to verbal reports of park maintenance staff, the well was originally cased to a depth of 80 feet and then was open hole construction from 80-126 feet. At some later time, a 4-inch PVC liner and screen were installed. The annular space between the 4-inch PVC liner and 8-inch steel casing was filled with sand to reduce sediment flow into the well.

The old pump was pulled from the well on April 23, 2002. The measured depth of the well was 130 feet below ground surface. The static water level was 33 feet below ground surface. The check valve in the top of the pump was broken. This allowed water to flow down the pipe and into the well after the pump had shut off, spinning the pump in a backward direction. As water filled the well and reached the upper electrode, the pump would automatically be started. Over some period of time, the excessive torque caused by the pump turning on while spinning backward caused the drive shaft between the pump and motor to break. This is the reason that no water could be pumped from the well, even though the pump could be heard running. The pump that was removed from the well was a Grundfos 10S15-21 with a 1½ hp motor. It was installed in 1996 at a setting of 115 feet below ground surface.

The well was redeveloped by jetting, using a high-volume, high-pressure air compressor for several hours. The maximum depth of jetting was 125 feet below ground surface. We did not want to jet to the bottom of the well because that might have breached the seal at the bottom of the 4-inch PVC liner and allowed the sand filter material from the annular space to flow into the well. Water was blown from the well at a very low rate (less than 5 gpm) during the jetting process. There was not enough water in the well to get the surging action needed to remove fine-grained sediments, which might have allowed increased production from the well. Small amounts of very-fine grained sand were produced during the jetting operation and later during the test pumping. It does not appear possible to eliminate the sand-pumping problem at this well.

A new pump was installed in the well, including new electrical cable, drop line, torque arrestors, etc. The pump is a Grundfos 5S03-9 with a Franklin 1/3 hp motor. This is a "5 gpm" pump. The top of the pump is about 104 feet below ground surface and the pump intake is about 105 feet below ground surface. The bottom of the airline is at the top of the pump, 104 feet below ground surface. Figure 7 shows the completed well and a scale for converting the psi reading from the airline to depth below ground surface.

A low water level electrode was installed at the top of the pump to automatically turn the pump off when the water level was drawn down to that point. This protects the pump from running dry or sucking air. A high water level electrode was installed about 50 feet above the top of the pump. This electrode causes the pump to automatically be turned on when the water level in the well recovers to that level.

After installation of the new pump and equipment, the well was disinfected by pouring 2 gallons of bleach into the well and recirculating water pumped from the well back into the top of the well to completely cover the inside of the well with chlorinated water. The chlorine solution was allowed to remain in the well for 24 hours and was then pumped out on the ground as part of the test pumping.

Production from Well No. 3 was tested by pumping water into the old wastewater lagoon behind the water treatment building. The pump would produce 7 gpm, but the water level would be drawn down to the low water electrode in about 15 minutes causing the pump to shut off. It would take about 45-50 minutes for the water level to recover to the high water electrode, causing the pump to turn on again. The pump was allowed to automatically cycle on and off overnight to provide an estimate of the long-term production from the well. It was determined that the well would produce an average of about 100 gallons per hour. Drawdown and recovery of water levels in Well No. 3 during test pumping are shown in Figures 8 and 9.

## Summary

Three wells at Castolon were redeveloped by jetting using a high-pressure, high-volume air compressor. Jetting in Wells No. 2 and 3 did not result in any apparent increase in efficiency or productivity of the wells. Jetting at Well No. 1 removed some sediment from the well and resulted in the well being able to produce approximately 20 gallons per minute of good, clean water.

All of the equipment in each well was replaced with new equipment, including pumps, drop pipe, wire, torque arrestors, airlines, and water level sensors.

Wells No. 1 and 2 are capable of producing 15-20 gallons per minute for indefinite periods of pumping. Well No. 3 cannot sustain a 5 gallon per minute pumping rate. Using high and low water level sensors, Well No. 1 can be operated to automatically cycle on and off and can produce approximately 2500 gallons per day in this manner.

Table 1 summarizes the information related to the new pumps and production rates for the three water supply wells in the Castolon area.

## Recommendations

1. The next time the pump in Well No. 1 needs replacement, install a 20-gpm pump.

2. Use PVC drop pipe instead of the galvanized steel to eliminate corrosion problems.

3. The next time the pump in Well No. 2 needs replacement, install a 20-gpm pump.

4. Monitor static and pumping water levels in all 3 wells monthly. Monitor pumping rates from all 3 wells monthly. Routine monitoring will help identify well and pump problems before total failure of the well or pump occurs.

| | Well No. 1 | Well No. 2 | Well No. 3 |
|---|---|---|---|
| Total Depth | 48 feet | 68 feet | 132 feet |
| Depth to Pump Intake | 42½ feet | 63 feet | 105 feet |
| Static Water Level | 26 feet | 27 feet | 33 feet |
| Current Pump Model No. | Grundfos 25S30-15 | Grundfos 10S05-9 | Grundfos 5S03-9 |
| Pumping Rate with Current Pump | 30 gpm | 14 gpm | 6 gpm |
| Maximum Safe Yield of Well | 20 gpm | 20 gpm | less than 5 gpm |

All depths are measured from ground surface

Table 1. Information related to water wells and pumps in the Castolon Area following redevelopment project in April 2002.

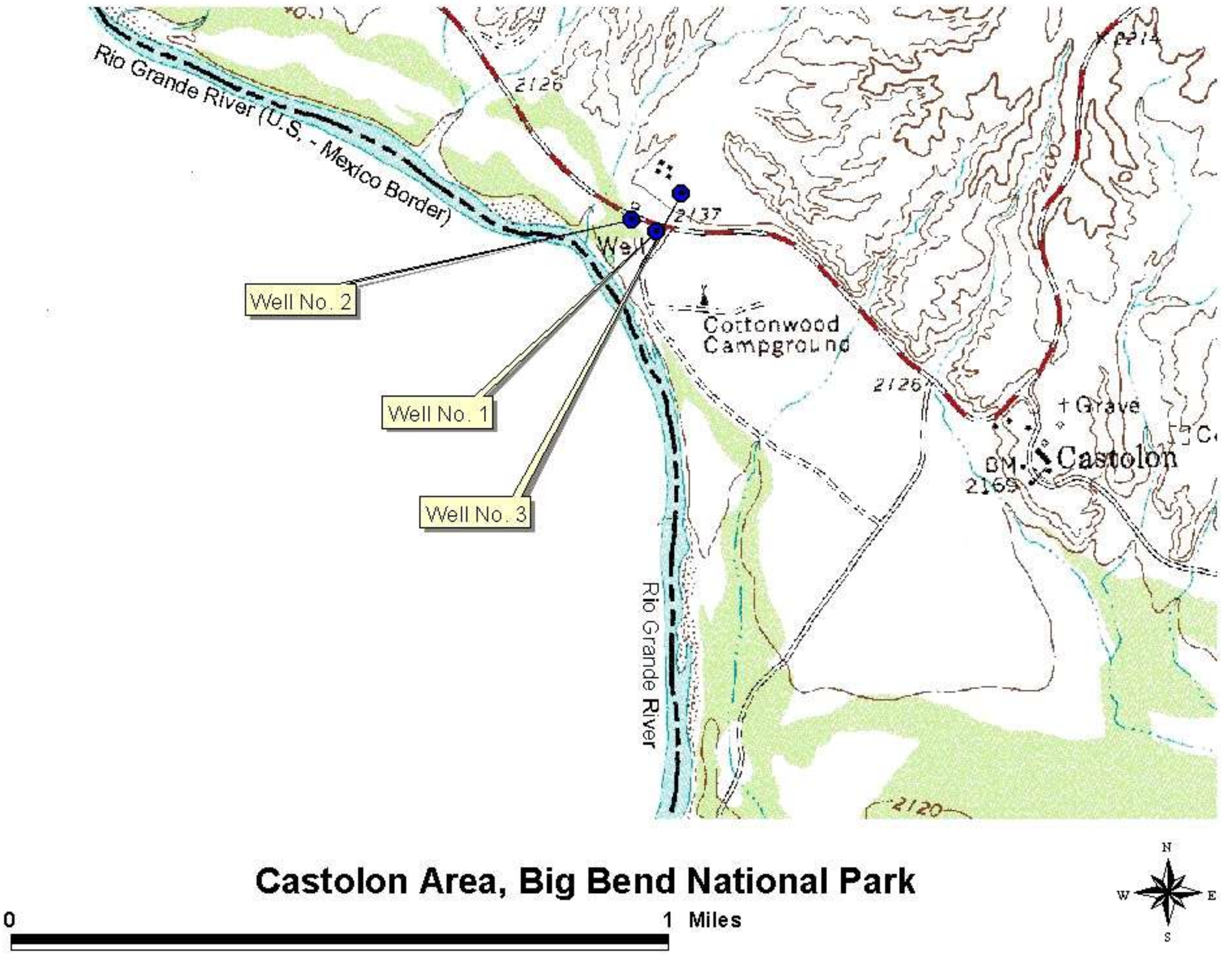


Figure 1. Locations of wells in the Castolon Area

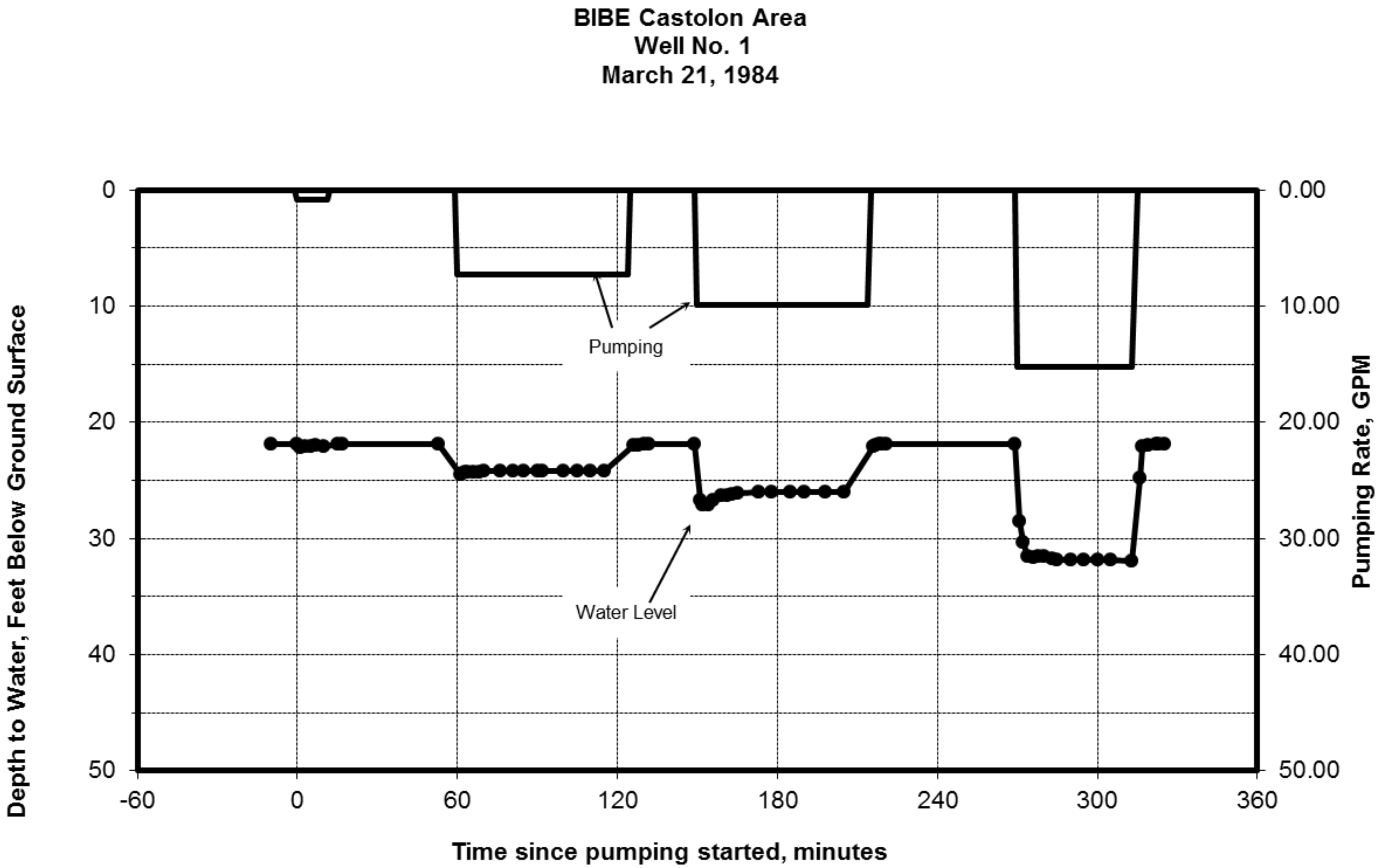


Figure 2. Step drawdown test of Well No. 1 on March 21, 1984

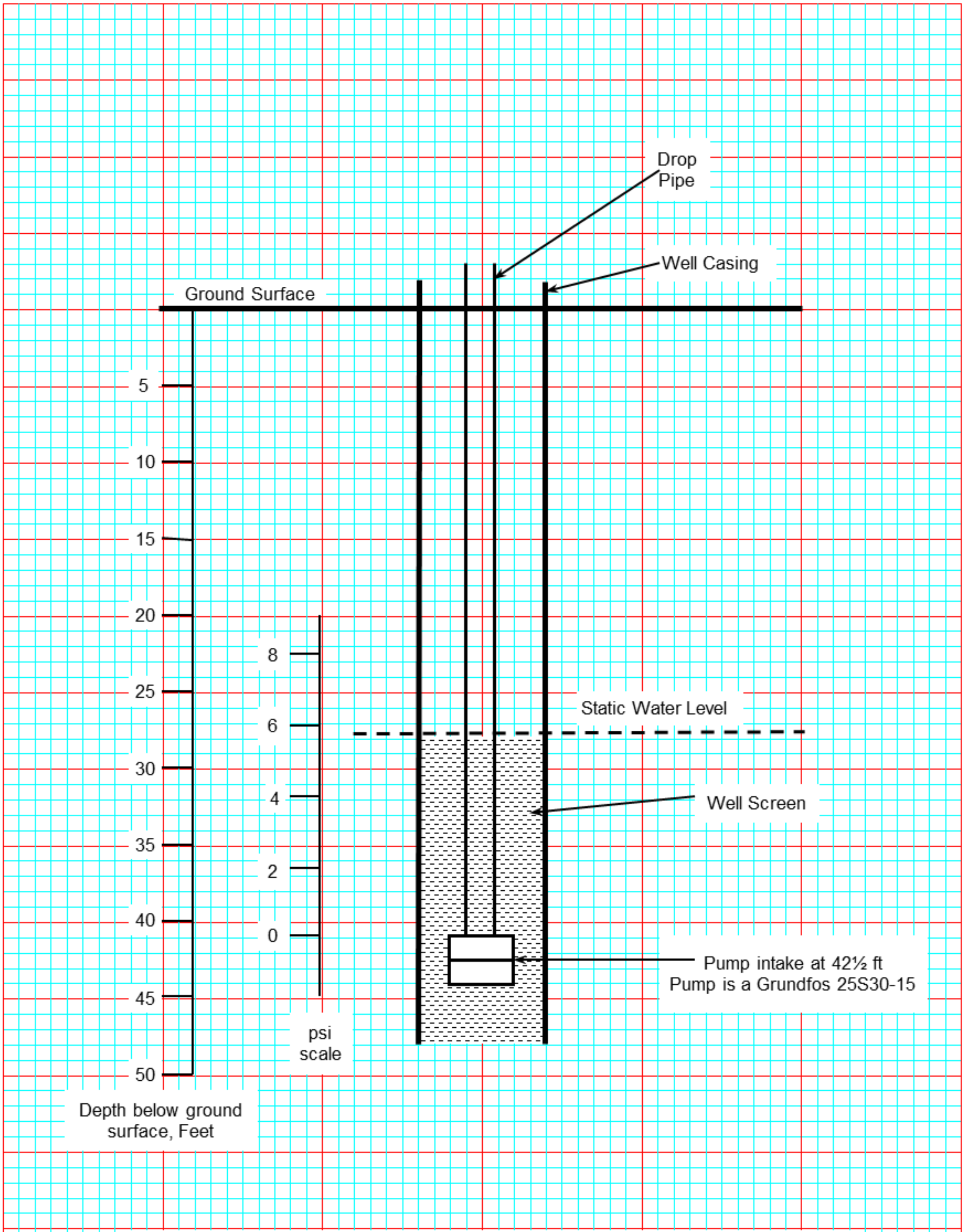


Figure 3. Well No. 1, Castolon Area, Big Bend National Park

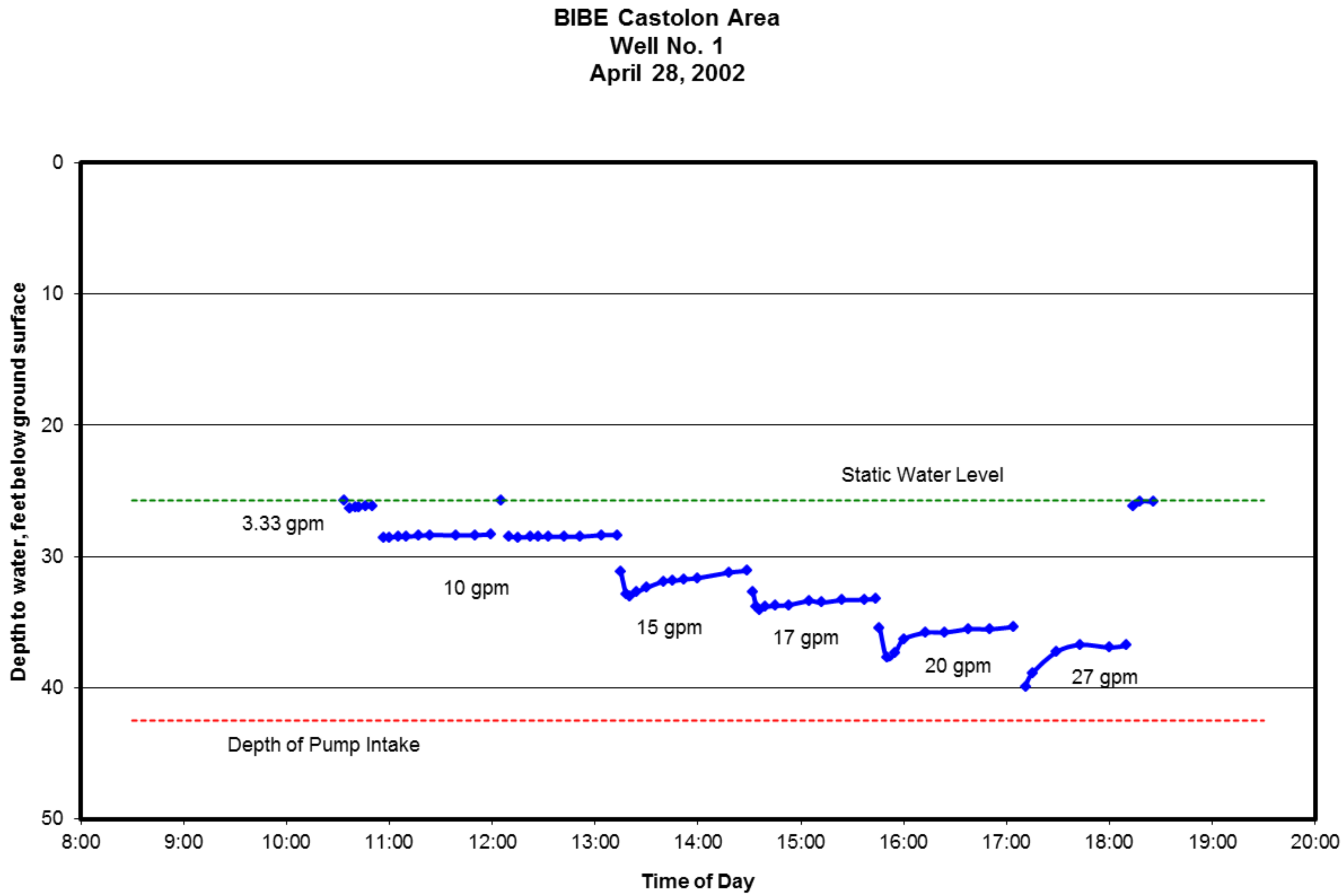


Figure 4. Step drawdown test of Well No. 1 on April 28, 2002

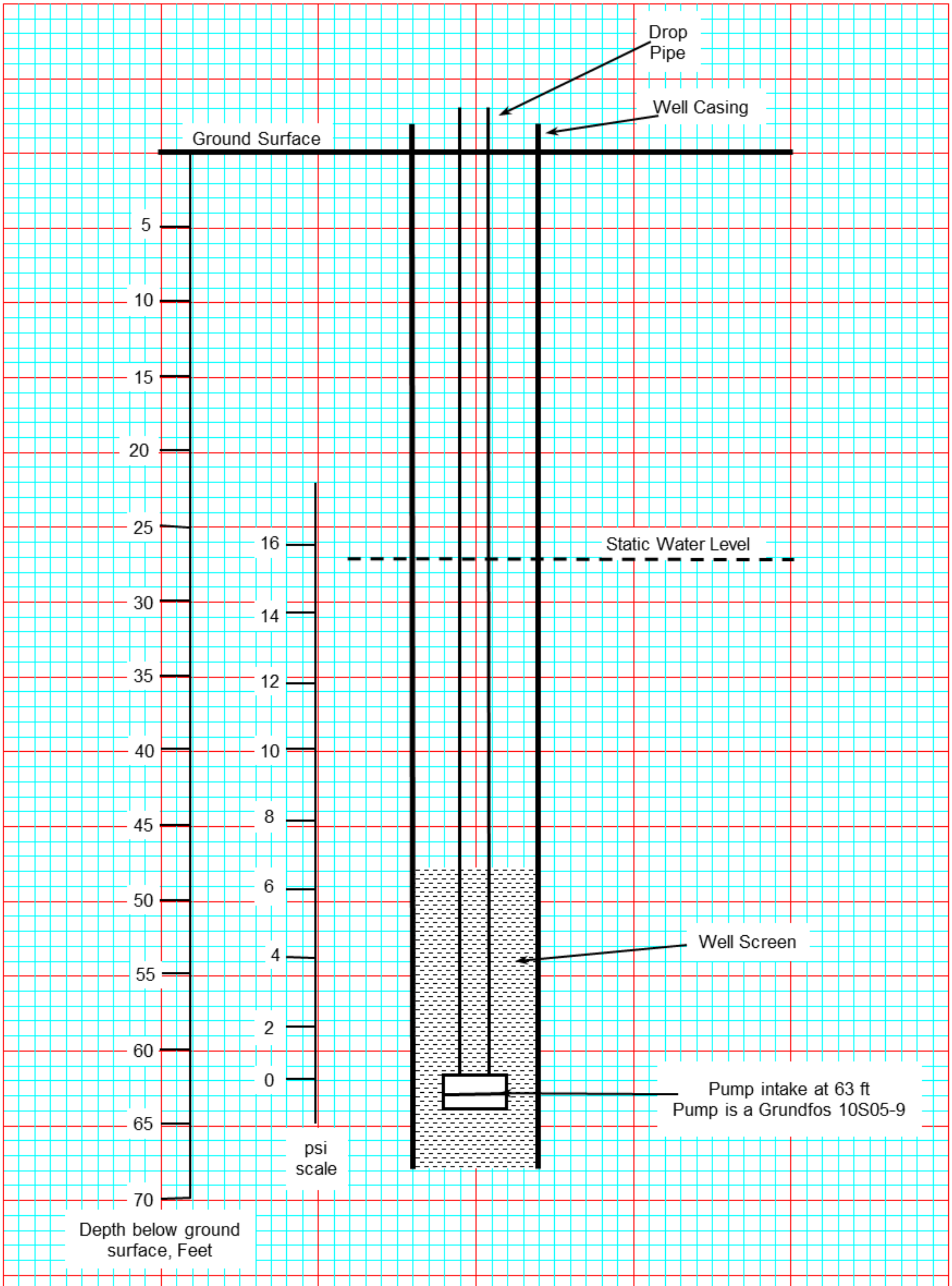


Figure 5. Well No. 2, Castolon Area, Big Bend National Park

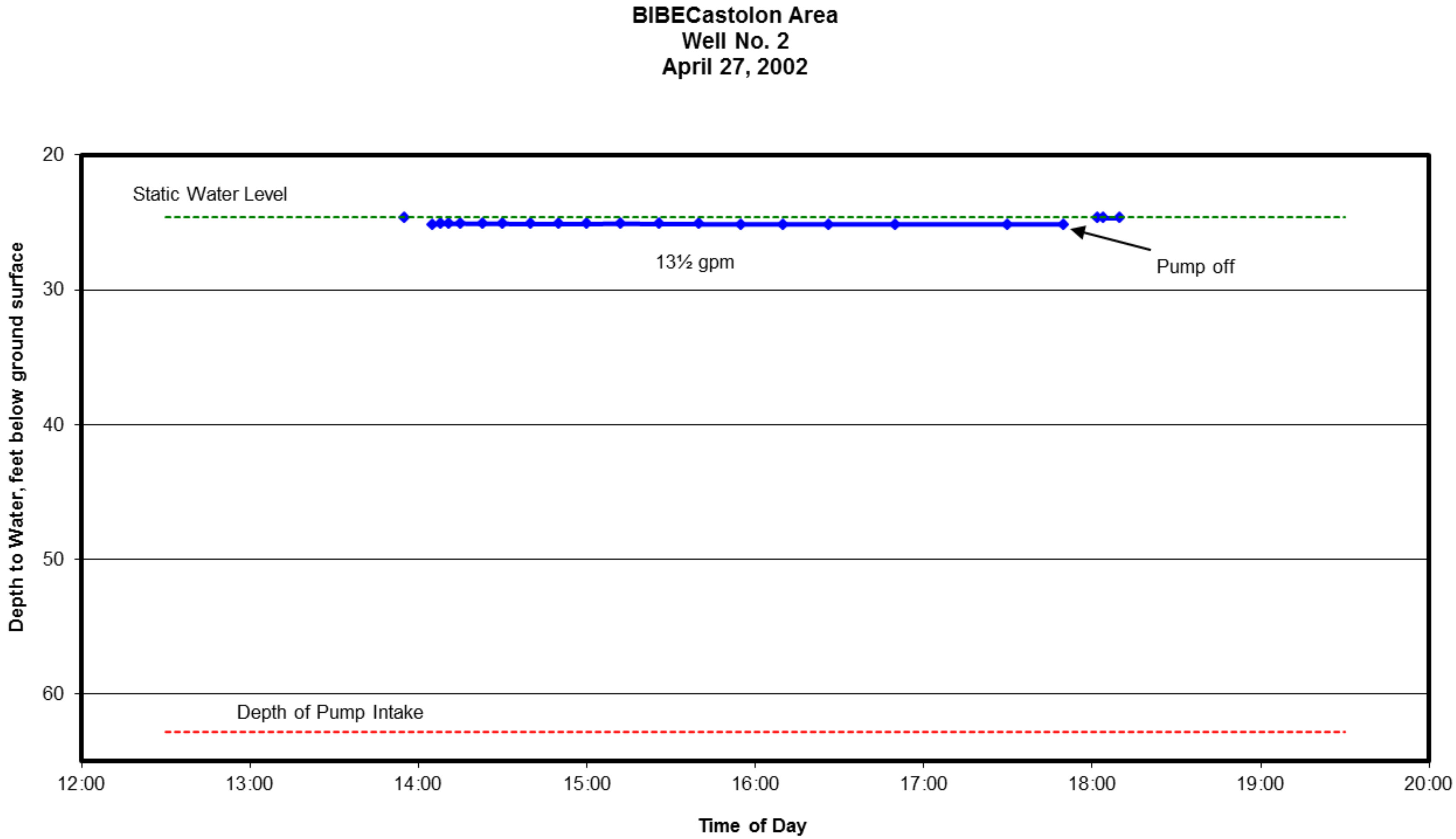


Figure 6. Drawdown test for Well No. 2, April 27,2002

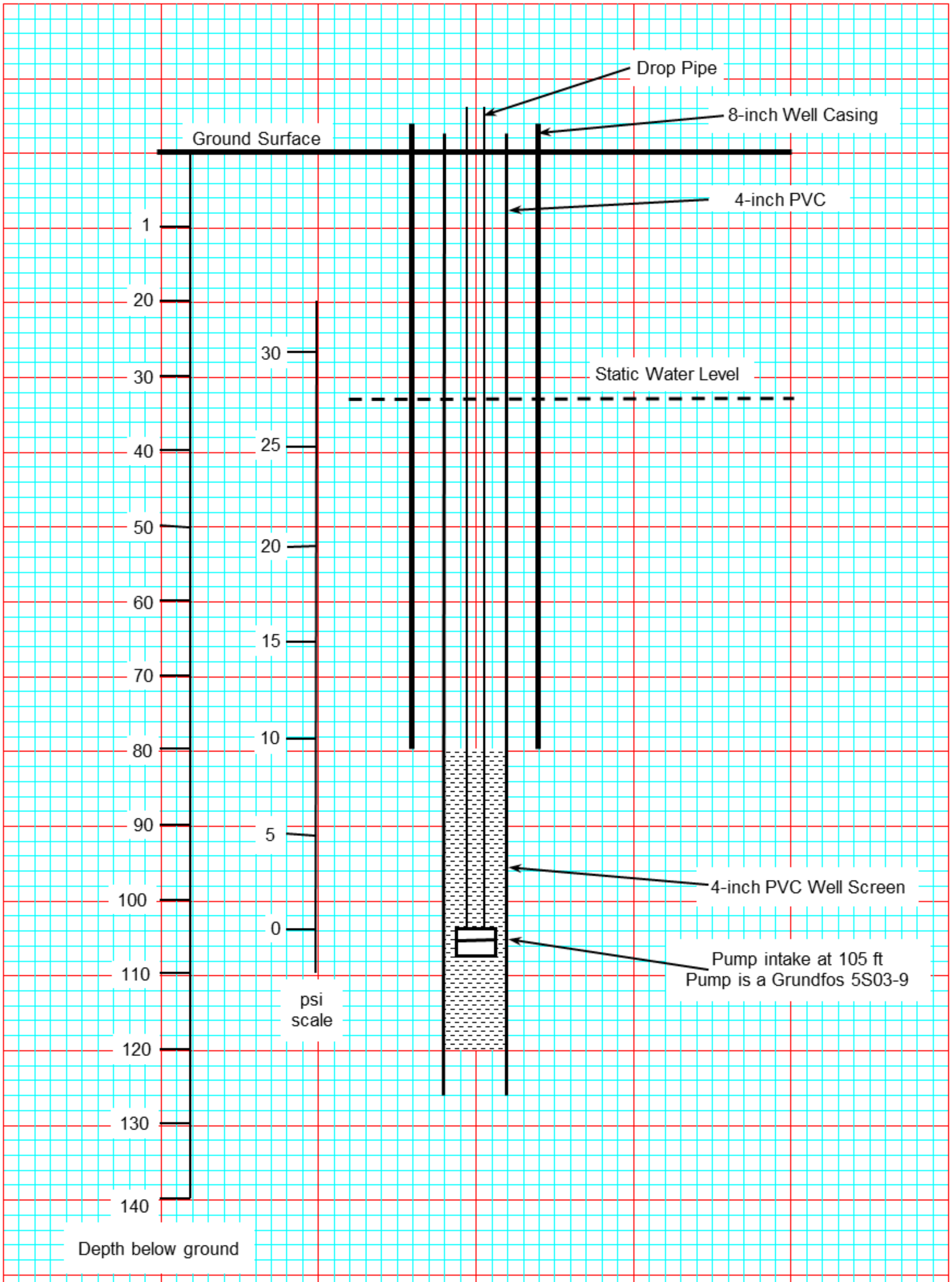


Figure 7. Well No. 3, Castolon Area, Big Bend National Park

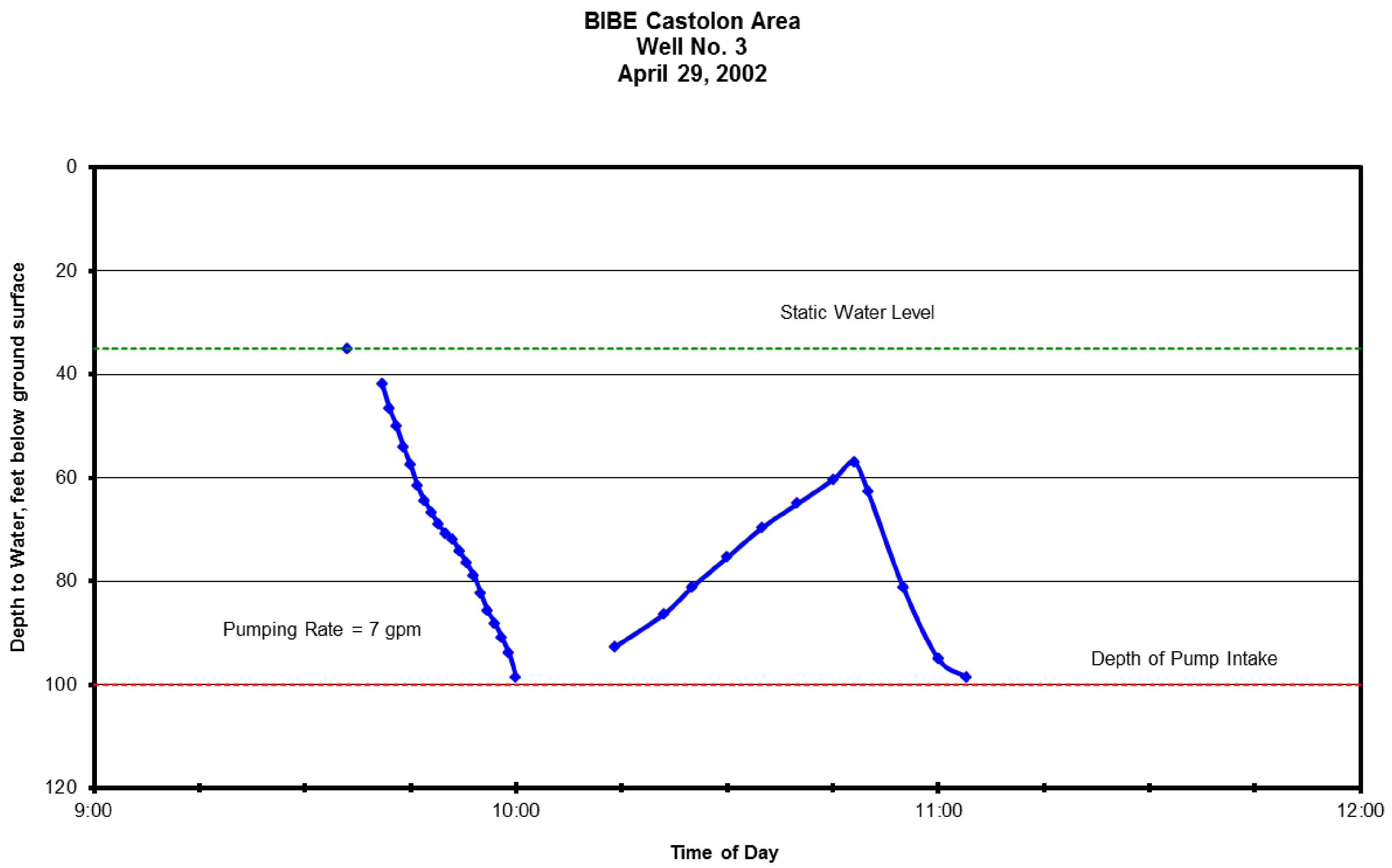


Figure 8. Drawdown and recovery test for Well No. 3, April 29, 2002

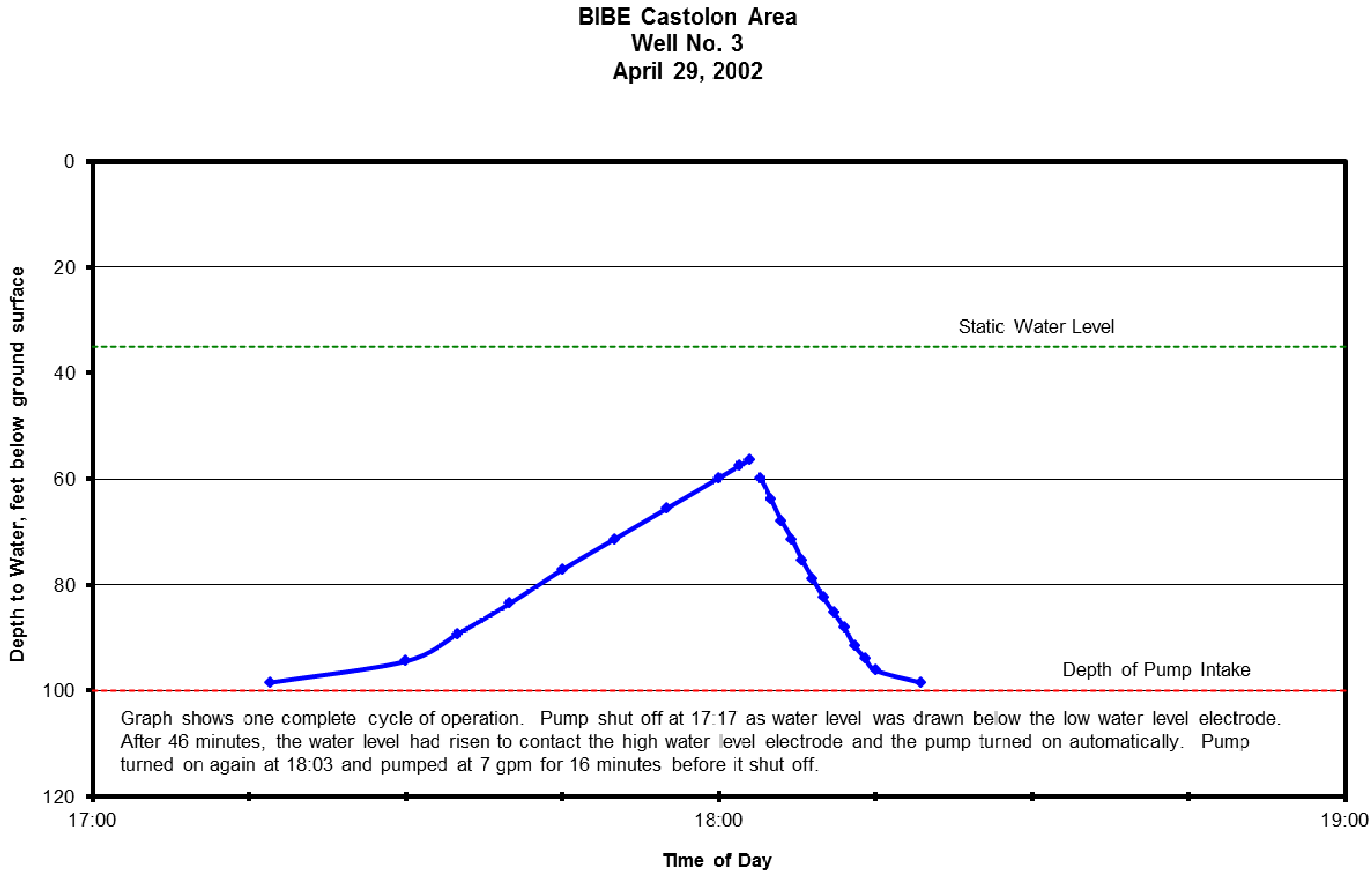


Figure 9. Drawdown and recovery test for Well No. 3, April 29, 2002