



United States Department of the Interior
NATIONAL PARK SERVICE
Water Resources Division
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IN REPLY REFER TO:

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BIBE/General

Memorandum

TO: Jim Pennigton, Civil Engineer, Denver Service Center

FROM: Larry Martin, Hydrogeologist, Water Resources Division

REFERENCE: Big Bend National Park, Castolon Water Supply Improvements

SUBJECT: Locating acceptable groundwater source for potable supply

I was asked to investigate the hydrogeology of the Castolon area at Big Bend National Park to advise the park and Denver Service Center on the probability and preferred location for finding and developing an acceptable groundwater supply. Water from the currently used water supply wells in the area is very hard and contains high concentrations of several minerals, notably sulfate, chloride, and in some cases fluoride. If a source of good quality groundwater can not be obtained, it will be necessary to treat water from the existing wells. To accomplish this effort, I reviewed material from files at the Water Resources Division in Fort Collins. These files included geologic and hydrologic reports and maps, reports of drilling and testing wells, and water quality data from existing wells and previous test wells.

Conclusions

The Castolon area is underlain by geologic formations containing gypsum. Gypsum is a compound of calcium sulfate. Groundwater flowing through the bedrock slowly dissolves calcium and sulfate from the rock, causing the groundwater to be both hard and have high concentrations of sulfate. Similarly, other minerals, such as sodium and chloride are dissolved from bedrock. Alluvium in the stream channels is derived from local bedrock sources. Thus, groundwater flowing through the alluvium is also in contact with gypsum rich rock and becomes mineralized.

Because gypsum, and other easily dissolved minerals, are prevalent in the geologic formations throughout the Castolon area, it is unlikely that good quality groundwater will be found anywhere in the general area. My review of information included data from

several test wells constructed into bedrock and shallow dug wells in the alluvium of the Rio Grande and tributaries. Water quality from all of these wells was very similar, generally having 400-500 ppm sulfate, 100-200 ppm chloride, and specific conductivity of 1500-2500 micromhos/cm.

In several cases, water quality from test wells initially appeared to show promise of better water quality, but after sustained pumping, the water quality worsened. At some locations, water quality from shallow test pits in the alluvium of tributary creeks was good, but test wells that were constructed deep enough to insure a sustainable supply of water encountered poor quality water.

Low recharge rates in an arid environment is another factor contributing to poor water quality in the Castolon area. Low recharge rates results in slow rates of groundwater flow from recharge to discharge areas, providing the groundwater with a long residence time and ample opportunity to dissolve minerals from the bedrock and sediments it flows through.

In summary, I conclude that because of the arid environment and abundance of gypsum in the area, it is unlikely that new wells anywhere in the Castolon area will provide water that is any better from that currently being obtained from existing wells.

The remainder of this memo provides more details on well construction, test drilling, and groundwater quantity and quality in the Castolon area.

DISCUSSION

Current Water Supply Wells

In the later 1990's, potable water for the Castolon area was being pumped from 3 wells. These wells were called Cottonwood #1, #2, & #3 by park staff. Cottonwood #1 is no longer used because it had high concentrations of iron and partial filling of the well with sediment and debris. Cottonwood #2 is the backup well and is only used intermittently. Cottonwood #3 is the primary supply well for the area.

Cottonwood #1 is located southwest of the intersection of the Castolon Road and the road to the campground. This well is labeled BK-73-52-9-08 in the Water Resources Division files. It is also called Castolon Well #6 in some reports. The well was constructed in 1983. It is 60 feet deep with the static water level about 22 feet below ground surface. The well was completed with 6⁵/₈-inch casing and 20 feet of well screen between 30-50 feet below ground surface. The driller's log indicates the well was constructed in alluvium, possibly encountering bedrock at a depth of 58 feet. The well was tested at several different pumping rates, from less 1-17 gpm. It was determined that the maximum sustained yield was around 14 gpm. Water from this well has 510 ppm sulfate, 190 ppm chloride, and specific conductivity of about 1800 micromhos,

Cottonwood #2 is located southwest of the intersection of the Castolon Road and the road to the campground. It was constructed in 1985 as a backup to Cottonwood #1 (Castolon #6) and is about 200 feet west from Cottonwood #1. This well is labeled BK-73-52-9-09 in the Water Resources Division files. It is also called Castolon Well #7 in some reports. It is 95 feet deep with the static water level about 20 feet below ground surface. The well was completed with 6-inch casing and 20 feet of well screen between 48-68 feet below ground surface. The driller's log indicates the well was constructed in alluvium to a depth of 73 feet and bedrock from 74-95 feet. It was reported to produce 30 gpm with no drawdown after 44 hours of pumping. Water from this well has 430 ppm sulfate, 125 ppm chloride, and specific conductivity of 1766 micromhos.

Cottonwood #3 appears to be the same well as Test Well T-2 constructed and tested under supervision of the USGS in 1963. The well was drilled to test the water supply potential of alluvium in the Blue Creek drainage at some distance away from the Rio Grande. Well T-2 was drilled near Blue Creek about 900 feet north of the Castolon Road. Alluvium was encountered to a depth of 40 feet. Clay was encountered from 40-60 feet. Water level in the well was about 17 feet below ground surface. Water samples were collected during drilling from depths of 47 and 60 feet. The water had about 70 ppm sulfate, 10 ppm chloride, and specific conductivity of about 600 micromhos. Torch slotted casing was installed from 15-45 feet. Test pumping showed the well could produce about 13-14 gpm. Water samples taken after 6 hours of test pumping had 33 ppm sulfate, 4.5 ppm chloride, specific conductivity of 595 micromhos, and 4.2 ppm fluoride. Recent (1994) tests of water from this well detected 384 ppm sulfate, 81 ppm chloride, and specific conductivity of 1871 micromhos.

Maintenance staff at the park believe the pump setting in Cottonwood #3 is about 120 feet. If this is the case, then Cottonwood #3 can not be the same as Test Well T-2, as T-2 is only 60 feet deep. If Cottonwood #3 and Test Well T-2 are different wells, they are at least in close proximity.

Rio Grande Alluvium

The Castolon Dug Well is located near the old Castolon townsite. It was constructed in February 1961. It is a 36-inch corrugated metal culvert material installed to a depth of 18 feet below ground surface. Depth to water is about 14 feet. The well yields 25-35 gpm. The water contains 400-560 ppm sulfate, 110-175 ppm chloride, and has a specific conductance of 1600-2200 micromhos. Water quality from the well varies depending on the seasonal fluctuation of water quality in the adjacent Rio Grande River.

The Castolon Gallery Well is near the Rio Grande about 100 yards downstream of the confluence with Blue Creek, just west of the campground entrance. It is a dug well, 26 feet deep and 7½ feet diameter. It was constructed in 1968. The well is perforated starting at 11 feet below ground surface. The water level on January 15, 1969 was 11 feet below land surface, but probably fluctuates in response to changes in the stage of the river. Water from the well has a hardness of 308 ppm, 340-394 ppm sulfate, 62-83 ppm chloride, and specific conductance of 1200-1600 micromhos. . Water quality from the

well varies depending on the seasonal fluctuation of water quality in the adjacent Rio Grande River.

Aguja Formation (bedrock)

The bedrock underlying the Castolon area is Aguja Formation. The Aguja consists of fine sand, silt, clay, sandstone, gravel, and gypsum. The Aguja Formation in the Castolon area is about 1000 feet thick. The abundance of gypsum in the Aguja Formation is likely the source of hardness and high sulfate concentrations in groundwater in the area. (Gypsum is calcium sulfate.) Since the alluvium associated with the stream channels is derived from weathering and erosion of local bedrock, it follows that we would also expect high concentrations of sulfate in the alluvial groundwater.

Springs

Springs can sometimes be used as indicators of quantity and quality of groundwater that would be available if a well was constructed into the geologic formation feeding the spring. The nearest springs to the Castolon area are 1½ miles away, and yield small quantities of mineralized water. A park inventory of springs identified 16 springs within 10 kilometers of Castolon. All of these springs yield only small (less than 10 gpm) quantities of water, and the water generally has chemistry similar to that from wells in the Castolon area.

Blue Creek

The "Contractor's Well" was drilled in October 1962. It is located about 1300 feet east of the channel of Blue Creek and north of the Castolon Road. The well was drilled through about 100 feet of silt, sand, and gravel. The material is considered to be alluvium associated with Blue Creek or possibly Aguja Formation. It may also be alluvium deposited by the Rio Grande. Water from the well has high concentrations of sulfate (402 ppm), chloride (122 ppm) and specific conductance of about 1500 micromhos.

A pit was constructed (1962) in the channel of Blue Creek about 40 feet downstream from the Castolon Road to supply water for road construction. Water from this pit was similar to that from the Contractor's Well, having 392 ppm sulfate, 92 ppm chloride, and specific conductance of 1330 micromhos.

Water chemistry tests showed that water from alluvium in the lower part of Blue Creek is similar to water in the alluvium of the Rio Grande. Groundwater from the alluvium underlying the Rio Grande and the lower part of Blue Creek are probably hydraulically interconnected. Pumping water from a well completed in alluvium within several hundred feet of the Rio Grande creates a cone of depression in the water table around the pumped well and induces flow of groundwater from near the river toward the well. This lowering of the water table also induces infiltration of water from the river to the alluvial groundwater system.

It was hoped that better water quality could be achieved by constructing a well in the alluvium of Blue Creek beyond the influence of the Rio Grande. A test pit was constructed at the confluence of Blue Creek and an unnamed tributary, about 1000 feet

upstream from the Castolon Road. The results of chemical analyses of water taken from the test pit were promising. The water had 57 ppm sulfate, 9 ppm chloride, and specific conductance was 826 micromhos. With these seemingly promising results, two test wells were constructed in the alluvium of Blue Creek.

Well T-1 was drilled in 1963, approximately 2400 feet north of the Castolon Road, near the confluence of Blue Creek and an unnamed tributary. Drilling was through alluvium to a depth of 40 feet and then through clay to a depth of 190 feet. Sand was encountered from 190-215 feet. Water was first encountered at 200 feet. The water had 26 ppm hardness, 5 ppm sulfate, 778 ppm chloride, and a specific conductivity of about 2500 micromhos. Oil was encountered between 210-215 feet and the well was plugged, capped, and abandoned.

Well T-2 was drilled near Blue Creek about 900 feet north of the Castolon Road. Alluvium was encountered to a depth of 40 feet. Clay was encountered from 40-60 feet. Water level in the well was about 17 feet below ground surface. Water samples were collected during drilling from depths of 47 and 60 feet. The water had about 70 ppm sulfate, 10 ppm chloride, and specific conductivity of about 600 micromhos. Torch slotted casing was installed from 15-45 feet. Test pumping showed the well could produce about 13-14 gpm. Water samples taken after 6 hours of test pumping had 33 ppm sulfate, 4.5 ppm chloride, 4.2 ppm fluoride, and specific conductivity of 595 micromhos.

It appears that this well may be the same as the current (2000) water supply well called Cottonwood #3 by park staff. Water sampled from this well in 1994 had a 384 ppm sulfate, 81 ppm chloride, and specific conductivity of 1871 micromhos. This is the primary water source for the Castolon area, supplying about 75% of the water.

The Old Castolon Store Well is located about 300 feet northwest of the intersection of the Castolon Road and the dirt road to the campground and old maintenance area. A chemical analysis data sheet for a sample collected on 8/20/73 indicates the well is 140 feet deep and 25 years old. Water from this well 490 ppm sulfate, 135 ppm chloride, and a specific conductivity of 2500 micromhos

Alamo Creek

Test Well T-3 was drilled in 1963, along Alamo Creek, about 800 feet north of the Castolon Road. The well was drilled through alluvium to a depth of 46 feet and clay from 46 feet to the total depth of 69 feet. Static Water level was 32 feet below ground surface. Water from the well had 324 ppm sulfate, 10 ppm chloride, 3.8 ppm fluoride, and specific conductivity of 1250 micromhos. The well was completed with 6-inch casing, which was torch slotted from 25-47 feet. Drawdown and yield testing showed the well was capable of producing about 35 gpm. Indications are that the water quality from this well may be slightly better than from wells constructed in the Blue Creek and Castolon areas. However, several other test wells that initially appeared to be promising, later showed a deterioration of water quality with sustained pumping. This well could be

retested if the park should wish to reconsider using this well as a supply source. Testing should include continuous pumping for 48-72 hours with periodic water level measurements and collection of water quality samples. If the water quality proves to remain stable and similar to that from the 1963 testing, the water would still require treatment to meet current drinking water standards. Development of well(s) in the Alamo Creek area would require approximately 2 miles of pipeline to convey the water to the Cottonwood Campground area to connect with the existing distribution system.

Santa Elena Canyon Area

Notes (dated 1957) in WRD files refer to a dug well at the Santa Elena picnic area. The well was reported to be 14 feet deep and constructed of 30-inch culvert pipe and then backfilled with gravel around a 6-inch casing. Water level was about 4 feet below ground surface. A windmill was used to pump water. Two water analyses were available for the well. The water had a hardness of 470-680 ppm, 750-1300 ppm sulfate, 20-30 ppm chloride, and specific conductivity of 2340-3926 micromhos. Bill Werrell could not find any wells in the Santa Elena area during several reconnaissance trips in 1993 and preceding years.

There are no active water supply wells in the Santa Elena area at this time (2000). NPS does not provide water at any of their facilities in the area.

No test wells have been constructed in the alluvium of Terlingua Creek. However, the results of chemical analyses of surface water showed that it had a high concentration of sulfate (516 ppm). It would be expected that alluvial groundwater would also have high concentrations of sulfate. The sulfate is derived from gypsum mixed in with the clays and silts of the Tornillo and Terlingua Clay formations that outcrop in much of the drainage basin of Terlingua Creek.

Smoky Creek

Smoky Creek is the next large drainage to the southeast of Castolon. The drainage basin may be large enough to provide sufficient groundwater recharge to the alluvium to warrant investigation. The geologic formations underlying the Smoky Creek drainage basin are primarily tuffaceous sediments and lava, almost no gypsiferous sediments are found in this area. Thus, the sulfate concentrations should be lower in alluvial groundwater. Smoky Creek is about 5½ miles southeast from Castolon. No test wells have been constructed in this area, so the quantity of water available for sustained yield is unknown. The hypothesis that water quality from the Smoky Creek alluvium would be of better quality is speculative.

New Maintenance Area Well

There is a well at the new maintenance area, approximately 1 mile northeast of the old Castolon townsite. The well is currently (2000) not being used. Water for the new maintenance and employee housing areas is piped in from the Cottonwood wells. The well was constructed in August 1979. It is 200 feet deep and was completed with 6⁵/₈" casing and well screen from 180-190 feet below ground surface. The static water level was 40 feet below ground surface. The well was tested at 30 gpm for 24 hours,

resulting in drawdown of the water level to 85 feet below ground surface. The water has 540 ppm sulfate, 9.2 ppm fluoride, 1690 ppm total dissolved solids, and specific conductivity of 2700 micromhos.

Information on existing wells in the Castolon area is summarized in the attached table.

Maps showing well locations are attached.

1. Sketch map of well locations near the campground
2. Topographic map showing location of all wells in the area
3. Detail map of Santa Elena area
4. Detail map of Alamo Creek
5. Detail map of Castolon area

REFERENCES

Leggat, E.R., 1963, Water Supply for the Castolon Area, Big Bend National Park, Brewster County, Texas, USGS open file report, 19 pp.

National Park Service, 1996, Water Resources Management Plan - Big Bend National Park. Department of Hydrology and Water Resources, University of Arizona, Tucson, Big Bend National Park, Texas, and National Park Service - Water Resources Division, Fort Collins, Colorado. 163 pp. plus appendices

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cc:

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w/o attachments

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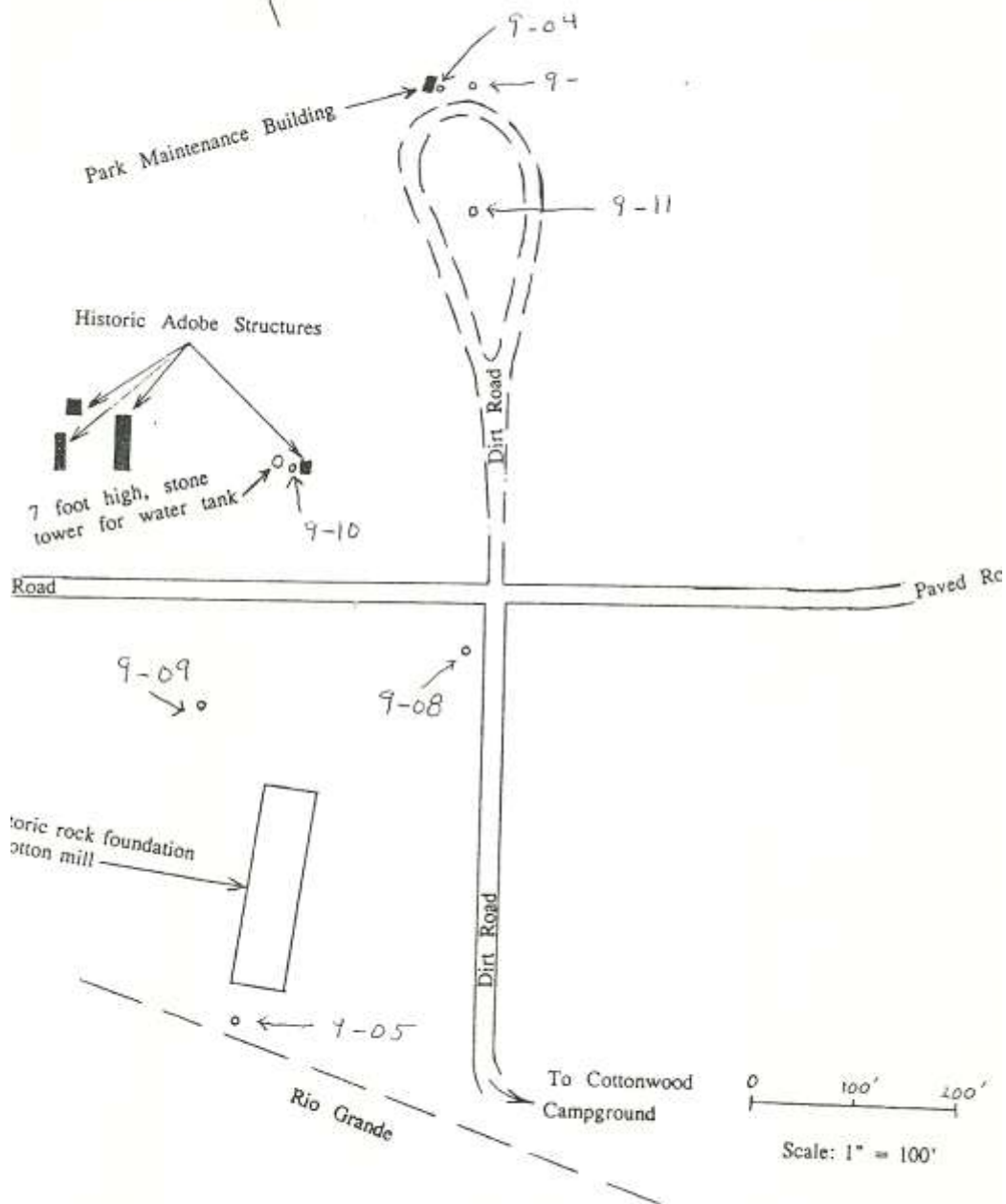
Summary of water well information for the Castolon area, Big Bend National Park

Map #	TX Well #	Well Name	Location Description	Status	Construction Date	Depth Ft	Depth to Water	Yield gpm
1	BK-73-52-401		Santa Elena Canyon	Abandoned	1948?	14	4	10-25
2	BK-73-52-801	T-3	Alamo Creek, 800' North of Castolon Road		1963	69	32	35
3	BK-73-52-901	Dug Well P-2	Southwest of Castolon town site, near 912		1961	18	14	25-35
4	BK-73-52-902	Contractor's Well	1300' East of Blue Creek, North of Castolon Road		1962	101	31	20
5	BK-73-52-903	T-1	2400' North of Castolon Road at confluence of Blue Creek and unnamed tributary	Abandoned Encountered oil	1963	215	200	
6	BK-73-52-904	T-2 Cottonwood #3	Blue Creek, 900' North of Castolon Road	Current water supply well	1963	60	17	14
7	BK-73-52-905	Gallery Well	Near Rio Grande, about 100' downstream of confluence with Blue Creek, at campground entrance	Current irrigation supply?	1968	26	11	800
8	BK-73-52-906		Well number not assigned					
9	BK-73-52-907		Well number not assigned					
10	BK-73-52-908	Cottonwood #1 Castolon Well #6	Southwest corner of Castolon Road and campground entrance road	Currently not being used	1983	60	22	14
11	BK-73-52-909	Cottonwood #2 Castolon Well #7	200' West of Cottonwood #1 SW corner of Castolon Road and campground entrance road	Backup supply well	1985	95	20	30
12	BK-73-52-910	Old Castolon Store Well	300' NW of the intersection of Castolon Road and the campground entrance road		1948?	140?		
13	BK-73-52-911	Cartledge's #4 Well	Center of loop in dirt road, West of old maintenance building	Abandoned	1983	260	Dry	Dry
14	BK-73-52-912	Test well	SE of Castolon town site, near 901, 400 yards south of Castolon Store	abandoned	1983	40	Dry	Dry
15	BK-73-52-913	New Maintenance Area Well	New Maintenance Area	unused	1979	200	40	30

BIG BEND NATIONAL PARK

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Castolone Area



Map prepared by use of steel tape and Brunton Compass

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