

HYDROGEOLOGIC ANALYSIS AND WATER SUPPLY RECOMMENDATIONS

WHITE WOLF AREA, YOSEMITE NATIONAL PARK

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Summary

There are 3 wells in the White Wolf area. Well No. 1, constructed in 1968, should produce about 8 gpm of good quality water. Well No. 2, constructed in 1982, (located in the campground loop) should produce 10 gpm of water with a high concentration of iron and manganese. The third well, constructed in 1993, was not tested because the expected yield (after casing and grouting) was less than 2 gpm.

I recommend constructing a new well adjacent to the 1993 test well, but with less casing and grout so as to not seal off the water bearing fracture zones from 40-60 feet below ground surface. A variance will be required from the state standard of casing and grouting to a depth of 50 feet to provide a sanitary seal. Hydrofracking the new well and/or the existing wells may significantly increase the yield of the wells.

Well No. 1 (1S/21E-10K1)

White Wolf Well No. 1 was completed in August 1968. The well is 232 feet deep and 6" diameter. The location is reported as, "in meadow, about 310 feet S28°E of SE corner of lodge. SW¼, NW¼, SE¼, Sec. 10, T1S, R21E". Water is obtained from various zones of fractured granite in the well. The well was tested by USGS personnel (Hugh T. Mitten) and determined to yield 8-10 gpm (1968).

A 14" borehole was drilled from 0-16 feet. This part of the well was cased with 7" steel casing. The annular space was cemented from 0-16 feet, to seal out surface water and water from the unconsolidated material from entering the well. The remainder of the well, 16-232 feet, was drilled and completed as an open borehole (no casing).

Testing of the well in 1968 produced the following drawdown and yield data:

<u>Discharge, gpm</u>	<u>Drawdown, feet</u>
4	35
8	90
12	155

Static water level was not provided.

Chemical analysis of a sample (8/29/68) from the well produced the following results;

Temperature	8.0 °C
Silica (SiO ₂)	15.0 mg/l
Iron (Fe)	0.01 mg/l
Calcium (Ca).....	6.1 mg/l
Magnesium (Mg)	1.0 mg/l
Sodium (Na).....	4.6 mg/l
Potassium (K).....	1.2 mg/l
Bicarbonate (HCO ₃).....	32.0 mg/l
Carbonate (CO ₃).....	0.0 mg/l
Sulfate (SO ₄)	2.0 mg/l
Chloride (Cl)	0.2 mg/l
Fluoride (F)	0.0 mg/l
Nitrate (NO ₃).....	0.1 mg/l
Boron (B)	0.05 mg/l
Dissolved Solids (calculated).....	46.0 mg/l
Hardness as CaCO ₃	19.0 mg/l
Noncarbonate as CaCO ₃	0.0 mg/l
Percent Sodium	33.
Specific Conductance (umhos @ 25°C).....	61.
pH.....	7.1

White Wolf No. 2 1S/21E-10G1

Well No. 2 was drilled in Fall 1982. It is 248 feet deep and was drilled through granite for its' entire depth. The borehole was 8" diameter and is cased with 6" steel casing. The casing was grouted to a depth of 40 feet. The casing was perforated from 168-248 feet. As described in the driller's log the perforations are, "slots are 2½" long, machine cut, 6 rounds, 37 cuts/round and slot size is 3/16-inch". Fractures in the granite were encountered at depths of 22, 47, 65, and 130 feet. Depth of water was reported to be about 9½ feet below ground surface after completion of the well (10/20/82). The water had a conductivity of 50 umhos, indicating an exceptionally pure chemistry, pH was 7.5.

The well was tested at two different pumping rates to determine drawdown and yield characteristics. During the first test, the well was pumped at 9 gpm for 2½ hours, resulting in 40 feet of drawdown. For the second pumping period, the well was pumped at 23 gpm, however, at 82 minutes into the test there was a sharp decrease in the pumping rate (as drawdown increased, the pumping rate decreased). The maximum drawdown during the second test was 194 feet below land surface. It was concluded that the well should not be pumped at a rate exceeding 10 gpm, as the rate of drawdown increased greatly at higher rates.

1993 Test, Well No. 1

Well No. 1 was retested in 1993. The test was started at a pumping rate of 23 gpm. It quickly became apparent that the well was not capable of producing that amount of water on a sustained basis and the test was terminated. After the water level was allowed to recover, the test was restarted at a rate of 7-8 gpm (typical operation rate) and continued for 12 hours. Drawdown in the well stabilized at 95 feet below ground surface. Pre-test static water level in the well was 2.8 feet below ground surface. Following termination of pumping, the water level had recovered to within 10 feet of ground surface. Investigators concluded that the well was capable of being pumped continuously at a rate of 10 gpm with an expected pumping water level of 150-175 feet below ground surface.

Well No. 2 was not retested in 1993.

Iron problems

The issue of high iron concentrations in water from wells at White Wolf was addressed in the report by HRS Water Consultants (HRS, 1994). As stated in that report;

“Though undesirably high levels of dissolved iron would be suspected in the wet-meadow location of White Wolf well no. 1, excessive iron levels have not been reported. It is often the case that near-surface soils in meadow/wetland areas are oxygen-poor and chemically-reducing conditions prevail. Under such anaerobic conditions, we have commonly seen undesirably high reduced (ferrous) iron and manganese concentrations in nearby wells.”

“It is our hypothesis that the reduced iron and manganese are mobilized into nearby pumping wells due to drawdown-induced downward water movement from the near-surface meadow soils. Once the iron-enriched pumped water comes into contact with oxygen in a water-supply system, the iron oxidizes to the relatively insoluble ferric (Iron III) form, where it can cause orange or brown fixture staining and encrustation. Fortunately, and for reasons of which we are unsure, the dissolved iron concentration in White Wolf well no. 1 never has been high enough to be a problem.”

“Paradoxically, White Wolf well no. 2, located on a granodiorite outcrop in a campground loop adjacent to the Middle Fork of the Tuolumne River about 1/3 mile north of well no. 1, does show an undesirably high iron concentration. Though we did not test White Wolf well no. 2 as part of the current work effort, we did notice that there is considerable rusty discoloration in the bed of the Middle Tuolumne adjacent to well no. 2. It may be the case that well no. 2 captures dissolved iron from the surface stream, which appears to have mobilized and concentrated dissolved iron from further upstream. A full analysis of the well no. 2 iron problem is, however, beyond the scope of the present investigation.”

1993 Test Well

A test well was constructed in 1993, located about 25 feet east of the White Wolf entrance road and 2500 feet north of the Tioga Pass road. Water-bearing fracture zones were encountered at 18-19 feet, 40-43 feet, and 47-48 feet below ground surface. Estimated flow from these fracture zones was 15 gpm. These fracture zones were sealed off by installation and grouting of steel casing to a depth of 50 feet. The hole was drilled to 400 feet, but the only water bearing fracture encountered was at a depth of 58-60 feet with an estimated yield of 2 gpm. The well was capped and left in place without testing because of the low estimated yield.

These results are not unexpected. Generally the number and size of fractures decreases with depth, so that most of the water produced by wells constructed in fractured bedrock is from shallow depths. In this well, the main water bearing zones were sealed by casing and grouting the first 50 feet of the well.

Site Selection for Test Well Drilling

The report by HRS Water Consultants (HRS, 1994) gives a detailed description of the procedure used to identify potential test well locations. This is the same procedure we would use today if we were planning to drill additional test wells. There is no need to repeat this effort. Test well drilling in 1993 resulted in a successful well, but the water-bearing zones were sealed off because California regulations call for 50 feet of surface casing. Apparently no effort was made to obtain a waiver from these regulations.

Recommendations

A well should be constructed adjacent to the test well constructed in 1993. The new well would be drilled to a depth of 200 feet to allow ample distance for drawdown during pumping. The well should be cased and grouted only to 35 feet to avoid sealing off the water bearing fractures starting at 40 feet below ground surface. (Actual depth of casing and grout will be determined during drilling, dependent on where the fractures are found. These estimates are based on information from the 1993 test well.) Seeps and a wet meadow in this area indicate it is an area of groundwater discharge, so the general direction of groundwater flow is toward the surface, reducing the potential for infiltration in the vicinity of the well to enter the well, reducing the need for the full 50 feet of casing and grouted specified by California regulations. Bedrock was encountered at this site at a depth of 9½ feet below ground surface.

The alternative site selected in 1993 is near the river. Well No. 2, in the campground loop and near the river, produces water with a high iron concentration. Speculation is that the source of the iron is higher up in the watershed and that as iron is transported downstream by the river, some portion of the water produced by the well is influent from the stream, resulting in high iron concentrations. Drilling at this site is not recommended because it is likely that there would be high concentrations of iron in water produced by a well located near the river.

If there are well drillers in the region who are familiar with, and have the equipment, hydrofracking the existing wells may be a viable alternative to increase their yield. This would likely also require video logging of the wells to identify fracture zones so that the hydrofracking can target the zones where it is most likely to be successful.

References

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