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Construction of Two Water-Supply Wells at Moraine Park, Rocky Mountain National Park

Water for the Headquarters East water system at Rocky Mountain National Park has been provided by shallow wells in Moraine Park for many years; since about 1960. The Headquarters East water system provides water to NPS facilities in Moraine Park, including the campground and visitor center, the Beaver Meadows entrance station and visitor center, and the headquarters area, including park offices, maintenance and housing areas. The existing wells are so close to the Big Thompson River that the source would probably be classified as “groundwater under the direct influence of surface water”, which would require the water to be treated as if it were from a surface-water source.

Two new wells were constructed at Moraine Park with the goal of obtaining a water supply that would be classified as a “groundwater” source. The new wells needed to be located within 200 feet of the existing wells to transfer the water right. If the new wells were farther than 200 feet from the existing wells, it would be necessary to go through the water court to get a new water right. The goals of moving farther from the river and staying within 200 feet of the existing wells greatly limited the options for locating the new wells.

Hydrogeology

Moraine Park is a broad valley that was scoured by glaciers and subsequently refilled with sediments and glacial deposits. Moraine Park is approximately a half mile wide and two miles long. The Big Thompson River meanders across the valley.

The east-west trending ridges to the north and south of Moraine Park are lateral moraines; material deposited along the sides of a glacier. The lateral moraines contain an unsorted mix of sediments, including a large amount of clay and silt. The clay and silt cause the moraine deposits to have low permeability and will not yield much groundwater to wells.

The valley-fill sediments in Moraine Park are primarily alluvium that has been reworked by running water. Sediments are constantly reworked as the river meanders back and forth across the valley. Running water carries away the silt and clay fraction of the sediments, leaving behind sand and gravel which are very permeable and will yield large quantities of groundwater to wells.

Granitic bedrock underlies the alluvium. The granite is essentially impermeable. Small amounts of groundwater may be obtained from fractures in the granite.

Existing Wells

There were two existing wells at Moraine Park (No. 2 and No. 3). Both wells are located within about 20-30 feet of the Big Thompson River (Figure 1).

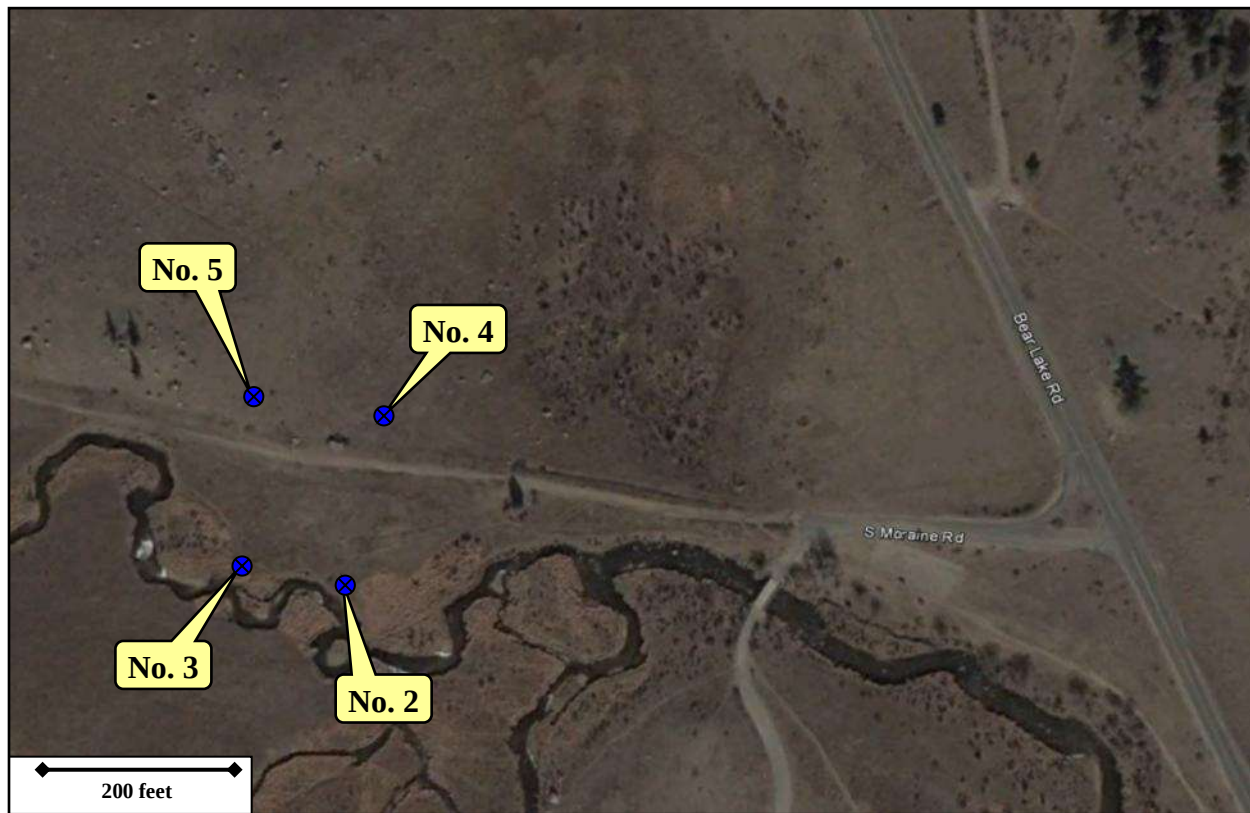


Figure 1. Locations of wells at Moraine Park. Wells No. 2 & 3 were existing wells. Wells No. 4 & 5 were constructed in October-December 2011.

Well No. 2 was constructed in 1970. It was drilled to a depth of 87 feet. There is no mention of encountering bedrock (granite). The drillers' log lists only sand and gravel sediments. The well was completed with Johnson-type well screen which would allow development of a natural gravel filter around the screen and even flow of groundwater to the entire screened area, reducing the potential for continual pumping of fine-grained sediments. Well No. 2 has been the primary water source for the Headquarters East system for many years.

Well No. 3 was constructed in 1984. It was drilled to a depth of 50 feet. There is no mention of encountering bedrock (granite). The drillers' log lists only sand and gravel sediments. The well was completed with perforated steel casing. The openings in perforated casing are too large to allow development of an effective sediment filter around the perforations. Groundwater flow is funneled to the few large openings in the casing, resulting in high velocity flow into the well and a large potential for continual pumping of fine-grained sediments. Well No. 3 has been the backup source for the water system because it does not produce as much water as Well No. 2 and the water tends to have a higher turbidity, both of these drawbacks can be attributed directly to completing the well with perforated casing rather than well screen.

New Wells Constructed in 2011

The alluvial sediments comprising the valley-fill aquifer are the only target zone for a high-capacity well in the Moraine Park area. Since there was no mention of encountering granitic bedrock in the previous wells, it was hoped that the new wells could be screened more than 100 feet below ground surface. Screening the well below 100 feet would help meet the Colorado Dept. of Public Health requirements for separation from surface-water sources. The new wells needed to be located within 200 feet of the existing wells to meet the Colorado Dept. of Water Resources requirements for transferring the existing water rights from the old wells to the new wells. A new water right would be required if the new wells were more than 200 feet distant.

Well No. 4 was drilled in October 2011. It encountered granite at 55 feet, but drilling continued to 105 feet to make certain that it wasn't just a large boulder and because of the desire to have a well that was more than 100 feet deep. About 5 gpm were available from a fracture zone in the granite at about 95 feet below ground surface. The state water well inspector would not allow the well to be completed in two different aquifers (alluvium and granite), so the bottom part of the borehole had to be plugged with cement grout to seal off water from the granite. The log for the well follows;

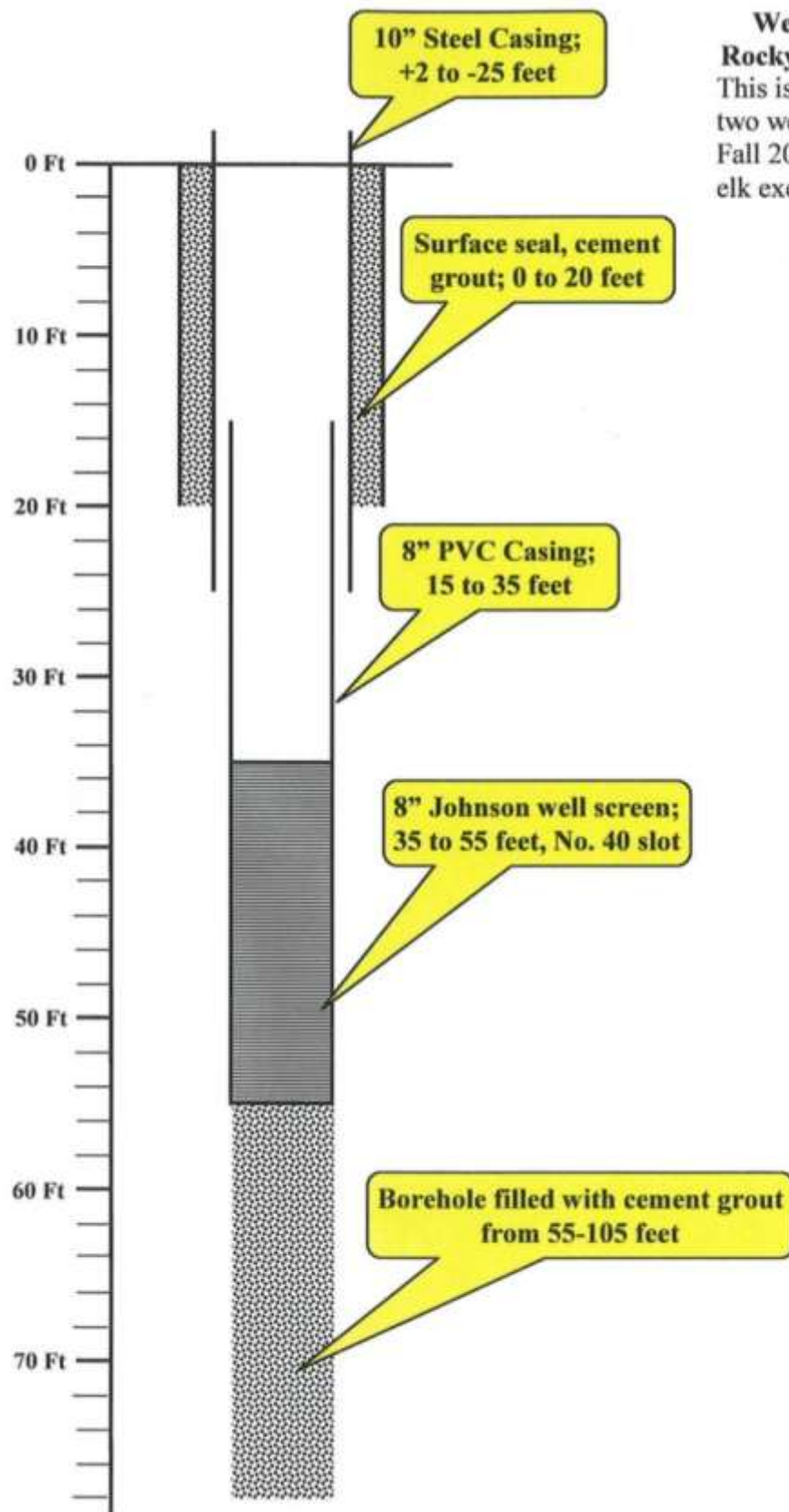
0-35 feet	Silty-sand, medium sand, gravel, cobbles
35-55 feet	Medium-to-coarse sand and gravel
55-105 feet	Granite (bedrock)

Well No. 4 was completed with 20 feet of Johnson well screen from 35-55 feet. The well screen has 0.040" openings (No. 40 slot size). A schematic drawing of Well No. 4 is shown in Figure 2.

Well No. 5 was drilled in November 2011. Granite was encountered at a depth of 60 feet and drilling continued to the end of that piece of drilling pipe at a depth of 67 feet. The 10 feet of sediments immediately overlying the granite were very dense, containing a lot of clay. These sediments would not be permeable because of the amount of clay. Ten feet of well screen was placed in what appeared to be the most permeable strata from 38-48 feet below ground surface. The log for the well follows;

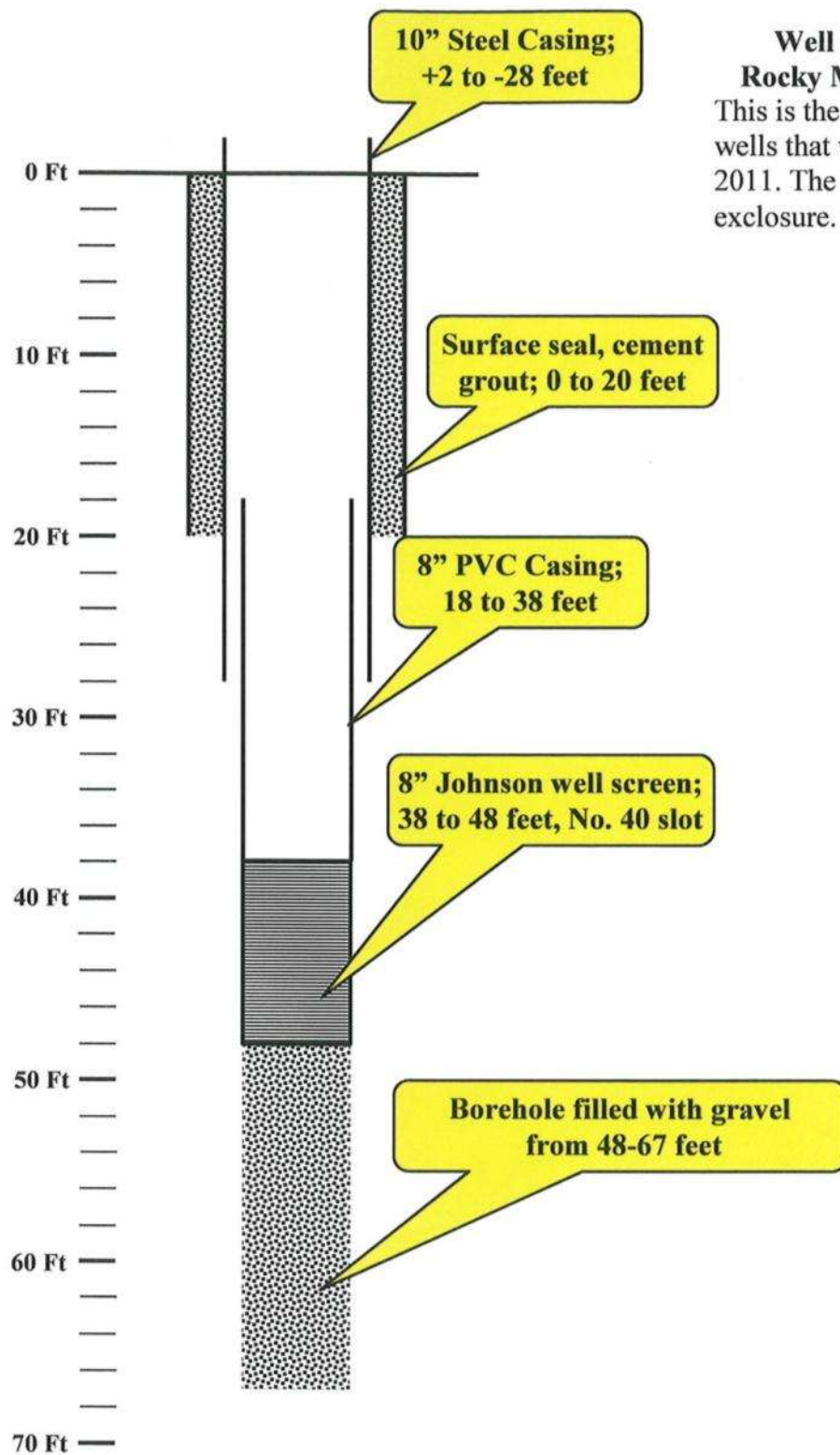
0-8 feet	Brown, medium sand
8-11 feet	Brown, medium sand and gravel
11-20 feet	Brown, medium sand and boulders
20-45 feet	Brown, medium-to-coarse sand and gravel
45-50 feet	Color changed from orange-brown to gray, medium-to-coarse sand and gravel
50-60 feet	Gray, clay, silt, and gravel, densely compacted sediments
60-67 feet	Granite (bedrock)

Well No. 5 was completed with 10 feet of Johnson well screen from 38-48 feet. The well screen has 0.040" openings (No. 40 slot size). A schematic drawing of Well No. 5 is shown in Figure 3.



**Well No. 4, Moraine Park,
Rocky Mountain National Park**
This is the more easterly of the
two wells that were constructed in
Fall 2011. The well is inside the
elk enclosure.

Figure 2. Schematic drawing of Well No. 4.



**Well No. 5, Moraine Park,
Rocky Mountain National Park**
This is the more westerly of the two wells that were constructed in Fall 2011. The well is outside the elk enclosure. (50' west of the fence)

Figure 3. Schematic drawing of Well No. 5.

Both wells were developed by blowing high volumes of air through the drill stem to create turbulent conditions in the well, flushing the fine-grained sediments from the screened area and creating a natural gravel filter. The drill pipe was moved up and down throughout the screened interval to develop the gravel filter. Development of the 20-foot interval in Well No. 4 lasted 6 hours. Development of the 10-foot interval in Well No. 5 lasted 4 hours.

Pumping Tests

Pumping tests were conducted on the two new wells in December 2011.

The static water level in Well No. 4 was 8.7 feet below ground surface. Well No. 4 was pumped for 24 hours. The initial pumping rate was 38 gpm for 1 hour, resulting in drawdown of the water level to 14½ feet below ground surface. The pumping rate was increased to 58 gpm for 2 hours, resulting in drawdown of the water level to 17½ feet below ground surface. The pumping rate was then increased to 88 gpm for 21 hours, resulting in drawdown of the water level to 23 feet below ground surface. The top of the well screen is 35 feet below ground surface. At the maximum sustained pumping rate for this test (88 gpm) the water level remained 12 feet above the top of the screened interval.

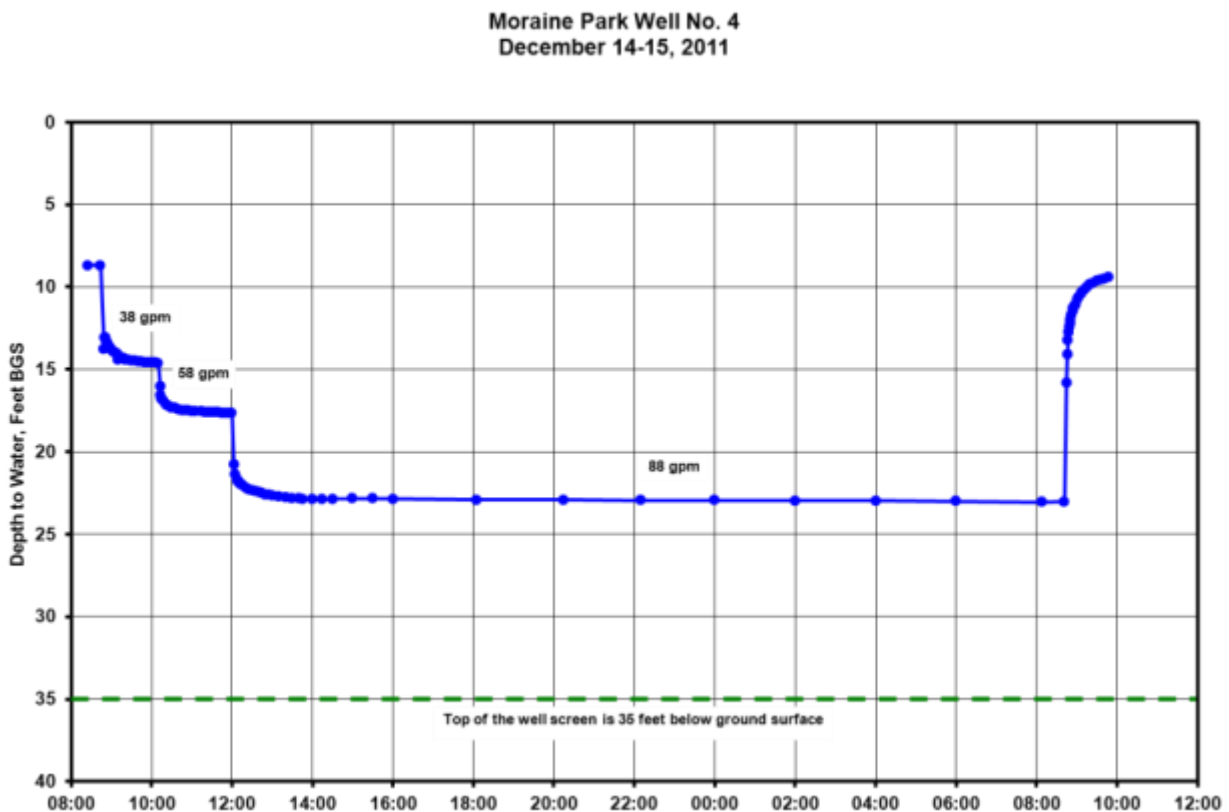
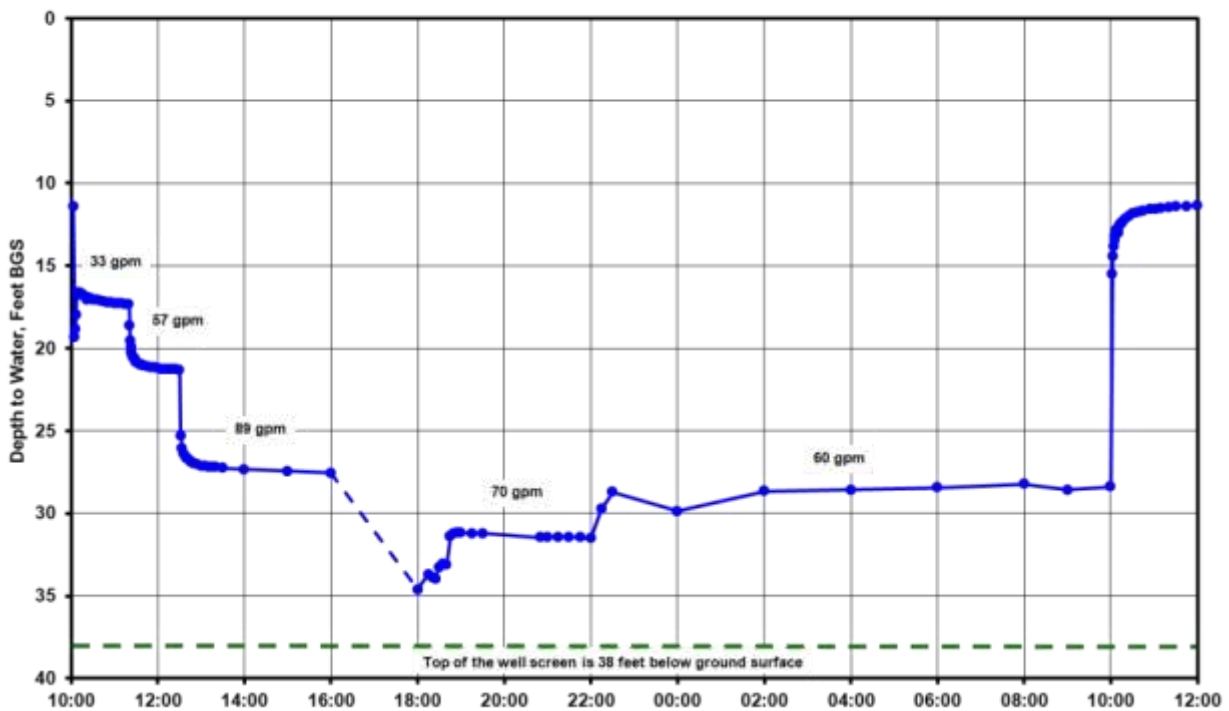


Figure 4. Water level during pumping test of Well No. 4

The static water level in Well No. 5 was 11½ feet below ground surface. Well No. 5 was pumped for 24 hours. The initial pumping rate was 33 gpm for 1 hour, resulting in drawdown of the water level to 17¼ feet below ground surface. The pumping rate was increased to 57 gpm for 1 hour, resulting in drawdown of the water level to 21¼ feet below ground surface. The pumping rate was then increased to 89 gpm, resulting in drawdown of the water level to 27½ feet below ground surface. It appeared that the water level would be stable, as it was during the pumping of Well No. 4, but there was a sudden precipitous drop between 4:00 and 6:00 pm. When the well was checked at 18:00, the pump was sucking air and the water level had probably been drawn down to the screened interval. Water and air surging into the well near the top of the screened interval caused movement of some fine-grained sediment into the well, as observed on the MPA filter. The pumping rate was reduced to find a pumping rate that would allow continuous pumping without drawing the water level down to the screened interval. There was still a slight downward trend in the water level at 70 gpm. At 60 gpm, the water level trend was slightly upward. It would appear that the maximum sustained yield for this well is at least 60 gpm, but probably less than 70 gpm.

Moraine Park Well No. 5
December 15-16, 2011



Conclusions

Two new wells were constructed at Moraine Park. Both wells are more than 200 feet from the Big Thompson River. Further testing will probably be required to determine whether these wells will be classified as a “groundwater” source or as “groundwater under the direct influence of surface water.”

A microparticulate test (MPA) was conducted during the pumping test of each well. Water chemistry samples were collected in the last hour of the pumping test at each well. Analytical results will be available in a couple of weeks.

Well No. 4 will probably provide a sustained yield of 100 gpm. Well No. 5 will probably provide a sustained yield of 60-70 gpm. These estimates of sustained yield are only valid if only one well is pumping. If the wells are pumped simultaneously, the pumping rates will need to be reduced because the drawdown from the two wells is additive. Further testing and analyses will be required if operations will require pumping from both wells at the same time.