Hydrogeologic Conditions and Options for Water Well Construction in the Vicinity of Flagg Ranch John D. Rockefeller, Jr., Memorial Parkway Wyoming

Introduction

Water for facilities at Flagg Ranch is obtained from two wells located approximately a mile north of the ranch. The water is slightly mineralized and has a component of geothermal water as shown by the high temperature, high specific conductance, and a high concentration of chloride. General locations are identified where a new water supply well could be constructed that should have better water quality.

Previous Investigations

Richmond (1973) published a surficial geologic map of the area. A copy of part of that map is attached to this report. Love and Antweiler (1975) included the Flagg Ranch area in their study of the mineral potential of the area. They also discussed the chemistry of Huckleberry Hot Springs. The area is included in the geologic map of Grand Teton National Park (Love and others, 1992). Hedmark and Young (1999) investigated the hydrogeology and water quality of the Flagg Ranch area. Additional data was obtained from the USGS database (http://waterdata.usgs.gov/nwis/gw) and the Wyoming State Engineers Office (http://seo.state.wy.us/wrdb/index.aspx).

Hydrogeology

Upland areas adjacent to the Snake River valley are covered with a veneer of glacial till overlying volcanic bedrock (primarily rhyolitic tuff). The glacial till has low permeability due to an abundance of clay and silt and is therefore unlikely to yield water. Groundwater in the volcanic bedrock is likely to have poor water quality and was not considered as a potential source of potable water.

The glacial till may act as a confining layer, trapping geothermal water in the underlying volcanic rocks. At the margin of the till, the geothermal water can escape, rising to the surface as hot springs (such as Huckleberry Hot Springs) or mixing with the adjacent groundwater. The current water supply wells are completed in alluvial sediments near the contact with the till. It is likely that the water pumped from the wells is a mixture of geothermal groundwater from the volcanic bedrock and alluvial groundwater. This would explain the high water temperature, high specific conductivity, and high concentrations of arsenic and chloride in water pumped from the supply wells. Arsenic is present in volcanic

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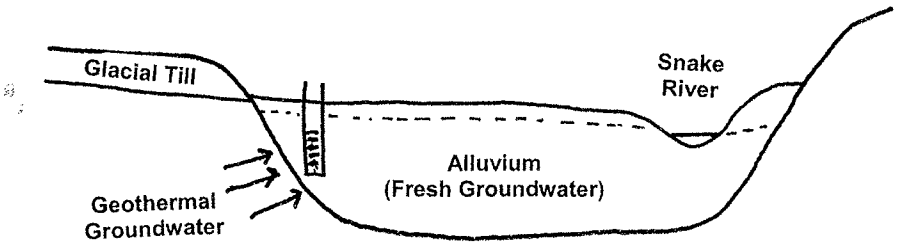
gases and is a common constituent of geothermal water and chloride is a common constituent in hot springs (Hem, 1985).

A schematic northwest-southeast cross section through the area is shown in the following figure. It shows how the location of the current water supply wells makes them susceptible to "contamination" from geothermal groundwater flowing from the volcanic bedrock into the alluvium. Better quality groundwater should be available further south of the current well locations, toward the middle of the alluvial sand and gravel deposits. Groundwater flow is slower toward the margins of the alluvial deposits, very much like the current in a river is slower near the bank and faster in the middle of the river. The combination of slow groundwater flow and inflow of geothermal groundwater causes the water quality to be poorer along the northern margin of the alluvial sand and gravel north of Flagg Ranch.



The Snake River valley is filled with coarse-grained, permeable, alluvial sediments. During post-glacial times, the flow of the Snake River was larger due to glacial meltwater runoff and the active valley was much larger. The large terrace north of Flagg Ranch was formed by deposition of alluvial sediments during this time. Areas mapped as "psg" and "sg" on the geologic map are predominantly sand and gravel alluvial deposits. The current water supply wells and the well at the former campground south of the Snake River show that the alluvial deposits are at least 100 feet thick. A well completed in the alluvial sediments should be capable of yielding at least 50-100 gpm of good quality water.

Downstream of Flagg Ranch, extensive deposits of fine-grained humic alluvium form a thin veneer (5-10 feet) over most of the floodplain. These deposits were likely formed in the shallow waters of the Snake River delta as it entered Jackson Lake during a time when the lake level was higher than it is now.

Existing Wells

The locations of existing wells near Flagg Ranch are shown on the attached map. The two water supply wells (FR-1 and FR-2) were constructed in 1978 and 1979 and are about 100 feet deep. The driller's report for FR-1 states that the well will produce 165 gpm with about 40 feet of drawdown. Information regarding

the yield of FR-2 was not available. There was a supply well (SP-1) at the former campground location, south of the Snake River. That well is also about 100 feet deep. Information regarding the yield of SP-1 was not available.

There are at least 6 monitoring wells in the vicinity of the sewage lagoons. The geologic logs for the monitoring wells indicate the sediments are very permeable and likely to yield large quantities of groundwater to pumped wells.

There were approximately 50 shallow (20 feet deep or less) monitoring wells constructed in the Flagg Ranch area between the campground and the Snake River as part of a site investigation and remediation for a leaking underground fuel storage tank.

Groundwater Quality

Water from the supply wells (FR-1 and FR-2) is warmer and more mineralized than water from other wells in the area. The temperature of water from the supply wells is around 16-19°C. Water from the monitoring wells near the sewage lagoons is 6-8°C. The specific conductivity of water from the supply wells is around 400-500 uS/cm. Water from the monitoring wells near the sewage lagoons has a conductivity of 250-350 uS/cm. Dissolved chloride concentrations for water from the supply wells is generally about 25-35 mg/l. Water from the monitoring wells near the sewage lagoons generally has 2-10 mg/l chloride.

Water from well FR-2, the well closest to Huckleberry Hot Spring, is warmer and has higher concentrations of chloride and higher specific conductivity than water from well FR-1.

It seems fairly obvious that groundwater quality is affected by inflow of geothermal water along the north margin of the alluvial aquifer. Better quality water will be found closer to the middle of the aquifer and near the river where the flow of fresh groundwater is greater.

Potential Well Sites

Very permeable alluvial sediments underlie the entire area that is generally bounded by the Snake River on the east and south, Polecat Creek on the west, and Huckleberry Hot Springs and wells FR-1 and FR-2 on the north. This includes most of Section 21. A well constructed anywhere in this area would probably yield a large quantity of water. However, water quality will probably be better closer to the river and further from the hot springs. Also, pre-existing land uses make some areas, such as near the sewage lagoons, less desirable than other areas. The attached map shows several potential well locations.

Well Construction

Because the new well will be constructed in the unconsolidated sand and gravel aquifer, it should be completed with a well screen rather than perforated casing. The proper size well screen can only be selected after completing grain-size analyses of samples obtained during drilling. A properly constructed well should be capable of providing more than 100 gpm. For example, a well completed with 10 feet of 8-inch Johnson well screen with a 0.020" slot size will be capable of producing 130 gpm (provided that the aquifer will yield that much water). Following are recommendations for construction of a new well in the Flagg Ranch area:

1. Drill an oversize hole and install temporary surface casing to 20 feet.
2. Continue drilling the hole with an air rotary rig while driving casing to prevent the hole from collapsing. The casing should be either 6 or 8 inch diameter, depending on the size of pump that will be installed in the well.
3. Collect sediment samples at intervals of 5 feet, or less.
4. Total depth of the well should be 100 feet. If the sediment samples from 90-100 feet show that is likely to be a permeable zone, that will be the screened interval. If the 90-100 foot interval does not appear to be permeable, select another interval for the well screen.
5. Conduct grain-size analyses of samples from the interval where the well screen will be placed. These data will be used to select the correct slot size for the well screen.
6. Install a 10-foot section of stainless steel well screen at the selected interval by telescoping the screen inside the casing. Pull back the casing to expose the well screen.
7. Install a cement grout or bentonite surface seal in the annular space outside the well casing while removing the temporary surface casing.
8. Develop the well to remove the fine-grained portion of the sediment from the area adjacent to the well screen.
9. Install a pump and test the well for yield and drawdown.

It will take at least a week to perform the grain-size analyses, select the correct size well screen, and have it shipped from the supplier. During this time there will be no activity at the well site.

References

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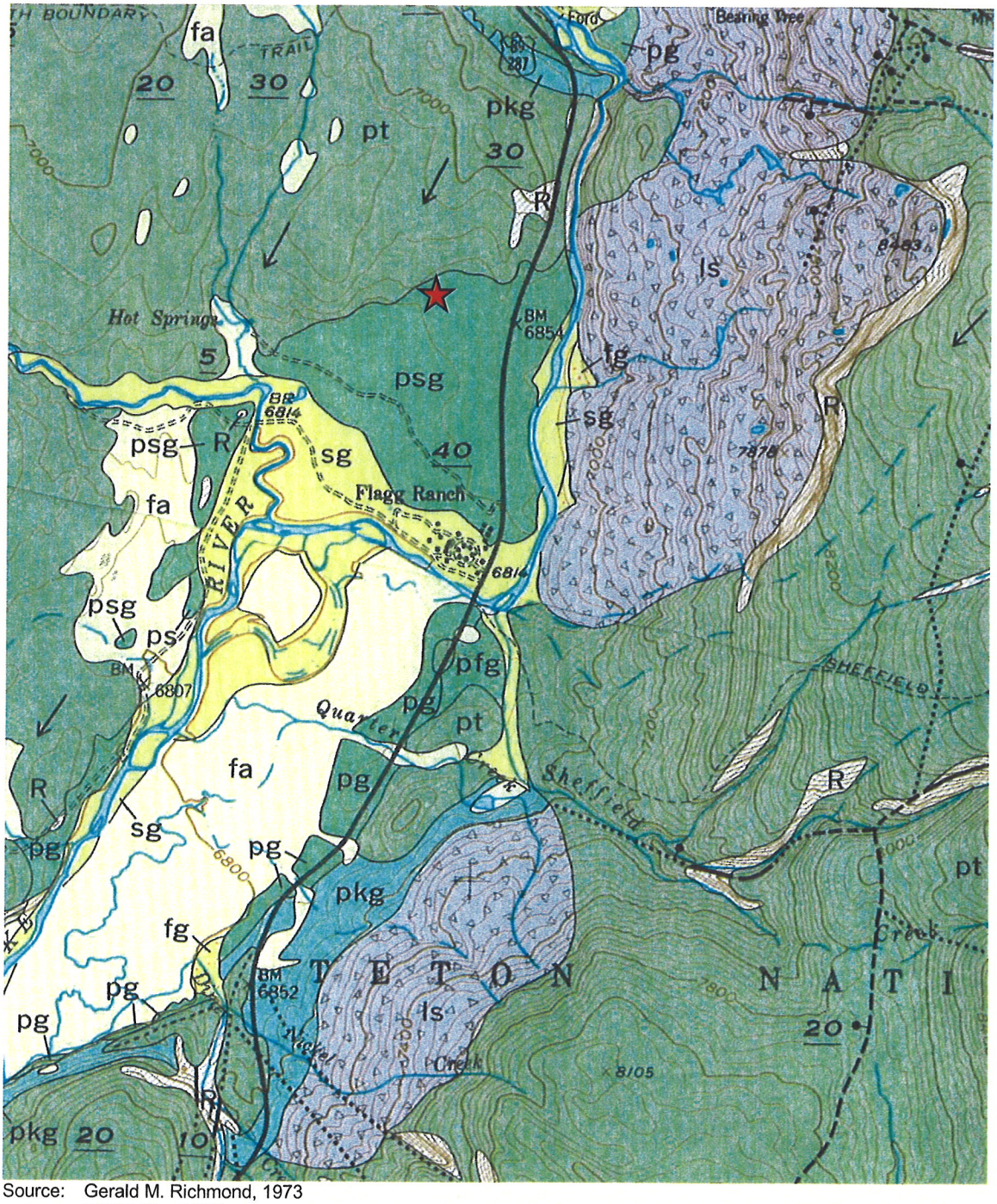


Source: Gerald M. Richmond, 1973
USGS Map I-639

Surficial Geologic Map of the Flagg Ranch Area

The red star shows the approximate location of the current water supply wells for Flagg Ranch. Major geologic units of interest are: pt, Pinedale age till; psg, sandy gravel alluvium; sg, stream gravel; fa, fine-grained humic alluvium; and ls, landslide deposits.

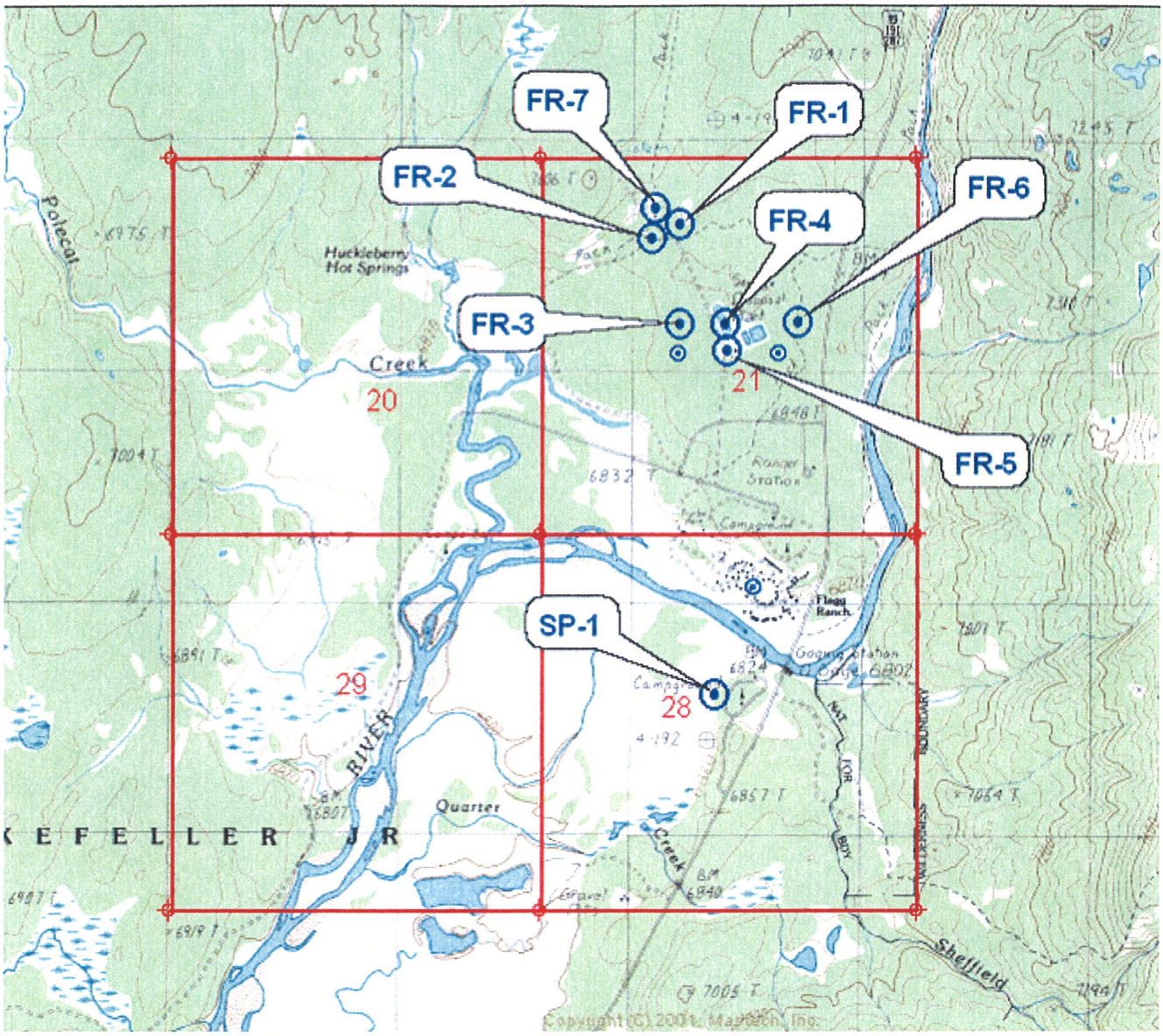
Description of Geologic Units

Post-Glaciation

fa	Fine-grained humic alluvium	Dark-gray to gray-brown silt, sand, and clay. Found on older parts of floodplains, commonly marshy, generally no more than 5-10 feet thick. Overlies stream gravel (sg) along floodplains. Probably deposited as lake sediments during times when Jackson Lake was larger, during glacial periods.
sg	Stream gravel	Gravel, cobbles, and boulders in a coarse sand matrix. Underlies Snake River and adjacent low terraces, and floodplains of tributary streams. Most rocks are 1-6 inches diameter, but some exceed 1 foot. Deposits are well sorted, poorly bedded, and include some beds of sand and silty sand.
ls	Landslide deposits	Large mass of debris including both till (pt) and bedrock that has slumped and flowed downslope. Material is clayey to silty with many large and small clasts. Deposits characterized by steep hummocky topography and undrained depressions.

Pinedale Glaciation

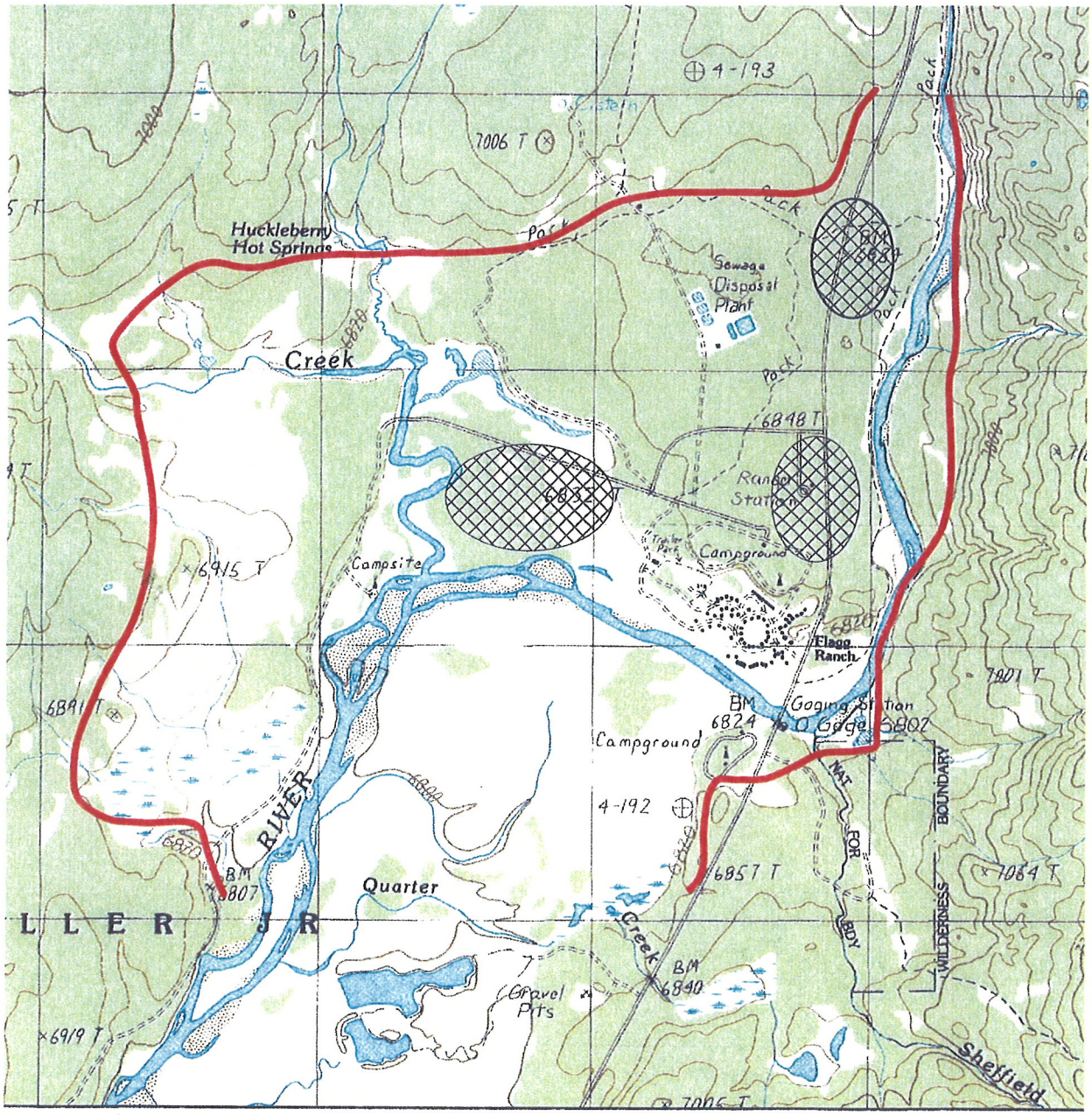
psg	Sand & gravel	Gravel underlying stream terraces. Irregularly bedded, well sorted, well rounded. Contains cobbles and boulders as much as 1 foot in diameter. Deposits along Snake River near Flagg Ranch are notably sandy.
pt	Till	Gray-brown to gray, stoney clayey sandy silt; loose to compact; stones angular to subround. Surface topography smooth to hummocky. Ice-molded topography common on uplands.



Wells in the Flagg Ranch Area

SP-1	Snake River Picnic Area	98'	1974
FR-1	Supply Well No. 1	95'	1978
FR-2	Supply Well No. 2	100'	1979
FR-3	Monitor Well	37'	----
FR-4	Monitor Well	121'	1974
FR-5	Monitor Well	47'	1996
FR-6	Monitor Well	48'	1996
FR-7	Upper Test Well	27'	May have been plugged and destroyed.

Several new monitoring wells were constructed in 2001. These wells are shown by small, unlabeled blue circles. There is one monitoring well at the circle of buildings at the ranch (15 feet deep), one monitoring well southeast of the sewage lagoons (40 feet deep), and a nest of three monitoring wells (37, 42, 52 feet deep) west of the sewage lagoons.



Potential Locations for a New Water Well at Flagg Ranch

Potential locations for a new water well are indicated by crosshatching. The red lines delineate the approximate extent of the highly permeable alluvial aquifer. Abundant supplies of groundwater should be available to a well constructed anywhere in the alluvial aquifer. Better water quality will be obtained if the new well can be located nea the middle of the valley, where the velocity of groundwater flow is greater. Areas alon the north and west boundary of the alluvium should be avoided because of the potentia for inflow of geothermal groundwater from the underlying volcanic bedrock. Areas of potential contamination, such as the wastewater treatment lagoons and the highly developed area at Flagg Ranch, should also be avoided.