A Brief Discussion of the Potential for Construction of a Water Supply Well for NPS facilities at the South Rim, Black Canyon of the Gunnison National Park

Introduction

The issue of a water source to supply park facilities at the South Rim has reoccurred with regularity for at least the past 50 years. Memos in the WRD correspondence files discussing this issue date back to 1954. There is almost no mention of well drilling or potential groundwater supplies in the numerous reports and memos on the subject. Most likely, this is because most investigators would have very quickly dismissed the hydrogeologic conditions as being unsuited for development of groundwater.

This report is a result of an office study of the geology and hydrogeology of the South Rim area. Conclusions and recommendations presented herein are largely based on interpretation of geologic maps and basic well construction data. It should be viewed as preliminary, pending an on-the-ground inspection of the area.

Two potential well locations are identified outside of the park boundary. The sites are, however, on private land and would be located 2-3 miles from the park boundary and at an elevation 500-1200 feet lower than Jones Summit. Both of these locations are in hydrogeologic settings and areas that already have several private domestic wells. The occurrence and availability of groundwater at these locations has been proven. There is no risk of drilling a dry hole in either of these areas.

Two potential well locations are identified inside the park boundary. One location would probably require construction of a deep (greater than 1000 feet) well into fractured granitic rock near the park entrance. The water-producing potential of the fractured granite is unknown and impossible to predict. The other potential target inside the park boundary is a fault zone in the sedimentary rocks located immediately southeast of the helipad. The water-producing potential at this location is unknown, but several nearby private wells obtain water from similar hydrogeologic settings.

Figure 1 shows the general vicinity of the South Rim area and the general locations where wells might be constructed to supply water for park facilities.

Hydrogeology

Figure 2 is a geologic map of the area modified from USGS Map I-584 (Hansen, 1971). In addition to the geologic units, it shows the major faults that were mapped by Hansen.

Most of the area within the boundary of the park is underlain by PreCambrian igneous intrusive rocks. The rocks are granite, gneiss, quartz monzonite, and similar

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type rocks. In layman's terms, we might refer to them collectively as being granitic rocks. These rocks have no pore spaces for groundwater to move through them. The only groundwater to be found in these geologic formations is in fractures and faults. Only a very small area near the park entrance is not underlain by granitic rocks.

The Red Rocks Fault Zone forms the boundary between the granitic rocks underlying the South Rim and the sedimentary rocks to the south. The fault runs generally northwest-southeast near the southern boundary of the park. The fault passes just south of the campground and just north of the highway at Jones Summit.

Sedimentary rocks inside the park boundary are limited to a very small area generally south of the main park road. As discussed in the following paragraphs, these geologic units would generally not be expected to yield water to a well except in areas where the rocks are fractured.

Sedimentary rocks outside the park boundary have the potential to be sources of groundwater for park facilities if political, legal, and financial obstacles could be surmounted. Sedimentary rock units and geologic formations of interest include (from youngest to oldest); alluvium, Mancos Shale, Dakota Sandstone and Burro Formation, Morrison Formation, Wanakah Formation, and Entrada Sandstone.

The alluvium underlying Bostwick Park ("Location 2" on Figure 3)is described by Hansen (1971) as consisting of a succession of locally-derived silty sands and gravel overlying well-rounded, well-sorted stream gravels derived from volcanic terranes in the San Juan Mountains. The alluvium is up to 175 feet thick in the center of the valley. Bostwick Park is an ancient stream valley that was a major drainage, heading in the San Juan Mountains and draining to the Gunnison River via Red Rock Canyon.

There is a large area of alluvium mapped as "boulder gravel" on a bench northeast of Bostwick Park. This area is identified as "Location 1" on Figure 3. Hansen (1971) described the boulder gravel as consisting of a mixture of boulders, cobbles, pebbles, and sand. The thickness is undetermined, but probably exceeds 20 feet.

The Mancos Shale is a silty clay shale and is essentially impermeable. It is not a source of groundwater. The only occurrence of Mancos Shale in the study area is underlying the alluvium in Bostwick Park. There are extensive outcrops of Mancos Shale on both sides of Hwy. 50 between the turnoff to the park and Montrose.

The Burro Canyon Formation and the Dakota Sandstone have been mapped as a single unit in this area due to their similarity and will be referred to in this report as the Dakota Sandstone. The Dakota Sandstone is a fine-to-very-fine grained sandstone, containing more conglomerate toward the base of the formation. The Burro Canyon Formation is primarily conglomeratic sandstone. There are extensive areas where the formation outcrops at land surface, primarily northwest of the entrance road

between Bostwick Park and Jones Summit. In most of these areas, the thickness of the Dakota Sandstone is not great enough to contain significant quantities of groundwater. These outcrops occur at high elevation and have very limited areas for recharge and infiltration of groundwater.

The Morrison Formation consists of alternating thin layers of siltstone, mudstone, claystone, and a few layers of limestone. The Morrison Formation ranges from about 400-600 feet thick in the area. It underlies the Dakota Sandstone and various alluvial deposits between Bostwick Park and Jones Summit. The Morrison Formation outcrops south and east of the entrance road in the last mile before reaching the park entrance at Jones Summit. The Morrison Formation is unlikely to contain or transmit appreciable amounts of groundwater due to the impermeable nature of the sediments comprising the formation. There are some lenses of sandstone and conglomerate contained within the Morrison, however, these lenses are small and are surrounded by relatively impermeable sediments. The Morrison essentially forms an impermeable boundary below the Dakota Sandstone.

The Wanakah Formation is a series of alternating beds of limestone and silty mudstone. The only surface exposures of the Wanakah Formation are adjacent to the PreCambrian granitic rocks from Jones Summit toward the east and southeast. The Wanakah Formation underlies the Morrison throughout the area. It contains considerable amounts of gypsum ($CaSO_4$). The Wanakah Formation is not likely to contain appreciable amounts of groundwater due to the impermeable nature of the silty mudstone and gypsum that predominates the formation. If it did contain groundwater, it would likely be of very poor quality due to dissolution of the gypsum, which would result in high concentrations of sulfate in the groundwater. The Wanakah Formation is probably around 200 feet thick in this area.

The Entrada Sandstone is a fine-to-medium grained sandstone that is a major geologic unit to the west and southwest, into Utah and Arizona. The formation is about 85 feet thick at Red Rock Canyon and thins toward the east. It is about 40 feet thick at Jones Summit and pinches out entirely a short distance to the east. Because the Entrada Sandstone is thin, pinches out a short distance east of Jones Summit, and is generally buried below a thick sequence of relatively impermeable rocks, it is unlikely to be a reliable source of groundwater.

Figure 4 is a geologic cross-section from Hansen (1971) showing the relationship of geologic units and faults in the area. The cross-section is along a southwest to northeast line from Bostwick Park, through Jones Summit and the new visitor center on the South Rim.

Big Draw – Lions Spring

The USGS conducted a field reconnaissance (Coffin, 1965) to determine the water-bearing potential of the alluvium associated with Big Draw. Big Draw is a small drainage basin extending about 1½ miles southward from Chasm View (Figure 5). Some of the rainfall in the Big Draw drainage basin infiltrates into the alluvium along

the stream channel and flows slowly toward the north as groundwater. The alluvium pinches out slightly upstream from where the draw drops over the canyon rim. At this point, the groundwater in the alluvium emerges as springflow at Lions Spring. This is not likely a reliable source of water for the park because the drainage basin is small and precipitation (and therefore infiltration) is low, thus the volume of water available for development would be small and susceptible to depletion during the dry summer season. If the alluvium were developed as a supplemental water supply it would probably require treatment as a surface water source. Extraction of the water from this source would probably cause impairment of park natural resources by eliminating one of the few natural sources of water for wildlife.

Potential Well Locations

Four locations were identified as potential areas where a groundwater supply could be developed to provide water for NPS facilities at the South Rim (Figure 3). Locations 1 and 2 are outside the park boundary and would need to surmount legal, political, and economic obstacles to be considered as potential water supply sources. However, wells constructed at Locations 1 or 2 are more certain to be successful because the hydrogeologic conditions are more favorable and there are already existing wells in these areas; proving that there are developable groundwater supplies there. Location 3 is within the park boundary and while the geologic conditions appear favorable, there is no certainty that groundwater will be encountered. There is a very real risk of drilling a dry hole in excess of 1000 feet deep. Location 4 is also within the park and is in a hydrogeologic setting that is similar to several nearby private wells. However, that does not guarantee that the proposed location will result in a productive well.

Several low-yield domestic supply wells have been constructed in the vicinity of "Location 1" on Figure 3. The area is generally the SW¼ of Section 12 and is west of the park entrance road, about 2 miles north of Highway 50 between elevations of about 7500-7600 feet. These wells are probably completed in the Dakota Sandstone. A well constructed in this area would be about 2-2½ miles southwest of Jones Summit and at an elevation about 600-700 feet lower than Jones Summit. Figure 4 shows a geologic cross-section through this area. A well drilled at Location 1 would penetrate the boulder gravel (Qtb) at the surface and be completed in the underlying Dakota Sandstone (Kdb). A well drilled to 300-500 feet in this area would probably fully penetrate the boulder gravel and Dakota Sandstone. There is a slightly downwarping synclinal structure in the sedimentary rocks underlying this area. The downwarped geologic structure of the syncline helps to trap groundwater in the structural basin, creating hydrogeologic conditions that allow construction of low-yield domestic wells in the area. The Colorado Department of Water Resources on-line database contains records for at least 8 domestic wells in this area. The wells generally range from about 300-500 feet deep and produce 7-10 gpm (gallons per minute).

There are many domestic wells in the Bostwick Park area (Location 2 on Figure 3). Bostwick Park is an irrigated valley about 1½ miles north of Hwy 50 at an elevation of

7000-7200 feet. Location 2 is shown on the geologic cross-section in Figure 4. Wells in Bostwick Park are completed in the alluvium (Qab) which fills the valley to a depth of 175 feet along the axis of the valley. A water supply well in Bostwick Park would be about 3 miles south-southwest of Jones Summit and at an elevation of 1000-1200 feet lower than Jones Summit. Maximum depth of a well constructed at Location 2 would be 175 feet. Sedimentary rocks underlying Bostwick Park also have a slightly downwarping synclinal structure. The downwarped geologic structure of the syncline helps to trap groundwater in the structural basin, creating hydrogeologic conditions that allow construction of low-yield domestic wells in the area. The Colorado Department of Water Resources on-line database contains records for at least 16 domestic wells in Bostwick Park. The wells generally range from about 50-175 feet deep and produce 15-20 gpm (gallons per minute).

Location 3 (Figures 3 and 6) identifies a potential target site in fractured granitic rock inside the park boundary. A test well could be drilled in the area between two branches of the Red Rocks Fault zone. Presumably, the granitic rock in this area would be severely fractured and might contain groundwater. Near the Jones Summit entrance, the road parallels the Red Rocks fault zone between the entrance and the campground (Figure 6). A southwest-northeast trending secondary fault intersects the Red Rocks fault south of the campground. The Red Rocks Fault system extends for several miles in both directions (east-west) from the Jones Summit area. Since the fault system is quite extensive, there is a potential for it to act as a conduit for groundwater flow from a large area. A well constructed in the area between the mapped faults in the Jones Summit area might encounter enough fractured rock associated with the fault zones to allow production of some amount of groundwater. There are no data to indicate whether a well constructed at this location would encounter groundwater, or simply unsaturated fractured rock. Figure 7 shows an expanded view of the geologic cross-section through this area (Hansen, 1971). There should be a large zone of fractured granitic rock between the two fault zones. Whether the fractures are saturated is unknown. A test well in this area should be budgeted to reach at least 1000-1500 feet deep to allow conclusive testing of this option.

Location 4 would target a fault zone in the sedimentary rocks near the south boundary of the park (Figures 3 and 6). The outcrop area of sedimentary rocks within the park boundary is very small; generally limited to the area south of the road between the entrance at Jones Summit and the campground. Sedimentary rocks underlying the area inside the park boundary are generally impermeable or too thin to be considered as potential sources of groundwater. However where the rocks have been fractured by faulting, there may be sufficient permeability to supply a low yielding well. A well at Location 4 would be designed to intersect the SW-NE trending fault zone in the sedimentary rocks. The fault intersects the Red Rocks Fault zone a short distance east of the heliport. The fault zones could be hydrologicially interconnected, providing a large source area for recharge of groundwater in the fault zones. Alternatively, the fault zones could be dry. Data from the Colorado Department of Water Resources provide evidence of the water

producing potential of fractured sedimentary rocks. Figure 8 shows the location of four private stock or domestic supply wells near the south entrance to the park. Three of the four wells are closely associated with fault zones and produce 5-15 gpm from wells that are 100-300 feet deep. The fourth well (northeast of Signal Hill), that is not associated with a fault zone, produces ½ gpm. Thus, we might surmise that a well constructed into the fault zone south of the park helipad might yield sufficient water to supply park demands. A reasonable depth for a test well at this site might be 500 feet. It would also be prudent to conduct a geophysical survey to determine the dip angle of the fault zone so that the test well can be located in the optimal location.

Summary

Many people have investigated potential water supplies for the South Rim of the Black Canyon. None of the previous investigations have considered potential groundwater sources. This report identifies two locations outside the park that would have a very high probability of success for construction of a water supply well. There are two locations inside the park boundary where test wells could be constructed to test the availability of groundwater. The potential for success at either of the two locations inside the park boundary is both unknown and unpredictable.

References

Coffin, Donald L., 1965, Memo from USGS District Geologist to NPS Associate Regional Director, June 6, 1965, 3 pp.

Hansen, Wallace R., 1971, Geologic Map of the Black Canyon of the Gunnison River and Vicinity, Western Colorado, USGS Miscellaneous Geologic Investigations Map I-584

Basic construction data for wells were obtained from the Colorado Department of Water Resources website: http://water.state.co.us/

Attached Figures:

1. General location map showing potential locations for water supply wells for facilities at the South Rim
2. Geology of the South Rim area
3. Geologic map of the South Rim entrance area showing potential locations for water-supply wells
4. Geologic cross-section showing potential locations for water supply wells
5. Location of Big Draw drainage basin and Lions Spring
6. Detailed geologic map of the Jones Summit area showing potential test well locations within the park
7. Expanded view of the geologic cross-section in the vicinity of a potential test well site in the Jones Summit area
8. Location of private domestic and stock wells near the South Rim entrance area

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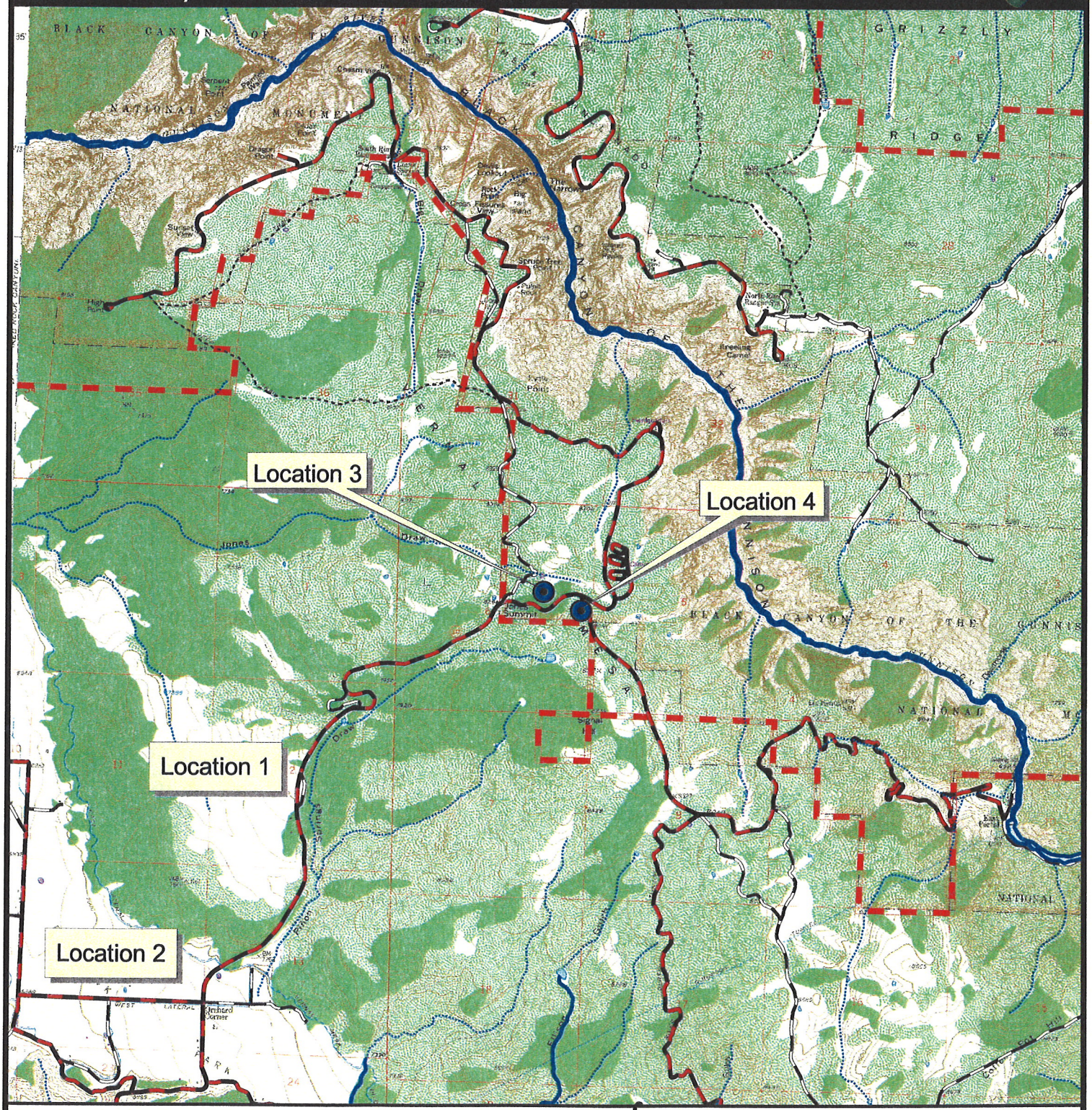
South Rim Area

Black Canyon of the Gunnison

National Park Service
U.S. Department of the Interior



Hydrography
- Ditch or canal
- Intermittent Stream
- Perennial Stream
- Lake or Pond

Roads and Trails
- Primary Road
- Secondary Road
- Jeep Trail
- Hiking Trail

Park Boundary

Figure 1. General location map showing potential locations for water supply wells for facilities at the South Rim

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0.25 0 0.25 0.5 0.75 1 1.25 1.5 Miles

1 : 47,520 1 inch = 0.75 miles

January 12, 2005

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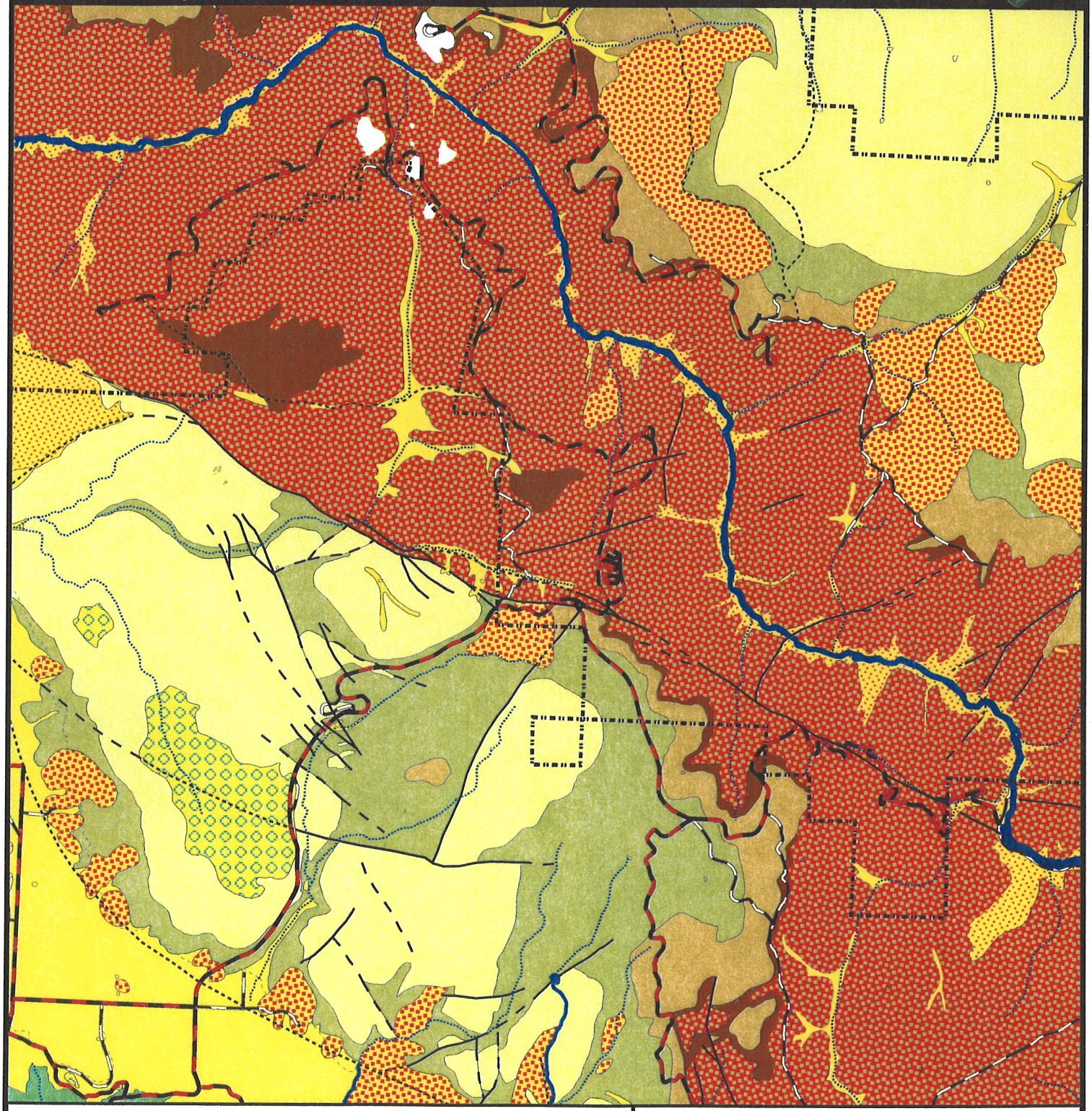
South Rim Area
Black Canyon of the Gunnison

National Park Service
U.S. Department of the Interior



Park Boundary

Geologic Faults
- known location
- approximate location
- concealed location

Geologic Formations
- Quaternary Alluvium
- Landslides
- Talus
- Boulder Gravel
- Mancos Shale
- Dakota Sandstone and Burro Formation
- Morrison Formation
- Wanakah Formation
- Entrada Sandstone
- PreCambrian Rocks
- Water

Figure 2. Geology of the South Rim area

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1 : 47,520 1 inch = 0.75 miles

January 13, 2005

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South Rim Entrance Area

Black Canyon of the Gunnison

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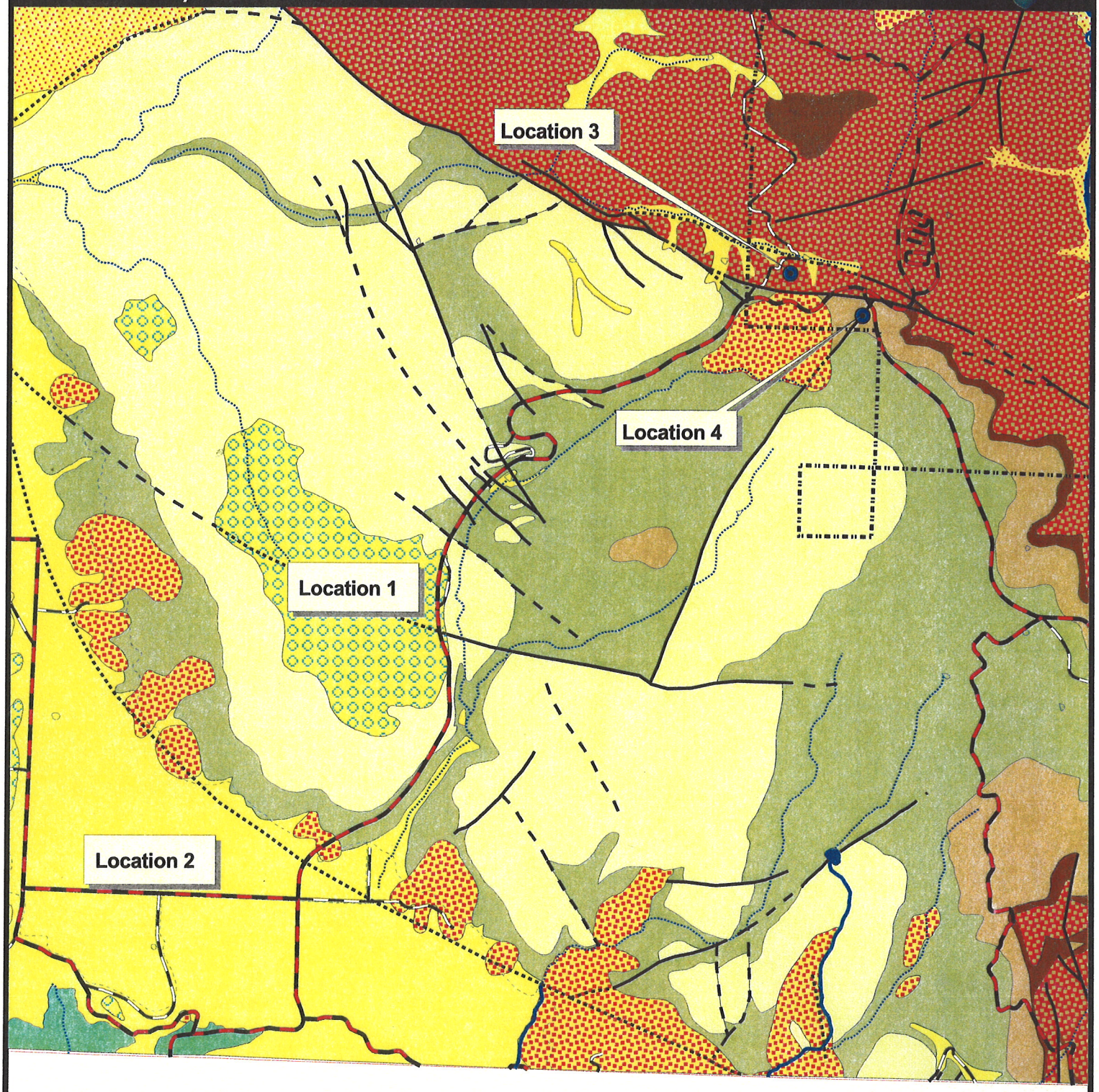

Park Boundary

Geologic Faults
- known location
- approximate location
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Geologic Formations
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- Landslides
- Talus
- Boulder Gravel
- Mancos Shale
- Dakota Sandstone and Burro Formation
- Morrison Formation
- Wanakah Formation
- Entrada Sandstone
- PreCambrian Rocks
- Water

Figure 3. Geologic map of the South Rim entrance area showing potential well locations

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January 14, 2005

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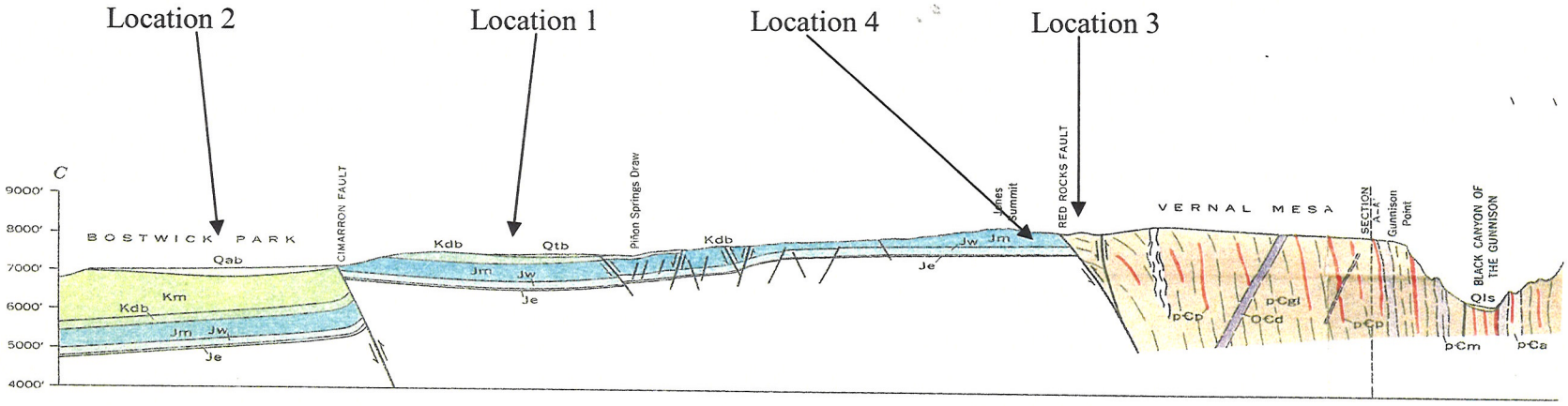

Figure 4. Geologic cross-section from Hansen (1971) showing the potential locations for water supply wells that might supply facilities at the South Rim of the Black Canyon of the Gunnison National Park. A well at Location 1 would be completed in the alluvial boulder gravel deposit (Qtb) and the Dakota Sandstone (Kdb) on the bench northwest of Bostwick Park. A well at Location 2 would be completed in the alluvial fill (Qab) in Bostwick Park. A well at Location 3 would be completed in the fractured granitic rock associated with the Red Rocks fault zone in the Jones Summit area.

Big Draw - Lions Spring

Black Canyon of the Gunnison

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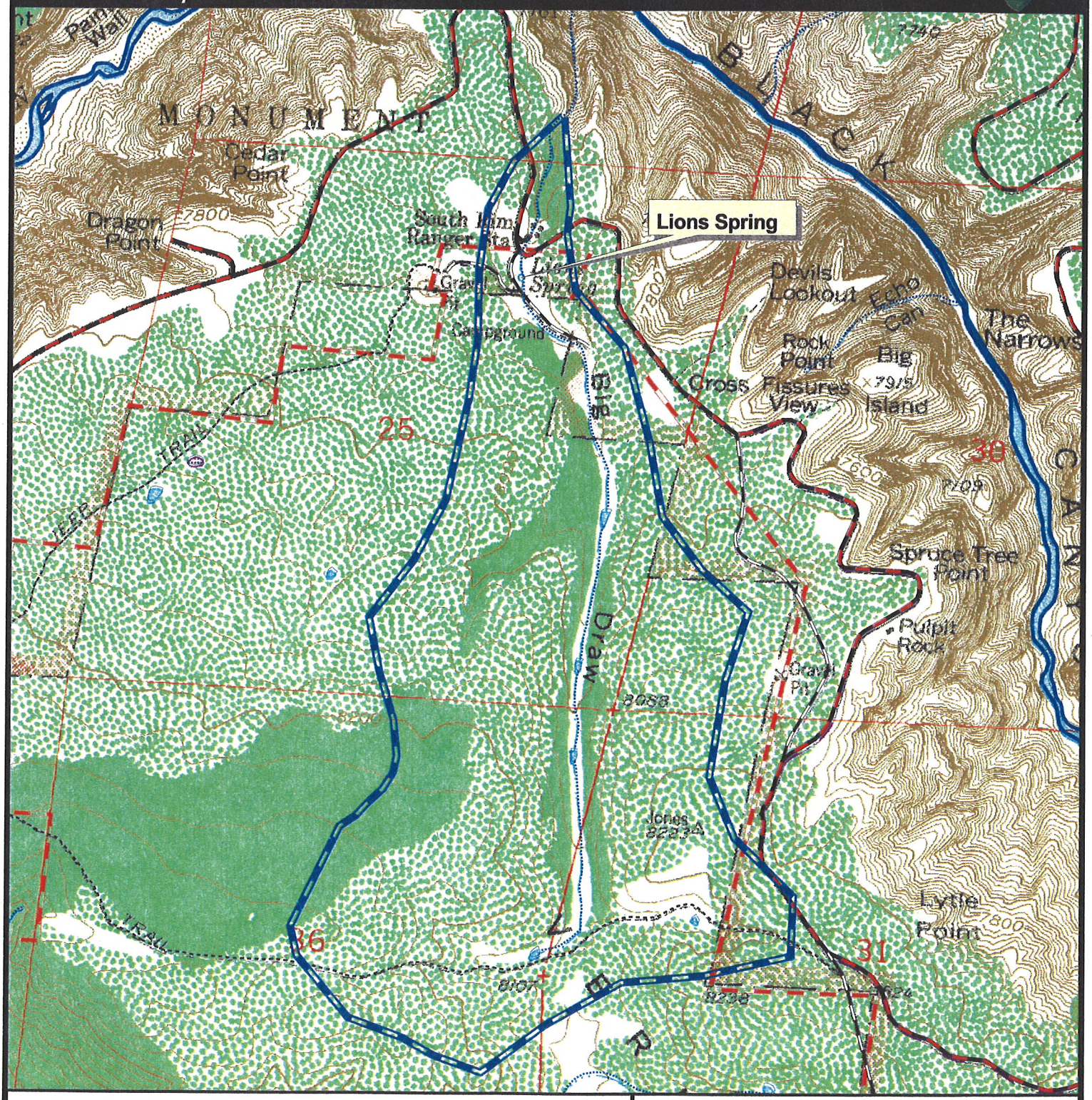

Big- Draw drainage basin

Park Boundary

Figure 5. Location of Big Draw drainage basin and Lions Spring

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January 14, 2005

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South Rim Entrance Area

Black Canyon of the Gunnison

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Park Boundary

Geologic Faults
- known location
- approximate location
- concealed location

Geologic Formations
- Quaternary Alluvium
- Landslides
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- Boulder Gravel
- Mancos Shale
- Dakota Sandstone and Burro Formation
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- Wanakah Formation
- Entrada Sandstone
- PreCambrian Rocks
- Water

Figure 6. Detailed geologic map of the Jones Summit area showing potential test well locations within the park

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January 12, 2005

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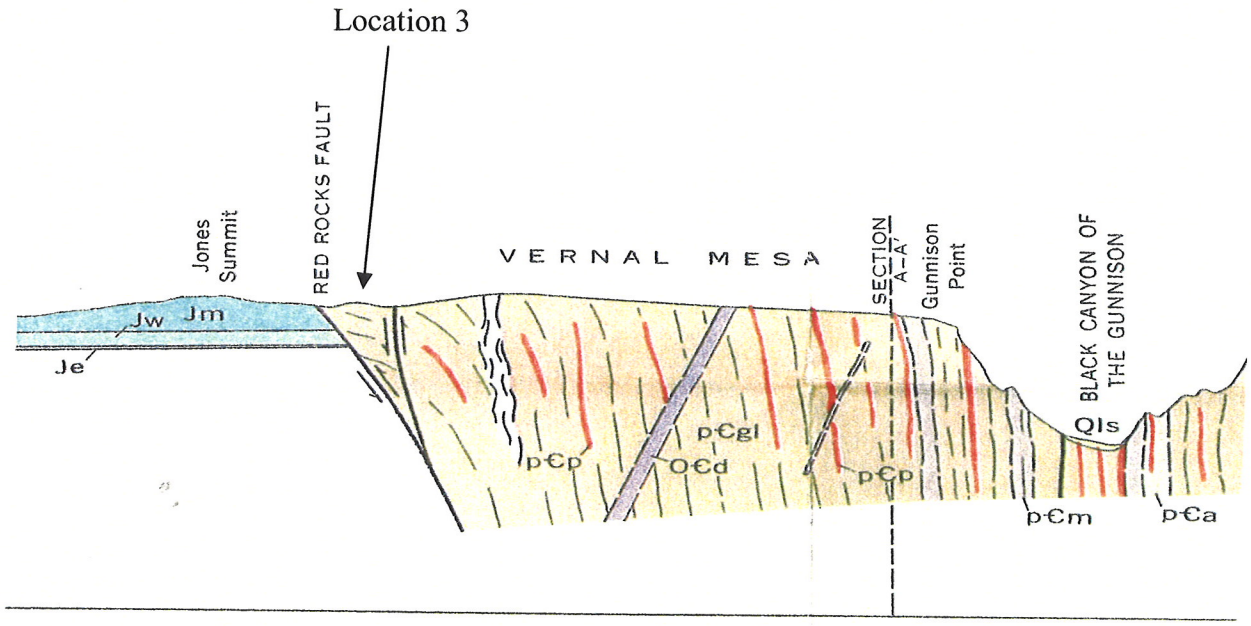

Figure 7. An expanded view of the geologic cross-section in the vicinity of a potential test well site in the Jones Summit area (Location 3). The well would be completed in fractured granitic rock between two branches of the Red Rocks Fault.

South Rim Entrance Area

Black Canyon of the Gunnison

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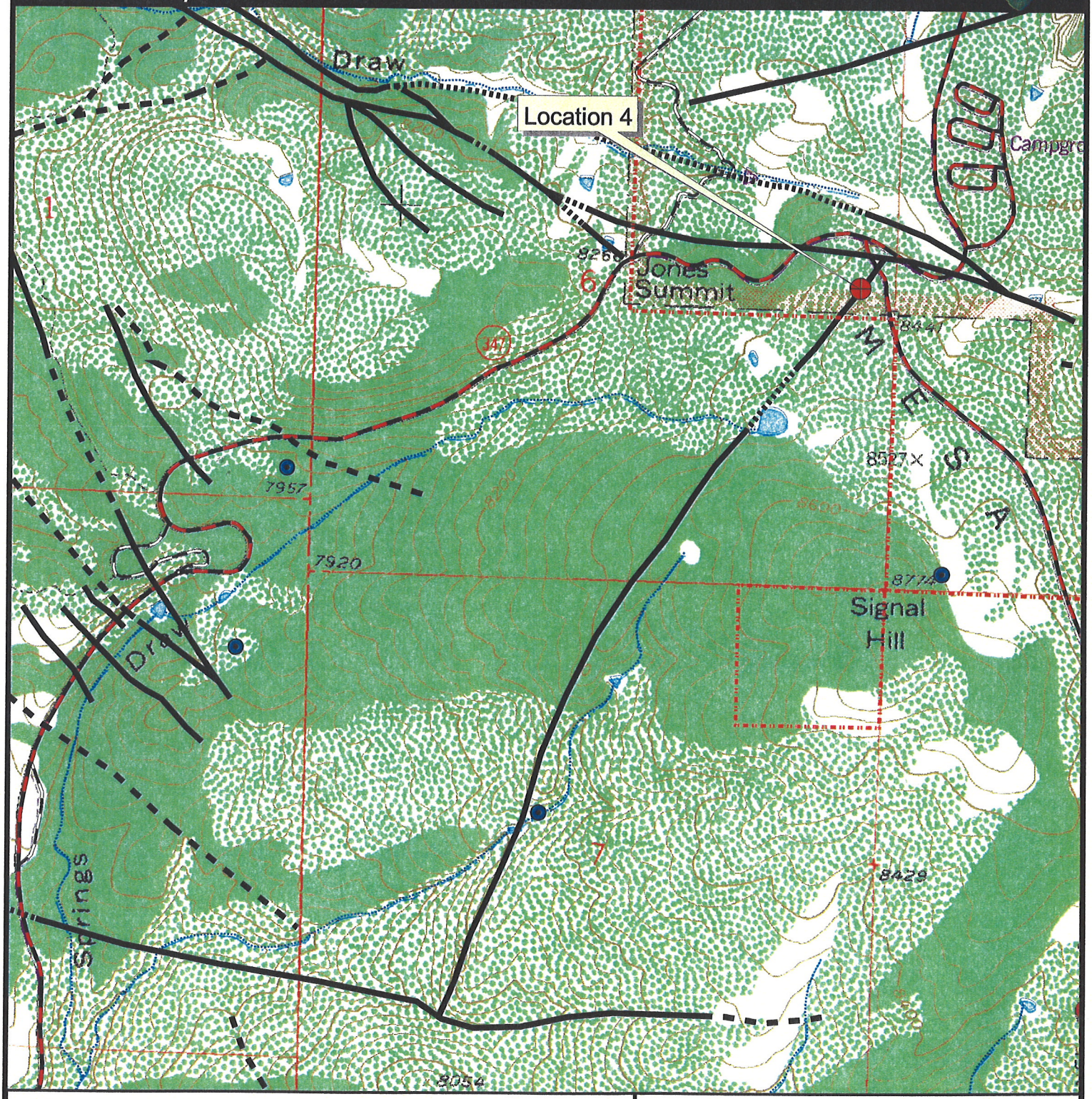

Private domestic & stock wells

Park Boundary

Geologic Faults
- known location
- approximate location
- concealed location

Figure 8. Location of private domestic and stock wells near the South Rim entrance area

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1 : 15,840 1 inch = 0.25 miles

January 13, 2005

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