

September 21, 1990

Mayor Bob Bradley
Tropic Town
Tropic, Utah 84776

Dear Mayor Bradley:

Re: Hydrogeologic Study with Recommendations
for Additional Water Supply for Tropic Town

As a follow-up to my previous recommendations to you on May 14, 1988, and later during my meeting and examination of the subject area on September 14-15, 1990, and by telephone September 17, 1990, I submit the following report and recommendations.

In my research of the hydrogeologic conditons of the Tropic area, I have made reference to the following resources, in addition to my personal field-study:

Blanchard, P. J., 1986, Ground-water Conditions in the Kaiparowits Plateau Area, Utah and Arizona, with Emphasis on the Navajo Sandstone: Utah Dept. of Nat. Resources Tech. Pub. 81;

Bradley, Robert, 1990, personal communication; Tropic, Utah;

Carpenter, C. H., et al, 1967, Ground-water Conditons and Geological Reconnaissance of the Upper Sevier River Basin, Utah: U. S. Geol. Survey Water-Supply Paper 1836;

Cordova, R. M., 1981, Ground-water Conditons in the Upper Virgin River and Kanab Creek Basins Area, Utah, with Emphasis on the Navajo Sandstone: Utah Dept. of Nat. Resources Tech. Pub. 70;

Goode, H. D., 1970, Appraisal of Water Supplies for Municipal Use in Tropic, Cannonville, and Henrieville, Garfield County, Utah: Dept of Geol. and Geophysical Sciences, Univ. of Utah, Memorandum Report;

Goode, H. D., 1990, Personal communication;

Gregory, H. E., 1951, The Geology and Geography of the Paunsaugunt Region, Utah: U. S. Geol. Survey Prof. Paper 226;

Gregory, H. E. and Moore, R. C., 1931, The Kaiparowits Region: U. S. Geol. Survey Prof. Paper 164;

Hintze, L. F., compiler, 1963, Geologic Map of Southwestern Utah: Brigham Young Univ. and Utah State Land Board;

Ott, Wallace, 1990, personal communication; Tropic, Utah;

Pollock, Afton, 1990, personal communication; Tropic, Utah;

Robison, R. A., 1966, Geology and Coal Resources of the Tropic Area, Garfield County, Utah: Utah Geol. and Min. Survey Special Studies 18;

U. S. Geological Survey: various topographical survey quadrangles;

Utah Division of Oil, Gas and Mining, 1990: Well log records;

Utah Division of Water Rights (State Engineer's Office), 1990, Dept. of Nat. Resources: Well drillers logs and water rights files.

INTRODUCTION: In the 1970's Tropic Town moved their domestic water supply from the historic spring diversion located southwest of town within the mouth Bryce Canyon in the SE/4 Sec. 5, T37S, R3W, SLB&M, (see attached topographic map of Bryce Canyon National Park) to a spring called the Dr. Goode Spring No. 10, located north of Town in the south edge of Paria Wash, Tropic Canyon and within the National Park boundaries, center of NW/4 Sec. 22, T36S, R3W (see attached Recommended Well Location and Topographic Map of the Tropic Area). In this dry year of 1990, this current-use spring has dried-up, leaving the Town to divert Paria Wash underflow water of bacterial-contaminated quality, having a flow of about 15 gpm, into their collection and conveyance system for use, and the hauling of potable-quality water from nearby communities to be used for drinking purposes.

Thus, the urgent need is to obtain an additional and more dependable potable water supply for Tropic Town. Their present water rights provide for the diversion of 200 gallons per minute, less 13 percent owned by certain third parties, from the "Dr. Goode No. 10 Spring to the Bryce Canyon Park Boundary in Tropic Canyon." See attached copy of deed from Tropic and East Fork Irrigation Company to the Town of Tropic.

The Town has also acquired an half interest in unapproved Applications to Appropriate Water, filed in 1971, No. 40809 (89-161) for 0.2 cfs to be used year-round for domestic purposes of 21 families and stockwatering; and No. 40812 (89-164) for 3 cfs to be used for the supplemental irrigation of 400 acres with stockwatering and fire protection, year-round. These applications are from wells at locations and depths as shown on the attached copies of the filings. The applications were protested by area water users and a hearing was conducted by the State Engineer on the same March 22, 1972. From information obtained at this hearing, notes of the State Engineer's Area Engineer Gerald Stoker on file with the applications, and my personal meeting with the State Engineer Robert Morgan and his Engineer in charge of Appropriations, Kent Jones, on September 17, 1990, it is apparent that these unapproved applications and any new ones could not be approved in this area unless they were limited to deep bedrock aquifers that do not contribute to surface or spring water rights in the local area, and would then be approved conditionally for a limited number of years while inter and intra-state water allocations are being worked-out by the State Engineer. Since municipal uses are a high priority water right in terms of beneficial use, it is probable that future needs of the town will be respected and considered favorable so far as Colorado River drainage allotments are made, in my judgement.

HYDROGEOLOGY WITH CONCLUSIONS AND RECOMMENDATIONS: Although considerable hydrogeology has been obtained on the region, there is very limited data available on the deeper bedrock aquifers of the Tropic area. The formerly used springs southwest of Town in the mouth of Bryce Canyon, now being used solely for irrigation purposes, have also dropped considerably in flow compared to the 250-300 gpm estimated by Goode (1970) in the year 1968, because of the recent dry years. These springs are discharging directly from clayey and silty, sand and gravel alluvium into several shallow collection drains constructed, which are open to surface contamination. The alluvium here is apparently being recharge mainly from underground spillage out of the fractured, Cretaceous

age Wahweap and possibly Straight Cliffs sandstone bedrock formations, immediately west of the major Paunsaugunt Fault, with its down-dropped segment of about 1500 feet (Robison, 1966) on its west side. See attached Hydrogeologic and Structure Map of the Tropic Area, which has been superimposed on Robison's, 1966, geologic map of the area; and geologic formation sections and descriptions from Gregory (1951), Robison (1966), and Goode (1970). It is obvious to me that additional water could be obtained from this spring area by the more efficient installation of underground drains, especially southwest of the presently constructed system, and more directly into bedrock, which would be properly protected from contamination and infestation and plugging by shrubbery and tree roots. This could amount to an additional 50-100 gpm. However, the town's attempt to divert water from this spring area would be in competition with the irrigation users who are presently diverting the water from there under their rights.

As illustrated in the attached hydrogeologic and structure maps, along with the descriptions of the various rock formations with their water-bearing characteristics, the present water uses in the Tropic area have been limited to springs and wells developed within the unconsolidated alluvium of the Bryce Canyon and Paria River valleys and the spillage from the Cretaceous-age sandstones of the Wahweap, Straight Cliffs and Dakota formations, and spillage from the Tertiary-age Wasatch formation of sandstone, conglomerate and limestone that is truncated and butted against the west side of the Paunsaugunt Fault. Except for the flows from the springs at the mouth of Bryce Canyon and the Dr. Goode No. 10 spring, the yields have been relatively small (less than 60 gpm). The quality of this water is generally potable with the poorer quality coming from the Dakota Sandstone and wells that have penetrated the Cretaceous-age Tropic shale.

Some wells in the Cannonville and Henrieville areas have produced small yields of water from the Jurassic-age Entrada Sandstone which have high calcium sulfate content (Goode, 1970).

The springs presently being used by Cannonville located in the SE/4 Sec. 1, T37S, R3W, although developed within the alluvium of the Paria River Valley, appear to be mainly recharged by spillage from the Dakota Sandstone aquifer where it has been eroded by the cutting of the river.

The rock strata of the area generally dip gently northward within a few degrees of horizontal and are truncated on the west by the extensive Paunsaugunt Fault previously referred to. It is very likely that permeable, underlying sandstone formations such as the Dakota, Entrada and Navajo are being partly recharged from water that has entered the Paunsaugunt Fault plane, coming from out of the Wasatch Formation which receives its recharge from the high Paunsaugunt Plateau to the west. Likely the diversion of water from the East Fork of the Sevier River into the Tropic Canal, which crosses over the Bryce Canyon plateau contributes to the general groundwater recharge. The springs that I observed and studied discharging out of the toe of the north bank of Paria Wash is most likely being recharged from leakage out of the Tropic Canal into permeable alluvium, that rests on the relatively impermeable Tropic Shale formation. These springs are within the SE/4 NE/4 NW/4 Sec. 22, T36S, R3W, immediately northeast of the Dr. Goode No. 10 spring.

The Dr. Goode No. 10 spring has most likely received its recharge, up to 200 gpm of potable water (346 ppm TDS, Goode, 1970) from spillage out of the Wasatch Formation where it has been truncated by the Paunsaugunt Fault, immediately west of the spring. Since it has now dried up, the potentiometric groundwater surface or level in the Wasatch Formation aquifer has dropped below the spill elevation of the springs. Thus, the only way to obtain additional water from the Goode springs is to lower the elevation of their diversion by excavating them deeper or drilling an inclined angle hole or vertical well westward into the Wasatch Formation on the west side of the Paunsaugunt Fault, immediately west of the springs, and pumping the water therefrom. Such poses a problem of permission, being within the National Park boundary.

The Tropic Canal is still flowing water and the springs located in the north edge of Paria Wash, immediately northeast of the Dr. Goode spring are also still flowing. The Tropic Canal is located immediately northwest and north, upslope from these presently flowing springs. Thus, it is apparent that these springs are completely dependent on the flows in the Tropic Canal and they could be developed and used by Tropic Town, with the permission of the National Park, the State Engineer and the Utah Department of Health, with the understanding that the water quality and quantity is directly related to what is in the Tropic Canal.

The Dakota Sandstone aquifer can likely be penetrated at an approximate depth of 260 feet beneath the Town of Tropic, and by drilling to an approximate total depth of 350 feet be produced. The quality of the water will likely contain higher total dissolved solids than what is presently being produced at the Cannonville Springs. The Dakota groundwater level would likely be within 150 feet of ground surface at Tropic Town. Producing this water would subtract from the total volume in the aquifer, and depending upon the rate of natural recharge and well discharge, it may or may not adversely affect the Cannonville Springs flow. Likely the State Engineer would be hesitant to approve a new water appropriation from the Dakota aquifer without an understanding that pumping may be reduced or stopped depending upon accurate, regular measurements of the Cannonville Springs before and after pumping. Thus, it would be my recommendation to avoid the problem, even though I had suggested this alternate source of water to you verbally, heretofore.

Although the Entrada Formation contains permeable sandstone beds and small yields of ground water could likely be developed at some intervals of penetration at Tropic Town, its past record in the area of containing poor quality water, even closer to its outcrop, is not encouraging. Such aquifer zones could be sampled and the water analyzed in the drilling of a well through them, but would require open-hole drilling methods with successive sampling and testing of all waters encountered in the hole, or expensive drill-stem testing with rubber packers and special tools which may not completely seal-out other zones of gypsiferous water, by other drilling methods.

The deeper Navajo Sandstone formation is a known and proven aquifer of high quality water in the general region. It is approximately 1500 feet thick in the Tropic area, and where fractured it is known to produce high yields to wells, up to 1000 gpm or more. Attached to this report is a copy of a segment of the Navajo Sandstone aquifer in the Kanab and Johnson

Creek area, on the west and down-dropped side of the Paunsaugunt Fault (Cordova, 1981). Here the potentiometric groundwater surface slopes to the south and spills to springs in Kanab and Johnson Canyons, as illustrated on the attached map.

With its regional dip to the north and northeast, the Navajo Sandstone formation outcrops to the south of Tropic Town about 10 miles within the Paria River erosion cut or canyon. The Navajo Sandstone was penetrated by two deep, oil test-wells in the local area. As shown on the attached hydrogeologic map, URC Corporation drilled a well in the NW/4 NE/4 Sec. 29, T37S, R2W, between Cannonville and Henrieville; and Tenneco drilled a well in the NW/4 NW/4 Sec. 1, T37S, R2W, two miles north of Henrieville.

The URC well reported encountering the Navajo Sandstone at 1099 feet depth, which flowed up to 600 barrels of fresh water per hour (420 gpm). See attached copy of well record and field water analysis from the Utah Division of Oil, Gas and Mining. The water analysis includes mixing of other waters in the hole above the Navajo Sandstone.

The Tenneco well reported the top of the Navajo Sandstone at a depth of 1805 feet. It was drilled open-hole with compressed air rotary-tools. Fresh water was reported from the Navajo Sandstone and the overlying Carmel Formation from 1750-1850, and also from deeper formations. No estimate of quantity of flow from the Navajo Sandstone was provided (Goode, 1970).

Using formation depth and water data from these wells, along with other wells farther north and northeast (see attached data sheets from Robison, 1966, on three oil test wells including the Tenneco well just mentioned), along with regional dip, topography, and the groundwater gradient in the Navajo Sandstone from the Kanab-Johnson Canyons area, I have constructed the attached hydrogeologic and structure map. By projecting this information beneath Tropic Town, I have estimated that the Navajo Sandstone here will be encountered at a depth of 2350 feet and if penetrated 100 feet, result in a well 2450 feet deep, to test the Navajo Sandstone aquifer. I estimate conservatively that the potentiometric groundwater level in the Navajo would be near or within 200 feet of the ground surface.

Thus, in view of the immediate and future growing water needs of the Town of Tropic, and the above information presented, in addition to well locations which I have recommended to you June 6, 1988, I recommend the drilling of a deep well to produce from the Navajo Sandstone aquifer, to be at the Town. This location would be on the Town lot at an approximate point E. 1600 ft. and N. 500 ft. from the SW Cor. Sec. 35, T36S, R3W, SLB&M. The well could be drilled with mud-rotary tools into the top 10 feet of the Navajo Sandstone, then cased with at least 10-inch diameter casing and pressure cemented through the casing for at least 200 feet on its outside up from the top of the Navajo Sandstone, and down 100 feet from the ground surface, or preferably cemented the full length of the casing. Then using the rotary tools with either air or water, or by cable tools, the Navajo could be drilled into at least 100 feet, and the well test pumped, for at least 24 hours.

The well could also be drilled with air-rotary tools with casing and cementing done as recommended above.

A mill-slotted liner or stainless steel screen could be placed in the

bottom of the hole through the exposed Navajo Sandstone section.

An alternative to the above is to first drill a small diameter (8-inch) pilot or test hole with mud rotary tools into the top 20 feet of the Navajo Sandstone, run a conventional drill stem test with rubber packer, and obtain a water sample with flow rate and hydrostatic pressures. Then based on this information, ream the hole and complete it of a larger diameter with cemented casing, and pump test for at least 24 hours.

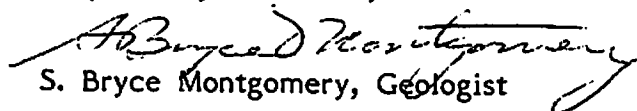
Water samples of the test pumping should be taken at least at the beginning, midway, and at the end.

Rock cutting samples should be collected for every 10 feet of penetration and change in formation and preserved in properly labeled containers, and examined by a capable geologist. Preferably a geophysical log, containing at least gamma ray, spontaneous potential and induction resistivity curves, should be run in the hole upon penetrating the Navajo Sandstone at least 10 feet and before running casing.

I further, recommend that a new Application to Appropriate Water for Tropic Town municipal purposes be filed with the State Engineer for 1000 gpm, from the Navajo Sandstone aquifer. While this application is being processed and advertized, a request for a test well permit could be made of the State Engineer, and efforts be made by the Tropic Town to inform holders of water rights in the area of your intent, in order to prevent the filing of protests, and to facilitate the State Engineer's approval of the water application.

Although the cost of the recommended well in the Navajo Sandstone aquifer will be expensive for the Town, it will eventually provide for the expansion of the Town, and the revenues obtained by the sales of much needed water for development will allow repayment of the costs. Special consideration could be given to older, long established residents who have a low, fixed income.

Respectfully submitted,


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P. S. I have inclosed a copy of Dr. Goode's 1970 report which he has kindly provided me.