Project: Second UGMS inspection of the new Quail Creek Dike cutoff trench			Requesting Agency: Division of Water Rights, Office of Dam Safety
By: William Lund, Susan Olig, Mike Lowe	Date: 3-14-90	County: Washington	Job No.: (GH-2) 90-03
USGS Quadrangle: St. George NE (78)			

At the invitation of the Utah Division of Water Rights, Office of Dam Safety, a second inspection was made on March 10, 1990 of the geology exposed in the cutoff trench excavated for the new Quail Creek Dike in Washington County. The first inspection was made by William Lund and Suzanne Hecker on January 31, 1990, prior to the cleaning of the trench walls and during a phase of construction that limited access to many areas of the cutoff excavation (see memo of February 1, 1990 to MLA). At the time of the second inspection, both the up- and downstream faces of the cutoff trench had been cleaned, as had the ground surface beneath the footprint of the dam on the downstream side of the excavation. The entire cutoff trench was accessible except for the slot trench in the bottom of the excavation, which had been filled with concrete since the time of the first inspection. We were accompanied during the inspection by Rick Hall and Chad Gorley of the Office of Dam Safety, and by Chuck Payton and Eric Rennat, geologists for Morrison-Knudson Engineers, Inc. (the design engineers) who were in the process of mapping the cutoff trench at the time of our visit.

The cleaning of the cutoff trench walls provided a much clearer view of those features identified during the first inspection (open and closed joints, faults and shears, zones of soft rock, water seeps, secondary gypsum along joints and bedding planes, and stringers of elemental sulphur) as being of concern to the construction of a water-retention facility at the Quail Creek site (see memo of January 31, 1990). The oil seeps previously observed in the slot trench (now filled with concrete) were no longer visible, but H_2S gas could still be smelled in some areas of the excavation and could be seen bubbling up through puddles of water in the bottom of the cutoff trench. The H_2S gas was noted primarily in an area of the trench (about station 4+50) where a spring in the bottom of the excavation was flowing at an estimated rate of 5 to 10 gpm. It is our understanding that an attempt was made to grout the spring, but without success.

A second spring discharging about 2 gpm was discovered issuing from an open joint at station 5+00 in the south (downstream) wall of the cutoff trench about 20 feet above the floor of the excavation. According to Mr. Payton, the spring was not there two days earlier when that area of the trench was mapped. The Washington Water Conservancy District is filling Quail Creek Reservoir to the extent permitted by the dike construction in order to store water for the upcoming irrigation season. Because of the topography in the reservoir basin, the water in the reservoir was not yet approaching the construction site on the day of our inspection, but the level of the water in the reservoir was about 20 feet above the bottom of the cutoff trench (C. Payton, oral communication). Mr. Payton attributed the appearance of the new spring to the rising level of the reservoir. Since no other source of water exists on the downstream side of the cutoff trench, Mr. Payton's explanation seems reasonable. For the water to appear high on the south trench wall, it would be necessary for a flow path (open joint or bedding plane) to extend from the reservoir (several hundred yards distant) to beneath the cutoff trench, and presumably below the concrete-filled slot trench, along which the water migrates until a pathway (an open joint or shear) to the surface is encountered. The water then rises under the pressure of the reservoir head until it daylights in the cutoff trench.

A second observation of significance during this inspection was the discovery by workmen of a large solution channel in the north (upstream) wall of the cutoff trench. The channel was at about station 7+50 and approximately 20 feet below the top of the trench. It was a foot or more in diameter and extended 40 feet horizontally toward the reservoir. The channel appears to be localized along the intersection of two large joints. We believe it is important to note that the large spring in the bottom of the cutoff trench, the small spring on the south wall of the trench, and the solution channel in the north wall all occur in relatively close proximity to one another (within a few hundred feet) in the general area where the original dike failed. This is also the area of the cutoff trench where the largest and most continuous open joints were observed.

Two high-angle reverse faults, both dipping to the east, were clearly exposed by the cleaning in the north wall of the trench at about stations 10+50 and 11+00. West of the faults, the rock exposed in the trench walls was highly deformed, exhibiting numerous small anticlines, synclines, normal and reverse faults, and steeply dipping beds. The trench is shallow in this area (4 to 6 feet) and the final height of the dike will be less than 10 feet. Therefore, the deformation in this part of the trench is probably of little consequence to the stability of the structure, but Mr. Payton indicated that the original dike did leak in this area.

Probably the single most striking feature revealed by the cleaning of the trench walls was the large amount of secondary gypsum present along bedding planes and joints in the rock exposed in the cutoff trench. These layers are continuous and often closely spaced. Gypsum was particularly abundant at the east end of the trench from about stations 1+00 to 4+00, but was evident throughout the excavation. In many areas, layers of gypsum along bedding planes are up to an inch thick. It is understood that the high percentage of gypsum in the rock at the Quail Creek site has been recognized and efforts are being made to accommodate it in the design of the dike. Nevertheless, the shear volume of this potentially soluble and easily erodible mineral in the foundation of the dike is cause for great concern, especially considering the recent appearance of the spring in the cutoff trench wall before any water has been impounded directly behind the dike.

The results of the second inspection of the Quail Creek Dike cutoff trench show that open, continuous conduits (joints, shears, and bedding planes) exist in and beneath the dike foundation, and that it is possible, even with a concrete-filled slot trench, for water from the reservoir to find its way directly to the dike foundation. It is considered probable that other, as yet undetected, conduits will also convey water to and beneath the dike foundation once the dike is complete and water is impounded behind it. For that reason, we recommended that consideration be given to a grouting program on the upstream side of the cutoff trench prior to construction of the dike to seal as many potential conduits as possible. Isolating the gypsum-rich foundation rocks from flowing water would reduce the amount of dissolution and erosion that could take place. Grouting prior to the dike construction would allow better access to the dike foundation, both for the grouting and for packer tests to evaluate the effectiveness of the program. The geologic logs of the trench walls prepared by the Morrison-Knudson geologists could be used to identify critical areas along the dike alignment requiring special attention during the grouting program; although the vicinity of the two springs and the zone of open joints at the east end of the cutoff trench are clearly two areas of particular concern.