

<b>TAUM SAUK UPPER RESERVOIR REBUILD LESTERVILLE, MISSOURI</b>		YEAR COMPLETED	
		PROFESSIONAL SVCS: <b>2006 – 2010</b>	CONSTRUCTION (IF APPLICABLE) <b>2010</b>
PROJECT OWNER'S INFORMATION			
PROJECT OWNER <b>Ameren Missouri</b>	POINT OF CONTACT NAME <b>Thomas Hollenkamp</b>	POINT OF CONTACT TELEPHONE NUMBER <b>(314) 554-2042</b>	

**RIZZO Associates (RIZZO)** was the Engineer of Record for the Taum Sauk Upper Reservoir Rebuild Project.

On December 14, 2005, a 700 foot section of the dam surrounding the Upper Reservoir failed and released 1.4 billion gallons of water. The reservoir was reported to have drained in about ½ hour. Approximately 4,300 Acre-feet of storage was released. The breach flow passed into East Fork of Black River (the river upstream of the lower Taum Sauk Dam) through a State Park and campground area and into the Lower Reservoir. After this catastrophic event, the Federal Energy Regulatory Commission (FERC) required the Owner, Ameren Missouri, to conduct a thorough investigation to determine the cause of the failure, which resulted in the recommendation to rebuild the entire facility.



*Taum Sauk Upper Reservoir Failure*

Ameren Missouri contracted RIZZO to provide a conceptual and then a detailed design of the new dam as well as manage the construction of this \$400 million rebuild. The Taum Sauk project is located in Reynolds County in Southeastern Missouri, about 100 miles south of St. Louis. The project was completed in 1963 as a reversible pumped storage project with an Upper and Lower Reservoir, used to supplement the generation and transmission facilities of the utility with a 450-MW, two-unit pump-turbine. The Lower Reservoir, operated as a run-of-river reservoir with outflow being maintained at approximately equal to natural inflow, providing storage for water to be pumped to the Upper Reservoir at night or during periods of low power demand. The project structures include a concrete faced rockfill dam (dike), that encircles and forms the Upper Reservoir; a concrete gravity dam impounding the Lower Reservoir (the lower dam was designed as an uncontrolled overflow spillway with no spillway gates so that flood waters could safely pass over the dam); a reversible turbine powerhouse; a gravel trap dam located upstream of the outlet canal in the lower reservoir, and a small dike that impounds the seepage collection pond at the toe of the Upper Reservoir.



*Taum Sauk Upper Reservoir Rebuild*

The surface area of the reservoir is 54.5 acres, with a total storage of 4,350 acre-feet, and live storage of 2,560 acre feet used for production of power. The new Upper Reservoir involved a complete rebuild of the dam consisting of approximately 2.8 million cubic yards of Roller Compacted Concrete (RCC) and 300,000 cubic yards of conventional concrete. The footprint of the new structure is similar to that of its predecessor, and is approximately 6,700 feet long, 120 feet tall, and 150 feet wide at the base. The Upper Reservoir is impounded by a kidney shaped rim dike at the top of a planed-off mountain.

At the time of construction, the Taum Sauk Upper Reservoir Rebuild was the largest RCC dam under construction in the U.S. RIZZO was the single point of contact for the Project and was the Owner's Representative on site and coordinated and managed the work of the Contractor.



RIZZO's Scope of Work is detailed as follows:

**FORENSIC ANALYSIS:** RIZZO conducted a detailed forensic engineering analysis to determine the causes of the failure. Analysis included stability and seepage, dam breach (to determine time and to evaluate mode of failure), complete review of instrument control systems, sediment transport, detailed mapping of breach zone, drilling and sampling of remaining portions of the dike, and a subsurface investigation to analyze both the existing dike and its foundation and the potential foundation of a new dam.

**DESIGN ENGINEERING:** RIZZO prepared both conceptual and a detailed designs of the Rebuild, including analyzing and developing various options to rebuild the Project. Construction costs and schedule, as well as potential regulatory challenges with each option, were fully evaluated.

Based on substantial investigation and design, RIZZO determined that a repair of the existing Dike was not technically feasible due to flaws in the original construction. Substantial areas of the existing dike were founded on residual soil. Additionally, few construction controls were utilized to control the gradation and character of the rock fill. Due to this and other factors, a complete rebuild of the upper reservoir was required.

RIZZO evaluated several alternates for a Rebuild and selected a symmetrical (0.6H to 1.0 V upstream and downstream) RCC dam. The symmetrical slopes reduce the demand on the rock foundation and allow for inclusion of less than ideal aggregate to create the RCC mix. This allowed the use of recycled aggregate to create the RCC mix. The existing rockfill dike material (rhyolite) will be processed and utilized to create aggregate for the RCC.

RIZZO developed an appropriate seismic design basis for the site and completed a series of finite element analyses to predict seismic stresses during a design basis earthquake event. All calculations, design reports, and construction documents were reviewed by the FERC and an Independent Board of Consultants (BOC). RIZZO formally presented various design alternatives to both the FERC and the BOC for review and approval.

Fly ash was the primary component of the RCC Mix, which contained 100 pounds of both cement and fly ash per cubic yard. The fly ash was excavated from an existing Ameren Missouri facility, which was processed, and utilized in the RCC Mix. In addition to cost savings by not having to purchase commercial fly ash, this created additional landfill space for use by Ameren. Additionally, the use of fly ash reduced the heat of hydration of the overall RCC Mix.

