



# LARGE DIAMETER TUNNELS



## SUMMARY

Kilduff Underground Engineering, Inc., (KUE) senior staff have over 100 years of combined experience in the design and construction of large diameter tunnels. On the Construction side, Todd Kilduff has worked as a Project Manager and Estimator for some of the largest general contractors in the industry. During that time, he managed tunneling contracts ranging in diameter from 8 to 58-feet with contract values from \$5M to \$65M. Including Todd, senior staff have extensive experience constructing various means and methods of tunnel excavation and support systems and each have developed and managed schedules and budgets as well as been responsible for the safety aspects on tunneling projects. In regard to Tunnel Design, KUE also has substantial experience in ground characterization and predicting ground behavior with the performance of proposed tunneling methodologies in mind. The firm has designed tunnel support systems utilizing rock bolts, shotcrete, steel sets and cast-in-place concrete linings.

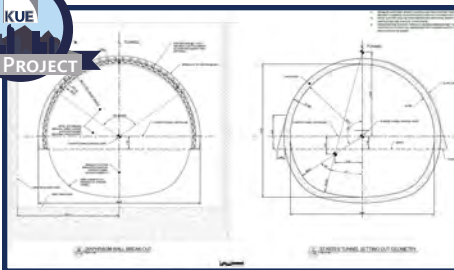
## KEY PROJECTS

### SAN ANTONIO WATER SYSTEMS | SAWS UPPER W6 | SAK CONSTRUCTION | SAN ANTONIO, TX | JUNE 2020 - ACTIVE



The SAWS Upper W6 project involves the construction of 11 deep shafts and over 26,000 linear feet of 8-12 foot diameter tunnels excavated via a Tunnel Boring Machine (TBM) to replace an aging 58-inch Interceptor sewer. KUE was retained by SAK Construction to design the initial support for the shafts, ranging in diameters from 32 to 40 feet and depths of 50 to 120 feet deep. Shaft support was designed with liner plate with ring beams and/or ring beams with timber lagging. KUE designed the tunnel initial support with liner plates and/or steel ribs and boards depending upon the amount of groundwater infiltration. All ground support designs were challenged by high swelling/squeezing ground. In addition, KUE supported the project with geotechnical instrumentation, contact and backfill grouting design submittals.

### UNDISCLOSED OWNER | SLC NORTH TEMPLE TUNNEL | DRILL TECH | SALT LAKE CITY, UT | FEB 2020 - ACTIVE



KUE has been hired to design a pipe roof canopy tunnel for a project located in downtown Salt Lake City, Utah. The project involves designing a low-cover 128-ft-long pedestrian tunnel that will tie into an existing parking garage and utilizes pre-support from a pipe roof canopy. Initial and final liner compositions were designed utilizing analytical and numerical methods with consideration to the pipe roof canopy and the desired internal clearances. We are also performing construction sequencing for break-in, mining and support, and break-out into an existing structure, as well as the structural and waterproofing tie-ins at either end of the tunnel. Lastly, KUE is producing an instrumentation and monitoring program for the subsurface utilities and liner deflections. The project is in the design phase and construction is anticipated for summer 2020.

### UNDISCLOSED OWNER | LADY WASHINGTON MINE REHABILITATION | PUGLISI ARCHITECTS | TUOLUMNE, CA | OCT 2019 - ACTIVE



KUE was hired to evaluate the proposed support system consisting of wiremesh and shotcrete for a hard rock tunnel mine portal in the hills outside Tuolumne, CA. The tunnel which is horseshoe in shape was constructed in heavily jointed rock and measures 6.5' wide x 8' high x 130' in length. Further into the horseshoe tunnel is a tunnel adit that is used by the owner and therefore additional support design was needed to shore up and secure the adit. Due to a tunnel collapse in 2008, emergency repairs were made to shore up the failed tunnel however only recently were long term upgrades planned. KUE has had engineering personell on site to evaluate the failed tunnel and adit and is currently in the design phase with rehabilitation work being planned for later in 2020 going into 2021.

### SFPUC | HETCH HETCHY MOUNTAIN TUNNEL REHABILITATION | MOCCASIN, CA | SEPT 2017 - ACTIVE



Since 2016, KUE has been retained by the San Francisco Public Utilities Commission (SFPUC) to serve on a technical review panel (TAP) for efforts to rehabilitate 10 miles of Tunnel near Moccasin, CA. The importance of the Hetch Hetchy Mountain Tunnel is paramount as it serves as the primary source of drinking water for the city of San Francisco. Since 2015, KUE has supported SFPUC by providing design and cost recommendations for the tunnels rehabilitation. KUE has provided independent assessments on the tunnel design concept as well as the approach planned for the design of the tunnel, shafts, connections to existing utilities and the impacts such work would cause to nearby surface facilities. KUE also oversaw the sequence of tunneling, shoring, excavation, groundwater control, monitoring of ground movement and other precautionary measures. In detail, KUE advised the project teams in the evaluation of the tunnel design, including type of lining to be used, tunnel construction methods, ground water control and muck disposal plan. The Hetch Hetchy Mountain Tunnel project is currently in progress and expected to be completed by 2021.

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### KEY PROJECTS (CONTINUED)

#### DOMINION SEWER & WATER DISTRICT | HOCK HOCKING MINE PORTAL STABILIZATION | HARRISON WESTERN | ALMA, CO | 2017



KUE was retained by Dominion Sewer & Water District (DSWD) to perform a condition assessment of the tunnel's portal structure. The mine, formerly produced gold, silver, lead and zinc but was shut down in the early 20th century. It was purchased by DSWD in 2016 to serve as a water supply source to the expanding community in the front range of Colorado. KUE visited the mine site at elevation of nearly 11,000 feet, performed geologic mapping of the walls and roof inside and around the portal structure, inspected the timber sets and portal support system and evaluated the slopes around the portal structure. Information obtained was summarized in a condition assessment report prepared for DSWD. Our findings indicated the structure was in overall good condition and rehabilitation work was ultimately avoided.

#### EPA | STANDARD MINE ROCK SUPPORT & HYDRAULIC PLUG | HARRISON WESTERN | CRESTED BUTTE, CO | 2017



KUE was retained by Harrison Western to design and oversee the construction efforts on this EPA Mine Closure. The mine, located in the Rocky Mountains near the town of Crested Butte, CO, consisted of a 7 to 9-foot diameter horseshoe tunnel interconnected with other tunnels, stopes, drifts and shafts. Similar to the work performed on the Mary Murphy Mine, KUE was retained to visit the site, map the geology and design a mine plug to inundate the structure and minimize future contamination. In addition to this work, KUE provided design recommendations for additional rock support at the mine portal.

#### SOUTH COAST WATER DISTRICT | LAGUNA BEACH INTERCEPTOR TUNNEL REHAB | TRAYLOR BROS INC. | LAGUNA BEACH, CA | 2016



For 64 years, a two-mile sewer tunnel beneath the bluff in South Laguna Beach has carried up to one million gallons of wastewater per day to a local treatment facility. When built in 1954, the tunnel was considered an engineering marvel. Even today, the system is innovative because it relies solely on gravity flow, which eliminates costly and unsightly infrastructure, including unnecessary lift stations and several thousand feet of sewer lines. The system has maintained a minimal carbon footprint since its first day of operation and it remains a vital piece of regional infrastructure in Orange County, CA. Due to years of continuous operation, the 64-year-old tunnel was in dire need of repair. Undersized, deteriorating, and posing substantial risk of injury to workers and the environment, plans were made to stabilize the tunnel and ultimately replace the pipeline. KUE was awarded a design contract by Traylor Bros. for a 25-ft diameter shaft and low-rise arch, steel-rib-supported access tunnel approximately 9.75-ft-high x 11-ft-wide. Tunneling was completed by excavator and tunnel shield with initial support in the form of steel sets and fiber reinforced shotcrete, replacing rotten timber supports and loose rock. The new tunnel was planned to intercept a pre-existing sanitary sewer running parallel to the Laguna Beach coastline. A 300 LF section of the existing sewer tunnel was also improved and widened from a horse-shoe approximately 5-ft in height up to a maximum opening of 18-ft wide at the cavern intersection of the new access tunnel. These upgrades would ultimately ensure safer working conditions and greater access for future pipeline maintenance and repair.

#### ALABAMA STONE QUARRY | ALABAMA STONE QUARRY MINE STABILITY ANALYSIS | VETTERSTONE | RUSSELVILLE, AL | 2016



Following a rock fall inside the mine, KUE was retained to inspect, perform geologic mapping and perform calculations to design a rock support system in areas of concern. KUE visited the site, obtained survey data of the mine, installed crack gauges for monitoring movements, mapped the geology and obtained rock cores for assessing the quality of the rock. Utilizing the Rocscience software UNWEDGE, KUE performed an analysis within areas of concern and developed a rock support system consisting of rock dowels and rock bolts. KUE later provided oversight during installation of the support system.

#### COLORADO SPRINGS UTILITIES | STANLEY CANYON | HARRISON WESTERN | COLORADO SPRINGS, CO | 2015



KUE was retained on this Design-Build project by the Joint Venture of Garney-Harrison Western to provide design and construction services for the rehabilitation of a tunnel for Colorado Springs Utilities (CSU). The 3.1-mile tunnel is a key component of Colorado Springs Utilities' Northfield Water System providing water supply and generating power to the city. The 9-foot diameter tunnel was lined with steel and concrete, and serves as a penstock operating at pressures up to 765 psi. KUE supported the design-build team's plan for decommissioning, providing health & safety (H&S) measures within the tunnel for performing a tunnel condition survey and making emergency repairs to the structure. Specifically, KUE designed the ventilation system, established H&S and communications, and managed the construction efforts for the JV which included surveying, steel lining installation and grouting. Lastly, KUE helped develop a future maintenance and inspection program in accordance with FERC requirements.

## LARGE DIAMETER TUNNELS

### KEY PROJECTS (CONTINUED)

**SAN DIEGO COUNTY WATER AUTHORITY | MACARIO CANYON TUNNEL DESIGN | KIEWIT - SHEA DESALINATION | CARLSBAD, CA | 2015**



KUE was retained by the joint venture of Kiewit-JF Shea to provide engineering support to the JV for the construction of a water distribution tunnel under the Macario canyon. The purpose of the structure was water supply conveyance from a new desalination plant on the Carlsbad coastline. The tunnel is approximately 3,000 linear feet, half constructed with a 9-foot dia. horseshoe excavated by roadheader and supported with steel sets and half constructed with a 78-inch diameter microtunnel. The two tunnels met at a chamber at about the half way point under the canyon where the MTBM was retrieved underground and pulled out of the horseshoe tunnel. KUE was retained to perform a subsurface exploration consisting of eight borings and five observation wells, with rising and falling head tests performed in the field. KUE also retained a subcontractor to perform a seismic refraction survey above the tunnel alignment. Information collected was summarized on a geotechnical data report issued to the client. KUE also evaluated each tunnel segment and provided recommendations for support with steel sets, timber lagging and 78-inch diameter, 1-inch wall steel jacking pipe. KUE later developed a Geotechnical Baseline Report (GBR) and provide part-time construction oversight in the field.

**EPA | MARY MURPHY GOLF MINE | HARRISON WESTERN | BUENA VISTA, CO | 2014**



KUE was retained by Harrison Western under contract with Environmental Resources, Inc. to design and oversee the construction efforts on this EPA, Superfund Mine Closure. The mine consists of a 9-foot diameter horseshoe tunnel interconnected with other tunnels, stopes, drifts and shafts. The mine was under study for decades prior to the contract as a result of heavy metal contamination leaching from the mine into the native ground water supply. KUE was retained to visit the site, map the geology and design a mine plug at the 1400 level (Golf Mine) to inundate the structure and minimize future contamination. The plug had to be designed far enough within the structure (1,600 LF) to minimize hydraulic fracturing. KUE designed the plug to resist a hydraulic pressure of up to 1,500 feet and to maintain a 100 year service life. During construction KUE provided construction oversight of the new steel sets, rock bolts, designed the blast patterns and served as blaster-in-charge for shooting the plug. KUE also designed the plug bulkheads and oversaw concrete filling operations.

**CDOT | TWIN TUNNELS EXPANSION | OBAYASHI CORP. | IDAHO SPRINGS | 2014**



TOP PROJECT



The Twin Tunnels project involved two existing 30-foot diameter highway transportation tunnels expanded to 58-feet in diameter. The expansion was facilitated by bypassing existing traffic around the clear creek and reconnecting with I-70 at Floyd Hill. The existing portals and liner were demolished and drill and blast methodology was performed utilizing Atlas Copco E2C Drill Jumbos. Rock support consisted of spiles, rock bolts, straps, steel sets at the portals and 6 to 12 inches of fiber reinforced shotcrete.

Todd Kilduff formed his company (KUE) between the Eastbound and Westbound contracts, with KUE being retained to support efforts on the Westbound (2nd) Contract. Todd's specific role included preparation of technical submittals and serving as blaster-in-charge on the rock cuts at the portals removing more than 45,000 cubic yard of rock and overseeing the installation of support consisting of rock dowels and rock bolts.