Water Well Drilling

Since its establishment in 1999, BAUER Technologies South Africa (BTSA) has executed several deep, large diameter drilling for well, mineral exploration, hydrogeological exploration and dewatering borehole projects in over 20 countries in Africa. With a dedicated team of well-trained experts and state-of-the-art equipment, the company has achieved noticeable successes In challenging ground conditions.

In 2019, BTSA was contracted by a a large-scale copper and cobalt mine in Kolwezi, Democratic Republic of Congo, to drill and construct large diameter water wells with the aim of dewatering the pit floor and also contributing to the water management plan of the mine. These boreholes were located inside the producing open pit – noted for its exceptionally challenging ground conditions for water well drilling.

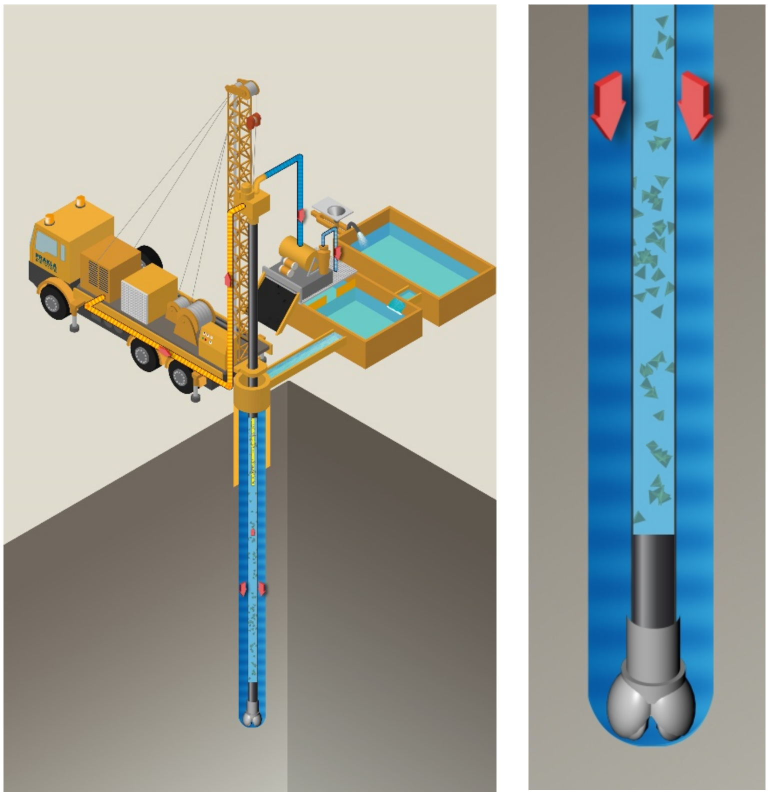
Due to several unsuccessful attempts by local water well drilling firms within the pit, the contractor was provided with core photographs from an exploratory hole drilled within the project area, see Fig 1. This was to in part confirm the long help opinion regarding the extremely difficult ground conditions and also aid the contractor to plan for and overcome such challenges.

Fig:1 Core samples from an exploratory hole (157 to 162m)

The well design included installing 28-inch and 24-inch steel casings at appropriate sections of the borehole, a 16-inch steel pump chamber, and 10-inch liner section with wire wrapped stainless casings and screens.

Drilling started with a 30-inch Tricone bit from 0 to 15m using the direct (flush) mud circulation drilling method. With this method, the drilling mud is pumped by a mud pump into the drill string. It passes through the drilling bit nozzles and rises, together with the cuttings, within the annular space between drill string and borehole wall to the surface. On the surface, the cuttings are separated from the drilling mud by deposition in a settling pit. The settling tanks are often divided into two parts, the first and largest serving as the deposition of the cuttings, the second acts as a sump for the mud pump. The drilling mud is pumped back into the drilling string for another circulation.

It continued with the 27-inch Tricone bit from 15 to 150m, 20- inch Tricon bit from 150 to 250m and finally with the 14-3/4-inch Tricon bit from 250 to 350m using the air-lift drilling method. This method uses compressed air as the transport medium. The compressed air is injected in a small sized pipe that is fixed at the outer side of the drill string. The air is released directly above the drilling bit into the drill string. The injection of air reduces the weight of the mud column relative to the weight of the mud column in the annular space and carries the mud with the cuttings upwards within the drill string with a velocity of more than 2 m/s. The drilling mud is fed by gravity from a settling tank.



Schematics for Airlift Drilling

The dewatering boreholes were drilled using the PRAKLA RB 40 universal drilling rig (Fig.2). This rig is highly suited for several drilling methods including rotary-drilling with reverse/direct circulation, auger drilling, percussion core drilling, wire-line core drilling, down the hole hammer drilling and RC-drilling.

Fig 2: RB 40 multipurpose drill rig with drilling platform in operation

Drilling through a highly fractured-massive to weathered complex alternating layers of the Roan Series consisting of Dolomite, Shale, Schist, and Sandstone required a strong mud management system. The mud parameters were regularly monitored to ensure the subsurface pressure was controlled, the borehole wall was stabilized, cuttings were removed, water losses were minimized and the aquifer protected by forming a seal. Various mud recipes were prepared to take care of varying situations such as unconfined aquifers, confined aquifers, mud losses and drilling through cement plugs.

All the installed steel casings including the 16” pump chamber were fully grouted in the annular space to secure the well properly and seal against water seepage and washouts in case the casing thread is not watertight. Cementation was done through the cementation string fitted into the check valve of the casing shoe. The float shoe reduced hook weight and ensured that the casing is well centered while the check valve in the float shoe prevented reverse flow of cement grout or mud from annulus into the casing.

Fig 3: RB 40 casing installation at night shift

Spherical silica gravels (1mm diameter) were installed to cover the whole length of the wire-wrapped slotted pipes. To enhance the removal of filter cake formed by the deposition of Bentonite at the screen sections of the well, Tetrasodiumdiphosphate with water was injected at the appropriate sections of the well before swabbing. The borehole was left undisturbed for 12 hours to ensure adequate reaction time before borehole development began. The boreholes were developed to remove the finest particles from the surrounding filter gravel pack, ensure the gravel pack is well stabilized, remove clogging and ultimately improve upon the porosity and hydraulic conductivity of the aquifer. All the boreholes met the minimum residual sand content requirement of < 0.1 g/m^3 and yielded over 250cbm/hr. Prior to hand over, permanent locking borehole protectors were installed on each well.

“These large diameter dewatering wells drilled to a maximum depth of 350 m in the exceptionally challenging ground conditions at the pit by BTSA are the deepest successful well installations in the history of the mine operations,” Nana Anderson of BAUER Technologies South Africa, said. “Our team achieved such feat while maintaining very high HSE standards and performance, with no LTI’s or environmental incidents.”