Upper he creek hydraulic and hydrogeologic control solutions in east central Tennessee

Terry W. Schmidt

Vice President of Engineering, Earthres Group, Inc., Philadelphia, USA, tschmidt@earthres.com

Extended Abstract

An area surface mine in east central Tennessee completed coal removal activities in 1992 in the upper He Creek watershed. Concurrent backfilling occurred during mining. Approximate original surface contours were re-established in 1993. Following land reclamation and grading, the backfill water level increased and mining influenced water discharged through seepage locations near the perimeter of the permitted areas.

Sumps were established to capture and pump the mining influenced water where it could be treated and discharged through an existing National Pollutant Discharge Elimination Permit (NPDES) discharge point. A dewatering well was drilled in the backfill and a pump was installed in late 1993 to reduce discharges to the Little He Creek sump. Due to the effectiveness of the dewatering well, dewatering wells and pumps were added at additional locations in the upper He Creek watershed.

Mining influenced water was effectively managed though backfill dewatering, sump collection and pumping, treatment to meet effluent limits, and discharge through approved NPDES discharge points for the subsequent 20-year period. However, the water level in the backfill varied by more than 10 meters during a year, introducing dissolved oxygen to the backfill groundwater where contact with pyritic material was possible. During the 20-year treatment period, the level of acidity varied by less than 20%.

An upper He Creek water balance study was conducted in 2013 to define the sources and quantities of water introduced to the backfill, determine how and where water leaves the site, and provide insight regarding the applicability of water management controls using hydraulic and hydrogeologic solutions. The study included collection and assessment of groundwater elevation data, pump dewatering rates, treatment system flow rates, He Creek tributary flow rates, weather station data, evapotranspiration measurements, and review of historic atmospheric and climatological data. Water balance results indicated 20.5% recharge, 33.6% runoff, and 45.9% evapotranspiration occurred from rainfall events during the 2013 study period.

The water balance data was evaluated to determine the recirculation loss from the dewatering system discharge points to the treatment system and from the treatment system to the NPDES discharge point. Based on the average dewatering rate, it was discovered that approximately one third of the pumped water was lost to recharge and evapotranspiration. To reduce recirculation of treated water into the backfill, a plan was developed to extend piping, line selected channels, and remove two basins. These planned activities reduce potential recharge to the backfill where the water could become affected by prior mining activities. These hydraulic controls were installed from 2014 to 2017.

The water balance data was also evaluated to identify areas where surface watershed runoff could be collected and routed directly to the receiving streams where possible, and the locations where additional basins constructed in backfill areas could be removed. These hydraulic controls reduced rainfall recharge potential to the backfill where the water could become affected by prior mining activities. These described hydraulic controls were also installed from 2014 to 2017.

From 2017 through 2023, the focus shifted to hydrogeologic controls. The water balance data analysis indicated that rainfall did not account for all the recharge into the backfill and groundwater inflow must also be occurring. Groundwater generally flowed north to south toward the receiving streams. An electrical resistivity (ER) survey was conducted north of the site to assess potential areas where groundwater may be preferentially entering the site. If this groundwater could be captured prior to entering the backfill at the site, mine related effects could be prevented. The ER survey determined that preventive pumping could be an option for reducing clean groundwater flow into the backfill. However, a cost benefit analysis indicated limited benefit, and preventive pumping was not pursued.

From 2020 through 2023, activities focused on hydrogeologic controls including increased dewatering capacity within the backfill areas to reduce variability in backfill water levels. In a typical annual cycle, the backfill water level varies by 10 m or more and provides conditions where dissolved oxygen can be introduced for continued acidity generation. Two new high-capacity wells were installed in 2023. The site also experienced draught conditions in 2023 resulting in the lowest backfill water levels in 20 years. As the backfill water levels recover during the rainy season, the newly installed pumps can be used to manage backfill water levels and reduce opportunities for dissolved oxygen introduction.

Keywords: Hydrology, hydrogeology, dewatering, pumping, acid rock drainage, AMD, ARD

Acknowledgements

The author would like to thank Navajo Transitional Energy Company for sharing data and allowing the presentation at the WVTF & IMWA 2024 Conference.