Abandoned mine pools: A threat to the environment or a water resource for beneficial uses

Wanfang Zhou[1], Jeff Zoeckler[2], Scott Bailey[3], Marcus Kim[4]

Hana Engineers and Consultants, LLC.; [1]wanfang.zhou@hanaengineers.com; [2]jeff.zoeckler@hanaengineers.com; [3]scott.bailey@hanaengineers.com; [4]marcus.kim@hanaengineers.com

Extended Abstract

Abandoned mine pools (AMPs) result from groundwater rebounding after closure of mines that are partially or completely below groundwater tables or under potentiometric pressure. They can encompass hundreds of square kilometers in extensively mined regions and are potential sources for underground water reservoirs, heat pump solutions for building heating and cooling (Banks et al. 2017), and threats to human health and the environment (U. S. Environmental Protection Agency 2017). Abandoned mine pools are physically and hydraulically different from "typical" aquifers. Groundwater dynamics and geochemical evolution follow unique rules, and analyses using traditional methods present challenges. Because of the size and man-made connectivity of mined voids, the AMPs' behavior has little in common with the Darcian laminar-flow aquifers which account for most aquifers in traditional textbooks. However, under certain circumstances, AMPs display marked behavioral similarities to well-developed karst aquifers with multiple sizes of porosity such as caves, conduits, fractures, and intergranular pores, although they can be distinguished from these natural relatives by the geometries of voids and the lateral scale of interconnections (Younger and Adams 1999).

The experience and lessons learnt from several case studies involving both abandoned mine pools and karst systems demonstrate that the appropriate site characterization and mitigation methods used in large-scale karst investigations can be adapted to mine pools with some modifications. The specific methods used, and type of data collected for a particular mine pool depend on the development of a representative conceptual site model. Fig. 1 presents a schematic conceptual site model that includes the recharge sources, mine workings, and pathways from recharge through the AMPs to receptors by integrating three attributes: hydrogeological, geochemical & biological, and geotechnical attributes. Techniques and tools commonly used in karst investigations such as high-resolution geophysical survey, isotopic fingerprinting, microbiological analysis, conduit-flow modeling, and tracer testing are applicable to understanding these attributes and evaluating the feasibility of its beneficial uses, hazard to the public, risk to human health and the environment, and remedies to mitigate any unacceptable risks.

Unlike karst systems that evolve over a geological time, the abandoned mine pools include caves and fractures that are induced from mining in a relatively short period of time, and these voids are back filled quickly with groundwater rebounding in response to mine closures. Furthermore, the groundwater rebounding can damage coal barriers that were left from mining and resulted in hydraulic connections between adjacent abandoned mine pools, forming larger mine pools. Therefore, abandoned mine pools are very dynamic during rebounding processes. From a safety perspective, abandoned mine pools can be associated with ground subsidence or be potential sources of water inrushes for adjacent but deeper active mining. If water of poor-quality discharges from the abandoned mine pools as springs to surface rivers, hydraulic control measures are often effective to prevent the interaction with surface water. After groundwater in the abandoned mine pools reaches equilibrium with the surrounding water systems, the mine pools functions like an underground river or cave. Depending on characteristics of the three attributes, the water quality in the AMPs may improve over time, which is a prerequisite for many beneficial uses.

Keywords: Conceptual site model, abandoned mine pool, geohazard, beneficial use

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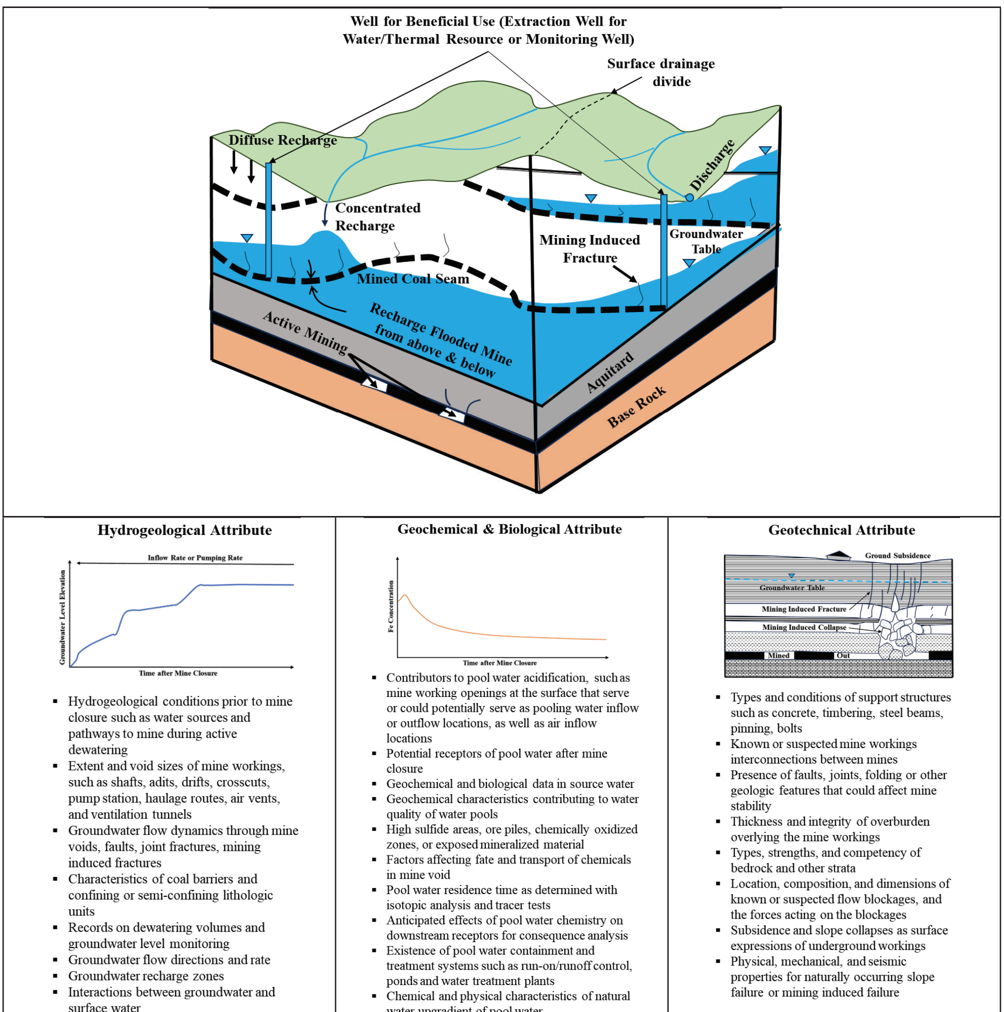

Figure 1 Schematic conceptual site model of an AMP