MODELING THE FLOODING OF BELOW-DRAINAGE UNDERGROUND COAL MINES, PITTSBURGH COAL BASIN, WV-PA

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ABSTRACT

Underground coal beds mined down-dip to below surface drainage elevation tend to flood towards the surface after mining is complete. Such is the case within the northern Pittsburgh coal basin (Monongahela Group, Pennsylvanian age) in West Virginia and Pennsylvania. Since the Clean Water Act, uncontrolled discharge from flooded mines in the Pittsburgh has been closely regulated. Mined coal and overlying collapsed overburden form an aquifer of high porosity/hydraulic conductivity that is completely saturated (confined) in deeper portions of the mine and unsaturated (vadose) in shallow portions. Between these zones lies a narrow wetting front where the aquifer is phreatic; its uncontrolled advance updip would ultimately result in discharge either from portals at the outcrop or into stream alluvium. Such discharge may be prevented by (and may require) pumping to safely maintain low groundwater levels.

Groundwater level observations in the Pittsburgh basin from 1980 to the present show phenomena thought to be characteristic of flooding behavior of such mines. These include: (1) development of isolated "sub-pools" of groundwater prior to flooding, (2) merging of these into a single large "pool" as the wetting zone advances, and (3) isolation of the main pool from adjacent mines by coal barriers 15 to >400 ft thick. Where groundwater from mines must be controlled, pumping is generally used to stabilize groundwater level safely below the elevation of hydraulic head in overlying streams. The pumping rate required to achieve hydrologic steady state is the net mine inflow rate, which includes recharge to the vadose zone, leakage to the confined zone, and any net horizontal leakage across barriers. Key controls on flooding rate are the rates of recharge, vertical leakage, and horizontal leakage from adjacent mines, and the geometry of the bedrock aquitard beneath the mined aquifer.

The concept of a “pool” of groundwater has been applied to describe one or more flooded mines closely interconnected by zones of high conductivity. Such pools of mine water may consist of one or more mines, depending on the hydraulic conductivity of barriers between mines. A test for pool connectivity is a comparison of detailed water level trends between adjacent mines suspected to be in the same pool. All locations within a pool display coeval water level fluctuations of about the same magnitude, separated by a time lag of a few days or less. Normally, all locations within

a fully-flooded mine lie within a single pool, although, during flooding, different regions of a single mine may display “sub-pools” at different elevation heads.

A related concept to that of the mine “pool” is the mine groundwater catchment, which defines a region of mine pools that all report to the same discharge (usually either a treatment plant, pump, or surface discharge). Defining mine groundwater catchments is more challenging than identifying mine pools. It requires accurate estimates of mine infiltration, the distribution and conductance of inter-mine barriers, and groundwater levels in numerous mine pools. It is effectively accomplished using numerical models of groundwater flow. Groundwater catchments define regions of influence of known mine discharges. Successful control of groundwater discharge from the basin dictates that all groundwater catchments terminate where water may be pumped and treated prior to release. An example of groundwater catchment mapping is shown for the Pittsburgh coal basin.