XI. RELATIONSHIP BETWEEN GROUND WATER AND SURFACE WATER

Pertinent 30-CFR[1] Sections:

Description of hydrology and geology.
Surface-water information.
Ground-water information.
Protection of hydrologic balance.
Alternative water-supply information.

Streamflow at any site fluctuates seasonally and with variations in precipitation and water use and also reflects the geohydrologic properties of the streambed and adjoining aquifers. Streams are locations of ground-water discharge as well as channels for runoff from precipitation. Stream reaches that receive ground-water discharge are called gaining reaches; the ground-water conditions adjacent to such reaches are illustrated in plan view and cross section in figure XI-1A. Reaches that lose water by infiltration through the streambed are called losing reaches. During periods of little or no precipitation, flow decreases or goes dry wherever the water table declines, below the streambed. The ground-water conditions near losing reaches are illustrated in figure XI-1B.

Man's activities can alter the water-table altitude and thereby affect streamflow. The allegation that surface or underground coal-mining operations cause a significant long-term decrease or increase in stream low flow can be substantiated only through analysis of long-term hydrologic records and site-specific data collection. Such data would include: (1) periodic streamflow measurements of stream reaches within the general area; (2) continuous measurements at stream gaging stations near the upstream and downstream boundaries of the proposed mine area; (3) periodic water-level measurements in wells near the stream; (4) continuous measurements in selected wells between the mining operations and the stream; and (5) local precipitation measurements. Interpretation of streamflow data together with mine-pumpage information will aid in evaluating the validity of such allegations.

Information supplied by the mine-permit applicant to the regulatory authority includes low-flow data, which is a measure of the discharge characteristics of the adjoining aquifer (s). Streamflow records from many localities are analyzed and published by State and Federal agencies.

An essential component of a low-flow analysis is flow-duration curves. These curves are drawn from long-term mean daily discharge data from stream-gaging stations and show the percentage of time that a specific discharge was equaled or exceeded. Flow duration curves are a graphical presentation of the variation of stream flow discharge versus percent of time. Curves that are steep and intersect the percent line at values less than 90 are ephemeral and are not satisfactory for water supply purposes. Curves that are flat and do not intersect the percent line are perennial and have the potential to satisfy the water supply demands depending upon discharge available. Inclusion of flow-duration curves with the other hydrologic data help define the relationship between ground water and surface water at the site in question.

[1]CFR = Code of Federal Regulations

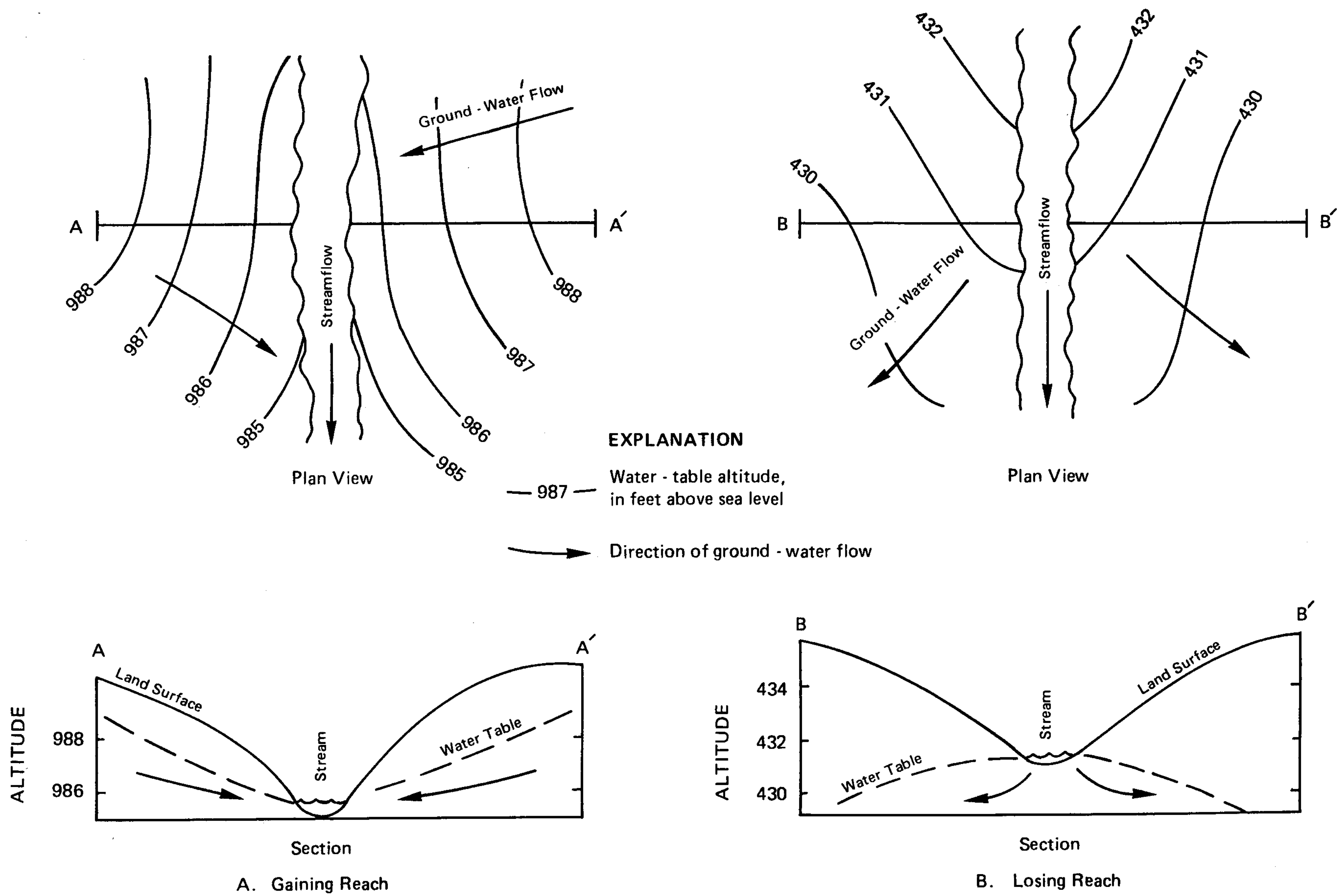

Figure XI-1.— Water-table altitude in relation to streambed altitude along a gaining stream reach (A) and a losing stream reach (B). (Modified from Meinser, 1923b, fig.26)

Flow-duration curves apply only to the period of record on which they are based; therefore changing land-use practices or streamflow use are reflected in the slope and shape of the curve. Surface-mine reclamation could affect streamflow significantly, and reservoirs may also modify streamflow. The percentage of drainage area affected by the activity influences the degree of change in the flow-duration curves.

Streamflow data from new gaging stations will not have sufficient record to construct flow-duration curves. The reader is referred to Searcy (1959) for more information on the construction and analysis of flow-duration curves.

Many reports on coal-area hydrology (chapter XV-1) include representative flow-duration curves. The example given in figure XI-2 is a composite flow-duration curve with ordinate values in discharge per mi^2 (square mile); flow-duration curves for individual gaging stations give ordinate values of discharge only. The shape and slope of the curve is a measure of streamflow variability and is controlled by the hydrologic and geologic characteristics of the drainage basin. Examples of flow-duration curves from two different basins with differing ground-water flow conditions are presented in figure XI-3. The steep curve (Brush Run) indicates negligible base flow and highly variable streamflow derived largely from precipitation runoff. This stream is underlain mostly by sandstone and shale that are low in ground-water storage. The flatter curve (Short Creek) reflects buried valley systems partly filled with saturated sand and gravel, which serve as a ground-water source to streams in that area. A curve with flat slope also indicates relatively uniform discharge from surface storage, such as discharge controlled by lakes or reservoirs.

Low-flow information is particularly useful in determining the probably adequacy of a stream for water supply or for receiving waste discharges. In the Ohio River region (Bloyd, 1974, p. A7), the stream discharge that is equaled or exceeded 90 percent of the time, called 90 percent flow, generally is assumed to consist entirely of ground water. In other regions of the country, however, percentages between 55 and 90 have been reported as base flow. The mean unit discharge at 90 percent duration in figure XI-2 is 0.12 $(ft^3/s)/mi^2$ (cubic feet per second per square mile) and ranges from 0.09 to 0.16 $(ft^3/s)/mi^2$. If a proposed mine-permit application was being made in the area represented by figure XI-2, and the drainage area at the permit site were 100 mi^2, the base-flow discharge would be about 12 ft^3/s but could vary between 9 and 16 ft^3/s. This would be the magnitude of stream flow discharge that the applicant would monitor and sample for ground-water quality monitoring.

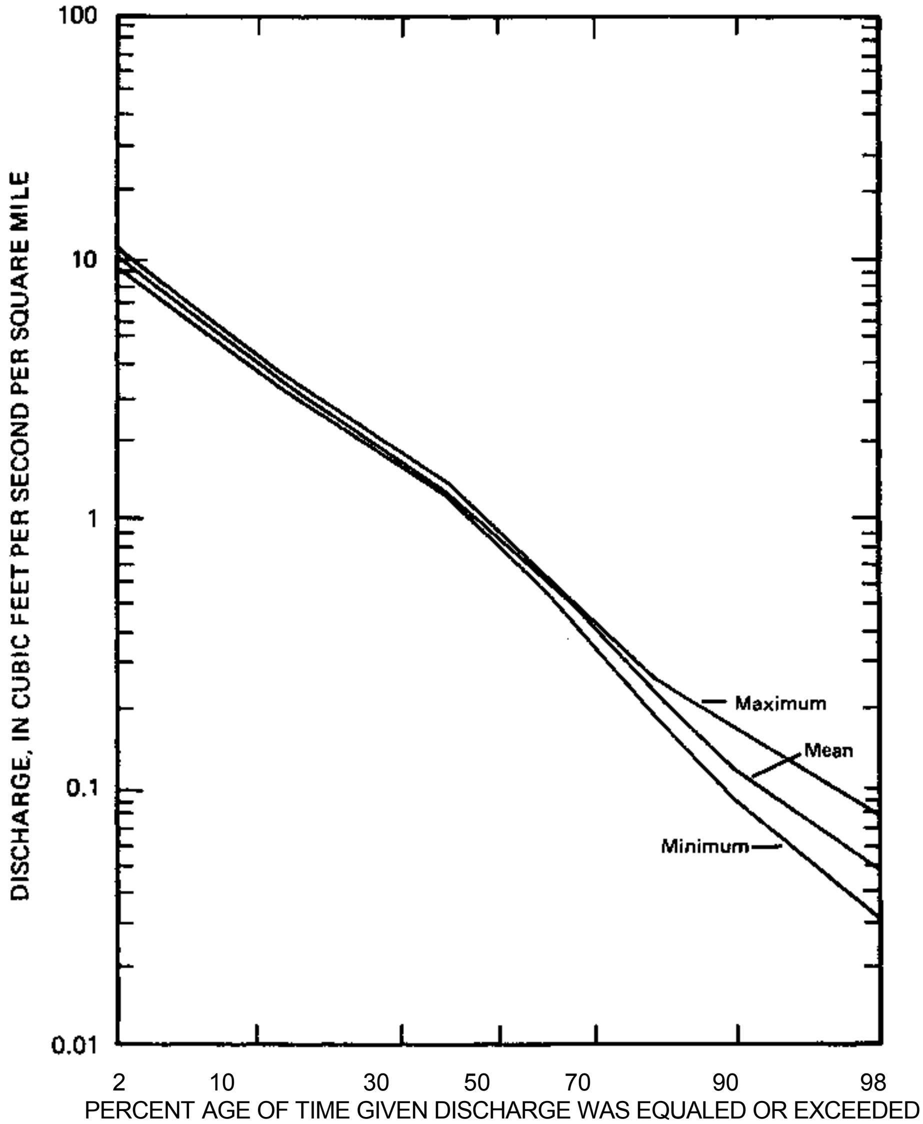

Figure XI-2.— Composite flow-duration curves, for Area 3 in western Pennsylvania. (From Herb and others, 1981, fig. 9.5.2-1)

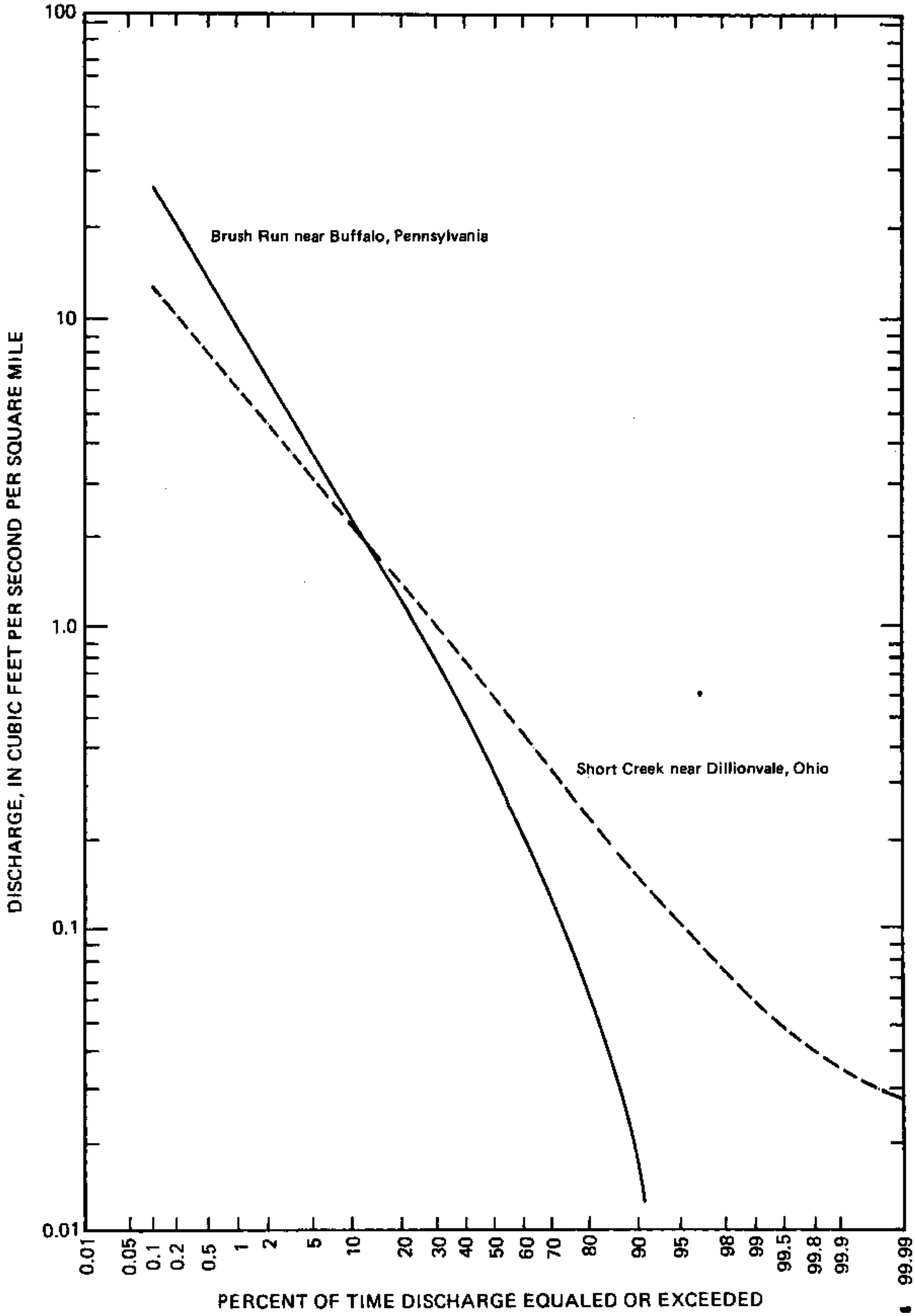

Figure XI-3.— Flow-duration curves for Brush Run near Buffalo, Pa., and Short Creek near Dillonvale, Ohio.
(From Roth and others, 1981, fig. 4.4-1)