1.4 Bedrock Geology

As explained in the previous section, physiographic provinces are characterized by the geologic formations they contain. The following discussion will outline the geology unique to each province in WMA 4. In addition to the underlying bedrock geology, the surficial geology of WMA 4 consists of glacial deposits, which contribute to the uniqueness of the landforms and hydrology of each province. Surficial geology is the topic of the next section in this report (see Section 1.5). The following discussion describes the geology unique to each province in WMA 4 and relates how they are amenable to the formation of aquifers. A discussion of the aquifers in WMA 4, including significance of aquifer hydraulic properties to watershed management and the contribution of geochemistry to the quality of aquifer water is discussed in Section 1.8, which describes the groundwater system in greater detail.

The Newark Basin formed as a consequence of the tensional forces associated with the opening of the Atlantic Ocean. Similar provinces are found from Nova Scotia to North Carolina, including the Connecticut River Basin and the Gettysburg Basin (Van Houten 1969). These basins were once called the "Piedmont Lowlands."

The principal rocks in the basin (Plate 1.4.1) were formed mostly from land-derived sediment, which accumulated during the Late Triassic and Early Jurassic Periods (Olsen 1980). These include: reddish-brown siltstone and shale (the Brunswick Group); hard, dark gray shale (the Lockatong Formation); and light brown sandstone (the Stockton Formation). Between and within these sedimentary rock strata, crystalline rocks, which include lavas and intrusives of basaltic composition, also occur. The bedrock strata tend to dip to the northwest, typically at an angle of 3 to 12 degrees from the horizontal. With the exception of the Brunswick Group, which directly underlies the surficial deposits, all of these formations are only encountered at great depth in WMA 4.

The majority of WMA 4 is underlain by the sandstone, siltstone, and shale sequences of the Brunswick Group, which form major aquifers in the area. A typical sequence in the Brunswick Group consists of alternating blocky and friable units of red siltstone (Carswell and Rooney 1976). These units both range up to 10 feet or more in thickness and each unit ultimately pinches out laterally, to be replaced by the other unit. The friable units form the aquifers. The blocky units function as leaky aquitards. Consequently, Brunswick Group aquifers tend to become confined at depth, even if they are unconfined at the surface (Gill and Vecchioli 1965). Plate 1.4.1 shows the limits of three formations to which this description applies: the Towaco Formation, the Feltville Formation, and the Passaic Formation. These formations all exhibit some variability of the lithology regionally, being coarser or finer in some locations than others.

The Passaic Formation is subdivided into different lithofacies in the most recent mapping, which is reproduced in Plate 1.4.1. In the north end of WMA 4, the Passaic Formation is coarser than elsewhere in the watershed management area (Drake *et al*. 1996). There are varying amounts of conglomerate interbedded with sandstone. Toward the west the conglomerate becomes dominant and contains quartz pebbles that weathered

out of the Highlands to the west. Further from the source of coarse rock fragments, in the center of WMA 4, the sandstone becomes finer and coarse fragments are much fewer. Still further to the south and east a sandy mudstone facies is encountered, as silt and clay fractions increase in the rock. Finally, at the southeast end of WMA 4, the sand fraction is very low and the rock is composed primarily of cemented silt (siltstone) or clay (shale).

The basaltic lava that caps the Watchung Mountains was particularly fluid. Periodically during the early Jurassic Period, basaltic magma would reach the surface through a fissure and erupt forming flat, laterally extensive sheets that covered the surface of the sediments that had been accumulating in the basin (Van Houten 1988). During the periods of time that elapsed between lava flows, additional sediments were deposited. When the composite strata were tilted and eroded during the Cretaceous Period, the basalt, being more resistant to erosion, stood out in relief, forming the ridges of the Watchung Mountains. The aquifers in the basalt tend to be unconfined, except where covered by glacial till (Nichols 1968).

During the Early Cretaceous Period, the Newark Basin may have been below sea level for a time. From the Late Cretaceous until the present time, most of the basin has been above sea level.