Appendix 14-A: Historic and Contemporary Modifications to Channels and Valleys

Awareness of modifications made to channels and valleys is essential for identifying causes of instability and may lead to practical alternatives for designs to accommodate or provide countermeasures for future channel changes. In Maryland, legacy effects persist from historic and recent modifications that include deforestation and cultivation, milldam construction, flood control projects, the installation of sewer lines and other utility crossings, channelization, local widening or deepening of channels, and mining.

Early Land-Use Practices, Milldams, and Legacy Sediments

Milldams or other dams should be located on historic documents. In the field, persons conducting the assessments should pay particular attention to high banks composed of laminated fine-grained sediments. These sediments are common in most of the valleys of the Piedmont and Coastal Plain physiographic regions. The banks are formed in floodplain deposits believed to be the result of legacy sediments (fine-grained sediments deposited during periods of past land use) introduced primarily during the colonial agricultural period (Costa 1975; Cravens 1925; Jacobson and Coleman 1986). During early European settlement of Maryland, deforestation and poor agricultural practices resulted in rapid soil erosion and extensive development of gullies. The eroded soils produced a high supply of sediment to stream channels and floodplains that continued at least until the early 20th century. During much of this same period, milldams were common on streams (Hopkins 1975; Scott 1807) and created backwater conditions that resulted in massive deposition of sediment that buried the pre-settlement floodplains and may have buried pre-settlement channels. Throughout Maryland’s Piedmont and Coastal Plain regions, the effects of this massive deposition can be observed today as thick laminated deposits of sand, silt, and clay that cover most of the valley bottoms. In the Piedmont and Coastal Plain, these “post-settlement” alluvial deposits typically overlay an organic (peat-like) layer of sediment that represents the pre-settlement floodplain. In parts of the valley bottom, sandy quartz gravel and cobble typically lie between the organic, pre-settlement floodplain and the underlying bedrock. In other locations, the organic layer lies directly on bedrock. The buried bedrock is often highly fractured and weathered. In some locations, saprolite (very weak and highly weathered and erodible bedrock) underlies the quartz gravel. Channel incision into these fine-grained sediments results in entrenched channels over parts of the Coastal Plain and much of the Ridge and Valley, Appalachian Plateau, and Piedmont physiographic regions.

Flood Control Projects

Persons conducting the assessment should look for signs of flood control projects and their effect on the stream channel. Levees and walls have been constructed and channels have been relocated, straightened and enlarged to contain flood flows along many Maryland streams and rivers. As a consequence of these projects, the channel depth, velocity, and bed stresses for a range of flood levels has increased significantly, resulting in channel incision that frequently causes channel degradation through the post-settlement and pre-settlement alluviums and into the underlying bedrock. In some locations, the incision of the channel into bedrock and the deposition of boulders where the slope decreases or the valley widens downstream are both serious problems that cause channel instability and decreased flood capacity in the region of these flood control projects.

Sewer Lines and Other Utility Crossings

All utility crossings should be identified through available mapping and/or in the field. Crossings for sewer lines and other utilities are often encased and protected with stone or concrete. These utilities were frequently installed decades ago into the legacy sediments. As the channels degrade through these sediments, the armored crossings become a temporary base level or grade control with a steep bed slope or step on the downstream side of the crossing. Although these crossings currently provide grade control and prevent bed degradation from traveling upstream, they may be replaced or lowered in the future, especially to provide for fish passage. Their removal or deterioration allows the bed degradation to continue upstream. In some locations, these utilities also parallel the stream at elevations near or above the current or pre-settlement bed levels. The parallel utility lines may limit lateral migration and evolution of the channel planform. Moreover, as the channel’s sinuosity increases, the flow will begin to erode the material around the utility lines, eventually exposing them.

Channelization

Persons conducting the assessment should look for signs of channelization on available mapping and in the field. Channel straightening and channel enlargement result in increased channel gradient and entrenchment, which causes channel incision (Parker and Andres 1976). Experience in conducting channel morphology studies by OBD indicates that over various periods, sections of streams in all farmable valley bottoms examined to date appear to have been straightened and relocated to improve drainage for agriculture, to accommodate embankments for railways and roads, or to support various other valley uses. A general trend of channel incision (degradation) is observed throughout the Piedmont physiographic region and in some parts of the Coastal Plain region. The streams have incised in response to increased channel gradients and reduced planform resistance caused by channel straightening, channel confinement by embankments and other valley fills, and the reduction in fine-grained sediment load from improved erosion control and land-use practices. The channels incise into the previously deposited post-settlement alluvium, forming high banks composed of fine-grained laminated sediments. Quartz gravels and cobbles are common on sections of stream channel; however, fine-grained sediment, typically with a high content of silt and clay, is present below many streambeds, indicating that the channel may be “perched” on post-settlement alluvial deposits. Other signs of perched stream channels include streams along the valley hillslope on degrading bedrock or the lack of a consistent gravel layer in the banks along the stream bed. Although culvert inverts, utility crossing protection, dams, and other grade controls may prevent some channels from degrading, channels in the Piedmont may continue to degrade until the pre-settlement gravels are exposed. Exposure of bedrock in the center of the valley or exposure of the organically rich peat-like sediment may indicate that the stream has incised to the pre-settlement level. Further degradation may be inhibited for two reasons: (1) the bedrock or cobbles may become exposed, limiting degradation, or (2) gravels at the base of the otherwise cohesive stream banks are prone to erosion, which results in the undermining of banks. Collapse of undermined banks and associated tree fall result in development of bends, which in turn causes a rapid increase in channel length, an increase in channel width, and a reduction in channel gradient. Consequently, channel incision is somewhat inhibited once the underlying gravel, cobble, or bedrock is exposed.

Where historic mapping and/or site information indicate the presence of a mill, the channel was probably relocated and protected to accommodate the milldam, mill pond, and mill race (Evans 2003; Hunter 1979; Leffel 1881). A typical milldam of 8 to 10 ft could have a far-reaching impact upstream, depending on the valley slope. Because of the subsequent pervasive manipulation of valley bottoms and channels for agriculture or transportation, discerning all of the details of the early channel modifications may not be necessary; however, awareness of the substantial manipulations of the streams and the valley can help in determining the magnitude and direction of future channel response.

Local Widening or Deepening of Channels at Crossings

All instances of local channel widening should be identified, particularly if the assessment is being conducted for an existing crossing that will be replaced. A common practice for increasing local conveyance to increase flood flow capacity and meet design storms has been to increase the local flow area. The increase is usually accomplished through a gradual expansion of the channel as it approaches the crossing and then a contraction of the channel immediately downstream of the crossing. The bridge or culvert is then constructed to match the enlarged cross section. Typically, the width of the structure is substantially wider than the channel upstream or downstream of the structure. Although these locally expanded channels may initially convey the design flow, a large percentage of the expanded cross section typically fills with sediment over a short period of time. The reduction in designed flow area over time is a function of many parameters that include the characteristics of the sediment load and the frequency of flow contraction during floods caused by waterway crossing embankments.

Mining

The person conducting the assessment should examine current mapping and historic documents for evidence of mining. Some Maryland streams were relocated for mining operations. Entire floodplains were excavated to expose quartz gravel and cobble that contained gold
(Griscom 1830, Goetz 1996). Streams in the vicinity of quarries or other mining operations should be examined for the possibility of channel armoring, relocation, and adjustment initiated in response to the relocation. Although armoring of the channel may have maintained a stable channel in the past, evidence of the failure of the armoring may indicate that the channel will become unstable. These mining operations may have also altered the valley bottom and foundation of the stream/floodplain materials. Pre-settlement streams that once flowed over a foundation of gravels and possibly bedrock may currently flow over wash-pond or other fine sediments left over from the mining operations. These systems will frequently show high erosion of fine sediments, deep

pools, and large gravel bars. The streams will continue to remove the fine sediments of the banks and bed while leaving behind sands and gravels as floodplain and bed material