Navajo County Department of Public Works

Erosion Hazard Assessment

The Navajo County Department of Public Works has developed the following guidelines to help identify erosion hazards along streams and watercourses in Navajo County. Stream channel erosion can increase local flood hazards by causing bank failures or undermining structures. Channel erosion can occur on all stream types, including perennial streams, ephemeral washes, man-made channels, or in areas of sheet flow. The following guidelines are intended to help identify watercourses that could be subject to erosion. Technical references are also listed to provide more detailed information.

Identifying Characteristics for Stream Channel Erosion

Streams that have experienced erosion exhibit certain characteristics which can be readily identified in the field. The lists of characteristics shown below are divided into those that can be observed along natural reaches (no structures present), and those that can be observed where structures have been built in the channel. In addition, the following general rules apply to streams in Navajo County:

- Streams which have experienced erosion problems in the past will experience erosion problems in the future.
- Undisturbed natural streams are less likely to experience erosion than streams that have been altered or that flow through urban areas.
- As a stream and its watershed become more disturbed, the stream is more likely to experience channel erosion.
- The most effective way to avoid erosion damages is to avoid construction or other development activities in the floodplain.
- Bank erosion occurs more rapidly on the outside of bends (meanders) than on the inside of bends.
- Vertical bank slopes are the most readily identified sign of high potential for channel erosion.

Natural Features

The following list of natural channel features are evidence that stream erosion has occurred in the recent past, or is likely to occur in the future. However, erosion can occur on any streams, regardless of its current appearance.

Cut or undercut stream banks. Cut banks occur where erosion has left stream banks steeper than the natural angle of repose of the soil material. Signs of cut banks include lack of bank vegetation, loose soil material (slides when touched), tension cracks in the soils adjacent to the banks, piles of soil at the base of the bank slope, and bank vegetation leaning into the stream corridor. (Figure 1.)

Vertical banks. Vertical banks are the most easily identified evidence of bank erosion. Except where the vertical banks are composed of solid bedrock, vertical banks are never stable, and indicate recent channel erosion. (Figure 2.)

Bank vegetation leaning into channel. Trees and other bank vegetation will fall into the channel as the soil around the roots is removed by erosion. Once the bank vegetation fails, bank erosion occurs more rapidly. (Figures 3 & 4).

Roots of bank vegetation exposed. Exposed roots of bank vegetation indicates that soil material has been removed from the banks and that erosion is beginning to occur. (Figures 3 & 4).

Lack of bank vegetation. Where no vegetation is present along the banks, especially on perennial or intermittent streams, it has either been artificially removed or eroded away by the stream. Where a stream's bank vegetation is discontinuous compared to upstream and downstream reaches, the stream is more likely to erode its banks. (Figures 1-4).

Mid-channel bars higher than floodplain elevation. Where the elevation of the top of the mid-channel bars is close to or higher than the floodplain elevation, rapid bank erosion and channel avulsions are more likely. (Figure 5).

Gully formation in the watershed. Gully formation in a watershed indicates excess runoff and a sediment deficit, which may cause bank erosion on main stem streams. (Figure 6).

Irregular channel geometry. Natural channels generally have gradual changes in the channel width and depth over short reaches. Where channel width and depth change rapidly without a recognizable pattern, it is likely that the channel is unstable and subject to erosion. (Figure 6).

Piping of bank soils. Piping, or formation of zones of high hydraulic conductivity in a stream bank, can destabilize the banks and lead to more rapid erosion. (Figure 7).

Perched tributaries. Tributaries normally join the main stream at an elevation equal to the bed elevation of the main channel. Where the elevation of the tributary mouth is significantly higher than the main stem, it is likely that accelerated bank erosion of the main stem will occur. (Figure 8).

Man-Made Features

Man-made structures, since they are generally not designed to move, offer a reference point from which to assess the magnitude of channel change since their construction date. Some types of structures that can be used to identify erosion include the following:

Failed bank protection. Failures of bank protection, such as slumped rip rap or cracked concrete, may indicate long term degradation of the channel or channel movement. (Figure 9).

Footings of structures. Footings are typically designed below the elevation of the stream bed. If exposed or undercut, it can be assumed that the stream channel has degraded or moved. (Figures 10-12) .

Activities That Can Increase the Potential for Stream Erosion:

The following human activities can increase the potential for river erosion:

- Removing vegetation from channel banks or the channel bed.
- Excavating sand and gravel material from the channel bed.
- Lining only one bank with permanent bank protection such as rip rap.
- Changing the natural channel geometry by channelization or grading.
- Straightening a naturally sinuous channel.
- Increasing the frequency of runoff by discharging urban runoff into a stream.
- Developing within the floodplain.
- Constructing an on-line detention basin or dam upstream.
- Removing a large number of trees from a forested watershed.
- Removing of watershed vegetation by overgrazing.

Erosion hazards should be considered in the design of structures along any watercourse that exhibits any of the features described above.

Constructed Channels

Man-made channels will erode if the flow velocity exceeds the threshold of movement of the material in the bed and banks. Maximum allowable velocity values for different channel materials are shown in Table 1. Where design velocities exceed the values shown in Table 1, erosion protection should be provided.

Table 1. Allowable Velocity Data

Channel Material	Mean Channel Velocity (ft/sec)
Fine Sand	2.0
Coarse Sand	4.0
Fine Gravel	6.0
Earth	
Sandy Silt	2.0
Silty Clay	3.5
Clay	6.0
Grass-Lined Earth (slopes < 5%)	
Bermuda Grass	
Sandy Silt	6.0
Silt Clay	8.0
Kentucky Blue Grass	
Sandy Silt	5.0
Silt Clay	7.0
Poor Rock (usually sedimentary)	
Soft Sandstone	8.0
Soft Shale	3.5
Good Rock (usually igneous or metamorphic)	20.0

Source: USACOE, 1994, *Channel Stability Assessment for Flood Control Projects*. EM 1110-2-1418, Table 5-1, p. 51.

Technical References for Identifying Erosion Hazards

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Technical References for Designing Erosion Protection

ADOT, 1989, *Sizing Riprap for the Protection of Approach Embankments and Spur Dikes and Limiting the Depth of Scour at Bridge Piers and Abutments* - Two Volumes. Report for the Arizona Dept. of Transportation. Report #FHWA-AZ89-260.

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