4.16 Shoreline Erosion

4.16.1 Introduction

Resource Issues
▶ Rate of erosion of reservoir and tailwater shorelines

Soil erosion, whether from upstream land use practices or from the cutting away of stream and reservoir shorelines, can cause adverse environmental impacts. Sediments from eroded soils can alter water chemistry and aquatic habitats, restrict navigation, and reduce water storage capability. Erosive forces can cause stream and reservoir banks to recede, resulting in loss of land and vegetation that provides important canopy cover for habitat. Sediments and nutrients, particularly nitrogen and phosphorus, from eroded soils are the cause of water quality impairment of more miles of rivers and streams in the United States than any other pollutants (USEPA 1992).

Natural erosion is a process driven by raindrop impact forces, streamflow shearing forces, and wave energy that dislodges and moves sediments from highlands through waterways to the oceans. Human activities have and will continue to accelerate the natural process. A portion of the erosion and sedimentation affecting the waterways in the TVA system is a result of land use activities in the backlands that are within the watershed but outside the control of TVA, such as soil disturbances associated with construction, agriculture, and forestry. Some erosion and associated sedimentation also occurs in the tailwater streambanks and the reservoir shorelines due to the presence and operation of TVA facilities for power generation, navigation, flood control, and wave action associated with recreational boating. These latter causes of erosion are the subject of this section. Sediment contamination of TVA waterways, produced either through reservoir operations or from activities on land within the watershed, is discussed in Section 4.4, Water Quality.

The primary issue for this resource area is the potential changes (increase) in the rate of erosion of reservoir and tailwater shorelines. To help focus the definition of the affected environment, the erosion analysis used seven representative reservoirs and tailwaters of the TVA system (Table 4.16-01). Considerations used to select the reservoirs and tailwaters included representation of the various physiographic regions in the TVA study area, representation of both mainstem and tributary reservoirs, and the amount of available data.

4.16.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

Section 26a of the TVA Act provides TVA with permit authority for structures along the shoreline. This regulation allows TVA to require applicants to incorporate erosion control measures into the design and construction of docks and other alterations fronting waterfront property.

Table 4.16-01 Representative Reservoirs Used in the Erosion Analysis

Reservoir	Physiographic Region	Reservoir Type
Chatuge	Blue Ridge	Tributary storage
Douglas	Valley and Ridge	Tributary storage
Fort Loudoun	Valley and Ridge	Mainstem storage
Nickajack	Cumberland Plateau	Mainstem run-of-river
Tims Ford	Highland Rim	Tributary storage
Normandy	Highland Rim	Tributary storage
Pickwick	Coastal Plain	Mainstem storage

TVA Management Activities

Hydro Modernization Projects. TVA is rehabilitating and modernizing the hydro turbine units at various dams. HMOD projects seek to improve operating efficiency and provide additional peak generating capacity while maintaining safe and reliable peak power generation. Because the modernization of the units may potentially increase peak flows and change flow, TVA investigates the potential effects on erosion in the tailwater. The investigations are incorporated into EAs under NEPA where appropriate. TVA has prepared EAs for its existing HMOD projects and will continue to prepare these assessments as additional units are considered for hydro modernization.

Shoreline Treatment Program. TVA has been conducting a widespread, intensive effort to treat critical erosion sites. Shorelines for the entire TVA reservoir system have been surveyed to identify and prioritize those that are in need of stabilization. Treatment techniques are focused on bioengineering (use of live and dead vegetation for reinforcement and protection of soil) where appropriate, which provide increased benefits to aquatic habitat, water quality, and aesthetics. More intensive treatment techniques, such as riprap, a combination of riprap and bioengineering, gabion walls, or live crib walls are used if needed. TVA typically applies stabilization treatments to approximately 20 critically eroded sites each year (TVA 1998). TVA can treat shorelines only on TVA-owned and managed lands; however, TVA encourages private landowners to implement treatments and provides educational materials and technical support.

4.16.3 Reservoir Shoreline Erosion Conditions

Existing Conditions

TVA has conducted an extensive analysis of the shoreline conditions of each reservoir in its system to prioritize erosion sites for possible future treatment. TVA maintains the Automated Land Information System (ALIS) Shoreline Conditions Database (TVA 2002), a geographic information system (GIS) for storing and graphically displaying shoreline conditions. The ALIS data cover virtually all of the shorelines in the TVA reservoir system. Because of the direct impact on land and property, erosion of shoreline above summer pool has been a greater concern; therefore the data describe the shoreline conditions only at summer pool elevations. No systematic data were available about the shoreline status at winter pool elevations or at intermediate elevations between summer pool and winter pool.

Two rating systems have been used to characterize the shoreline. The Muncy system, used on some TVA reservoirs, was developed to identify and prioritize areas for shoreline stabilization; this system focuses entirely on shoreline erosion conditions, vegetation cover, and land use. The Shoreline Aquatic Habitat Index (SAHI) is used to rate aquatic habitat conditions. While it includes ratings of shoreline erosion and vegetation, the focus of the index is on aquatic habitat structure and conditions in areas that are under water at full pool. The erosion condition metric (good, fair, or poor) from the available system was compiled (see Table 4.16-02 and Figure 4.16-01) to show the extent of erosion on TVA reservoirs. The differences in purpose and frame of reference between the two rating systems must be taken into account when interpreting Table 4.16-02 and Figure 4.16-01.

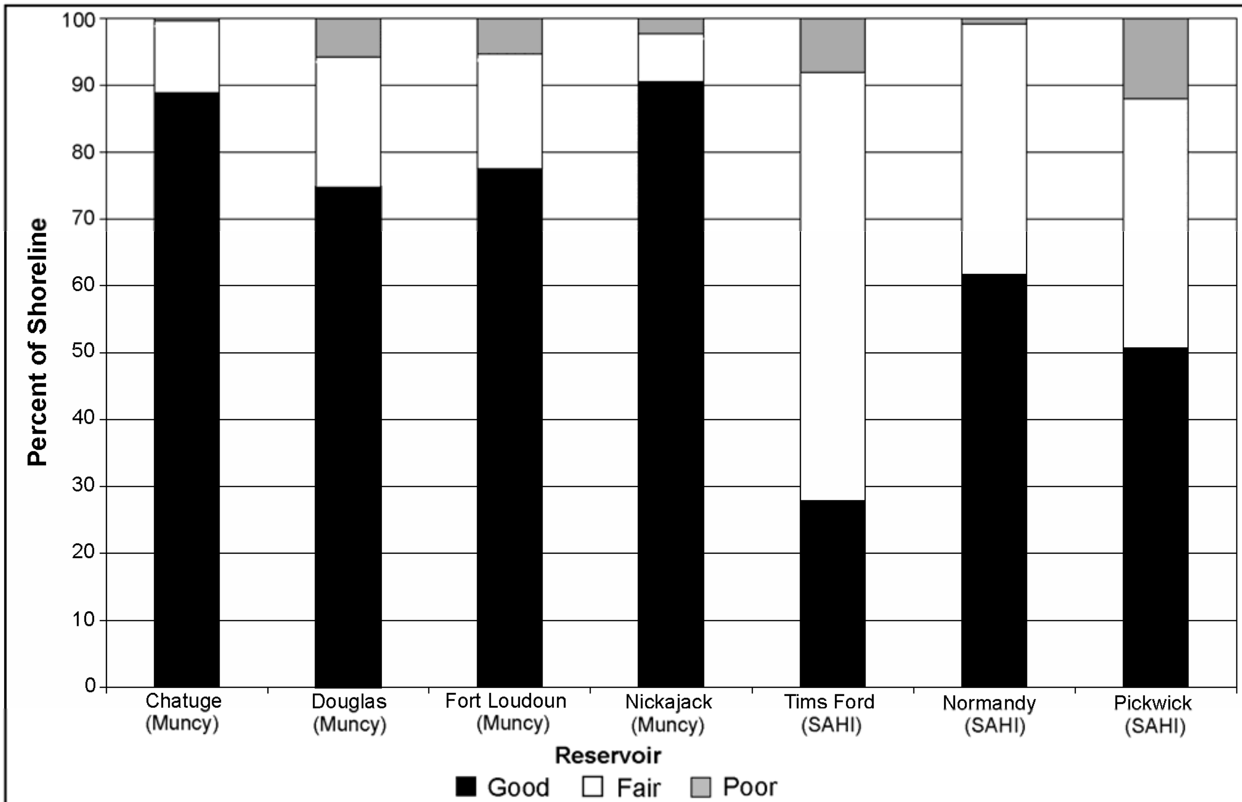
Erosion conditions of the shorelines for the seven representative reservoirs varied, but much of the difference is because of the rating systems used. Among the reservoirs rated using the Muncy system, most (75 to 91 percent) of the shoreline was characterized as being in good shape; a smaller portion (7.2 to 20 percent) was rated fair, and relatively little was rated as poor (0.41 to 5.8 percent). These small percentages represent substantial shoreline length in some cases (up to 26.8 miles of poor shoreline on Douglas). The reservoirs rated using the SAHI were approximately equally good and fair (28 to 62 percent good and 37 to 64 percent fair). Again, the smallest portion was rated poor (0.89 to 12 percent), representing up to 51 miles on Pickwick Reservoir.

Future Trends

Without a change in reservoir operations, erosion in the reservoirs is anticipated to continue through the 2030 study period. Factors such as the 16-percent projected increase in recreational boating (see Section 4.24, Recreation) and the associated boat waves would likely accelerate the erosion of shorelines. The application of treatments and best management practices (BMPs) by TVA and other shoreline landowners would partially reduce erosion effects.

Table 4.16-02 Reservoir Shoreline Erosion Conditions from TVA Automated Land Information System (ALIS) Data

Erosion Conditions	Reservoir						
	Chatuge	Douglas	Fort Loudoun	Nickajack	Tims Ford	Normandy	Pickwick
Rating method	Muncy	Muncy	Muncy	Muncy	SAHI	SAHI	SAHI
Total shoreline miles	128.2	512.7	336.0	137.4	259.0	75.2	491.3
Shoreline miles unrated	0	48.3	0	0	0	0	73.1
Miles erosion rating poor	0.52	347.1	18	3.13	21.13	0.667	50.67
Percent erosion rating poor	0.41	74.7	5.36	2.28	8.16	0.89	12.1
Miles erosion rating fair	13.85	90.53	57.6	9.89	165.8	28.2	155.7
Percent erosion rating fair	10.8	19.5	17.1	7.20	64.0	37.5	37.2
Miles erosion rating good	113.8	26.76	260.4	124.4	72.1	46.3	211.8
Percent erosion rating good	88.8	5.76	77.5	90.5	27.8	61.6	50.6



Notes:
Two rating systems were used to characterize the shoreline: the Muncy system (Muncy) and the Shoreline Aquatic Habitat Index (SAHI).
Because no ratings are available for 48 miles at Douglas, 3.7 miles at Normandy, and 73.1 miles at Pickwick, less than 100 percent of the shoreline has been rated.
Source: TVA data 2003.

Figure 4.16-01 Reservoir Shoreline Erosion Rankings (Percent)

4.16.4 Tailwater Shoreline Erosion Conditions

Existing Conditions

Tailwaters include the waterbodies immediately downstream of dams. Tailwaters can be subdivided into tributary and mainstem tailwaters. Tributary tailwaters are riverine waterbodies, whereas mainstem tailwaters typically are the upstream section of the next downstream reservoir. Data for the conditions of the representative tailwaters were obtained from the erosion potential surveys conducted for HMOD reports and from a field survey program conducted in November 2002. The tailwater surveys generally considered:

- Bank stability at the toe and high-flow areas and evidence of existing erosion;
- Slope and height of the stream bank;
- Canopy cover—the percentage of tree or shrub cover along the bank; and,
- Riparian zone—the width of area adjacent to the bank containing woody vegetation.

Qualitative assessments were made of these characteristics for segments of the river that exhibited consistent properties (for those tailwaters studied for HMOD analysis) or at specific discrete locations along the tailwater (for those tailwaters surveyed by Normandeau Associates in November 2002). The data then were generalized to classify the condition of the entire tailwater. Table 4.16-03 summarizes the results of the surveys.

Table 4.16-03 Tailwater Shoreline Erosion Conditions

Tailwater	Bank Stability	Slope and Height of Bank	Canopy Cover	Riparian Zone
Mainstem Tailwaters				
Fort Loudoun	TBD	TBD	TBD	TBD
Nickajack	Fair to good	Varies from 1.5:1 to vertical, high	Good	Good
Pickwick	Poor	Typically 1:1 and high	Poor to fair	Poor to fair
Tributary Tailwaters				
Tims Ford	Poor to good	Typically 1:1 and low	Fair	Fair
Normandy	Fair to good	Typically 1:1 and low	Fair	Fair
Chatuge	Fair to good	Steep and high	Good	Good
Douglas	Fair to good	Steep and low	Good	Fair

Future Trends

Without a change in reservoir operations, erosion in the tailwaters is anticipated to continue through the 2030 study period. Although recreational use is not thought to be a primary driver in erosion of tributary tailwaters (see Section 5.16), increased recreational boat traffic would likely accelerate the erosion of shorelines. The application of treatments and BMPs by TVA and other shoreline landowners would partially reduce erosion effects.