CHAPTER 2 - ALTERNATIVES

TVA has developed alternatives for minimizing the potential for the failure of Cherokee, Fort Loudoun, Tellico, and Watts Bar dams during the PMF, and for prevention of increased flooding at downstream locations during the PMF. Development of these alternatives took into consideration the level of risk reduction to the public, constructability, potential environmental impacts, and cost. TVA has performed preliminary internal scoping and identified a No Action Alternative and two Action Alternatives: (1) Permanent Modifications to Dam Structures: Combination of Concrete Floodwalls and Earthen Embankments/Berms, and (2) Permanent Modifications to Dam Structures: All Concrete Floodwalls.

2.1. Description of Alternatives

TVA considered several potential alternatives which minimize the potential for failure of Cherokee, Fort Loudoun, Tellico, and Watts Bar dams, and which prevent an increase in flooding at downstream locations, including TVA's nuclear plants during the PMF. These potential alternatives included both structural modifications to TVA facilities and non-structural changes to TVA reservoir operations. The following sections describe the three alternatives analyzed in detail in this EIS and the alternatives considered but rejected from detailed consideration.

2.1.1. Alternative A – No Action Alternative

As described in Section 1.3, TVA made temporary and permanent modifications to the four dams in 2009. These modifications consisted of the installation of a total of approximately 17,880 linear feet of 3- or 4-foot-tall HESCO barriers (stacked two barriers high in some portions to increase the height of those dam segments by 7 or 8 feet) on the four dams and the installation of permanent concrete mats covering a 2-acre area at Watts Bar Dam. The HESCO barriers were installed as an interim measure. Under the No Action Alternative, TVA would leave the existing HESCO barriers in place and maintain them as necessary. The major maintenance activity would be the replacement of the geotextile liners on an approximately five-year cycle. This would require removing the crushed stone from the containers, removing and replacing the liners, and then refilling the containers with the previously used crushed stone. TVA currently conducts monthly inspections of the HESCO barriers; these would be continued under the No Action Alternative.

Under the No Action Alternative, the HESCO barriers would continue to minimize the potential for failure of the four dams and prevent an increase in flooding at downstream locations, including TVA's nuclear plants during the PMF. However, in a letter to TVA dated January 25, 2012, the NRC stated, "the NRC staff finds that the HESCO barriers are not capable of resisting debris impact...if a design flood were to occur, there is a high likelihood that significant debris would accompany flood waters which could impact the barriers. There is the potential for this debris to damage the barriers or push the individual barriers apart causing a breach... Therefore, HESCO barriers that are not designed and constructed to withstand impacts from large debris are not acceptable as a long-term solution."

While TVA has therefore concluded that the No Action Alternative is not an adequate long-term solution for addressing the PMF, it represents the baseline conditions against which the effects of the Action Alternatives are evaluated. The No Action Alternative is the current existing condition at the Cherokee, Fort Loudoun, Tellico, and Watts Bar Dam sites. A permanent

concrete mat structure was installed in the downstream embankment of Watts Bar Dam, and HESCO barriers were installed at Cherokee, Fort Loudoun, Tellico, and Watts Bar dams (see Section 1.3 for detailed discussion of temporary measures). These items would remain in place and would be maintained as needed.

2.1.2. Alternative B – Permanent Modifications of Dam Structures: Combination of Concrete Floodwalls and Earthen Embankments/Berms

Under Action Alternative B, the HESCO barriers would be removed and permanent dam modifications in the form of a combination of concrete floodwalls, raised earthen embankments or earthen berms, and gap closure barriers (gate-like barriers used to close gaps between the floodwalls) would be made to each of the four dam structures. The concrete mat structure would remain in place at Watts Bar Dam. Concrete floodwalls would be constructed from reinforced concrete designed to withstand the hydrostatic forces resulting from the PMF. The concrete would either be provided from an existing concrete suppliers (Table 2-1), or, for Cherokee and Fort Loudoun/Tellico, onsite concrete batch plants. The approximate distances of the concrete suppliers to the project area (by dam) and the times it would take for concrete to be transported to the project area are also listed in Table 2-1.

Table 2-1.
Potential Concrete Suppliers for Floodwall Modifications

Dam	Concrete Plant	Approximate Distance from Project Area (in miles)	Approximately Time Required to Reach Project Area (in minutes)
Cherokee	AW Ready Mix	28.6	44
Cherokee	Blalock Incorporated	26.8	41
Cherokee	Cloud 9 Materials	25.5	38
Cherokee	Concrete Materials, Dandridge	17.8	33
Cherokee	Concrete Materials, Morristown	21.3	33
Cherokee	Ready Mix USA	20.0	30
Fort Loudoun/Tellico	Adams Ready Mix	5.9	12
Fort Loudoun/Tellico	Lambcon Ready Mix	7.7	12
Fort Loudoun/Tellico	Knoxville Concrete	21.7	30
Fort Loudoun/Tellico	Harrison Construction	25.1	31
Fort Loudoun/Tellico	R&S Concrete	39.0	49
Watts Bar	Irving Materials – Dayton	17.0	22
Watts Bar	Irving Materials – Decatur	6.0	8
Watts Bar	Lambcon Ready Mix	19.4	27
Watts Bar	R&S Concrete	28.1	40

Figure 2-1 is a generalized configuration of the concrete floodwalls. In some locations, the HESCO barriers would be replaced with raised earthen embankments or berms instead of concrete floodwalls. Factors used in determining the feasibility of embankments or berms in particular locations included the height increase necessary to meet PMF elevations, ease of access for construction equipment, and public use of the existing embankments. TVA determined the height increases necessary to meet PMF elevations at each dam as follows: Cherokee – 6.6 feet; Fort Loudoun – 5.8 feet; Tellico – 4.8 feet; and Watts Bar – 2.3 feet (above existing floodwall); all permanent modification structures (floodwalls and/or embankments) would be constructed to these specific heights per location.

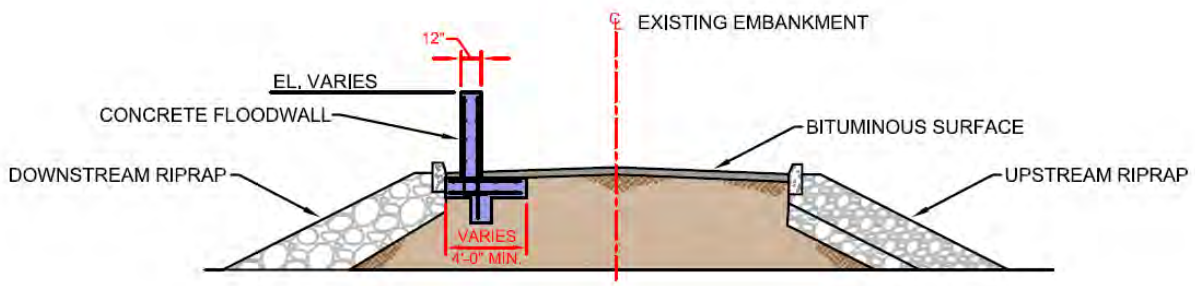

Figure 2-1. Generalized Conceptual Design of a Concrete Floodwall Constructed on Earthen Embankment with Riprap on Slopes and a Roadway on Top

Alternative B would prevent the potential for failure of the dams due to overtopping during a PMF event and prevent increased flooding at downstream locations during the PMF. This would ensure that the integrity of the downstream embankments would be maintained and thereby increase the public safety of downstream residents and the safety of TVA's critical nuclear facilities.

The HESCO barriers installed as temporary modifications in 2009, which are currently in place at each dam, would be replaced by the permanent project actions. With implementation of the Proposed Action, the HESCO barriers at all project area dam segments would be removed by emptying the barriers of crushed stone and either reusing it at other TVA locations for roadbed materials, returning or reselling to the supplier, or disposing of it at a municipal landfill. The stone fill material would be removed from each HESCO barrier using a vacuum truck and temporarily stockpiled until it could be hauled via dump truck to the final disposition area (yet to be determined). The HESCO barriers (wire basket structures) would either be reused at another location or disposed of at a municipal landfill.

To construct the concrete floodwalls, the existing roadbed or sidewalk would be cut, removed, and disposed of, most likely at an approved landfill. The foundation would be excavated and forms and steel reinforcing bars installed. Concrete would be poured for the foundation. After the concrete has cured, forms and steel reinforcing bars would be installed for the upright wall, and concrete poured. The forms would be removed after the concrete has cured. Excavated soil or other fill would be replaced around the foundation and the roadbed or walkway reestablished as appropriate.

The embankments or berms would be constructed by spreading and compacting approved impervious earthen borrow materials in multiple lifts to reach the desired elevations (see

schematics of embankments and berms throughout this Chapter). Proposed borrow areas for Cherokee, Tellico, and Watts Bar dams are shown below in Figures 2-3, 2-8 (Tellico only; modifications to Fort Loudoun would not require any borrow material), and 2-17, respectively. The embankments would be planted with native and/or non-invasive grass cover, and as necessary, stabilized with riprap. Upstream and downstream faces would have slopes of 2:1 to 3:1 depending on available land area, the frequency of grounds maintenance, and other factors. All construction would take place entirely within TVA right-of-way (ROW). Specific details on the alternatives for Cherokee, Fort Loudoun, Tellico, and Watts Bar dams are provided below.

Cherokee Dam

Due to site and engineering constraints, floodwalls were selected as the permanent modification type for five of the six Cherokee Dam segments (totaling approximately 6,085 feet). The Cherokee Dam Proposed Action is illustrated in Figure 2-2 and the borrow area is shown in Figure 2-3.

Legend

- Staging Area
- Gate Location
- Recreational Area
- TVA Owned Land
- Permanent Modification = Floodwall or Berm
- Permanent Modification = Floodwall

N

0 500 1,000 2,000 Feet

Source: Aerial is provided by ArcMap World Imagery 2012

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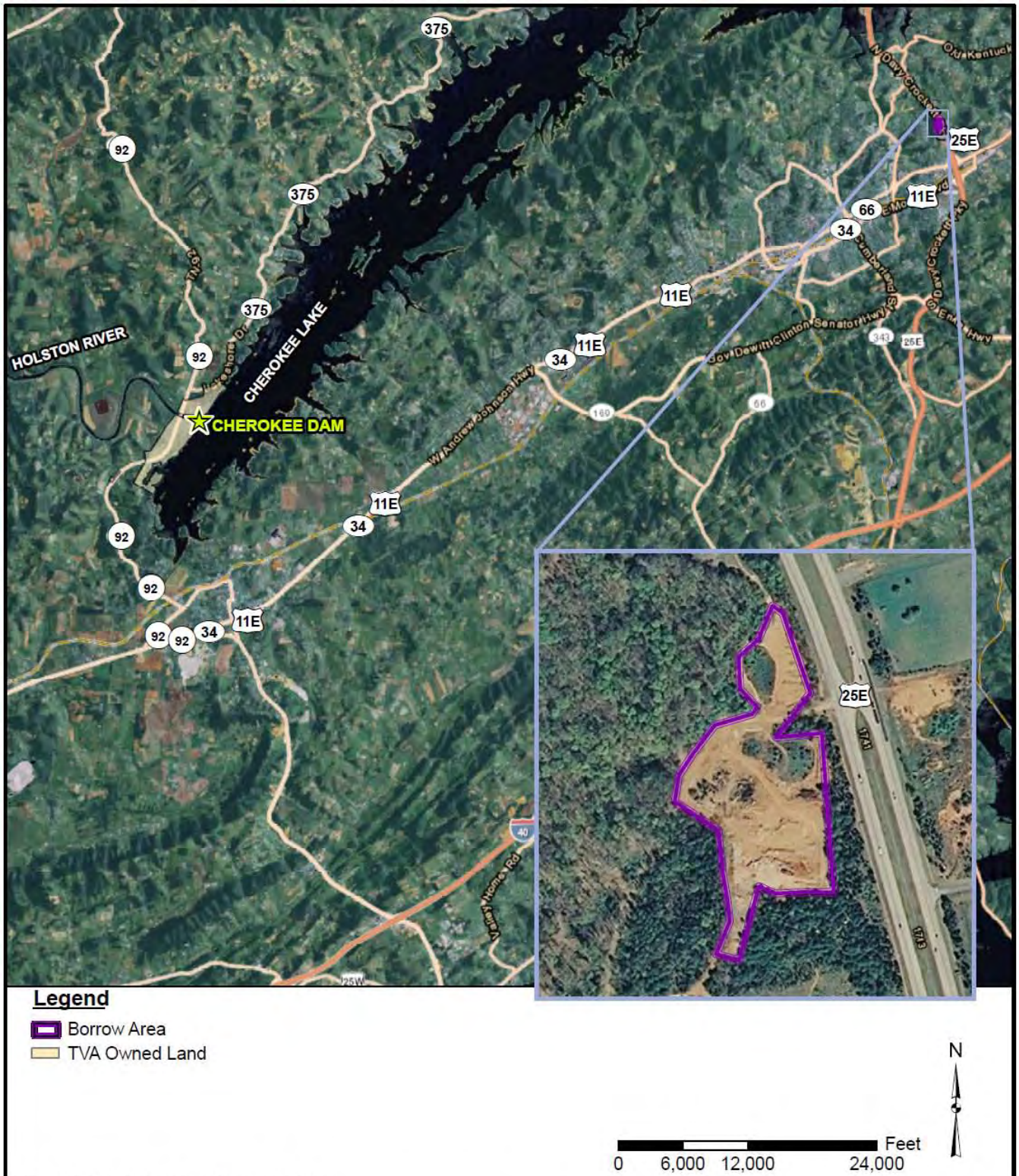
Figure 2-2
Cherokee Dam Proposed Action

Tennessee Valley Authority



Source: Aerial is provided by ArcMap World Imagery 2012

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Figure 2-3
Cherokee Dam Proposed Action Borrow Area

Tennessee Valley Authority

Floodwalls would be installed to replace the 2,150-feet and 2,650-foot-long rows of HESCO barriers currently in place on the north and south embankments (Segments C-1 and C-2), respectively (Figure 1-2). Concrete floodwalls would likely be installed on the west (downstream) side of the roadway running the length of the embankments and would be built to a height of 6.6 feet (Figure 2-4).

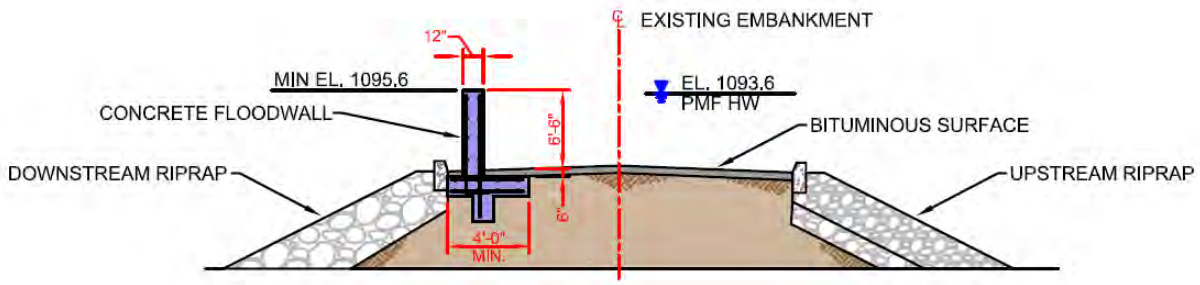

Figure 2-4. Cherokee Dam - Concrete Floodwall Concept for North and South Embankments

A total of approximately 1,285 feet of concrete floodwall (Figure 2-5) would also be constructed along the downstream (north) side of the TVA access road from Parking Area 3, across Saddle Dam 1, to Parking Area 5 (Segments C-3 through C-5 on Figure 2-2). Approximately 200 feet of concrete floodwall would be constructed at Segment C-3. At Segment C-4, the concrete floodwall would begin at Parking Area 3 and extend along the downstream (north) side of the access road across Saddle Dam No. 1 for approximately 860 feet. The permanent concrete floodwall could also be constructed on the upstream side of the access road; the HESCO barriers currently in place for this segment are located on the upstream side of the access road. A fifth segment (Segment C-5) of concrete floodwalls would extend from west of Parking Area 5 for 225 feet to just east of the Visitor's Building parking area (Figure 2-2).

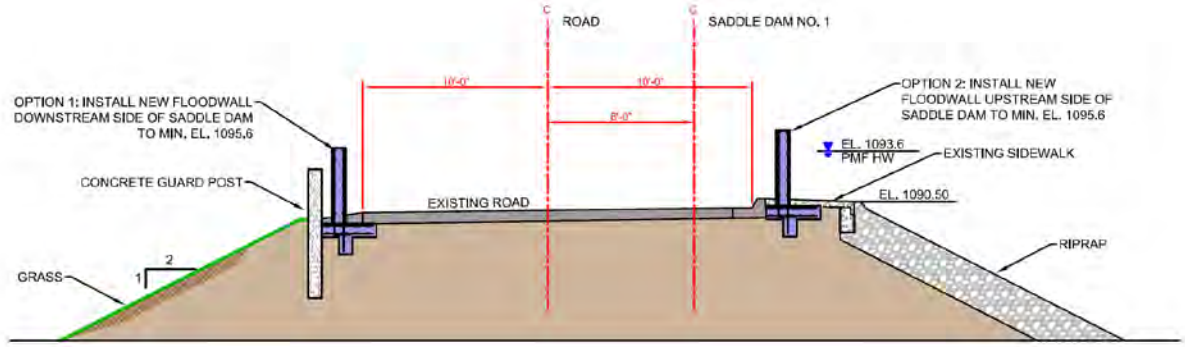

Figure 2-5. Cherokee Dam - Concrete Floodwall Concept for Segments C-3 through C-5 (Including Saddle Dam No. 1)

The final segment (Segment C-6) runs south of the Visitor's Building, along the west side of the parking lot located adjacent to the boat ramp parking area, extending 600 feet, terminating at elevation at the boat ramp access road (Figure 2-2). The proposed permanent modification type for Cherokee Dam Segment C-6 at the Boat Ramp Parking Area would be a 600-foot-long raised earthen embankment constructed to a height of 6.6 feet on the downstream (north) side. of the parking area driveway (Figure 2-6).

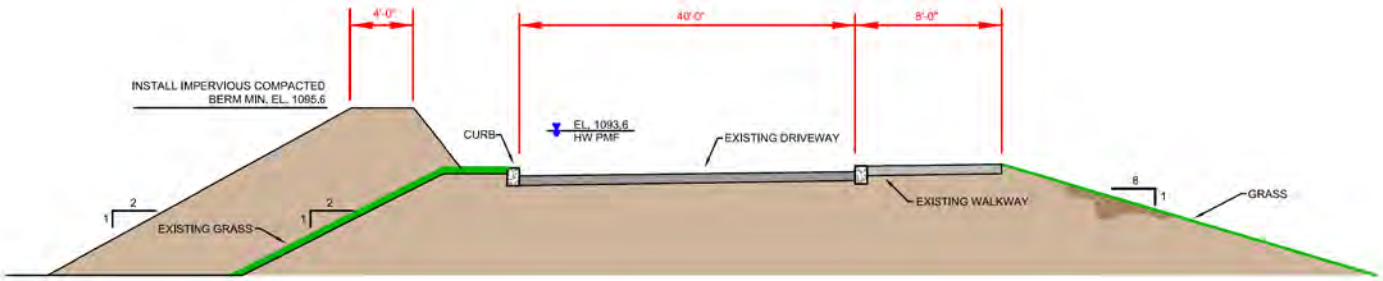

Figure 2-6. Cherokee Dam – Raised Earthen Embankment Concept for Segment C-6 (Boat Ramp Parking Area)

Two gap closure barriers would also be required in order to provide continuous flood protection under the permanent modifications at Cherokee Dam. The first gap closure barrier would be located between segments C-2 and C-3, at the southern end of the south embankment (Figure 2-2). The second gap closure structure would connect segment C-5 with the existing elevation at the east corner of the Visitor's Building (Figure 2-2). The exact gap closure barrier type is not known at this time; however, TVA has identified two potential barrier types: (1) Automatic floodgates, and (2) Removable floodwall systems. Automatic floodgates, such as FloodBreak® Automatic Floodgates, would automatically rise during a flood event. Removable floodwall systems, such as the Invincible Flood Control Wall™, would be permanently installed with concrete foundations and steel post anchors. When a flood threatens, vertical support posts are installed and then planks are set in place between the posts. Construction and installation efforts are similar between the two barrier types, as both would require excavating the area where they would be installed and pouring concrete foundations. In addition, both barrier types would require periodic inspections. The automatic floodgates may require periodic maintenance to clear debris, while the removable floodwall system would require nearby staging areas for the support posts and planks. Personnel would be required to install support posts and planks in the removable floodwall system prior to potential flood events.

Construction staging areas at Cherokee Dam are illustrated in Figure 2-2. Construction at Cherokee Dam would occur sequentially, and is estimated to take up to two years to complete. Construction crews of approximately 15 to 20 workers would be required per site; crews would work at one dam and complete those permanent modifications before moving on to the next location. Approximately 5,575 cubic yards (yds^3) of fill material would be required for constructing the berm at Segment C-6. The fill would be obtained from an existing borrow area on the west side of U.S. Highway 25 East about 0.8 mile north of the intersection of U.S. Highway 25 East and U.S. Highway 11 East near Morristown (Figure 2-3). Approximately 2,630 yds^3 of concrete would be required for the floodwalls. Concrete would be delivered to the project area by truck from existing commercial concrete plants or produced at an onsite batch plant. Potential concrete suppliers for Cherokee Dam are listed in Table 2-1.

Two additional dam safety modifications could be made at Cherokee Dam. Up to 50 post-tensioned anchors could be installed, distributed across the concrete portion of the dam. Post-tensioned anchors are multistrand metal tendons installed in holes drilled through the concrete portion of the dam into the underlying bedrock. They are anchored to the bedrock, stressed, locked off, and grouted to prevent corrosion. The holes would be drilled with a drill rig mobilized on top of the dam. The second additional modification consists of the possible installation of concrete armouring in the vicinity of the switchyard on the north downstream side of the dam.

The area to be armoured could be between 5 and 10 acres; engineering studies are ongoing to better delineate the area to be armoured and the type of concrete armouring to be installed.

Fort Loudoun Dam

At Fort Loudoun Dam, there are three existing embankment segments where concrete floodwalls would replace the temporary HESCO barriers (Figure 1-3). Permanent modifications at Fort Loudoun Dam and the potential construction areas are illustrated in Figure 2-7.

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Figure 2-7
Fort Loudoun Dam Proposed Action

Tennessee Valley Authority

Due to site and engineering constraints, the construction of one or more earthen berms instead of concrete floodwalls is not feasible at any Fort Loudoun Dam segment. The first segment (FTL-1) is located at the north saddle dam near Fort Loudoun Marina. The existing floodwall is approximately 500 feet in length, terminates at elevation at both ends, and will need to be modified or completely rebuilt to accommodate the calculated PMF elevations. Under temporary measures, HESCO barriers were stacked two high at Segment FTL-1 to add 7 to 8 feet to the overall height and prevent overtopping during the PMF; therefore, the proposed permanent modification for FTL-1 is a concrete floodwall (Figure 2-8) built to a height of 5.8 feet.

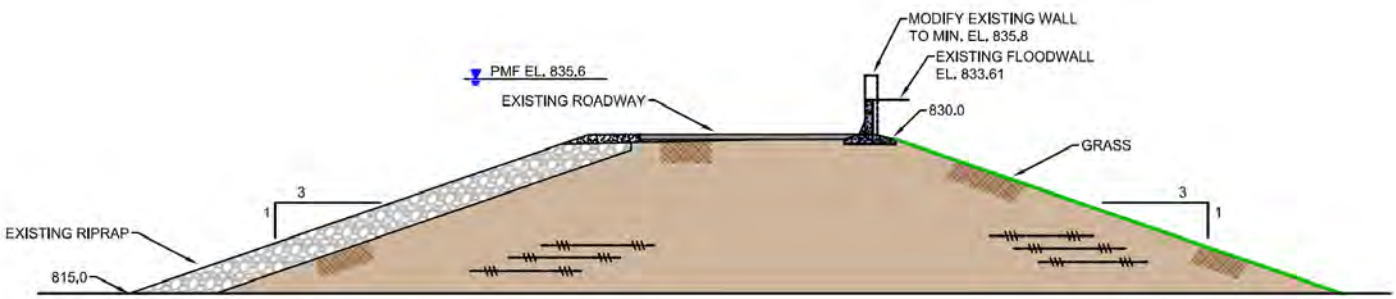

Figure 2-8. Fort Loudoun Dam – Concrete Floodwall Concept for Segment FTL-1 (North Saddle Dam near Marina)

The second segment at Fort Loudoun Dam (FTL-2) is located immediately south of the concrete portion of Fort Loudoun Dam and extends from the USACE Lock Operations Building southward for 800 feet to the U.S. Highway 321 Carmichael Greer Bridge (Figure 2-7). The northern 330 feet of this floodwall would be built under the bridge on the upstream (east) side of U.S. Highway 321. The southern 470 feet of the floodwall would be built under the bridge on the downstream (west) side of U.S. Highway 321. Under temporary measures, this portion of Fort Loudoun Dam has HESCO barriers stacked two-high to provide an additional 7 to 8 feet of height to the existing floodwall. The proposed permanent modification for Segment FTL-2 would be a concrete floodwall ranging in height from 6 to 7 feet (Figure 2-9).

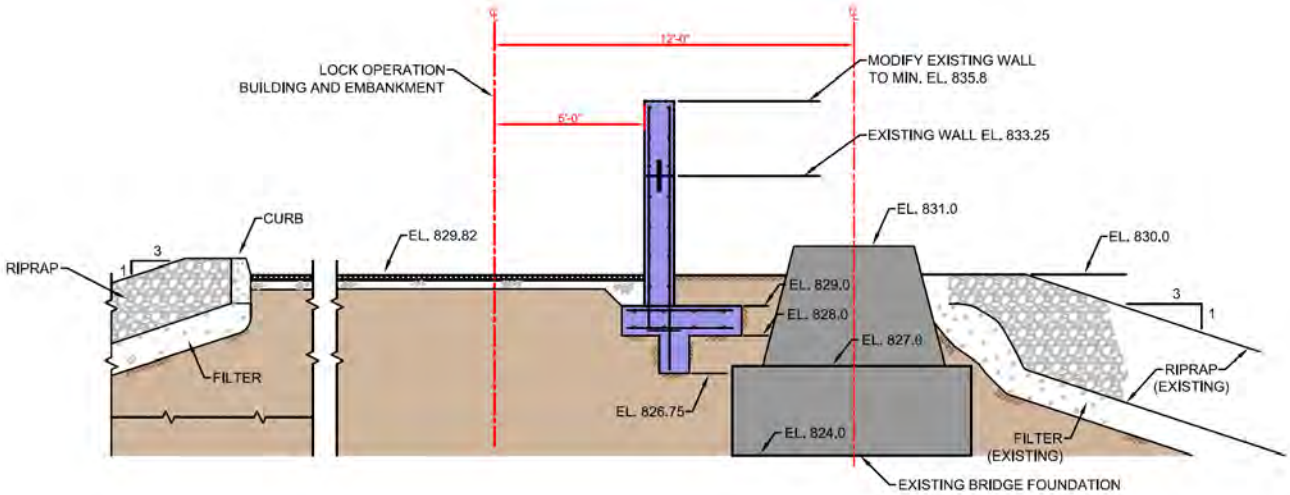

Figure 2-9. Fort Loudoun Dam – Concrete Floodwall Concept for Segment FTL-2 (Under U.S. Highway 321 Bridge)

The third segment at Fort Loudoun Dam (FTL-3) would be built along the shoulder of U.S. Highway 321 from the south end of the U.S. Highway 321 Bridge approximately 2,500 feet south of the entrance to the Tellico Recreation Area (Figure 2-7). This segment of concrete floodwall could be built on either the upstream (east) side or the downstream (west) side of U.S. 321 and would be constructed to a height of 5.8 feet (Figure 2-10); however, the current HESCO barriers are located on the upstream side of U.S. Highway 321 due to identified traffic hazards associated with locating the barriers on the downstream side of U.S. Highway 321, adjacent to the existing floodwall. While increasing the height of the existing floodwall is an option, there are concerns that the same hazards would exist while also requiring a much higher wall to accommodate the lower elevations associated with the downstream side of the embankment.

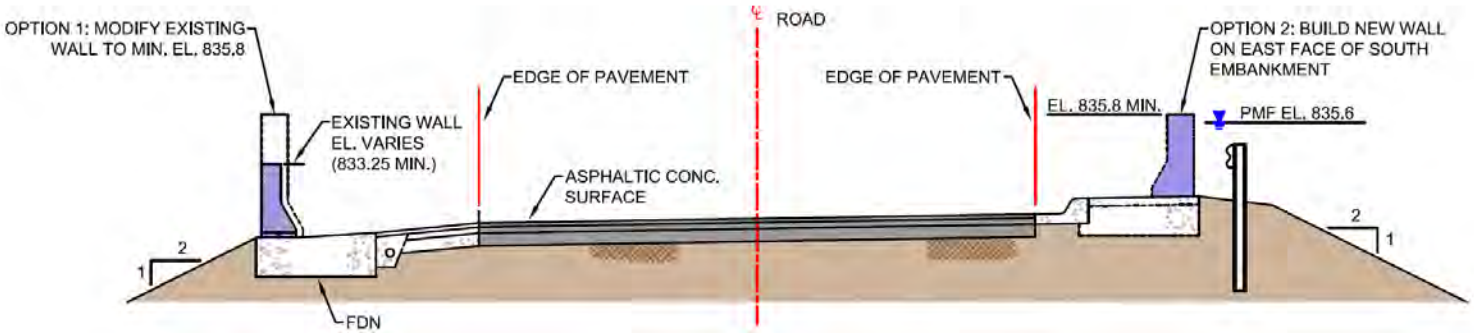

Figure 2-10. Fort Loudoun Dam – Concrete Floodwall Concept for Segment FTL-3 (U.S. Highway 321 Bridge to Tellico Recreation Area)

Under Alternative B, a gap closure barrier would also be required in order to provide continuous flood protection at the connection point between FTL-3 and Tellico Segment T-1 (intersection of Fort Loudoun and Tellico dams near the Tellico Recreation Area; Figures 2-7 and 2-11). As described above for Cherokee Dam, the exact barrier type is not known at this time; however, TVA has identified two potential gap closure barrier types: (1) Automatic floodgates, and (2) Removable floodwall systems, described in the Cherokee Dam section.

Three existing parking lots would be used as temporary construction staging areas during the construction of permanent modifications at Fort Loudoun Dam (Figure 2-7); one of these is adjacent to the north saddle dam near the Fort Loudoun Marina. The other two potential staging areas, which would also serve as staging areas for work at Tellico Dam, are located in the Tellico Recreation Area adjacent to: (1) the parking lot near the entrance, and (2) the boat ramp parking lot at the west end of the canal. These areas would be used to store construction materials for the duration of the construction period for permanent modification work at Fort Loudoun and Tellico dams. Approximately 1,295 yds^3 of concrete would be required to construct the floodwalls. This concrete would be delivered by truck from existing commercial concrete plants or from an onsite concrete batch plant serving both Fort Loudoun and Tellico Dams. Potential concrete suppliers for Fort Loudoun and Tellico dams are listed in Table 2-1.

Tellico Dam

Under Alternative B, permanent modifications at Tellico Dam are proposed for a total of four segments (Figure 2-11). Earthen fill material for construction of embankments/berms at Tellico Dam would be collected from the borrow area locations shown in Figure 2-12.

Source: Aerial is provided by ArcMap World Imagery 2012

AECOM

Figure 2-11
Tellico Dam Proposed Action

Tennessee Valley Authority

Legend

Borrow Area

TVA Owned Land

N

0 5,000 10,000 20,000 Feet

Source: Aerial is provided by ArcMap World Imagery 2012

AECOM

Figure 2-12
Tellico Dam Proposed Action Borrow Area

Tennessee Valley Authority

Concrete floodwalls would be constructed for a 300-foot portion of T-1 and the entire T-2 segment; the remaining segments could be permanently modified by construction of either raised embankments or concrete floodwalls. The first segment (T-1) would begin at the intersection of Tellico Parkway and the Tellico Recreation Area access road, across the road from the end of the floodwalls extending south from Fort Loudoun Dam (Figure 2-11). Segment T-1 would likely run southwest for 300 feet along the downstream (west) side of the access road and then northwest/west along the Canal Saddle Dam for 1,900 feet to the Tellico Dam access road and main dam embankment for a total length of 2,200 feet. Under this alternative, the height of the 1,900-foot-long Canal Saddle Dam portion of Segment T-1 would be raised 4.8 feet with an embankment constructed from rolled impervious fill (Figure 2-13). The embankment would likely have a minimum of 2.5:1 slope and the existing walkway on the saddle dam would be rebuilt on top of the raised embankment. The east end of this raised embankment would tie into the 300-foot long concrete floodwall portion of T-1, which is adjacent to the recreation area access road.

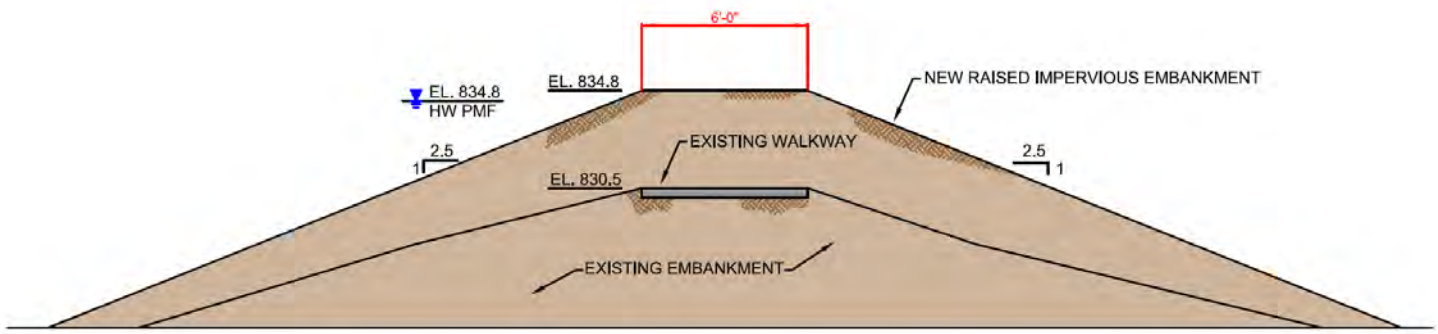

Figure 2-13. Tellico Dam – Raised Embankment Concept for Segment T-1 (Canal Saddle Dam)

The second Tellico Dam segment (T-2) is referred to as the Tellico Main Embankment and runs approximately 3,000 feet from the Tellico Dam Access Road and terminates at the first training wall of the concrete portion of the dam (Figure 2-11). A 4.8-foot-tall concrete floodwall would likely be constructed on the downstream (northwest) side of the main dam embankment and span the entire 3,000-foot length of the embankment under this alternative (Figure 2-14).

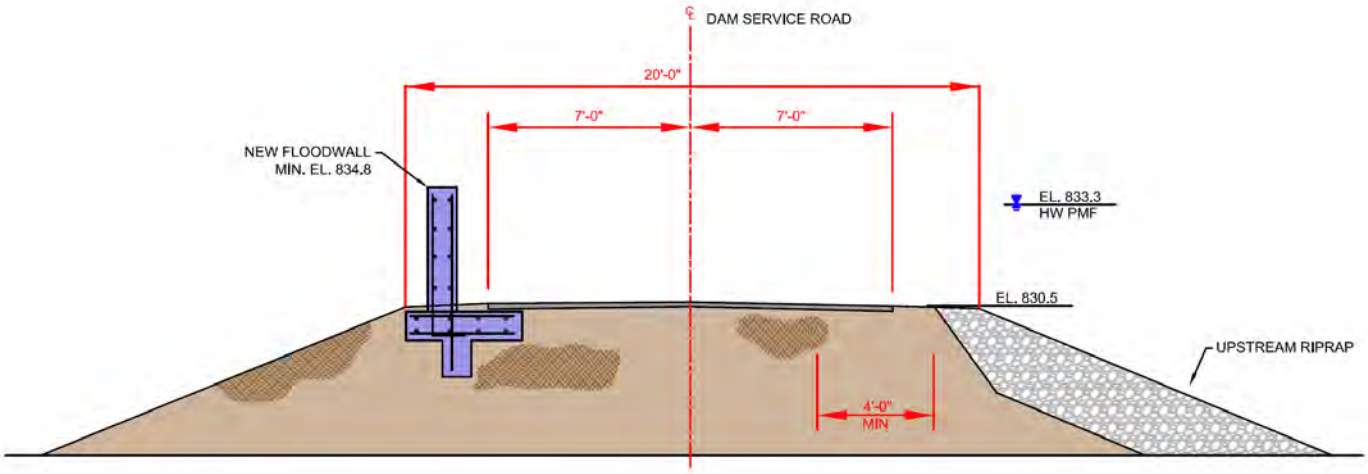

Figure 2-14. Tellico Dam – PMF Floodwall Concept for Segment T-2 (Main Embankment)

The third and fourth segments of Tellico Dam are referred to as Saddle Dam No. 2 (Segment T-3) and Saddle Dam No. 3 (Segment T-4). Proposed permanent modifications for these segments of flood protection would be a 525-foot-long raised earthen embankment or earthen berm at T-3 and a 300-foot-long raised earthen embankment or earthen berm at T-4 (Figures 2-15 and 2-16). These proposed embankments/berms would raise the current height of T-3 and T-4 by 4.8 feet.

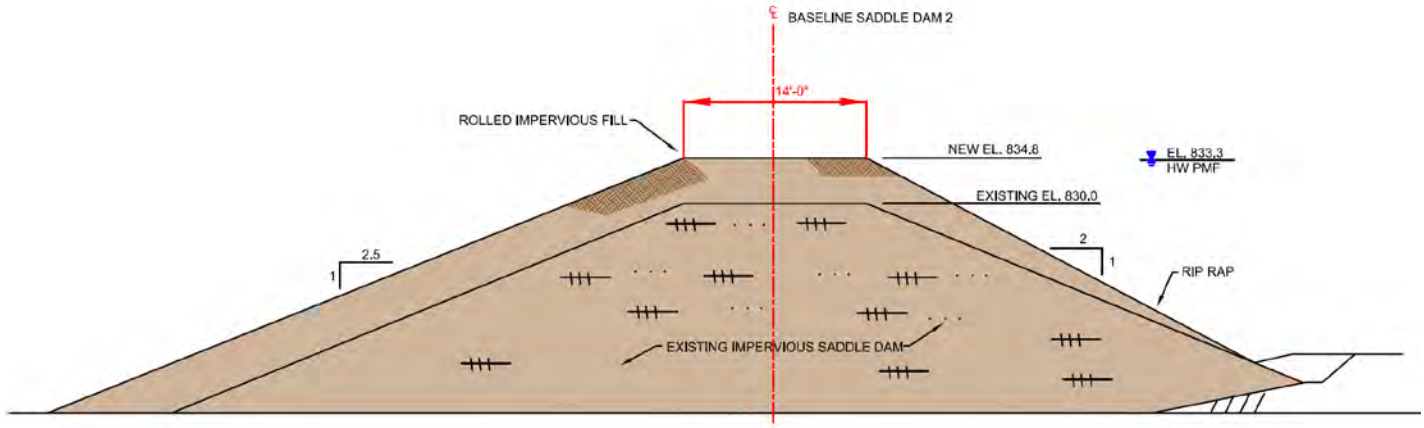

Figure 2-15. Tellico Dam – Raised Earthen *Embankment* Concept for Segments T-3 and T-4 (Saddle Dams No. 2 and No. 3)

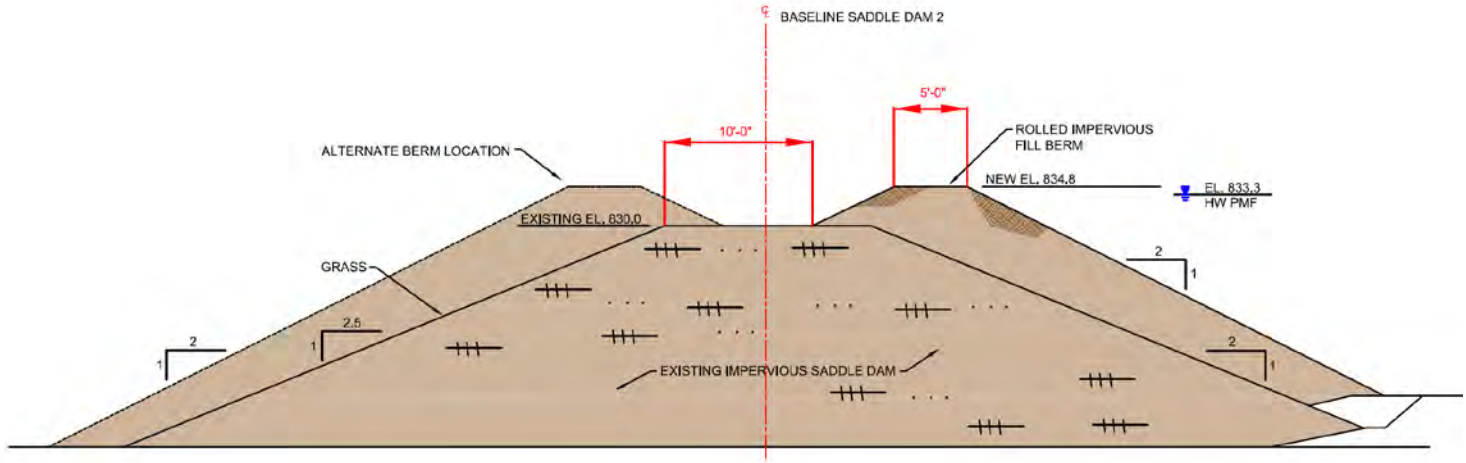

Figure 2-16. Tellico Dam – Raised Earthen *Berm* Concept for Segments T-3 and T-4 (Saddle Dams No. 2 and No. 3)

As previously discussed under Fort Loudoun Dam, a gap closure barrier would be required in order to provide continuous flood protection at the connection point between FTL-3 and Tellico Segment T-1 (intersection of Fort Loudoun and Tellico dams near the Tellico Recreation Area, Figures 2-7 and 2-11). Additionally, the connection point between Segments T-1 and T-2 at the intersection of the Tellico Dam Access Road would also require a gap closure barrier in order to provide continuous flood protection (Figure 2-11). As described above for Cherokee Dam, the exact barrier type is not known at this time; however, TVA has identified two potential barrier types: (1) Automatic floodgates, and (2) Removable floodwall systems.

Construction staging and borrow areas at Tellico Dam are illustrated in Figures 2-11 and 2-12, respectively. Construction of the Proposed Action would occur sequentially and is estimated to last up to two years. Approximately 8,150 yds^3 of fill material would be required for constructing the berms. Two potential existing borrow areas are located adjacent to State Route 95/U.S. Highway 321 northwest of Lenoir City (Figure 2-8). One of these is in the southeast quadrant of the State Route 95/U.S. Highway 321 - Interstate-40 interchange. The other is on the west side of State Route 95/U.S. Highway 321 about 0.5 miles south of Interstate-40. Approximately 1,990 yds^3 of concrete would be required for the floodwalls. Concrete would be delivered to the project area by truck from existing commercial concrete plants or produced at an onsite concrete batch plant serving both Fort Loudoun and Tellico dams. Potential concrete suppliers for Tellico Dam are listed in Table 2-1.

Watts Bar Dam

Under Alternative B, proposed permanent modifications at Watts Bar Dam would consist of raised earthen berms along the entire length of the four segments where HESCO barriers are currently installed (approximately 1,640 feet total; Figure 2-17). The new permanent berms would increase the total height of the existing embankments by 2.3 feet (Figure 2-18). Segment WB-1 begins at the northern end of the Watts Bar Recreation Area and runs for approximately 350 feet along the Recreation Area access road. Segments WB-2 (290 feet), WB-3 (470 feet), and WB-4 (530 feet) continue south along the access road until WB-4 ties into the east end abutment of the Watts Bar Highway Bridge (Figure 2-17).

The permanent concrete mat structure installed in the downstream embankment of Watts Bar Dam as part of temporary measures would remain in place.

Legend

- Gate Location
- Permanent Modification = Floodwall or Berm
- Borrow Area
- Staging Area
- Recreational Area
- TVA Owned Land

N

0 250 500 1,000 Feet

Source: Aerial is provided by ArcMap World Imagery 2012

AECOM

Figure 2-17
Watts Bar Dam Proposed Action

Tennessee Valley Authority

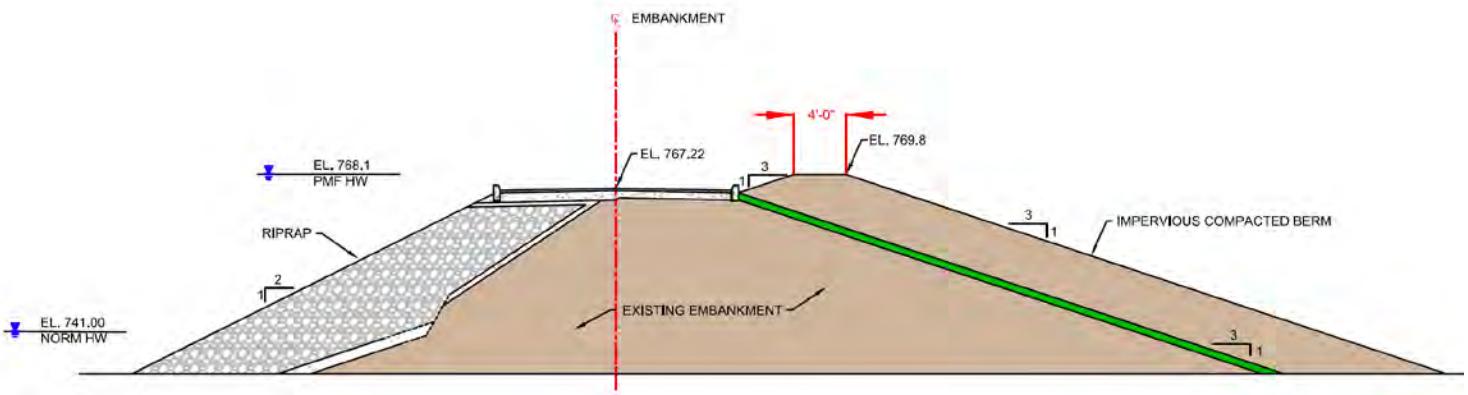

Figure 2-18. Watts Bar Dam – Raised Earthen Berm Concept for Segments WB-1 through WB-4

Three gap closure barriers would be required to provide continuous flood protection and maintain existing roadways under the permanent modifications at Watts Bar Dam. The first gap closure barrier structure would be located between segments WB-1 and WB-2, at the opening to an access road (Figure 2-17). The second gap closure barrier would connect Segments WB-2 and WB-3; this gap closure barrier is located at the only entrance to a parking lot that will be used as a construction staging area; therefore, this barrier is potentially unnecessary should TVA decide to permanently close off that parking lot following construction, when it is no longer needed for staging. The third gap closure barrier would be required to maintain Watts Bar Lane as the main roadway into the Watts Bar Dam Recreation Area. Specifically, this barrier would be located between Segments WB-3 and WB-4. As described above for Cherokee Dam, the exact barrier type is not known at this time; however, TVA has identified two potential barrier types: (1) Automatic floodgates, and (2) Removable floodwall systems.

Potential construction staging areas associated with the Watts Bar Dam portion of the project area include the two large parking lots in the recreation area adjacent to the proposed floodwalls and an area downstream of the dam adjacent to the lock channel (Figure 2-17). Approximately 12,750 yds^3 of earth fill material would be required for constructing the berms described above. Fill material would be obtained from a previously disturbed borrow area on TVA property about 0.3 mile north-northeast of the northern end of the proposed berms (Figure 2-17).

2.1.3. Alternative C – Permanent Modifications of Dam Structures: All Concrete Floodwalls

Under Action Alternative C, the HESCO barriers would be removed, and permanent dam modifications would be made to each of the four dam structures. The potential modifications would consist of all concrete floodwalls and gap closure barriers. The concrete would either be provided by commercial concrete suppliers (Table 2-1) or by onsite concrete batch plants at Cherokee and Fort Loudoun/Tellico Dams. The permanent concrete mat structure in the downstream embankment of Watts Bar Dam would remain in place. Under this alternative, the potential for failure due to overtopping of the dams during a PMF event would be prevented. This would ensure that the integrity of the downstream embankments would be maintained, thereby increasing the public safety of downstream residents and the safety of TVA's critical nuclear facilities.

Cherokee Dam

Under Alternative C, Cherokee Segments C-1 through C-5 would be permanently modified with concrete floodwalls as was described for Alternative B. However, the temporary measures at Cherokee Dam Segment C-6 (boat ramp parking area) would be permanently replaced with a concrete floodwall constructed to a height of approximately 6.6 feet on the downstream (north) side of the parking area driveway (Figure 2-19), instead of the raised berm that was proposed under Alternative B. This concrete floodwall would be built south of the Visitor's Building, likely along the west side of the parking lot located adjacent to the boat ramp parking area extending 600 feet terminating at elevation at the boat ramp access road (Figure 2-2). Under Alternative C, the actions associated with gap closure barriers, construction staging areas, borrow areas, post-tensioning, and installation of concrete armouring would be the same as described for Alternative B.

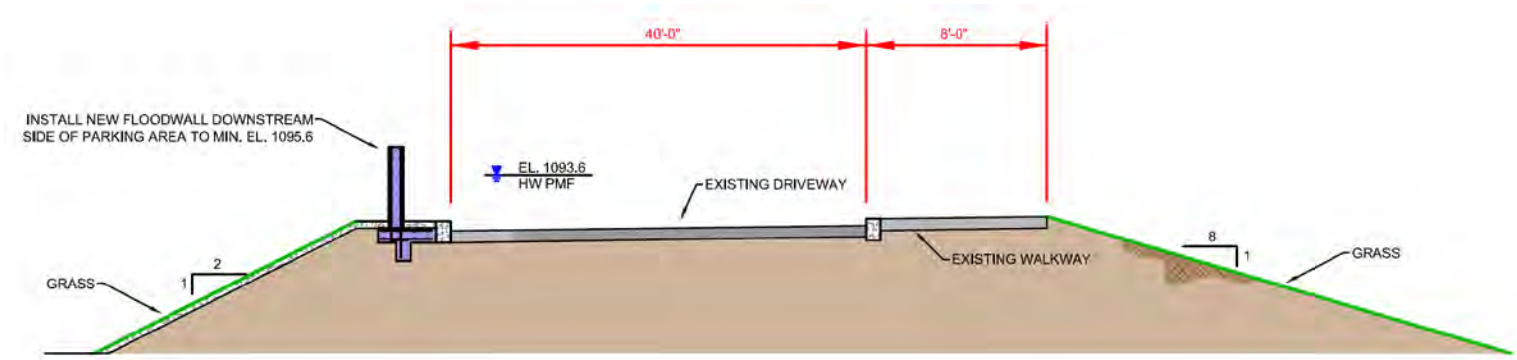

Figure 2-19. Cherokee Dam – PMF Floodwall Concept for Segment C-6 (Boat Ramp Parking Area)

Fort Loudoun Dam

Due to site and engineering constraints, the construction of one or more earthen berms instead of concrete floodwalls is not feasible at Fort Loudoun Dam; therefore, the actions proposed at Fort Loudoun Dam would be the same under Alternatives B and C.

Tellico Dam

Under Alternative C for Tellico Dam, four segments of concrete floodwalls built to a height of 4.8 feet would be installed and no raised embankments would be constructed. The first segment, T-1, would likely run southwest for 300 feet along the downstream (west) side of the access road and then northwest/west along the Canal Saddle Dam for 1,900 feet to the Tellico Dam access road and main dam embankment for a total concrete floodwall length of 2,200 feet (Figure 2-11). The permanent modification for Segment T-2 would remain a concrete floodwall as described under Alternative B. Under Alternative C, permanent modifications to Tellico Segments T-3 and T-4 (Saddle Dams No. 2 and No. 3) would consist of a 525-foot-long concrete floodwall for T-3 and a 300-foot concrete floodwall for T-4 (Figure 2-20). These floodwalls would likely be built on the downstream (west) side of the saddle dams and would be 4.8 feet in height. Under Alternative C, the actions associated with gap closure barriers,

construction staging areas, and borrow areas would be the same as described under Alternative B.

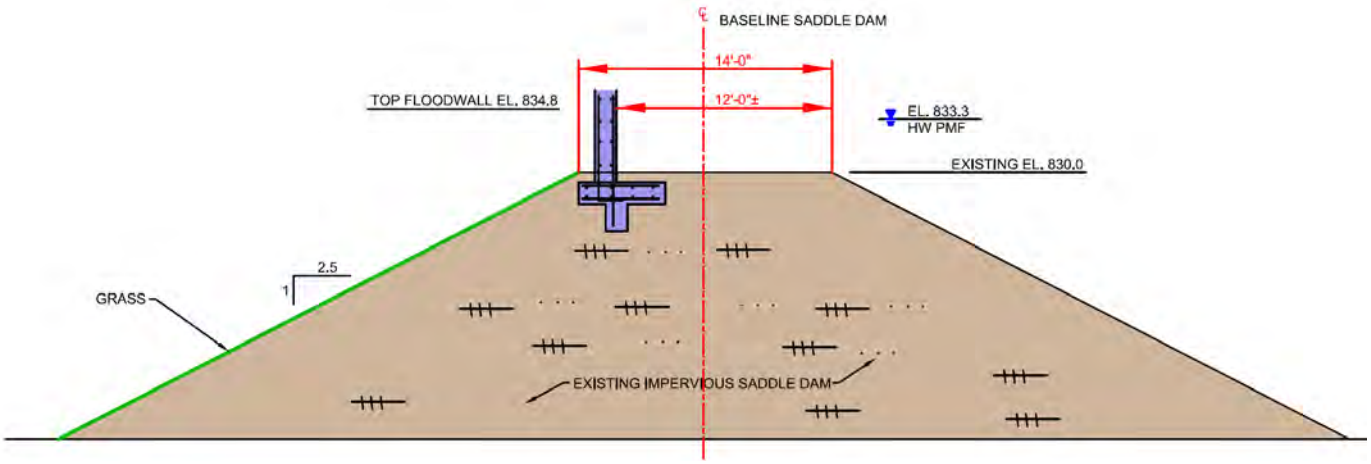

Figure 2-20. Tellico Dam – PMF Floodwall Concept for Segments T-3 and T-4 (Saddle Dams No. 2 and No. 3)

Watts Bar Dam

Under Alternative C, permanent modifications at Watts Bar Dam include four different wall segments (WB-1 through WB-4) varying in length from approximately 300 to 500 feet (Figure 2-17). Concrete floodwalls would be built 2.3 feet tall, likely on the east shoulder of the east embankment road tying into the south embankment of the dam and running north to the campground for a total length of approximately 1,600 feet (Figure 2-21). As opposed to Alternative B, under which the temporary measures at all four segments were permanently replaced by berms, Alternative C involves the replacement of temporary measures with concrete floodwalls at all four segments. Approximately 440 yds^3 of concrete would be required to construct the floodwalls. This concrete would be delivered by truck from existing commercial concrete plants. Information on potential concrete suppliers is provided in Table 2-1. All actions associated with gap closure barriers, construction staging areas, and borrow areas would be the same as described under Alternative B.

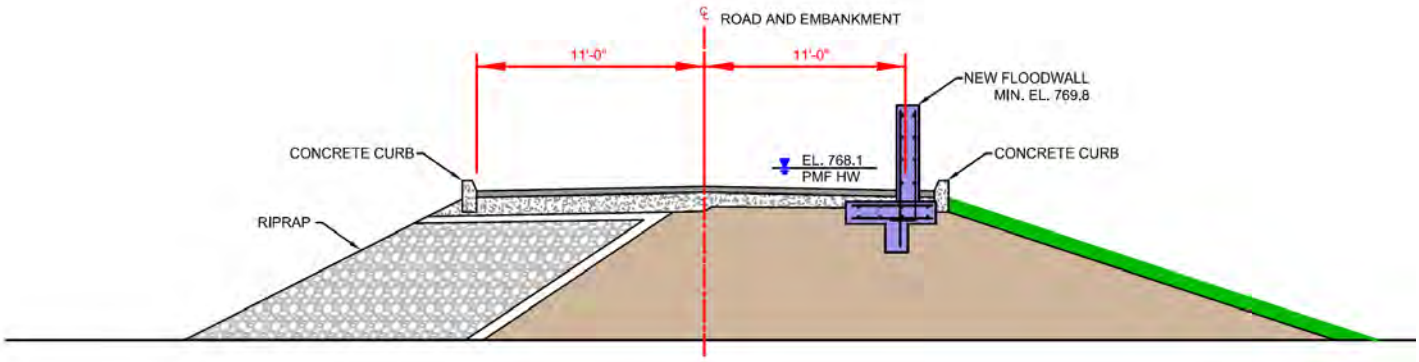

Figure 2-21. Watts Bar Dam – PMF Floodwall Concept for Segments WB-1 through WB-4

2.1.4. Alternatives Considered but Eliminated From Further Discussion

Several potential alternatives to minimize the potential for failure of Cherokee, Fort Loudoun, Tellico, and Watts Bar dams due to overtopping during the PMF, and which would prevent an increase in flooding at downstream locations including TVA's Watts Bar, Sequoyah, and Browns Ferry Nuclear Plants during the PMF, were evaluated and eliminated from further consideration. These potential alternatives are described below.

Increase Spillway Capacity

Various modifications to one or more of the dams to provide additional capacity for passing water during the PMF were considered. These modifications included:

- Lengthening the existing emergency spillway at Tellico Dam
- Constructing new emergency spillways at one or more dams
- Adding spillway gates at one or more dams
- Constructing fuse plugs[1] in earthen embankments at one or more dams.

All of these modifications would be major construction projects with the potential for adverse environmental impacts. While they would eliminate the potential overtopping and failure of the dams, they would allow more water to pass the dam during the PMF and increase flood elevations at downstream nuclear plants, as well as other downstream locations. Because they would not prevent an increase in flooding at downstream locations including TVA's nuclear plants, these approaches to increase spillway capacity do not meet the purpose and need of the project.

Change Reservoir Operations

TVA could conceivably revise its reservoir operations policy to provide additional storage that would prevent the potential overtopping and failure of the four dams during a PMF. This policy revision would require TVA to permanently lower the pool levels not only at these four projects, but at other projects upstream of Watts Bar Dam to provide the total additional flood storage necessary. This change would forego most of the multiple-purpose benefits currently provided by the dams and reservoirs. In addition, the policy would require higher discharge rates earlier in storm events, which would severely decrease TVA's ability to provide significant flood reduction in lesser events, such as the 10-, 50-, 100- and 500-year flood events. This would result in hundreds of millions of dollars of reduced flood control benefits as well as significantly alter designated floodplains below tributary dams.

TVA's current reservoir operating policy was adopted in 2004 following completion of the Reservoir Operations Study (ROS) and associated Final Programmatic EIS (TVA 2004). During the ROS, TVA conducted an initial screening of 65 policy alternatives for operating the reservoir system. These were screened, narrowed, and condensed to a final set of eight policy alternatives, which were comprehensively analyzed. Each of these "was required to be capable of adjusting the balance of operating objectives in response to expressed public values; continuing basic reservoir system benefits of flood control, navigation, and power production,

[1] A fuse plug is a collapsible section of a dam. During all but certain defined, extreme flood conditions, the dam would operate normally with floodwaters passing through the dam's spillway. During the defined extreme flood, the fuse plug section of the dam would wash out to pass floodwaters without further damage to the dam.

and being environmentally, economically, and technically feasible" (ROS Executive Summary, TVA 2004: page ES-6). The motivation for the ROS was largely from public pressure to raise pool levels on TVA reservoirs, and none of the policy alternatives considered in detail the lower pool levels and overall increases in flood storage capacity of the magnitude necessary to accommodate the PMF without modifying the dams. One of the early policy alternatives included lower pool levels and increases in flood storage capacity. Even though these changes would have been considerably less than those necessary to accommodate the PMF, TVA rejected this policy alternative because of its unacceptable impacts to other operating purposes. Since the recently completed ROS considered and rejected alternatives, which were much less restrictive than a policy designed solely to provide additional flood protection at critical dams and facilities, changing reservoir operations is not a reasonable alternative.

Armor Earthen Embankments

One way to allow water to safely pass through and over Fort Loudoun, Tellico, Watts Bar and Cherokee dams during a PMF without the subsequent failure of the dams would be to armor the earthen embankments at each dam. This would be done by placing concrete, riprap, or other material on the tops of the embankments to protect them from being eroded by floodwaters flowing over them. Although this alternative would prevent the potential failure of the dams, it would allow more water to be passed through and over the dams during the PMF which would increase flood elevations at downstream nuclear plants, as well as other downstream locations. Because they would not prevent an increase in flooding at downstream locations, including TVA's nuclear plants, this alternative does not meet the purpose and need of the project.

Floodproof Watts Bar, Sequoyah, and Browns Ferry Nuclear Plants

During the public scoping for this project, some respondents recommended that TVA consider the alternative of floodproofing the nuclear plants to protect them from increased PMF flood levels instead of modifying the dams. While the construction of walls or levees around the nuclear plants could protect them from flooding during a PMF, this alternative would not prevent the potential overtopping and failure of the four dams during the PMF.

Based on recent cost estimates, floodproofing the three nuclear plants could cost about $1 billion. This alternative would cost much more than the Action Alternatives, and would not meet the purpose and need of the project because it would not ensure that the dams could safely pass the PMF without failure.

Develop and Implement a Flood Emergency Preparedness Plan

During the public scoping for this project, some respondents recommended that TVA consider the alternative of developing and implementing a flood emergency preparedness plan to prevent damages and loss of life at the nuclear plants and other locations downstream of the four dams during a PMF. TVA already has notification procedures in place that are designed to alert TVA facilities and other agencies of potential flooding. In addition, TVA has developed Emergency Action Plans (EAPs) for all of the TVA dams that are provided to local emergency management agencies. These EAPs provide inundation mapping and other information related to a PMF, and are consistent with the Emergency Action Planning for Dam Owners (Federal Emergency Management Agency [FEMA] 64) provisions in Federal Guidelines for Dam Safety (Interagency Committee on Dam Safety 2004).

While this alternative could reduce some downstream flood damages, it would not significantly reduce the potential for overtopping and failure of the four dams or prevent an increase in flooding at downstream locations, including TVA's nuclear plants during a PMF. Therefore, this alternative would not be consistent with the Federal Guidelines for Dam Safety or the Nuclear Licensing agreements for TVA's operating nuclear plants. This alternative would not meet the purpose and need of the project.

Remove the HESCO Barriers and Return the Dams to Pre-Modification Conditions

Some comments during the public scoping for this project stated that TVA should remove the HESCO barriers and return the dams to their pre-modification conditions. This alternative would not minimize the potential for overtopping and failure of the dams or prevent an increase in flooding at downstream locations, including TVA's nuclear plants during a PMF. It would also be inconsistent with the Federal Guidelines for Dam Safety (Interagency Committee on Dam Safety 2004) and the Nuclear Licensing agreements for TVA's operating nuclear plants. This alternative would not meet the purpose and need of the project.

Construct Removable or Hidden Floodwalls

In response to comments received during public scoping, TVA considered constructing removable or hideaway floodwalls that would be deployed when a PMF were to occur. Floodwalls of this type include:

1. Pop-up barriers that are installed along the embankment roadways or access roads and deployed by the force of water moving into the barrier chamber.
2. A wall system consisting of support anchors and bases pre-installed in the embankments with the wall columns and wall planks stored at the dams. In a flood, personnel would be required to install the columns and walls.
3. Inflatable air or water bladders.

These floodwall systems have all been tested and shown to be effective in providing flood protection. However, there are several potential problems in their deployment at the four dams. In the event of a PMF, there would likely be a limited time period between identification of the potential for floodwaters to overtop the dams and when the overtopping would occur. This time period could be inadequate for deploying the floodwalls, given that the shortest total length of deployable floodwalls at one of the dams is 1,100 feet and both Cherokee and Tellico dams would have over a mile of floodwalls. Transporting work crews to the dams would be logistically difficult and once on site, personnel would be working under extreme weather conditions in confined working environments on top of the embankments. Optimal deployment of such systems would more than likely require collaboration with local National Guard units.

Additionally, the cost of installing removable or hidden floodwalls would be substantially greater than Alternatives B and C. The costs of the wall column and plank system described above range from $360,000 for a 100-foot long by 3-foot tall wall to $720,000 for a 100-foot long by 7-foot tall wall as required at Fort Loudoun. These costs do not include installation. For these reasons, removable or hidden floodwalls have been eliminated from further consideration.

Construct Interlocking Block Floodwalls

This potential alternative consists of the construction of floodwalls in the locations described for Alternative B using interlocking solid concrete blocks such as those often used for constructing retaining walls. Although these blocks have previously been used for floodwalls, this is not a common practice and is a relatively untested application of the blocks. Additionally, there are construction and maintenance concerns regarding the joints between the blocks. Mortar would need to be placed between the joints along the full length of the wall to create the watertight barrier. These joints would need periodic inspection and maintenance. For these reasons, this potential alternative was eliminated from further consideration.

2.2. Comparison of Alternatives

Table ES-1 provides a comparison of impacts associated with the No Action Alternative and the action alternatives, Alternative B and Alternative C.

2.3. Identification of Mitigation Measures

The Proposed Action would not result in significant impacts to any resource that would require mitigation; therefore, no required mitigation measures have been identified at this time. However, best management practices (BMPs) and probable mitigation activities are identified and discussed in the appropriate resource area discussions.

2.4. The Preferred Alternative

TVA has identified Alternative B – Permanent Modifications of Dam Structures: *Combination of Concrete Floodwalls and Earthen Embankments* as the Preferred Alternative. This alternative would result in less impact to recreation and other visitor use at Cherokee and Tellico dams and less visual impact at Cherokee, Tellico, and Watts Bar dams than would Alternative C – Permanent Modifications of Dam Structures: *All Concrete Floodwalls*. Construction cost evaluations conducted to date show relatively little difference in Alternatives B and C.