SECTION 2

PROPOSED ACTION AND ALTERNATIVES

2.1 OVERVIEW

This section describes the No Action Alternative (Alternative A) and two action alternatives (Alternatives B and C) that the NPS is considering to meet the project objectives. Alternatives considered early in the planning process, but later dismissed from further study because they were not realistically feasible or did not adequately meet the project purpose and need, are also described.

The descriptions of alternatives are based on preliminary designs and information available at the time of this writing. Specific distances, areas, and layouts used to describe the alternatives are estimated based on good engineering practice and may change during the actual design. If changes during any approved design are not consistent with the intent and effects of the selected alternative, additional compliance may be required prior to project implementation to ensure that NEPA guidelines are met. In addition to describing a range of alternatives, this section provides a description of the resource protection measures that have been incorporated into the project to reduce or avoid adverse environmental effects.

2.2 ALTERNATIVE A – NO ACTION – CONTINUE CURRENT MAINTENANCE

Alternative A (No Action) is defined as a continuation of current maintenance of the Catoctin Aqueduct. The No Action Alternative provides a basis for comparing the management direction and environmental consequences of the action alternatives. Should the No Action Alternative be selected for implementation, the NPS would respond to future needs and conditions associated with the Catoctin Aqueduct without major actions or changes from the present course.

The Catoctin Aqueduct ruins, canal prism, towpath, and Bailey bridge crossing Catoctin Creek would remain unaltered in form and function under Alternative A (Figures 2-1 and 2-2). The NPS would continue to inspect the aqueduct ruins and conduct routine maintenance. The remaining east arch, piers, and wing walls would continue to be susceptible to further deterioration and collapse. The Bailey bridge would continue to be inspected and maintained to provide a safe crossing at Catoctin Creek. The abutments of the pedestrian bridge immediately upstream of the aqueduct would not be removed or altered. Public access to and use of the area would continue to be available year round, excluding periods when flooding or other conditions make continued use unsafe or impractical.

2.3 ALTERNATIVE B – STONE MASONRY ARCHES

Alternative B would involve restoring the Catoctin Aqueduct by re-constructing the center and west arches using ring and barrel arch-stones of appropriate size and appearance in a manner similar to the original construction (Figure 2-3). The original elliptical shape of the center arch has an inherent structural weakness. This structural weakness would be rectified by installing an internal, reinforced concrete saddle over both arches. Construction of the saddle would increase the height of the aqueduct prism by one foot and would result in a one-foot reduction in the height of the towpath and berm, as measured from the top of the prism (Figure 2-4). The spandrel walls would be constructed with stone masonry 12 to 18 inches thick, similar to the historic size and appearance. Stone salvaged from the original structure would be used in the restoration to the maximum extent possible. As discussed in Appendix A, most of the stone recovered is from the downstream face of the aqueduct. Upon positive approval of the proposed project's compliance, restoration work could begin in summer of 2008 and be completed by summer 2009. Elements of the proposed action that would be the same under Alternatives B and C are described below in Section 2.5.

2.4 ALTERNATIVE C – REINFORCED CONCRETE ARCHES (PREFERRED ALTERNATIVE)

The Preferred Alternative, Alternative C, would involve restoring the center and west arches of the Catoctin Aqueduct by constructing self-supporting, reinforced concrete arches in the original shape (Figure 2-3). The concrete saddle required in Alternative B would not be

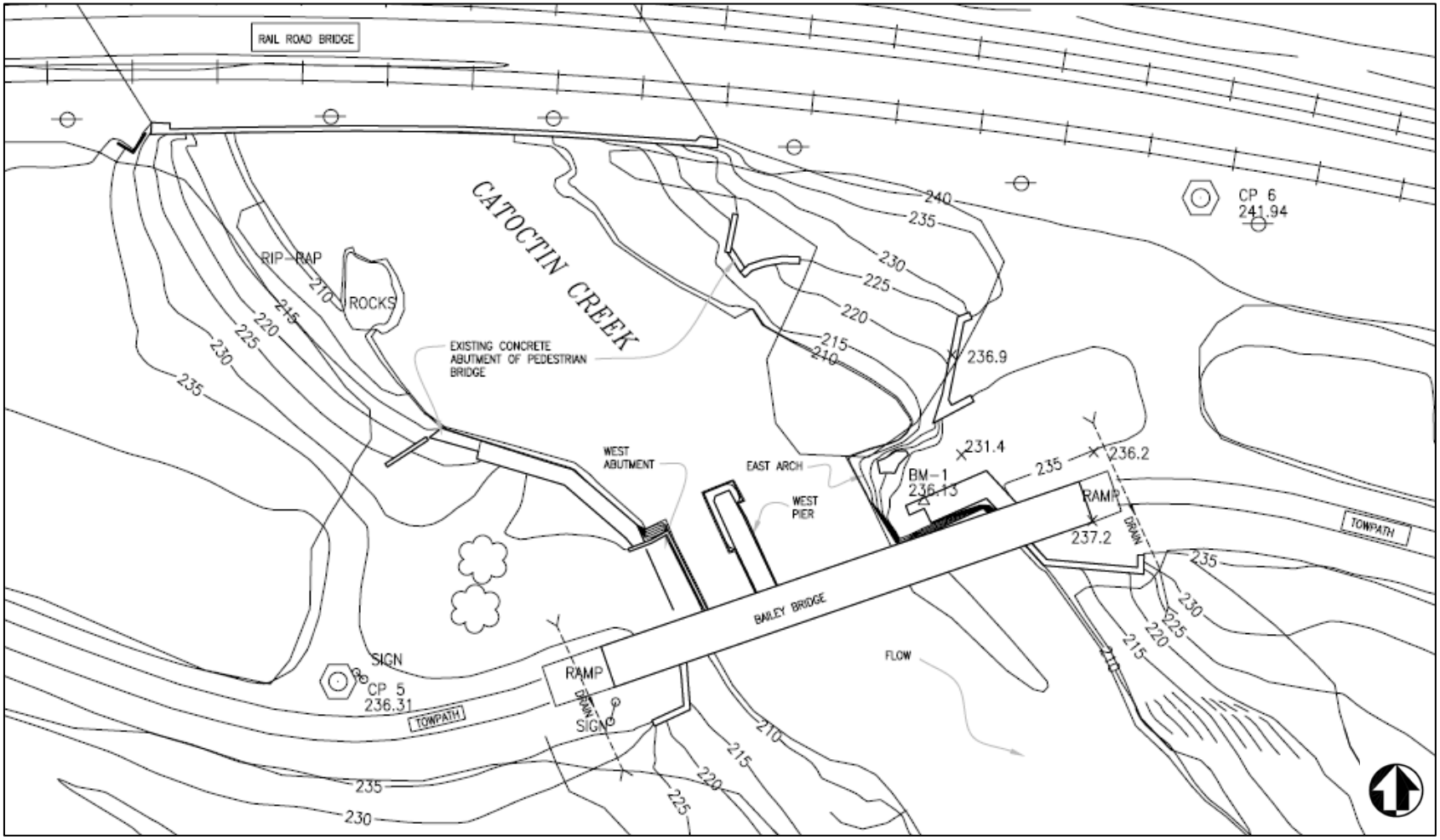

FIGURE 2-1
SITE PLAN OF EXISTING CONDITIONS AT CATOCTIN AQUEDUCT
(Drawing Source: McMullan & Associates)

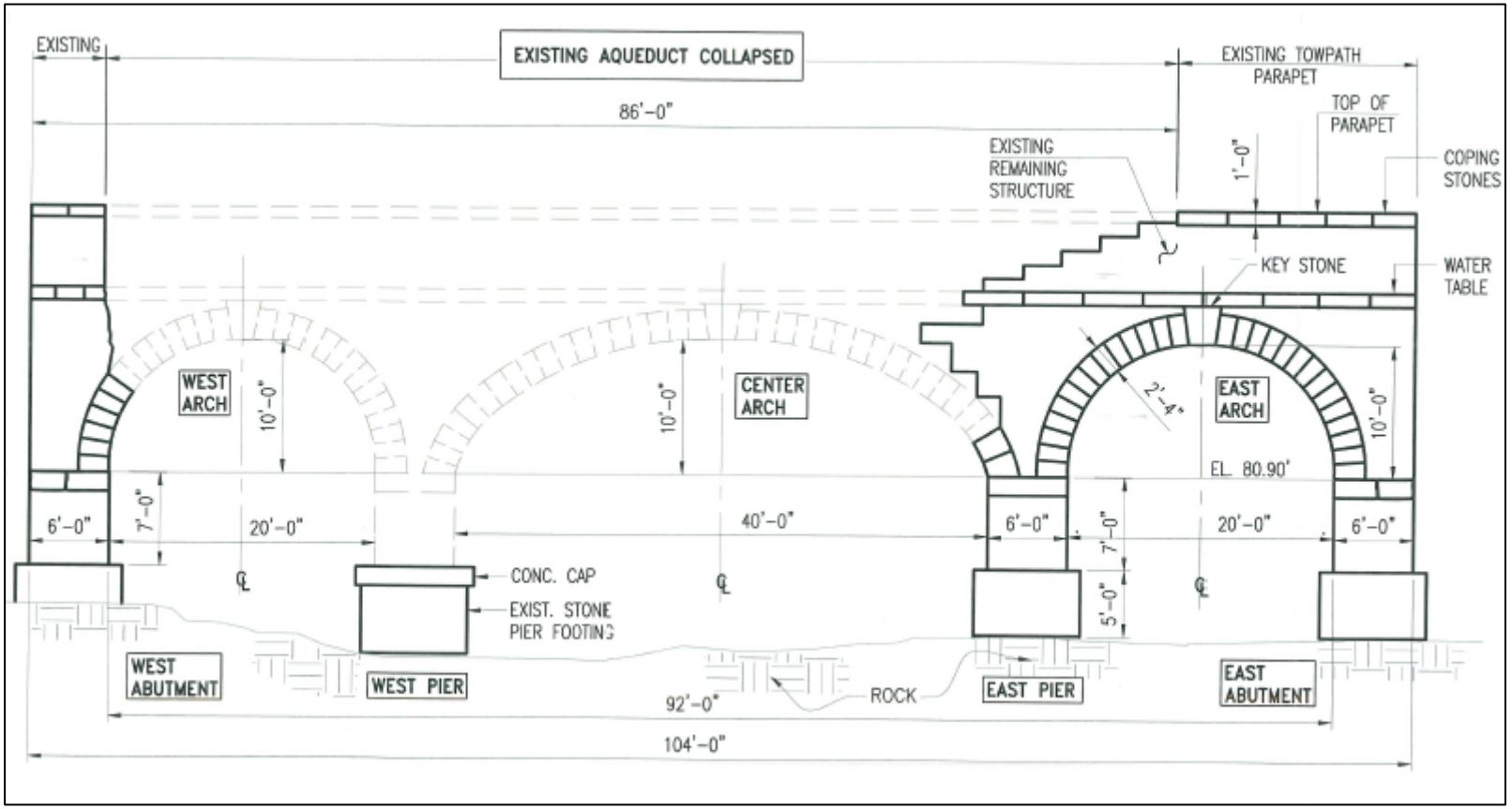

FIGURE 2-2
EXISTING SOUTH ELEVATION OF CATOCTIN AQUEDUCT
(Drawing Source: McMullan & Associates)

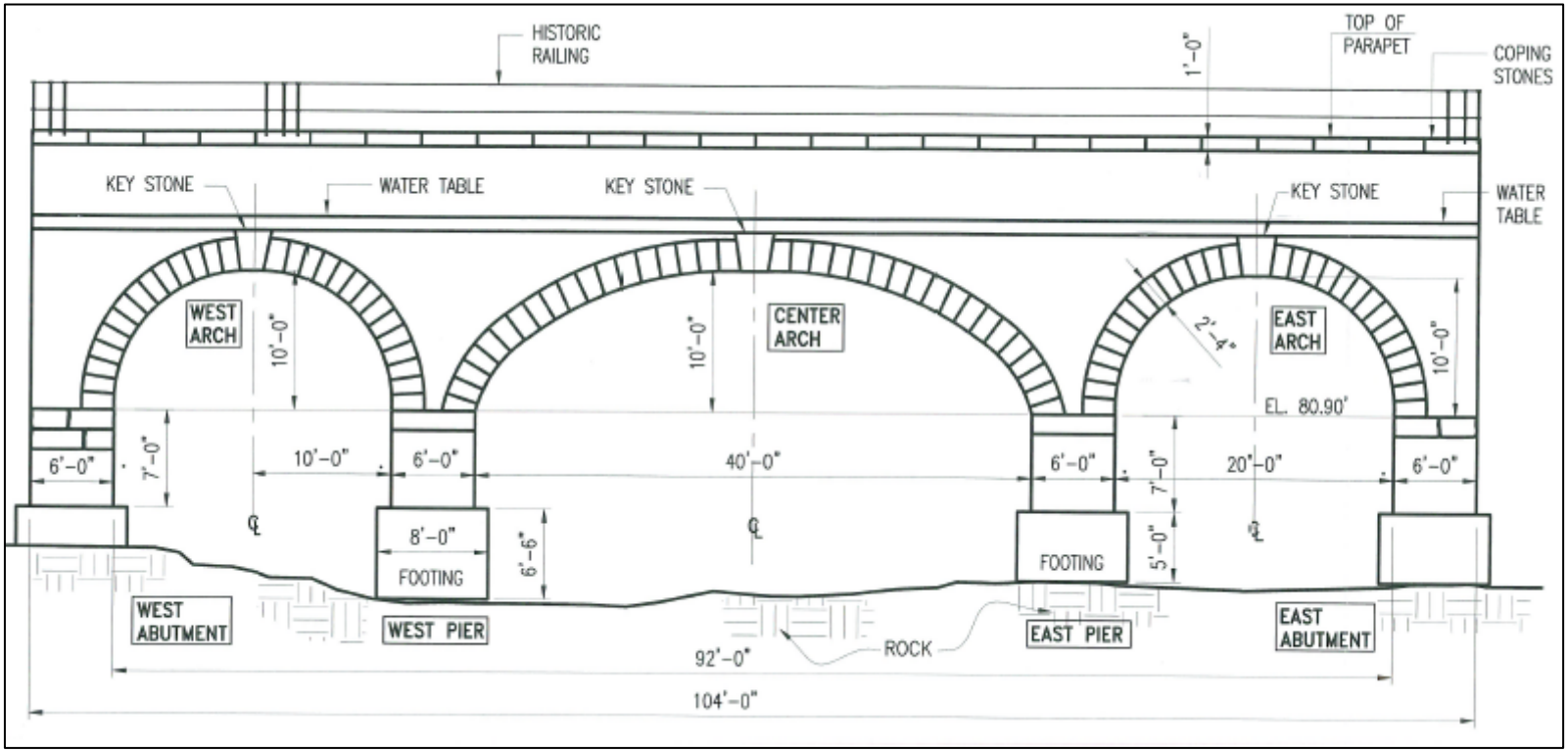

FIGURE 2-3
PROPOSED SOUTH ELEVATION FOR CATOCTIN AQUEDUCT – ALTERNATIVES B AND C
(Drawing Source: McMullan & Associates)

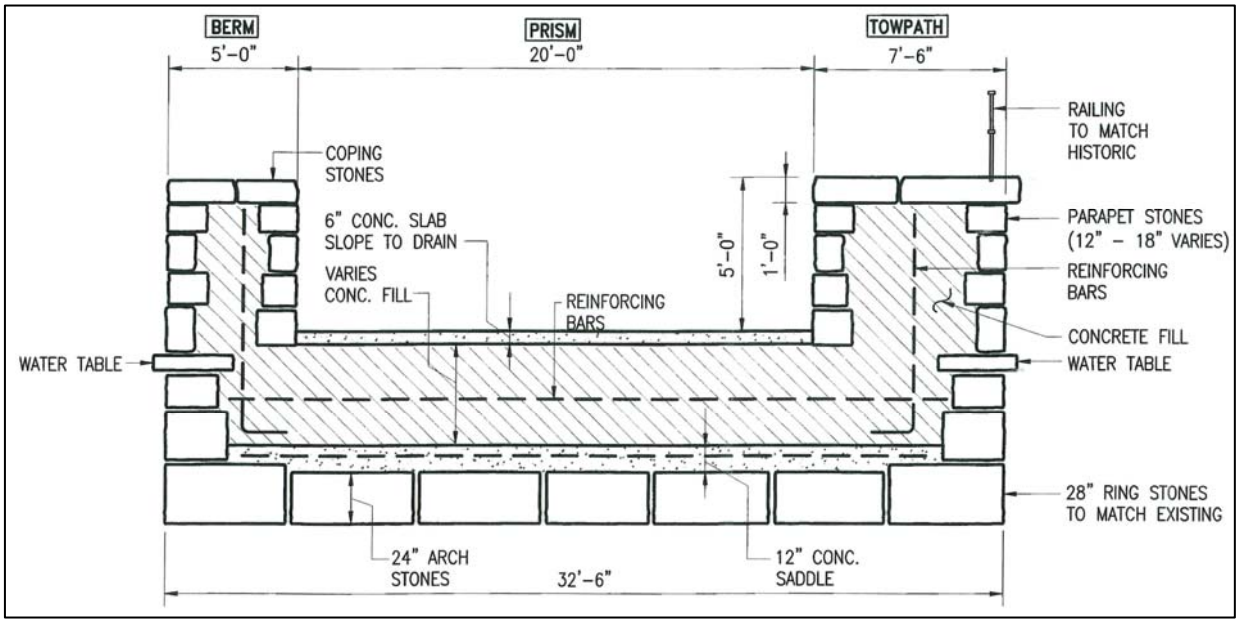

FIGURE 2-4
PROPOSED CROSS SECTION FOR CATOCTIN AQUEDUCT ALTERNATIVE B
(Drawing Source: McMullan & Associates)

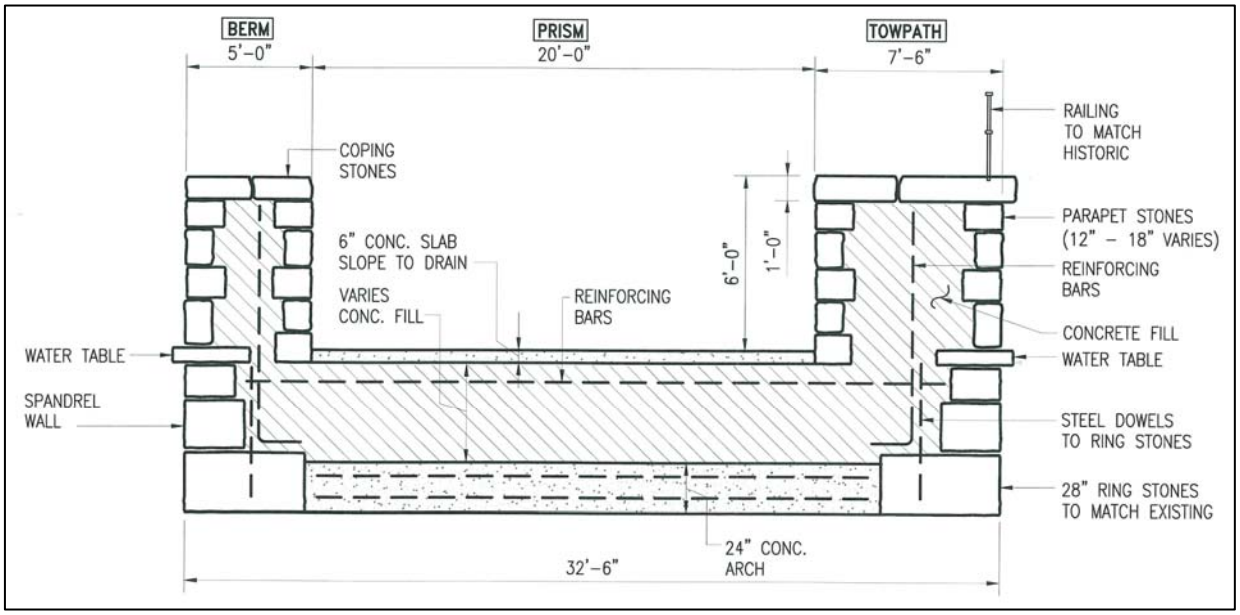

FIGURE 2-5
PROPOSED CROSS SECTION FOR CATOCTIN AQUEDUCT ALTERNATIVE C
(Drawing Source: McMullan & Associates)

necessary under Alternative C and the height of the aqueduct prism would not be altered from its original design (Figure 2-5). Therefore, the aqueduct would be restored in elevation to its original configuration. The concrete arches would be faced on the north and south sides with ring stones matching the extant span. The concrete undersides of the arches would not be faced in stone, but would be textured with a form-liner and stained to provide visual compatibility. From a distance, the undersides of the arches would have the general appearance of stone, but the concrete would be readily recognizable up close. The treatments applied to the undersides of the concrete arches are not intended to mimic stone work. The concrete core would be designed to carry the stone masonry spandrels, parapets, and prism walls. This would require both new and reused voussoir stones to be cut to a consistent depth of 12 inches to accommodate the structural cast in place concrete core arch. Stone salvaged from the original structure would be used in the restoration to the maximum extent possible. As discussed in Appendix A, most of the stone recovered is from the downstream face of the aqueduct. Upon positive approval of the proposed project's compliance, restoration work could begin in summer of 2008 and be completed by summer 2009, but the restoration period would be shorter than Alternative B because less stone masonry work would be required under Alternative C. Elements of the proposed action that would be the same under Alternatives B and C are discussed below in Section 2.5.

2.5 ELEMENTS COMMON TO ALTERNATIVES B AND C

As discussed above, the primary difference between Alternatives B and C would be the materials and methods used for arch construction. The project area (Figure 2-6) and site plan (Figures 2-7 and 2-8) would be the same. Under both alternatives the Catoctin Aqueduct would be restored in accordance with *The Secretary of the Interior's Standards for the Treatment of Historic Properties*. Appendix A provides additional details regarding the proposed restoration method for Alternative C (Preferred Alternative). Elements of the proposed action that would be the same for Alternatives B and C are described below:

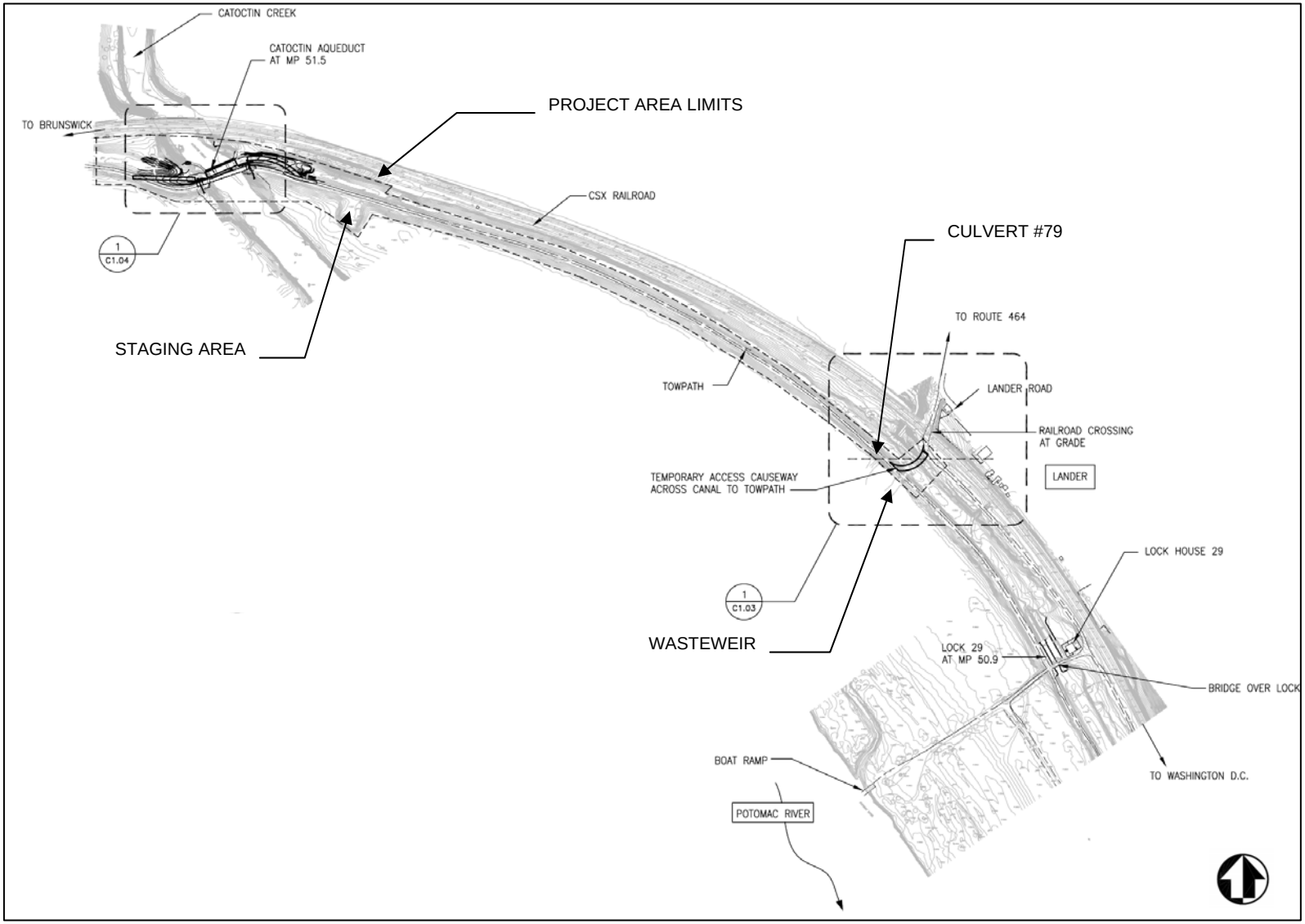

FIGURE 2-6
CATOCTIN AQUEDUCT PROJECT AREA
(Drawing Sources: McMullan & Associates)

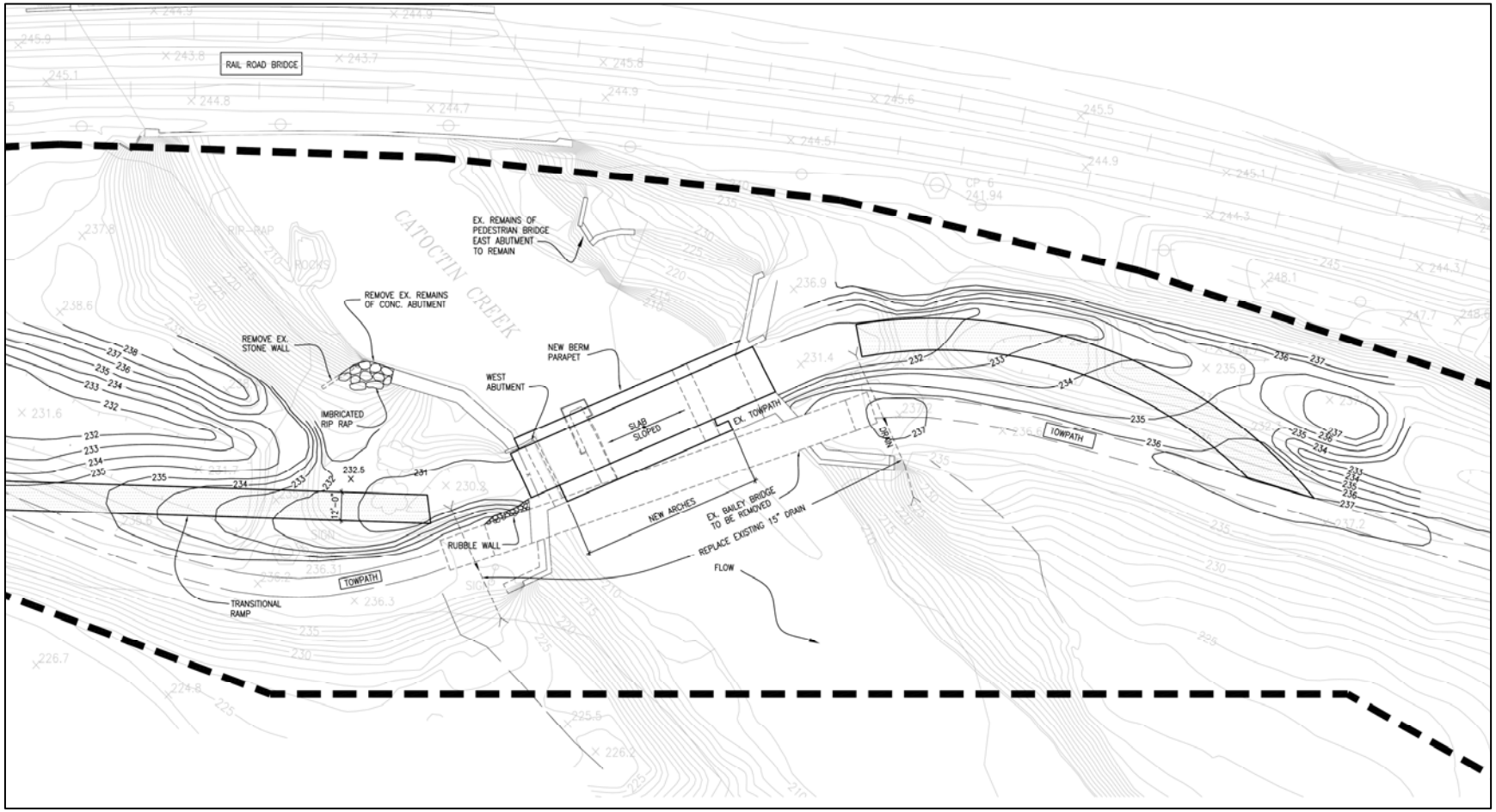

FIGURE 2-7
PROPOSED SITE PLAN AT CATOCTIN AQUEDUCT ALTERNATIVES B AND C
(Drawing Source: McMullan & Associates)

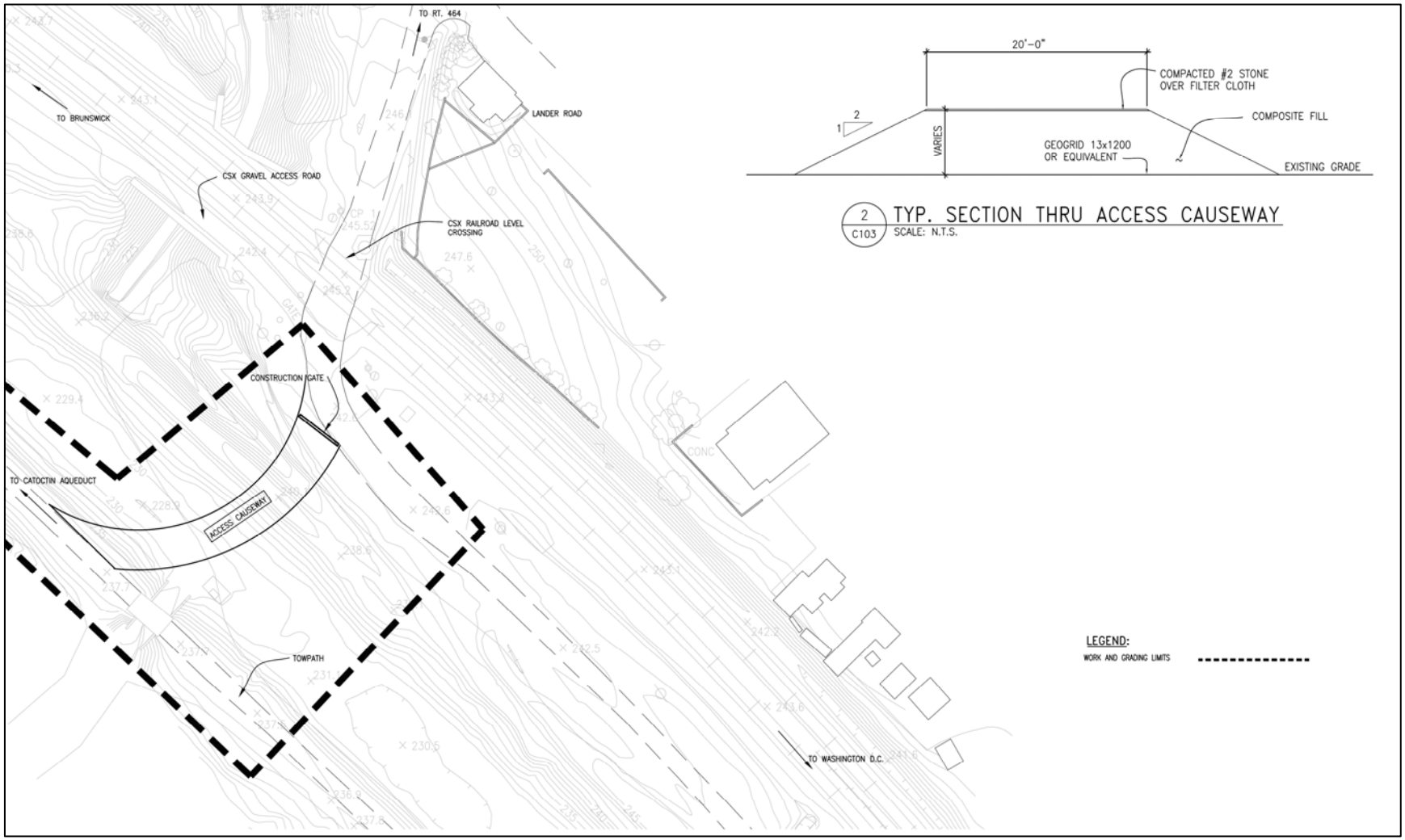

FIGURE 2-8
PROPOSED SITE PLAN AT ACCESS CAUSEWAY AND TYPICAL CROSS SECTION
(Drawing Source: McMullan & Associates)

- Stone salvaged from the original structure would be used in the restoration to the maximum extent possible. As discussed in Appendix A, most of the stone recovered is from the downstream face of the aqueduct. If necessary, additional stones that match the existing stones would be acquired from an appropriate source. Any unused original stone would continue to be protected at the Catoctin Aqueduct site and managed in accordance with Sections 106 and 110 of the National Historic Preservation Act. Unused stones would be stacked in an area southeast of the aqueduct and covered with a layer of dirt. An inventory of all unused stones would be maintained by NPS.

- The aqueduct's severely deteriorated west pier and footing would be removed and reconstructed. Scour under and around the existing aqueduct abutments and piers would be repaired. Instream work would be accomplished using "in-the-dry" (using cofferdam or other water diversion methods) and/or "in-the-wet" (underwater placement of concrete or other materials) construction methods, as determined during the design process. All instream work would be conducted in accordance with Maryland Department of the Environment and U.S. Army Corps of Engineers permit conditions and *Maryland's Waterway Construction Guidelines* (MDE 2000). Work in Catoctin Creek would be conducted from a small barge.

- The aqueduct berm and towpath parapets would be rebuilt and topped with original coping stones, many of which are available. Matching replacement stones would be used if original stones are not available. Other remaining portions of the structure (east arch and wing walls) would be repaired, stabilized, and restored, as needed.

- A railing compatible with the appearance of the original railing would be installed along the aqueduct's towpath. Where appropriate, portions of the original wrought iron railing would be incorporated into the work. The railing would meet required safety codes and the center section (approximately 100 feet) would be removable to avoid damage during flooding.

- The existing Bailey bridge would be removed (Figure 2-7) and its components salvaged. The Bailey bridge's concrete abutments would be removed, if necessary to achieve required grade.

- The towpath would be returned to its original alignment with the aqueduct's towpath following removal of the Bailey bridge. Permanent transitional ramps would be constructed from the towpath to the canal/aqueduct prism (Figure 2-7) to allow maintenance/emergency vehicles, equestrians, and bicyclists to cross Catoctin Creek via the aqueduct prism following restoration and removal of the Bailey bridge. These ramps would be similar to the ramps at many other aqueducts in the park. Signs would be posted requiring bicyclists to dismount and walk their bikes across, if they choose to stay on the towpath. The ramps would be constructed of compacted fill and topped with gravel, similar to the existing towpath. The side slopes would be planted in grass for stabilization and maintained through mowing.

- The pedestrian bridge abutment and associated stone wall on the west bank of Catoctin Creek (Figure 2-7) would be removed. Imbricated rip-rap would be installed in this area (approximately 200 square feet) to stabilize the creek bank. Imbricated rip-rap consists of large, two to three foot-long boulders, which are generally flat or rectangular in shape, arranged like building blocks to stabilize steep banks.

- The pedestrian bridge abutment on the east bank of Catoctin Creek (Figure 2-7) would remain in place and minor improvements would be made so it can serve as a viewing platform for the restored aqueduct. Improvements would include installing safety rails, clearing exiting shrubby vegetation, and topping the existing dirt access trail with gravel similar to the towpath.

- A temporary equipment access road would be established from Lander Road to the towpath at Milepost 51.07 (Figures 2-6 and 2-8). This road would include a temporary causeway through the dry canal prism, immediately north of the wasteweir and immediately south of culvert #79. After crossing the causeway, equipment would access the aqueduct area via the towpath. The causeway would be constructed with composite fill and compacted gravel over a geogrid, which helps to disperse weight and minimize impacts to underlying soils. The access road and causeway would be removed and the area restored upon completion of the project. Resource protection measures outlined in Table 2.1 would be followed.

- A second temporary equipment access road would be established from the towpath to the east bank of Catoctin Creek (Figure 2-7) using gravel over a

geogrid. This access road would be used to transport a barge and associated equipment to Catoctin Creek to accomplish required instream work. The gravel and geogrid would be removed and the area restored upon completion of the project. Resource protection measures outlined in Table 2.1 would be followed.

- Temporary equipment and material staging areas would be established in previously disturbed areas, including a flat area southeast of the aqueduct (Figure 2-6), edges of the towpath, and grassy areas on both sides of the aqueduct.

- Selective vegetation clearing would be necessary to construct the permanent transitional ramps and temporary access roads, and vegetation in other work areas would be disturbed. The limits of vegetation disturbance/clearing would be established by NPS staff prior to construction. These limits would be clearly noted on construction documents and marked in the field by NPS staff. Trees to be retained within the disturbance/clearing limits would be marked and NPS, National Capital Region *Guidelines for Tree Preservation* (NPS 2004) would be followed. Large trees would be retained to the maximum extent possible (Table 2.1). The total area of vegetation disturbed/cleared would be approximately 1.5 acres (see Table 4.2). This would include tree clearing within the canal prism east and west of the aqueduct to accommodate construction of the transitional ramps and to help restore the cultural landscape. Areas cleared within the canal prism would be planted in grass and maintained through mowing to allow visitors to see the canal prism and aid in interpretation of the "crooked aqueduct." All cleared woody vegetation would be chipped and used as mulch within the park or disposed of accordingly, in accordance with plans established by NPS staff prior to removal.

2.6 RESOURCE PROTECTION MEASURES

Resource protection measures that would be used to prevent or minimize potential adverse effects associated with the project are summarized in Table 2.1. These measures would be incorporated into the project construction documents and plans. The impact analyses in the environmental consequences section were performed assuming that these resource protection measures would be implemented under Alternatives B and C.

TABLE 2.1 RESOURCE PROTECTION MEASURES FOR ALTERNATIVES B AND C

Impact Topics and Resource Protection Measures
Soils, Surface Water, Floodplains, Wetlands, and Aquatic Life • An erosion and sediment control plan would be prepared and implemented in accordance with *Maryland Erosion and Sediment Control Guidelines for State and Federal Projects* (MDE 2004a). The plan would include resource protection measures that conform to *Maryland Standards and Specifications for Erosion and Sediment Control* (MDE 1994) and would be submitted to the Maryland Department of the Environment, Water Management Administration for approval. Coverage under Maryland's *General Permit for Construction Activity* would be obtained by submitting a Notice of Intent to the Maryland Department of the Environment. • A geogrid base would be used for temporary access roads and staging areas to minimize soil disturbance and compaction. These areas would be restored with native plants upon completion of project. • A *Joint Federal/State Application for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland* would be submitted and applicable permits obtained from the Maryland Department of the Environment and U.S. Army Corps of Engineers prior to initiating work. All regulated activities within waters of the U.S. and waters of the State, including the 100-year floodplain and jurisdictional wetlands, would be conducted in accordance with permit conditions and *Maryland's Waterway Construction Guidelines* (MDE 2000). • Turbidity curtains, anti-washout admixture, and appropriate pumping rates would be used during underwater placement of cement grout or concrete to maintain instream pH levels below 8.5. • All fuel storage, equipment refueling, and equipment maintenance would be accomplished in designated areas with secondary containment in accordance with NPS-approved procedures to avoid incidental spills. The contractor would be required to have contingency procedures in place to respond to incidental spills in accordance with federal, state, and local regulations and NPS policy. The contractor would remove all equipment and fuel from the area, as directed by NPS staff, if conditions indicate that flooding might occur. Contractor will be responsible for submitting a Spill Response Plan to address the above listed requirements. **Vegetation** • The limits of vegetation disturbance/clearing would be established by NPS staff prior to construction. These limits would be clearly noted on construction documents and marked in the field by NPS staff. Trees to be retained within the disturbance/clearing limits would be marked and NPS, National Capital Region *Guidelines for Tree Preservation* (NPS 2004) would be followed. Large trees would be retained to the maximum extent possible. • All cleared woody vegetation would be chipped and used as mulch within the park or disposed of accordingly, in accordance with

Impact Topics and Resource Protection Measures
plans established by NPS staff prior to removal. • Areas temporarily disturbed during construction (e.g., work areas, access roads, staging areas) would be restored using native plants in accordance with NPS, National Capital Region *Revegetation/Reclamation Guidelines* (NPS 2001), and C&O Canal NHP native plant listings.
Wildlife • The limits of vegetation clearing would be clearly noted on construction documents and marked in the field by NPS staff to minimize disturbance and alteration of wildlife habitat. • Vegetation clearing would be conducted outside the breeding season for migratory birds (typically April through August) and/or no occupied bird nests would be removed to ensure compliance with the Migratory Bird Treaty Act.
Rare, Threatened, and Endangered Species • Areas supporting rare plants identified by the Maryland Department of Natural Resources during 2007 surveys would be avoided. Protective fencing and erosion control devices would be installed around occupied rare plant habitats identified in the immediate vicinity of the project site. • The protection measures listed above for other resources would also serve to protect rare species.
Archeological Resources • If previously unidentified archeological resources or human remains were discovered, work would be stopped in the area of discovery, protective measures would be implemented, and procedures outlined in 36 CFR 800 would be followed. • A geogrid base would be used for temporary access roads and staging areas to minimize soil disturbance and compaction, and to protect any previously unidentified archeological resources. • Work crews would be educated in the importance of archeological resources and cautioned regarding the illegality of collecting resources in the park.
Cultural Landscape and Architectural Resources • The Catoctin Aqueduct would be restored in accordance with *The Secretary of the Interior's Standards for the Treatment of Historic Properties*. • Potential impacts to the towpath and Culvert #79 would be avoided and minimize by placing and compacting gravel on the towpath's surface prior to access; enforcing established weight restrictions (12 tons); escorting heavy equipment and limiting speeds to 10 miles per hour; and restoring the towpath's surface following construction. Access by equipment exceeding the 12

TABLE 2.1 RESOURCE PROTECTION MEASURES FOR ALTERNATIVES B AND C

Impact Topics and Resource Protection Measures
ton limit would be evaluated on a case-by-case basis by the park engineer and protective steel plates would be placed over Culvert #79, as needed. • Potential impacts to the canal prism at the temporary access causeway would be minimized through use of a geogrid base. The causeway would be removed and the area restored upon completion of the project. **Historic Material** • Any salvaged Catoctin Aqueduct stones that are not used in the restoration would remain in the Catoctin Aqueduct project area to retain contextual integrity. These architectural artifacts would continue to be protected and managed in accordance with Sections 106 and 110 of the National Historic Preservation Act. Unused stones would be stacked in an area southeast of the aqueduct and covered with a layer of dirt. An inventory of all unused stones would be maintained by NPS. **Visitor Use and Experience** • Necessary towpath closures would be limited to short intervals (5 to 30 minutes). Visitors would be notified of the restoration work through signage, public announcements, and other means. The project would be phased so that the restored aqueduct would be open to foot traffic prior to removal of the Bailey bridge. **Public Safety** • Visitor access to work areas would be restricted during restoration using fencing and signage, as appropriate. Work areas will closed to the public using fencing, signage, etc., as appropriate. The park's towpath will remain open for visitors unless otherwise noted, as listed above. • Flagmen would escort heavy equipment along the towpath and speeds would be limited to 10 miles per hour.

2.7 ALTERNATIVES CONSIDERED BUT DISMISSED

In addition to Alternatives A, B, and C described above, the park staff considered the following alternatives, but eliminated them from further consideration because they are not practical or feasible, or do not fully meet the purpose of the action:

- Restore the Catoctin Aqueduct to its exact original condition and geometry, using historic materials only. This alternative is not feasible because: (1) the elliptical center arch had an inherent structural weakness, (2) all of the original stones are not available, and (3) some of the original stones are no longer structurally sound. Slight changes to the aqueduct's original materials and/or geometry are necessary to provide a structurally sound and sustainable structure. Therefore, this is not considered a reasonable alternative and was not carried forward for detailed analysis in this EA.
- Stabilize the Catoctin Aqueduct ruins without reconstructing the collapsed arches. Other stabilization methods do not fully meet the project objectives with respect to historic preservation and enhancement of the cultural landscape. This alternative would not allow for removal of the Bailey bridge, because the stabilized aqueduct ruins would not provide a crossing over Catoctin Creek. In addition, analysis indicates that reconstructing the collapsed portions of the aqueduct is the most sustainable means of stabilization. Therefore, this is not considered a reasonable alternative and was not carried forward for detailed analysis in this EA.

2.8 ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is the alternative that would best promote policies expressed in NEPA. The environmentally preferred alternative would cause the least damage to the biological and physical environment and would best protect, preserve, and enhance historical, cultural, and natural resources. Section 101(b) of NEPA identifies the following six criteria to help determine the environmentally preferred alternative:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

2. Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.

3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.

4. Preserve important historical, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.

5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Continuing the current conditions under Alternative A (No Action) would have less impact on natural resources compared to the action alternatives because no construction activities would occur and land and water resources would not be disturbed. However, the Catoctin Aqueduct would continue to be susceptible to further deterioration under Alternative A. This alternative would not assure preservation of this important historic architectural resource for future generations. The historic preservation, historical interpretation, and public safety benefits achieved under Alternatives B and C would not be realized under Alternative A.

Impacts on the natural environment would be similar under Alternatives B and C, and these impacts would be greater than Alternative A as a result of restoration activities that would disturb land and water resources. However, Alternatives B and C would achieve historic preservation, historical interpretation, and public safety benefits through restoration of the Catoctin Aqueduct.

The primary difference between Alternatives B and C would be the materials and methods used in aqueduct restoration. Both alternatives would result in a restored aqueduct that is structurally sound and similar in appearance to the original structure. Alternative B would involve restoring the Catoctin Aqueduct by re-constructing the center and west arches using stone masonry similar to the original construction. However, this restoration method would require installation of a structural, reinforced concrete saddle over both arches. The

saddle would increase the height of the aqueduct prism by one foot and would result in a one-foot reduction in the height of the towpath and berm, as measured from the top of the prism. These changes in aqueduct geometry would slightly diminish the historic integrity of the Catoctin Aqueduct and would be visible from the towpath. However, these changes would not be noticed by most visitors.

Alternative C would involve restoring the center and west arches of the Catoctin Aqueduct by constructing self-supporting, reinforced concrete arches in the original shape. The concrete arches would be faced on the sides with stones matching the extant span, while the undersides of the arches would be textured with a form-liner and stained to provide visual compatibility. From a distance, the undersides of the arches would have the general appearance of stone, but the concrete would be readily recognizable up close. The treatments applied to the undersides of the concrete arches are not intended to mimic stone work. The concrete core would be designed to carry the stone masonry spandrels, parapets, and prism walls. This would require both new and reused voussoir stones to be cut to a consistent depth of 12 inches to accommodate the structural cast in place concrete core arch. Unlike Alternative B, the geometry of the restored aqueduct would be the same as the original structure under Alternative C. However, the textured concrete undersides of the arches, which would be visible from limited areas, would not match the original stone masonry construction. This change in construction material would slightly diminish the historic integrity of the Catoctin Aqueduct, but would not be visible from the towpath and would not be noticed by most visitors.

In summary, the adverse effects on the natural environment and the beneficial effects on cultural resources of Alternatives B and C would be the same or very similar. Both of the action alternatives have distinct advantages and disadvantages with respect to historic integrity of the restored aqueduct, but there is no appreciable difference between the alternatives. Therefore, both Alternative B and C are considered environmentally preferred alternatives.

Table 2.2 provides a comparative summary of alternatives and whether each alternative would meet the project objectives. As shown on the table, either Alternative B or Alternative C would successfully meet all of the objectives of this project. Alternative A would, to a large degree, fail to meet project objectives. Table 2.3 summarizes the environmental consequences of alternatives.

TABLE 2.2

ABILITY OF THE ALTERNATIVES TO MEET THE PROJECT OBJECTIVES

Objective	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete Arches
Preserve the historic integrity of the Catoctin Aqueduct ruins and restore the structure to the original design, to the extent feasible, in a manner that is structurally sound and sustainable.	Not fully met	Fully met	Fully met
Enhance the continuity of the C&O Canal towpath, the interpretive value of the Catoctin Aqueduct, and visitors' understanding of the canal's history.	Not fully met	Fully met	Fully met
Enhance the cultural landscape and improve the visual quality of the Catoctin Aqueduct area.	Not fully met	Fully met	Fully met
Correct and prevent unsafe conditions at the Catoctin Aqueduct.	Not fully met	Fully met	Fully met
Maintain towpath access for visitors, park maintenance vehicles, and emergency vehicles.	Fully met	Fully met	Fully met

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Soils	Alternative A would result in long-term, negligible, adverse effects to soils based on continued baseline soil erosion conditions. Other actions would not contribute to long-term cumulative impacts to soils. Alternative A would not result in impairment of park soil resources or values.	Construction activities associated with Alternative B would result in short-term, minor, adverse effects to soils based on implementation of resource protection measures and the relatively small area of disturbance (1.5 acres). Other actions would not contribute cumulative impacts to soils. Alternative B would not result in impairment of park soil resources or values.	Construction activities associated with Alternative C would result in short-term, minor, adverse effects to soils based on implementation of resource protection measures and the relatively small area of disturbance (1.5 acres). Other actions would not contribute cumulative impacts to soils. Alternative C would not result in impairment of park soil resources or values.
Geology	Alternative A would result in long-term, negligible, localized, adverse effects to geology based on continued scour around Catoctin Aqueduct. Other actions would not contribute cumulative impacts to geological resources. Alternative A would not result in impairment of park geological resources or values.	Overall, Alternative B would result in long-term, negligible, beneficial effects to geology by correcting existing scour issues at the Catoctin Aqueduct. Other actions would not contribute cumulative impacts to geological resources. Alternative B would not result in impairment of park geological resources or values.	Overall, Alternative C would result in long-term, negligible, beneficial effects to geology by correcting existing scour issues at the Catoctin Aqueduct. Other actions would not contribute cumulative impacts to geological resources. Alternative B would not result in impairment of park geological resources or values.
Surface Water Quality	Alternative A would have no effect on surface water quality. Other actions would not contribute cumulative impacts to surface water quality. Alternative A would not result in impairment of park surface water resources or values.	Construction activities associated with Alternative B would result in short-term, minor, adverse effects to surface water quality. Minimal increases in turbidity, total suspended solids, nutrient loading, and pH are anticipated. Implementation of resource protection measures would minimize impacts. The effects would be localized and limited to Catoctin Creek. Other actions would not contribute cumulative impacts to surface water quality. Alternative B would not result in impairment of park surface water resources or values.	Construction activities associated with Alternative C would result in minor, short-term adverse effects to surface water quality. Minimal increases in turbidity, total suspended solids, nutrient loading, and pH are anticipated. Implementation of resource protection measures would minimize impacts. The effects would be localized and limited to Catoctin Creek. Other actions would not contribute cumulative impacts to surface water quality. Alternative C would not result in impairment of park surface water resources or values.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Floodplains	If further collapse of the aqueduct were to occur under Alternative A, the long-term, beneficial effects on floodplains would be minor and localized. Floodplains would not be affected if further collapse were not to occur. Other actions would not contribute cumulative effects to floodplains.	Alternative B would result in long-term, moderate, adverse effects to floodplains by increasing water surface elevations and the magnitude of the 50- and 100-year flood events. The effects would be localized and no inhabited structures would be affected. Localized flooding under Alternative B is expected to be similar to conditions experienced prior to the partial collapse of Catoctin Aqueduct in 1973. However, the magnitude of flooding could be slightly greater if Catoctin Creek discharge volume has increased since 1973, as a result of increased development and runoff in the Catoctin Creek watershed. Other actions would not contribute cumulative impacts to floodplains. Alternative B would not result in impairment of park floodplain resources or values.	Alternative C would result in long-term, moderate, adverse effects to floodplains by increasing water surface elevations and the magnitude of the 50- and 100-year flood events. The effects would be localized and no inhabited structures would be affected. Localized flooding under Alternative B is expected to be similar to conditions experienced prior to the partial collapse of Catoctin Aqueduct in 1973. However, the magnitude of flooding could be slightly greater if Catoctin Creek discharge volume has increased since 1973, as a result of increased development and runoff in the Catoctin Creek watershed. Other actions would not contribute cumulative impacts to floodplains. Alternative C would not result in impairment of park floodplain resources or values.
Vegetation	Alternative A would result in long-term, negligible, adverse effects to vegetation and the effects would be localized. When the effects of other actions and Alternative A are combined, the cumulative, long-term, adverse effects would remain negligible and localized. Alternative A would not result in impairment of park vegetation resources or values.	Construction activities under Alternative B would result in temporary disturbance (0.5 acres) and permanent clearing (1.0 acres) of vegetation. The total area of vegetation disturbance would be approximately 1.5 acres. The short- and long-term, adverse effects of Alternative B to vegetation would be minor and localized. The cumulative adverse effects to vegetation from other actions and Alternative B would be long-term, minor, and localized. Alternative B would not result in impairment of park vegetation resources or values.	Construction activities under Alternative C would result in temporary disturbance (0.5 acres) and permanent clearing (1.0 acres) of vegetation. The total area of vegetation disturbance would be approximately 1.5 acres. The short- and long-term, adverse effects of Alternative C to vegetation would be minor and localized. The cumulative adverse effects to vegetation from other actions and Alternative C would be long-term, minor, and localized. Alternative C would not result in impairment of park vegetation resources or values.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Wetlands	Alternative A would have no affect on wetlands and there would be no cumulative effects from other actions. Alternative A would not result in impairment of park wetland resources or values.	The total area of disturbance to resources that could be classified as wetlands, wetland buffers, and/or waters of the U.S./State would be approximately 1.3 acres for Alternative B. The approximate total area of temporary fill would be 0.15 acres and total area of permanent fill would be 0.11 acres in these areas. Overall, Alternative B would result in short- and long-term, minor, adverse effects to wetlands, wetland buffers, and waters of the U.S./State. The adverse effects would be localized. Permanent loss of jurisdictional wetlands is not expected to occur and the need to mitigate (create replacement wetlands) is not anticipated. Other actions would not contribute to cumulative effects. Alternative B would not result in impairment of park wetland resources or values.	The total area of disturbance to resources that could be classified as wetlands, wetland buffers, and/or waters of the U.S./State would be approximately 1.3 acres for Alternative C. The approximate total area of temporary fill would be 0.15 acres and total area of permanent fill would be 0.11 acres in these areas. Overall, Alternative C would result in short- and long-term, minor, adverse effects to wetlands, wetland buffers, and waters of the U.S./State. The adverse effects would be localized. Permanent loss of jurisdictional wetlands is not expected to occur and the need to mitigate (create replacement wetlands) is not anticipated. Other actions would not contribute to cumulative effects. Alternative C would not result in impairment of park wetland resources or values.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Wildlife and Aquatic Life	Alternative A would have a negligible effect on wildlife and aquatic life. Other actions would not contribute cumulative effects. Alternative A would not result in impairment of park wildlife and aquatic life resources or values.	Alternative B would result in short- and long-term, adverse effects to terrestrial wildlife and their habitat. All adverse effects to terrestrial wildlife would be localized and the intensity would range from negligible to minor. Alternative B would result in short-term, negligible to minor, adverse effects to aquatic life and long-term, negligible benefits to their habitat. Other actions would not contribute to cumulative effects. Alternative B would not result in impairment of park wildlife and aquatic life resources or values.	Alternative C would result in short- and long-term, adverse effects to terrestrial wildlife and their habitat. All adverse effects to terrestrial wildlife would be localized and the intensity would range from negligible to minor. Alternative C would result in short-term, negligible to minor, adverse effects to aquatic life and long-term, negligible benefits to their habitat. Other actions would not contribute to cumulative effects. Alternative C would not result in impairment of park wildlife and aquatic life resources or values.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Rare, Threatened, Endangered and Species	Alternative A would have no effect on rare, threatened, and endangered species and other actions would not contribute cumulative effects. Alternative A would not result in impairment of park rare, threatened, and endangered species resources or values.	Alternative B would have no effect on federally listed species, the brook floater (state-listed endangered), or squawfoot (state status in need of conservation). Resource protection measures developed in consultation with the Maryland Wildlife and Heritage Service would be implemented to avoid and minimize impacts to the white trout lily (state-listed threatened) and star-flowered Solomon's-seal (state-listed endangered). Known areas of these plants and their habitats will be outside of the construction limits of disturbance, however some unidentified individual plants or habitat could be inadvertently damaged or destroyed, Alternative B would not affect the viability of state-listed plant populations or the continued existence of state-listed species within or outside the park. Alternative B is expected to result in short-term, minor, adverse effects on individual state-listed plants and/or their habitat. Other actions would not contribute to cumulative effects. Alternative B would not result in impairment of park rare, threatened, or endangered species resources or values.	Alternative C would have no effect on federally listed species, the brook floater (state-listed endangered), or squawfoot (state status in need of conservation). Resource protection measures developed in consultation with the Maryland Wildlife and Heritage Service would be implemented to avoid and minimize impacts to the state-listed white trout lily (state-listed threatened) and star-flowered Solomon's-seal (state-listed endangered). Known areas of these plants and their habitats will be outside of the construction limits of disturbance, however some unidentified individual plants or habitat could be inadvertently damaged or destroyed, Alternative C would not affect the viability of state-listed plant populations or the continued existence of state-listed species within or outside the park. Alternative C is expected to result in short-term, minor, adverse effects on individual state-listed plants and/or their habitat. Other actions would not contribute to cumulative effects. Alternative C would not result in impairment of park rare, threatened, or endangered species resources or values.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Cultural Resources	Alternative A would have no affect on archeological resources or historic materials. While maintenance and emergency repair work accomplished on the Catoctin Aqueduct under Alternative A would have minor, short-term beneficial effects, further collapse of the structure is possible over the long-term. The physical integrity of the Catoctin Aqueduct would diminish under Alternative A and existing visual impacts associated with the modern Bailey bridge and pedestrian footbridge abutments would remain. Consequently, Alternative A would result in moderate, long-term, adverse effects to the C&O Canal cultural landscape and architectural resources. When the effects of other actions and Alternative A are combined, the cumulative effects would be long-term, minor, and adverse. Alternative A would not result in impairment of park cultural resources or values.	Alternative B would result in both adverse and beneficial effects to cultural resources. The effects on archeology would be long-term, negligible, adverse, and localized. All of the short- and long-term adverse effects on the cultural landscape and architectural resources would be minor and localized. The overall integrity of the cultural landscape and architectural resources would not be diminished. Restoration of the Catoctin Aqueduct, removal of the Bailey bridge, and clearing vegetation in the canal prism would noticeably enhance the cultural landscape and architectural resources, resulting in long-term, moderate, beneficial effects to these resources. When the effects of other actions and Alternative B are combined, the cumulative, long-term benefits would remain moderate, but they would be magnified relative to Alternative B alone. In addition, the cumulative benefits would be realized over a larger portion of the park. Alternative B would not result in impairment of park cultural resources and values. The NPS finds that implementation of Alternative B would result in a finding of no adverse effect to historic properties for compliance purposes under Section 106 of the National Historic Preservation Act. This finding is considered preliminary, pending State Historic Preservation Officer concurrence.	Alternative C would result in both adverse and beneficial effects to cultural resources. The effects on archeology would be long-term, negligible, adverse, and localized. All of the short- and long-term adverse effects on the cultural landscape and architectural resources would be minor and localized. The overall integrity of the cultural landscape and architectural resources would not be diminished. Restoration of the Catoctin Aqueduct, removal of the Bailey bridge, and clearing vegetation in the canal prism would noticeably enhance the cultural landscape and architectural resources, resulting in long-term, moderate, beneficial effects to these resources. When the effects of other actions and Alternative C are combined, the cumulative, long-term benefits would remain moderate, but they would be magnified relative to Alternative C alone. In addition, the cumulative benefits would be realized over a larger portion of the park. Alternative C would not result in impairment of park cultural resources and values. The NPS finds that implementation of Alternative C would result in a finding of no adverse effect to historic properties for compliance purposes under Section 106 of the National Historic Preservation Act. This finding is considered preliminary, pending State Historic Preservation Officer concurrence.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Visitor Use and Experience	Alternative A would result in long-term, minor, adverse effects on visitor experience because opportunities to interpret the canal's history would continue to be missed on a localized basis. The adverse effects of Alternative A are offset somewhat by the beneficial effects of the Monocacy Aqueduct restoration and occasional use of the Lander Lock House as an interpretive center, but the cumulative, adverse effects on visitor use and experience would remain long-term, minor, and localized.	Under Alternative B, disruptions to visitor use and diminished visitor experience would be short-term and localized, occurring for only the duration of the restoration activities, and would result in minor, adverse effects. Following completion of the restoration project, visitors would have improved opportunities to interpret the C&O Canal's history, which is considered a critical characteristic of the desired visitor experience. Overall, Alternative B would result in long-term, moderate, beneficial effects to visitor use and experience. When the effects of other actions and Alternative B are combined, the cumulative, long-term benefits would remain moderate, but they would be magnified relative to Alternative B alone. In addition, the cumulative benefits would be realized over a larger portion of the park.	Under Alternative C, disruptions to visitor use and diminished visitor experience would be short-term and localized, occurring for only the duration of the restoration activities, and would result in minor, adverse effects. Following completion of the restoration project, visitors would have improved opportunities to interpret the C&O Canal's history, which is considered a critical characteristic of the desired visitor experience. Overall, Alternative C would result in long-term, moderate, beneficial effects to visitor use and experience. When the effects of other actions and Alternative C are combined, the cumulative, long-term benefits would remain moderate, but they would be magnified relative to Alternative C alone. In addition, the cumulative benefits would be realized over a larger portion of the park.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Park Operations	Under Alternative A, a reoccurring need to address acute deterioration issues at the Catoctin Aqueduct would exist and could detract human and fiscal resources from other park operations. Alternative A would result in long-term, minor, adverse effects to park operations. When the effects of other actions and Alternative B are combined, the cumulative, effects to park operations are negligible.	Alternative B would result in short-term, minor, adverse effects to park operations based on the substantial commitment of human resources required for coordination, oversight, and implementation of the planning, design, and construction processes for the Catoctin Aqueduct restoration. Changes in long-term maintenance requirements would result in minor, adverse and minor, beneficial effects. When these adverse and beneficial effects are considered together, Alternative B would have a long-term, negligible effect on park operations. When the effects of other actions and Alternative B are combined, the cumulative, long-term effects to park operations are negligible.	Alternative C would result in short-term, minor, adverse effects to park operations based on the substantial commitment of human resources required for coordination, oversight, and implementation of the planning, design, and construction processes for the Catoctin Aqueduct restoration. Changes in long-term maintenance requirements would result in minor, adverse and minor, beneficial effects. When these adverse and beneficial effects are considered together, Alternative C would have a long-term, negligible effect on park operations. When the effects of other actions and Alternative C are combined, the cumulative, long-term effects to park operations are negligible.
Public Safety	Alternative A would result in long-term, minor, adverse effects to public health and safety because unauthorized access to unstable portions of the aqueduct ruins is a safety risk and risks could increase with continued deterioration. When the effects of other actions and Alternative A are combined, the cumulative, long-term, adverse effects to public health and safety remain minor.	Short-term, adverse effects of Alternative B to public health and safety would be negligible and localized because appropriate protective measures would be implemented during construction. Restoration of the Catoctin Aqueduct would eliminate current safety risks associated with unstable portions of the aqueduct ruins and would result in long-term, minor, beneficial effects to public health and safety. When the effects of other actions and Alternative B are combined, the cumulative, long-term, beneficial effects to public health and safety remain minor.	Short-term, adverse effects of Alternative C to public health and safety would be negligible and localized because appropriate protective measures would be implemented during construction. Restoration of the Catoctin Aqueduct would eliminate current safety risks associated with unstable portions of the aqueduct ruins and would result in long-term, minor, beneficial effects to public health and safety. When the effects of other actions and Alternative C are combined, the cumulative, long-term, beneficial effects to public health and safety remain minor.

TABLE 2.3 COMPARISON OF IMPACTS OF THE ALTERNATIVES

Impact Topic	Alternative A – No Action	Alternative B – Stone Masonry Arches	Alternative C – Reinforced Concrete
Socioeconomic Environment	Alternative A would have no effect on the socioeconomic environment. When the effects of other actions and Alternative A are combined, the cumulative, long-term, beneficial effects to the socioeconomic environment would be negligible.	Alternative B has the potential to increase tourism and spending at local business slightly, but measurable changes in local economic activity, employment, or structure of primary industries are not expected. Alternative B would have long-term, negligible, beneficial effects on the socioeconomic environment. When the effects of other actions and Alternative B are combined, the cumulative, long-term, beneficial effects to the socioeconomic environment would be negligible to minor.	Alternative C has the potential to increase tourism and spending at local business slightly, but measurable changes in local economic activity, employment, or structure of primary industries are not expected. Alternative C would have long-term, negligible, beneficial effects on the socioeconomic environment. When the effects of other actions and Alternative C are combined, the cumulative, long-term, beneficial effects to the socioeconomic environment would be negligible to minor.