North Carolina Department of Natural and Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Roy Cooper
Secretary Susi H. Hamilton

Office of Archives and History
Deputy Secretary Kevin Cherry

March 13, 2018

Clinton E. Jones
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, TN 37902

cjones5@*tva*.gov

Re: Proposed Roof Replacement, Fontana Dam Powerhouse, Tennessee Valley Authority, Graham and Swain Counties, ER 18-0267

Dear Mr. Jones:

Thank you for your February 1, 2018, submittal containing information about the above referenced project, plus the additional information supplied by TVA's Steve Cole March 6, 2018. We concur that the two proposed options for installing a new membrane roof:

- Option A involving removal and reinstallation of existing coping stones, and
- Option B involving wrapping the coping with membrane,

meet the *Secretary's Standards for Preservation* and will result in no adverse effect to the National Register-listed Fontana Hydroelectric Project (GH0058) of which the dam is a contributing resource.

Should Option B be selected, the roof membrane must be secured to the existing masonry joint, without introducing any new fasteners into the original and character-defining coping stones. As indicated in the submittal, compliance with the *Standards* will require reinstallation of the unique roof cladding system composed of concrete pedestals and pavers. Overall dimensions of the pavers may be modified as indicated in the submittal to facilitate reinstallation and maintenance.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579 or environmental.review@ncdcr.gov. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

Received: 02/09/2018
State Historic Preservation Office

ER 18-0267

TVA

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902

Due -- 2/26/18
ONAE
R- ER letters
GH0058 3/13/18

February 1, 2018

Ms. Renee Gledhill-Earley
North Carolina State Historic Preservation Office
109 East Jones Street, Room 258
Raleigh, North Carolina 27601

Dear Ms. Gledhill-Earley:

TENNESSEE VALLEY AUTHORITY (TVA), PROPOSED ROOF REPLACEMENT AT THE FONTANA DAM POWERHOUSE, GRAHAM AND SWAIN COUNTIES, NORTH CAROLINA.

TVA is proposing to replace the roof at the Fontana Dam Powerhouse in Graham and Swain Counties, North Carolina (Figure 1; 35.4516809º, -83.8045812º). The current roof, built in 1942-1944, is in a state of deterioration, and is increasingly developing leaks. The Powerhouse roof is constructed of a built-up roofing membrane covered by concrete pavers, with a perimeter formed by a heavy limestone coping. TVA proposes in-kind replacement of the existing roofing system. The limestone coping stones are in good condition and would be retained and used in the new roof. TVA is considering two options for the project. Option 1 would require the limestone coping stones to be removed and stored while other work is completed, and then put back in place. Option 2 would involve leaving the limestone coping stones in place while the work proceeds. With Option 2, the stones would be covered in a fully reversible manner. Both options would involve removing and discarding the original concrete pavers, the built-up roof membrane, and damaged portions of the original metal flashing, and replacing with new in-kind materials. The repaired roof would be at the same elevation as the original roof in both options.

TVA has determined the area of potential effects (APE) for above ground resources to be areas within 0.5-mile radius of the proposed undertaking that have a direct line of sight to the Powerhouse roof (Figure 2). As the proposed undertaking involves no ground disturbance and only involves the replacement of the roof on the powerhouse TVA finds that the undertaking is not of a type with potential to affect archaeological properties.

TVA Cultural Compliance staff conducted background research and identified two historic properties in the APE: The Fontana Hydroelectric Project and the Appalachian Trail. The Fontana Hydroelectric Project, which is included within the Multiple Property Documentation Form, "Historical Resources of the Tennessee Valley Authority Hydroelectric Project, 1933-1979", was listed on the National Register of Historic Places (NRHP) under criterion A and C for its historical and engineering significance on August 11, 2017. The Powerhouse is considered to be a contributing building to the Fontana Hydroelectric Project. According to the North Carolina State Historic Preservation Office HPOWEB GIS Service, the Appalachian Trail (AT), which runs across the top of Fontana Dam, was determined eligible ("DOE'd") and certified as eligible throughout its entire extent by the Secretary of the Interior in 2009. The AT was placed in the Historic Preservation Office Study List. However, the AT is not listed on the NRHP.

TVA contracted with Lord, Aeck & Sargent to conduct an evaluation of the Fontana Dam Powerhouse and to assess potential effects of the proposed roof replacement to the property. Enclosed are two bound copies of the report titled, *Fontana Dam Power House, Documentation of Effect Under 36 CFR 800 for Roof Replacement*, along with electronic copies on CD.

Lord, Aeck & Sargent recommends that the proposed undertaking would not adversely affect the Fontana Dam Hydroelectric Project. TVA has reviewed the enclosed report and agrees with the author's recommendation.

The proposed undertaking would not result in any physical changes to the AT, but would not diminish the setting. The proposed undertaking would result in minor visual changes that would be visible to users of the AT. TVA finds that the undertaking would not meet the criteria of adverse effect under 36 CFR § 800.5(a)(1). Therefore, TVA finds that the proposed undertaking would result in an effect on the AT, but that the effect would not be adverse.

Pursuant to 36 CFR § 800.5(c), we are seeking your concurrence with TVA's finding that no historic properties listed or eligible for listing in the NRHP would be adversely affected by the proposed undertaking.

If you have any questions or comments, please contact Marianne Shuler by telephone, (865) 632-2464 or email, mmshuler@tva.gov.

Sincerely,

Clinton E. Jones
Manager
Cultural Compliance

SCC:ABM
Enclosures

Figure 1. Aerial view of the Fontana Dam Powerhouse Roof.

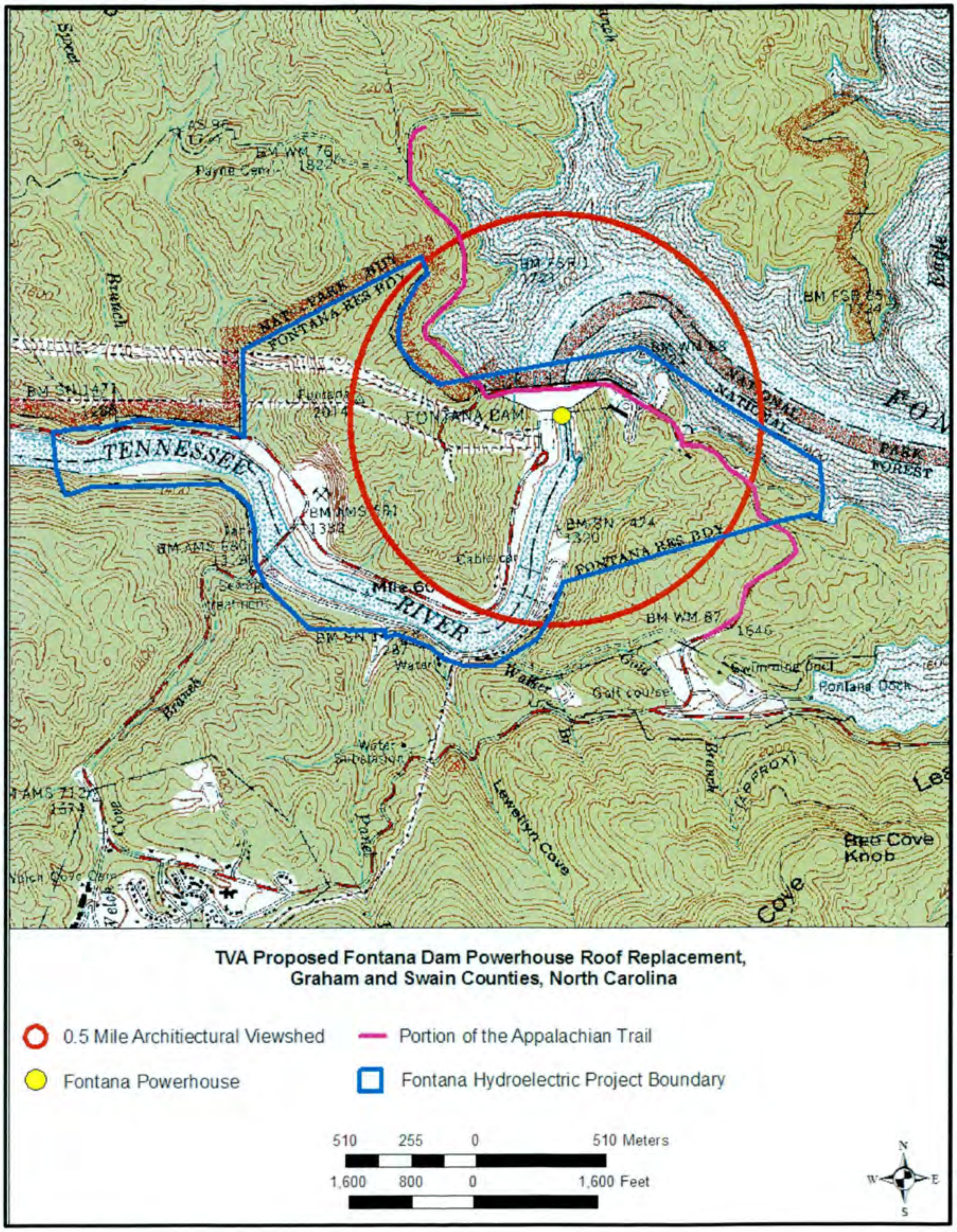

Figure 2. Architectural APE.

DOCUMENTATION OF EFFECT UNDER 36 CFR 800 EVALUATION

FOR THE PROPOSED ROOF REPAIRS TO THE

FONTANA DAM POWER HOUSE

NORTH CAROLINA

Prepared by Lord Aeck Sargent
Atlanta, Georgia

December 13, 2017

TABLE OF CONTENTS

MANAGEMENT SUMMARY

This report has been prepared for the Tennessee Valley Authority (TVA) for use in completion of applicable Section 106 procedures in compliance with the National Historic Preservation Act (NHPA) of 1966 and subsequent amendments. The Fontana Hydroelectric Project, including the Power House, was listed on the National Register of Historic Places on August 11, 2017. Pursuant to 36 CFR 800.4 of the NHPA, the TVA is required to evaluate potential effects to properties listed in or eligible for listing in the NRHP, when such properties are proposed for rehabilitation, alteration, demolition, sale or lease or other actions which may impact their architectural or historical character. The architectural and historic preservation firm of Lord Aeck Sargent, in Atlanta, Georgia, has assisted the TVA in this evaluation and determination of effects.

Fontana Dam is an imposing concrete structure that spans the Little Tennessee River in Graham and Swain counties, North Carolina. The Aluminum Company of America (ALCOA) purchased the site in the early 1900s for the purpose of building a dam to supply power to its facilities in nearby, Alcoa, Tennessee. Motivated by flood control of the greater Tennessee Valley, the TVA signed an agreement with ALCOA through which TVA would build and operate a dam, with ALCOA being the primary recipient of the electrical output for at least 20 years. Congress appropriated funding in 1941, when World War II required a significant increase in aluminum production. Construction began in January of 1942 and concluded late in 1944 with power generation beginning in early 1945. Fontana Dam and its Power House are the work of the TVA's Chief Architect, Roland Wank.

The Power House is a cast-in-place concrete structure with clean, fine lines of exposed architectural concrete, limestone walls, and large glazed walls surrounding the generator room and wings that comprise ancillary functions. Limestone coping forms the roof perimeter.

Based upon site observation and a review of the original drawings, the building appears to have changed very little since it was constructed, retaining its primary character-defining features. The building is listed on the National Register of Historic Places. It retains its integrity, is significant for its association with the TVA and the World War II war effort, is an excellent example of industrial architecture and mid-century modern architecture, and retains the fine craft of its limestone and cast-in-place exposed architectural concrete construction.

The proposed project is focused on replacing the building's roof. The limestone coping, roof pavers, roof flashings, and very possibly the built-up roof membrane, are original to the building. No other exterior work and no interior work is proposed.

Two options are being considered for the proposed work. One option will focus on retaining historic materials and in-kind replacement, where repair is infeasible. A second option also retains historic materials and utilizes in-kind replacement, but employs a fully reversible non-historic coping covering.

Lord Aeck Sargent recommends a determination of **No Adverse Effect** to this building as a result of this project.

CURRENT CONDITION AND NATIONAL REGISTER EVALUATION

The Fontana Hydroelectric Project, including the Power House, was listed on the National Register of Historic Places on August 11, 2017.

The Power House roof is an essentially flat roof with a built-up roofing membrane, covered by concrete pavers. The limestone coping, roof pavers, roof flashings, and very possibly the built-up roof membrane, are original to the building. At the roof perimeter is a limestone coping. The roof can be viewed from the Visitor's Center that is positioned diagonally up slope at one end of the dam and from a similar lookout from the road to the west of the dam.

The concrete structural roof slab slopes toward drains. The original construction drawings indicate no insulation above the slab, with the roof membrane applied directly to concrete deck. The roofing membrane is a built-up bituminous roof membrane, probably coal tar, with a flood coat of bitumen, without coating or aggregate surfacing. The roof membrane is covered in its entirety by concrete pavers approximately 42-44 inches square, 2 inches nominal thickness, reinforced with wire mesh, with an exposed aggregate finish. Pavers are supported on round precast concrete cylindrical pedestals. The walking surface of the pavers is flat. The clear space between the roof membrane and the flat underside of the pavers varies from a few inches to about a foot.

View of Power House roof from Visitor's Center

The perimeter of the roof is formed by a heavy limestone coping. The coping stones are set on raised cants (indicated on the original construction drawings to be of "nailing concrete"). The roof is subdivided by construction joints, which also terminate with raised cants. Both the cants at the construction joints and at the building perimeter are covered with metal flashing.

The original construction drawings indicate two types of metal flashing that cover construction joints and form through-wall flashing underneath of stone coping perimeters: "26 ga metal flashing by roofing contractor" and "24 ga metal flashing MK2". A note on the drawings indicates that materials bearing mark numbers (MK) are to be furnished by TVA. Those furnished by TVA tend to be three dimensional fabrications that involve complex cutting, folding, seaming, and soldering. Those furnished by the contractor tend to be straight lengths of bent metal. Although the available drawings do not indicate the type of metal in each case, two types of metal flashing exist on the roof: metal with a typical copper patina (predominantly brown with some green) and a bending strength of copper, and metal with a typical tinned or galvanized steel appearance exhibiting moderate corrosion and a bending strength of steel sheet.

The railing along the rear of the building adjacent to the dam face and the funicular appears in the original construction drawings. It may have been subject to significant repairs or even replacement in recent years. The drawings indicate posts that are set into the coping joints, not into the concrete structure. The railing resists lateral loads by the overturning moment of the heavy coping stones. The remaining façades do not possess railings or other fall protection.

Perimeter coping, roof pavers, pedestals, and nailable concrete cants over construction joints. The roof membrane is visible where pavers are displaced.

Base flashing and sheet metal flashing at construction joint and perimeter coping

TVA has experienced active leaking of the roof. Many of the concrete roof pavers are cracked and broken and have been removed entirely in some locations, exposing the membrane beneath. Many of the concrete pedestals that hold the roof pavers are cracked or even disintegrating. The perimeter limestone coping remains in good condition. Due to the condition of the existing roof, TVA has determined that this is the appropriate time to undertake a roof replacement.

PROJECT DESCRIPTION

Two options for roof replacement are being considered for the Fontana Dam Power House roof.

OPTION A – REPLACE IN-KIND

This option is an in-kind replacement of the existing roofing system. The limestone coping stones, which are in good condition, would be retained. The roof installation will require removing and storing these stones for reinstallation after the roofing work is complete. When completed, this option will provide a new roof, with essentially the same materials, configuration and appearance as the historic condition. Components of this Option will be as follows:

Removal:

- Remove pavers and pedestals and discard.
- Remove railings and discard.
- Remove limestone copings, identify each piece and store for reinstallation.
- Remove metal flashings and discard.
- Remove base flashings and built-up roof membrane and discard.
- Depending upon condition, possibly remove nailing concrete cants at construction joints.

Reconstruction:

- Restore / repair / reconfigure nailing concrete cants at perimeters.
- Install new coal tar roof membrane.
- Install new base flashings (simplify construction joint and metal flashing configuration – this is possible due to elastomeric materials).
- Install a combination of new railings to replace existing and a fall restraint system; evaluate attachment of the railings to the deck versus the coping stones; possibly move the railing inboard a couple of feet.
- Reinstall original limestone copings.
- Install new pavers on pedestals at the original flat elevation (up to 12” above roof membrane); 4 x 4 foot nominal format; provide for access for drain inspection and maintenance. Concrete material will match the historic pavers in both composition and appearance. See Variant on Size of Concrete Pavers, below.
- Clean out roof drains (displaced bitumen and debris); repair / restore / replace broken or deteriorated cast iron drain parts.

Variant on Size of Concrete Pavers:

The current 4 x 4 foot nominal format of the pavers results in units that weigh approximately 350 to 400 pounds each. This makes ongoing roof inspection and maintenance (even cleaning of drains) quite difficult or impossible without importation of moving equipment. For this reason, TVA is considering an alternate paver replacement with 2 x 2 foot nominal units, which could be removed and reinstalled without the use of heavy equipment, to facilitate ease of maintenance. The paver color and exposed aggregate texture would match that of the historic pavers and the visual appearance of the original format would be simulated by a dark concrete stain line applied on a 4 x 4 format to the edge of the 2 x 2 pavers. When viewed from the Visitor’s Center, this variation from the historic condition should not be noticeable and the improved ease of maintenance should result in better care of the historic resource.

OPTION B – RETAIN COPING STONES IN PLACE

Due to the weight of the coping stones and the care that will be required for their removal and protection for reinstallation, an option is being considered that allows the coping stones to remain in place. While this option requires covering the coping stones, this will be accomplished in a fully reversible manner. Leaving the coping stones in place will result in a more cost effective solution.

In all other respects, this option will provide a new roof, with essentially the same materials, configuration and appearance as the historic condition. Components of this Option will be as follows:

Removal:

- Remove pavers and pedestals and discard.
- Remove railings and discard.
- Retain limestone copings in place.
- Retain metal flashings under copings; cut off exposed portions of metal flashings under copings; remove and discard other metal flashings (over construction joints).
- Remove base flashings and built-up roof membrane and discard.
- Depending upon condition, possibly remove nailing concrete cants at construction joints.

Reconstruction:

- Restore / repair / reconfigure nailing concrete cants at perimeters.
- At and over the perimeter in-place copings, install PVC roof membrane in loose laid fashion without adhesives or mechanical fasteners into the copings; attach the membrane to concealed concrete deck and to outboard wall joints so as to leave no adhesive residue on stones nor actual holes in the stones.
- In addition to covering the copings with single ply membrane, cover the single-ply membrane with limestone-colored Kynar-coated metal to further shield the membrane and extend its life, presumably by some decades. As with the single-ply membrane, the metal would not be attached through the coping stones to avoid irreversible impact.
- Transition the single-ply membrane to a new coal tar roof membrane.
- Install a combination of new railings to replace existing and a fall restraint system; evaluate attachment of the railings to the deck versus the coping stones; possibly move the railing inboard a couple of feet.
- Install new pavers on pedestals at the original flat elevation (up to 12” above roof membrane); 4 x 4 foot nominal format; provide for access for drain inspection and maintenance. Concrete material will match the historic pavers in both composition and appearance. See Variant on Size of Concrete Pavers in Option A, above.
- Clean out roof drains (displaced bitumen and debris); repair / restore / replace broken or deteriorated cast iron drain parts.

As with Option A, a variant on the size of the concrete pavers may be considered to improve ease of maintenance.

EFFECTS TO NATIONAL REGISTER PROPERTIES

The Fontana Hydroelectric Project, including the Power House, was listed on the National Register of Historic Places on August 11, 2017. Pursuant to 36 CFR 800.4 of the NHPA, the TVA is required to evaluate potential effects to properties listed in or eligible for listing in the NRHP, when such properties are proposed for rehabilitation, alteration, demolition, sale or lease or other actions which may impact their architectural or historical character.

WHAT ARE EFFECTS TO HISTORIC PROPERTIES?

Regulations codified at 36 CFR 800 require Federal agencies to assess their impacts to historic resources. The regulations provide specific criteria for determining whether an action will have an effect, and whether that effect will be adverse. These criteria are given below.

36 CFR 800.5 Assessment of Adverse Effects

(a) Apply Criteria of Adverse Effect. In consultation with the SHPO/THPO and any Indian tribe or Native Hawaiian organization that attaches religious and cultural significance to identified historic properties, the Agency Official shall apply the criteria of adverse effect to historic properties within the area of potential effects. The Agency Official shall consider any views concerning such effects which have been provided by consulting parties and the public.

(1) Criteria of adverse effect. An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.

(2) Examples of adverse effects. Adverse effects on historic properties include, but are not limited to:

(i) Physical destruction of or damage to all or part of the property;

(ii) Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access that is not consistent with the Secretary's Standards for the Treatment of Historic Properties and applicable guidelines;

(iii) Removal of the property from its historic location;

(iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

(v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;

(vi) Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and;

(vii) Transfer, lease or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

EFFECTS TO THE NATIONAL REGISTER-ELIGIBLE PROPERTY

Lord Aeck Sargent recommends a determination of **No Adverse Effect** for the proposed work to the Fontana Dam Power House since the project entails only essentially in-kind replacement of the roof in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties.

Applying the Criteria of CFR 800.9 (b)

The proposed work at the Fontana Dam Power House would have **No Adverse Effect** under the following criteria of CFR 800.9 (b):

(i) Physical destruction of or damage to all or part of the property;

The replacement of the Fontana Dam roof will only remove historic fabric that is already damaged beyond repair. Historic limestone copings will be retained. Although Option B proposes to cover these copings, this will be done in a fully reversible manner. All other materials that are proposed to be replaced will be replaced using materially and visually compatible materials.

(ii) Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access that is not consistent with the Secretary's Standards for the Treatment of Historic Properties and applicable guidelines;

The proposed repair materials, procedures and methodologies have been devised based upon the Secretary of the Interior's Standards for the Treatment of Historic Properties and applicable guidelines. Retention of historic fabric and doing no harm to that fabric has been a primary goal, while attempting to develop durable and maintainable solutions.

(iii) Removal of the property from its historic location;

Not applicable as the location will not change.

(iv) Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

The property's use will not change. The proposed repair methods and materials will not change the property's setting.

(v) Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;

The property's appearance will remain essentially unchanged. Option B will introduce a minor but reversible change in appearance where new coverings will extend over the coping stones. The variant to alter the concrete paver format will be designed to reduce change to the appearance and this change is likely to be undiscernible at the distance from which the roof can be practically viewed. There will be no atmospheric or audible changes.

(vi) Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and

Not applicable.

(vii) Transfer, lease or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

Not applicable since the property will remain in TVA's ownership.

SUMMARY

This report has been prepared for the Tennessee Valley Authority (TVA) for use in completion of applicable Section 106 procedures in compliance with the National Historic Preservation Act (NHPA) of 1966 and subsequent amendments. The Fontana Hydroelectric Project, including the Power House, is listed on the National Register of Historic Places. Pursuant to 36 CFR 800.4 of the NHPA, the TVA is required to evaluate potential effects to properties listed in or eligible for listing in the NRHP, when such properties are proposed for rehabilitation, alteration, demolition, sale or lease or other actions which may impact their architectural or historical character.

The TVA proposes to replace the roof of the Fontana Dam Power House to address active roof leaks and deteriorated materials. The work includes in-kind replacement, with minor and reversible deviations, consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties and applicable guidelines. Retention of historic fabric and doing no harm to that fabric has been a primary goal in the development of the proposed repair procedures and approaches. Therefore, Lord Aeck Sargent recommends a determination of **No Adverse Effect** to the Fontana Dam Power House as a result of this project.

APPENDIX

LORD
AECK
SARGENT

June 6, 2017

Craig Morris
FAM Manager
Tennessee Valley Authority

Project: Fontana Dam Power House Roof Assessment
No. 10697-00 pH 130

Dear Mr. Morris:

At the request of the Tennessee Valley Authority (TVA), Richard Robison of Lord, Aeck & Sargent visited the Power House of Fontana Dam on January 19, 2017, accompanied by TVA personnel to assess the condition of the roof and make recommendations for future action. Eight sheets of original construction drawings (46N406R2, 46N407R3, 46N408R2 dated 2-7-43 and 46N444R2, 46N445R5, and 46N446R3 dated 3-2-43, and 46W501 and 46W502 dated 11-3-42) were made available for the site visit or subsequently. This report summarizes our observations, conclusions, and recommendations. Although the report makes reference to the façade and structure, the focus of the assessment and report is limited to the roof.

Background

Fontana Dam is an imposing concrete structure that spans the Little Tennessee River in Graham and Swain counties, North Carolina. The Aluminum Company of America (ALCOA) purchased the site in the early 1900s for the purpose of building a dam to supply power to its facilities in nearby, Alcoa, Tennessee. Motivated by flood control of the greater Tennessee Valley, the TVA signed an agreement with ALCOA through which TVA would build and operate a dam, with ALCOA being the primary recipient of the electrical output for at least 20 years. Congress appropriated funding in 1941, when World War II required a significant increase in aluminum production. Construction began in January of 1942 and concluded late in 1944 with power generation beginning in early 1945. Fontana Dam and its Power House are the work of the TVA's Chief Architect, Roland Wank[1]

The Power House is a cast-in-place concrete structure with clean, fine lines of exposed architectural concrete, limestone walls, and large glazed walls surrounding the generator room and wings that comprise ancillary functions. Limestone coping forms the roof perimeter. Based upon site observation and a review of the original drawings, the building appears to have changed very little since it was constructed, retaining its primary character-defining

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[1] Wikipedia https://en.wikipedia.org/wiki/Fontana_Dam

1175 Peachtree Street NE, Suite 2400
Atlanta, GA 30361
877-929-1400
LordAeckSargent.com

features. The building is not listed on the National Register of Historic Places, but it appears eligible for listing because it retains its integrity, it is likely significant for its association with the TVA and the World War II war effort, it is an excellent example of industrial architecture and mid-century modern architecture, and it retains the fine craft of its limestone and cast-in-place exposed architectural concrete construction.

From a dam height 480 feet[2], primary public views of the Power House roof are possible from the Visitor's Center that is positioned diagonally up slope at one end of the dam and from a similar lookout from the road to the west of the dam. On grade access from the down slope side is available to the public from a distance outside of the secured zone surrounding the Power House and yard.

Due to inherent siting of the dam and Power House as well as security and access restrictions, the façade can be seen from the down stream side at a distance of several hundred yards, and the roof, which is covered with exposed aggregate pavers approximately 4 feet square, is visible at a distance of several hundred yards from the Visitor's Center at the top of the dam. The funicular railway that connects the Visitor's Center to the Power House has not been operational for some years. The public does not currently have access to the interior of the building or the yard surrounding the Power House.

View from the Visitor's Center

The technology of cast-in-place concrete structures began in the very late 19^{th} century and early 20^{th} century. During the 1930's and 40's it continued to evolve, and by the 1950's it had reached the point of a mature technology. The

[2] ibid.

Power House was designed and constructed with numerous joints that separate the structure into at least eleven portions and that divide beams, columns, and slabs in ways that are now considered to be archaic. The drawings available at this time show these joints to be “contraction joints” (or “contr jt”) which we view as construction joints or cold joints between discrete concrete placements, tied together with reinforcing steel. No structural drawings were available for the assessment.

OBSERVATIONS

TVA personnel pointed out a number of active leaks during a tour of the interior of the building. These included spaces located at or near the face of the dam such as:

a display room or corridor behind the control room

stairwell

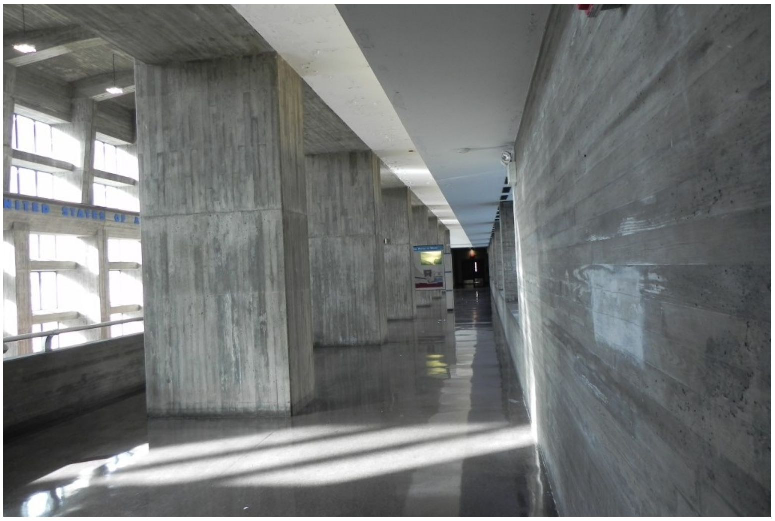
small parts storage (rear NE corner of building)

Water was either currently seeping or was reported to seep during or after heavy rains. Typical seepage locations included the floor or ceiling line and along construction joints in walls, columns, beams, or overhead slabs.

On the main generator room level, leaks were reported on the ceiling and north wall of the 480v room; a gutter had been installed along the ceiling directly underneath of a construction joint in the roof slab above.

480 V. room

Past leaks, no longer active, were reported along the north wall of the generator room at or along the juncture above the visitor's gallery.



Peeling paint is visible on ceiling of visitor's gallery

No significant leaks were reported in main roof of the generator room.

The roof membrane is covered in its entirety by concrete pavers approximately 42-44 inches square, 2 inches nominal thickness, reinforced with wire mesh, with an exposed aggregate finish. Cracked and broken pavers abound along with apparently intact pavers. Pavers are supported on round precast concrete cylindrical pedestals of low strength; many are cracked or even disintegrating. In diverse locations throughout the roof, pavers have been removed and slid aside to expose the membrane beneath. All observations noted herein of the membrane below the pavers were made through such existing openings. Pavers of this size weigh some 350 to 400 pounds and cannot be lifted without appropriate equipment. The walking surface of the pavers is dead level. The perimeter of the roof is formed by a heavy limestone coping. The coping appears to be intact and in excellent condition.

Perimeter coping, roof pavers, pedestals, and nailable concrete cants over construction joints.
The roof membrane is visible where pavers are displaced.

The roofing membrane is a built-up bituminous roof membrane with a flood coat of bitumen, without coating or aggregate surfacing. One small sample of mastic material was taken; it had a distinctive coal tar smell. When later immersed in mineral spirits, approximately three-quarters of the sample dissolved, indicating a high asphalt content.

The concrete structural roof slab slopes toward drains. The drawings indicate no insulation, with the membrane applied directly to concrete deck. The clear space between the roof membrane and the dead level underside of the pavers varies from a few inches to about a foot.

Over the Visitor's Gallery, recent repairs included application of a modified bitumen sheet membrane.

Two types of metal flashing were observed on the roof: metal with a typical copper patina (predominantly brown with some green) and a bending strength of copper, and metal with a typical tinned or galvanized steel appearance exhibiting moderate corrosion and a bending strength of steel sheet.

The railing along the rear of the building adjacent to the dam face and the funicular appears in the original construction drawings. It may have been subject to significant repairs or even replacement in recent years. The drawings indicate posts that are set into the coping joints, not into the concrete structure. The railing resists lateral loads by the overturning moment of the heavy coping stones. The remaining façades do not possess railings or other fall protection.

The façade comprises limestone masonry panels, exposed cast-in-place concrete structural elements, and large glazed portions. A barely cursory look at the joint work observed reasonably intact mortar joints, but some deterioration may be apparent if the façade were more closely observed.

Façade

DRAWING NOTES

The drawings indicate that the construction joints in the structure continue above the roof slab and are constructed of “nailing concrete” (which we interpret as a relatively weak, nailable concrete mix) in the form of raised cants approximately 8 inches above the roof plane and capped with metal flashing. Perimeters have similarly raised cants on which are set metal through-wall flashing and limestone copings.

The drawings indicate two types of metal flashing that cover construction joints and form through-wall flashing underneath of stone coping perimeters: “26 ga metal flashing by roofing contractor” and “24 ga metal flashing MK2”. A note on the drawings indicates that materials bearing mark numbers (MK) are to be furnished by TVA. Those furnished by TVA tend to be three dimensional fabrications that involve complex cutting, folding, seaming, and soldering. Those furnished by the contractor tend to be straight lengths of bent metal. Although the available drawings do not indicate the type of metal in each case, we note that two metals were observed on site. The drawings indicate many flashings to receive three coats of “Bitumastic No. 50”; that type of coating was observed in many locations on roof.

Base flashing and sheet metal flashing at construction joint and perimeter coping

CONCLUSIONS

The materials and configurations observed on site correlated well with those observed on the drawings, which is to say we did not note any striking variances between the drawings and as-built conditions, nor did we observe significant subsequent additions or modifications.

Original drawings illustrate that the Power House structure is cast against the face of the dam and that there is a construction joint between the face of the dam and the Power House structure. Leaks in the lower rear rooms appear to be correlated with construction joints in the cast-in-place structure and the extension of those joints through to daylight. These leaks may be correlated with age-related deterioration in limestone coping joints, base flashings, associated sheet metal flashings, and construction joints in nailable concrete roofing cants. The drawings generally do not indicate any through wall flashings at the base of limestone masonry veneer (see specific examples at detail D-D sheet 46N407 and wall sections on 46N445). In some instances we suspect that leaks occur due to the complete absence of through wall flashing at these locations. (Historically, omission of this type of flashing was common practice during the transition from heavy mass masonry walls to the late 20th century practice of light weight veneer coverings.) We suspect that the recently constructed modified bitumen repair above the Visitor's Gallery was occasioned by that condition.

Peeling paint on the suspended plaster ceiling of the Visitor's Gallery appears correlated with the horizontal plenum that is ventilated to the exterior per drawing 46N444. Condensation can occur with daily or seasonal changes in exterior temperature and humidity on one side of the plaster ceiling and more stable temperature and humidity on the interior side of the ceiling.

Without certainty, there is a good possibility that the built-up roof is the original roof installed circa 1944-45. Alternate possibilities are 1) that it was reroofed at age 35 years or so; or 2) the original roof may have received a flood coat of bitumen or a restaurant at a late age. There are signs of maintenance activities on the roof including the small modified bitumen re-roof zone over the visitor's gallery. Because the intricate sheet metal flashing work associated with the limestone copings appears to be intact and original, and because there is no obvious sign of significant re-work or a second roof (such as telltale base flashing lines and similar modifications or remnants), we conclude that the roof is probably the original roof. Because of the distinctive smell of the single sample of mastic, and more particularly because coal tar was the roof of choice for heavy industrial buildings of the era[3], we conclude that the bitumen is probably coal tar, although this is not a positive determination. If this is indeed the original roof, the exceptional longevity of 70 years we attribute to 1) application direct to concrete deck (not over insulation) which tends to stabilize temperature fluctuations in the membrane and reduce heat aging of the bitumen, and 2) shielding of the membrane from UV light by the paver assembly. Heat aging and UV attack are two significant sources of membrane deterioration.

OTHER CONSIDERATIONS

Before undertaking repair/renewal/removal of the roof membrane, the membrane and flashings must be tested for the presence of asbestos (which is highly probable), and sufficient samples of the membrane should be taken and tested to make a positive determination of the bitumen type (coal tar or asphalt).

If the bitumen is coal tar and a complete tear-off is adopted, we note that warm weather removal of the coal tar can be exceedingly difficult due to the softening of the bitumen, and priority should be given to scheduling removal during cool weather. We also note that early removal of the entire paver surface to facilitate a 100% inspection of the roof could cause bitumen to soften and flow from the ridge to the drains to a detrimental degree.

Current conditions on the roof require that personnel take particular care to safely access the roof for required periodic inspection and maintenance of roof drains. These conditions include broken or displaced pavers, weak pedestals, and a lack of roof-edge fall restraint or roof-edge railings.

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[3] A series of coal mine strikes in the 1940's and 1950's brought the production of coal tar to a virtual standstill, which created a need for an alternative bitumen and a market opening for asphalt bitumen, leading to the steady demise of coal tar as a roofing and waterproofing material.

Consideration of alternative repair / renew / replace options for the roof will include the historic significance of the building, its historic appearance, and the impact of these options on its character-defining features. The building owner will continue to own and operate the building for an indefinitely long period of time and therefore the long term cost and value of the roof become an important part of the first cost vs. life cycle cost equation.

Repair or replication of the complex sheet metal flashing conditions extant on the roof may well far exceed now-current workmanship capabilities of the average roofing crew; if the sheet metal flashings are repaired or replicated in kind, successful execution will depend on specific pre-qualification of skilled sheet metal craftsmen and elimination of unqualified workers.

If and when reroofing occurs, a traditional built-up coal tar roof may be difficult or impossible to acquire due to low or no availability of the roofing pitch or to low or no availability of qualified roofers within a reasonable geographic radius of the project. A very few companies continue to produce either traditional coal tar pitch or new variants such as coal tar emulsions, modified coal tars, and modified bitumen sheets (rubberized coal tar sheet). If replacement with coal tar pitch is not viable, other excellent options include SBS-modified asphalt in either hot fluid applied or multi-ply sheet form. Either of these, when best-quality design, workmanship, and materials are employed, can give a service life well exceeding the life of a standard 20 or 30 year commodity product.

The current 4 x 4 foot format of the pavers weighs some 350 to 400 pounds each which makes ongoing roof inspection and maintenance (even cleaning of drains) quite difficult or impossible without importation of moving equipment.

The public can view the Power House only from a distance of a thousand feet or so from the Visitor's Center at the top of the dam or from several thousand feet at the western lookout, or from similar distances through the yard downstream.

PROJECTED LIFE OF THE EXISTING ROOF MEMBRANE

Low slope roofs that are installed on late 20th century and on 21st century buildings tend to be installed over rigid insulation (to avoid high heating and cooling energy costs), tend to be exposed to sunlight, and tend to have an actual life of, say, 10 to 30 years or so before total replacement. Built-up coal tar roofs, even when exposed to heat and sunlight, easily last significantly longer; a life of 40 to 50 years is not unusual. (A typical mode of failure of insulated coal tar roofs is where the asphaltic base flashings are not maintained and fail, which allows water intrusion into the insulation layer and necessitates the removal and replacement of the roofing even though the coal tar membrane itself is in viable condition.) Even though the existing roof may be as old as 70 years, because it has not been exposed to sunlight and because the direct-to-deck configuration maintains the membrane at a relatively constant temperature, the roof may still have a future service life of considerable length. To realize this future life, one may need to undertake some repair or renewal of existing base flashings or other significant maintenance.

On the other hand, if more in-depth reporting of past and current roof leaks indicates failures, or if a closer inspection of the membrane indicates significant deterioration of the membrane itself or other issues, the option of extending the life of the membrane may not be available.

OPTIONS FOR REPAIR / RENEWAL / REPLACEMENT OF THE ROOF MEMBRANE

Outlined below are several viable options for repair / renewal / replacement of the roof membrane. From the available universe of many, many possibilities, the options we list are we believe both 1) either historically in kind or are of no or low impact or are 100% reversible and 2) can reasonably be expected to provide a service life well in excess of the now standard 20 or so years before replacement.

Option “A” – Replace In Kind

- remove pavers and pedestals and discard
- remove railings and discard
- remove limestone copings, identify each piece and store for reinstallation
- remove metal flashings and discard
- remove base flashings and built-up roof membrane and discard
- possibly remove nailing concrete cants at construction joints
- restore / repair / reconfigure nailing concrete cants at perimeters
- install new roof membrane (either coal tar, hot fluid-applied rubberized asphalt, or modified bitumen sheet)
- install new base flashings (simplify construction joint and metal flashing configuration – this is possible due to elastomeric materials)
- install a combination of new railings to replace existing and a fall restraint system; evaluate attachment of the railings to the deck versus the coping stones; possibly move the railing inboard a couple of feet
- reinstall salvaged limestone copings
- install new pavers on pedestals at the original flat elevation (up to 12” above roof membrane); 4 x 4 foot nominal format; provide for access for drain inspection and maintenance
- clean out roof drains (displaced bitumen and debris); repair / restore / replace broken or deteriorated cast iron drain parts

Option “B” – Retain Coping Stones In Place

- remove pavers and pedestals and discard
- remove railings and discard
- retain limestone copings in place
- retain metal flashings under copings; cut off exposed portions of metal flashings under copings; remove and discard other metal flashings (over construction joints)
- remove base flashings and built-up roof membrane and discard
- possibly remove nailing concrete cants at construction joints
- restore / repair / reconfigure nailing concrete cants at perimeters
- install a new premium-quality single-ply PVC roof membrane, fully adhered to deck in cold adhesive
- at and over the perimeter in-place copings, install the PVC roof membrane in loose laid fashion without adhesives or mechanical fasteners into the copings; attach the membrane to concealed concrete deck and to outboard masonry wall joint so as to leave no adhesive “goo” on stones nor actual holes in the stones.
- install a combination of new railings to replace existing and a fall restraint system; evaluate attachment of the railings to the deck versus the coping stones; possibly move the railing inboard a couple of feet
- install new pavers on pedestals at the original flat elevation (up to 12” above roof membrane), 4 x 4 foot nominal format; provide for access for drain inspection and maintenance
- clean out roof drains (displaced bitumen and debris); repair / restore / replace broken or deteriorated cast iron drain parts

Variants Available With Either Option “A” Or Option “B”:

1. Paver Size:
   - due to the weight of the 4 x 4 foot pavers and to facilitate easy future inspection and maintenance, install 2 x 2 foot pavers which can be removed and replaced without the use of heavy equipment
   - paver color and exposed aggregate texture to match that of existing pavers
   - the visual appearance of the original format can be simulated by a dark concrete stain line applied on a 4 x 4 format to the edge of the 2 x 2 pavers

2. Paver Height:
   - install new pavers on 5/8-inch-thick neoprene setting tabs in lieu of pedestals up to 12 inches tall
   - pavers will follow the slope of the concrete deck structure
   - install a shaped paver at the roof perimeter to transition from the new, lower perimeter paver elevation to the higher, original paver elevation

3. Cover Copings:
    - if Option "B" is adopted, in addition to covering the copings with single ply membrane, cover the single ply membrane with limestone-colored Kynar-coated metal to further shield the membrane and extend its life presumably by some decades. As with the single-ply membrane, the metal would not be attached through the coping stones to avoid irreversible impact.
    - if Option "A" is adopted, leave copings in place and cover with single ply membrane and metal as described in the previous variant. A project-specific detail and proprietary membrane is required to interface with a coal tar roofing membrane.
    - ***or*** as a further variant and in lieu of covering with metal, simply increase the thickness of the single ply coping cover to 80 or 90 mils thickness to provide extended life.
    - these three coping cover variants are a response to a unique historical condition and, because they fall outside of manufacturer's standard and tested details, will rely on experience and judgement for detailing to resist wind uplift.

4. Expose Membrane:
    - do not install new pavers
    - leave the roofing membrane exposed to view and to sunlight
    - where a bituminous membrane is employed, a granule or other surfacing will be required (not this variant may not have as long a life as a paver-covered membrane)

Option "C" – Repair & Maintain

- this option is available if and only if additional field investigation determines that there is significant viable service life in the existing membrane
- remove the pavers and discard
- perform additional maintenance operations that may include (as indicated by field investigation):
    - o remove and discard base flashings, and install new modified bitumen base flashings
    - o perform spot repair or renewal of the existing membrane
    - o apply a flood coat of bitumen to the membrane
- install a combination of new railings to replace existing and a fall restraint system; evaluate attachment of the railings to the deck versus the coping stones; possibly move the railing inboard a couple of feet
- install new pavers on pedestals at the original flat elevation (up to 12" above roof membrane), 4 x 4 foot nominal format; provide for access for drain inspection and maintenance
- clean out roof drains (displaced bitumen and debris); repair / restore / replace broken or deteriorated cast iron drain parts
- in the future, at end of the service life of the membrane, the pavers can be displaced to permit total reroofing at that time, then reinstalled

Variants Available with Option "C":

1. reduce paver size as described in variants, above, and / or
2. adjust paver height as described in variants, above

3. ***either*** retain in place the stone copings and metal flashings under coping (if field investigation warrants), ***or***
4. remove stone copings, renew through wall flashing (with metal-elastomeric combination flashings), and reinstall stone copings (if field investigation so indicates)

COST MAGNITUDE

While a genuine cost estimate is not within the scope of this assessment, our rough order-of-magnitude *guestimate* of the construction cost is as follows: if Option "C3" costs $1, then Option "C4" costs $2 and Option "B" costs $2 and Option "A" costs $4. This *guestimate* was arrived at by taking approximate square foot and linear foot measurements from the roof plan drawing and evaluating five major line items comprising the work and applying a ballpark unit cost to each. The individual unit costs are a *guestimate* based on years of experience on a variety of projects, and should not be the basis for a final decision, which should be informed by more precise estimates.

We hope that this assessment will be of value as you move forward in evaluating a course of action. Please let us know if you have any corrections to or questions concerning the assessment. We look forward to serving the Tennessee Valley Authority in the future.

Sincerely,

Richard E. Robison, R.A., C.C.S
Principal
Lord, Aeck & Sargent, Inc.

Copy: Susan Turner

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