

# Preservation of Ruins at Sweetwater Creek State Park Mill

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and Mark Girton

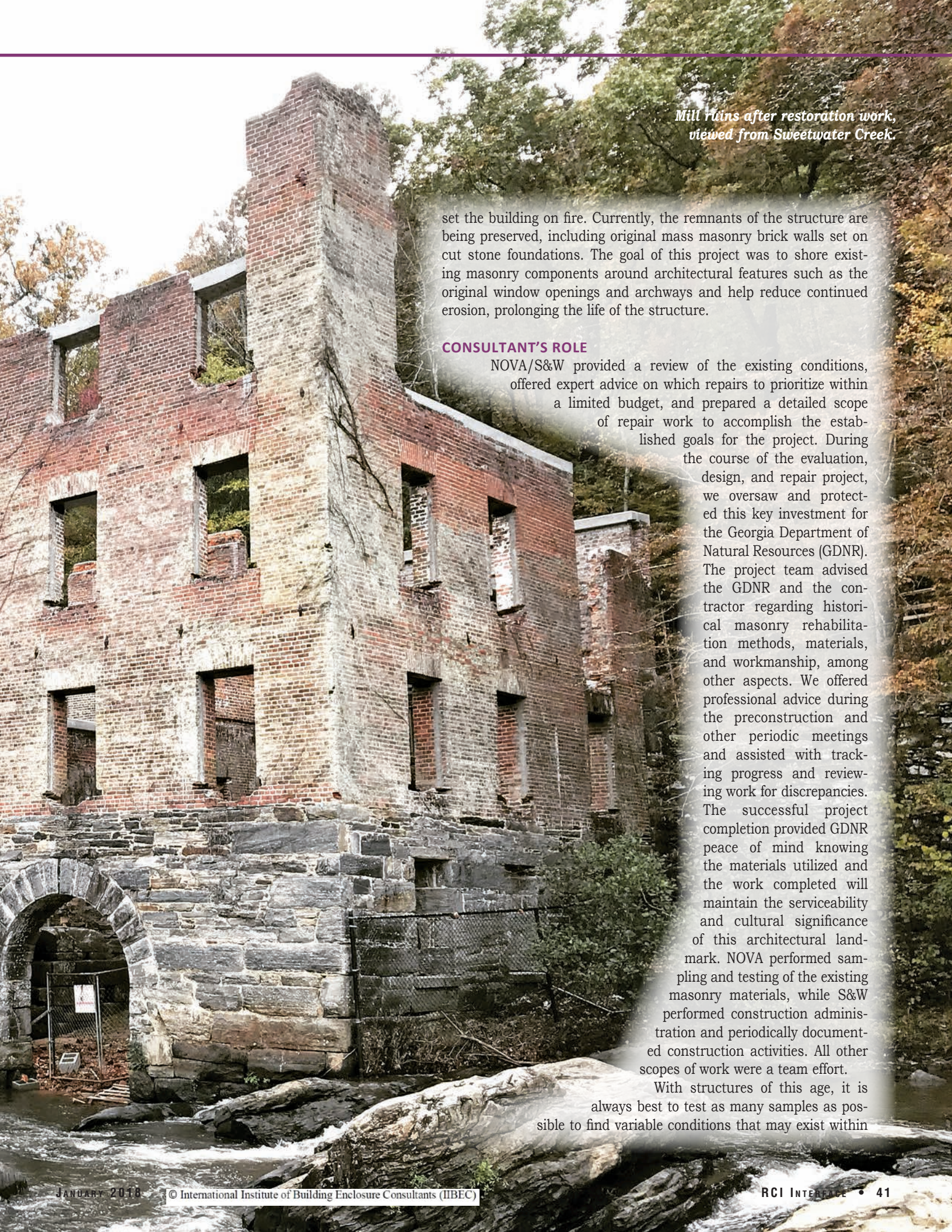
## OVERVIEW

NOVA Engineering and Environmental (NOVA) and Stevens & Wilkinson (S&W) teamed up to provide forensic engineering evaluation, repair design, and construction administration services at the historic Sweetwater Creek State Park Mill Ruins in Lithia Springs, Georgia.

The mill was constructed using slave labor in 1846-1849 as a five-story water-powered mill for production of thread yarn, cloth, and other materials. The lumber was supplied and bricks were manufactured on site, a few hundred yards upstream from the mill. The basement contained sperm whale oil storage for machinery use; the first floor was used for picking cotton seeds and cleaning raw textile materials; and the second through fifth floors were used for stretching, straightening, spinning, and weaving cotton. A 16-foot-wide, 12-foot-diameter, 45,000-plus-pound waterwheel provided power to machinery throughout the structure.

During the 1860s, the mill produced Confederate Civil War uniforms, until its demise on July 9, 1864, when Union troops imprisoned the workers, poured flammable liquids on all five floors, and





*Mill ruins after restoration work, viewed from Sweetwater Creek.*

set the building on fire. Currently, the remnants of the structure are being preserved, including original mass masonry brick walls set on cut stone foundations. The goal of this project was to shore existing masonry components around architectural features such as the original window openings and archways and help reduce continued erosion, prolonging the life of the structure.

#### **CONSULTANT'S ROLE**

NOVA/S&W provided a review of the existing conditions, offered expert advice on which repairs to prioritize within a limited budget, and prepared a detailed scope of repair work to accomplish the established goals for the project. During the course of the evaluation, design, and repair project, we oversaw and protected this key investment for the Georgia Department of Natural Resources (GDNR). The project team advised the GDNR and the contractor regarding historical masonry rehabilitation methods, materials, and workmanship, among other aspects. We offered professional advice during the preconstruction and other periodic meetings and assisted with tracking progress and reviewing work for discrepancies. The successful project completion provided GDNR peace of mind knowing the materials utilized and the work completed will maintain the serviceability and cultural significance of this architectural landmark. NOVA performed sampling and testing of the existing masonry materials, while S&W performed construction administration and periodically documented construction activities. All other scopes of work were a team effort.

With structures of this age, it is always best to test as many samples as possible to find variable conditions that may exist within



*Photo 1 – View of original water-powered mill archway before timber framing removal.*

*Photo 2 – View of five-story brick masonry piers, three stories of which are free-standing.*



*Photo 3 – View of mill interior before repair.*

the mortar and brick components. Using American Society for Testing Materials (ASTM) standards, we developed a scope of work within the available budget to best evaluate the materials for uniformity and consistency with raw natural resources being utilized as building materials in the mid 1800s. The budget constrictions limited our proposed testing to small portions of the as-built structure. We recognized that variations could exist beyond what was discovered during our testing.

**GENERAL OBSERVATIONS**

The project team visited the site in the summer of 2016 to gather information about the history of the structure, including previous attempts to stabilize the walls (*Photos 1-3*). The wall heights range from second-story level to just above the fourth-

floor level. A large portion of the exposed brick masonry exhibits some form of deterioration through weathering, aging, vandalism, and neglect. Some areas of the walls exhibit various forms of physical damage. Site personnel reported that prior to the state taking ownership of the structure, it was common for the walls to serve as a target or backstop for firearms practice. Evidence of this is the number of holes of various diameters in the walls. A few targeted areas were so consistent and dense that resulting larger holes in the masonry wall are present, some of which extend the full depth of the masonry.

Another type of physical damage present was vandalism. People have etched names or initials through the brick skin. We understand that a small number of these etchings

may be a part of the building's early history. The etched areas can more readily absorb water, since the brick cores tend to be more porous than the baked skin. Vertical cracks in the brick masonry were visible in a few locations. In most instances, the cracks do not appear to telegraph through to the opposite face of the wall. We did not verify the depth or the number of wythes that have cracked.

**BRICK MASONRY WALLS**

The brick masonry walls rest on a cut-stone foundation. In some areas, the brick

masonry is below current grade, and rising dampness appears to be occurring in some of the masonry where brick is in contact with earth. Rising dampness is ground moisture being wicked into the common-occurring capillaries of the wall system components. The constant moisture facilitates vegetative growth, which is displayed on various wall surfaces. Rootlets from climbing vines and other types of plant life work into the mortar, causing it to loosen and leave large capillaries in the joints.

Over the years, the absence of a roof and crumbling of the structure have left horizontal surface areas of brick masonry exposed where water collects. The water migrates into the masonry assembly, accelerating the erosion process. Other areas of possible water collection include pockets in the walls that previously served as framing pockets for wood beams, joists, and/or lintels above window openings. The jagged tops of the wall structure also likely retain water pools.

The firing of the brick during the manufacturing process caused the bricks to form an exterior skin that is more resistant to water absorption than the inner core of the bricks. This is commonly referred to as the

“fire skin.” We noted numerous bricks that have lost their fire skin; therefore, the brick is more porous and capable of absorbing greater quantities of water.

Mortar within the brick joints exhibited some natural erosion, such as loss of lime binder (as indicated by the sandiness of the joint). Continued recessing of the mortar creates ledges for water to collect. The mortar we observed that has not yet weathered appeared to be in fair condition for a structure of its age. The observed concealed mortar was solid and well adhered to the brick.

#### PREVIOUS MASONRY REPAIRS

It was our understanding that the earlier masonry repairs, while changing the look of the structure, were performed to ensure that some of the mill structure would be salvaged from further decay or loss. We observed some areas of previous mortar pointing repair that appeared to have a cement content, which does not match the lime-based mortar from original construction. Two conditions probably occurred at these previously repaired locations. First, the likelihood is that the repaired mortar is stronger than the brick composition. Should

the masonry expand, it could shear the face off of the brick or pop the mortar from the joint. Second, heavily lime-based mortar allows the passage of water vapor much faster than most cement-based mortars. The cement mortar will impede the exiting of water from the wall system, causing the lime mortar to remain in a moist state for longer periods. If the amount and longevity of a moist state is substantial, the lime may actually wash from behind the cement mortar, leaving voids and compromising the structural integrity of the walls.

#### MATERIAL TESTING

The project team removed five brick units and several mortar samples from the site for the purpose of determining the average rate of absorption and the average compressive strength of the brick units (Photo 4). Three of the brick units were from exposed conditions, and the remaining two samples were from areas not commonly exposed to direct weathering. The mortar samples were taken from the east wall in a location within the wall not exposed to normal weathering. Laboratory testing included ASTM C67, *Standard Test Methods for*



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Testing Brick and Structural Clay Tile (modified) and ASTM C1324, Standard Test Method for Examination and Analysis of Hardened Masonry Mortar (modified), which helped identify the composition, compressive strength, and the absorptive qualities of the existing masonry.

The modified ASTM C1324 testing included acid digestion of mortar samples to determine the composition of the existing material. The collected information was used in determining a recommendation for compatible repair methods and materials. The test results indicated the mortar material consists of a lime putty and sand mixture that is consistent with the historical period.

ASTM C67 typically requires no fewer than ten bricks. To reduce costs in this particular case, five brick units were selected for a modified test procedure—some from worst-case erosion conditions and others selected from areas with limited wear. The brick units typically had a compressive strength ranging between 690 psi and 1110 psi. A single outlier brick unit tested to 3750 psi. Testing of the samples concluded that the mortar had a low compressive strength, thereby indicating the use of portland cement in the mortar was unlikely.

The tested absorptive qualities of the brick reflected percent absorptions ranging from 9.7% to 22.1%. Results beyond 20% are considered high and will likely affect the long-term performance of the brick. U.S. Heritage Group assisted with testing and analysis. One brick sample tested exceeded 20% absorption.



Photo 4 – Brick samples collected and analyzed per ASTM C67, Standard Test Method for Sampling and Testing Brick.

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*Photo 5 – Sloped concrete caps installed to protect walls and shed standing water.*

**ANALYSIS AND SUMMARY OF FINDINGS**

We researched and evaluated various repair procedures and methods, assisted with product selection, and discussed testing and site visit results with GDNR to help them develop the conceptual scope of work for repairs and restoration. The test and survey results, as well as the repair recommendations developed, were presented in a formal summary report with photographic documentation and a point cloud analysis of the existing structure. While the current standards—such as those outlined in technical notes developed by the Brick Industry Association (BIA)—did not exist in the late 1840s, based on test results, we believe the bricks included in our sampling would rate very near a Class II brick, with the exception of one brick that more than doubled the Class I standard of compressive strength. We suspect this may be the result of being over-burnt during the manufacturing process. Currently, Class II brick is typically used in a configuration such that it will be covered by an additional component because of the rough, sometimes nonuniform, appearance.

The mortar appears to exhibit various forms of weathering, although joint cracks were rare. While we could not closely inspect the higher regions of the wall, some of the joints appear to be recessing because of water likely cascading from the upper horizontal surfaces of the standing walls. Stresses, such as settling, have resulted in vertical cracks that extend through the masonry. These cracks were located higher up on the walls than we could access. Transmission of the cracks was not visible on the opposite face of the walls.



*Photos 6 and 7 – Window openings with brick masonry repairs and steel plate lintels.*



*Photos 8 and 9 – Granite arch after restoration, as viewed from hiking trail. Note timber framing has been replaced with architectural steel bracing (hidden from public view).*



### RECOMMENDED REPAIRS

We developed a conceptual scope of repair work to address the decaying conditions observed at the Sweetwater Creek Mill Ruins. Our recommendations took into account the historic importance of the structure and the function of the wall components in place.

Since its burning in 1864, we assume little to no large-scale maintenance or repair has been performed on this building. Despite the abandonment and long-term exposure to moisture on all sides, significant portions of the structures still remain because of the naturally occurring characteristics of the brick masonry and lime mortar working in concert. It is for these reasons we did not recommend full-surface coatings or repellants be applied to the walls with exposure to moisture on all sides. The introduction of these inhibitors could significantly decrease the wall system's ability to vent/release moisture and function as it has for the past 150 years. Instead, we provided recommendations for repairing areas with conditions that allow bulk water to enter the system through cracks, openings, and high-absorption areas caused by standing water.

We discussed the scope with GDNR and agreed upon the following repair work, which was then presented to bidding contractors in the form of specifications and drawings. A quantity of the original brick units were salvaged and utilized to perform repairs. This included removing and rebuilding unstable brick units exhibiting advanced deterioration. A sloped, low-profile, generally moisture-resistant concrete cap was placed on horizontal surfaces to alleviate standing water (Photo 5). Other repair areas included


*Photo 10 – Saw-cut mortar joints in preparation for tuckpointing mortar.*



bracing brick headers and freestanding brick piers with concrete lintels, installing new concrete lintels at severely deteriorated openings, and infilling voids above lintels with original brick. New steel lintels and architectural steel plates were installed to support less-deteriorated brick headers exhibiting horizontal cracking and granite stone block arches (Photos 6-9). Vegetative growth was removed from wall surfaces. Mortar joints were repointed with abnormal lime putty and sand mortar formulations (Photo 10). The existing material has lasted over 150 years with little to no maintenance, despite being subjected to high temperatures during the 1864 burning. Introduction of a mortar with common cements could be destructive to the existing mortar, the softened brick masonry, and, in our opinion, would produce further and accelerated moisture damage.

The estimated construction cost was \$257,000, and the final bills totaled \$280,000. Given the unknowns dealing with a 150+ year-old structure and the complicated site access, the project team was

satisfied with limiting change orders to a 9% increase. NOVA/S&W's budget and actual cost was \$34,300. This repair project will

extend the life of the structure 50 or more years and preserve a historic structure for park visitors for years to come. 



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*Leso has 15 years of work experience and a master's degree in architectural engineering with a minor in architecture, having studied abroad in Italy and England and graduated from Penn State University. He participates in RCI, NRCA, USGBS, ICRI, BEC-Atlanta, CEFPI, GASFA, BOMA, and other groups.*

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**Mark Girton**

*Mark Girton has 35 years' experience in the architectural engineering field, focusing on roofing and waterproofing systems. He excels at water leakage investigations and producing repair designs. He is also an expert in electronic leak detection and infrared thermography and was trained in architectural and advanced structural design at Phoenix Institute of Technology, uniform building code determination and enforcement at New Mexico Polytechnic Institute, and computer-aided drafting and design at New Mexico Junior College.*

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