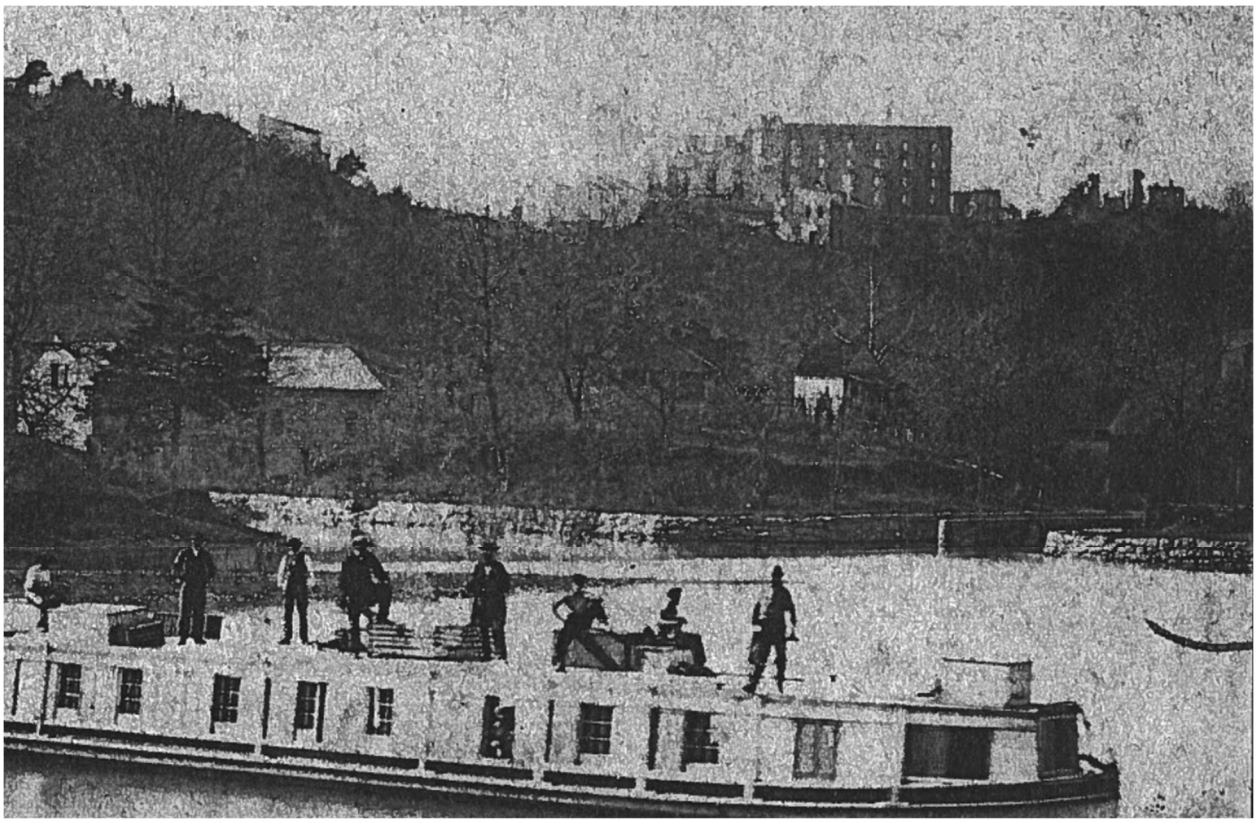
Jordan's Point Park

HISTORIC WALL CONDITION ASSESSMENT REPORT

MARCH 2020



McMullan & Associates
Douglas E. Bond, PE
Reston, Virginia
March 12, 2020

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CONSULTING ENGINEERS

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Background

McMullan Consulting Engineers was retained by the City of Lexington to provide a site visit to observe and assess the foundation conditions of stone masonry walls along the historic Mill Race at Jordan's Point. Water levels in the race have dropped due to the removal of a dam in the adjacent Maury River in the spring of 2019.

There are two walls to be investigated, a Canal Gauge Dock at the east end of the race, and the foundation of a mill building adjacent to the bridge across to the island near the midpoint of the race. The connection between the mill race and the Maury river at the west end of the race is no longer active since the lowering of the water resulting from the dam removal.

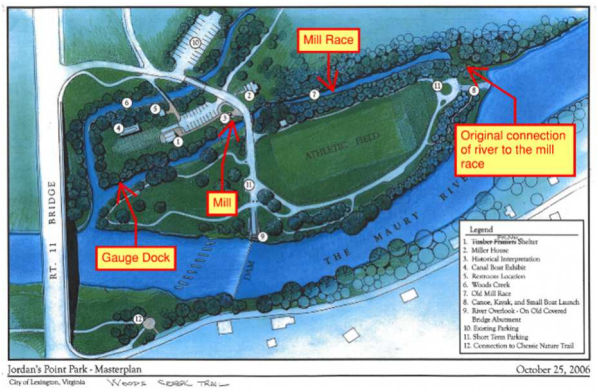

Figure 1 - 2006 graphic of the master plan for Jordan's Point with locations of the Lexington Gauge Dock and the Mill indicated with red arrows.

The city has expressed concerns that foundation timbers observed at the Canal Gauge Dock may be affected by the drop in water. The purpose of this assessment is to evaluate the foundation conditions at these two walls and make recommendations to the city.

The Lexington Canal Gauge Dock was part of the James River and Kanawha Canal North River Navigation system that operated from Richmond to Lexington in the mid-19th century. The dock was used to measure the weight of cargo in canal boats for tolls.

During the visit, the Department of Public Works (DPW) for the city of Lexington used pumps to lower water levels and hand excavated test pits to expose the foundation conditions. This work was observed by Douglas Bond, PE of McMullan Consulting Engineers, Joseph Loferski, PHD, Professor of Wood Science at Virginia Tech, and Arne Glaeser, planning director for Lexington.

Mr. Bond worked with the DPW in determining the location and depths of excavations. Tape measurements, general observations, and photographs were taken of several conditions. Field sketches of the exposed parts of the wall were taken.

McMullan Consulting Engineers has performed similar engineering assessments at many historic canals, including the Chesapeake and Ohio Canal, the James River and Kanawha Canal, the Morris Canal, the Erie Canal, the Augusta Canal, and the Ohio and Erie Canal. It has been our pleasure to provide our engineering services to the City of Lexington.

The James River and Kanawha Canal

This canal was begun in 1785 with George Washington as honorary president. The James River Company was originally opened in 1790 and supplemented bateaux transportation on the James River. By 1801, the James River Company had improved 20 miles of the Maury, up to Lexington, by building sluices (channels) through the rocky shoals, and low piles-stone walls called wing dams to funnel the river into the sluices. The canal project stalled after the War of 1812 until the Commonwealth of Virginia took control of the project in 1820 and resumed construction using state funds. The project stalled again and was

then resumed in 1835 under the new James River and Kanawha Company.

The canal extended 196 miles from Richmond to Buchanan by 1851.

In that year, the North River Navigation Company began to build locks and dams in order to extend the canal to Lexington. The canal system reached the Lexington Docks in 1860 with a series of locks and dams along the river. The canal system operated until 1880 after being sold to the Richmond and Allegheny Railroad company in 1878. This canal is documented in the Maury River Atlas published by the Virginia Canals & Navigation Society and was prepared by W.E. Trout III and Philip de Vos.

Past Studies

A short assessment of the stone masonry walls was produced by Nick A. Brash, PE, of Comprehensive Construction Services, Inc. in September of 2018.

In this report, the timbers were observed from the northside stream bank at the east end of the mill race to extend under the stone wall on the south bank. The timbers were said to be in danger of deterioration due to exposure to air.

Research and Historical Documents

A brief internet search was conducted for information for the Lexington Canal Gauge Dock. No specific data was found, but some related lock wall specifications for the James River & Kanawah canal were located.

There is a book available on Google Books "Reports, Specifications, and Estimates of Public Works in the United States of America" by William Strickland, that contains the original specifications for a few of the dams and aqueducts on the James River and Kanawha Canal. The following items contained in those specification and may have been used during the Lexington Gauge Dock construction:

- Canal Locks were to be founded on 12" x 12" white oak or pine timbers laid 6 inches apart.
- Two layers of 2.5" thick planking were to be fastened to the timbers using wood tree nails and spikes.
- The lock stone masonry walls were to be founded on top of the planking
- Cement for the mortar for locks east of Scottsville was to be obtained from Richmond, and those locks above Scottsville it was to be procured from "some point west of the Blue Ridge and within ten miles of the Blue Ridge canal"

The Maury River Atlas contains an excellent copy of an 1866 photograph of the gauge dock. The photo is reportedly in the archives at the Virginia Military Institute.

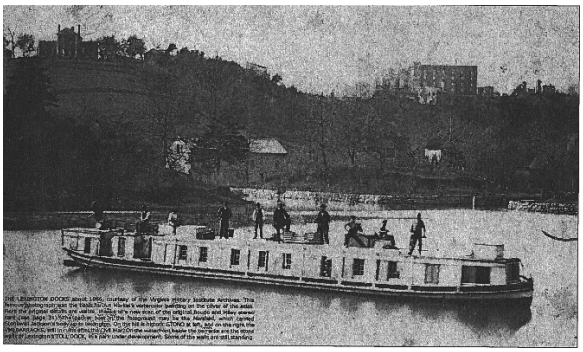

Figure 2 – 1866 Photograph taken from the Maury River Atlas of a packet boat in the Maury River just east of the Lexington Gauge Dock.

Enlargement of the photo shows that there were three walls at the Gauge Dock, one on each bank at the eastern exit of the tail race into the Maury river and one wall in the middle of the race.

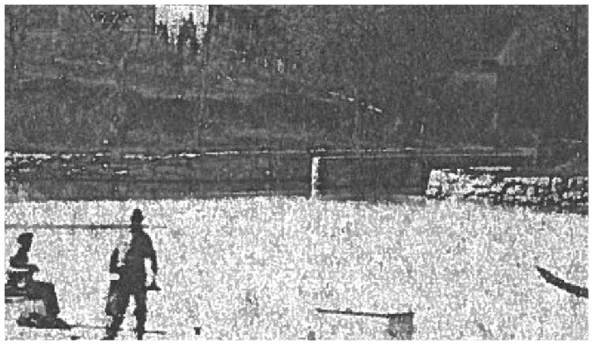

Figure 3 - Enlargement of the 1866 Photo with the Gauge Dock in the background. Note the wall in the center of the tail race, and the slope of the grade behind the south bank wall,

It is important to note in the photo that the earth behind the wall on the south bank appears to be nearly level for several feet to the south before it slopes upward.

An 1873 survey plan provided by the city, does not show the middle wall, but does indicate the location of the gauge dock. A number of buildings are indicated on the island between the tail race and the river (noted as "BASIN" in the image below). The Mill building is located on the south side of the race adjacent to the bridge to the island.

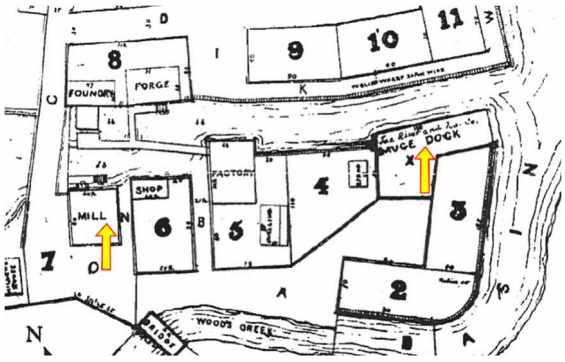

Figure 4 – 1873 Survey Plan of Jordan's Point. Arrows indicate the Lexington Gauge Dock and the Mill.

An 1877 Map of the City of Lexington shows a rail line located on the west side of the island, which differs from the location of trestle in the tail race just west of the Millers House.

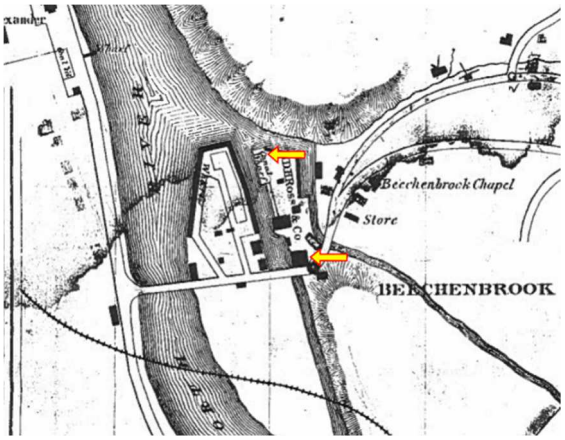

Figure 5 - 1877 Survey of Jordan's Point. Arrows indicate the location of the Gauge Dock and the Mill

A later survey, date unknown, shows the correct location of the rail line located north of the mill, as well as a spur line located south of the mill that runs to the east. This is important because the grade would have to be level for trains to operate on the spur, and the current grade behind the gauge dock wall is much steeper than indicated in the 1866 photograph. Also, the Gauge Dock does not appear in this survey, and has presumably been removed.

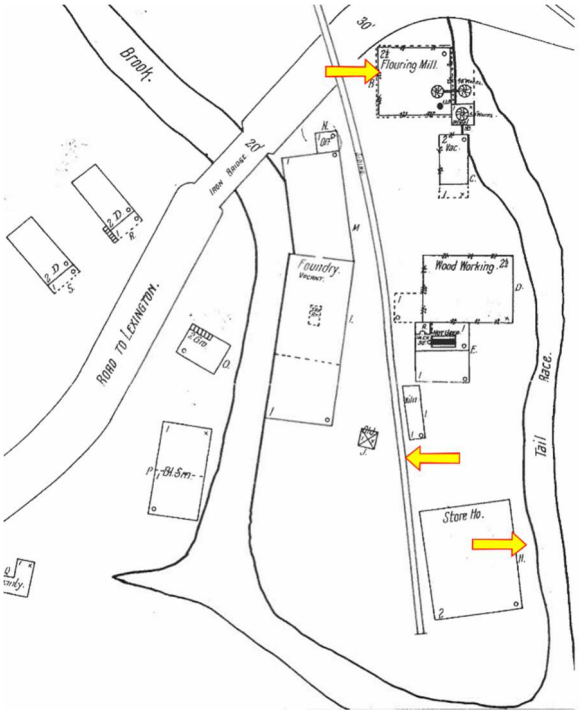

Figure 6 - Survey of Jordan's Point, date unknown but assumed to be after 1877. There is a rail spur located to the south of the Mill and the Gauge Dock has been removed (left pointing arrow).

The Mill building wall originally extended above the bridge as indicated in the photo below, but has been lowered to nearly match the elevation of the bridge.

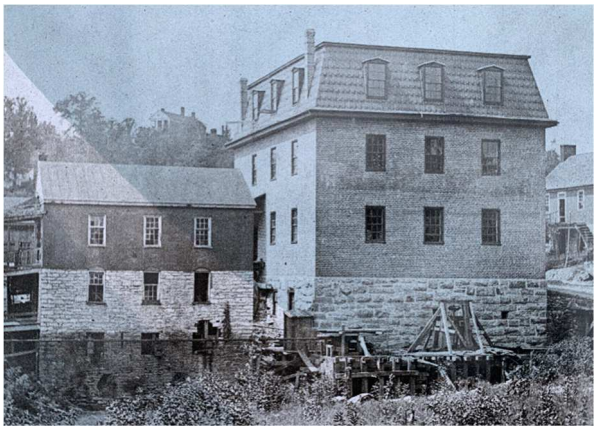

Figure 7 - The Mill building foundation wall is seen to extend above the grade of the roadway

Field Investigation

The field investigation was conducted on February 24, 2020. Two trash pumps were used by the City Department of Public Works personnel to lower the water level in front of the Canal Gauge Dock wall and the Mill Foundation Wall.

Canal Gauge Dock Wall

The water over the timbers was about 18-24 inches deep before pumping. Only one timber could be seen in the sediment prior to pumping.

Excavations were conducted at four locations along the wall and timbers were exposed at all four. In addition, a rebar was used to probe into the soft sediment along the wall and attempt to locate additional timbers. Measurements, photographs and field sketches were recorded.

Figure 8 - The sediment above the timbers was excavated by DPW personnel and can be seen in the photo.

Three groups of timbers were observed to extend perpendicular from the face of the wall about 20 feet into the tail race. The timbers are consistently 8”x8” and there is about 12 inches clear between the timbers. Samples of the timbers were extracted in 6 locations by Mr. Loferski, noted E-1 through E-6 on the sketch below which also indicates the plan locations of the excavations. The cores were taken with an increment bore tool. All the timbers where found to be very difficult to core, with one being so hard that extracting a core was not accomplished.

Figure 9 - Cores were extracted from several of the timbers using an increment borer. The cores were taken to the lab at Virginia Tech for species identification.

See the attached report from Mr. Loferski for more details on the condition of the timbers. A field sketch was prepared to indicate the approximate locations of the timber groupings along the wall.

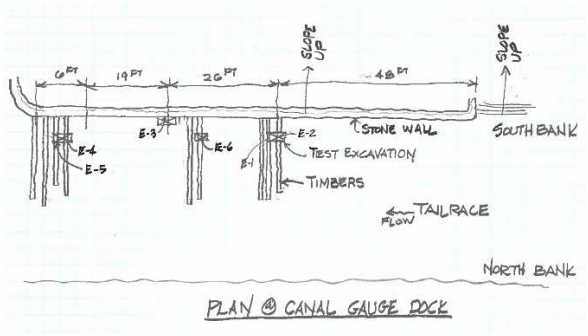

Figure 10 - Field Sketch - Plan of the Dock Excavation with locations of timbers and test pits

No excavations or probing for timbers was done for the western half of the wall where the sediment was deeper than the east half.

Along the base of the wall, there is an 8” deep timber that runs flush with the face of the stones. The perpendicular timbers which extend into the tailrace run underneath this face timber.

Figure 11 - An 8x8 inch timber was seen to run parallel to the wall under its face. End of the tape measure is in contact with the timber.

Timbers were only found at the locations indicated in the sketch and many of the areas between the timbers were probed with the rebar at about 2 to 3 inches on center in an attempt to find other timbers, but none were found. We assumed that these groups of the timbers extend from the wall and formed part of a foundation for the wall in the middle of the race that can be seen in the 1866 historic photograph included previously in this report.

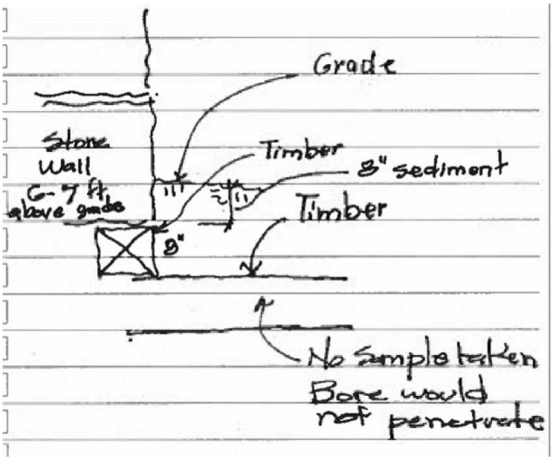

Figure 12 - A field sketch of the timber at the face of the wall was prepared to show how the cross timbers run underneath

The wall was measured to be about 6’-6” above the timber foundation. The tilt of the wall was measured in several locations and found to be up to 8” of horizontal within 6’-6” vertical. This tilt is quite noticeable when standing next to the wall.

Figure 13 – Field sketch at base of stone wall showing 8" timber parallel to the wall and cross timbers below at Location E-6

The stones are roughly coursed with varying sizes. Typical stone sizes within the wall were measured to be as follows:

- 27"x8"
- 20"x40"
- 20"x65"

The stones have a hammered finished face and appear to be quarried from a sedimentary type rock. There are horizontal planes in some of the stones that indicate that the stones have some minor deterioration in the bedding planes which can be expected from this kind of stone. Random mortar bed joints between stones were measured and found to vary from 0 to 1".

Figure 14 – Close-up view of the Dock Stone Masonry

Mortar joint widths varied, from zero up to about 1-inch in width. Smaller stones were used as chinking between the larger stones in some locations.

The mortar is in fair condition and was found to be fairly hard and not crumble when scraped with a trowel. There is missing mortar in many of the joints. Some pieces of mortar that were removed from the wall could be broken by hand. The sand in the mortar appears to be consistent and well graded. Given its condition, it is likely that some hydraulic lime or natural cement is contained in the mortar. A mortar analysis would provide more detailed information.

The grade behind the wall slopes steeply down to the wall. The grade in the historic 1866 photograph presented earlier in this report does not appear to be as steep as the present condition.

Two iron rods were found by the DPW crew while excavating in the sediment. These are assumed to have been used to tie timbers together for some structure in the past.

Figure 15 – Iron bars found at the bottom of the wall

The slope at the back of the wall was too steep to allow equipment access and so a text pit excavation to explore the back of the wall condition was not attempted.

Between the foundation wall of the Mill and the Gauge Dock Wall, water was observed seeping into the mill race from the base of the slope.

Mill Foundation Wall Investigation

At the Mill foundation wall, two pumps were used to draw down the water. The water was lowered about 18-20 inches, but could not be lowered further due to the inflow of water from western side of the bridge.

Figure 16 - Foundation wall for the Mill. The stones in the tail race were likely foundation stones for the turbine.

At the base of the bridge foundation, there is a concrete slab placed on timbers that are exposed on the eastern edge. In the concrete abutment, there are vertical slots on the north and south sides that appear to be for the use of wooden boards to temporarily dam the water and allow for repairs of the mill turbines.

Figure 17 - Slab at the base of the bridge was placed on timbers. There is a slot or notch in the concrete abutment, likely used to slide in boards to dam the water during repairs to the turbine.

In order to lower the water further, larger pumps or a temporary sandbag cofferdam would be needed.

Figure 18 - Stones at the base of the Mill wall

We were able to probe the ground in several places in front of the Mill wall with a reinforcing bar to search for timbers. The rod was unable to penetrate more than a few inches of sediment in any one location due to the rocky surface below the sediment. We could not determine if this was natural rock or creek stone.

Vegetation was observed growing through the wall, and has been cut back in some locations.

Figure 19 - Vegetation was observed to be growing in the joints between the stones at the Mill Foundation wall

Analysis and Conclusions

Our analysis was based on measurements and observations, no calculations were performed.

Gauge Dock Wall

This masonry is in fair condition. There has been loss of mortar in the joints as well as deterioration of the stones, but the wall remains in plane with no bulges or other distortions. There is a significant (8-10 degree) tilt to wall, probably as a result of lateral earth pressure from the slope behind the wall. It appears that the slope has increased since the 1866 photo, and it is assumed that when the rail grade was installed after the 1877 survey, the grade was raised to level.

There is little evidence of vegetation growing through the wall but there are several small trees at the top of the wall whose root structures could be penetrating the masonry and could lead to further deterioration of the masonry over time. Removing trees requires care not to damage the masonry, but vegetation should not be allowed to grow into the masonry if at all possible. Consideration should also be given to avoid de-stabilizing the slope by removing trees.

Timber Foundation at Gauge Dock Wall

The timbers at the base of the wall were found to be white oak in reasonably good condition. This is probably due to their being located under water since there construction. White oak has some natural decay resistant properties and was used in many historic canal specifications for lock wall foundations and lock gates. As described by Loferski, keeping the timbers in an environment with as little exposure to oxygen, such as being submerged in water, is key to their continued good condition. McMullan has observed many canal structures where the decay of similar timber foundations has resulted in the tilting of masonry walls and other damage to the masonry.

Mill Foundation Wall

This masonry is also in fair condition. There appeared to be no tilt to the wall. Although no foundation timbers were found, there is no

evidence of foundation deterioration. There has been a loss of mortar in the joints between the stones, but no large cracks or bulges in the stone masonry were observed. There does appear to be some vegetation growing from the joints between the stones. If left untouched, this could grow to the point that it will lead to damage of the masonry. There are a number of trees at the top of the wall with root structures that may be working their way into the masonry.

Recommendations

The following recommendations represent our professional opinion based on our observations, measurements, and experience with other similar structures. The goal of the recommendations is to preserve the two historic wall structures that we studied.

Gauge Dock Wall:

1. Remove some of the slope behind the wall to provide a gentler slope, similar to that seen in the historic photograph. This will reduce the earth pressure on the wall and still promote ground run-off to flow over the wall.
2. Leave the wall in its current tilted position. By reducing earth pressure and keeping the foundation timbers submerged, the wall should remain stable for some time.
3. Remove some of the vegetation at the top of the wall to prevent it growing into the masonry.
4. Do not allow any vegetation to grow through the wall.

Timber Foundation at Gauge Dock Wall:

1. Keep the timbers submerged in water. That is the best way to preserve them. If they were to decay, that would likely result in damage to the Gauge Dock Wall masonry.

Mill Foundation Wall

1. Remove any vegetation that is growing through the wall. Don't disturb the masonry by pulling the roots out. Coat any remaining roots with herbicide.
2. Remove vegetation at the top of the wall, but do not damage any masonry by using excessive force. A railing or fence may have to be considered since removing the vegetation may result in a falling hazard.

General comment:

Trees that grow into masonry cause damage. See the image below for an example in another McMullan project where a stone was pushed out of a wall from tree roots.

Figure 20 - Example of wall damage by vegetation, This stone was pushed out of the plane of the wall by the growth of tree roots (located at the C&O Canal in Washington DC)

Appendix A – Wood Identification Report

March 6, 2020

Douglas E. Bond, PE, SE, Principal
McMullan & Associates
11800 Sunrise Valley Drive, Suite 430,
Reston, VA 20191

Dear Doug,

This is a report on my investigation of the timbers in the millrace of Jordan's Point Park located in Lexington Virginia. I visited the site on February 24, 2020. During my site visit I was accompanied by Mr. Arne Glaeer of Lexington, and yourself, Mr. Doug Bond. Also present were multiple workmen of the Lexington public works department.

The objective of my visit was to inspect the condition of the timbers and to identify the wood species.

Upon arrival, the workmen used portable water pumps to dewater the site so that I could get access to the timbers that are located in the sediment in the bottom of the millrace and the bottom of the stone wall. I was able to obtain wood samples from five timbers. I used a hand-held increment core borer to drill into the timbers and remove a core from the timber for use in wood species identification. The cores are approximately 0.2 inches in diameter and ranged from 3 to 5 inches long.

One core was removed from each timber that was found. All the timbers were very hard and had sound, solid, non-decayed wood. The increment core borer made a high-pitched squeaky sound as it was turned into the wood indicating that the timbers had very little deterioration. The outer approximately ¾ inch of the cores removed from the timbers were black colored and wood deeper in the timbers was light colored and appeared fresh even though the timbers were installed 100+ years ago. The wood from the black outer zone had a characteristic musty odor of anaerobic bacteria which decompose the wood cell wall very slowly compared to decay fungi. No wood boring insects were observed in any of the timbers.

Each core was placed in a plastic zipper lock-bag labeled and with a permanent marker to identify the sample number and the location of the timber. Later, I used microscopic wood identification techniques to identify the wood species. All the timbers are white oak (*Quercus alba*). The following chart shows the sample location and wood species and condition.

Photographs in the Appendix show the millrace.

Jordan's Point Park Mill Race Lexington Virginia 2020			
Sample	Location	Wood Species	Condition
E-1	Middle of wall	White Oak	Outer 3/4-inch anaerobic bacteria; sound, solid core
E-2	West of E-1	White Oak	Outer 3/4-inch anaerobic bacteria; sound, solid core
E-3	Under wall	White Oak	Outer 3/4-inch anaerobic bacteria; sound, solid core
E-4	East of E-3	White Oak	Outer 3/4-inch anaerobic bacteria; sound, solid core
E-5	Eastern most	White Oak	Outer 3/4-inch anaerobic bacteria; sound, solid core

If you have any questions regarding this report please contact me.

Sincerely,

Joseph Loferski, PhD, Professor
Department of Sustainable Biomaterials
Virginia Tech
Blacksburg VA.

Appendix

Photograph 1: Workmen using pump to dewater the site. The stone wall is visible on the right.

Photograph 2: Workmen digging access hole to timber. Stone wall is visible behind workmen.

Photograph 3: Workmen digging two timbers.

Photograph 4: View of mill race with workmen on left.