12-8-2023

Condition assessment of the northern climatic research house at the USDA forest service forest products laboratory

Tanaya Johnson
Mississippi State University, tlj25@msstate.edu

Condition assessment of the northern climatic research house at the USDA forest service forest products laboratory

By

Tanaya Johnson

Approved by:

Rubin Shmulsky (Major Professor/Graduate Coordinator)
Iris Montague
Laya Khademibami
L. Wes Burger (Dean, College of Forest Resources)

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Sustainable Bioproducts
in the Department of Sustainable Bioproducts

Mississippi State, Mississippi

December 2023

Name: Tanaya Johnson

Date of Degree: December 8, 2023

Institution: Mississippi State University

Major Field: Sustainable Bioproducts

Major Professor: Rubin Shmulsky

Title of Study: Condition assessment of the northern climatic research house at the USDA forest service forest products laboratory

Pages in Study 45

Candidate for Degree of Master of Science

In 2001 a Northern Climatic Test House (the House) was constructed to demonstrate appropriate and novel building techniques and materials for the upper Midwest region of the USA. The House is a 2,300-square-foot, two-story structure located on the grounds of the USDA Forest Service Forest Products Laboratory (FPL) in Madison, Wisconsin. It is considered a research structure and not part of the FPL's building inventory. Following construction, the House was heated and cooled but not occupied. Regular (sometimes daily) tours were conducted from it's opening until about 2008, when tours had diminished to less than one per week. Since eliminating regular tours, the house has been used occasionally for special events, intermittent tours, and storage. In May-July 2023 a visual and minimally invasive condition assessment was performed on the House. This report details the findings of this assessment. This report focuses on existing or potential problem areas.

ACKNOWLEDGEMENTS

I would like to thank USDA Forest Service Forest Products Laboratory for allowing me to conduct research on their research house. I also thank USDA Forest Service Forest Products Laboratory for funding my research project. I would like to thank my major professor, Dr. Rubin Shmulsky for trusting me to inspect the home and for showing me the ropes of how to inspect properties the proper way. I would like to thank my committee members, Dr Iris Montague, and Dr. Laya Khademibami for helping me throughout this journey. I am forever grateful. I would like to thank my PI, Dr. Kevin Ragon and Aleria Story for making the trip to Madison Wisconsin and for helping with the inspection of the house.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

LIST OF FIGURES iv

CHAPTER

I. INTRODUCTION 1

History of the house 1
Current Status of the House 3
Demand for the Location 3
Literature Review 3

II. METHODOLOGY 5

How was the house inspected? 5
What to look for during the house inspection? 9
Tools and equipment used for the inspection of the house. 9

III. RESULTS 11

Data that was collected during the inspection. 11

IV. CONCLUSIONS AND RECOMMENDATIONS 42

Conclusions and recommendations 42

REFERENCES 44

LIST OF FIGURES

Figure 1 This image is illustrating the student using a hammer gently striking silver area which is the sheath underneath the siding of the house to determine if moisture is present. ...6

Figure 2 The student is kneeling down to insert a screwdriver into the front porch steps to measure the dept of decay. ...8

Figure 3 The circled image is the joist box and the rail. The circle is showing how the Joist box to rail connection is showing insufficient fixity. ...11

Figure 4 Dr. Shmulsky is measuring the deck height to ensure it is up to code with the International Residential Code. ...12

Figure 5 A and B, the images are of the back deck, and it shows the problematic areas. Images of the rail-to-post connects have completely failed in the highlighted location. ...13

Figure 6 A through D, Images of figures A through D shows images of the damaged storm door from the back deck. The images show that the door is severely deteriorated. ...14

Figure 7 Dr. Shmulsky is measuring the deteriorated area with a tape measurer to get the width of the deteriorated deck that was removed. Some of the deck could be removed without effort as illustrated in the image above. ...17

Figure 8 A through D, Deteriorated rail-to-post was severely decayed and the rail can be removed from the post and the post was also decayed. When probing the post with a screwdriver, the screwdriver went in the post without much effort. ...18

Figure 9 The image shows advanced decay in carrying beams which support the floor frame of the accessibility ramp. The screwdriver is in the decayed area in the carrying beam, the image shows dept of decay. ...21

Figure 10 The image is one of the entrance ways to the accessibility ramp and its exemplar "Closed" sign and rope barricade at one of three entrance points to the accessibility ramp. ...22

Figure 11 This image of the accessibility ramp from the front porch view. The images shows that the area should have a closed sign as in figure 10. ...23

Figure 12 The student is inserting a flat head screwdriver into the post to indicate decay is present in the structure. ...24

Figure 13 A and B, in image A screwdrivers were inserted into the decayed portions to probe the extent of the deterioration, however, in image B, students kneeling to insert screwdriver into the front porch step. The screwdriver was inserted into the decayed portion to probe the extent of the deterioration. 25

Figure 14 Dr. Ross is bending over to show where the front porch can be lifted, therefore, the porch flooring near the top of the steps has become unfastened due to fastener corrosion. 27

Figure 15 The image is still of the front porch entrance and the post trim showing signs of deterioration. 28

Figure 16 The image is of the front porch ceiling, and the photo depicts tongue and grove ceiling swelling indicating moisture issues.....29

Figure 17 The image is the back deck of the demo house where the T1-11 siding is mostly located on the house and the image shows signs of decay and missing pieces of the siding.....31

Figure 18 This image is a closer look at the siding and the siding is deteriorating beneath the vicinity of the triple mullion dining room window. The screwdriver is inserted in the decayed area to indicate that the area is deteriorating. 32

Figure 19 This image is a large cedar tree near the house, which is located on the Southwest side of the house where decay may be accelerated because of the tree due to the fact that there's not enough sunlight which means more moisture is acceptable in this area. 33

Figure 20 This image shows the section of T1-11 siding removed beneath the triple mullion dining room window to prepare to test the silver area to indicating if moisture is present behind the siding. 35

Figure 21 This image is illustrating the student using a hammer gently striking silver area underneath the side to determine if moisture is present.....36

Figure 22 The photograph is of the areas where utilities are attached and show similar signs of decay. 36

Figure 23 The image is of the trim boards of the house and the trim boards around the house are showing signs of decay due to failure of paint. 37

Figure 24 The image is of the roof shingles and the shingles showing signs of weathering. Biological growth and puckering can be seen on the shingles of the roof. 38

Figure 25 A fracture or buckling of sheet rock in the great room and the right-side header inside the great room shows fracture or buckling in the drywall above the door opening.....40

Figure 26 These images show signs of settling in the foundation, photo located in the southwest portion of the basement and top left photo in front of the carport. The treated plywood foundation shows un-leveling underneath the flooring. 41

CHAPTER I

INTRODUCTION

History of the house

A Northern Climatic Test House was built in 2001 in the upper Midwest region of the USA. The house is a 2,300 square-foot, two-story dwelling located on the grounds of the USDA Forest Service Forest Products Laboratory (FPL) in Madison, Wisconsin (Williamson et al. 2010). The house is a research structure to conduct studies on moisture in the cold climate region; however, it is not part of the FPL's building inventory. According to the USDA Walkthrough Tour brochure (Williamson et al. 2010), moisture and mold were major natural issues and researchers wanted to educate builders on the best way to construct buildings to reduce or if possible, eliminate moisture and mold on the structures.

The Northern Climatic Test house is also known as the Research Demonstration "Demo" House. The Research Demo House was created as part of the Advance Housing Research Center (AHRC). AHRC was a natural effort to promote the wise use of wood in construction such as Southern Pine. After the construction was completed, the house was heated and cool; however, the house was not occupied. Between May and July 2023, a visual and minimally invasive condition assessment was conducted on the house. The specific details included a visual inspection of the timber and other wood structural elements. The assessment was done when the house was approximately 22 years old. The findings of this assessment are summarized in this report as well as the existing or potential problem areas.

The ramp located from the sidewalk and parking area leading to the front porch provides accessibility to the house. The ramp was built with four different types of wood. Then the ramp was treated with nine different preservative treatments. An untreated black locust and IPE were used to build the ramp and black locust was used because it is decay resistance. IPE is a beautiful piece of wood from Central and South America usually used for decks. The ramp railing was finished with penetrating oil stain that was developed at FPL.

The exterior siding was made from specially manufactured plywood commonly known as T1-11. T1-11 siding was a wood material, usually plywood, used to cover the exterior of a building. There were several other materials that covered the exterior such as brick veneer, stucco, and lap siding. The purpose of using various materials for the siding was to determine those techniques can reduce moisture penetration.

The shingles of the house contain different hand-split cedar shakes. According to the Walkthrough Tour brochure (Williamson et al. 2010) the shingles are made of a wood-plastic composite material consisting of wood waste and recycled plastic milk containers. The wood-plastic composite material made it easy to install without any special tools. The roof is fire and hail resistant and according to the brochure, it also carries a Class A fire rating and a Class C hail rating. The wood -plastic composite material was used to determine its durability and life expectancy. It is unknown whether this research is ongoing, but it appears to have ended.
The front and rear porch and the stairs leading to the porch are pressure treated wood. The front porch floorboards are 1 by 4-inch tongue and groove made with Southern Pine. The pine is finished with an oil-based wood stain. The ceiling over the front porch is made from Southern pine; however, the boards are reversed to show a beaded pattern on the side opposite to the smooth finish side according to the brochure (Williamson et al 2010). Furthermore, according to

the brochure (Williamson et al 2010), a problem has occurred and water vapor from the house interior venting above the ceiling and condensing on the cold ceiling surface causing the ceiling boards to swell and buckle. The back porch and stairs are also constructed with Southern Pine lumber. The deck and framing, as well as the stairs are all constructed with pressured-treated Southern Pine. According to the brochure, treated lumber is strong and durable and with proper care, the lumber can extend the life expectancy to up to 30 years (Williamson et al 2010).

Current Status of the House

The house is currently vacant and is not being used. The house is located on the grounds of the USDA Forest Service Forest Products Laboratory in Madison Wisconsin. The house is used as a research and demonstration test house and the current staff at the USDA Forest Service Forest Products Laboratory in Madison WI appear to be unsure regarding the future of the structure that is either fix and repair or demolish the house to build something else.

Demand for the Location

Some of the staff at the USDA Forest Service Forest Products Laboratory in Madison WI want to build another lab while others want to keep the building and make the repairs. FPL would like to utilize the space and make sure it is safe for visitors and staff to use for whatever purposes. The University of Wisconsin would like to purchase land to expand and the amount of the land is 5 million dollars per acre.

Literature Review

Mississippi State University (MSU) was contacted by USDA Forest Service, Forest Products Laboratory (FPL) in Madison Wisconsin to conduct an assessment on the Research Demo House that sits on FPL property (Ross et al., 2023). The house is considered a research

structure and not part of the FPL's building inventory. The house was heated and cooled but not occupied. However, minimal, and reactive maintenance has been performed on the house. According to Bortolini and Forcada 2018, the objective of inspection is to obtain useful information about the technical performance of a building. Bortolini and Forcada 2018 go on to discuss what technical performance is, which describes the structure of well-being, whether it is suitable to work in, live in or to be used for other purposes. The objective of this research is to determine if the demo house is feasible to continue to use as a research house, to assess the condition of the timber, and to determine if the cost of repairs is worth the value of the house.

According to Ross et al., 2023, the simplest way to determine deterioration is by visible inspection of the wood structure. Ross et al., 2023 go on to discuss the importance of visible inspection and how useful it is to detect surface decay, water damage, mechanical damage, or failed members; however visual inspection cannot detect early stages of decay or deterioration according to Ross et al., 2023.

During visual inspection one often looks for fruiting bodies which demonstrates that there is advanced decay, stain or discoloration, insect activity such as holes, frass and powder posting, plant or moss growth, deep checks or splits and failed or missing members (Ross et al, 2023). The team from MSU did a visible inspection of the ramp outside of the demo house and in the inside as well as the basement. The team from MSU looked for evidence of water damage to the wood structure. The team from MSU also looked for damage in the foundation and other areas of the wood structure. The last thing the team looked for was if there was evidence of structural failure of the timber.

CHAPTER II

METHODOLOGY

How was the house inspected?

The staff from FPL and the team from MSU examined the exterior by using visual methods and tools to probe the ramp and to measure the depth of deterioration. The ramp was closed due to the poor condition of the wood. The railing of the ramp could be pulled up without much effort. The flooring of the ramp was also in poor condition, some of the wood used was deteriorated and easy to be pulled up without effort. The structural posts, carrying beams, deck boards, and rails were all deteriorated. Many of the structural posts were decayed at their cores and hollowed out to the extent that they do not securely hold the rails. As stated, the rails can be lifted off the post. The rails were let-in to the posts by mortise and tenon type construction. The mortise pockets appear to have water traps. The ramp should remain closed until it is repaired.

The exterior of the house was inspected by removing the siding from the house to see if there was any decay under the T1-11 siding (Figure 1). The house wraps and flashing beneath the siding appeared intact and functional. The sheathing was probed by striking a hammer to the area under the siding to prove that the area was intact and functional. The sheathing appeared intact based on the hammer's sound and return bounce upon striking. Since the sheathing appeared intact and not decayed, it was assumed that the wall framing beneath the sheathing in this area was also intact and not decayed. The siding in other areas where utilities were attached

were showing signs of decay. Then, the T1-11 siding was placed back over the area the siding was removed from with nails and a hammer.

Figure 1 This image is illustrating the student using a hammer gently striking silver area which is the sheath underneath the siding of the house to determine if moisture is present.

The exterior of the porch step was probed with a screwdriver (Figure 2) in where the railing leading to the porch. The bottom of the post appeared to be connected to the stair stringer with screws. The porch flooring near the top of the steps has become unfastened due to the fastener corrosion and rust. The ceiling of the same porch tongue and groove indicated that the porch takes on moisture.

The roof shingles appeared to be hand-split cedar shakes, but a wood-plastic composite material made from wood recycled plastic milk container. There was puckering, also known as buckling, or lifting, in many areas of the roof. Densified and compressed composites swell when exposed to moisture over a prolonged period. This swelling causes adjacent shingles to push on each other and ultimately lift off the roof structure. On the front side of the house, over the garage door and over the porch entry, it appears that both shingles and the roof sheathing are lifting off the roof framing. The shingles are showing signs of biological growth, this is an indication of water being held on the surface of the shingles.

Figure 2 The student is kneeling down to insert a screwdriver into the front porch steps to measure the dept of decay.

The back entrance stoop leading into the kitchen is cause for imminent concerns. The back deck presents some wood decay. The joists are connected to the joist box (also called the rim joist) with, appropriate hanger. The joist box, which carries the load of the joists is not well connected to the support post. The joist box to the post connection system is not sufficient. For safety, the rails and guard system are required on decks that are 30 inches or more off the ground. The rail to post connection has completely failed in several locations. This failure renders the guard system unable to resist any loading and the rail and guard system is supposed to resist a 200-pound lateral load according to the International Residential Code. Also, the rail

to post connections were initially and inadequately connected with non-structural #4 or #6 finish nails. This connection detail likely contributed to guard system failure.

Moisture from the rain and snow are apparent around the house, these have led to weathering issues. Visible inspection from the exterior shows weathering, splitting, and warping of preservative treated wood foundation members. There wasn't visible decay, the extensive splitting and warping creates paths for moisture ingress. In several areas, the fasteners (galvanized nail) withdrawal was evident.

What to look for during the house inspection?

The researchers were looking for anything that was not routine in doing a house inspection. The researchers looked for water damage, splits and checked decay and deteriorated areas. The researchers looked for areas where there were cracks in the foundation and puckering on the shingles of the roof.

Tools and equipment used for the inspection of the house.

The tools and equipment used for the inspection of the house were basic tools. A hammer and screwdriver were used to determine the dept of damage. A hammer was used on the side of the house. The sheathing appeared intact based on the hammer's sound and return bounce upon striking. The screwdriver was used for the ramp leading to the house, the siding and the steps leading to the front porch as well as the stoop and railing on the side of the house. The main tool used to do the inspection was the naked eye or visible inspection. In this visual inspection of the wood members of the House, specific attention was given to:

1. Evidence of water intrusion and subsequent damage, especially where the wood members in contact with the foundation, exposed to exterior conditions, exposed to persistent or prolonged moisture or water leaks, and other areas where the wood members appear compromised.

2. Evidence of existing or imminent structural failure of wood members, timbers, panels, and subassemblies.
3. The accessibility ramp
4. The back stoop, rail/guard, and stairs
5. The front porch stair treads
6. The exterior cladding (siding)
7. The roof

CHAPTER III

RESULTS

Data that was collected during the inspection.

The back-entrance stoop, leading into the kitchen, is cause for imminent concern. The back deck presents some wood decay. The joists are connected to the joist box (also called rim joist) with appropriate hangers. The joist box, which carries the load of the joists is not well connected to the support post. This joist box to post connection system is not sufficient (Figure 3).

Figure 3 The circled image is the joist box and the rail. The circle is showing how the Joist box to rail connection is showing insufficient fixity.

For safety, rail and guard systems are required on decks that are 30 inches or more off the ground. Rail and guard systems are supposed to resist a 200-pound lateral load applied at any location (International Residential Code, 2018 – Section R312, R312.1.1). In this case, the deck height is 41 inches (Figure 4). In addition, the rail-to-post connections have completely failed in several locations (Figure 5 a-b). This failure renders the guard system unable to resist any loading. It appears that the rail-to-post connections were initially and inadequately connected with non-structural #4 or #6 finish nails. This connection detail likely contributed to guard system failure. It is recommended that this stair / stoop structure be immediately and actively closed to prevent any use, until it can be replaced.

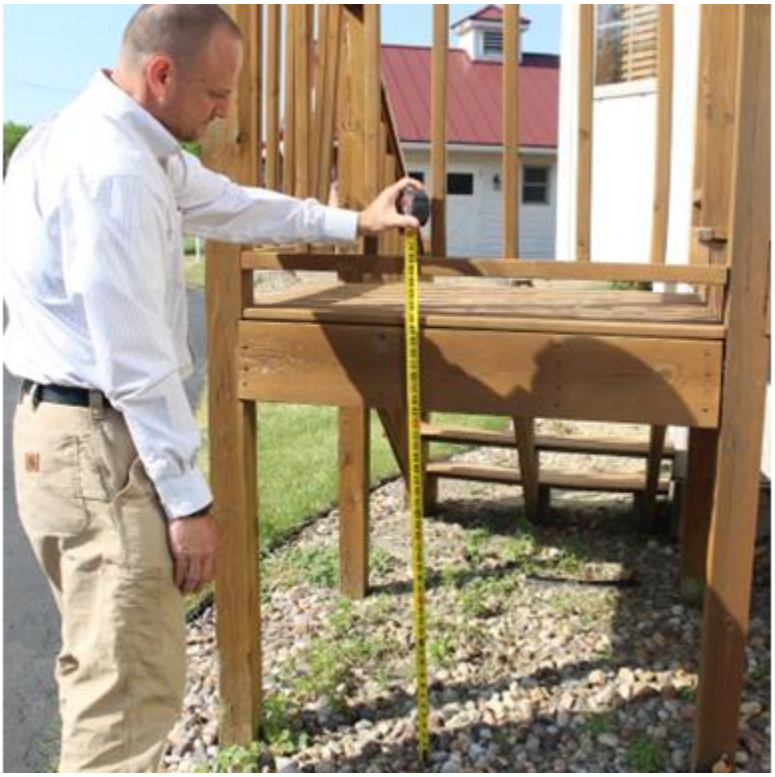
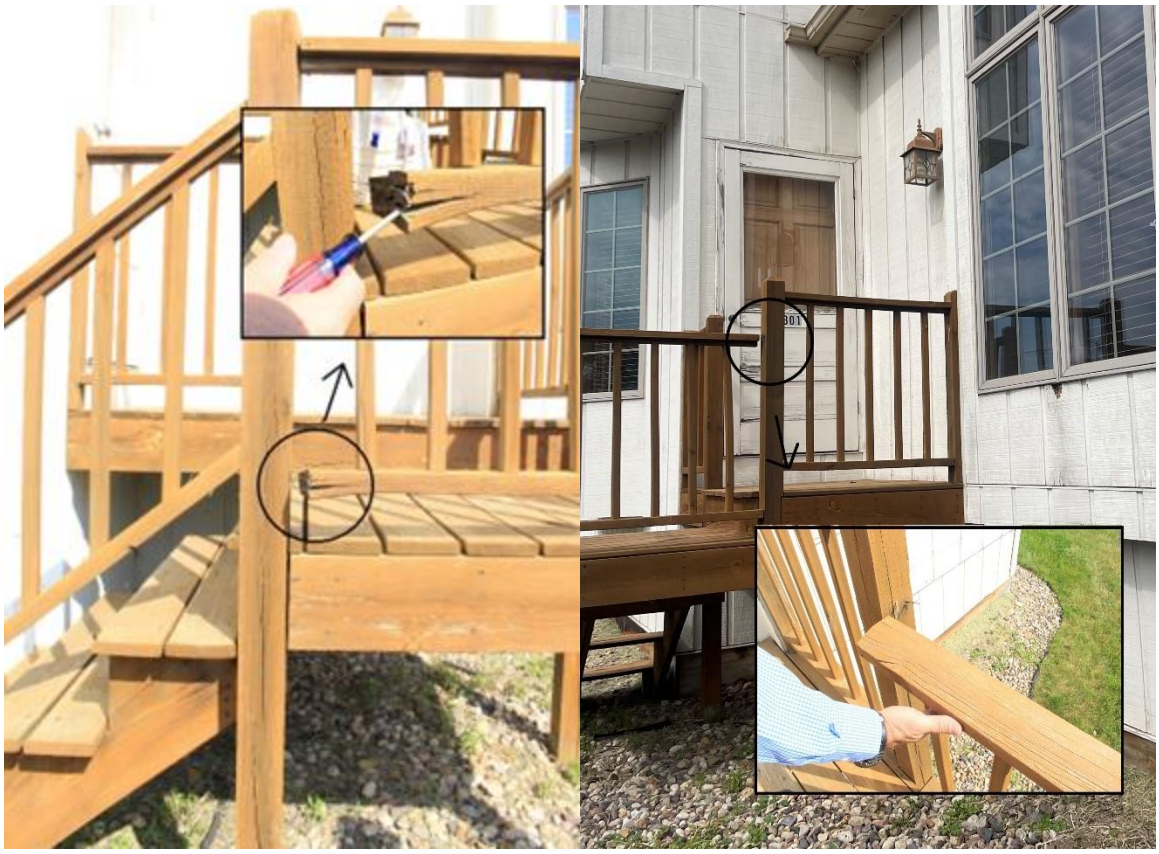


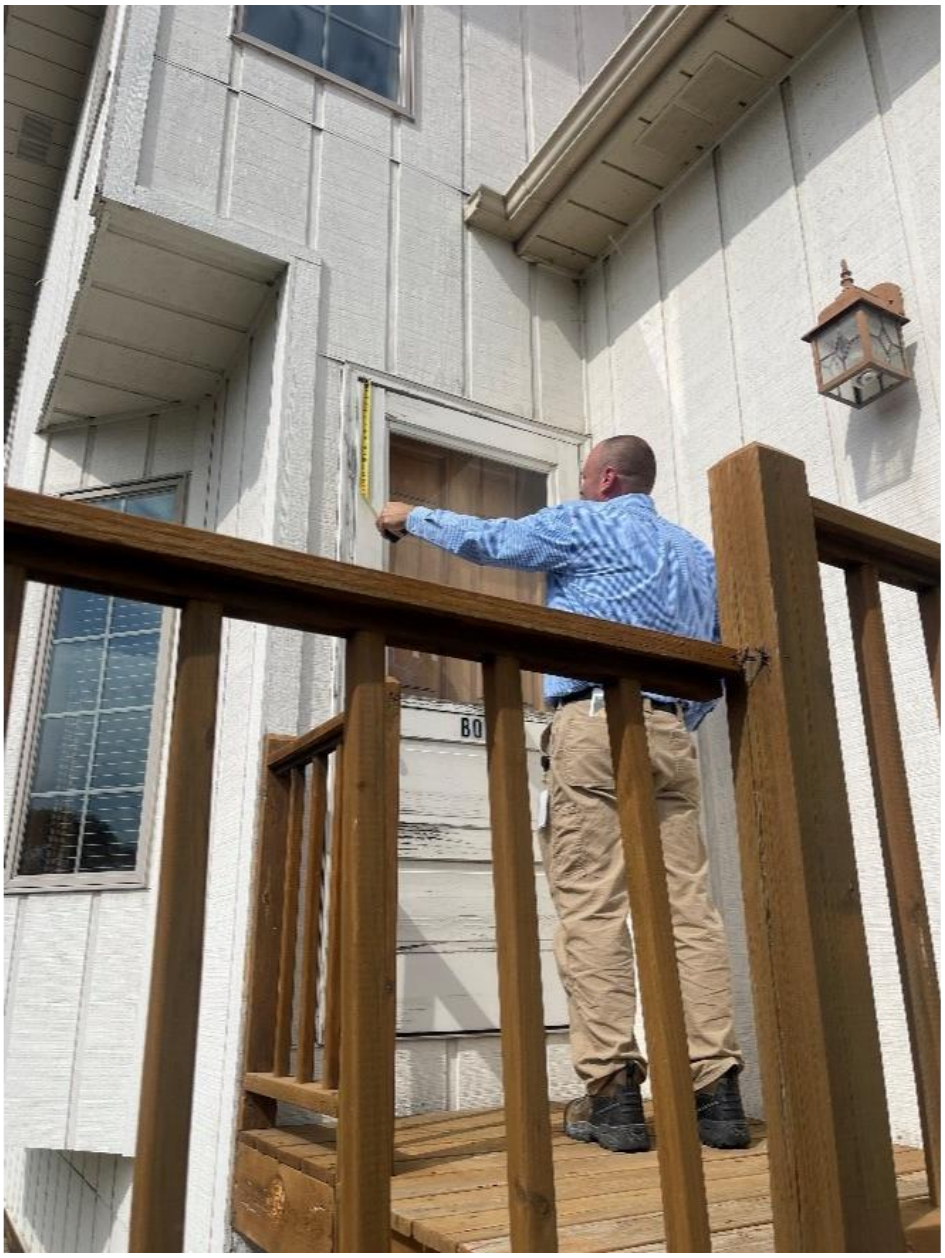
Figure 4 Dr. Shmulsky is measuring the deck height to ensure it is up to code with the International Residential Code.



A B

Figure 5 A and B, the images are of the back deck, and it shows the problematic areas. Images of the rail-to-post connects have completely failed in the highlighted location.

Also, the storm door leading from the kitchen to the stoop has deteriorated beyond repair (Figure 6, a-d). In its current state it is not functioning as needed, that is, as a means of preventing water infiltration into the structure. Replacement or removal of the storm door appears to be the only options to restore its intended functions of energy savings and protection from water intrusion.



A

Figure 6 A through D, Images of figures A through D shows images of the damaged storm door from the back deck. The images show that the door is severely deteriorated.

B

Figure 6 (continued)

C

D

Figure 6 (continued)

The accessibility ramp is severely deteriorated. The structural posts, carrying beams, deck boards, and rails are all deteriorated to some degree. Some of the deck boards have deteriorated to the extent that they can be removed by hand and are at risk of bending failure (Figure 7). Many of the structural posts are decayed at their cores and hollowed out to the extent that they do not securely hold the rails. In many cases the rails can be lifted off the posts (Figure 8, a-d). The rails were let-in to the posts by mortise and tenon type construction. The mortise pockets appear to have served as water traps. As a result, the tops of the posts are severely decayed to a depth of approximately 12-inches or more. As such, the posts are no longer able to hold or remain fixed to the handrails. In many cases the handrail boards are also decayed particularly at the end. Some of the support cross beams that are affixed to the posts and support the deck framing, are severely deteriorated in their cores (Figure 9).

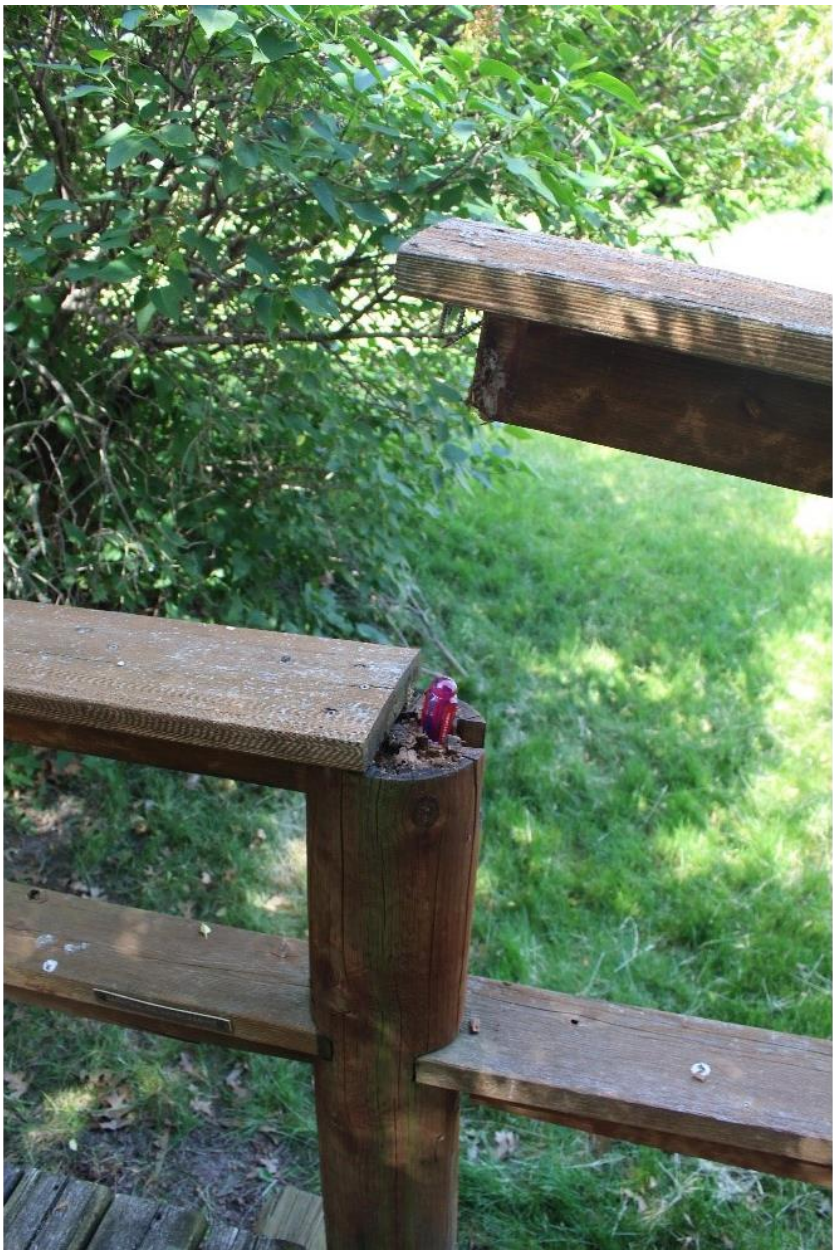
Figure 7 Dr. Shmulsky is measuring the deteriorated area with a tape measurer to get the width of the deteriorated deck that was removed. Some of the deck could be removed without effort as illustrated in the image above.

A B

Figure 8 A through D, Deteriorated rail-to-post was severely decayed and the rail can be removed from the post and the post was also decayed. When probing the post with a screwdriver, the screwdriver went in the post without much effort.

C

Figure 8 (continued)



D

Figure 8 (continued)

Figure 9 The image shows advanced decay in carrying beams which support the floor frame of the accessibility ramp. The screwdriver is in the decayed area in the carrying beam, the image shows dept of decay.

In sum the posts, carrying beams, decking, and handrails are severely decayed and need immediate replacement. Because many of the deck boards, many of the support beams, the structural posts, and the handrails are severely deteriorated, the structure must be closed and actively blocked. Two of the three entrance points to the ramp (that is the two along the paved driveway are posted “closed” and blocked with rope in (Figure 10). One of the three entrance points to the ramp, that is the location where the ramp connects to the front porch, is open (Figure 11). This entrance point must also be actively blocked and posted as closed to prevent pedestrian access to the ramp.

Figure 10 The image is one of the entrance ways to the accessibility ramp and its exemplar "Closed" sign and rope barricade at one of three entrance points to the accessibility ramp.

Figure 11 This image of the accessibility ramp from the front porch view. The images shows that the area should have a closed sign as in figure 10.

The front entrance deck rail posts have decayed. A screwdriver was inserted into the top of the post to probe the extent of the decay (Figure 12). The bottom of the post appeared to be connected to the stair stringer with screws. This method of post fixity is not considered sufficient to provide the 200-pound resistance as required by the building code (International Residential Code, 2018 – Section R312, R312.1.1). The stair treads were decayed. Screw drivers were inserted into the decayed portions to probe the extent of the deterioration (Figure 13 a and b). The porch flooring near the top of the steps has become unfastened due to fastener corrosion and rust and post trim showing signs of deterioration (Figure 14 and 15). It is recommended that the porch steps, posts, rail, and guards, be replaced and the porch decking be refastened or repaired as necessary. Ceiling tongue and groove indicated that the porch takes on moisture (Figure 16).

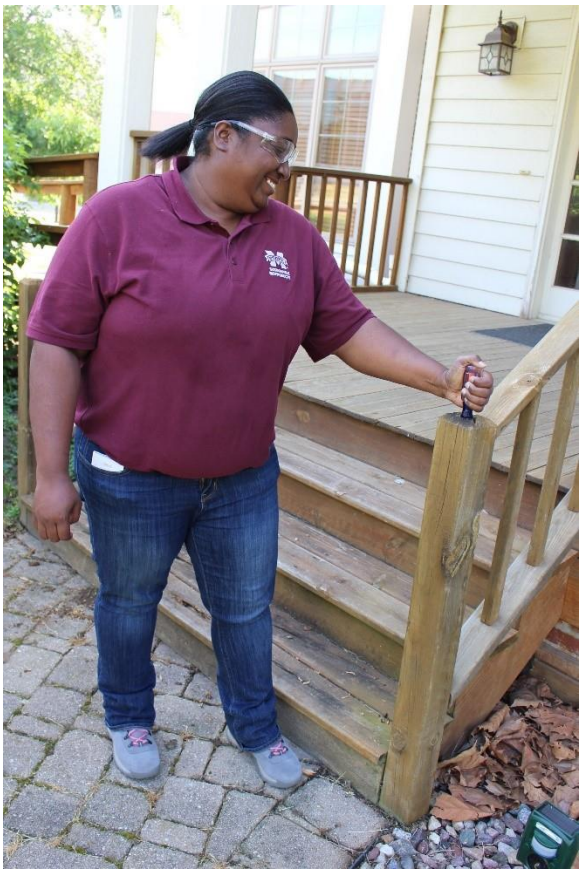
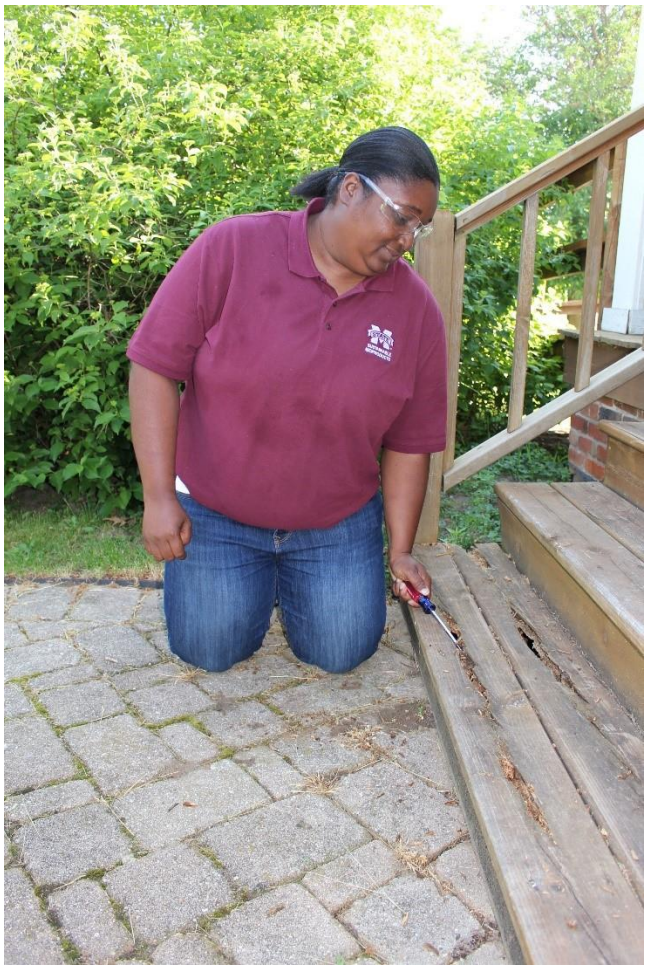


Figure 12 The student is inserting a flat head screwdriver into the post to indicate decay is present in the structure.

A

Figure 13 A and B, in image A screwdrivers were inserted into the decayed portions to probe the extent of the deterioration, however, in image B, students kneeling to insert screwdriver into the front porch step. The screwdriver was inserted into the decayed portion to probe the extent of the deterioration.



B

Figure 13 (continued)

Figure 14 Dr. Ross is bending over to show where the front porch can be lifted, therefore, the porch flooring near the top of the steps has become unfastened due to fastener corrosion.

Figure 15 The image is still of the front porch entrance and the post trim showing signs of deterioration.

Figure 16 The image is of the front porch ceiling, and the photo depicts tongue and grove ceiling swelling indicating moisture issues.

It is noteworthy that with the entrance ramp closed due to major deterioration failure, the decay and failure of the front posts and treads, and the immediate need to close the rear steps and stoop due to fastener and other failure, at present there is no safe means of entering or exiting the building. The guard and railing system at the front porch is fastened with small (approximately 4d) finish nails, like the back stoop. This fastening system is inadequate and should be replaced.

Most of the siding (cladding) on the house is Texture 1-11 (also known as T1-11) plywood. There is also an 8-inch-wide oriented strand board lap siding as well as stucco and brick veneer in small areas and on some wall portions. The T1-11 siding is failing due to decay in places along the Southeast and Southwest sides of the house. The worst location is in the vicinity of the dining room, particularly near the triple-mullion dining room window (Figure 17 and 18). The siding under and around said window needs replacement. In other places the siding is beginning to rot, particularly at the lowermost edges of the various T1-11 panels. These bottom edges often become water traps which do not readily drain and dry. There is decay in the vicinity of an electrical conduit/LB conduit body penetration on one of the Southwest walls. Some of this decay may be accelerated because there is a large tree located near the exterior siding (Figure 19). The proximity of the tree to the siding prevents and/or retards redrying of the siding after rain events. As such, the walls remain wet longer than otherwise possible thereby accelerating decay.

Figure 17 The image is the back deck of the demo house where the T1-11 siding is mostly located on the house and the image shows signs of decay and missing pieces of the siding.

Figure 18 This image is a closer look at the siding and the siding is deteriorating beneath the vicinity of the triple mullion dining room window. The screwdriver is inserted in the decayed area to indicate that the area is deteriorating.

Figure 19 This image is a large cedar tree near the house, which is located on the Southwest side of the house where decay may be accelerated because of the tree due to the fact that there's not enough sunlight which means more moisture is acceptable in this area.

During the inspection, an approximate 18 × 48-inch section of T1-11 siding was removed from under the dining room triple mullion window unit (Figure 20). The house wraps and flashing beneath the siding appeared intact and functional. The sheathing was probed by striking it with a hammer (Figure 21). The sheathing appeared intact based on the hammer's sound and return bounce upon striking. Because the sheathing appeared intact and not decayed, it is assumed that the wall framing beneath the sheathing in this area is also intact and not decayed.

Siding in other areas where utilities are attached are showing similar signs of decay (Figure 22) and some trim boards are showing signs of decay due to failure of paint (Figure 23).

Figure 20 This image shows the section of T1-11 siding removed beneath the triple mullion dining room window to prepare to test the silver area to indicating if moisture is present behind the siding.

Figure 21 This image is illustrating the student using a hammer gently striking silver area underneath the side to determine if moisture is present.

Figure 22 The photograph is of the areas where utilities are attached and show similar signs of decay.

Figure 23 The image is of the trim boards of the house and the trim boards around the house are showing signs of decay due to failure of paint.

Should the structure be kept then repair and replacement of the siding is in order. Additionally, the only portion of sheathing that was evaluated was under the decayed 18 × 48-inch section of siding that was removed. This section accounts for less than 1% of the clad area. It is unknown the extent to which sheathing and potentially wall framing in the other +99+% of the wall area may be impacted by water intrusion and its negative effects on wood.

The roof shingles appear to be hand-split cedar shakes but are actually a wood-plastic composite material made from wood recycled plastic milk containers. From the exterior, it is noted that the roof shingles are puckering (also known as buckling or lifting) in many areas. To the assessors' knowledge, the shingles are composite. Densified and compressed composites swell when exposed to moisture over prolonged periods. This swelling causes adjacent shingles to push on each other and ultimately lift off the roof structure. On the front side of the house, over the garage door and over the porch entry, it appears that both the shingles and the roof sheathing are lifting off the roof framing. The shingles are showing signs of biological growth,

this is an indication of water being held on the surface of the shingles (Figure 24). As the shingles pucker and lift / separate off the roof, their ability to resist wind and shed wind driven rain decreases. Similarly, when roof sheathing swells and lifts off the roof framing, it loses its ability to shed wind-driven rain. The intrusion of said rain then ultimately leads to deterioration within wood framing. Additionally, water damage is noted in the main stairwell between the first and second floors. This is noted as a small blackish colored hole at the top of the stairwell ceiling, with rust colored splash marks beneath said hole. This moisture intrusion appears to be coming from a hole or penetration in the roof.

Figure 24 The image is of the roof shingles and the shingles showing signs of weathering. Biological growth and puckering can be seen on the shingles of the roof.

During the condition assessment no shingles were removed for inspection of the roof sheathing and truss/rafter roof framing. Additionally, from the attic, the roof framing and sheathing at the eaves, over the garage, and elsewhere were inaccessible. As such, given the appearance of the puckered shingles and swelled sheathing, one must assume that there is some level of water-intrusion related damage to the sheathing and framing. As such, repair and replacement of at least a portion of the roof sheathing and framing should be included in any type of roof repair cost estimation.

Moisture from rain and snow are apparent around the house; these have led to weathering issues. Visible inspection from the exterior shows weathering, splitting, and warping of preservative treated wood foundation members. While not visibly decayed, the extensive splitting and warping creates paths for moisture ingress. Additionally, in several places, fastener (galvanized nail) withdrawal was evident. This withdrawal is not uncommon when smooth shank nails are used with wood members that cyclically shrink and swell. The extent to which fastener withdrawal has reduced the overall capacity of the foundation system is unknown.

Other issues may be with the soil around the house's foundation. Signs of fracture or buckling of the dry wall can be seen in (Figure 25). A corresponding un-leveling in the basement could explain the buckling of drywall. Deconstruction of the basement floor would be needed to investigate the issue. This may be from soil erosion from rain and moisture. Soil erosion can be seen in front of the garage (Figure 26). A possible contributor to the foundation / soil settling issues is the disconnected downspout. The downspout is located at the front of the house, near the location where the accessibility ramp connects to the porch. The downspout is supposed to be connected to a water collection and drainage device. The downspout is however disconnected.

As such, rain from the roof is collected by the gutters, transferred through the downspout, and deposited immediately adjacent to the foundation at this location.

Figure 25 A fracture or buckling of sheet rock in the great room and the right-side header inside the great room shows fracture or buckling in the drywall above the door opening.

Figure 26 These images show signs of settling in the foundation, photo located in the southwest portion of the basement and top left photo in front of the carport. The treated plywood foundation shows un-leveling underneath the flooring.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations

In conclusion, there are areas of the house that need some repairs. The entrance ramp is deteriorated beyond repairs. Two of the entrance points are closed and need to remain closed until it can be replaced or removed. The third entrance point, that is on the porch, must be closed to prevent pedestrian access to the ramp. The back entrance where the kitchen doorstep stoop is, needs to be closed immediately. The deterioration of some of the stair treads, under-designed joist box-to-post installation, and failed rail/guard system present a potentially unsafe situation. This structure should remain closed until it can be replaced or removed. The front porch steps (treads) and posts are deteriorated. These require replacement. Taken together, the decay or disrepair associated with these items render a person no safe means of entering or exiting the structure at present. The siding on the Southeast and Southwest sides of the house needs repair and/or replacement. The roof shingles are puckering in many places due to irreversible moisture-induced swelling. This puckering leads to roof leaks. One such leak is noted inside the house at the ceiling of the main stairwell. Should the building be kept, then a financial plan to replace the roof shingles needs to be made. Given the house's approximate 22-year age, entire roof replacement, rather than piecemeal patching, is in order. Roof replacement cost estimation should also consider the potential need for some portion of sheathing and framing repair given visibly swollen sheathing noted previously. Additional more-intensive evaluation of the

permanent wood foundation, including removal of a portion of the basement flooring and wall coverings to access the treated wood framing is recommended.

REFERENCES

Bortolini, R. and Forcada, N. 2018.Building Inspection System for Evaluating the Technical PERFANCE OF Existing Buildings. Journal of Performance of Constructed Facilities 32(5): 04018073-1-04018073-14.

FPL. 2021. Wood handbook: wood as an engineering material. General Technical Report FPL-GTR-282. Madison, WI: U.S Department of Agriculture, Forest Service, Forest Products Laboratory. 543 p.

International Code Council (ICC) (2017) IRC: International residential code for one-and two-family dwellings. Country Club Hills, IL.

Ross, R.J.; Wang, X. 2005. Quincy mine blacksmith shop— Condition assessment of timbers. Structure. September 2005: 32–34.

Ross; R.J.; Soltis, L.A.; Otton, P. 1998. Assessing wood members in the USS Constitution using nondestructive evaluation methods. APT Bulletin. 29(2): 21–25.

Ross, R.J.; Volny, N.; Pellerin, R.F.; Salsig, W.W.; Falk, R.H. 1999. Inspection of timber bridges with stress wave nondestructive evaluation tools. A guide for use and interpretation. General Technical Report FPL–GTR–114. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Ross, R.J.; Brashaw, B.K.; Wang, X. 2006. Structural condition assessment of in-service wood. Forest Products Journal. 56(6): 4–8.

Ross, R.J and Spinelli Correa, L.M. 2022. Condition Assessment of Wood Members in a Historic Building in the Tomah VA Medical Center, Tomah Wisconsin. Forest Products Journal.

Ross, R.J.; Wang, X.; Senalik, C.A.; Allison, R.B.; Zhou, L. 2017. Nondestructive assessment of wood members from a historic viewing tower. Research Note FPL–R; N–0349. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Ross, R.J.; Senalik, C.A.; Wang, X. 2018. Nondestructive assessment of wood members in a viewing tower in Potawatomi State Park, Door County, Wisconsin, USA. Research Note. FPL-RN-0366. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 12 p.

Ross, Robert J.; Wang, Xiping; Brashaw, Brian K.; Cai, Zhiyong; Hasburgh, Laura E.; Kukay, Brian; Rodrigues, Brunela Pollastrelli; Senalik, C. Adam; Shmulsky, Rubin; Spinelli Correa, Laurice. 2023. Wood and timber condition assessment manual: third edition. General Technical Report FPL-GTR-299. Madison, WI: U.S. Department of Agriculture Forest Service, Forest Products Laboratory.

Williamson, T.G., C.M. Kaake, M.A. Ritter, M.R. Yoklic, S. LeVan-Green. 2010. Research Demonstration House and Carriage House; A Walkthrough Tour. USDA Forest Service, Forest Products Laboratory. Madison, WI. 46 p.

Hidden test to allow template to find last page in document