

New Hampshire  
**DOT**  
Research Record



Research-Synthesis of  
Wood Treatment Alternatives  
for  
Timber Railroad Structures

Final Report

Prepared by the New Hampshire Department of Transportation, in cooperation with the U.S.  
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<b>16. Abstract</b> <p>A wealth of information exists on various wood preservatives, treatment techniques, curing practices, and other engineered controls, along with alternative materials for replacement. This study was initiated to review and synthesize available information so that future bridge timber work could be completed in a manner that would optimize performance while eliminating damage to the environment. This project was triggered by dripping creosote from the Frankenstein Trestle within an environmentally sensitive area.</p> <p>Of the seven products evaluated, two are recommended for railroad bridge timbers: Copper Naphthenate and Creosote. Copper Naphthenate is commonly used in other jurisdictions, especially over sensitive aquatic environments and where preservative drippage is a concern. The product has low toxicity, is not listed as a restricted-use pesticide (RUP) by the U.S. EPA, and has shown equal or superior performance compared to creosote or pentachlorophenol. State DOTs including Iowa and Minnesota specify Copper Naphthenate for replacement and renovation of wooden bridges. Its only disadvantage is a limited supply of product currently. Creosote-treated wood has proven its effectiveness and longevity. To minimize potential issues, best management practices (BMPs) are required. These include specification of the correct retention rate for the wood species and type of use, specification of the empty-cell process, and the use of expansion baths for post-treatment. Only straight creosote or a 75/25 creosote/petroleum solution should be specified.</p> <p>As a result of this study, the Department's specifications for railroad bridge timbers have been modified to reflect improved standards for preservatives, including treatment techniques and post-treatment procedures. In order to optimize performance while mitigating environmental concerns, a series of best management practices (BMPs) covering the design, purchase, delivery, handling, installation, and inspection of timbers are also being incorporated into future projects. It is expected that these recommendations will be incorporated into wooden highway structures as well.</p>			
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# **RAILROAD BRIDGE TIMBER TREATMENT STUDY**

## **BACKGROUND**

Railroad bridge timbers are the structural wood members that support the rails and sit on either steel or wooden stringers. Since the design and construction of each railroad bridge is different, the size and configuration of the bridge timbers vary on every bridge, and in most cases there are many differently configured timbers on a single bridge.

The timbers on most bridges have cutouts (daps) on the bottom of the timber so they will sit tightly on the stringers and not move from side to side under train loadings. To account for variations in the size, thickness and spacing of the stringers across the bridge, the dap locations and depths vary on the timbers so that the top surface of the timbers will provide a uniform grade for the rail. In the manufacture of the bridge timbers, it is standard procedure to cut the daps and treat the wood at the same facility. Producing the timbers in this manner eliminates having to cut the daps at the project location after the wood has been treated which is not as exact as the machine cuts, takes more time, generates additional waste material and requires applying field treatment on the exposed cuts.

In the past, the New Hampshire Department of Transportation (herein referred to as “the Department”) has used mostly creosote treated southern yellow pine timbers because they are structurally strong, accept a large amount of the treatment product (penetration) and provide the longest life span. The Department has also used creosote-treated oak timbers, and in environmentally sensitive areas they have used standard pressure treated preservatives.

Wood is an ideal material to support the rails on bridges because it provides cushioning of the wheel impact load as the train moves across the bridge. This cushioning and spreading of the load reduces the stress on the bridge stringers and the rail.

## **PURPOSE**

The purpose of this Study was to determine available wood treatment options and other alternative materials available for the replacement of Department’s railroad bridge timbers so that bridge timber work can be completed in a manner that will eliminate environmental damage at the bridge sites. For this Study, the applicable Use Category System for bridge timbers was Use Category 3B (above-ground, exterior, exposed or poor water run-off).

## **PROJECT ACTIVITIES**

Work conducted on this project included identifying: 1) different wood species and treatment options; 2) current industry-employed engineering controls that can be used to limit or prevent the release (e.g., weeping) of preservatives from treated timbers; and 3) any alternative non-wood products currently being used as bridge timbers by the railroad industry.

In addition, State transportation (New England states and other states across the United States) and Federal (United States Environmental Protection Agency [USEPA] and United States Department of Agriculture [USDA] Forest Service) agencies, wood treatment facilities and manufacturers were contacted to obtain information on product restrictions, regulatory controls or other issues that may impact the use or non-use of the materials. A summary of information obtained for this project is provided in Table 1.

## **HISTORY OF TREATED WOOD**

For over 150 years, treated wood products have played an essential role in the infrastructure of the United States. Treated wood has been used in the transportation (railroad ties and timbers that carry trains across bridges that cross roads, rivers and streams); utility (poles that carry power and communication lines); and commercial and industrial sectors (docks and piers).

The most common preservatives used to treat wood contain copper or creosote (which is composed of polycyclic aromatic hydrocarbons), both of which are classified as pesticides by the USEPA and regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). FIFRA requires that all pesticides be registered with the USEPA through a registration process that requires the collection of data to evaluate and determine the effectiveness and hazards of a particular compound.

During the 1990s, many scientific studies were performed to assess potential impacts of treated wood on aquatic environments. These studies have produced a significant amount of information on the behavior of wood treatment chemicals and how they effect aquatic environments. “A worldwide review of scientific information failed to find a single case where appropriately produced and installed treated wood products resulted in a significant adverse environmental impact. Studies of treated wood in the most sensitive aquatic environments have shown that the risks associated with treated wood are small and easily manageable” (Western Wood Preservative Institute, 2006).

## **EFFECT OF WOOD SPECIES ON PRESERVATIVE PENETRATION**

The effectiveness of preservative treatment is influenced by the penetration and distribution of the preservative in the wood. In general, the sapwood of most wood species is not difficult to treat. Sapwood is defined as “the wood of pale color near the outside of the log” (Forest Product Laboratory, 2010) or the living portion of the wood, which transmits liquids and nutrients between the roots and the leaves of the tree. Wood species within the Southern Pine group (i.e., Loblolly, Longleaf, and Shortleaf pines) are characterized by a large sapwood zone that is readily penetrated by most preservatives. Due to their large sapwood zone, these pine species are used for the vast majority of treated wood products in the United States.

Conversely, the heartwood of most wood species is difficult to treat. Heartwood is defined as “the wood extending from the pith (soft core occurring near the center of a tree trunk or log) to the sapwood, the cells of which no longer participate in the life process of the tree” (Forest Product Laboratory, 2010). In most cases, the pores of the heartwood are closed or partially closed with gum-like materials called tyloses. The presence of tyloses in wood reduces preservative penetration. Tyloses are commonly found in white oak and black locust. “Because the penetration of the preservative will tend to be greater in lumber produced from species whose heartwood is relatively easy to treat, buyers should look for species identification on the treated wood” (Iowa State University, 1994). Experience indicates that only southern pine, red pine and ponderosa pine are readily treatable with all types of wood preservatives. Table 2 gives the relative resistance of the heartwood to treatment of various wood species.

## **EFFECT OF PRESERVATIVE ON WOOD MECHANICAL PROPERTIES**

Although preservative treatments generally reduce the mechanical properties of the wood, any initial loss in strength from treatment must be considered against the progressive loss of strength from decay when untreated wood is used. The effect of chemical preservatives on the mechanical properties depends on the wood species, the specific chemical used in the process and various pre and post treatment processes. Non-swelling liquids such as oil-borne wood preservatives

(creosote) are practically inert to wood and have no chemical influence that would affect its strength.

Commonly used water-borne preservatives (chromium, copper, arsenic and ammonia) are reactive with wood. Therefore, these chemicals are potentially damaging to the mechanical properties and may also promote corrosion of metal fasteners (nails, screws, pins). In general, the energy-related properties of the wood are often reduced and the wood may become brittle. However, strength and elasticity properties are generally not affected when correct treatment levels are used (Forest Products Laboratory, 2010).

## WOOD PRESERVATIVES

Wood preservative chemicals can be divided into oil-borne and water-borne preservatives. Currently, the AWWA has identified approximately 30 different preservatives available to treat wood. However, only 7 are commonly used by wood treatment facilities today and include:

- Oil-Borne (creosote, pentachlorophenol and copper naphthenate).
- Water-Borne (ammoniacal copper zinc arsenate [ACZA], chromated copper arsenate [CCA], alkaline copper quaternary [ACQ] and copper azole [CA]).

Information on the most common oil-borne and water-borne preservatives is presented in Tables 1 and 2. Table 1 lists the treatments recommended for use on railroad bridge timbers for the reasons explained below, and Table 2 lists all other wood treatments that are not recommended for railroad bridge timber use. The following provides a summary of these wood treatment preservatives:

- Copper naphthenate because: 1) it is commonly used for bridge timbers, especially over sensitive aquatic environments and where preservative drippage is a concern (Wacker and Crawford, 2003); 2) low toxicity (Brient et al., 2004); 3) is not listed as a RUP; 4) it has been tested extensively by the Forest Products Laboratory and has shown comparable, if not better performance than creosote and pentachlorophenol; 5) it is used and recommended by other state transportation agencies (Minnesota and Iowa) on replacement and renovation of wooden bridges; and 6) improves the dimensional stability of the wood; has good handling characteristics and clean surfaces after application; and potential for fewer environmental impacts (Bigelow et al., 2009). Wood treatment plants, the USEPA and railroad/utility industries recognize that copper naphthenate is the “greenest” chemical used to treat wood (The Daily Times, 2011). One disadvantage is currently a limited supply of copper naphthenate is available.
- Creosote treated wood due to its proven effectiveness and longevity. To minimize/eliminate potential issues, the following Best Management Practices (BMP) should be followed: 1) specify the correct retention rate for the wood species, types of use and preservative; 2) **specify empty-cell process**; and 3) use expansion baths as part of the post-treatment process. The treatment should be straight creosote or a 75/25 creosote-petroleum solution.
- Pentachlorophenol has been used for over 70 years to treat utility poles, bridge timbers, laminated beams and fresh water foundations and piling. However, the railroad industry has not used pentachlorophenol for the treatment of bridge timbers or crossties for decades (RTA, 2010). In conversations with wood treatment

facilities, pentachlorophenol is only being used to treat utility poles. Based on this information, pentachlorophenol treated wood will not be discussed further.

- Other considerations include the use of treated wood using less toxic (copper-based) chemicals such as ACZA, CCA, ACQ and CA. Due to the “clean surfaces” secondary coatings can be readily applied to wood treated with ACZA, CCA, ACQ and CA. As indicated by the New Hampshire Department of Environmental Services (NHDES), it is recommended that treated wood be coated with a product to seal the wood and reduce leaching and is only applicable to wood treated with water-borne wood preservatives. Disadvantages of using these preservatives include there are a limited number of treatment facilities using water-borne preservatives (i.e., predominantly used at treatment facilities in the western United States) and the treatments accelerate corrosion of metal fasteners relative to untreated and creosote-treated wood.

Since the water-borne preservatives listed in Table 2 accelerate the corrosion of metal fasteners and the steel/iron bridge stringers, and affect the mechanical properties of the wood (i.e., increase in the brittleness of the wood that affects its load carrying capacity after several years), these types of treatments will not be discussed further.

Therefore, the remainder of this Study will focus on the oil-borne preservatives listed in Table 1 since they will not affect the mechanical properties of the wood, do not damage steel bridge and/or rail components, provide an environmentally safe product when processed correctly, meet the needs of the railroad operators and provide a long useful life.

## **WOOD TREATMENT PROCESS**

The following sections present the recommended processes for using creosote and/or copper naphthenate wood preservatives.

### **Pre-Treatment Processes**

Prior to treatment, the wood must be properly conditioned in order to achieve the desired preservative penetration and retention. Conditioning of the wood shall be performed in accordance with AWWA Standards T-11: Use Category System: Processing and Treatment Standard, and M1-11: Standard for the Purchase of Treated Wood Products. In general, the conditioning of the wood is performed by one of the following: kiln drying; air seasoning or drying; Boulton Conditioning or steam conditioning. It should be noted that if the wood becomes *too dry*, over treatment can occur which may lead to bleeding and/or weeping issues when the wood is used.

### **Wood Treatment Processes**

There are two methods for applying preservatives to wood products; a pressure process and a non-pressure process. These processes are discussed below.

#### ***Pressure Process***

Pressure treating is a process where the wood preservative or treating solution is forced into the wood under pressure. The three pressure processes that can be used in the treatment of bridge timbers are the full-cell (Bethel) process, modified full-cell process and the empty-cell process, with the empty-cell process being the most commonly used.

The **full-cell process** is used when the wood product requires retention of a maximum amount of preservative to provide a longer useful life. The full-cell process is summarized below:

- The wood is placed in the treatment cylinder and an initial vacuum applied to remove air from the cylinder and wood.
- Preservative is then added to the cylinder without breaking the vacuum.
- After the cylinder is filled, pressure is applied “forcing” the preservative into the wood until the wood can no longer take the preservative or until the required retention of the preservative is achieved.
- When this portion of the process is completed, the preservative is removed from the cylinder and a final vacuum applied to remove excess preservative from the wood surface.

The full-cell process is most often used for treating wood with water-borne preservatives and for treating marine pilings with creosote. This process is not recommended for wood bridge timbers treated with creosote or other oil-based preservatives because this process can result in excessive bleeding of preservatives on the wood surface.

The **modified full-cell process** is similar to the full-cell process except that it uses a lower initial vacuum and occasionally uses an extended final vacuum (Forest Products Laboratory, 2010).

The **empty-cell process** results in good penetration, is very effective and uses less treatment chemicals than the full-cell process. For treatment with oil-based preservatives, the empty-cell process should be used as long as the desired retention can be achieved. There are two variations of the empty-cell process: 1) the Lowry Process; and 2) the Rueping Process. The Lowry Process is generally used for oak and hickory and consists of the following:

- The wood and treating solution is introduced into the treatment cylinder and heated together.
- The pressure within the cylinder is increased to impregnate the treating solution into the wood.
- After a period of time, the pressure is released and the treating solution that is not retained in the wood is forced out of the wood.
- At the end of the pressure period, the cylinder is drained and a final vacuum is applied to the cylinder to remove any excess preservative from the wood.

The Rueping Process is similar to the Lowry Process except that initially air is forced into the vessel under pressure before the treating solution is introduced into the cylinder.

Both of these processes are able to achieve deep penetration within the wood with a relatively low net retention. As a result, the potential for surface bleeding or weeping of the preservative onto the wood surface is less than with the full-cell process. ***It is recommended that empty-cell processes be used for all bridge timbers involving oil-based preservatives, provided that the appropriate retention requirements are achieved.***

Preservative retention level refers to the amount of preservative that remains in the wood after the treatment process has been completed and is expressed as weight of the preservative per unit

volume. This value is usually expressed as pounds per cubic foot (lb/ft<sup>3</sup>) or kilograms per cubic meter (kg/m<sup>3</sup>). The recommended preservative retention levels for various preservatives discussed previously are provided in Table 3. This information was taken from the 2011 AWPA Book of Standards.

### ***Non-Pressure Processes***

Non-pressure processes consist of the following: 1) surface application of preservatives by brief dipping; 2) soaking in oil preservatives or steeping in solutions of waterborne preservatives; 3) diffusion processes with water borne preservatives; and 4) vacuum treatment (Forest Products Laboratory, 2010). However, these processes are not approved by the AWPA and do not achieve the desired preservative penetration. Therefore, these processes will not be discussed further. ***Wood treated using these processes shall not be used.***

### **Post-Treatment Process**

For projects where bleeding or weeping of preservative oil is objectionable, the empty-cell process is followed by post-treatment processes. These processes focus on the recovery of the preservative and reducing/eliminating potential environmental issues/concerns. The post-treatment processes are as follows:

- Temperature considerations of the preservative as the pressure periods are completed.
- Expansion bath to assist in the recovery of the preservative.
- Vacuum cycles to recover the preservative.
- Steaming to improve the surface appearance of the treated wood.

## **TRANSPORTATION AGENCY INFORMATION**

State transportation agencies were contacted as part of this research project. The following provides a brief summary on the information reviewed from the various state transportation agencies:

- All state transportation agencies required that the wood be treated in accordance with AWPA and American Railway Engineering and Maintenance-of-Way Association (AREMA) Specifications and Standards.
- There wasn't a clear consensus on a "recommended" wood preservative to be used on projects. However, many of the agencies are not using or are discontinuing the use of CCA. In addition, the use of copper naphthenate has been increasing.
- The most commonly recommended wood species used for bridge timbers are Southern Yellow Pine (Eastern United States) and Coastal Douglas Fir (Western United States).
- Most state transportation agencies have similar concerns with the use of treated wood products in sensitive aquatic environments and have developed Best Management Practices or protocols for the use of treated wood products in these types of areas.

As stated above, the most commonly recommended wood species used for bridge timbers are Southern Yellow Pine and Coastal Douglas Fir. However, based on conversations with several eastern wood treatment facilities, Southern Yellow Pine is the most commonly used wood

species. Coastal Douglas Fir can be obtained, but the cost for the wood would be more expensive than Southern Yellow Pine because of the increased transportation cost. Since both woods meet the railroads needs, the wood selected is usually based on the most economically priced material in that area.

#### *New Hampshire Department of Transportation*

For projects requiring the use of treated wood bridge timbers in the past, the Bureau of Rail and Transit had specified Southern Yellow Pine treated with 50/50 creosote-petroleum solution full cell minimum 10 lb retention. After the problems with the timbers weeping on the Frankenstein Trestle, no additional bridge timbers have been ordered. As a result of these problems, the Bureau drafted Best Practice 05 Creosote Treated Rail Road Wood Products Use and Management (dated December 3, 2009). Included in this report is an updated BMP for using treated wood products, and following these guidelines should ensure that bridge timbers do not weep excess creosote that could cause environmental problems in the future. The document also specifies that the wood products are to be treated with a 75/25 creosote-petroleum solution or straight creosote. Suggested changes to the Department's practice of ordering bridge timbers are provided in the Recommendations portion of this report.

#### *Maine Department of Transportation*

The Maine Department of Transportation requires that the wood selected and preservative treatment be performed in accordance with AWPAs Standards. The recommended wood species for bridge timbers are Southern Yellow Pine. The Maine DOT does not specify a specific wood treatment preservative for bridge timbers. The Maine DOT requires that the wood be treated in accordance with AWPAs Standards. In the past, the Maine DOT has used both CCA treated and creosote treated wood for bridge timbers. Currently, the individual railroads are responsible for the maintenance/renovation activities associated with railroad bridges, and generally use creosote treated wood.

#### *Vermont Department of Transportation*

The Vermont Agency of Transportation requires that the wood selected and preservative treatment be performed in accordance with AWPAs Standards. The recommended wood species for bridge timbers are Coastal Douglas Fir and Southern Yellow Pine. In the past, the Vermont Agency of Transportation has used both CCA treated and creosote treated wood for bridge timbers. Currently, the individual railroads are responsible for the maintenance/renovation activities associated with railroad bridges, and generally use creosote treated wood

#### *Delaware Department of Transportation*

Currently, the Delaware Department of Transportation (Delaware DOT) specifies the use of creosote-treated wood on railroad bridges in accordance with AREMA Specifications. Best Management Practices followed by the Delaware DOT for the use of creosote-treated bridge timbers include: 1) specify the correct retention rate for the wood species, types of use and preservative; 2) **specify empty-cell process** rather than full-cell treating; 3) use creosote – petroleum solution (75 percent creosote); and 4) use expansion baths as part of the post-treatment process.

In Delaware, the preferred species of wood for bridge timbers are Southern Yellow Pine and Coastal Douglas Fir.

## ***Iowa Department of Transportation***

In the State of Iowa, most transportation projects are handled by each of the counties. However, they generally use the specifications developed by the Iowa Department of Transportation (Iowa DOT) for road, bridge and rail projects. The recommended wood species for bridge timbers are Coastal Douglas Fir and Southern Yellow Pine. The Iowa DOT has conducted numerous studies evaluating the service life and potential environmental impacts of various wood preservatives currently available on the market. The following summarizes some of these findings:

- The most commonly recommended wood species used for bridge timbers were Coastal Douglas Fir and Southern Yellow Pine.
- The AWPAs standards are the basis for the Iowa DOT specifications.
- Copper naphthenate, pentachlorophenol, and creosote are the recommended wood preservatives for timber piles. Copper naphthenate is the recommended preservative treatment for timber bridge elements. Copper naphthenate has been extensively tested by the United States Department of Agriculture Forest Products Laboratory (FPL) and has shown comparable, if not better performance to other commonly used preservatives such as creosote. Additional reasons for recommending copper naphthenate include good handling characteristics, clean surfaces, not a RUP, and the potential for less environmental impacts.

## **REGULATORY OVERVIEW**

In general, there is limited regulatory information on the use or restriction of wood preservatives except for CCA treated wood. Most of the information reviewed was general in nature and only provided recommendations. The following provides a summary of NHDES recommendations for the use of treated wood.

- Treated wood has not been banned for use as bridge timbers.
- Use only wood treated to AWPAs specifications.
- Limit the use of creosote-treated wood in fresh water applications and above water bodies.

## **DISPOSAL OPTIONS – USED TREATED WOOD**

Used treated wood is not listed as a hazardous waste under Federal law and can be disposed of in any waste management facility authorized under NHDES and local laws to manage such material. In addition, treated wood materials are not considered pesticides and are therefore not regulated under FIFRA. Used treated wood removed from service or generated as a construction waste that have no other useful application is considered a solid waste.

The NHDES considers used treated wood as a solid waste. Dispose of used treated wood in an approved landfill or at a certified incineration facility. Do not use treated wood as compost or mulch. Used treated wood should never be burned in open fires because of the toxic chemicals produced as part of the smoke and ashes.

## **POTENTIAL ALTERNATIVES TO TREATED WOOD**

Currently, all of the state transportation agencies contacted use treated timbers in their railroad bridge projects. Based on a review of available literature, there are very limited potential alternatives to using treated timbers on railroad and/or bridge construction projects. The following provides findings of this data review:

- Some alternative materials include exotic decay-resistant woods, composite woods (plastic woods), vinyl and rubber. However, with the exception of exotic decay-resistant wood, these materials have been used only on pilot or research projects and further assessments are being made on the structural integrity of the materials. These materials are not currently mass produced or approved by the American Railway Engineering and Maintenance-of-Way Association (AREMA).
- One potential alternative is the use of reinforced thermoplastic materials to manufacture bridge timbers. However, at this time these projects are considered to be pilot studies and further assessments are being made on the structural integrity of the materials. These materials are not currently mass produced or approved by AREMA. One difficulty for this product will be to find a way that they can be manufactured with the daps required for each bridge.

Based on our study, there are not currently any approved or acceptable alternatives to using treated wood for the manufacture of bridge timbers.

## **SUMMARY OF FINDINGS**

Based on the information presented in this paper, the following conclusions are presented:

1. There are not currently any approved or acceptable alternatives to using treated wood for the manufacture of bridge timbers. Alternative materials are being tested and studied and may be available in the future. The Department should monitor these alternate materials to determine when and if they will be available as an acceptable alternative to treated wood.
2. There wasn't a clear consensus on a "recommended" wood preservative to be used for bridge timbers. However, the information indicated that the water-borne preservatives such as CA, CCA, ACZA and ACQ will accelerate corrosion of metal fasteners and the steel or iron bridge stringers and should not be used for bridge timbers.
3. The oil-borne preservative treatments acceptable to treat bridge timbers are creosote and copper naphthenate. The use of copper naphthenate has been increasing.
4. The most commonly recommended wood species used were Southern Yellow Pine (Eastern United States) and Coastal Douglas Fir (Western United States). In addition to the Southern Yellow Pine, the Department has also found white oak to be an acceptable wood for bridge timbers. However, it does not accept the preservative treatments as well as the Southern Yellow Pine, which may be an advantage in environmentally sensitive areas since the timbers generally do not weep.
5. All state transportation agencies, including New Hampshire, require that the wood be treated in accordance with AWPA and AREMA Specifications and Standards.

6. Most state transportation agencies have similar concerns with the use of treated wood products in sensitive environments and have developed Best Management Practices or protocols for the use of treated wood products in these types of areas.
7. The NHDES has not banned the use of treated wood products.

## **RECOMMENDATIONS**

The following recommendations are provided:

1. Review locations where bridge timbers are required, and when working in an environmentally sensitive area, select the treatment method with the least possibility of bleeding and weeping and causing contamination. In other less sensitive areas, the choice can be made to go with the best long-term cost effective solution, or the one that has the least chance of causing contamination.
2. There are 3 segments of the bridge timber order that can be varied:
  - **Preservative types** (creosote and copper naphthenate)
  - **Treatment methods** (modified full-cell process or empty-cell process). However, the empty-cell process is the most effective in preventing or minimizing bleeding/weeping of preservative from the wood. If creosote is the selected preservative, the preservative retention should not exceed 8 pounds per cubic foot.
  - **Wood species** (Southern Yellow Pine, white oak and Coastal Douglas Fir)

It is suggested that the Department varies the bridge timber orders to evaluate various combinations, especially in environmentally sensitive areas. Once successful processes have been determined for bridge timbers based on the site location, use these as the standards for purchasing bridge timber materials in the future.

3. If bridge timbers can be obtained from a manufacturer treated with copper naphthenate, they should be tried because the performance may be as good or better than other commonly used preservatives such as creosote without the environmental concerns.
4. If creosote treatment is specified, it should be “straight” creosote or creosote-petroleum solution (greater than 75 percent creosote) because these solutions have a satisfactory record of performance, especially for use on bridge timbers. It is strongly recommend that the Department discontinue the use of creosote-petroleum solution that uses greater than 25% petroleum solution since it is more viscous and has a greater tendency to accumulate on the surface of the treated wood rather than penetrate into the wood. As a result, bleeding or weeping of the preservative more commonly occur causing contamination issues.
5. Ensure that the wood treatment facility uses the appropriate seasoning and conditioning methods prior to treatment. The wood must be conditioned in accordance with:
  - AWPA M1-11: Standard for the Purchase of Treated Wood Products

- AWPA U1-11: User Specifications for Treated Wood
  - AWPA T1-11: Processing and Treatment Standard
6. Ensure that the wood treatment facility performs their treatment process in conformance with the AWPA Standards and does not over-treat the wood.
  7. The only way that the Department can ensure that the manufacturer and processing facility perform to the Departments specifications and to AWPA Standards is to have an inspector at the plant. It is highly recommend that the Department engage the services of an independent inspector familiar with wood treatment to oversee the manufacture and treatment of the Department's bridge timber order.
  8. Thoroughly inspect the bridge timbers when they are delivered to ensure they are clean and relatively dry. The new timbers should be stored until any surface wetness dries so there is no chance of contamination due to dripping or weeping. If the timbers show excessive free product on the surface at the time of delivery, the timbers should be rejected.
  9. Continue to monitor and review literature concerning advances in wood treatment technology and alternative bridge timber materials.
  10. Prepare and follow Best Management Practices (BMP) for all future bridge timber construction projects. A copy of BMP for bridge timbers treated with creosote or copper naphthenate is provided in Appendix A.

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**Table 1**  
**Recommended Wood Preservative Treatment Options - Bridge Timbers**

Material	Treatment	Cost	Available Manufacturers	Longevity (years)	Interaction with Bridge Components	Environmental Considerations	Other Special Considerations	Disposal
Wood	Straight Creosote or Creosote - Petroleum Solutions (Greater than 75% creosote)	Inexpensive	<b>Readily Available</b> - treatment facilities are located throughout the United States. (Koppers, Thompson Industries and Appalachian Timber Services.)	47 to 62 <sup>(1)</sup>	Creosote treatment does not accelerate, and may even inhibit the corrosion of metal fasteners.	Creosote is classified as a RUP by the USEPA. Do not use creosote treated wood where it may come into direct or indirect contact with public drinking water or drinking water for domestic animals or livestock.	Wood freshly preserved with creosote ignites easily and will burn readily, producing dense smoke. However, after several months of seasoning the more volatile components of the oil has evaporated and the treated wood is no easier to ignite than untreated wood. Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Avoid frequent or prolonged skin contact with creosote treated wood; when handling the treated wood, wear long-sleeved shirts and long pants and use gloves (i.e., vinyl coated). After working with the treated wood, and before eating, drinking and use of tobacco products wash exposed areas.	Dispose of creosote treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.
Wood	Copper Naphthenate	Inexpensive	<b>Available</b> (Mellott Wood Preserving Company - Needmore, PA; Wheeler Wood Works - South Dakota; Boatright Companies - Alabama)	55 to 78 <sup>(1)</sup>	Copper naphthenate treatments do not significantly increase the corrosion of metal fasteners relative to untreated wood.	Copper naphthenate is not listed as an RUP by the USEPA. Copper naphthenate can be purchased at retail lumberyards and hardware stores for field application. Copper naphthenate has gained market acceptance because of its low toxicity.	Wood treatment plants, the USEPA and railroad/utility industries recognize that copper naphthenate is the "greenest" chemical used to treat wood. There is a limited supply of copper naphthenate due to the closure of three manufacturers in the United States in mid-2011. These closures were not due to product failure but because the USEPA had requested additional documentation on the treatment. These companies made a business decision to stop manufacturing the preservative. Currently, there is one manufacturer of this preservative (Nisus Corporation). Copper naphthenate loses some of its ability to penetrate wood when it is dissolved in heavier oils. Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. After working with the wood, and before eating, drinking and use of tobacco products wash exposed areas.	Dispose of treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Notes:  
RUP = Restricted-Use Pesticide  
USEPA = United States Environmental Protection Agency  
AWPA = American Wood Protection Association  
(1) Information on the predicted service life was taken from Preservation Treatment for Wood Bridge Application (Bigelow et al., 2009).

Contact Information (Copper Naphthenate)

Mellott Wood Preserving (717) 573-2519 contact Howard Tomlinson  
Boatright Companies (800) 873-2020 contact Dwight Mitchell  
Wheeler Lumber LLC (800) 843-8304 contact Dave Koch

**Table 2  
Other Wood Preservative Treatment Options - Bridge Timbers**

<b>Material</b>	<b>Treatment</b>	<b>Cost</b>	<b>Available Manufacturers</b>	<b>Longevity (years)</b>	<b>Interaction with Bridge Components</b>	<b>Environmental Considerations</b>	<b>Other Special Considerations</b>	<b>Disposal</b>
Wood	Untreated	Inexpensive		6 to 12	None	None	None	Dispose of as a solid waste by ordinary trash collection.
Wood	Penta	Inexpensive	<b>Readily Available</b> - treatment facilities are located throughout the United States. (Koppers)	60 to 91 <sup>(1)</sup>	Penta treatment does not accelerate the corrosion of metal fasteners relative to untreated wood.	Penta is classified as a RUP by the USEPA. Do not use pentachlorophenol treated wood where it may come into direct or indirect contact with public drinking water or drinking water for domestic animals or livestock.	Penta treated wood should not be used where it will be in frequent contact with bare skin unless an effective sealer has been applied. Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Avoid frequent or prolonged skin contact with penta treated wood; when handling the treated wood, wear long-sleeved shirts and long pants and use gloves (i.e., vinyl coated). After working with the treated wood, and before eating, drinking and use of tobacco products wash exposed areas.	Dispose of pentachlorophenol treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.
Wood	Ammoniacal Copper Zinc Arsenate (ACZA)	Inexpensive	<b>Readily Available</b> - mostly available by West Coast treatment plants due to the availability of Douglas Fir. Gemini Forest Products, Los Alamitos, CA	30 to 69 <sup>(1)</sup>	Do not use standard carbon steel or aluminum products in direct contact with wood treated with ACZA. Specially coated fasteners and connectors (i.e., double galvanized or stainless steel) are required.	ACZA is classified as a RUP by the USEPA. ACZA treated wood should not come into direct or indirect contact with drinking water. Potential leaching of copper, arsenic and zinc.	Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Wear gloves when working with the wood. After working with the wood, and before eating, drinking and use of tobacco products wash exposed areas.	All sawdust and construction debris should be cleaned up and disposed of after construction. Dispose of treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.
Wood	Chromated Copper Arsenate (CCA)	Inexpensive	<b>Readily Available</b> - mostly available by West Coast treatment plants due to the availability of Douglas Fir. Gemini Forest Products, Los Alamitos, CA	30 <sup>+</sup>	Do not use standard carbon steel or aluminum products in direct contact with wood treated with CCA. Specially coated fasteners and connectors (i.e., double galvanized or stainless steel) are required.	CCA is classified as a RUP by the USEPA. CCA treated wood should not come into direct or indirect contact with drinking water. Potential leaching of copper, chromium and arsenic.	Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Wear gloves when working with the wood. After working with the wood, and before eating, drinking and use of tobacco products wash exposed areas.	All sawdust and construction debris should be cleaned up and disposed of after construction. Dispose of treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.

**Table 2**  
**Other Wood Preservative Treatment Options - Bridge Timbers**

Material	Treatment	Cost	Available Manufacturers	Longevity (years)	Interaction with Bridge Components	Environmental Considerations	Other Special Considerations	Disposal
Wood	Alkaline Copper Quaternary (ACQ)	Inexpensive	<b>Readily Available</b> - mostly available by West Coast treatment plants due to the availability of Douglas Fir.	30 <sup>+</sup>	Due to high levels of copper, ACQ treated wood is 5 to 10 times more corrosive to carbon steel. Therefore, specially coated fasteners and connectors (i.e., double galvanized or stainless steel) are required.	ACQ is not classified as a RUP by the USEPA.	Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Wear gloves when working with the wood. After working with the wood, and before eating, drinking and use of tobacco products wash exposed areas.	All sawdust and construction debris should be cleaned up and disposed of after construction. Dispose of treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.
Wood	Copper Azole (CA)	Inexpensive	Readily Available	30 <sup>+</sup>	Hot dipped galvanized fasteners and connectors meeting ASTM standards are recommended. Aluminum should not be used in direct contact with CA treated wood.	CA is not classified as a RUP by the USEPA.	Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask and perform these activities outdoors. Wear gloves when working with the wood. After working with the wood, and before eating, drinking and use of tobacco products wash exposed areas.	All sawdust and construction debris should be cleaned up and disposed of after construction. Dispose of treated wood by ordinary trash collection. Treated wood should not be burned in open fires, or in fireplaces and stoves or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (construction sites) may be burned only in permitted commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Notes:  
RUP = Restricted-Use Pesticide  
USEPA = United States Environmental Protection Agency  
AWPA = American Wood Protection Association  
Penta = Pentachlorophenol  
(1) Information on the predicted service life was taken from Preservation Treatment for Wood Bridge Application (Bigelow et al., 2009).

**Table 3**  
**Relative Preservative Penetration of the Heartwood for Various Wood Species**

<b>Least Difficult</b>	<b>Moderately Difficult</b>	<b>Difficult</b>	<b>Very Difficult</b>
	Balcyypress		
	California red fir		
	Douglas fir (coast)		
	Eastern white pine		
Bristlecone pine	Jack pine		
Pinyon	Loblolly pine (southern pine)		
Ponderosa pine	Longleaf pine (southern pine)	Eastern hemlock	Alpine fir
Redwood	Red pine	Spruce	Corkback fir
Basswood	Shortleaf pine (southern pine)	Grand fir	Douglas fir (Rocky Mountain)
Beech	Sugar pine	Lodgepole pine	Northern white cedar
Black tupelo	Western hemlock	Noble fir	Tamarack
Green ash	Black willow	Sitka spruce	Western red cedar
Pin cherry	Chestnut oak	Werstern larch	American beech
River Birch	Cottonwood	White fir	American chestnut
Red oaks	Bigtooth aspen	White spruce	Black locust
Slippery elm	Hickory	American sycamore	Blackjack oak
Sweet birch	Silver maple	Hackberry	Sweetgum
Water tupelo	Sugar maple	Rock elm	Western birch
White ash	Yellow birch	Yellow poplar	White oaks
Information taken fom Table 15-7 in Chapter 15 - Wood Handbook dated April 2010.			

**Table 4**  
**Preservative Retentions - Pounds per Cubic Foot <sup>(1)</sup>**

Preservative	Standard Reference	Pines				Spruce		Coastal Douglas Fir	Hem - fir Hem - fir (North) Eastern Hemlock	Western Red Cedar Redwood	White oak	Red Oak		Maple	Black and Red Gum
		Southern Mixed Southern	Ponderosa Red Eastern White	Jack Lodgepole	Western White Engelmann Sitka Spruce	Spruce - Pine-Fir (West)	< 5"					> 5"			
Creosote	P1/P13	8.0	8.0	8.0	8.0	#	8.0	8.0	8.0	R	6.0	5.0	10.0	6.0	
Creosote - Solution	P2	8.0	8.0	8.0	8.0	#	8.0	8.0	8.0	R	6.0	5.0	#	6.0	
Creosote - Petroleum Solution	P3	8.0	8.0	8.0	8.0	#	8.0	8.0	8.0	R	6.0	5.0	#	6.0	
Copper Naphthenate	P8/P9	0.04	0.04	#	0.04	#	0.04	0.04	0.04	#	#	#	#	#	
PCP-A	P8/P9	0.40	0.40	0.40	0.40	#	0.40	0.40	0.40	R	0.30	0.25	#	0.30	
PCP-C	P8/P9	0.40	0.40	0.40	0.40	#	0.40	0.40	0.40	R	0.30	0.25	#	0.30	
Notes:															
(1) Information taken from American Wood Protection Association (AWPA) Standard U1-11 Use Category System: User Specification for Treated Wood, Commodity Specification A: Sawn Products - UC3B.															
PCP = Pentachlorophenol															
# = Either no proposal for standardization and/or data demonstrating efficacy of a preservative/species combination has been submitted to AWPA or the use of the preservative/species combination has been proven ineffective.															
R = Treatment to Refusal															

## **APPENDIX A**

### **Best Management Practices**

# **NH DEPARTMENT OF TRANSPORTATION**

## **BEST MANAGEMENT PRACTICES**

### **Railroad Bridge Timbers**

The following Best Management Practices are to be used in the design, purchase, delivery, handling and installation of preservative treated timbers on railroad bridges to limit the amount of preservative available to migrate into the surrounding environment:

1. Inspect the bridge and surrounding area to determine if there are any environmentally sensitive areas located nearby.
2. Select a wood treatment that will create the least impact to the surrounding environment, and still provide the needed life span and meet the project requirements.
3. Review project specifications to ensure that the specified treatment meets the requirements of the American Wood Preservers Association (AWPA). Use the Lowry empty-cell process for treating the wood. If creosote treatment is specified, the treatment shall not exceed 8 pounds retention and the treatment should consist of straight creosote or creosote-petroleum solution (greater than or equal to 75 percent creosote). Specify that the bridge timbers shall be delivered visibly clean and free of surface residue.
4. After a manufacturer has been selected, the Department or their designee should contact the wood treatment facility to review the project, specifications and material expectations.
5. The Department should hire an independent inspector/consultant to inspect the manufacture and treatment of the bridge timbers. The third party agency evaluation shall be performed in accordance with AWPA M22-11: Standard for Third-Party Agency Evaluation of Inspection Data. The independent inspector should;
  - a. perform a site visit and audit of the wood treatment facility to assess the facility's quality control procedures and wood treatment operations. The audit should be performed in accordance with but not limited to the following: AWPA M1-11: Standard for the Purchase of Treated Wood Products; M2-11: Standard for Inspection of Wood Products Treated with Preservatives; M3-11: Standard Quality Control procedures for Wood Preserving Plants; and M4-08: Standard for the Care of Preservative Treated Wood Products. The audit shall focus on but not be limited to the following: 1) good housing practices at the facility to minimize debris/residues from collecting on the wood surface prior to treatment; 2) condition of the treatment cylinders; 3) clean treating solutions; 4) wood storage area (pre and post treatment areas); 5) use of appropriate seasoning and conditioning methods for the specified preservative treatment; and 6)

conformance with AWPA U1-11: User Specifications for Treated Wood and T1-11: Processing and Treatment Standard.

- b. inspect the bridge timbers prior to treatment in accordance with AWPA M2-11 Standard for Inspection of Wood Products Treated with Preservatives. Reject and eliminate all wood containing defects that may impact the project.
  - c. ensure that the wood treatment facility uses the appropriate seasoning and conditioning methods prior to treatment. The wood must be conditioned in accordance with AWPA M1-11: Standard for the Purchase of Treated Wood Products; AWPA U1-11: User Specifications for Treated Wood; and T1-11: Processing and Treatment Standard.
  - d. ensure that the bridge timbers are treated in such a manner as to minimize (avoid over treating) the amount of preservative placed into the wood while assuring conformance with the AWPA Standards.
  - e. ensure that the wood treatment facility performs final post-conditioning processes to recover excess preservative (minimize the amount of bleeding/weeping of the creosote from the treated wood) and obtain a clean wood product. The post-treatment process on the bridge timbers must be performed in accordance with AWPA M1-11: Standard for the Purchase of Treated Wood Products; AWPA U1-11: User Specifications for Treated Wood; and T1-11: Processing and Treatment Standard.
  - f. provide a letter of certification that the treated products meet the specified AWPA Standards and the Departments requirements for the project.
6. Inspect the bridge timbers upon delivery from the wood treatment facility. No visible dripping, bleeding or exudation of preservatives from the wood shall be present. Any bridge timbers exhibiting these conditions shall be rejected.
  7. Treated bridge timbers should be stored at a location where any releases from the wood (i.e., weeping or bleeding) will not contaminate a sensitive environment area (i.e., soil, groundwater, surface water or sediment). The treated timbers shall be stored in a manner that supports the wood without producing noticeable distortion and to permit air space beneath and around the material in order for any excess treatment chemicals to completely dry. The treated timbers shall be delivered in advance of the project to allow additional drying time if needed before use. The treated timbers shall remain stored until the Department is satisfied that the timbers are sufficiently dry so they will not present an environmental hazard when they are installed.
  8. Sawing, cutting and drilling of the wood product should be kept to a minimum after the timbers are treated. All sawdust and shavings shall be collected and contained and be disposed of properly. No additional preservative shall be applied in the field, even if the timbers are field cut.

9. Worker safety is essential for all projects. The supplier of the treated material will provide an USEPA-approved Consumer Information Sheet (CIS) or Consumer Safety Information Sheet (CSIS) and Material Safety Data Sheet (MSDS) for the treated material. Since the preservatives discussed in this paper are pesticides, special precautions need to be followed when using and handling treated wood.