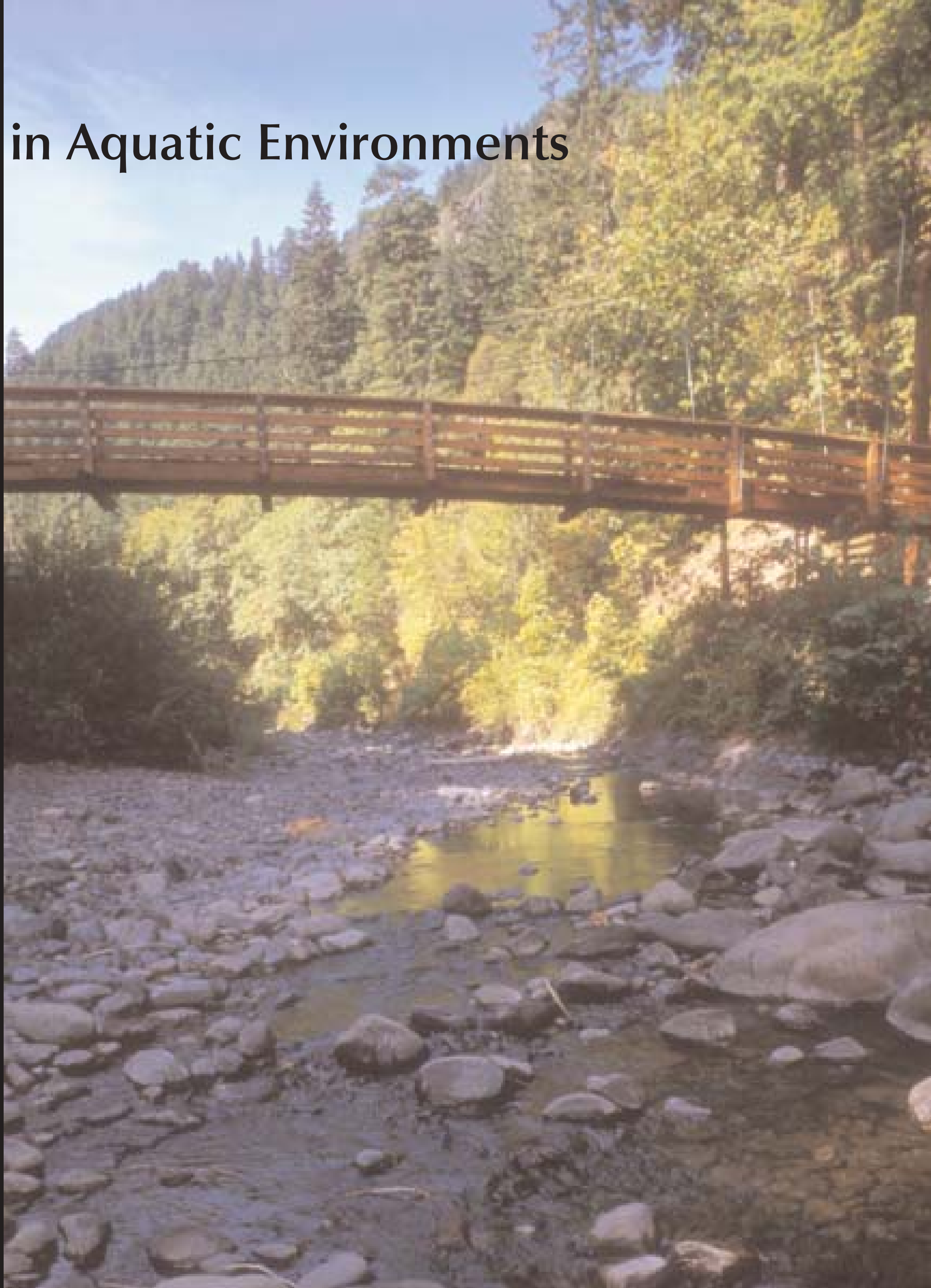
Treated Wood in Aquatic Environments



TimberPilingCouncil
FOUNDATION & MARINE PILING

A Specification and Environmental Guide to Selecting, Installing and Managing Wood Preservation Systems in Aquatic and Wetland Environments

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Your Internet Companion Additional materials and references are provided throughout this document and are all available via the Internet at www.WWPInstitute.org, www.spta.org, www.timberpilingcouncil.org

- **If you are** *viewing this document online*, **you need only double click on the reference indicated by blue or green print and a number** (1).
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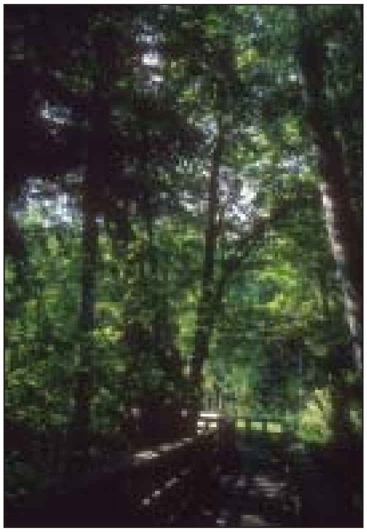


Terminology

To take full advantage of this guide, it will be important to understand critical terminology referred to throughout the publication. Following are definitions you'll need to know.

Standards The American Wood-Preservers' Association (AWPA) is the national standards-setting organization for treated wood in the U.S. and its counterpart in Canada is the Canadian Standards Association (CSA). The consensus standards of these two organizations establish what preservatives and chemical formulations are appropriate for common applications; set treating procedures; establish wood species requirements and testing procedures. The AWPA standards establish treatment requirements for wood products in Standard U1, "Use Category System: User Specification For Treated Wood." Section 2 of the standard will guide users to the appropriate Commodity Specifications in Section 6. These include the specifications for sawn products, posts, crossties and switchties, poles, round timber piling, wood composites, marine (salt water) applications, fire retardants and nonpressure applications.

Best Management Practices (BMPs) These are a set of environmental guidelines established by the Western Wood Preservers Institute and Wood Preservation Canada for products used in aquatic applications. They are formally known as the *Best Management Practices for the Use of Treated Wood in Aquatic Applications* (BMPs). Inspection services and a BMP Certification Mark program are available for BMP materials.

Consumer Information Sheets or Consumer Safety Information Sheets For wood treated with restricted-use preservatives, EPA has approved Consumer Information Sheets (CIS) and Consumer Safety Information Sheets (CSIS) to provide guidelines for safe and appropriate use of these materials. In addition, producers will provide Material Safety Data Sheets (MSDS) for the treated wood.

Incising Many species, such as western softwoods, do not accept pressure treating easily and must be *incised* to ensure adequate penetration to meet the treating standards. Incising is a process where small cuts are made on the wood surface in a regular pattern to enhance preservative penetration. Incising does *not* need to be specified since the requirements for each species are included in the AWPA C Standards. For aesthetic reasons, designers may choose species which do not require incising in the standards; others may forego incising on non-structural components of a project, recognizing the wood will not meet AWPA standards, although this practice is not recommended.

Penetration In general, only a shell of material around the perimeter of the wood is treated. *Penetration* is the measure of how deep the treatment extends into the wood. Required minimum penetration depths and percentage of sapwood treated are stipulated for each wood species, type of preservative and end use by AWPA standards. Project engineers and end users *do not* need to specify penetration depth, but instead merely the acceptable wood species, preservatives, AWPA Standard U1, and applicable Use Category.

Pressure Treatment The term *pressure treated wood products* generally refers to wood products that have been treated in a pressure cylinder, called a *retort*, in a highly controlled process using pressure to force the needed amount of preservative chemical into the wood. Depending upon the preservative system, the wood may be conditioned prior to treatment through drying or in the retort using steam and vacuum processes. Finally, the retort is filled with the treating solution in either a water- or oil-based carrier; then pressure is applied and held for a set amount of time. At the end of the treating cycle, the cylinder is drained and excess preservative is drawn off with vacuum before the wood is removed to the drip pad area, where it is held until free of preservative drippage. Sample borings are taken and tested to be sure the material *penetration* and *retention* standards have been met.

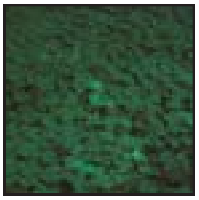
Quality Assurance Structural materials produced by the industry are subject to plant quality control procedures and third-party inspection to assure compliance with the AWPA standards. Building codes require that all treated wood used in structural applications must be inspected by an American Lumber Standard Committee (ALSC) accredited third-party agency.

Quality Assurance Information (7)

Registered Preservatives Wood-treating chemicals are pesticides and as such go through rigorous periodic review by the Environmental Protection Agency, Health Canada's Pesticide Management Regulatory Authority (PMRA), and/or state agencies. These detailed scientific health and environmental studies establish if the chemical will be registered as a wood preservative, and if so, what conditions apply. They may be classed, as most are, as restricted-use pesticides that can only be used by certified applicators in approved treating plants and only for certain uses. Alternatively, they may be classified as a general use pesticide and available for treatment of wood used for non-industrial applications as well as for field treating of drill holes or abrasions in treated materials.

Retention Retention is a measure of the amount of treatment chemical present in the portion of wood called the assay zone. It is measured in *pcf* – pounds of preservative per cubic foot – or kg/m^3 of the assay zone. Retention is cited in the Standards both as pcf and in kilograms per cubic meter, but this document will use only pcf. In AWPA standard U1, minimum retention values are defined by reference to the applicable Use Category in each commodity specification. Although retention values are included in this document for your information, when specifying, reference the applicable Use Category to ensure the proper retention level.

Treated to Refusal Sometimes hard-to-treat materials are placed in the treating cylinder (retort) for a long period at a given pressure to force as much preservative into the wood as possible. Often such materials *do not* meet the penetration and/or retention requirements. *Treated to Refusal* material should *not* be accepted in lieu of material inspected and marked as meeting the specified retention.



Why Treated Wood?

Wood's structural, economic, environmental and aesthetic benefits make it the preferred building product in a wide variety of construction applications – including bridges, boardwalks, piers and structures in or near our waterways and wetlands.

Wood's one weakness is its susceptibility to attack by natural enemies - marine borers, insects, decay and fungus. For most species, this means its useful life in open environments can be measured in terms of only a few years. Over the past century a variety of wood preserving treatments have been developed that introduce a small controlled amount of protective preservative into wood cells. The life of treated wood products can now be measured in terms of decades, not years.

For well over a century, treated wood has played an essential role in the economic prosperity and quality of life in North America. From the ties that carry the trains; to the poles that carry communications and power; to bridges that cross our rivers; to docks and piers that support recreation and commerce; to boardwalks that allow school children to view the wonders of sensitive wetland habitats, treated wood has been the preferred, time-proven material.

The environmental awakening of our society in the second half of the twentieth century brought an appropriate and continuing review of treated wood. Wood-treating chemicals became regulated by the environmental agencies, which produced guidelines intended to protect human health and the environment.

It was not until the 1990s that the potential impacts of treated wood used in our most sensitive ecosystems – aquatic environments – was the focus of close scientific study. Various governmental agencies, universities and the wood treating industry have undertaken extensive efforts to understand the potential effects of treated wood in aquatic environments. This continuing work has produced a substantive base of scientific knowledge about the behavior of treated wood and the level of risk it represents when used in aquatic environments. A worldwide review 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.

Protection of water quality and diversity of various life forms found in the lakes, streams, estuaries, bays and wetlands of North America is a responsibility shared by every private and corporate citizen. The treated wood industry is committed to actively supporting this important societal value. The purpose of this guide is to help you understand the facts and provide the tools and guidance to ensure that treated wood products are selected, specified and used in an environmentally appropriate manner.

Five Steps to Appropriate Use of Treated Wood in Aquatic Environments

This guide will help you understand the science and learn how to select and manage your use of treated wood to achieve the performance your project requires while minimizing the potential for any adverse environmental impacts. The process begins at project conception and tracks all steps through installation and maintenance.

The five basic steps are:

1. **Selecting the Proper Preservative and Retention Level**
2. **Environmental Considerations and Evaluations**
3. **Specifying the Best Management Practices**
4. **Providing Quality Assurance and Certification**
5. **Appropriate Handling, Installation and Maintenance**

Step 1: Selecting an Appropriate Preservative and End Use Category

(8) *U.S. Forest Products Lab*

To use treated wood appropriately, you need to fully understand your treatment options and how to select and specify material for different uses. A more extensive discussion of Wood Preservation can be found in the U.S. Forest Products Lab (FPL) Wood Handbook.

The initial step in specification for a particular application (piling, decking) is to determine the desired preservative for the project and select the appropriate End Use Category. These judgments should be made in conjunction with the environmental evaluation in Step 2.

Treatments Available for Use in Aquatic and Wetland Projects

While AWPA has identified 27 different preservative systems, only seven are commonly available and designated for freshwater and/or marine aquatic uses by AWPA standards and governmental registrations. These preservative systems can be divided into two general categories – Waterborne and Oil-type systems. The distinctions between them follow.

Waterborne Systems

(8A) *U.S. Forest Products Lab*

In waterborne systems, water is the carrier for the preservative chemicals. The chemicals react or precipitate into the wood substrate and become attached to wood cells, minimizing leaching. There are five main waterborne preservatives used in aquatic applications:
CCA – Chromated Copper Arsenate; **ACZA** – Ammoniacal Copper Zinc Arsenate;
ACQ – Alkaline Copper Quat; and **CA-B** – Copper Azole.

(9) *Preservative-specific Links*

Waterborne preservatives leave a dry, paintable surface and are commonly used in aquatic projects such as docks, boardwalks and bulkheads. For a detailed discussion of the preservative formulations in waterborne systems, refer to the U.S. Forest Products Lab Handbook or specific chemical manufacturer's web sites.

Oil-type Preservatives

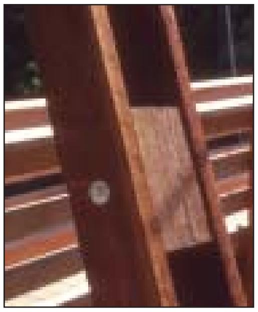
In oil-type systems the preservative is 100 percent active (creosote) or dissolved in an oil-based solvent. The mixture then fills or coats the wood cell walls during treatment. There are three oil-type preservatives that are used in aquatic or wetland applications: **Creosote, Pentachlorophenol** and **Copper Naphthenate**.

(6) *Consumer Information Sheets or Consumer Safety Information Sheets*

Oil-type preservatives are commonly used to treat round, solid-sawn and laminated products used in aquatic applications for piling, timbers, bulkheads, bridges and boardwalks. Because of their oil carrier and possible aroma, they are not acceptable for applications involving frequent or prolonged skin contact or interior uses unless the wood is sealed.

(8B) *U.S. Forest Products Lab*

The oil present in these preservative systems also acts as a water repellant and can help limit checking and splitting. You may select the type of carrier oil to meet specified uses – such as selecting light solvents where a clear untreated appearance is desired with Penta or Copper Naphthenate. For a detailed discussion of the preservative formulations for oil-type preservatives, refer to the U.S. Forest Products Handbook.



Selecting the Appropriate End Use Category

AWPA Standard U1, The Use Category System: User Specification for Treated Wood, is based on the end use hazard, similar to other international standards for wood treatment. The Use Category System (UCS) is used to specify the wood treatment based on the desired wood species and the environment of the intended end use. There are six Use Categories which describe the exposure conditions that wood may be subject to in service. Use categories 3, 4 and 5 have multiple risk levels.

Use Category UC1 Wood and wood-based materials used in interior construction not in contact with the ground or foundations.
Use Category UC2 Wood and wood-based materials used for interior construction that are not in contact with ground, but may be subject to dampness. These products are continuously protected from the weather but may be exposed to occasional sources of moisture.
Use Category UC3A Wood and wood-based materials used for exterior construction that are coated and not in contact with the ground. Such products may be exposed to the full effects of weather, such as vertical exterior walls or other types of construction that allows water to quickly drain from the surface.
Use Category UC3B Wood and wood-based materials used in exterior construction and not in contact with the ground. Materials do not require a coating, but may be finished to achieve a desired aesthetic appearance. (Retentions above the minimum specified for materials in the use category may be required for products where the individual components are difficult to maintain, repair or replace and are critical to the performance and safety of the entire system).
Use Category UC4A Wood and wood-based materials used in contact with the ground, fresh water, or other situations favorable to deterioration.
Use Category UC4B Wood and wood-based material used in contact with the ground either in a severe environment, such as horticultural sites, in climates with a high potential for deterioration, in critically important components such as utility poles, building poles and permanent wood foundations, and wood used in salt water splash zones.
Use Category UC4C Wood and wood-based material used in contact with the ground either in a severe environment, or climates demonstrated to have extremely high potential for deterioration, in critical structural components such as land and fresh water piling and foundation piling, and utility poles located in a semi-tropical or tropical environment.
Use Category UC5A Wood and wood-based materials exposed to salt and brackish water generally to the north of New Jersey on the East Coast and north of San Francisco on the West Coast to the extent that the marine borers can attack them.
Use Category UC5B Wood and wood-based materials exposed to salt and brackish water between New Jersey and Georgia on the East Coast and south of San Francisco on the West Coast to the extent that the marine borers can attack them.
Use Category UC5C Wood and wood-based materials exposed to salt and brackish water south of Georgia and along the Gulf Coasts in the Eastern U.S. as well as Hawaii and Puerto Rice, to the extent that the marine borers can attack them.

WWPI Abbreviated Guide (2)

Use Category System (3)

Which Preservative to Use?

Given the proper standard, many factors enter into your decision on which specific preservative meets your needs best. You will likely weigh the economics, type of project, wood species, aesthetics and availability as well as being sensitive to environmental concerns. These decisions are a matter of personal preference, organization policy, professional knowledge and the specific environment in which your project will be placed. To help you make your selection, you may want to investigate the links to manufacturers' preservative information.

Preservative-specific Links (9)

Guide to Retentions for Treated Wood End Uses

USE	AWPA STANDARD: Use Category System	OIL-TYPE PRESERVATIVES Minimum Retentions – Pounds Per Cubic Foot[1]: Copper Naphthenate	Creosote	Pentachlorophenol
BEAMS & TIMBERS, glue laminated before or after treatment				
Interior, dry	1	0.04	8.0	0.30
Interior, damp	2	0.04	8.0	0.30
Exterior, above ground	3B	0.04	8.0	0.30
Exterior, ground contact	4A	0.06	10.0	0.60
Highway construction	4B, 4C	0.080 – 0.15* *after gluing	9.0 – 12.0	0.45 – 0.60
HIGHWAY MATERIAL				
Lumber and timbers for bridges, structural members, bridge decking, cribbing and culverts	4B	0.075	10.0	0.50
Structural lumber, beams and timbers:				
– In saltwater use and subject to marine borer attack	5A, 5B, 5C	Not Listed	25.0	Not Listed
– Piles, foundation, land and fresh water use	4C	0.10 – 0.14	12.0 – 17.0	0.60 – 0.85
– Piling in saltwater use and subject to marine borer attack	5A, 5B, 5C	Not Listed	16.0 – 20.0	Not Listed
– Posts: Round, half-round, quarter-round (General const. – fence posts, sign posts, handrails)	4A	0.055	6.0 – 8.0	0.40
– Posts: Round, half-round, quarter-round (Guardrails, spacer blocks, critical structural members	4B	0.069	10.0	0.50
– Posts: Sawn (General const. – fence posts, sign posts, handrails	4A	0.06	10.0	0.40
– Posts: Sawn (Guardrails, spacer blocks, critical structural members	4B	0.075	10.0	0.50
LUMBER AND TIMBERS				
Above ground	3B	0.04	8.0	0.40
Ground contact and freshwater use	4A	0.06	10.0	0.50
MARINE LUMBER AND TIMBERS				
Members above ground and out of water but subject to saltwater splash	4B, 4C	0.06, 0.075	10.0, 12.0	0.50, 0.60
In brackish or saltwater use and subject to marine borer attack	5A, 5B, 5C	Not Listed	25.0	Not Listed
PILES				
Foundation, land and freshwater use (round)	4C	0.10 – 0.14	12.0 – 17.0	0.65 – 0.85
Marine (round) in salt or brackish and subject to marine borer attack	5A, 5B, 5C	Not Listed	16.0 – 20.0	Not Listed
Marine, dual treatment (round) for maximum protection	5B, 5C	Not Listed	20.0	Not Listed
Sawn timber piles	4B, 4 C	.075	10.0 – 12.0	0.50
PLYWOOD				
Sub-floor, damp, above ground	2	0.04	8.0	0.40
Exterior, above ground	3B	Not Listed	8.0	0.40
Soil contact	4A	Not Listed	10.0	0.50
Marine	5A, 5B, 5C	Not Listed	25.0	Not Listed

NOTE: *This is a summary document only; for complete information, see AWPA Book of Standards.*

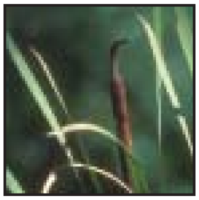
[1] Retentions vary because of differences in wood species or project location.
[2] Alkaline Copper Quat
[3] Ammoniacal Copper Zinc Arsenate
[4] Copper Azole
[5] Salt water splash only; sawn members must be 2″x 8″ or 3″x 6″ in nominal dimension or larger.
[6] Chromated Copper Arsenate
[7] It is generally recognized that Douglas fir is extremely difficult to treat with CCA to required penetration and retention.

Guide to Retentions for Treated Wood End Uses

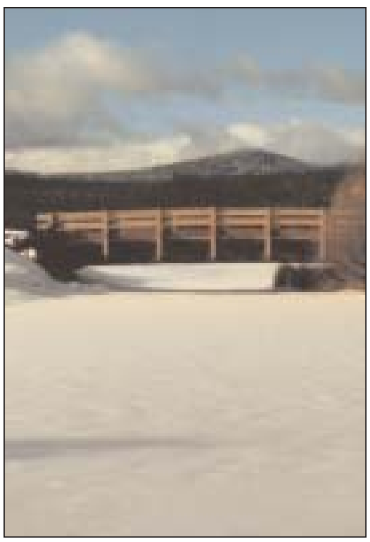
	WATERBORNE PRESERVATIVES Minimum Retentions – Pounds Per Cubic Foot[1]			
USE	ACQ[2]	ACZA[3]	CA-B[4]	CCA[6,7]
BEAMS & TIMBERS, glue laminated before or after treatment				
Interior, dry	0.25	0.25 – 0.30	Not Listed	0.25*
Interior, damp	0.25	0.25 – 0.30	Not Listed	0.25*
Exterior, above ground	0.25	0.25 – 0.30	Not Listed	0.25*
Exterior, ground contact	0.40	0.40 – 0.60	Not Listed	0.40*
Highway construction	Not Listed	0.40 – 0.60*	Not Listed	0.40*
		*before gluing		*before gluing
HIGHWAY MATERIAL				
Lumber and timbers for bridges, structural members, bridge decking, cribbing and culverts	0.60	0.60	0.31	0.60
Structural lumber, beams and timbers:				
– In saltwater use and subject to marine borer attack	Not Listed	2.50	Not Listed	2.50
– Piles, foundation, land and fresh water use	Not Listed	0.80 – 1.0	Not Listed	0.80 – 1.0
– Piling in saltwater use and subject to marine borer attack	Not Listed	1.50 – 2.50	Not Listed	1.50 – 2.50
– Posts: Round, half-round, quarter-round (General const. – fence posts, sign posts, handrails)	0.40	0.40	0.21	0.40
– Posts: Round, half-round, quarter-round (Guardrails, spacer blocks, critical structural members	0.50	0.50	0.31	0.50
– Posts: Sawn (General const. – fence posts, sign posts, handrails	0.40	0.40	0.21	0.40
– Posts: Sawn (Guardrails, spacer blocks, critical structural members	0.50	0.50	0.31	0.50
LUMBER AND TIMBERS				
Above ground	0.25	0.25	0.10	Not Listed
Ground contact and freshwater use	0.40	0.40	0.21	Not Listed
MARINE LUMBER AND TIMBERS				
Members above ground and out of water but subject to saltwater splash	0.60	0.60	0.31	0.60[5]
In brackish or saltwater use and subject to marine borer attack	Not Listed	2.50	Not Listed	2.50
PILES				
Foundation, land and freshwater use (round)	0.80	0.80 – 1.0	Not Listed	0.80 – 1.0
Marine (round) in salt or brackish and subject to marine borer attack	Not Listed	1.50 – 2.50	Not Listed	1.50 – 2.50
Marine, dual treatment (round) for maximum protection	Not Listed	1.0	Not Listed	1.0
Sawn timber piles	0.60	0.60 – 0.80	Not Listed	0.60 – 0.80
PLYWOOD				
Sub-floor, damp, above ground	0.25	0.25	0.11	0.25
Exterior, above ground	0.25	0.25	0.11	0.25
Soil contact	0.40	0.40	0.21	0.40
Marine	Not Listed	2.50	Not Listed	2.50

NOTE: *This is a summary document only; for complete information, see AWPA Book of Standards.*

1 Retentions vary because of differences in wood species or project location.
2 Alkaline Copper Quat
3 Ammoniacal Copper Zinc Arsenate
4 Copper Azole
5 Salt water splash only; sawn members must be 2″x 8″ or 3″x 6″ in nominal dimension or larger.
6 Chromated Copper Arsenate
7 It is generally recognized that Douglas fir is extremely difficult to treat with CCA to required penetration and retention.



STEP 2: Environmental Considerations and Evaluations



Understanding Risk and Treated Wood

To protect wood from attack by insects and decay, materials must be treated with controlled amounts of preservatives. Like most chemicals (natural or man-made), they can be "toxic" to life forms at high enough concentrations. To manage the risk, society has turned to the Federal Environmental Protection Agency (US EPA) and other state or provincial agencies to conduct expansive scientific reviews of wood-treating preservatives to evaluate the risks to human health and the environment versus the benefits.

This process determines which treating preservatives will not be allowed, which will be allowed under strict application restriction and which will be allowed for more general use. The results are expansive regulations governing the handling and application of preservatives in the treating process and guidelines for the use of the products. Ongoing US EPA and Canadian registration processes are the first level of Risk Management.

The purpose of this document is to provide guidance to a second level of Risk Management for treated wood that is to be used in the most sensitive environments – waterways and wetlands.

After identifying a preferred preservative, you need to review your project for its potential environmental impacts. In rare instances, this review will cause you to change the preservative you have selected.

Environmental Concerns with Treated Wood

Nearly all materials, man-made or natural, placed in an aquatic environment will introduce chemicals which, if present in large enough concentration, will either immediately or over time pose a potential threat to plant and animal life forms dependent upon that environment.

A certain quantity of the chemicals used to preserve wood will leach or migrate from treated wood structures built in aquatic and wetland areas into the water column and surrounding sediments. The question is how much and when will the preservatives move into the environment and under what circumstances might they represent a significant risk. Section B of this report concentrates on the science behind this question. The following summarizes the issues.

Chemicals of Potential Environmental Concern

For all practical purposes only three compounds used in common preservative systems could potentially cause concern in aquatic environments. Understanding these chemicals will help assure that the products you specify and handle will avoid risk to the aquatic and wetland environments.

Copper

Copper is a commonly used component in several wood preservatives. Many preservatives classified "general use" by the EPA rely on copper as the principal component for biocidal activity. For waterborne systems and for oil-based copper naphthenate, the chemical of concern is copper. Fishes and aquatic organisms are much less tolerant of copper than are people or other mammals. If the levels of copper from treated wood are appropriately managed for aquatic use, other chemicals used in waterborne preservative systems such as arsenic, zinc, chromium, tebucoazole and quaternary compounds simply are not present at levels of concern. Extensively reviewed and published information is available on the effects of copper in the environment and the biological importance of copper.

CCA Assessment (10)
ACZA Assessment (11)
ACQ Assessment (12)
Copper Information (13)
CA-B Assessment (14)

PAH

The toxic compounds in creosote are called polycyclic aromatic hydrocarbons or PAH. These naturally occurring substances are also generated by forest fires, volcanoes, coal deposits and oil seeps. They are formed whenever there is combustion. Power generation, automobiles and asphalt paving are common sources of PAH associated with human activity. PAHs are not water soluble and are generally of little concern in the water column. However, they can accumulate in sediments to levels of 10 to 20 parts per million (ppm) that have been associated with cancer in fish.

PAHs are rarely found at concentrations that are acutely toxic to aquatic organisms except in association with historic industrial activities. Because they have been part of our environment long before mankind, they are metabolized by most organisms. In fact, bacteria efficiently break them down in healthy environments where there is sufficient oxygen, and they decompose more slowly in the absence of light or in anaerobic environments.

Creosote Assessment (15)

Pentachlorophenol

Pentachlorophenol (Penta) from treated wood may be dissolved in the water column and sorbed to matter in bottom sediments. Penta readily degrades in the environment by chemical, microbiological, and photochemical processes. Penta-treated materials used in aquatic applications are limited to above-water structures and freshwater pole or piling structures. If present in large enough quantities, penta may be toxic to fish and other aquatic life. Accumulation in fish and other animals is not a concern for penta.

Penta Assessment (16)

Where Are Preservatives a Concern?

The safety of treated wood products is confirmed by their long history of use without a single documented instance in which treated wood products have jeopardized natural environments. However, wood preservatives do leach or migrate from pressure treated wood at very low rates. Previous research has accurately defined these loss rates allowing industry to produce guidelines and risk assessment models that insure the continued safe use of these products. For example, Figure 1 on page 12 describes the loss of copper from CCA-C treated wood. Risk assessments are based on the first few days of immersion because that is when preservative loss rates are highest. These rates decline very quickly over time and are generally undetectable in the water after the first few weeks.

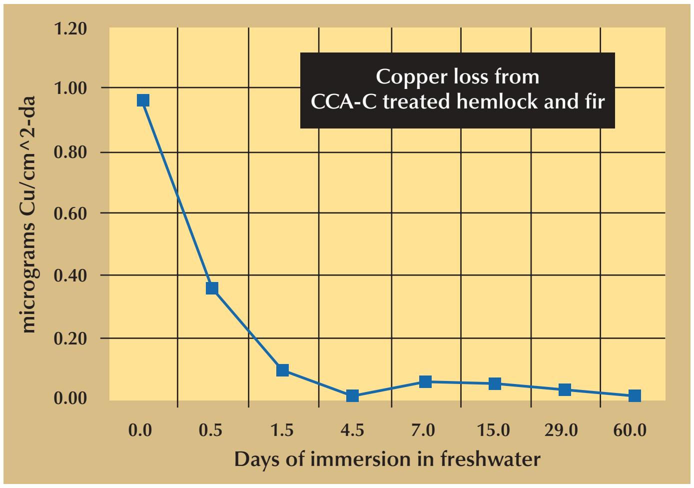


Figure 1

(17) *WWPI Risk Assessment Models*

Because of the very low amounts of chemical that will move into the environment, the appropriate use of treated wood will not represent an adverse risk except in cases where the sites were previously contaminated from other sources, or in very sensitive environments with almost no water current where very large projects are planned.

Environmental Evaluation and Risk Assessment

Knowledge of preservative loss rates from properly treated wood, when coupled with site-specific environmental data (such as water current speeds and background levels of metals and organics), allow the industry to use relatively simple computer models to predict the environmental response to any project you might design. These models have been peer-reviewed, repeatedly field-tested and proven to protect the environment. They are used by the U.S. Forest Service, U.S. Park Service, Environment Canada and Canadian Department of Fisheries & Oceans as well as a host of local and state regulatory bodies.

Examples of Typical Models

Example 1: The models have also been used to define categories of projects that should require no risk assessment and those where additional assessment should be carried out during the preliminary design phase. As an example, Tables A and B below describe the number of CCA-C, ACZA, ACQ-B, CA-B or Copper Naphthenate piling or timber that can be placed in a row paralleling freshwater currents without jeopardizing the environment. The tables were constructed assuming a receiving water pH of 6.5, hardness of 75 mg $CaCO_3$/L, and a background copper concentration of 1.5 µg Cu/L. These values are typical of many rivers and lakes in the country.

Most large lakes have current speeds greater than 2.0 cm/sec and river speeds greater than 10 cm/sec. Most projects being permitted today involve fewer that four piling placed in a row parallel to the currents (i.e. along the shore) and all four of the preservatives listed in the table are acceptable in most applications.

Table A: Guide for number of CCA-C, ACZA or Copper Naphthenate piling (see UCS 4C) that can be placed in a row paralleling freshwater currents without jeopardizing the environment.

Preservative	Day 0.5 loss rate micrograms Cu/cm^2	Maximum Current Speed (cm/sec)							
		0.5	1.0	1.5	2.0	3.0	5.0	7.5	10.0
CCA-C	3.98	66	132	198	264	397	661	992	1322
ACZA	39.60	7	13	20	27	40	66	100	133
CuN	17.37	15	30	45	61	91	151	227	303

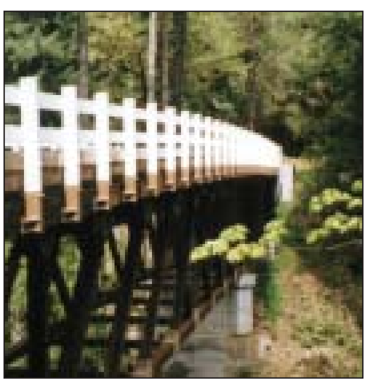


Table B: Guide for number of ACQ-B or CA-B timbers (see UCS 4A) that can be placed in a row paralleling freshwater currents without jeopardizing the environment.

Preservative	Day 0.5 loss rate micrograms Cu/cm^2	Maximum Current Speed (cm/sec)							
		0.5	1.0	1.5	2.0	3.0	5.0	7.5	10.0
ACQ-B	44.10	6	12	18	24	36	60	90	119
CA-B	40.30	7	13	20	26	39	65	98	131

Example 2: Creosote-treated projects are typically located in marine environments and their evaluation is somewhat more complex. The figure below describes projects where creosote-treated wood should not be used without a risk assessment (red); where it is not likely to have an effect but caution suggests an individual risk assessment should be completed (yellow); and where creosote-treated projects are not likely to affect the environment and require no additional assessment (blue or green). The values in each cell are the maximum predicted sediment concentrations of PAH.

Creosote is broken down by microbes in sediments and microbes need oxygen to start that process. Therefore, the suitability of creosote in an environment depends in part on the availability of oxygen – as measured by the depth of the reduction-oxidation potential discontinuity (RPD) in this chart. The RPD in healthy environments is generally greater than 3 cm and typical maximum current speeds present in most projects will be > 3 to 5 cm/sec. In sum: the typical small creosote-treated piling project is not likely to affect healthy marine environments.

Table C: Creosote Guide for determining need for Risk Assessment (RA).
Red: RA recommended; Yellow: RA advised; Green or Blue: no RA needed

	Depth of Reduction-Oxidation Potential Discontinuity (cm)						
Maximum current speed (cm/sec)	**0.0**	**0.5**	**1.0**	**1.5**	**2.0**	**3.0**	**4.0**
0.5	262.96	120.25	66.79	43.83	33.05	25.50	24.57
1	131.48	60.13	33.40	21.91	16.52	12.75	12.29
2	65.74	30.06	16.70	10.96	8.26	6.37	6.14
3	43.83	20.04	11.13	7.30	5.51	4.25	4.10
4	32.87	15.03	8.35	5.48	4.13	3.19	3.07
5	26.30	12.03	6.68	4.38	3.30	2.55	2.46
6	21.91	10.02	5.57	3.65	2.75	2.12	2.05
7	18.78	8.59	4.77	3.13	2.36	1.82	1.76
8	16.43	7.52	4.17	2.74	2.07	1.59	1.54
9	14.61	6.68	3.71	2.43	1.84	1.42	1.37
10	13.15	6.01	3.34	2.19	1.65	1.27	1.23
11	11.95	5.47	3.04	1.99	1.50	1.16	1.12
12	10.96	5.01	2.78	1.83	1.38	1.06	1.02
13	10.11	4.63	2.57	1.69	1.27	0.98	0.95
14	9.39	4.29	2.39	1.57	1.18	0.91	0.88
15	8.77	4.01	2.23	1.46	1.10	0.85	0.82

When Is a Full Risk Assessment Needed?

A Starting Point

To be conservative, an individual Risk Assessment is recommended in the general cases that follow.

You can access on-line the actual guidelines that apply and the Microsoft EXCEL™ computer models that allow you to conduct your Risk Assessment. It should be emphasized that the criteria below are very conservative and it is likely that fewer than five percent of all typical projects will actually require a complete Risk Assessment.

WWPI Risk Assessment Models 17

- Projects involving greater than 100 piling
- Substantial projects having large treated wood surface areas such as bulkheads

- Projects in industrial areas where there may be high background levels of metals or polycyclic aromatic hydrocarbons
- Projects in close proximity (<50 feet) to other projects involving more than 20 piling that are treated with a similar preservative (creosote, copper based, etc.)

The industry is proud of the improvements in production processes and its history of environmentally appropriate product performance. The use of these guidelines and risk assessments is intended to insure that this history of safe use continues into the future.

Aquatic Use and Selection Guides for In-water Applications

In addition to running the models just described, the following preservative-specific criteria should be considered to determine if a full Risk Assessment is called for in water projects:

(17) *Risk Assessment Models*

NOTE: For each preservative, select the model that fits your specific application.

Creosote (freshwater or marine)
- The sediments are black and smell of hydrogen sulfide
- Maximum current speeds are less than three cm/sec
- Project involves more than four piling placed in a row parallel to the currents

Pentachlorophenol (freshwater only)
- Maximum current speeds less than 2.5 cm/sec
- Project involves more than four piling placed in a row parallel to the currents

Copper Naphthenate (freshwater)
- Maximum current speeds less than 1.0 cm/sec
- Project involves more than six piling paralleling the currents

Waterborne treatments (freshwater)
- Maximum current speeds less than 1.0 cm/sec or:

  CCA-C. Project involves more than 100 piling parallel to the currents
  ACZA. Project involves more than 25 piling parallel to the currents
  CA-B. Project involves more than two timbers parallel to the currents
  ACQ-B. Project involves more than two timbers parallel to the currents
  The pH of the receiving water is less than 5.5

Waterborne treatments (marine environments)
- Maximum current speeds less than 1.5 cm/sec or:

  CCA-C. Project involves more than four piling parallel to the currents
  ACZA. Project involves more than two piling parallel to the currents

Over-water Considerations

While the greatest potential environmental exposure is with in-water use of treated material where direct contact and higher retention levels exist, the large volume of wood used in above-water structures and decking also merits risk consideration and sound chemical management. Splash and rain runoff represent potential paths for treating chemicals to move from treated wood into the environment. Experience has shown that where environmental concerns have been raised, any adverse impacts found were caused by improper specification, treating or installation.

CONCLUSION *It should be emphasized that these recommendations are very conservative from an environmental point of view. Pressure treated wood has a long history of safe use in aquatic environments with no published report describing a significant loss of biological integrity associated with its proper use. Adverse impacts, where they have occurred, have been linked to significant concentrations of the preservative chemicals at old treating facilities and not with use of the treated product. The industry is proud of the improvements in production processes and its track record of environmentally appropriate product performance. The use of these guidelines and risk assessments is intended to insure that this history of safe use continues into the future.*

STEP 3: Specifying the Best Management Practices

The treating industry believes the potential for any adverse environmental impact is reduced when certain conditions are met:

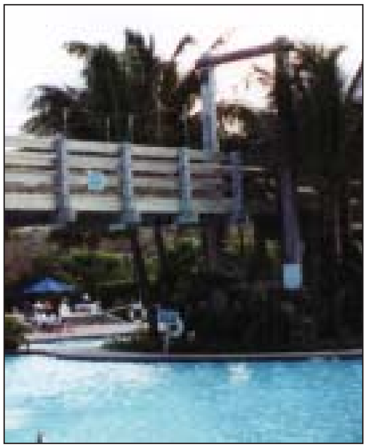
- Materials are specified with the minimum retention needed for their application
- Best Management Practices (BMPs) are mandated with certification of inspection
- Proper field guidelines are followed

Best Management Practices

Protecting the lakes, streams, bays, estuaries and wetlands of North America is a responsibility shared by every citizen. The pressure treated wood products industry is committed to ensuring that its products are manufactured and installed in a manner which minimizes any potential for adverse impacts to these waters. To achieve this objective, the industry developed and encourages the use of the **Best Management Practices** or **BMPs**. BMPs are *in addition to the AWPA standards* and contain guidelines specific to each preservative system related to the treating process. These include technical guidance on the handling and use of the treating preservative, wood preparation and treating procedures, post treatment processes and inspection. The BMPs are designed to:

Complete BMP Document (4)

- Minimize the amount of preservative placed into the wood while assuring conformance with AWPA standards
- Maximize fixation or stabilization in waterborne systems
- Minimize surface residues and bleeding from oil-type, preservative-treated products.



The specification for treated wood products used in aquatic and wetland applications should contain language to the effect: *These products are to be produced in accordance with the Best Management Practices for Treated Wood in Aquatic Environments issued by the Western Wood Preservers Institute, Wood Preservation Canada, and The Timber Piling Council.* Using such a reference, you will not need to list the specific requirements of the BMPs.

STEP 4: Providing Quality Assurance and Certification

Treating Quality and BMP Assurance

Sound project management will provide for quality control to assure that the treatment and BMP specifications have been met. Third-party independent inspection procedures are in place to meet these needs.

Treating Quality

7 *Quality Assurance Information*

To assure products meet the specified AWPA standards, the presence of a quality mark or letter of certification from a third-party inspection agency should be required in the specification. Building codes require all treated wood used in structural applications must be inspected by an American Lumber Standard Committee (ALSC) accredited third-party agency. The presence of the CheckMark logo on structural materials notifies the user that the inspection agency and materials were under the ALSC Treated Wood Enforcement program to assure compliance with AWPA standards.

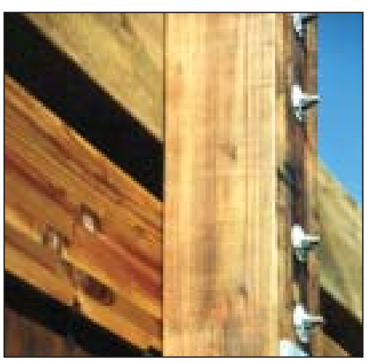
BMP Assurance

18 *BMP Quality Assurance*

Specifications for material intended for use in aquatic or wetland applications should require that the material be produced in accordance with the BMPs. Conformance should be certified by third-party inspection documented by written certification or the presence of the BMP Certification Mark. Check on-line for details.

Work with the Treater

It is strongly recommended that, once a supplier has been selected, the specifying organization and/or contractor contact the wood treating company directly to review the project, specifications and material expectations. Direct contact with the treating firm should be made even if the material is being purchased through a third-party wholesale firm. Experience has shown that where treated materials have *not* met the purchaser's expectations it has been the result of a lack or breakdown in communications. In addition to going over the treating requirements, calling the treater affords you an opportunity to review lumber grades and framing requirements that may have been part of the specification.



STEP 5: Appropriate Handling, Installation and Maintenance

The most critical time in the life of a treated wood project – in terms of potential environmental impacts – is during and immediately following construction. Specification of BMP materials will provide assurance that materials at the job site meet fixation requirements (for waterborne preservatives) and are free of excessive surface preservative. This minimizes initial risks.

There are several additional actions that can be taken to ensure the project is completed in an environmentally safe manner:

- **Framing, sawing, cutting and drilling.** To the maximum degree possible, framing, sawing, cutting and drilling should be done before treatment. Most treaters are able to provide these services or the work can be done prior to the material going to the treating plant. This may require more engineering and product coordination, but it assures the best treated product, minimizes the need for field treating and yields the more efficient installation.
- **Field inspection.** The materials should be visually inspected when they arrive on site. Materials which display excessive bleeding (oil-type) or surface deposits should be rejected and the supplier contacted for replacement.
- **Re-treatment.** If the materials do not meet the retention or penetration specifications, caution should be taken before agreeing to re-treat. This is especially true with oil-type preservatives, since re-treatment can lead to excessive retentions and increased potential for environmental impact.
- **Fasteners.** Fasteners for preservative-treated wood shall be hot dipped galvanized in accordance with ASTM A-153, silicon bronze, copper or 304 or 316 stainless steel. Stainless steel fasteners should be used below grade in Permanent Wood Foundations and are recommended for use with treated wood in other corrosive exposures such as in or near salt water.
- **Field fabrication.** All sawing and drilling should be done away from the water when practical, taking steps to collect, contain and prevent dust and shavings from entering the water or soil. Dispose of all scraps and sawdust in an appropriate landfill.
- **Field treating.** All field cuts and drill holes should be field treated. Field treating (as well as applying sealers) should be done well away from the water if at all possible. If over-water treatment is necessary, steps should be taken (such as using tarps) to collect any surplus treatment for removal and disposal.
- **Absorbent booms.** When oil-type materials are first placed into the water a sheen may appear on the water. While generally environmentally benign, a visual concern exists until the sheen evaporates or dissipates. You should consider installing absorbent materials to contain the sheen, and booms should remain in place until the sheen ceases.
- **Demolition.** Removal of old or abandoned treated wood structures from the water can disturb sediments, creating a greater potential concern than if left alone. Alternative strategies such as cutting them off at the sediment line or leaving them as fish habitat should be considered.
- **Worker safety.** The treated wood material supplier will provide an EPA-approved Consumer Information Sheet (CIS) or Consumer Safety Information Sheet (CSIS) and a Material Safety Data Sheet (MSDS) for the treated material. Be sure employees are aware of the information in the CIS or CSIS and follow the guidelines.

Fastener Information (19)

Disposal of Treated Wood (20)

Field Treating (21)

For another perspective on using treated wood in sensitive environments, it is suggested you access: ***Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments*** *published by the USDA Forest Products Laboratory.*

FPL Environmental Guide (22)

Consumer Information Sheets or Consumer Safety Information Sheets (6)

SECTION B
The Environmental Science

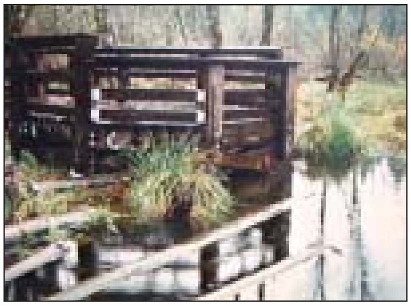
The Environmental Impact of Treated Wood – What Does the Science Say?

by Dr. Kenneth M. Brooks
President, Aquatic Environmental Sciences

Dr. Books heads up a leading biological laboratory located in Port Townsend, Wash. Under his guidance, extensive North American aquatic-oriented research in the areas of intensive fish and shellfish aquaculture and environmental response to pressure treated wood products is conducted. His work modeling and evaluating the environmental response to treated wood has been used by Environment Canada, the U.S. Forest Service and industry. Prior to forming the Aquatic Environmental Sciences Laboratory, Dr. Brooks, a doctor of Physics and Marine Biology, was a Navy researcher at Lawrence Livermore Laboratories. He worked extensively with conservation districts, the National Resource Conservation Service and state extension service; and served as chairman of both the Washington State Conservation Commission and Agriculture-Natural Resources Forum.

Over the last several decades, a great deal of research has been undertaken by scientists from around the world to understand the environment's response to pressure treated wood structures. Much of this work focused on the performance of pressure treated wood and on human health concerns. In addition, several laboratory studies were undertaken to understand the transport and fate of wood preservative chemicals that are slowly leached from wood projects in natural environments. Each Risk Assessment contains bibliographies for this literature.

When large blocks of treated wood were placed in small bowls of water, laboratory studies demonstrated adverse effects on a number of freshwater and marine animals. Missing from the literature were real world studies that measured and evaluated the impacts of large treated wood structures on natural biological communities. However, in recent years, a number of major field studies have been sponsored by the Canadian and U.S. governments to fill this knowledge gap. This Report focuses on the overall conclusions of this extensive research. You are encouraged to review the complete documents for a detailed discussion.



ACZA

ACQ-B

CCA-C

The Wildwood Study

Wildwood Study (23)

In 1996 the U.S. Forest Service and Bureau of Land Management constructed a massive board-walk system through wetlands created by a series of beaver dams in an abandoned channel of the Salmon River on the western slopes of Mount Hood in Oregon.

For background information on specific preservatives see:

CCA Assessment (10)

ACZA Assessment (11)

ACQ Assessment (12)

The 1,800-foot long boardwalk was built to provide public access to this pristine, otherwise inaccessible environment. Different sections of the boardwalk were constructed with ACZA, ACQ-B or CCA-C preserved wood. Soils, wetland sediments, the water and invertebrates living around the structures were carefully sampled and analyzed before construction began and periodically afterward for one year. Conditions at varying distances from the structures were compared with those at a similar control structure built of untreated wood in an isolated part of the wetland. The results of this study were published by the U.S. Forest Service in 2000.

The Wildwood site was chosen for this evaluation because the project was large and the environment sensitive. The soft and very slow-moving water, fine-grained sediments and heavy rainfall, combined with the massive scale of the boardwalk, led the authors to conclude this was a worst-case study. If adverse effects were to be found in sensitive invertebrate communities, they would be found here.

Each of the structures behaved differently but their metal loss rates were consistent with laboratory leaching studies. The full report contains a detailed description of the metal concentrations observed in the water and sediments within 12 meters of each structure during the entire study. For waterborne systems, copper is the metal of concern because aquatic organisms, unlike humans, are much less tolerant of copper than they are of arsenic, zinc or chromium. If the levels of copper from treated wood were maintained at less than toxic thresholds, then other chemicals used in waterborne preservatives would simply not be present at concentrations causing concern. The following discussion will focus on the results for the CCA-C structure because this preservative is the most commonly used product in the U.S.

What is intuitive for most people is the biological response. Wildwood is a “buggy” place: 86,144 bugs, snails, clams and worms were collected and identified in the 424 samples collected by the researchers. One hundred fifty-one different kinds of animals were identified from sediments, vegetation and on artificial substrate collectors used to sample the “drift community.” Scientists have numerous ways of analyzing databases developed in these kinds of studies and many of those analytical techniques were used here. Figures 2 and 3 on page 20 show four common ways of assessing animal communities. For each metric in the figures, higher values are associated with healthier communities.

No adverse effects on the sensitive invertebrate community were evident in this study at the structures built using ACZA, ACQ-B or CCA-C-treated wood.

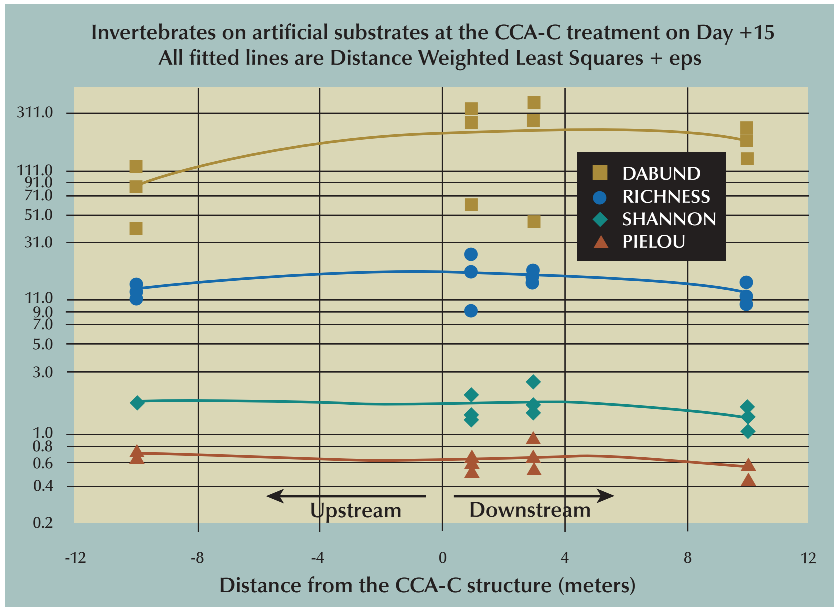


Figure 2

Figure 2 describes the response of invertebrates most exposed to the peak concentrations of dissolved copper observed two weeks after construction of the CCA-C viewing platform. Copper declined dramatically in all subsequent samples confirming that this first two-week period represented the worst case for this part of the insect community.

As many or more invertebrates were collected from the artificial substrates located immediately next to the treated wood (0 to 4 meters distance on chart) as were observed at the upstream control (–10 meters distance on chart). All of these indices (which measure the numbers and kinds of invertebrates and how well integrated they are in the community) showed no significant changes caused by the structure.

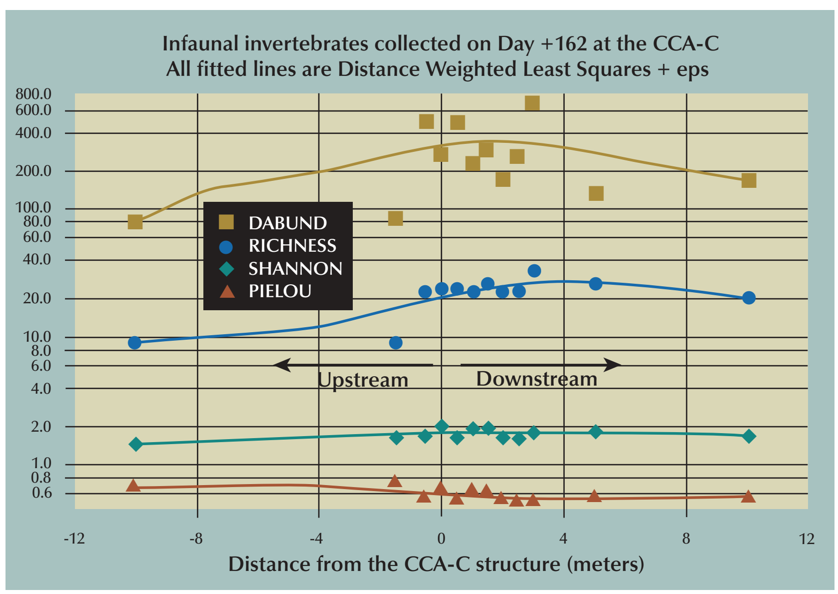


Figure 3

Figure 3 above describes the community of animals that live in the sediments (infauna) at the end of the study when sediment concentrations of all metals had reached their peak. Again, there is no indication that the CCA-C structure resulted in a compromise of these infauna, which are sessile (stationary) and had been exposed to the pressure treated wood structure for a year. The same results were obtained for the other two preservatives. It is impossible to prove a negative and therefore we cannot state that there could never be an adverse effect associated with these structures. *What we can say is that this worst case study did not reveal any adverse environmental effects and these results indicated that these preservatives can safely be used in sensitive wetland areas.*

New creosote-treated dolphin used to evaluate creosote in Sooke.

Sooke Basin Creosote Evaluation

At sufficiently high concentrations, polycyclic aromatic hydrocarbons (PAH), that make up 80 percent of creosote oil, can be acutely toxic. At moderate concentrations of 7.5 to 20 parts per million (ppm) in sediments, PAH have been associated with tumors in fish.

Polycyclic aromatic hydrocarbons are ubiquitous in our environment, including many natural sources such as volcanoes, forest fires, coal deposits, plants, peat bogs and oil seeps. Petroleum refining and distribution, asphalt paving, vehicle exhaust, coal, home fireplaces, power generating facilities, tires, BBQ's and a host of other human activities also contribute PAH to our environment.

Sooke Basin Study (24)

The natural sources have been present since before there were humans, and all living creatures have developed enzyme systems that break down these compounds. In fact, some strains of bacteria thrive on PAH as a food source and can very efficiently destroy even high concentrations. All PAH are eventually broken down to carbon dioxide and water, leaving no trace of their pre-existence. The fact is that no matter how hard we try, it is not possible or necessary to eliminate PAH from our environment. What we need to do is manage anthropogenic sources of PAH so they do not reach toxic levels and do not degrade valuable environments.

For background see:

Creosote Assessment (15)

In 1994, the Canadian Department of Fisheries and Oceans and Environment Canada initiated a long-term study to evaluate the environmental effects associated with creosote-treated wood used in marine environments. Because most creosote structures are located in harbors (where there are many confounding sources of PAH), this evaluation was conducted in an isolated portion of Sooke Basin, British Columbia, where low PAH background levels were observed and where there were minimal other sources.

The Sooke Basin site had very slow currents and fine-textured sediments supporting a healthy community of sessile invertebrates. Three dolphins were constructed with six class "A" piling in each structure. One of the dolphins was constructed of untreated wood, the second of eight-year-old piling pulled from a pier in Vancouver Harbor, and the third of new BMP piling that were over-treated to 27 pounds per cubic foot with marine-grade creosote. This over-treatment insured that the Sooke Basin Study would represent a worst-case evaluation.

The loss of PAH and their accumulation in sediments was modeled before constructing the dolphins. The environment around these dolphins was intensively monitored for four years, documenting the loss of PAH to the water and their accumulation in sediments. The biological response was evaluated in an exhaustive series of in-situ and laboratory bioassays coupled with thorough documentation of the invertebrate community living within 100 feet of each of the structures.

What Did This Study Find?

(25) *Creosote Model (Marine)*

- Creosote did migrate from the piling and accumulate in sediments downcurrent from the piling. As shown in Figure 4 below, the actual accumulation of PAH in sediments (red line) was less than that predicted in the model (blue line). These sediment concentrations also peaked earlier and declined faster than predicted. These models have been field-verified repeatedly over the last six years. In every case, they have proven conservative from the environment's point of view – that is, predictions of PAH accumulation were higher than what was actually observed.

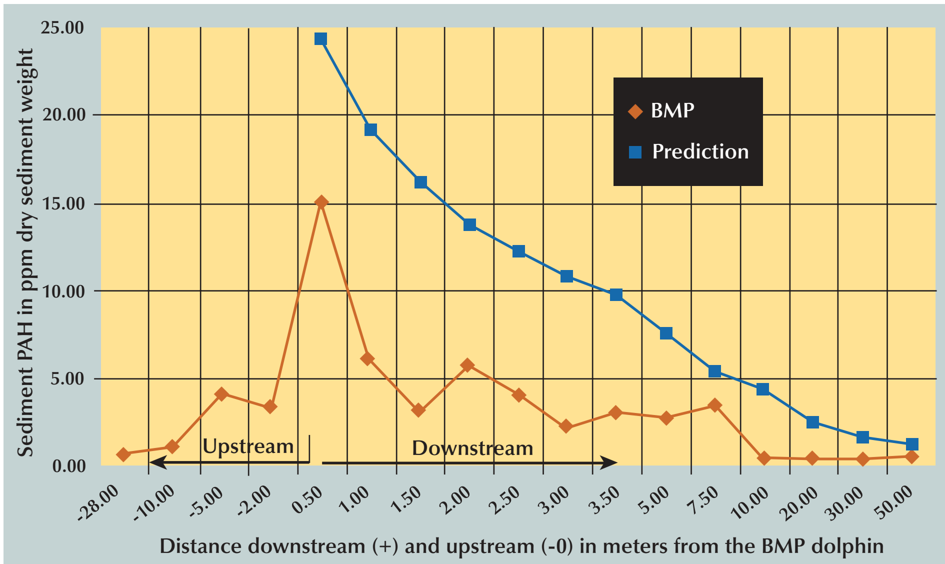
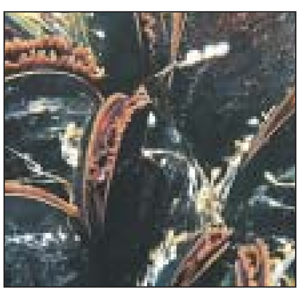


Figure 4

- Even at the peak of PAH accumulation, concentrations did not diminish the natural invertebrate community growing as close as one-half meter from the piling. However, evidence from the extensive suite of bioassays did indicate toxicity in sediments located within 0.65 meters of the dolphins. Mussels grown in cages within 15 cm of the piling did not accumulate significant amounts of PAH. Tissue concentrations peaked 14 days after construction at levels that were safe for human consumption. The same was true for mussels growing directly on the piling at the end of the study.

  As previously noted, concentrations of PAH in the sediments peaked earlier and declined more quickly than predicted by the models. The fact that there were lower-than-expected levels of PAH is an important environmental observation. Perhaps more important was the fact that the piling provided habitat for an astounding array of aquatic life with no significant or lasting adverse impact from the creosote treatment.



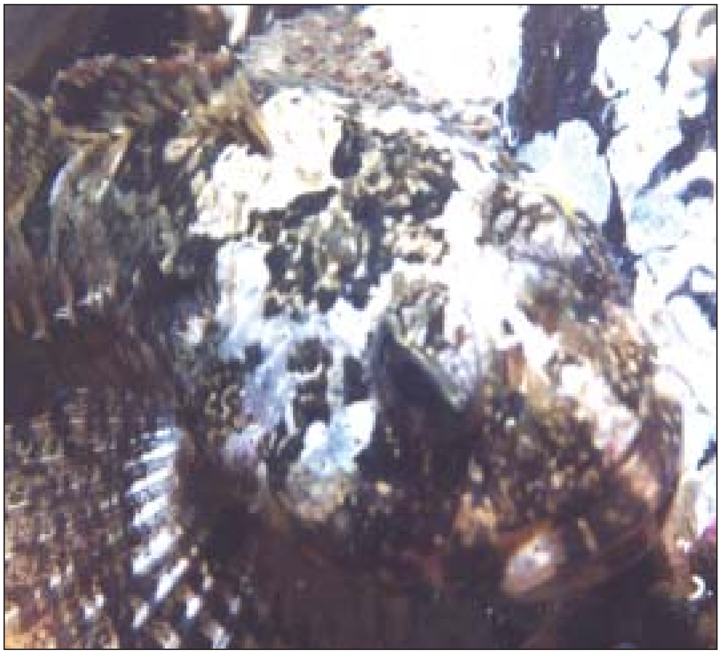
Blue mussels growing on creosote-treated piling

- Based on the evidence observed in Sooke Basin and on unpublished laboratory studies, the authors hypothesized that most of the creosote lost from the piling was transported as tiny droplets of oil – much of which likely originated from above the water line on hot summer days. As the piling aged, the air-exposed portion of the piling developed a hard covering of asphalt-like tar. This covering may have sealed the surface reducing further loss of creosote.

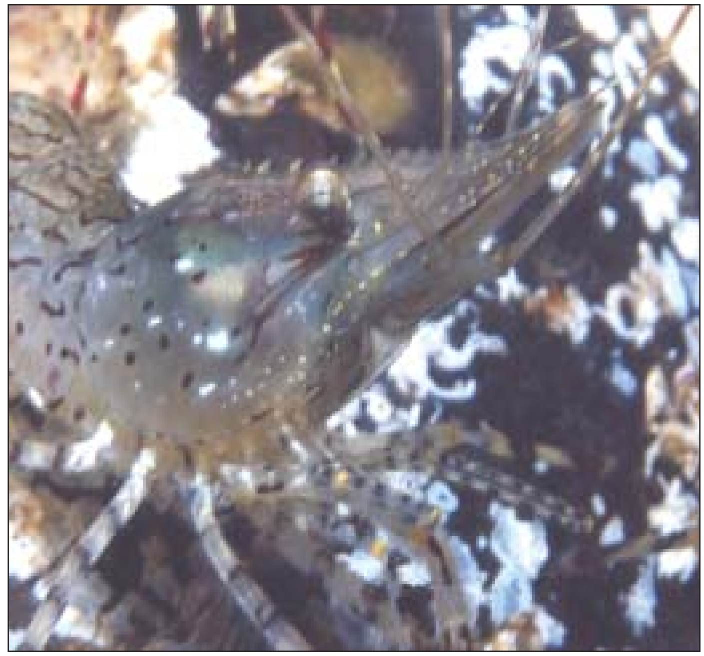
Tunicate growing on creosote treated piling

- The continually immersed portions of the creosote-treated piling were quickly overgrown with a rich and abundant community of fouling organisms. The full-page photograph on the next page shows one of the newly treated creosote piling at the end of the study. Dozens of species were identified including fish, shrimp, nudibranchs and tunicates such as *Cnemidocarpa finmarkiensis* shown at left. From an intuitive point of view, this luxuriant fouling community does not suggest that these piling were creating a toxic environment.

Invertebrate community growing on a new creosote-treated marine piling in Sooke Basin



Red Irish Lord



Coonstripe shrimp (Pandalus danae)

Many of these fouling organisms are considered highly sensitive to pollution and are used by regulatory agencies like the Environmental Protection Agency in setting water quality standards. The Red Irish Lord (*Hemilepidotus hemilepidotus*) shown above was resting on a clump of mussels attached to the piling, oblivious to the divers who were collecting samples.

Polycyclic aromatic hydrocarbons are hydrophobic – i.e. they don't like water. They bind to organic tissues that contain lipid. The mussels and other animals living on these piling generated a mat of lipid-rich organic detritus at the base of the fouling community. This detritus was being decomposed by bacteria. It is likely that it also intercepted much of the creosote oil still migrating from the treated wood. The microbial communities are expected to metabolize the creosote caught in this organic matrix. The point is that this luxuriant fouling community was likely reducing the migration of creosote to the sediments. Note that this appears to have been accomplished without the animals themselves becoming contaminated as evidenced by the lack of PAH in mussels.

Starfish (Pisaster ochraceus) foraging on the fouling community

Another possible hypothesis explaining the significant reduction in sediment PAH around the piling was also associated with the fouling community. The community was continually being devoured by predators like the Ochre Stars seen in the figure at left. This predation resulted in a raining down of enormous quantities of biological debris that collected around the base of the piling. This food attracted hundreds of Dungeness crab (*Cancer magister*), sea cucumbers (*Parastichopus californicus*) and a variety of anemones.

By the end of the study, all of this biological activity had exceeded the assimilative capacity of the sediments around the piling. They were anaerobic and contained very high levels of sulfide. The resulting sediment toxicity had nothing to do with the creosote treatment. In fact, these conditions were as bad or worse at the untreated control dolphin. Why? Because the untreated wood was quickly being consumed by marine borers (toredos, bankia and limnoria). Few fouling organisms were found on these piling because as soon as a community established itself, the wood failed and the organisms fell to the bottom where they were consumed by predators.

The untreated piling were deteriorating and did not support a vibrant fouling community

Dungeness crabs foraging on mussels dislodged by starfish around the new creosote-treated dolphin

It also appeared that the biological debris was diluting the sediment concentrations of PAH. All three of these factors were likely responsible for the unexpectedly quick decline in sediment PAH associated with the creosote-treated structures. Whatever the cause, the result was that the PAH lost from creosote appeared to have little long-term effect on the biology of the sediments – even within a few feet of the structures.

CREOSOTE SUMMARY *During the first year of the Sooke Basin study, creosote migrating from the piling did accumulate in sediments within 7.5 meters of the structures. The concentrations did not appear toxic to the local fauna because the infaunal community remained stable. However, toxicity was observed in laboratory bioassays of sediments located within two feet of the piling using sensitive species. The accumulation of PAH was overestimated by the model and the sediment concentrations declined more quickly than expected. At four years and presumably for the remainder of the 50- to 75-year life span of creosote-treated wood in this area, the major effect was caused not by the preservative, but by the flourishing community of animals that took up residence on the piling. By the end of the study, the creosote structures did not diminish marine life in this area – they enhanced it. Treated wood structures do typically attract large communities of organisms.*

The personal use pier shown here is constructed of creosote-treated piling with ACZA-treated walkways

Timber Bridge Study

(26) *Timber Bridge Study*

In 1997, the U.S. Forest Service initiated a study to examine the environmental response to the construction of timber bridges preserved with creosote, pentachlorophenol or CCA-C. Timber bridges are lightweight, long lasting and relatively inexpensive to build in rural areas carrying light to moderate traffic loads. The Timber Bridge study compared preservative concentrations in the water and in sediments under and downstream from two creosote-treated bridges in Indiana, two CCA-C-treated bridges in Florida and two pentachlorophenol-treated bridges on the West Coast. Invertebrate communities were carefully evaluated along with laboratory bioassays to determine the biological response to each bridge.

Measurably increased concentrations of metals, creosote or pentachlorophenol were not observed in the water under or downstream from any of these bridges. However, the active ingredients in each preservative were observed in sediments under each bridge – albeit at very low levels – and no decreases in the number of invertebrates or restrictions in the kinds of invertebrates were observed under or downstream from any bridge when compared with reference stations.

Pentachlorophenol-treated Timber Bridges

Dairy Creek Bridge

New York State has established a freshwater sediment quality criterion for pentachlorophenol. The maximum sediment pentachlorophenol concentration observed at the Satsop River bridge was 19 μg/kg (parts per billion or ppb), representing 4.5 percent of the New York State standard of 420 ppb. The maximum concentration observed at the Dairy Creek Bridge was 1.98 percent of the sediment standard. At these low concentrations, no adverse biological effects were anticipated at either bridge and none were observed.

Example of substrate in the Satsop River where salmon spawn

These two bridges were located over salmon-spawning rivers with sand-gravel and cobble substrates supporting a vibrant community of pollution-intolerant aquatic insects in the Orders Ephemeroptera (mayflies) and Trichoptera (caddis flies). The larvae of these Orders are generally associated with fast-moving oligotrophic streams and rivers. The biological response of this sensitive community is illustrated in the figure below. It describes sediment pentachlorophenol concentrations (µg/kg) in red; the proportion fine-grained sediments (sand, silt and clay) in blue; biological response described by the number of species (green); and the abundance of invertebrates (brown).

Note that the number of species and the total abundance of invertebrates were much higher three feet downstream from the bridge's drip line where the proportion of fine sediments dropped from 70 to 80 percent to about 40 percent. Also note that invertebrate abundance peaked where the proportion of fines decreased to between five and 12 percent. There were as many species and as many animals downstream from the bridge as there were at the upstream control. And there was essentially no correspondence between invertebrate community and the small amount of pentachlorophenol observed under the bridge and at the station located three feet downstream. Amphipod (*Hyalella azteca*) bioassays also found no evidence of toxicity in sediments from either of these pentachlorophenol-treated bridges. The invertebrate community was far more influenced by the substrate type than by the bridge.

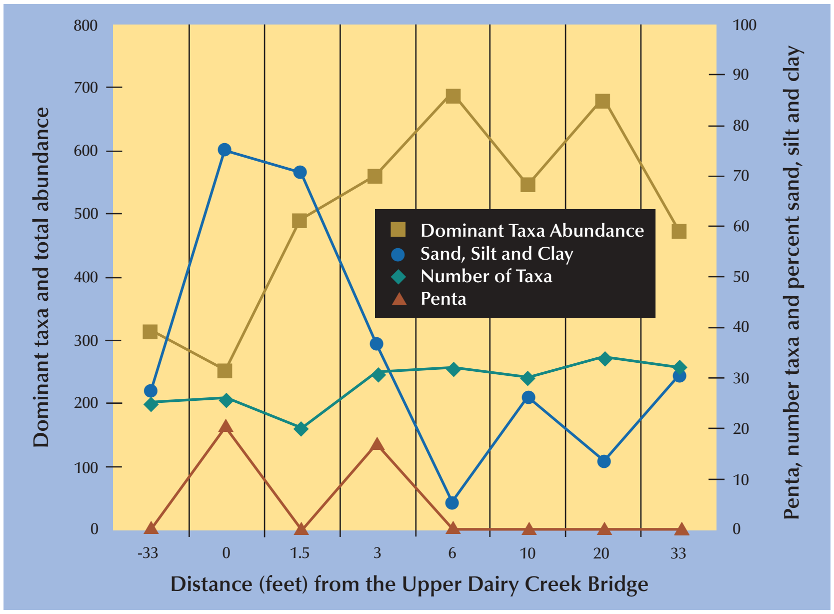


Figure 5

CCA-C-treated Timber Bridges

Horseshoe Bayou Bridge

Two bridges, each constructed entirely of CCA-C-treated wood, were evaluated in Sandestin, Florida. The Horseshoe Bayou Bridge, the largest, was designed to carry a 20-ton load. Its 160-foot span crossed a pristine marine estuary at the entrance to Horseshoe Bayou. Construction was just being completed when the survey was conducted. This timing was considered important to observing any increase in the concentration of dissolved metals during the period right after immersion when leaching is greatest from CCA-C-preserved wood.

As seen in Figure 6 below, copper and chrome concentrations were essentially the same along the sampling transect with no significant changes. Dissolved arsenic concentrations actually increased slightly with distance from the CCA-C-treated bridge.

It should be noted that all metals were below their respective water quality criteria of 3.1 μg copper/L, 36 μg arsenic/L and 50 μg chromium (VI)/L. As shown in Figure 7, increased sediment concentrations of all three metals were observed within 10 feet of the bridge.

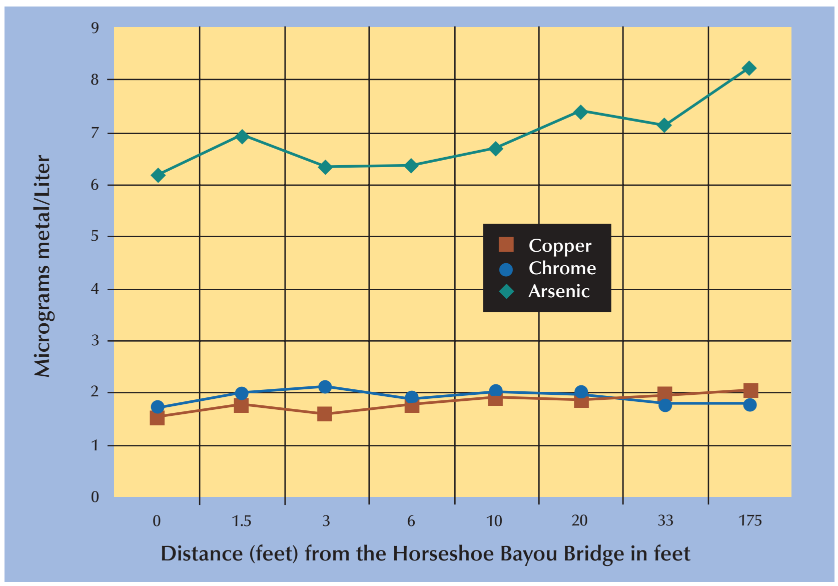


Figure 6

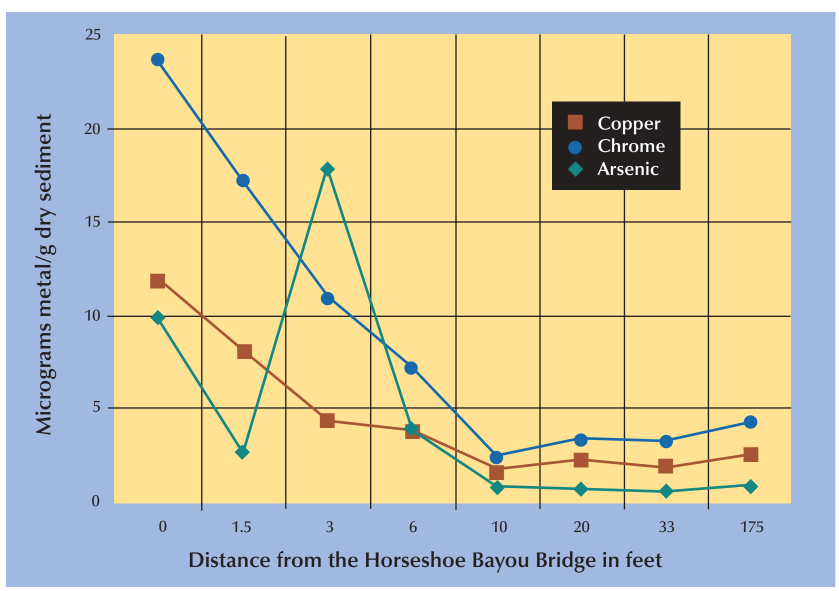


Figure 7

The reason for the increase illustrates an important point in the construction of treated-wood structures. As previously noted, this is a truly massive bridge. One thousand four hundred fifty-eight holes were drilled in the bridge to bolt together the heavy-duty treated-wood railing. Each hole was 3/4″ in diameter and approximately 14″ long. The drill shavings were not contained and they blew into the estuary where they could be seen on the bottom all around the bridge.

There are at least two reasons why the drill shavings, although an esthetic problem, did not result in measurable environmental damage. First, because the metals remained fixed in the wood shavings, they were expected to slowly leach out over time. Second, the resulting concentrations did not exceed commonly accepted sediment benchmarks of 63.4 μg copper/g; 16.2 μg chromium/g; or 24.4 μg arsenic/g dry sediment. This poor housekeeping practice resulted in what should be recognized as unnecessary environmental risk. There is no reason for those shavings to be there.

No adverse biological effects were anticipated at the low metal levels observed at Horseshoe Bayou and none were observed. As many or more species and numbers of animals were observed in sediments collected under and in the immediate vicinity of the bridge as were found at the reference station. Survival of *Menidia berylina* was excellent in all of the bioassays completed for this site, and no significant differences were observed when comparing stations close to the bridge with either the local reference station or laboratory controls.

The second bridge examined in San Destin was the 8-year-old Fountain Bridge, which crossed a freshwater marsh. This older bridge was examined to evaluate the accumulation of metals in sediments around the bridge and their effect on infauna. Increases in dissolved metals were not observed in the vicinity of the bridge in this essentially stagnant body of water.

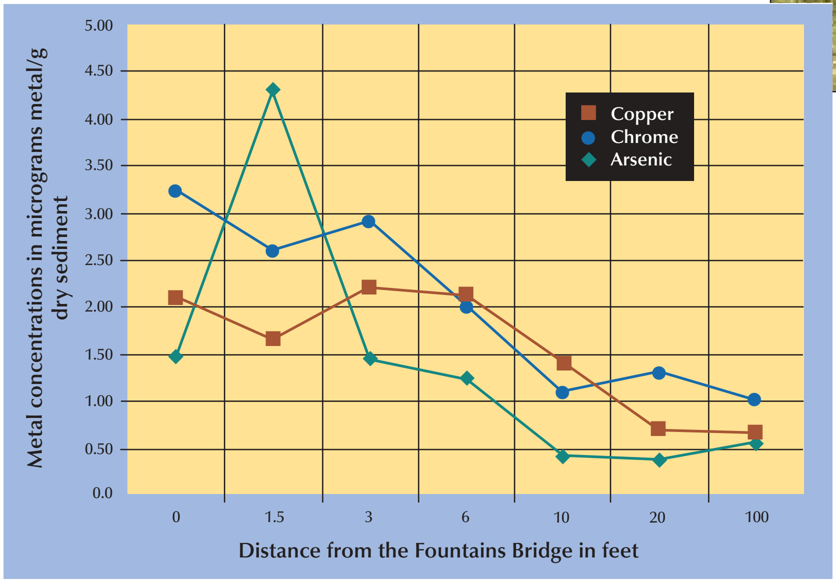


Figure 8

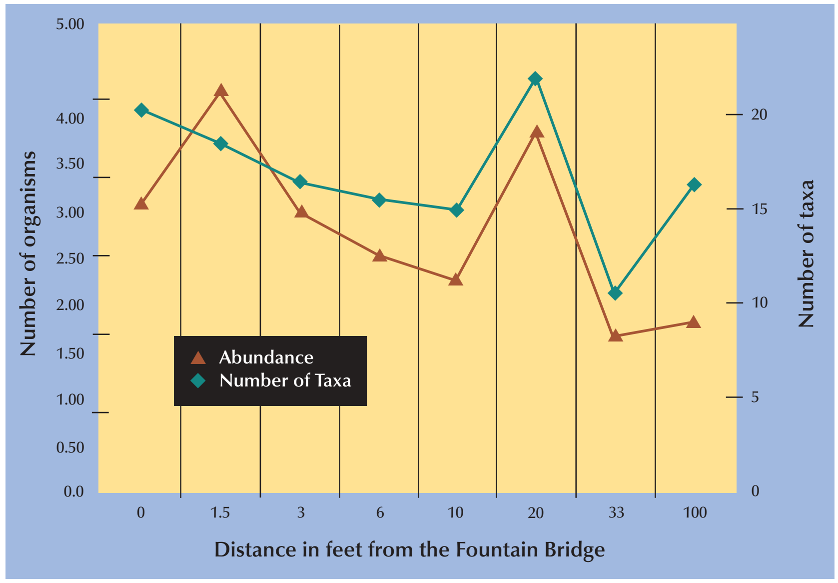


Figure 9

Figure 9 describes sediment concentrations of metals under and adjacent to the bridge. Sedimented metal concentrations were all very low (<4.25 µg/g). However, the bridge has left a definite signature in the muddy substrate that extends to a distance of between six and ten feet from the piling. Having said that, the maximum observed concentration of each metal was less than background concentrations in most parts of North America. No biological effects whatsoever could be expected at these concentrations and, as seen in Figure 9, none were observed. The abundance and diversity of invertebrates was as high under and immediately adjacent to the bridge as they were further away.

CCA-C SUMMARY *Metal losses from CCA-C-treated wood have been well known and predictable for at least 30 years. Losses from the bridges surveyed in this evaluation were so low as to be undetectable in the water. Metals did accumulate in sediments but to levels that were so low as to have no predicted or observed adverse biological effect. The CCA-C evaluation did point out the need to develop and use Construction Best Management Practices to insure that all waste is cleaned up and properly disposed of in a landfill. The drill shavings present in Horseshoe Bayou should not have been there: They represented unnecessary environmental risk and were an eyesore.*

Creosote-treated Timber Bridges in Cass County, Indiana

Creosote is the most common preservative used in the construction of timber bridges. Two creosote-treated bridges were evaluated on Pipe Creek in Indiana. Both bridges are substantial structures. They each sit on 20 Class A piling treated to a nominal retention of 17 pounds creosote per cubic foot (pcf) in the treated zone (outer 1.5″). Support beams, crossbeams, decking and guardrails were all similarly treated with creosote oil to a retention of 8 or 10 pcf in the treated zone.


Pipe Creek Bridge

Pipe Creek flows through corn country and carries a heavy load of sediment. Current speeds along the chosen sampling transects were very slow at <1.0 cm/sec. From an environmental point of view, both bridges behaved similarly. Slightly higher PAH concentrations were observed in sediments near the 2-year-old Bridge 146 than were found under the 8-year-old Bridge 148. The following discussion describes the results at new Bridge 146.

Creosote is a complex mixture of hundreds of compounds including many types of naturally occurring organic compounds called polycyclic aromatic hydrocarbons or PAH. Each of these PAH compounds degrade at different rates in the environment and they have different effects on biological organisms. This discussion will focus on the sum of the concentrations of all the PAH (TPAH) observed in Pipe Creek sediments. The parent report contains an evaluation of individual compounds and the results are not different from those presented here.

Sediment concentrations of polycyclic aromatic hydrocarbons (PAH) are described in Figure 10. This graph also includes sediment quality benchmarks described as the Threshold Effects Level (TEL), a value below which adverse biological effects are not generally observed under any condition, and the Probable Effects Level (PEL), a value above which increasingly severe biological effects should be anticipated in most environments. The mean of these values or MEL is also displayed. This mean is increasingly used as a reasonably protective benchmark for assessing environmental risk. Maximum sediment PAH concentrations between 1.5′ and 6.0′ downstream from the bridge exceeded the Threshold Effects Level for TPAH but not the Mean Effects Level. This suggests that adverse effects could be anticipated in a community of the most sensitive organisms.

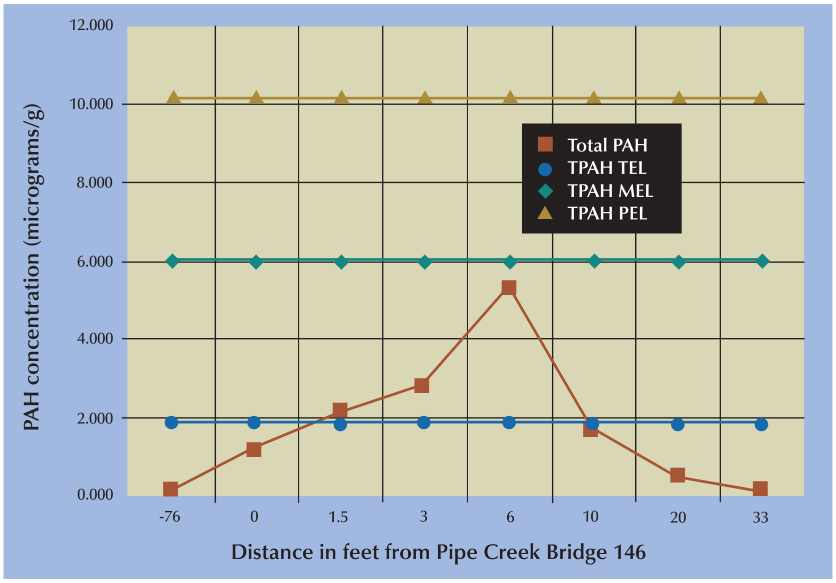


Figure 10

As previously discussed, Pipe Creek is a slow-moving stream flowing through cropland. It carried a significant bedload of sand, silt and clay. Like the Wildwood wetland, this is a naturally stressful environment and the invertebrate community was dominated by annelids (worms) and chironomids (midges). Both groups are generally robust and typically dominate other taxa in stressful environments. Therefore, it could be anticipated that the moderate levels of PAH observed in these sediments would not adversely affect this robust resident invertebrate community – and they did not.

Figure 11 compares the abundance (blue) and richness (green) of invertebrates observed in sediment samples from Pipe Creek Bridge 146 with the TPAH concentration in each sample. More species in greater abundance were observed with increasing TPAH concentrations. It might appear logical to conclude that the PAH were enhancing the invertebrate community. However, some other unmeasured factor in the environment was more likely responsible.

The point that should be made is that neither of these bridges lost enough PAH to affect the creek's invertebrate community. The results of this study were also consistent with those obtained in Sooke Basin. Lower sediment TPAH concentrations were observed at the older bridge and higher concentrations at the new bridge. Experience has shown that creosote- and pentachlorophenol-treated bridges are most likely to lose preservative during the first year following construction – particularly during extended periods of high ambient temperatures. Oil-type preservative losses decline significantly with time.

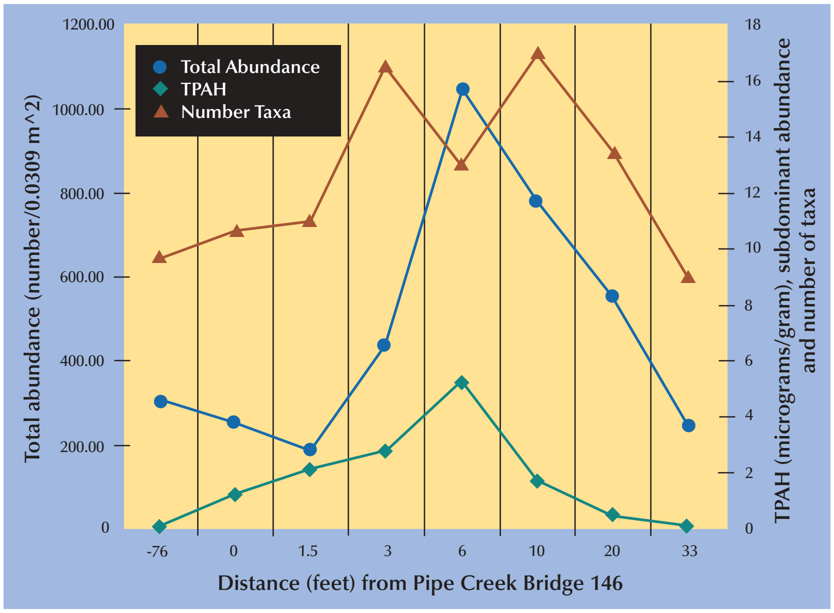


Figure 11

SUMMARY

A variety of types of treated wood have been used in aquatic environments for over half a century with no scientific reports documenting adverse environmental affects. These three studies have looked at a range of preservatives used to treat wood for constructing large structures in a range of sensitive marine and freshwater environments. Each of these studies was designed to conduct the assessments in worst-case conditions.

The following statements summarize the results of these three "real world" studies, describing the use of pressure treated wood in aquatic environments:

- Despite the production and use of billions of board feet of preserved wood, there are no published reports describing environmental damage associated with the use of these products in such structures.
- Small quantities of wood preservatives leached or migrated from all types of pressure treated wood. Using modern analytical techniques, small amounts of preservatives could be detected in the sediments but not in the water column around the treated-wood structures.
- The detailed studies discussed here were conducted to determine if treated-wood projects might be creating environmental damage on a scale so small as to have been previously ignored. No adverse effects were documented in association with the use of pentachlorophenol or the waterborne preservatives ACQ-B, CCA-C, CA-B or ACZA.
- Laboratory bioassays using very sensitive species indicated toxic effects in sediments collected within two feet of a large creosote-treated structure constructed in a worst-case marine environment. However, the resident infauna suffered no apparent harm.
- The longest-lasting effect of the installation of creosote-treated dolphins in Sooke Basin was a proliferation of life on and around the structures – creating a remarkable artificial reef.
- Models designed to assess the risks associated with very large treated-wood structures in sensitive environments have repeatedly been found to be conservative from the environment's point of view. These models can be used as a valuable tool in managing society's use of treated wood in aquatic environments.
- Most of the concern expressed by regulators regarding the use of pressure treated wood occurs during construction and/or demolition. Simple management practices can be used to eliminate the unnecessary risks sometimes created at the beginning and end of the 50- to 75-year life span of pressure treated wood structures. Best Management Practices (BMPs) are available to minimize preservative loss during the first year following construction of pentachlorophenol- or creosote-treated wood projects exposed to high ambient air temperatures.
- Based on the literature (including the detailed studies discussed here), there is no scientifically defensible reason to prohibit the use of treated wood in aquatic environments. Like many other human activities, treated wood simply needs to be managed.

(27) *Link to Science and Assessment*

(28) *BMP-related Information*

(29) *Using Treated Wood in Aquatic Environments*

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