Guidelines to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region

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2000

GUIDELINES TO PROTECT FISH AND FISH HABITAT FROM TREATED WOOD USED IN AQUATIC ENVIRONMENTS IN THE PACIFIC REGION

By

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This report outlines potential impacts to fish and fish habitat when treated-wood products are installed in aquatic environments. Commonly used heavy-duty preserved-wood structures are reviewed, in conjunction with alternatives to treated wood. All treated and untreated-wood structures have the potential to cause impacts in the aquatic environment. If treated wood is used, reducing these impacts requires choosing the appropriate wood treatment for the environmental conditions at the site, ensuring wood is factory treated to meet current industry standards, and imposing site-specific conditions such as restricting the timing of installation. In some cases, the potential for impacts may preclude the use of treated wood. These guidelines are designed to ensure the protection of aquatic life from installation through to decommissioning of the treated-wood structure.

RÉSUMÉ

Hutton, K. E. and S. C. Samis. 2000. Guidelines to protect fish and fish habitat from treated wood used in aquatic environments in the Pacific Region. Can. Tech. Rep. Fish. Aquat. Sci. 2314: vi + 34 p.

Le présent rapport décrit les impacts potentiels de l’installation dans les milieux aquatiques de produits en bois traité sur le poisson et son habitat. On traite des structures résistantes en bois traité communément utilisées de même que des solutions de rechange au bois traité. Toutes les structures en bois traité ou non traité peuvent avoir des impacts sur les milieux aquatiques. Si on utilise du bois traité, on doit pour réduire ces impacts choisir un type de traitement du bois adapté aux conditions environnementales du site considéré en veillant à ce que le bois soit traité en usine de façon à respecter les normes courantes de l’industrie, et en imposant des conditions propres au site ayant trait, par exemple, au moment de l’installation. Dans certains cas, le bois traité aurait des impacts potentiels trop importants pour qu’on puisse l’utiliser. Ces lignes directrices visent à protéger la vie aquatique depuis l’installation jusqu’au démantèlement des structures en bois traité.

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D. Goyette provided comment on the many drafts of these Guidelines, and offered hypotheses to explain the changes in the physical and chemical conditions surrounding the Sooke study test piling four years after installation.

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H. Walthert, Executive Director, Canadian Institute of Treated Wood (CITW), offered constructive comments on initial drafts of this document and, in collaboration with his colleagues in the treated-wood industry, provided valuable technical input into the development of these guidelines.

Fisheries and Oceans Canada Area Habitat and Enhancement Branch staff assisted the writers in ensuring that these guidelines can be practically applied.

The Creosote Evaluation Steering Committee comprised of: D. Goyette, Environment Canada; Dr. K. Brooks, Aquatic Environmental Sciences; H. Walthert, CITW; Dr. N. Nagpal, B.C. Ministry of Environment, Lands and Parks (MELP); T. Appleton and K. Hutton, Fisheries and Oceans Canada, supported the development of these guidelines.

The conclusions reached and recommendations presented may not necessarily reflect the opinions of these reviewers.

1.0. INTRODUCTION

Treated wood has a long history of use in Canada for the construction of shoreline facilities in marine and freshwater fish habitats. Chemical preservation is designed to make wood toxic to organisms that would otherwise use it as food. There are 6 heavy duty wood preservatives (listed below) registered under the *Pest Control Products Act (PCPA)* of Canada which is administered by Health Canada's Pest Management Regulatory Agency.

- Creosote;
- Pentachlorophenol (PCP);
- Copper naphthenate;
- Ammoniacal copper arsenate (ACA);
- Ammoniacal copper zinc arsenate (ACZA); and
- Chromated copper arsenate (CCA).

A brief description of ammoniacal copper quat (ACQ) is included in the document although this pesticide is not registered for use in Canada. Notwithstanding, wood products preserved with ACQ can be imported into Canada.

Environmental risk due to pesticide use is a function of both chemical toxicity and environmental exposure. The *PCPA* sets out the requirements for product labels, which outline the legal use of a pesticide and impose constraints to protect human health and the environment.

1.1. PURPOSE

The present Guidelines are intended for use by Fisheries and Oceans Canada staff to assist in the review of shoreline projects involving treated wood. Best Management Practices (BMPs) for the in-plant preservation of wood, including a rudimentary guide to the use of treated wood in aquatic environments, are contained in a 1997 document published jointly by the Canadian Institute of Treated Wood (CITW) and the U.S.-based Western Wood Preservers Institute (WWPI). These industry-developed BMPs have been recognized by Environment Canada as a useful tool for staff in the Pacific Region, with the provisos that the BMPs must be updated as knowledge improves, and that even wood treated according to BMPs can have impacts on aquatic life under certain conditions. The authors of the BMPs encourage the Canadian Standards Association (CSA) to continually explore the potential for reducing the retention standards for wood-treatment pesticides. Users of the present Guidelines should become familiar with key aspects of industry's BMPs. The BMP mark (see Figure 1) is registered under the U.S. Federal *Trademark Act* but it is not registered in Canada. However, in British Columbia the Canadian Softwood Inspection Agency is using the BMP mark to certify wood products treated with preservatives according to BMP specifications. Accordingly, Pacific Region staff need to specify that all treated wood used in water is so designated.

Fig. 1. BMP mark. This insignia is used by manufacturers of factory-preserved wood treated according to specifications set out in Best Management Practices for the Use of Treated Wood in Aquatic Environments (CITW and WWPI 1997).

Any project involving the aquatic use of treated wood may have adverse environmental effects, even if proponents ensure that manufacturers follow the treatment recommendations in the BMPs. Consultation with the appropriate regulatory agencies is required when such projects are proposed. Fisheries and Oceans Canada administers s. 35 of the *Fisheries Act* which prohibits the harmful alteration, disruption or destruction of fish habitat without authorization. Foreshore dock placement or the installation of piling can harmfully alter fish habitat. Consequently, Fisheries and Oceans Canada must be notified in advance of any such proposals so that an assessment can be conducted and the acceptability of the project and any mitigation and compensation determined according to the Policy for the Management of Fish Habitat (DFO 1986). Readers are referred to the 1995 Fisheries and Oceans Canada (DFO)-Ministry of Environment, Lands and Parks (MELP) Marina Development Guidelines for the Protection of Fish and Fish Habitat for further information on the biophysical impacts of building and maintaining dock structures. Part of the assessment for any such construction will be evaluation of the suitability of construction materials, including treated wood in the context of the specific site proposed for the development. Wood treatment products have the potential to be toxic to fish and thereby the potential to be deleterious under s. 36 of the Act. Environment Canada has the lead administrative authority for s. 36 of the *Fisheries Act* which prohibits the deposit of a deleterious substance into waters frequented by fish. Fisheries and Oceans Canada's Minister is legally responsible to Parliament for all sections of the *Fisheries Act*.

2.0. OIL-BORNE TREATMENTS, ENVIRONMENTAL CONCERNS AND ASSOCIATED MITIGATION STRATEGIES

2.1. CREOSOTE

Creosote, a distillate of coal tar, is a complex chemical mixture, up to 80% of which is comprised of polycyclic aromatic hydrocarbons (PAHs). High molecular weight PAHs can be carcinogenic, whereas the more volatile, low molecular weight PAHs are more likely to be acutely toxic to aquatic life. Creosote is applied to wood under pressure at specialized treatment facilities. Using methods recommended in the above-referenced Best Management Practices, operators apply creosote employing techniques to minimize residual pesticide on the surface of the treated product. This can result in significantly less surface residue of creosote on the newly treated wood than was the case with historical treatment methods (see Figure 2). The BMPs recommend treatment to CSA requirements which are linked to the minimum amount of pesticide required to preserve the wood, based on the intended use or exposure (i.e., ground contact, marine use). A number of new in-plant treatment processes including surface residue recovery of creosote are now routinely being used in B.C.

Fig. 2. A new pile treated with creosote to BMP standards, prior to weathering, compared to a pile treated to traditional standards. Note the obvious residual surface creosote on the pile receiving the traditional treatment. (Photo courtesy of R. D. Hayward.)

In recent years it was recognized that the borer hazard in marine waters north of San Francisco on the west coast and north of New Jersey on the east coast were such that lower retention levels could be used for creosote than were earlier required. The American Wood Preservers Association (AWPA) recommended changes to the U.S. standard after its Creosote Council identified the ability to properly preserve wood at lower retention levels. The CSA adopted the AWPA standard. The creosote retention standard was reduced from 20 to 16 pounds per cubic foot (pcf) for temperate marine waters such as in British Columbia.

Creosote is particularly effective in repelling marine borers. Creosote escapes from treated wood at a faster rate in freshwater than in salt water, although in both cases the loss of the preservative is small. In sensitive freshwater areas, particularly where there are low current velocities, and in anaerobic sediments, the use of alternatives to creosote-treated wood is recommended (see Section 4.0.). In estuarine areas, the proponent should be prepared to justify the need for creosote-treated wood by demonstrating the historic presence of marine borers in the area, and the lack of viable alternatives to creosote. Part of this justification can be as simple as gathering local information on the historic evidence of marine borer infestation. Fisheries and Oceans Canada's Small Craft Harbours (SCH) Branch, Pacific Region has been mapping the occurrence of *Limnoria* and *Bankia*, the 2 most common local marine borers. In sensitive estuarine environments, treated wood may not be acceptable.

Sheet-pile walls or other installations involving large volumes of creosote-treated wood could theoretically be the source of enough PAH dissolved in surrounding waters to be expected to cause toxic impacts to aquatic life. Such elevated concentrations of PAH in water are not common with most projects involving the installation of small numbers of dolphins or piles. Wood treated with creosote to BMP specifications typically releases only low amounts of PAH into the water column during the life of the structure. The initial release is seen as a hydrocarbon sheen on the water surface. Goyette and Brooks (1998) have shown that pile-sourced PAHs in the water column are of low concentration, and their occurrence is intermittent and of short duration. Of much greater concern for aquatic ecosystems is the accumulation of PAHs in the sediments surrounding piles. A summary of the Goyette and Brooks study is included in Appendix A.

Goyette and Brooks (1998) have hypothesized that PAHs are transported through the water column in particulate form. This hypothesis suggests that microlitre-sized particles of creosote fall through the water column and slowly work their way downward through interstices in sediments. These creosote particles may be formed when treated wood is subjected to intense solar exposure associated with elevated air temperatures. Therefore, care must be exercised when authorizing overhead structures treated with creosote where wood will be directly exposed to the sun. The loss of creosote from overhead structures can be ameliorated by artificial shading or by providing collectors to intercept the creosote before it drips into the aquatic environment. For example, sleeves, wrapping and coatings are options that may reduce the release of preservative from all types of treated wood. Creosote movement from unwrapped piling will eventually achieve equilibrium with microbial degradation in aerobic sediments (Brooks 1997a; Goyette and Brooks 1998). A wrapped pile may allow creosote to accumulate under the covering and move into the aquatic environment in a significant pulse if it is breached (Brooks 1999a).

Protective caps are being assessed for efficacy in mitigating creosote expulsion (Appleton 1998). Floating docks and boats can rub against creosote-treated piling resulting in the loss of significant amounts of treated-wood splinters. This compromises the integrity of the treated wood and results in unnecessary environmental risk associated with the loss of treated-wood fibres. In some cases, shifting bottom materials abrade the pile at the sediment-water interface. Losses due to abrasion can be minimized by armouring the wood with protective high-density polyethylene wear strips.

In the DFO-MELP 1995 Marina Guidelines use of creosote-treated wood was precluded in freshwater. As a result of further examination of this question, there may be limited circumstances where creosote-treated wood is acceptable in freshwater. The characteristics of an oil-borne preservative such as creosote are often preferred by industry for decking on industrial docks or in flooring, given that many users find that the wood remains softer and more resistant to wear from heavy use, compared to wood treated with water-borne preservatives. Notwithstanding, because creosote leaches relatively rapidly in freshwater and throughout the life of the structure, Fisheries and Oceans Canada is likely to significantly limit the freshwater use of creosote-treated wood, given that alternatives are readily available. In the case of utility poles, it has been reported that poles treated with water-borne preservatives are more difficult for repair crews to climb using spurs than poles treated with creosote (Walthert 1999). However, most utility poles now are treated with water-borne preservatives due to human health concerns associated with exposing repair crews to creosote. Creosote-treated wood is preferred by industry in the construction of laminated decks. This involves the use of creosote-treated lumber (e.g., 2x4 inches or 2x6 inches) placed on edge to create a surface which is covered with asphalt. The asphalt cover caps the tops of the lumber, leaving only the bottoms and the outer edge of the deck exposed to weathering, including solar radiation. Creosote should not be used in above-water or overhead structures where solar heating can result in the expulsion of creosote from the treated wood and its deposition into the aquatic environment. For example, creosote-treated wood used in a laminated deck may be acceptable, but the outer lumber and the ends of stringers, which will be exposed to solar radiation, should be protected from the sun. This may involve the use of protective polyethylene wraps, or a construction design to provide shading to the potentially exposed treated wood. A cautious approach should be used when reviewing proposals for dock and decking structures employing large volumes of creosote-treated wood. In some cases, the potential for adverse environmental impact will preclude this use of creosote-treated wood and alternative products will be required.

> **Note: Railway Ties**. The BMPs referenced above were designed for treated wood used in construction in aquatic environments. Railway ties are generally treated using a different process than piling or lumber. Creosote-treated ties are often preferred by the railroad industry for high-use areas because they have greater shock-absorbing capacity and are less likely to crack than concrete ties. Brooks is currently studying the loss of PAHs from creosote-treated railway ties. Results from the first year of study indicate that PAHs are migrating from the treated ties into the railway ballast, but have not been detected in stormwater, groundwater or a nearby wetland (Brooks 1999a). Further study is required to assess the potential impacts that treated railway ties may represent to the aquatic environment. Wan (1991) found dioxins and furans in drainage water from railway ballasts

on the B.C. Lower Mainland adjacent to ties which had been treated with a combination of creosote and PCP.

Apart from railway ties, all newly-treated wood should bear the BMP certification mark, ensuring that appropriate treatment and post-treatment measures have been employed in producing the preserved wood. The proponent should be prepared to produce documentation verifying that the treated wood to be used in a specific project has been certified. The supplier or installer should guarantee that all treated wood will be visually inspected before installation to ensure that there are no excessive preservative deposits or signs of bleeding of creosote. If deposits are present, the installer or supplier should reject the materials.

Piling are often brought to a site in rafts and remain alongside the pile-driver barge until installation. This practice can result in a release of creosote into the water at the surface which may subsequently deposit onto benthic sediments. The surface sheen contains the light, volatile and comparatively-toxic PAH fraction. Deployment of absorbent booms or pads during pile installation is advisable to capture this initial surface contamination. In-water storage of treated wood for any extended period should be avoided.

Splintering during pile driving can deposit PAHs on the bottom sediment through loss of creosote-impregnated wood debris. Over-water construction of bulkheads, stringers and other structures should be managed in such a way as to minimize any release of wood debris and sawdust into aquatic habitats. Efforts must be made to eliminate the release of such treated material (i.e., cut ends, borings, sawdust, splinters) during over-water construction. All construction debris must be contained and recovered.

When wharves or other structures are to be decommissioned, a reasonable attempt should be made to remove the entire creosote-treated pile. Piles should be removed by a slow, steady pull to minimize disturbance of surface habitats and to avoid bringing creosote-contaminated sediments to the surface. If the pile breaks off below the biologically-active zone in the sediment, it may not be advisable to dredge the remainder out, depending on the sensitivity of the habitat at the site. Appropriate disposal of used piles on land or reuse is also important to consider during the planning stages of the decommissioning.

When dredging and ocean disposal of sediments adjacent to docks or other structures built of creosote-treated wood is likely, proponents need to be aware of *Canadian Environmental Protection Act (CEPA)*-regulated requirements regarding maximum PAH levels in material designated for ocean disposal. The Environment Canada, Pacific and Yukon Region <u>Interim Contaminant Testing Guidelines for Ocean Disposal</u> (1997), prepared pursuant to *CEPA*, restrict total PAH levels to 2.5 $\mu g \cdot g^{-1}$ in sediments destined for designated ocean disposal sites. Sediments with PAH concentrations exceeding that limit would be rejected for ocean disposal.

If creosote-treated wood is proposed for upland construction projects, consideration should be given to the potential for contamination of surface-water runoff and groundwater.

<u>2.1.1. Weathered or Reused Creosote-treated Wood</u>

The crustacean *Limnoria* tends to bore tunnels through a pile, going progressively deeper into the pile as the surface of the wood flakes off, causing extensive structural damage. Piles infested with *Limnoria* are not usually suitable for reuse. *Bankia* is a mollusc which tends to drill tunnels that follow the grain of the wood; it is not known to cross other *Bankia* tunnels. This characteristic may result in less structural damage to the pile than would be the case with *Limnoria*. The type of marine borer causing the damage is therefore important in cases where the replacement or reuse of piling is being considered. In the case of piling infested with *Bankia*, the structural integrity of the wood may make it acceptable for selected uses. Industry is cautious about the reuse of piling for many reasons, including legal liability. The proponent is responsible for assessing whether used material is structurally suitable for the proposed installation. If a structure is being decommissioned, infested piling may be suitable for reuse in other, primarily non-structural applications, such as fender piles on a dock or upland, as landscape ties and fence posts.

- Reused, weathered piles will indefinitely lose creosote but the rate is reduced from that of new piles. The loss rate is thought to be proportional to the age of the wood and the amount of the original creosote charge. Creosote-treated piles can maintain their structural integrity for 20 to 90 years depending on use and location. Piles in Vancouver Harbour after 40 years of service have retained 75% of the original creosote charge.
- If creosote-treated wood is to be used/deposited on land, placement must be in accordance with Provincial and Municipal legislation.
- When a large volume of creosote-treated wood is taken out of service from in-water or on-land prior use, the proponent and regulator need to fully consider all reuse and disposal options to maximize protection of the aquatic environment.
- Used, treated wood should be inspected to ensure that the wood is in a condition that is suitable for the intended new use. Inappropriate reuse of treated wood could result in structural failure and lead to repeated habitat disturbance through decommissioning and reconstruction of a facility.
- Weathered or reused wood should be inspected to ensure there are no excessive deposits of creosote on the surface of the wood. Such deposits indicate there may be continuing, significant PAH loss from the wood. Such wood is unlikely to be suitable for use in fish habitat.

2.2. PENTACHLOROPHENOL

Pentachlorophenol is commonly used for utility pole and fence post preservation and is specified in the BMPs for use on lumber to be placed in freshwater areas, including timbers and piling; in laminated beams; and above the splash zone in saltwater environments. Pentachlorophenol is not recommended in the CSA standards for use in salt water environments (WWPI 1998). Researchers in one recent study (Brooks 1999b) of pentachlorophenol-treated bridges sampled for PCP in water and sediment in U.S. west coast streams. In this study, the PCP-treated wood was not immersed in the streams; its use was limited to the overhead structures. PCP was not detected in the water column at a detection limit of 0.25 $\mu g \cdot L^{-1}$. Sediment samples exceeded the detection limits of 7.2 to 11.0 $\mu g \cdot kg^{-1}$ in 5 of 16 samples with PCP levels up to 20.0 $\mu g \cdot kg^{-1} \pm 7.9$

$\mu g \cdot kg^{-1}$. No adverse effects were observed. Invertebrate abundance appeared to be more influenced by sediment composition than by pentachlorophenol levels (Brooks 1999b). Historic concerns with the use of pentachlorophenol due in part to contamination with dioxins, furans and hexachlorobenzene, and the potential for chronic impacts at low pentachlorophenol levels, has limited its use in aquatic environments. The more recent data do not preclude consideration of its use in treated wood for overhead structures. There is a risk assessment model that has been developed for pentachlorophenol (Brooks 1998b).

2.3. COPPER NAPHTHENATE

Copper naphthenate is an oil-borne preservative that is the reaction product of copper oxide and naphthenic acids. It is used primarily for above-water components and for hand dressing of end cuts. All end cuts should be treated in an upland contained area. Health Canada's Pest Management Regulatory Agency sets out use restrictions on pesticide product labels. However, label constraints have not historically been detailed with respect to ensuring fish habitats are protected. Following a 1992 label improvement initiative, copper naphthenate labels are now required to identify that this product is toxic to fish.

Copper naphthenate is occasionally proposed for freshwater structures such as timbers for bridges. Copper naphthenate is not listed in the CSA standards for lumber used in salt water or for any piling. Materials should only be used for listed applications (WWPI 1998). CSA standards are in effect for wood treatment with copper naphthenate in both ground contact and freshwater applications. There is no risk assessment model for the use of copper naphthenate.

For wood treated with copper naphthenate, as is the case with other heavy duty wood preservatives, compliance with the above-mentioned BMPs, including post-treatment steps involving the use of an expansion bath and vacuum recovery, is required. The treated wood should be visually inspected and rejected if there are excessive solids or grease-like deposits which can be scraped off the surface. Treated wood should be rejected where liquid preservative bleeds from the surface.

Copper naphthenate-treated wood is often used for utility poles, and is commonly available in retail lumber yards for use in fencing and decking.

3.0. METAL-OXIDE TREATMENTS, ENVIRONMENTAL CONCERNS AND ASSOCIATED MITIGATION STRATEGIES

Treatment using metal oxide involves forcing dissolved copper, chromium, arsenic and/or zinc under pressure into wood. As noted above, (see Section 2.1.) recent information shows that the borer hazard in marine waters north of San Francisco on the west coast and north of New Jersey on the east coast is lower than earlier believed. Accordingly, lower retention is appropriate and effective for CCA and ACA/ACZA, compared with that which was required earlier. Recently the AWPA recommended changes to the U.S. standard, and the CSA has adopted the revised U.S. standard. As a result, ACA/ACZA and CCA retention in treated wood was reduced from 2.5 to

1.5 pcf for structures in temperate marine waters such as in coastal British Columbia and further north.

According to the industry, the key aquatic environmental concern with wood treated with metal oxides is the initial copper loss (CITW and WWPI 1997). Use of the above-referenced BMPs by treatment plant operators involves ensuring that the metal oxides are properly fixed within the wood and therefore are significantly more resistant to leaching when the structure is installed in water. Industry recommends that wood treated with metal oxides not be painted immediately, but be allowed to dry thoroughly to improve paint adhesion to the surface.

3.1. Ammoniacal Copper Zinc Arsenate (ACZA) and Ammoniacal Copper Arsenate (ACA)

ACZA was registered for use in Canada in 1999, but has been in common usage in the United States for a number of years as an alternative to creosote. With ACZA, half the arsenic in ACA is replaced with zinc, therefore losses of arsenic from ACZA are expected to be lower than losses from ACA. ACZA and ACA are somewhat similar in chemical behaviour and are discussed together in the BMPs. Industry expects ACZA will rapidly replace ACA (Walthert 1999).

Successful metal-oxide fixation with ACZA is dependent on the evaporation of the ammonia-based solvent. The BMPs establish post-treatment procedures to ensure adequate fixation. If there is an obvious ammonia odour present, the chemical is not properly fixed in the wood and it should not be accepted for use. Brooks (1997c) contains a computer model to predict ACZA leaching rates under different environmental conditions. The metal-loss algorithm in Brooks (1997c) predicts loss rates from ACZA-treated wood that decline exponentially with time and reach background levels within one week after installation. The model predicts that copper is the contaminant of concern with ACZA. Adjacent to an ACZA-treated pile, if copper in water and sediment does not exceed water quality objectives or guideline levels, it is unlikely that chromium, zinc or arsenic will reach levels of concern. Industrial washing of the treated wood prior to installation may remove some of the metals that leach out during initial immersion. This is not a routine procedure. If required, washing must be carried out at the manufacturing site to ensure there is proper collection and reuse of the wash water.

ACZA is more effective than CCA in treatment of Douglas-fir and should be considered as an alternative to creosote for marine borer protection. ACZA is more likely to be used in piling and other industrial applications than is CCA.

3.2. Chromated Copper Arsenate (CCA)

CCA is used both for above-water components and a full range of aquatic installations, including piling. Industry does not recommend CCA for marine piling using Douglas-fir, which is favoured locally for strength. CCA is effective on many other western softwood species, including western hemlock and ponderosa pine. CCA fixation to wood cells is a function of time and temperature. According to the BMPs and the CSA, wood properly treated with CCA must pass the chromotropic acid test to verify the absence of chromium VI. Presence of chromium VI indicates that the fixation process is incomplete. Passing the test ensures that for aquatic applications 99.5% – 99.95% of the preservative is fixed to the wood (CITW and WWPI 1997). There are three common formulations of CCA, with minor differences in the forms of the metals. The most commonly used formulation is CCA-C. With in-water installations, most metal leaching from CCA-treated wood occurs in the first 90 days (CITW and WWPI 1997). In above-water structures most CCA leaching is thought to occur in the first year (Brooks 1997b). This weathering period is based on rain water flowing over the wood surface, thus intensity and duration of rain events is of significance in the weathering process.

Brooks (1996) used a model to predict environmental levels of copper following the installation of a bulkhead. The model predicted significant elevations of copper in the water column immediately following the installation of a bulkhead using CCA-treated wood where proper fixation of the chemical has occurred. In one example of a 500-metre-long bulkhead installed in freshwater where currents were flowing at a speed of 2.5 $cm \cdot sec^{-1}$ with a water hardness of 50 $mg \cdot L^{-1}$ $CaCO_3$, the model predicted a copper concentration immediately adjacent to the bulkhead of 2.13 μg $Cu \cdot L^{-1}$ on the first day of immersion. These levels declined exponentially and the copper concentrations were predicted to be 1.8 μg $Cu \cdot L^{-1}$ on the second day. The Canadian Council of Ministers of Environment (CCME 1999) identified the upper limit of 2 $\mu g \cdot L^{-1}$ copper as protective of freshwater aquatic life in waters where hardness is 120 $mg \cdot L^{-1}$ $CaCO_3$ or less.

The Brooks model further predicted that if copper concentrations in water remained below the regulatory standard, sediment copper concentrations should also be in adherence. It is important to note that the model is designed to be conservative, thus it will likely overestimate the amount of metal leached from the wood.

In laboratory flow-through and field in situ bioassays using CCA-C-treated southern yellow pine in sea water, blue mussels attached to or immediately adjacent to the treated wood did not accumulate copper, chromium or arsenic after up to 9 months of exposure (Adler-Ivanbrook and Breslin 1999). These authors concluded that although copper, chromium and arsenic were continually released from the treated wood, the concentrations measured in the water were not high enough to result in elevations in mussel tissue.

Weis et al. (1998) studied 5 CCA-treated-wood bulkheads of different ages in estuaries from New York to South Carolina. These authors concluded that metals leached from the treated wood and accumulated in the fine-grain fractions of nearby sediments. Benthic community species richness, diversity and biomass were reduced at sample stations 1 metre from the bulkheads, generally returning to background characteristics at a distance of 10 metres from the bulkheads. This was correlated with both the highest concentrations of copper and arsenic, and percent fines in sediments. Benthic response was thought to reflect sediment characteristics, not contaminant concentration. Factors influencing leaching and accumulation included the age of the treated wood (i.e., weathering time), sediment characteristics and the energy level of the aquatic environment. Weis et al. (1998) considered copper to be the metal most likely responsible for the effects documented in the benthic community. These authors referred to a previous study wherein sediment contamination was assessed adjacent to CCA-treated pilings. In that study, there was no significant sediment metal contamination or apparent changes to the benthic community near the piling in relatively well-flushed areas. Weis et al. (1998) also noted that while there was no marked accumulation of metals in well-flushed areas near the piling, metals that did leach from the wood were likely accumulating at downstream depositional sites.

CCA-treated wood is commonly available at retail lumber yards. In British Columbia, CCA is unlikely to be used for treating marine piling. CCA-treated wood can be stained green or brown, and is more likely than ACZA to be incised to permit penetration of the preservative into the wood.

3.3 AMMONIACAL COPPER QUAT (ACQ)

The active ingredients in ammoniacal copper quat are 62% to 71% copper oxide, and 29% to 38% quat (didecyldimethylammonium chloride or DDAC). ACQ is not registered for use in Canada, but ACQ-treated wood may be imported into Canada. It is generally used for dimension lumber, not usually exceeding 2x8 inches in size, and the wood is generally used in above-water installations such as decking. ACQ is not listed in the AWPA standards for wood placed in salt water or for any piling applications (WWPI 1998). Materials should only be used for those applications for which they are listed (Hayward 1999).

ACQ is considered to be an effective preservative for many western softwoods such as hemlock and Douglas-fir. Wood imported from the U.S. should have been treated according to BMP requirements. As with all treated-wood products, ACQ-treated wood should be visually inspected to ensure that there are no excessive pesticide residues on the finished product.

Brooks (1998a) included a risk assessment model for ACQ-B, the common formulation of this preservative. Following a recent study of treated wood in a wetland environment, Brooks (1999a) advised that ACQ-B appeared to lose more copper to the aquatic environment than CCA-C or ACZA. However, ACQ-B does not contain arsenic, chromium or zinc, which are present in CCA-C and/or ACZA.

4.0. WATER QUALITY ASSESSMENT OF A PROPOSAL FOR A TREATED-WOOD STRUCTURE

1. Consider the environmental risks associated with all types of construction materials, including treated wood and alternatives, particularly in sensitive shoreline areas. There are significant differences in the cost of various products. Alternatives to treated wood are generally more costly, but may be warranted.

    - Precast concrete structures may be advisable in areas with low current velocities and where there are anoxic, fine-textured sediments because such benthic areas exhibit relatively slow microbial degradation rates for creosote/PAHs. However, cast-in-place concrete operations may initially release water that is highly toxic because of elevated pH, and the work may increase water turbidity. In addition, use of alternatives to treated wood will dictate different construction techniques and machinery which could pose greater physical impacts on fish habitat.

- Steel structures are stronger than wooden ones, thus steel facilities can be built with fewer supporting members and with less associated environmental disruption, provided that the underwater substrate is suitable. Steel can require periodic repainting which sometimes involves repeated use of toxic paints, rust inhibitors and blasting abrasives. Often steel will require cathodic protection, usually in the form of sacrificial zinc anodes. In certain areas, such as shellfish growing waters, elevation of zinc levels may be of concern.
- Structural challenges for various foreshore projects can dictate development of innovative solutions. Damage to docking ships has been a growing concern to industry where steel and concrete are used, given that these materials lack the energy-absorption capacity of wooden structures.
- Untreated wood may be suitable for temporary use, or for structures with a relatively short lifespan, particularly in freshwater. However in salt water, structural integrity can be compromised by marine borer damage in a few years, thus dictating early structure replacement and associated habitat disruption.
- Full-pile polyurethane wraps can be used on treated or untreated wooden structures to ensure protection of particularly-sensitive habitats from wood leachates and from releases of creosote droplets. Other locations where wraps should be considered include areas having constricted water access, or those proximal to large volumes of treated wood. Some means of ensuring the integrity of the wrapping over time is required.
- Top caps are being examined for creosote-treated wood (Appleton 1998). It is hoped that such caps will effectively shield the supratidal portion of piles from solar heating and the possible blistering and spattering of creosote.
- New technology under development includes:
    - ♦ Plastic piling (pilot project was conducted at the CN terminal in Nanaimo in spring 1998);
    - ♦ Use of anchors rather than piling to hold floating structures in place (SCH is experimenting with durable Hardlast™ nylon rope);
    - ♦ Superwood, a plastic timber; and
    - ♦ TREX, a wood fibre and plastic composite used for decking.

Note: In some regions of the U.S. bans are being implemented on the use of plastics such as styrofoam in docks because of the litter produced as the material disintegrates.

2. When an unacceptable risk to the environment is expected, SCH engineers can assist HEB field staff in evaluating the potential for using alternatives to treated wood for specific projects.

3. If the proponent can demonstrate the need for preserved wood in a project, the proponent should then identify the most appropriate type of treated wood for the use required, considering existing environmental conditions at the site. For example, in an area with already-elevated PAHs in sediments, creosote-treated wood may not be acceptable and metal oxide-treated wood or non-wooden structures may be required.

4. In areas of low water hardness (i.e., 15-25 $mg \cdot L^{-1}$ $CaCO_3$), pH 5.5 or less and elevated background metals levels or metals-sensitive biota, the use of metal oxide-treated wood is not recommended.

5. In areas with anaerobic sediment, low total organic carbon in the sediment, or elevated background PAHs, the use of creosote-treated wood should be discouraged.

6. The proponent should make every effort to minimize or eliminate in-water or over-water (i.e., in situ) treatment. All end cuts and field boring should occur in an upland containment area where practicable. Over-water boring of treated wood should be minimized and all debris must be collected and deposited at an approved upland facility. Care should be taken to ensure there is no loss of wood-treatment chemicals into the aquatic environment. This may dictate the use of draping in treatment areas.

7. Losses of treated wood into the aquatic environment through abrasion can be minimized by armouring the wood with protective wear strips.

8. Timing restrictions may be required to protect sensitive aquatic species from physical impacts during construction, or to reduce the risk of exposing sensitive aquatic life stages to chemical contamination during initial submersion of the treated wood.

9. For all preserved wood, Fisheries and Oceans Canada staff should specify that the product is to be treated according to the above-referenced BMPs, and that the related post-treatment procedures (i.e., employment of vacuum recovery, expansion bath and steaming) are strictly followed. The installer and/or the supplier should guarantee provision of these measures, and be prepared to produce documentation to verify compliance.

5.0. RISK EVALUATION

To assist in risk assessment the industry has sponsored the development of risk assessment models that may be obtained through CITW. There are models available for creosote, CCA, ACZA (which may be used for ACA), ACQ-B and pentachlorophenol. Separate models are provided for bulkheads (BRISK) and piling (PRISK) projects. The models incorporate such variables as current velocity, sediment oxygen levels, sediment total organic carbon and the amount of treated wood involved in a project. The models allow input for background levels of metals, PAH or pentachlorophenol as appropriate, and so can be used in the assessment of cumulative effects.

Comparing the model predictions to actual values obtained through sampling indicates that the models are conservative (i.e., the models predict higher levels of contamination than have actually been measured). These models are currently being updated and will be made easier to use.

In conducting a site-specific risk evaluation, it is expected that the following factors will be considered:

- Average annual water temperature;
- Hardness and pH for water-borne preservatives, pH for pentachlorophenol;
- Salinity and related supporting information on marine borer prevalence;
- Background water chemistry, particularly concentrations of the metals and organic compounds found in the wood preservative;
- Current velocity and direction;
- Proximity to sensitive fish habitat (e.g., herring spawning habitat, eelgrass beds, kelp beds, juvenile rearing areas, shellfish areas);
- Timing of proposed construction;
- Size of proposed structure/number of treated piles;
- Chemical used in treatment and the application methods to be employed;
- Proximity of other preserved-wood structures;
- Other sources of contamination which may contribute to cumulative effects;
- Existing sediment chemistry (PAH, metals – Cu, As, Zn, Cr);
- Sediment characteristics (i.e., grain size);
- Sediment total organic carbon and redox potential when oil-borne preservatives (e.g., creosote) are proposed;
- Expertise of proponent and construction crew;
- Precedent-setting aspects of decisions; and
- Regional consistency.

6.0. SUMMARY

- Installation of any kind of piling can cause physical and chemical impacts on benthic habitats and fisheries resources.
- Treated-wood piles lose preservative chemicals into water and sediment; the rate and duration of leaching are governed by the pre-treatment condition of the wood, its species, the chemical, the treatment process used, the initial chemical charge, post-treatment steps and the nature of the environment into which it is placed.
- There should be no in situ or residential treatment of wood used in the aquatic environment. Creosote oil and copper naphthenate are wood-treatment products commonly sold at lumber yards for homeowner application. Only factory-treated wood bearing the BMP mark should be considered for aquatic use.
- In-water storage of treated wood for extended periods is not acceptable.
- For most estuarine and all freshwater installations the use of alternatives to creosote is recommended. In those few instances where the flexibility and durability of an oil-borne treatment is critical to the project, or where there is particularly low water pH and hardness, or high background metals levels (e.g., copper), the use of creosote-treated wood may be acceptable.
- Based on the recent Sooke Basin study, which was designed to reflect worst-case marine conditions, in the first year of the study sediment contamination by PAHs was restricted to within 7.5 metres of a six-piling creosoted dolphin treated to BMP standards.

- A single six-piling creosote-treated dolphin in a low current marine area would be expected to have localized, short-term impacts on benthic infauna. Part of this impact would be due to the physical disturbance during installation and the on-going physical presence of the structure. After the microbial flora have built up to break down PAHs following installation of the treated-wood structure (at Sooke Basin it took as much as 1000 days), the rate of microbial degradation of PAHs should exceed the deposition rate.
- ACZA when properly fixed in piling is expected to leach for the first week when submerged in water then decline to very low levels.
- CCA leaching from BMP-treated wood occurs mostly in the first 3 weeks after the treated wood is submerged, after which time leaching declines to very low levels. Elevated levels of copper in fine-grained sediments can be expected near the treated wood which could result in localized impacts to benthic communities.
- For all installations of treated-wood products, timing restrictions are recommended to protect aquatic resources from the initial release of wood-treatment chemicals following installation.
- Railway ties are treated by a different process than piling and should not be assessed using the present Guidelines, nor should ties be placed in aquatic habitat.

Further information is required concerning the impacts of creosote-treated wood, as follows:

- Phototoxicity of PAHs released from creosote-treated wood has not been fully studied in relation to aquatic life;
- Four years after installation, the BMP piling at Sooke Basin continued to show visible tar-like surface deposits of creosote. This experiment has shown that even though BMP piling lose less creosote than more heavily-treated piling, there continues to be some loss of PAH to the aquatic environment. The effects of this continuing exposure of local biota to PAHs have not been addressed;
- More work on endocrine disruption in aquatic life and PAHs is warranted;
- Data on the freshwater effects of creosote are limited, although the recent work reported in Brooks (1999b) showed that impacts at many sites appear to be insignificant. More information is required to fully evaluate the impact of creosote in freshwater;
- Tainting of aquatic organisms from exposure to creosote has not been fully addressed and may have implications for human use of fish; and
- More research is required on impacts to aquatic organisms of long-term exposure to low levels of mixtures of contaminants such as wood-treatment chemicals.

7.0. CONCLUSIONS

The use of treated wood in the aquatic environment is a controversial topic. The installation of treated-wood structures has both a physical and a chemical impact on the immediate aquatic environment. Many studies have been conducted to determine effects of treated wood in freshwater and marine installations. The use of Best Management Practices (CITW and WWPI 1997) for the in-plant application of wood-treatment pesticides and implementation of post-treatment recovery procedures reduces problems caused by the excessive use/improper fixation of treatment chemicals which are lost into the aquatic environment. Creosote-treated wood will lose PAHs to the water as long as the wood is in service. Metal oxide-treated wood will leach primarily in the first few weeks after installation, although some metals will continue to be lost at very low levels for months. Low levels of PAHs are biodegradable in aerobic sediments once appropriate microbial flora have become established. In anerobic sediments, PAHs may not be broken down appreciably.

There may be some freshwater installations where the flexibility and softness of creosote-treated wood are critical to a project. In such cases, and in freshwater areas where there is very low pH and hardness, or high background metals levels (e.g., copper), creosote-treated wood structures will be considered. In the review of such projects, consideration will be given to the biological sensitivity of the site and its sediment characteristics in terms of whether they would be conducive to the aerobic break down of PAHs. Metals leaching from treated wood are not degraded in the environment and as stated above, this may be a concern in low pH, low hardness waters where elevated copper already is in evidence. In such areas, the use of metal oxide-treated wood may be unacceptable.

In light of the lack of conclusive data on the long-term impacts of treated wood on the aquatic environment, a precautionary approach is required.

The following 15 points should always be considered in the review of proposals to use treated wood in water.

1. There will be an impact on fish habitat from the presence of a structure, whatever the construction material;
2. Alternatives to treated wood should be used wherever practicable;
3. Only wood treated to BMP specifications will be acceptable in or adjacent to aquatic areas;
4. The volume of treated wood used in water should be minimized by utilizing alternative materials and designs;
5. For most projects, creosote-treated wood is not required or recommended for use in freshwater;
6. Proposals to use exposed creosote-treated wood for above-water structures should be carefully evaluated, and only accepted when there is no alternative. Every effort must be made to shield the creosote-treated wood from exposure to solar heating and to prevent entry of the pesticide into the aquatic environment;
7. In areas where the water pH is less than 5.5, or where high background copper levels are present, the use of metal-oxide or waterborne preservatives may not be appropriate;
8. In areas with anaerobic sediments and low organic content, creosote-treated wood should not be used;
9. Timing restrictions on projects are generally required to ensure that particularly-sensitive biota are not exposed to the first flush of chemical released after installation of treated-wood products. In addition, the non-routine prewashing of metal oxide-treated wood at the treatment plant may be necessary;
10. Absorbent booms must be deployed and maintained during installation of all structures using oil-borne wood treatments. These booms should remain in place and operational until such time as visible evidence of wood-treatment chemicals on the water surface is no longer apparent;

11. All cutting and boring of treated wood should take place in upland areas; all waste materials must be kept out of the aquatic environment and be properly disposed of upland. Such work that must be done in situ is to be fully contained so that no waste materials are deposited into water or onto aquatic sediments;
12. Any cut wood, chips or sawdust that enters the aquatic environment is to be promptly collected and later disposed of at an acceptable upland site;
13. In situ application of wood-treatment chemicals is generally not acceptable. In the event that minor application of wood-treatment chemicals is required after construction of a treated-wood structure, all application areas must be contained or tarped so that no chemicals are deposited into the water or onto aquatic sediments;
14. Due to the availability of alternate chemicals, pentachlorophenol-treated wood should be discouraged for use in water; and
15. Railway ties are not covered by these Guidelines, nor should they be used in aquatic structures.

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APPENDIX A

RECENT REPORTS

A.1. BEST MANAGEMENT PRACTICES FOR THE USE OF TREATED WOOD IN AQUATIC ENVIRONMENTS (CITW and WWPI 1997)

The BMPs outline treatment and post-treatment procedures to be followed to reduce the potential for chemicals to be lost from treated wood. Reference is made to computer models which were developed to predict concentrations of contaminants released from treated wood under various environmental conditions. The CREORISK model calculates probable sediment PAH degradation rates based on factors such as sediment particle size, oxidation/reduction potential and organic content. Field testing has shown the model is conservative, that is, the model predicts somewhat higher PAH concentrations in sediment, and significantly higher concentrations of dissolved PAH in water than what has actually been observed.

The BMPs are designed so that an environmentally-sensitive product is manufactured. Some information is included on environmental considerations for use of treated wood in aquatic environments. Further information is provided in the Risk Assessment Documents (Brooks 1997a, b, c; Brooks 1998a, b) upon which the BMP recommendations are largely based. Environment Canada advised Fisheries and Oceans Canada that its regional staff will adopt these BMPs as recommended guidelines, while recognizing that site-specific conditions will affect the advice provided.

A.2. CREOSOTE EVALUATION PROJECT (EVS Consultants Ltd. 1994)

A study was undertaken in the early 1990s to identify PAH concentrations and the toxicity of sediments from two Lower Mainland sites near creosote-treated piles. One site was at Westham Island in the Fraser River estuary where piles were more than 8 years old and there was significant water exchange and sediment transport. The second site was at Belcarra Bay, Indian Arm, where piles were newer (i.e., less than 5 years old), the sediment carbon content was higher and there was a lower rate of water exchange (i.e., the current velocity was less than 5 $cm \cdot s^{-1}$) compared with that of the Westham Island site.

Results showed that sediment PAH concentrations at the Westham Island site were low. Amphipod survival was greater than 90%, and Microtox™ tests showed marginal impacts from the sediments collected near the piles. At the Belcarra Bay site, sediment PAH levels exceeded background levels within a 10-metre radius of the treated piles. Amphipod survival was lower than at the Westham Island site and Microtox™ inhibition was significant. A factor at the Belcarra Bay site was the elevated background levels of PAH which contributed to the toxicity observed.

The study showed that the cumulative effects of dense aggregations of creosote-treated piling in an industrial area with significant levels of background PAH and slow currents, resulted in biological stress in laboratory bioassays. No loss of biological integrity was documented in a moderately well-flushed freshwater site with significant numbers of older piling. The severity of the effects is dependent on factors such as:

- Age of the piling;
- Current velocity; and
- Sediment grain size and total organic content.

A.3 CREOSOTE EVALUATION: PHASE II. SOOKE BASIN STUDY – BASELINE TO 535 DAYS POST CONSTRUCTION. 1995-1996 (Goyette and Brooks 1998)

Environment Canada, Fisheries and Oceans Canada (Habitat and Enhancement Branch, HEB and SCH), MELP and CITW have been conducting a study in Sooke Basin on Vancouver Island to further examine the research questions posed for the 1994 EVS project (Goyette and Brooks 1998). The Sooke study was designed to assess in situ environmental effects on marine organisms and associated habitats from newly installed, BMP creosote-treated, and weathered, non-BMP creosote-treated piles. The monitoring program included sampling of wood cores from the piles, water column chemistry, sediment chemistry, benthic infaunal community analysis, liquid and solid phase Microtox™, echinoderm fertilization, and mussel (*Mytilus edulis edulis*) spawning and larval development tests. The study was designed to be a worst-case scenario and to be completed in 12 months, but initial results indicated that more extensive monitoring of sediments and biota was warranted, thus some limited additional sampling was conducted 18 months into the project.

Results showed that sediment PAH concentrations were highly variable. Comparison to values generated by the model developed by Brooks (1997a) showed that it tended to be conservative (i.e., it predicted higher concentrations of preservative chemicals in the aquatic environment than have been measured in verification studies). This conservative tendency has been apparent in five field trials, and the model appeared to be a useful tool for evaluating the environmental risks associated with creosote-treated wood.

Interestingly, no adverse effects were observed in the benthic community at any distance from the creosote-treated dolphins when compared to either the untreated Douglas-fir dolphin or the open control containing no structure. Amphipod survival and Microtox™ luminescence were lower in sediments collected immediately adjacent to both the untreated and treated dolphins when compared to the local reference station. These bioassay tests suggested greater adverse effects at the creosote-treated dolphin when compared to the untreated Douglas-fir structure. Significant adverse effects were restricted to distances less than 0.65 metre from the creosote-treated dolphins in this study under low current conditions. Sediment chemistry results indicated that PAHs were elevated at 7.5 metres downcurrent from the treated dolphin but declined to near background levels at 10.0 metres. In the first year after installation, creosote losses from the BMP-treated dolphin were similar to those from the dolphin constructed of weathered (i.e., used) creosote-treated piling. After 18 months, the PAH levels in sediments had not yet reached their peak and were projected to increase another 18% to their predicted maximum at 1,000 days post-installation.

Benthic toxicity tests showed some effects using sediment collected within 0.5 metre of the BMP-treated piles, the weathered, treated piles, and the untreated Douglas-fir piles. Accumulation studies with mussels showed some uptake of PAHs up to 2 metres from all creosote-treated piles. Levels of PAHs in tissues of caged mussels increased immediately after installation of the piling, and returned to pre-exposure levels by the next sampling event on Day 185. Mussel growth increased with distance from the creosote-treated piling. No adverse effects were observed on mussel survival, condition factor, spawning success or development of juveniles from any of the test sites at the treated or untreated dolphins.

It appeared that creosote was being deposited in sediments as small particles. The manner in which creosote was being lost from the piling was not investigated in this study. An initial surface sheen was noted during installation, but not quantified. However, dissolved PAH in the water column was measured on Day 250 and found to be only slightly elevated over background, and only in close proximity to the treated wood. The measured water column concentrations of PAH were not considered to be a significant concern for aquatic life protection, and sediment contamination was expected to be highly localized.

Goyette and Brooks (In Prep.) found that four years after installation, the appearance of tar-like deposits on bottom sediments near the piles was less common, and surface sediment PAH concentrations had declined from levels noted in Year 1 of the study (Goyette and Brooks 1998). Creosote losses from the BMP piling declined from Year 1 levels, due in part to extensive biological growth encasing the pile. The heavy marine growth also resulted in the deposition of large amounts of biological debris around the piles. This caused the formation of anaerobic conditions in the sediments, with levels of hydrogen sulphide that were toxic in benthic bioassays. This occurred at the untreated, weathered and BMP piling sites.

These authors have hypothesized that a significant amount of the localized sediment PAH contamination may originate from that portion of the piling exposed to sunlight, and that solar heating may draw the creosote to the surface of the piling. On the submerged portion of the piling, algal and mussel growth, and the limited exposure to solar heating in this zone, may restrict this route of creosote loss. Further study of this hypothesis could lead to a better understanding of the transport routes of creosote, and possible mitigation strategies to reduce the potential for impacts on the aquatic environment.

APPENDIX B

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITY SUBSTANCES LIST, STRATEGIC OPTIONS PROCESS

Environment Canada and partners are currently reviewing chemicals on the *CEPA* Priority Substances List (PSL). The management of toxic substances is guided by the CCME Policy for the Management of Toxic Substances (PMTS). Under PMTS, substances are managed in two ways: Track 1 substances are targeted for virtual elimination and include largely persistent, bioaccumulative substances; Track 2 substances are managed through a life-cycle approach with management options developed through a Strategic Options Process (SOP). The SOP is a consultative mechanism that provides the basis for recommendations to ministers, and includes a cradle-to-grave management approach for toxic substances, emphasizing technical controls at each phase of production, use and disposal, as appropriate. The SOP Issue Table includes representatives from Federal and Provincial regulatory agencies, consultants, ENGOs and industry. Fisheries and Oceans Canada has provided some input to the process and continues to seek opportunities to participate as an observer.

Recommendations to ministers may include the development of BMPs for the lifecycle management of creosote-treated wood products and wastes. To ensure national consistency, the provinces are consulted on SOP recommendations through existing federal/provincial consultative mechanisms. The Wood Preservation Issue Table could recommend amendments to the registration of creosote under the *Pest Control Products Act* to facilitate further controls on creosote-treated materials and wastes, but that or any other regulatory initiative under the SOP consultative process will not result in immediate changes to the use of treated wood in aquatic environments.

Of more immediate interest is the SOP Report for creosote-treated materials and wastes which was made available late in 1999. This document included a recommendation that BMPs be developed for the use of creosote-treated wood, including use in aquatic and terrestrial environments. It is anticipated that these BMPs will address in very general terms the ecological significance of creosote-treated wood in aquatic use and will support the present, more detailed and specific Fisheries and Oceans Canada Guidelines by increasing the awareness in industry and the public of the potential implications of using treated wood in aquatic environments.

Also included on the SOP list are arsenic and chromium which are constituents of CCA and ACA/ACZA, and dioxins and furans which occur as impurities in pentachlorophenol. The review of these chemicals by government and industry may result in management decisions that have implications for wood treatment and the aquatic use of treated wood.

APPENDIX C

WATER AND SEDIMENT QUALITY GUIDELINES

Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 1999)

WATER

Metals ($\mu g \cdot L^{-1}$)	Freshwater	Marine
Arsenic	5.0	12.5 [a]
Chromium VI	1.0	1.5
Chromium III	8.9 [a]	56 [a]
Copper at various water hardnesses:		
$CaCO_3$ <120 $mg \cdot L^{-1}$	2	
$CaCO_3$ 120-180 $mg \cdot L^{-1}$	3	No recommendation
$CaCO_3$ >180 $mg \cdot L^{-1}$	4	
Zinc	30	No recommendation

[a]Interim Guide

Polycyclic Aromatic Hydrocarbons (PAH, interim guidelines) ($\mu g \cdot L^{-1}$)	Freshwater	Marine
Acenaphthene	5.8	Insufficient data
Anthracene	0.012	Insufficient data
Benz(a)anthracene	0.018	Insufficient data
Benzo(a)pyrene	0.015	Insufficient data
Fluoranthene	0.04	Insufficient data
Fluorene	3.0	Insufficient data
Naphthalene	1.1	1.4
Phenanthrene	0.4	Insufficient data
Pyrene	0.025	Insufficient data

Freshwater Sediments

Metals (mg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Arsenic	5.9	17.0	11
Chromium	37.3	90.0	64
Copper	35.7	197	120
Zinc	123	315	220

Low Molecular Weight Polycyclic Aromatic Hydrocarbons (µg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Acenaphthene	6.71 [a]	88.9 [a]	48
Acenaphthylene	5.87 [a]	128 [a]	67
Anthracene	46.9 [a]	245 [a]	150
Fluorene	21.2 [a]	144 [a]	83
Naphthalene	34.6 [a]	391 [a]	210
Phenanthrene	41.9	515	280

High Molecular Weight Polycyclic Aromatic Hydrocarbons (µg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Benz(a)anthracene	31.7	385	210
Benzo(a)pyrene	31.9	782	410
Chrysene	57.1	862	460
Dibenz(a,h)anthracene	6.22 [a]	135 [a]	71
Fluoranthene	111	2355	1200
Pyrene	53.0	875	460

Source: CCME (1999)

Notes:
ISQG Interim sediment quality guideline
PEL Probable effects level
AEL Average effects level ((PEL + ISQG)/2 = AEL). Suggested remediation target for contaminated sediments
[a] Provisional Guideline
[b] British Columbia Ministry of Environment, Lands and Parks (1998)

Marine Sediments

Metals (mg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Arsenic	7.24	41.6	24
Chromium	52.3	160	110
Copper	18.7	108	63
Zinc	124	271	200

Low Molecular Weight Polycyclic Aromatic Hydrocarbons (μg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Acenaphthene	6.71	88.9	48
Acenaphthylene	5.87	128	67
Anthracene	46.9	245	150
Fluorene	21.2	144	83
Naphthalene	34.6	391	210
Phenanthrene	86.7	544	320

High Molecular Weight Polycyclic Aromatic Hydrocarbons (μg·kg^{-1} dry weight)	**ISQG**	**PEL**	**AEL[b]**
Benz(a)anthracene	74.8	693	380
Benzo(a)pyrene	88.8	763	430
Chrysene	108	846	480
Dibenz(a,h)anthracene	6.22	135	71
Fluoranthene	113	1494	800
Pyrene	153	1398	780

Source: CCME (1999)

Notes:
ISQG Interim sediment quality guideline
PEL Probable effects level
AEL Average effects level ((PEL + ISQG)/2 = AEL). Suggested remediation target for contaminated sediments
[b] British Columbia Ministry of Environment, Lands and Parks (1998)

APPENDIX D

CHECKLIST FOR PROJECT REVIEWERS

Construction of Treated-Wood Structures

Site Considerations:

- Determine the type (freshwater, estuarine, marine) and sensitivity of the aquatic environment and the overall acceptability of the proposed project.
- Determine timing windows for sensitive life stages of biota.
- Consult the Marina Development Guidelines (1995) in terms of minimizing biophysical impacts of structures.

Selecting the Most Appropriate Materials:

- Consider the use of alternative construction materials such as pre-cast concrete, steel and plastic wherever practicable.
- Encourage the use of anchors rather than pilings for floating structures.
- Request pre-cast concrete in areas with low current velocity and anoxic, fine-textured sediments (see Table 1, below).
- Railway ties are not acceptable for use in aquatic environments.
- Specify that all treated wood used in or over water must have a BMP certification mark.
- PCP-treated wood should only be considered for use where it will not be immersed in water (e.g., overhead construction).
- Douglas-fir is the most common wood used locally for marine piling. Most marine piling is treated with creosote. Considering the metal-oxide pesticides, Douglas-fir is most appropriately treated with ACZA. CCA is effective on other softwood species, including western hemlock and ponderosa pine.
- ACQ-treated wood is not appropriate for marine use. In marine areas, the use of ACQ-treated wood should be limited to above-water applications such as decking.
- Creosote-treated wood should only be used in situations where marine borers are a risk, or where there is a demonstrated need for the flexible and durable qualities imparted to the wood by creosote.
- Creosote-treated wood should not be used in locations with anaerobic sediments with low total organic carbon (see Table 2, below), or elevated PAH levels (see Appendix C).
- Metal-salt treated wood should not be used in conditions of low water hardness (15-25 $mg \cdot L^{-1}$ $CaCO_3$), low pH (≤ 5.5), elevated background metals levels (see Appendix C) or where metals-sensitive biota (e.g., shellfish) are prevalent.
- Where ambient levels of heavy metals are already high and CCA-, ACZA- or ACA-treated wood is proposed for use, consider having the wood pre-washed at the manufacturing site.

Design Details to Consider:

- Avoid approving the use of large volumes of treated wood in structures in aquatic environments.
- Request artificial shading, collectors, protective caps, wrapping or coatings for creosote-treated structures in conditions of intense solar exposure and/or elevated temperatures.
- Request that treated-wood surfaces subject to abrasion be armoured with protective wear strips (e.g., high-density polyethelene).

Best Construction Practices:

- Specify that all treated wood used in or near water must have a BMP certification mark.
- Direct the proponent to visually inspect and reject any wood that has obvious surface residues or bleeding of preservative.
- Require the inspection and rejection of any ACA or ACZA-treated wood that has an obvious ammonia odour.
- Require that all CCA-treated wood pass a chromotropic acid test before it is used.
- Minimize the in-water storage of treated wood during construction of the structure.
- Minimize the introduction of treated-wood debris into the aquatic environment by promoting prefabrication on land, containment of cuttings with draping, and the disposal of debris on land in accordance with Provincial and Municipal laws and policies.
- Specify containment and recovery techniques for any debris that enters the water.
- Request the deployment of absorbent booms during the installation of oil-based treated-wood pilings.
- Avoid the hand dressing of end cuts over water; wherever possible treat in a contained upland area. Where this is not possible, prevent pesticide entry into the water with the use of draping.

Decommissioning of Treated-wood Structures

- Remove the entire pile using a slow steady pull to minimize the disturbance of the substrate and avoid bringing contaminated sediments to the surface.
- If the pile breaks off below the biologically-active sediment zone, the impacts from dredging out the remainder may outweigh any benefit of removing a minor PAH source.
- The recovered wood must be disposed of or reused in an appropriate manner and in accordance with applicable Provincial and Municipal laws and policies.

Other Considerations

- Advise proponents of the *CEPA* maximum PAH level ($2.5\ \mu g \cdot g^{-1}$) in sediments proposed for ocean disposal.
- Consider the potential for additional contamination of surface water and groundwater where the use of treated wood is proposed for adjacent upland construction projects.

Maximum current speed (cm·sec^{-1})	Depth of the reduction-oxidation potential discontinuity (cm)						
	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	33.4	21.91	16.52	12.75	12.29
2	65.74	30.06	16.7	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
16	8.22	3.76	2.09	1.37	1.03	0.80	0.77
17	7.73	3.54	1.96	1.29	0.97	0.75	0.72
18	7.30	3.34	1.86	1.22	0.92	0.71	0.68
19	6.92	3.16	1.76	1.15	0.87	0.67	0.65
20	6.57	3.01	1.67	1.10	0.83	0.64	0.61

Table 1. Summary of least-risk (unshaded), moderate risk (lightly shaded) requiring additional risk assessment, and unsuitable (darkly shaded) environments with respect to the use of creosote-treated wood in marine environments. Table values are predicted maximum total sediment PAH in μg·g^{-1} (ppm) dry sediment weight, based on sediments containing 1.0% total organic carbon, located 0.33 metres from any of 4 newly-treated BMP piles installed in a row parallel to the currents and spaced 6 feet apart. (Goyette and Brooks 1998).

Puget Sound reference values for total organic carbon	
Silt-clay particles (percent dry weight)	**Total organic carbon (percent dry weight)**
0-20	0.5
20-50	1.7
50-80	3.2
80-100	2.6

Table 2. Total organic carbon in sediments. (Washington Department of Ecology 1991). Total organic carbon values less than those indicated in this table are be considered to be low values and may indicate areas unsuitable for the use of creosote-treated wood.