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# MEMORANDUM

TO: Hank Ouimet, PE, LEED AP

FROM: Frank Ricciardi, PE, LSP and Stephen Wiehe, PG

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SUBJECT: Treatment of Timber Piles

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The *Timber Pile Design and Construction Manual* published by the Timber Piling Council of the American Wood Preservers Institute and the Federal Highway Administration's (FHWA) *Design and Construction of Driven Pile Foundations* (FHWA HI-97-013) recognize the durability and utility of round timber piles. They suggest that use is a function of needs and site specific conditions, and conclude:

- Foundation piles submerged in ground water will last indefinitely
- Fully embedded, treated foundation piles partially above the groundwater with a concrete cap will last 100 years or longer.
- Treated trestle piles over land will last about 75 years in northern areas and about 40 years in southern areas of the United States.
- Treated piles in fresh water will last about five to ten years less than land trestle piles in the same area
- For treated piles in brackish water, the longevity should be determined by the experience in the area, and
- Treated marine piles will last about 50 years in northern climates and 25 years in southern climates.

Timber piles are durable structural elements; however, insect damage can reduce the service life of timber piles significantly, unless the pile is treated with a wood preservative. The American Wood Preservers' Association recommends timber piles be treated in accordance with the standard, C3-99 Piles-Preservative Treatment by Pressure Processes. Timber piles should be treated to prevent degradation of the wood from insect attack. Environments where degradation is a concern exist when the pile is exposed to alternate wetting and drying cycles or located above the water table. The most common treatments for timber piles are Creosote, Chromated Copper Arsenate (CCA) for southern yellow pine and other species and Ammoniacal Copper Zinc Arsenate (ACZA) for Douglas fir and

Pentachrlophenol (commonly referred to as "Penta" or PCP). Utility poles have been coated with pentachlorophenol (PCP) or creosote for many years in order to prevent the growth of fungi, bacteria, and insect infestation. The coating allowed the wood to last longer creating a more durable product that could be relied on for years.

Changes to the coating occurred in 1990 when the U.S. Environmental Protection Agency (EPA) included PCP as a regulated chemical. The major chemical that was a health concern was the presence of polycyclic aromatic hydrocarbons (PAHs) found in creosote. This new regulation resulted in concern about contamination from the PCP treated wood. More recently, the use of Chromated Copper Arsenate (CCA) treated wood has become more common instead of PCP and does not pose the similar environmental concerns. The introduction of CCA as a substitute for PCP for treating wood, in addition to preventing insect infestation and fungal growth, relieves the potential for environmental concern associated with PCPs.

CCA is a formulation of copper, chromium and arsenic, dissolved in an acidic aqueous solution. CCA combines the fungicidal properties of copper with the insecticidal properties of arsenic pentoxide. In CCA the fixation of arsenic and copper is dependent on the presence of chromium. CCA treated wood has been used in the construction of residential decks and playsets since the 1940s and has been widely used throughout the world as a wood preservative for over 80 years. CCA treated wood simply means that the wood was treated with chromated arsenicals, consisting of the following metals: arsenic, copper, and chromium. This treatment was developed in 1933. According to the EPA, for the purposes of residential use, the treated wood does not need to be disposed of in a special way. The wood can be disposed of in the trash but should not be reused in products or be burned. Burning the wood could release the chemicals in the air or they would be present in the ashes.

A study from 2004 used samples of both weathered and new CCA-treated wood in a leaching experiment. The new wood included samples of both treated and untreated southern yellow pine, while the two weathered wood samples were collected from a playground and a utility pole. The wood was drilled into in order to create saw dust that was then analyzed by either one or more of the following three methods: x-ray fluorescence spectroscopy, open digestion followed by flame atomic absorption, or open digestion followed by inductively coupled plasma atomic emission spectrometry. Various types of water were also involved in the leaching process during this experiment, including saltwater, rainwater, and distilled water. For the purposes of this research, the only results that will be focused on are for rainwater, since that would be the most relevant. From the rainwater results, the arsenic concentrations for the Solvent-Extraction Tests ranged from below detection limit to 9.08 mg/l. Allowable concentrations of arsenic in Massachusetts vary by location. Therefore, the results of this experiment cannot be used to determine whether the concentration would exceed the criteria for Massachusetts. The article provides data confirming the leachability of arsenic from CCA-treated wood.

Two different studies from 2004 and 2007 conducted experiments to see if there is a concern for the leaching of metals from CCA-treated wood after disposal. Especially in reference to landfills. Both studies included more factors than the experiment explained above, including types of leaching, pH, temperature, and contact time. Both experiments found that there is a potential for leaching of arsenic, copper, and chromium especially when large amounts are disposed of in a landfill. However, T. Townsend et al. even mentioned in the article that CCA-treated wood is excluded from the hazardous waste list. The purpose of these experiments was to examine the leachability based on disposal of large quantities of the material.

Pentachlorophenol (Penta) and Ammoniacal Copper Zinc Arsenate (ACZA) is an improved formulation of the original Ammoniacal Copper Arsenate (ACA) and has been available since the early 1980's and has now replaced ACA in the AWPA Preservative Standards. The proportions of copper, zinc and arsenic in ACZA are 2:1:1 respectively. ACA and ACZA are alkaline preservative systems and 22 were formulated to achieve consistent penetration in the treatment of refractory, or difficult to treat wood species (i.e., Douglas Fir). Penta is commonly used in New England in soils which are known to be above the seasonal high water table; however, Penta is not recommended for salt water installations.

Both CCA and ACZA are dissolved into water and are carried into the wood cells within a closed pressure chamber. The metal oxides injected into the wood under pressure during treatment react with the wood fibers resulting in a bonding or fixation of the chemical in the wood. This generally forms an insoluble compound and fixes the chemical within the wood fibers to resist leaching and provide long term protection of timber piles in service.

CCA and ACZA are commonly used for foundation piling and for both fresh and salt water applications for marine structures. CCA is olive green in color and is commonly used for treatment of wood used for residential decks and fences. ACZA is a turquoise green and is primarily used in commercial structures and where Douglas Fir is used. CCA treated piles are commonly used in New England where they are exposed to alternating wet and dry conditions and water table conditions.

The EPA has recognized the continued use of CCA for industrial uses and includes foundation piling, marine piling and structures, utility poles and construction poles in the list of approved industrial uses. Where CCA is considered safe for use in all markets where it has been traditionally used, other treatments are available for the retail market. Where piles are expected to be in service in a fluctuating fresh water table conditions, a treatment of 0.8 lbs per cubic foot CCA is recommended.

A study from 2014 focused on the use of copper azole treated wood in planters. Planters made of CA-treated Douglas-fir in which carrots, radishes, and potatoes were grown over a three-month period. Then the soil levels were examined for leachability potential from the treated wood. The results showed that the metals leaching from the wood did not travel far and stated that this is consistent with other studies on contamination paths from wood. The three crops did not sorb the metals into the edible portions of the crops. Copper was proven to have migrated from the wood; but as stated above, not in the edible portions of the crops. The foliage of each crop was examined to determine how much sorption occurred versus the edible parts. The article suggests that, to further prevent leaching from the wood into the soil, polyethylene lining could be used, but is not necessary.

It is important to realize that with the results from these various studies, it is difficult to say whether the concentrations would be above the criteria in Massachusetts because of the many different variables that go into determining the Massachusetts Contingency Plan (MCP). Not only is there a difference in groundwater and soil results, but the location of the site will determine what water classification is relevant to the site, which also affects criteria concentrations. Depending on the compound, it might also have to be compared against the hazardous waste compounds list. However, the use of CCA treated wood for the purpose of solar canopies presents a different scenario.

Because of concerns regarding the possible levels of wood preservatives in soils and groundwater adjacent to an estimated 54 million in-service poles that have been treated with either Penta or creosote, the Electric Power Research Institute (EPRI, 1997) commissioned a study to examine the release and migration of the wood preservatives. EPRI presented the results of the study, which was conducted by a META Environmental, Inc., of Watertown, Massachusetts; GEI Consultants of Colchester, CT; Utah State University and Science and Technology Management of Brookfield, Wisconsin, which included collection and analysis of over 8,000 soil samples which examined concentration of wood preservatives in soil adjacent to over 200 PCP and creosote treated in-service poles in 28 states. EPRI found the concentration of preservatives in soil adjacent to poles decreased significantly within three to eight inches from the poles.

This data is consistent with the study stated above with the small garden that used CA treated wood, stating that the highest concentrations were found in the soil closest to the treated wood. In conclusion, the study of available literature does not provide any evidence that the treatment of timber piles would have a negative impact to crops in the vicinity of the timber piles. Rather, any leaching of metals from the piles would occur in the immediate vicinity of the timber pile and would dissipate exponentially with distance. Further, the modern methods of timber treatment used today are more controlled than past practices, helping to ensure the right amount of preservatives that will be held within the wood fibers are impregnated into the timber.

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