NORTH AMERICAN WOOD POLE COUNCIL

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Preserved Wood Utility Poles and the Environment

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About NAWPC

The North American Wood Pole Council (NAWPC) is a federation of three organizations representing the wood preserving industry in the U.S. and Canada. These organizations provide a variety of services to support the use of preservative-treated wood poles to carry power and communications to consumers.

The three organization are:

Western Wood Preservers Institute
With headquarters in Vancouver, Wash., WWPI is a non-profit trade association founded in 1947. WWPI serves the interests of the preserved wood industry in the 16 western states, Alberta, British Columbia and Mexico so that renewable resources exposed to the elements can maintain favorable use in aquatic, building, commercial and utility applications. WWPI works with federal, state and local agencies, as well as designers, contractors, utilities and other users over the entire preserved wood life cycle, ensuring that these products are used in a safe, responsible and environmentally friendly manner.

Southern Pressure Treaters' Association
SPTA was chartered in New Orleans in 1954 and its members supply vital wood components for America's infrastructure. These include pressure treated wood poles and wood crossarms, and pressure treated timber piles, which continue to be the mainstay of foundation systems for manufacturing plants, airports, commercial buildings, processing facilities, homes, piers, wharfs, bulkheads or simple boat docks. The membership of SPTA is composed of producers of industrial treated wood products, suppliers of AWPA-approved industrial preservatives and preservative components, distributors, engineers, manufacturers, academia, inspection agencies and producers of untreated wood products.

Wood Preservation Canada
WPC is the industry association that represents the treated wood industry in Canada. WPC operates under Federal Charter and serves as a forum for those concerned with all phases of the pressure treated wood industry, including research, production, handling, use and the environment. WPC is dedicated to promoting and supporting a stronger Canadian wood treating industry; informing the public on the benefits to be gained from the use of quality wood products; and preserving the integrity of the environment through the promotion of responsible stewardship of our resources.

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Introduction

There are an estimated 150 million preservative-treated wood utility poles in service in the U.S. and Canada. Few question the necessity and benefits of this infrastructure in distributing electricity and communications services to society. Yet despite the benefits, there are questions about the use of preserved wood poles and their impact on the environment.

Too often, actions taken that restrict the use of preservative-treated wood utility poles are based on unfounded fears. These include undocumented claims that preserved wood poles significantly impact human health and the environment.

There are potential environmental risks for all materials and products. For utility poles, properly evaluating these risks requires an understanding of how and why preservatives are used, the potential impact of these preservatives on the environment and how to manage such risks.

Wood poles and pressure treating

Wood is a natural material. It comes from trees, which have a natural cycle of growing, dying and then returning to the earth as an organic material to support the next generation of trees.

After a tree dies, there are a multitude of organisms that seek to break down the wood fiber and transform it into organic material. These organisms are ever present in the environment and can deteriorate the wood, even if it has been turned into a wood product such as a utility pole.

Wood utility poles are used in the most demanding conditions, with constant exposure to weather and the elements. They are placed in the ground, which can provide the conditions and pathways for organisms to break down the wood.

Some 180 years ago, researchers discovered how to forestall this deterioration by creating a chemical barrier within the wood. The process uses pressure to integrate preservatives into the wood cells, extending the service life of the wood from years to many decades.

The pressure process for wood poles is intended to keep the preservative in the wood to provide long-term protection. However, because of the structure of wood cells, gravity and conditions where the pole is used, there is potential for some of the preservative to move into the soil surrounding the pole.

Wood preservatives

Preservatives used in commercial wood treating are regulated by the U.S. Environmental Protection Agency (EPA) or the Canadian Pest Management Regulatory Agency (PMRA). These agencies conduct extensive reviews of the risks and benefits of wood preservatives, with a heavy emphasis on human and environmental health effects.

Wood preservatives typically used for utility poles include Pentachlorophenol (Penta), Chromated Copper Arsenate (CCA), Copper Naphthenate (CuN), Alkaline Copper Quaternary (ACQ), Ammoniacal Copper Zinc Arsenate (ACZA), Creosote and 4,5-Dichloro-2-N-Octyl-4-Isothiazolin-3-One (DCOI).

Penta, Copper Naphthenate and DCOI use an oil-based carrier, such as biodiesel and diesel, to move the preservative into the wood. Creosote is a distillation of coal tar.

CCA, ACQ and ACZA are waterborne preservatives that are mixed with water to carry them into the wood during the pressure treating process.

Active ingredients in preservatives

Many of the biocides used in wood preservatives are natural components of the earth's crust and biosphere. For example, Creosote, which has been used to protect wood for nearly 200 years, is a mixture of naturally occurring polycyclic aromatic hydrocarbons (PAHs) derived from coal. These same PAHs are produced by the combustion of organic material associated with forest fires, volcanoes, automobiles, asphalt paving and your home's fireplace or barbecue grill

PAHs have been found in 2,000-year-old glacial ice in Sweden. Typically, naturally occurring background levels of PAHs are low, in the neighborhood of 10 to 100 parts per billion (by weight) in soils and sediments (Eisler, 1987).

Penta has been in use for more than 70 years in treating utility poles. It is produced by the direct chlorination of phenol.

Extensive scientific study has shown that Penta does not persist in most environmental settings and is effectively degraded in soil and water by both aerobic and anaerobic organisms, as well as by sunlight (Brooks, 1998a).

Copper Naphthenate is prepared from naphthenic acid, which occurs naturally in petroleum products (Brient et al., 2000). Copper Naphthenate is used to preserve new poles and for field treating field cuts and drilled holes.

Waterborne preservatives such as CCA, ACZA and ACQ rely on common metals such as arsenic, copper, zinc and chromium to deter molds, fungi and insects that would consume untreated wood.

The relative abundance in the earth's crust of copper, chromium, arsenic and zinc used in waterborne wood preservatives is provided in Table 1. Also included are natural background levels for these metals typically found in undisturbed environments.

Obviously, these metals are everywhere. Chromium, zinc and copper are essential trace elements for the proper functioning of our bodies.

We also know these same chemicals, while helpful or benign at normal exposure levels, can be toxic to plants or animals at high concentrations. We cannot – and need not – eliminate these chemicals from our environment. What we must do is manage the increases caused by human activity so that they don't reach toxic levels for people or the biological community.

Safe preservative levels in soil, water

What are safe levels of preservatives that can be in soil or water? This question could be applied to any of the multitude of products that contain these same metals, PAHs or chlorinated phenols.

Because these materials are so widely used, they have been well studied and regulatory agencies have defined benchmarks describing safe levels. Soil quality and drinking water benchmarks developed by the EPA are provided in Table 2 (U.S. EPA, 2019a).

EPA does not provide benchmarks for PAHs that are generally applicable to soils where Creosote may occur. However, in 2019, EPA developed PAH soil cleanup levels for the Quendall Terminal's Superfund site proposed cleanup plan for Operable Unit 1 (U.S. EPA 2019b). The site was a former Creosote manufacturing facility in Washington state.

A human health risk-based concentration was developed for carcinogenic PAHs and ecological risk-based concentrations were developed for low-molecular weight and high-molecular weight PAHs. Table 2 lists the chemicals that are included in each total.

Table 1 - Natural Background Levels of Wood Preservative Components

Metals	**Mean for Earth's Crust** ***(mg per kg)*** [1]	**Range in Soil Concentration** ***(mg per kg)*** [2]	**Range in Water Concentration** ***(mg per l)*** [3]
Chromium	198	1 - 2,000	0.0001 - 0.006
Zinc	80	5 - 2,900	0.0002 - 0.1
Copper	97	<1 - 700	0.0002 - 0.03
Arsenic	1.4	<0.1 - 97	0.0002 - 0.23

Concentrations listed in milligrams of metal per kilogram of soil or milligrams of metal per liter of water (parts per million). The metals are listed by relative abundance in the earth's crust, with ranking shown in parentheses.

[1] *Hem (1992; p.5)* [2] *Shacklette and Boerngen (1984)* [3] *Bowen (1979)*

Table 2 - Soil and drinking water guidelines from EPA's Regional Screening Levels

Environment	Arsenic [1]	Chromium (III)	Zinc	Copper	Penta	Total PAHs
Residential soil *(mg/kg)*	0.68	120,000	23,000	3,100	1.0	CPAHs: 0.11 [2]
Commercial/industrial soil *(mg/kg)*	3.0	1,800,000	350,000	47,000	4.0	--
Drinking water *(µg/l)*	0.052	22,000	6,000	800	0.041	--
EPA MCL *(µg/l)*	10.0	100 [3]	5,000 [4]	1,300 [5]	1.0	--
EcoSSL *(mg/kg)* [6]	18.0	26	46	28	2.1	LPAHs: 65.0 [7] HPAHs: 3.7 [8]

As of Dec. 17, 2019. Concentrations listed in milligrams of metal per kilogram of soil (parts per million) or micrograms of metal per liter of water (parts per billion).

[1] *Soil screening levels are only available for trivalent arsenic; the appropriate point of comparison for total arsenic in soil is local background.*

[2] *CPAH: carcinogenic polynuclear aromatic hydrocarbons – calculated based on benzo(a)pyrene equivalents. HHRA RBC 10-6 = Human Health Risk Assessment Risk-Based Concentration based on cancer risk of 1 x 10-6.*

[3] *Value for total chromium.*

[4] *Secondary standard.*

[5] *Lead and copper are regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.*

[6] *Lowest EcoSSL is shown: protects birds, mammals, soil insects, and plants.*

[7] *LPAH: low-molecular weight polynuclear aromatic hydrocarbons (acenaphthylene, acenaphthene, anthracene, fluorene, naphthalene and phenanthrene). ERA RBC HQ = 1 = Ecological Risk Assessment Risk-Based Concentration, based on noncancer hazard quotient of 1.*

[8] *HPAH: high-molecular weight polynuclear aromatic hydrocarbons (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k] fluoranthene, benzo[g,h,i] perylene, chrysene, dibenz[a,h]anthracene, indeno[1,2,3-c,d]pyrene, fluoranthene, and pyrene). ERA RBC HQ = 1 = Ecological Risk Assessment Risk-Based Concentration, based on noncancer hazard quotient of 1.*

Preservative movement from wood poles

Small amounts of preservative will leach or migrate from utility poles. The exact amount of preservative that moves into the environment depends on how well the wood was treated, how old it is and the soils and environment around the pole.

Most of the metal losses from CCA, ACZA and/or ACQ occur during rain events. While each of these preservatives behaves somewhat differently, the environmental risks are similar. The following discussion focuses on CCA, the most well studied of the waterborne preservatives.

A typical CCA-treated utility pole will be 40 feet tall and will average 10 inches in diameter. For each hour the pole is completely wetted by rainfall, it will lose an average of 0.000141 grams of arsenic, 0.000077 grams of copper and 0.000020 grams of chromium (Lebow et al., 1999).

ACZA behaves very similarly to CCA in terms of metal losses (Brooks, 1997b). ACQ does not contain arsenic or chromium but loses more copper than the other preservatives (Brooks, 1998b).

To put these numbers into context, a CCA-treated utility pole that is continually wetted will lose an average of 1.44 grams of copper each year during its lifetime. A penny made before 1984 contains 2.5 grams of copper, so a CCA-treated pole contributes about a penny's worth of copper to the environment every two years. But this may overstate the typical amount released, since utility poles are not continually wetted or immersed in water.

Preservative losses from Penta and Creosote treated poles are more difficult to predict. Losses associated with rainfall are very low at 7.75 ng (nanograms) of preservative per utility pole per hour of rainfall for Penta.

Creosote-treated poles lose 0.06 grams of PAHs per hour of rainfall (Brooks, 1997a). However, because these preservatives remain in a more liquid state within the wood cells, movement of preservative down the pole can be anticipated as a result of gravity.

This will sometimes result in an accumulation and darkening of the soil around the pole base. The rate of these losses depends on the temperature. However, as will be seen, the preservative typically remains within a few inches of the pole.

Preservative concentrations around poles

Utility poles are generally located in upland areas. Numerous studies have described the preservative concentrations in soils around poles.

Subtle differences in distribution of preservative concentrations are associated with soil type (clay, silt, loam, sand, etc.), the pH of the rainfall and the amount of sun exposure, as well as other factors.

The following describes typically observed soil concentrations of metals from CCA-treated poles as representative of waterborne treatments, and from Penta-treated poles as representative of oil type treatments:

Waterborne treatments (CCA, ACQ and ACZA)

Zagury et al. (2003) described the distribution of chromium, copper and arsenic around CCA-treated utility poles in service for at least four years.

Figure 1 indicates that highest metal levels were observed immediately adjacent to the pole (0.0 inches). These levels declined sharply with increased distance from the poles – chromium fell below local background levels at 4 inches from the poles while copper and arsenic were near local background levels at about 10 inches from the poles.

In the chart, copper exceeds only its residential benchmark for soils collected immediately adjacent to the pole. The higher concentrations next to the pole provide an extra measure of protection.

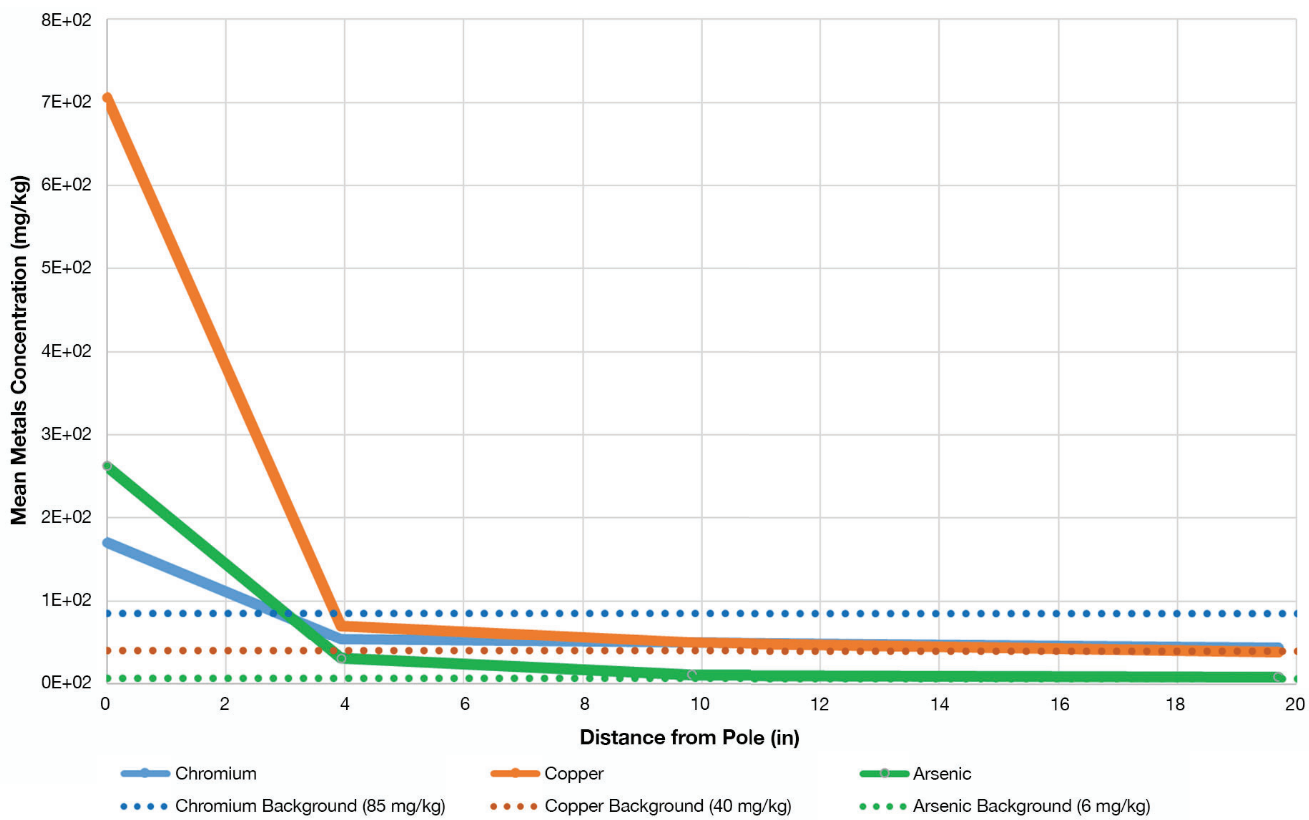
There is little likelihood that copper, chromium or arsenic will migrate through the soil into adjacent streams or downward into groundwater. This is supported by the findings of Cooper and Ung (1997), who observed that most of the metal was found in the upper 6 inches of the soil and at horizontal distances less than 9.75 inches from the perimeter of the pole.

If metals were not bound to the soil, they would have been found further away from the pole and at greater depths.

Oil treatments (Penta and Creosote)

The Electric Power Research Institute (EPRI, 1997) examined 180 Penta-treated utility poles to

Figure 1 - Concentrations in surface soils around CCA poles



Mean soil concentrations of chromium, copper and arsenic (mg/kg) in surface soils around Chromated Copper Arsenate (CCA) treated poles (Zagury et al., 2003).

Table 3 - Soil benchmarks for 2,3,7,8-TCDD TEQ (ng/kg) and Penta (mg/kg)

Chemical	Soil RSL - Residential [1]	Soil RSL - Commercial [1]	EcoSSL [2]	Background [3]	Notes
2,3,7,8-TCDD equivalent (TEQ) *(ng/kg)*	4.8	22	n/a	1.9 (rural) 12.2 (urban)	There is no EcoSSL for dioxins or TEQ
Pentachlorophenol *(mg/kg)*	1	4	2.1	n/a	Lowest EcoSSL is shown; protects birds, mammals, soil insects and plants

[1] As of May 21, 2019, EPA Regional Screening Updates. [2] U.S. EPA (2007) EcoSSL Document for Pentachlorophenol [3] Urban et. al. (2014)

determine the distribution of Penta in soils around the poles on the surface and at several depths.

The study reported that mean Penta concentrations decrease rapidly with distance from the pole, declining to the current residential screening level benchmark (1 part per million) within about 30 inches of the pole.

Preservative lost from Creosote-treated poles behaved very much like the Penta poles, with nearly all of the PAHs found at distances less than 8 inches from the perimeter of the poles. Creosote concentrations in soil did not decline as quickly with depth, as was observed for Penta. Both these organic based preservatives will biodegrade and, over time, will decompose to undetectable concentrations.

Recent data from studies by Bulle et al. (2010), the U.S. Fish and Wildlife Service (USFWS; Verbrugge et al., 2018) and the Alaska Department of Transportation (ADOT, 2018) confirm the EPRI (1997) results for Penta.

In addition, these three studies provide new information on the toxicity equivalent (TEQ) of dioxins and furans in soils near preserved wood utility poles:

- Bulle et al. (2010) collected clay, organic soil and sand field samples around six Penta-treated wooden poles in Canada (Montreal area) from depths of 0 to 40 inches and at distances of 0, 10 and 20 inches away from each pole.
- In 2015, the USFWS collected three surface soil samples at each of 12 utility poles adjacent to the Sterling Highway on the Kenai Peninsula in Alaska: one directly adjacent to the pole, one at 9.8 inches and one at 19.7 inches from the pole (Verbrugge et al., 2018).
- In 2018, ADOT collected soil samples up to 197 inches away from each of five utility poles adjacent to the Sterling Highway on the Kenai Peninsula from depths of 0–2 feet, 3.5–4.5 feet and 7.5–8.5 feet.

For context in interpreting the results of these studies, Table 3 shows soil benchmarks for Penta and TEQ. Regional screening levels (RSLs) for residential and commercial worker exposures are conservative values established by the EPA and applicable across the country.

The EPA also has published an ecological soil screening level (EcoSSL) for Penta. Table 3 cites the lowest EcoSSL, protective of birds; EcoSSLs for mammals, insects and plants are higher. There is no EcoSSL for dioxins, so Table 3 includes national background TEQ concentrations for urban and rural soils.

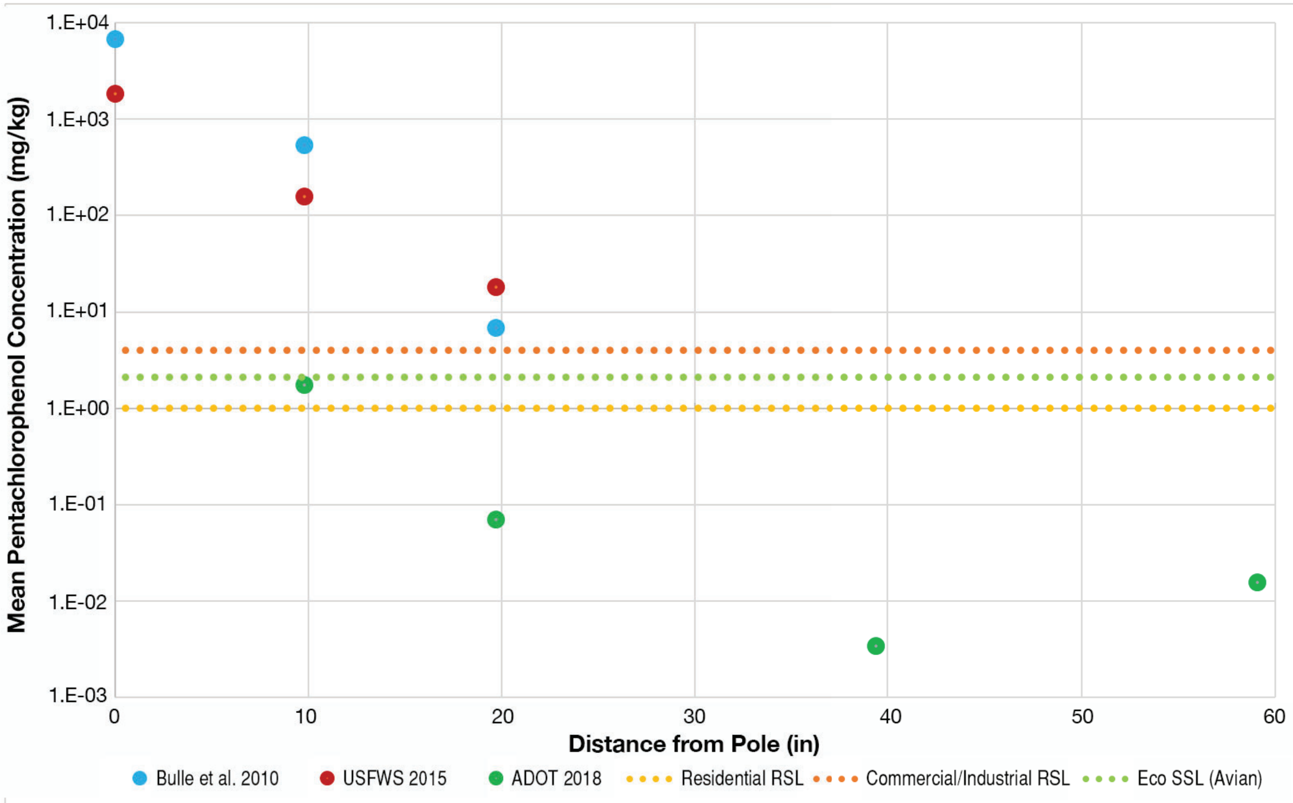
Like the EPRI (1997) study, the data from the 2010, 2015 and 2018 studies depict a general trend of average Penta concentrations in surface soils decreasing with distance from utility poles to levels below conservative benchmark and background concentrations, as shown on Figure 2 [(A)].

At approximately 40 inches away from the pole, Penta concentrations are below residential and commercial/industrial RSLs, and below the lowest EcoSSL that is protective of birds, mammals, plants, soil and insects.

At the same distance from the pole, average TEQ concentrations also drop below commercial/industrial RSLs and below the urban/suburban background concentrations. The average concentrations are near the residential RSL and are below all RSLs and rural background concentrations within 10 feet of the pole (Figure 3).

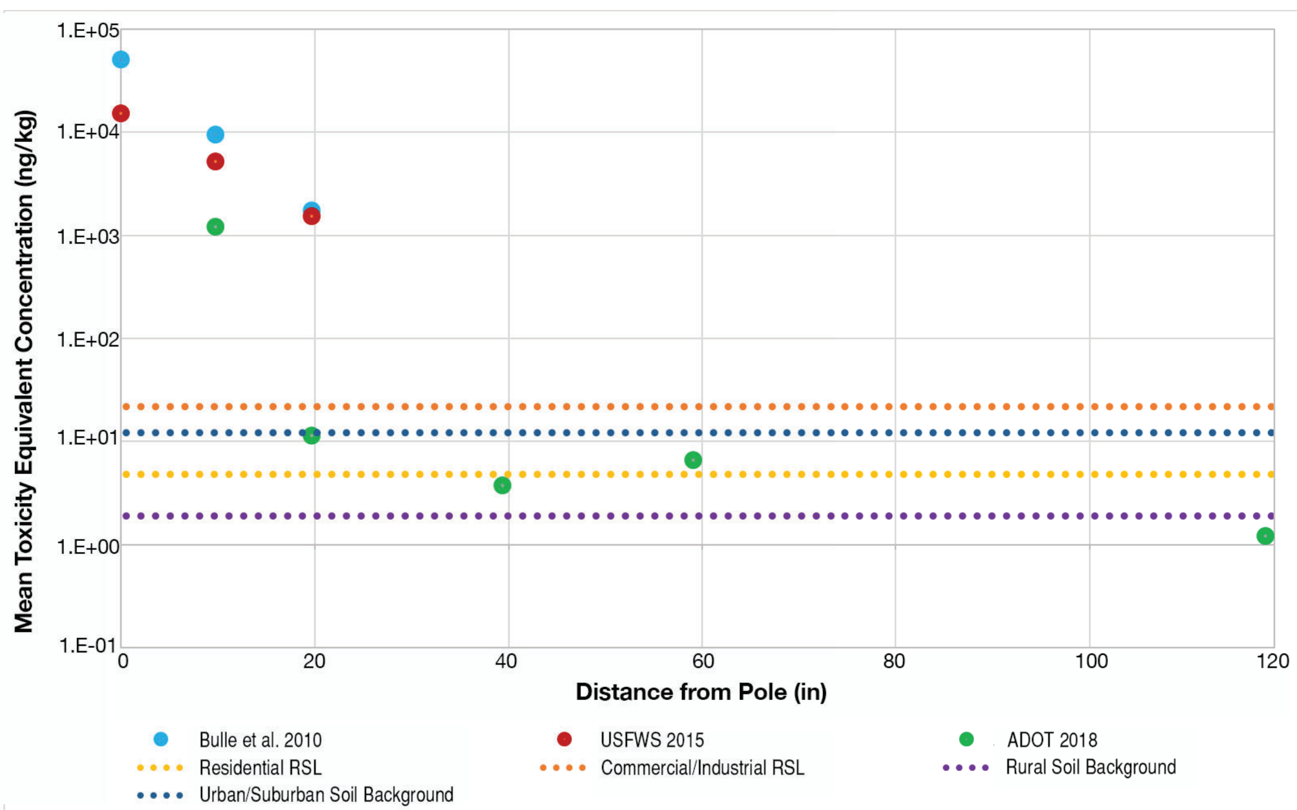
[(A)] Penta and TEQ soils data for one of the utility poles sampled by ADOT (2018) were confounded by the presence of treated wood supports on the ground that extended away from the pole, and were not used in this analysis.

Figure 2 - Penta concentrations in surface soils



Mean Penta concentrations in surface soils from three studies: Bulle et al. (2010), USFWS (2015), and ADOT (2018)

Figure 3 - Dioxin TEQ concentrations in surface soils



Mean Dioxin TEQ concentrations (ng/kg) in surface soils from three recent studies: Bulle et al. (2010), USFWS (2015), and ADOT (2018)

In deeper soils sampled by Bulle et al. (2010) and ADOT (2018), measurable Penta and TEQ concentrations were lower than in surface soils, except in soil very close to the pole. TEQ concentrations generally decreased with depth in these two studies.

Use of preserved wood poles in aquatic areas

Streams, rivers and wetlands are sensitive environments and have been the subject of extensive study in regard to appropriate use of preserved wood. State and federal sediment and water quality standards that protect these environments are actually lower (i.e., more restrictive) than the human exposure based standards in Table 2.

Extensive scientific studies have documented that when preserved wood structures (piles, poles, docks, boardwalks, bridges, etc.) are placed in water flowing at even very slow speeds, the small amount of preservative lost from preserved wood is diluted and/or degraded so quickly that it poses no threat to aquatic organisms.

Research also indicates that special care should be taken when significant numbers of poles are placed in sensitive wildlife habitats where the water is stagnant.

For additional information, consult the publication ***Specifiers Guide – Best Management Practices*** and the ***Online Environmental Assessment Model*** available at ***www.PreservedWood.org***.

Epilogue

There are environmental risks associated with everything we do and with all of the materials used to construct utility structures.

For instance, Morris (1998) documented the leaching of zinc from steel utility poles and found concentrations around two of five poles that exceeded the Canadian Council of Ministers of the Environment (CCME, 2019) benchmark of 250 mg zinc/kg soil for residential and agricultural use.

It is a basic truth that essentially every human activity — from the soil erosion associated with growing the wheat for a loaf of bread to producing the power that runs our appliances — has an environmental cost and risk associated with it.

Take automobile travel, for example. There is inherent risk in traveling by car, but we manage those risks with stop signs, speed limits, air bags and a host of rules that, when followed, can make any journey much safer. But there is nothing that can make that travel risk free.

As environmental management matures in North America, there is growing recognition that we are better served by seeking to manage environmental risks rather than rely on the polemics of risk aversion.

Appropriate rules are required to manage the environmental risks associated with our utility infrastructure. Years of research and experience have developed a strong scientific basis supporting a conclusion that when properly produced and used, preservative-treated utility poles pose minimal environmental risks.

Those risks can be managed with a host of proven tools and best practices that have been developed and are readily available to utilities and other users.

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