Pentachlorophenol Report

Response to PSB Docket #8310

December 23, 2015

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Acronyms

AAFM	Agency of Agriculture, Food & Markets (Vermont)
ACZA	Ammoniacal copper zinc arsenate
ANR	Agency of Natural Resources (Vermont)
ATSDR	Agency for Toxic Substances and Disease Registry (federal)
AWPA	American Wood Protection Association
BMP	Best Management Practices
BTEX	Benzene, toluene, ethylbenzene, xylenes
CCA	Chromated copper arsenate
CFR	Code of Federal Register
CIS	Consumer Information Sheet
CuNap	Copper napthenate
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
g/L	grams per liter
GHS	Global Harmonization System
GIDMO	Gravitational induced Downward Migration of Oil
HCB	hexachlorobenzene
HHE	Health hazard evaluation
IBEW	International Brotherhood of Electrical Workers
IRIS	Integrated Risk Information System
IROCPP	Investigation and Remediation of Contaminated Properties Procedure
L/kg	liters per kilogram
MCL	Maximum Contaminant Level
mg/kg/day	milligrams per kilogram per day
mmHg	millimeter of mercury
MSDS/SDS	Material Safet Data Sheet/Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
PAHs	Polycyclic aromatic hydrocarbons
PCP	abbreviation for pentachlorophenol
PD4	Position Document 4 for the Wood Preservative Pesticides: Creosote, Pentachlorophenol and Inorganic Arsenicals
Penta	abbreviation for pentachlorophenol
POET	Point of entry treatment
POP	Persistent Organic Pollutant
ppb	parts per billion (also micrograms per liter or micrograms per kilogram)
ppm	parts per million (also milligrams per liter or milligrams per kilogram)
PSB	Public Service Board (Vermont)
PSD	Public Service Department (Vermont)
RED	Reregistration Eligibility Document
SIM	Selected Ion Monitoring
SMAC	Site Management Activity Complete
SMS	Sites Management Section (within the Vermont Department of Environmental Conservation)

SOM	Superfund Organics Method
TCLP	Toxicity characteristic leaching procedure
UCS	Use Category System
US EPA	United State Environmental Protection Agency
USDA	United States Department of Agriculture
V.S.A.	Vermont Statutes Annotated
VDH	Vermont Department of Health
VGES	Vermont Groundwater Enforcement Standards
VT DEC	Vermont Department of Environmental Conservation

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Executive Summary

Pentachlorophenol is defined by the US EPA as a heavy duty wood preservative. It is used primarily to treat wooden utility structures including poles, crossarms and log anchors. The migration of pentachlorophenol beyond the immediate vicinity of treated utility poles has been documented nationally. It is typical to observe and measure pentachlorophenol in soil immediately adjacent to utility poles. In Vermont, there have been three documented instances of shallow drinking water contamination identified in the last six years. Also elevated levels of pentachlorophenol have been detected in soil near utility pole storage yards and utility lines; however, these releases did not result in contamination to drinking water. There have been no documented cases of bedrock aquifer contamination by pentachlorophenol in Vermont. With hundreds of thousands of utility poles in use and stored in the state, these few documented cases of contaminated drinking water suggest that these are rare events, although all environmental releases in the state may not have been identified and documented. As pentachlorophenol is toxic to human health and the environment, statewide efforts should be made to ensure that these events are avoided to the extent possible and that they are properly addressed when or if they do occur.

The documented environmental releases of pentachlorophenol prompted the opening of Public Service Board (PSB) docket #8310, at the request of state agencies, which authorized the establishment of a workgroup to undertake a general review into the practice of Vermont utilities using poles treated with pentachlorophenol. The workgroup consisted of 12 member organizations– Agency of Agriculture Food and Markets (AAFM), Agency of Natural Resources (ANR), Vermont Department of Health (VDH) and Public Service Department (PSD), four representatives from utility companies, and four other stakeholders. The workgroup reviewed the current practices involving the use of pentachlorophenol treated utility poles and evaluated the literature regarding the practice. This information was used to develop Best Management Practices (BMPs) for the Board's consideration. The workgroup did not conduct primary research, but rather relied on available studies and experience of workgroup members.

The workgroup held 8 meetings over the course of 8 months.

To develop the BMPs, the workgroup considered many aspects of utility pole life cycle in both transmission and distribution systems. Aspects evaluated were procurement, storage, siting, installation, decommissioning/removal, reuse of wood poles and the feasibility of alternative pole materials. The topic of undergrounding *vs*. overhead power lines was determined to be beyond the scope of this workgroup.

The workgroup also summarized background information on pentachlorophenol (registration history, use, potential health effects, environmental fate and transport) and identified current risks and benefits associated with pentachlorophenol-treated utility poles, available alternatives and revised the state public outreach materials.

Discussions regarding quality of pole treatment, pole siting and subsequent pole decommissioning and removal in or near sensitive environments were identified as areas of highest concern for the workgroup and the BMPs address these situations. Additionally, the state entities agreed on the appropriate response agency and general protocols to be used to assess and remediate environmental releases. Fact sheets for public information on response to suspected contamination and appropriate reuse for decommissioned poles are included.

This report represents the workgroup members' perspectives and opinions, as well as the group's conclusions, recommendations and the proposed BMPs. Workgroup members used recognized authoritative sources related to their individual fields of expertise, as such this report is not intended as a literature review, but rather represents the concerns, opinions, and perspectives of the workgroup members.

Statement of Purpose

In response to three known incidences of pentachlorophenol, which is also referred to as Penta or PCP, released from utility poles resulting in drinking water contamination in the past six years, and at state agencies' request, the Vermont Public Service Board (PSB) opened docket #8310. This docket authorized a stakeholder group to review current use practices associated with utility poles treated with pentachlorophenol. This review has resulted in conclusions and recommendations from the workgroup as well as the development of a set of Best Management Practices (BMPs) for Vermont utilities to proactively prevent environmental releases.

Below are the conclusions and recommendations of the workgroup, as a well as a review of many of the issues, concerns and science related to the use of pentachlorophenol. This investigation included background information on wood treatment, pentachlorophenol (registration history, use, potential health effects, and environmental fate and transport), an evaluation of other available non-pentachlorophenol options, the state policy for the reuse of pentachlorophenol-treated poles and the state agency framework for response to environmental releases of pentachlorophenol.

The proposed BMPs are presented in Appendix 1 as well as in a descriptive table at the end of this document.

Vermont Background

Since 2007, the Vermont Agency of Natural Resources (ANR) has managed the investigation and remediation of seven separate environmental releases of pentachlorophenol. In three of these instances, pentachlorophenol migrated from a treated utility pole and contaminated nearby shallow drinking water sources. In the four remaining cases, pentachlorophenol migrated through soil from pole storage yards and utility poles, but did not result in drinking water contamination. With consideration for the hundreds of thousands of pentachlorophenol-treated utility poles in use and stored throughout the state, the limited number of documented cases of contaminated drinking water and environmental releases suggest that these are rare events. It is appropriate to note that the extent of environmental releases is not fully characterized in Vermont.

Although pentachlorophenol is a cost-effective and reliable treatment option for utility poles in Vermont, its use presents potential risk to human health and the environment. The recent Vermont environmental releases demonstrate the need for heightened awareness of the risks and BMPs for the use of pentachlorophenol-treated utility poles. These environmental releases of pentachlorophenol have also provided valuable lessons to Vermont state agencies to better manage and mitigate contaminated areas.

In response to pentachlorophenol releases many Vermont utilities, including all the utilities represented in this workgroup, have implemented practices designed to better protect water sources and minimize environmental contamination from pentachlorophenol-treated poles.

Conclusions of the Workgroup

The rural nature of most Vermont service territories, along with economic, environmental, and safety considerations, suggest that wood will remain the dominant pole material for the foreseeable future. The service life and reliability of wood poles is greatly extended by wood preservation that is done in accordance with industry standards. When considering the options for wood preservation, Vermont utilities evaluate the reliability of the preservative, utility worker safety, public safety, system reliability and the human health and environmental impacts. According to the Vermont utilities, pentachlorophenol remains the best overall option for most utilities; however, they continue to assess responsible and cost-effective alternatives as they are developed and approved for use by regulatory agencies.

Exposure to pentachlorophenol and its contaminants has the potential to result in adverse human health effects, both cancer and non-cancer. The contaminants in pentachlorophenol may also cause adverse human health effects and persist and bioaccumulate in the environment.

The pentachlorophenol that is likely to be released into the environment from properly treated poles will likely be retarded by soil and naturally degrade without significant migration of the pentachlorophenol away from the immediate vicinity of the pole. However, if the soil conditions surrounding the pole are not conducive to natural degradation or adsorption, or if the pole is improperly treated and releases excessive amounts of pentachlorophenol, there is an increased risk to public health and the environment.

As pentachlorophenol is relatively immobile in the environment, migration of pentachlorophenol beyond the immediate area of a pole is unlikely when properly treated poles are installed. However, pentachlorophenol adsorbed to soil or organic particles can migrate with the soil if it is disturbed and mobilized (*e.g.,* excavation, pole removal, erosion). Pentachlorophenol dissolved in carrier oil from improperly treated poles can migrate with the oil as it will preferentially dissolve in the oil and not readily interact with and be retarded by organic matter in the soil.

In Vermont, and in other New England states, shallow groundwater wells serve as a domestic water supply for many homes and businesses, so proactively protecting those wells from contamination by pentachlorophenol and contaminants is necessary.

When state agencies and utilities assess environmental releases of pentachlorophenol solutions from utility poles, there are many factors to consider in determining when a release is ‘excessive’: topography, site conditions, soil type, proximity to sensitive areas, and total quantity of contamination. In some instances, this will be a difficult determination and professional judgment will be used. The ANR prefers that potential releases be reported to them, rather than waiting for confirmation by the utility or other sources.

The potential for leaching of pentachlorophenol-treated poles to soil and groundwater which results in adverse human health and environmental impacts exists in Vermont. Management practices that ensure high quality poles, appropriate siting, and proper decommissioning of poles will further decrease the potential for adverse effects. The members of the working group agree that proactive steps, such as instituting the BMPs and the proper reuse of treated poles minimizes environmental contamination and limits potential adverse effects.

These proposed BMPs should be implemented by Vermont utilities when using (procurement, storing, siting, decommissioning) pentachlorophenol-treated poles. When there are utility-specific and time-sensitive (emergency) situations which prevent these BMPs from being implemented, deviation from the BMPs should be noted and explained. Utilities may also have more restrictive BMPs than those presented here.

As the AAFM lacks regulatory authority over pentachlorophenol-treated poles, it will continue to assist the ANR to manage environmental contamination events under ANR's state statutory authority.

Responsible and appropriate reuse of pentachlorophenol-treated poles will help to protect human and animal health, as well as help to protect the environment. Responsible and appropriate reuse of pentachlorophenol-treated poles will also reduce the amount of waste in Vermont landfills.

Recommendations from the Workgroup

To help to protect human health and the environment, Vermont utilities, and their contracted entities, should implement the BMPs developed by this group to minimize environmental releases of pentachlorophenol. These proposed BMPs are not intended to replace any more stringent utility requirements.

Vermont utilities should continually evaluate other cost-effective and reliable utility pole materials and treatments that are less toxic to human health and the environment, while maintaining the safety of utility workers and the public. As wood provides a cost-effective and reliable source of pole material its continued use in Vermont is supported, with considerations of the results of these on-going evaluations.

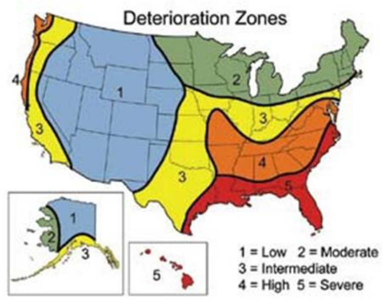
As additional scientific data becomes available from the US EPA's pesticide reevaluation process, Vermont should monitor and evaluate and the use and reuse of pentachlorophenol-treated wood in the state.

As there is limited Vermont-specific data available, utilities in Vermont could collaborate with state partners at ANR, AAFM, and VDH to design and implement a study to evaluate presence, fate, transport of pentachlorophenol related to utility poles. This study could in part take a closer look at what impact, if any, existing poles may have on shallow drinking water supplies located in close proximity to pentachlorophenol treated utility poles.

Wood Utility Poles

Wood poles are a sustainable source of material for utility support structures. They are the best option in areas inaccessible to line trucks as they can be easily climbed and are generally considered to be the most aesthetically-acceptable overhead systems. Wood poles, however, are subject to deterioration. Conditions that promote the growth of decay fungi, wood destroying insects and bacteria result in an increased likelihood of the deterioration of the wood pole. Deterioration of the pole presents both reliability issues (replacement) and safety (breakage) issues. Nationally, geographical zones have been delineated, showing estimated deterioration pressures based on environmental conditions (*e.g.*, temperature, soil moisture, pest pressure). (Figure 1). The zones indicate what level of wood treatment is needed to resist premature deterioration. Vermont is located in Deterioration Zone 2 (moderate). As such, wood poles used in Vermont must be able to resist the environmental stresses associated with Zone 2, if they are to be considered reliable.

Figure 1.



Wood Preservation

To delay and prevent deterioration by wood-decaying organisms, wood utility poles are treated with a chemical preservative. The US Environmental Protection Agency (US EPA) estimates the life span of treated wood is five or more times that of untreated wood. When properly treated with wood preservatives, utility poles can have useful service lives of 60 years or more. Treating utility poles prolongs the service life of the pole and increases worker and public safety by maintaining the structural integrity of the pole; however, the chemical preservative may result in environmental impacts.

The level of protection achieved by the treatment is related to the chemical preservative used, the penetration, the retention and the uniformity of the preservative in the wood, as well as the environment in which the pole is sited. The penetration and the retention of the chemical preservative in the wood pole are affected by many factors: preservative type (and carrier), species of wood, pre-conditioning of wood, and the application treatment method. Industry standards that account for these wood treatment factors are promulgated by the American Wood Protection Association (AWPA). The AWPA has created the Use Category System (UCS) to guide user specifications for treated wood commodities, specifying the preservative systems (treatment methods and compounds) and effective preservative retention rates for protecting wood products under specific use and exposure conditions. The major use categories are divided into sub-categories that address the degree of deterioration hazard and service life expectations for treated wood products. Generally, the more environmental stressors, the more critical the structural need for the wood, and the more difficult to replace, the higher the requirement for retention of the chemical preservative in the wood.

Treated wood poles that are used by Vermont utilities meet or exceed the AWPA category for service conditions that are in contact with the ground or fresh water under normal to extreme decay conditions. The majority of poles used in distribution systems in Vermont are Southern Pine species, whereas Douglas Fir species are preferred for transmission structures. These species have favorable form, length and strength properties: they also have properties that make them favorable to retain chemical preservatives which increase the pole service life.

Utility Worker Safety Communication

In 1986 US EPA concluded an eight-year study of the major wood preservatives under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). It evaluated the risks and benefits from the use of the wood preservatives, and cancelled the registration of wood preservatives that did not exhibit a positive risk/benefit relationship. In order to minimize exposure to the end users of treated wood, the industry agreed to undertake a Consumer Awareness Program to disseminate information concerning the proper use and handling of treated wood. One method of providing this information was through a Consumer Information Sheet (CIS). In addition to the CIS, since August of 1994 the manufacturers of treated wood have been distributing material safety data sheets (MSDS) for treated wood.

The OSHA Hazard Communication Standard requires annual worker refresher training of work place chemical hazards and safe work practices. The annual review includes the information provided on the MSDS (now called SDS under the Global Harmonization System [GHS]). The mandatory format of today's GHS Safety Data Sheets includes human protection measures and controls such as personal protective equipment. Utility safety manuals require personnel to wear the recommended personal protective equipment.

Wood Preservation Options

Utilities consider many factors when choosing a wood preservative for a utility pole: effectiveness to preserve wood (expected lifespan in environment), exposure of workers to the preservative (installation, line work), impact on line workers' safety (ability to climb, structural integrity), environmental impacts, use type (transmission/distribution), site, cost, and aesthetics.

There are limited heavy duty wood preservative options available for treating wood utility poles. Current options are creosote, pentachlorophenol, chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), and copper naphthenate (CuNap).

Creosote

Creosote is a derivative of coal tar and is used primarily to treat railroad ties. Vermont utilities have not typically used creosote-treated wood poles, and completely discontinued its use in 2003. There are still a few that remain in service in the state. Creosote is an effective wood preservative and relatively immobile in the environment. However, it does pose human health and environmental risks as well as safety risks for utility workers. Creosote is a very sticky substance that may leak from poles, particularly in warm weather, making poles slippery to climb and is difficult to keep off utility worker clothing and personal protective equipment during maintenance activities. Its use has been discontinued in Vermont to protect utility field personnel.

Chromated copper arsenate (CCA)

CCA is a water-borne preservative. It has been used as a wood preservative since the early 1940's when Bell Telephone installed about 20,000 CCA-treated utility poles on the East Coast. CCA was also extensively used for lumber in outdoor residential and playground settings. Up until 2004, most pressure-treated lumber available for retail sale was treated with CCA. At that time, concerns over human health impacts, particularly exposures to children, led to its voluntary withdrawal from the marketplace except for industrial uses. CCA is still widely used to treat wood utility poles in the United States, but these poles are not used by Vermont utilities. CCA, like other water-borne preservatives, makes the surface of the poles harder, and requires more effort when climbed. Treatment additives have been developed to "soften" CCA poles, but the effectiveness of this treatment in Vermont is undetermined. Vermont utilities have avoided the use of CCA-treated poles at the request of line workers.

Ammoniacal copper zinc arsenate/Copper naphthenate (ACZA/CuNap)

ACZA and CuNap are copper-based preservatives, used on a very small portion of utility poles nationwide. ACZA, like CCA, is a water-borne preservative. It is not considered a viable alternative in Vermont, where maintenance and restoration activities require frequent pole climbing. CuNap is an oil-borne product, and produces a pole with physical characteristics essentially identical to those of a pentachlorophenol-treated pole. CuNap has a lower human toxicity than pentachlorophenol and has been an effective wood preservative for over 100 years. Its use in utility poles is much more recent and its effectiveness has had mixed results. In the 1990s a significant number of CuNap-treated poles experienced premature failure. Many poles deteriorated and broke well above the ground line, some only 2 years post-installation. After these failures, most utilities discontinued or avoided using CuNap-treated poles. Subsequent investigations into the failures suggested that the premature failure was caused by high water content in the wood from improper drying and/or the use of non-standard naphthenic acids at particular treatment facilities. More recent applications, and more comprehensive surveys of the pole failures, have shown CuNap-treated poles to have failure rates similar to other chemical treatments. Drawbacks of this treatment include higher toxicity for aquatic organisms and limited availability. Some Vermont utilities stock small numbers of CuNap-treated poles, specifically for use in close proximity to shallow drinking water sources. Cooperative utilities do not generally use CuNap poles.

Pentachlorophenol

Pentachlorophenol has been used as a wood preservative for nearly 80 years, and as of 2008 was estimated to be used on 36 million poles in the United States. In the United States it is used almost exclusively to treat utility poles and crossarms. Pentachlorophenol, as an oil-borne wood preservative, does not cause poles to harden or become brittle, as some of the other chemical options do, thereby extending the service life of the pole as well as improving the climbing surface for line workers. The surface of pentachlorophenol-treated poles is drier than creosote-treated surfaces, and does not easily contaminate clothing or contact the skin. Unlike creosote, pentachlorophenol is not sticky and can be easily rinsed from skin. However, if pentachlorophenol comes in contact with skin, it is quickly absorbed. Chronic exposure to low levels of pentachlorophenol and some of its by-products can cause health problems. In the environment, properly treated pentachlorophenol poles are expected to have minimal migration from the pole to the environment directly surrounding the pole. Pentachlorophenol-treated poles have demonstrated extended lifespans in Vermont's weather conditions.

Alternative Material Options

Steel, fiberglass, and concrete poles are all available for purchase. All are substantially more expensive than wood poles. For example, a typical wood distribution pole used in Vermont costs roughly $350; an equivalent steel pole costs approximately $1,100; an equivalent fiberglass structure costs over $1,000. The most common alternative material is steel, which has been used for high-voltage transmission structures in select locations in Vermont. Steel poles have a long service life (up to 80 years in some applications) and can be recycled; however, a properly treated wood pole has a comparable service life with a lower initial cost, and can often have a secondary use (reuse) in exterior structural settings. Steel poles cannot be climbed, making them inappropriate for use, especially on distribution lines, in locations that cannot be directly accessed from a line truck. Climbing steps can be added, but they further increase cost and logistical challenges.

PSB Docket 6763

In a previous PSB Docket (#6763) October 2002, safety concerns related to creosote treated poles were identified. This PSB docket followed a National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation [NIOSH HHE-HETA 2001-0307]. The NIOSH report found "the transition to (new) creosote poles reintroduced an occupational hazard that was a major factor in the switch to pentachlorophenol treated poles." Creosote is the preferred pole treatment for marine environments; however, the NIOSH report found the creosote poles arriving in Vermont introduced new hazards "including degradation of natural rubber insulating gloves, electrical shock due to tracking through wet creosote, and ignition of creosote during work on creosote wet poles."

The NIOSH HHE was posted for a mandatory 30-day period in all Vermont utility work places. The International Brotherhood of Electrical Workers (IBEW) Local 300, representing Union workers in both Vermont electric and communication line worker communities, participated in the deliberations of Docket 6763. A final stipulation was introduced July 22, 2003, and following a one year wait period was closed July 13, 2004. The installation of new creosote treated poles in Vermont was discontinued.

When all of these considerations have been evaluated, most Vermont utilities have concluded that the use of pentachlorophenol-treated wood poles is the best overall option available. Based on demonstrated reliability, cost, environmental impacts, and utility worker and public safety, pentachlorophenol-treated wood poles are and historically have been the most widely used utility poles in Vermont.

Pentachlorophenol Registration History & Treated Article Exemption

In 1970, the US EPA was created and authorized to regulate pesticide registration, use and labeling. The current federal law which regulates the registration, use and labeling of pesticides is FIFRA. Section 3 of FIFRA requires that pesticides be registered by US EPA before they are eligible for initial distribution, sale or use. The pesticide registration process evaluates human and environmental health risks of pesticides. Section 4 of FIFRA requires the periodic review and re-registration of pesticide products to ensure they continue to not present "*unreasonable adverse effects to human health or the environment.*"

FIFRA is unique among federal laws as it designates the primary responsibility for enforcement of pesticide use violations to the states. Section 26 of FIFRA describes this division of responsibilities for various aspects of the law between US EPA and the designated State Lead Agencies for pesticide regulation. In Vermont, the Agency of Agriculture Food, and Markets is the state lead agency for pesticide use, regulation and enforcement.

Registration of Pentachlorophenol

Pentachlorophenol is a chlorinated phenol that has been used as a general biocide (*e.g.*, fungicide, herbicide, insecticide, molluscide) by many industries since the early 1900s. Pentachlorophenol was first registered in 1950 by the USDA. The pentachlorophenol registration was transferred to US EPA in 1970, upon creation of that agency. In 1984, and again in 2008, pentachlorophenol was reviewed for re-registration under Section 4 of FIFRA. Based on the 1984 review of health risks associated with pentachlorophenol, all non-wood uses were discontinued in the mid-1980s.

The *2008 Reregistration Eligibility Decision for Pentachlorophenol* (2008 RED) identified six pentachlorophenol products eligible for reregistration, provided that risk mitigation measures associated with the *use* of pentachlorophenol were adopted by the registrant(s) and the products labeled accordingly. The 2008 RED defined the *use* of pentachlorophenol as occurring only at the wood treatment facility. Therefore, the risk mitigation measures targeted reducing inhalation and dermal exposure to the workers at the wood treatment facility. The only non-occupational risk and mitigation measure addressed by the 2008 RED is for aquatic organisms where treated wood comes in direct contact with water.

Based on the 2008 RED, the use of pentachlorophenol is currently limited to a heavy duty wood preservative for application in commercial facilities capable of pressure treating the wood and mostly for exterior use. There are a few exceptions for interior use as structural support posts and poles which are in contact with soil and are subject to insect decay and infestations (*e.g.,* barns, stables). When used in the interior, treated wood must be sealed in accordance with label specifications.

Currently, pentachlorophenol is registered by the US EPA as a restricted use pesticide. Restricted use pesticides can only be applied by certified applicators. However, wood treated with pentachlorophenol is available for purchase and use by the public. Formulated products that are used to treat wood utility poles contain about 5-9% of technical-grade pentachlorophenol. Technical-grade pentachlorophenol (approximately 86% pure) is diluted in a petroleum-based carrier: fuel oils (P-9, #2), kerosene or mineral spirits for application to wood products.

In the United States, pentachlorophenol is currently undergoing another re-registration review by the US EPA. Pentachlorophenol is also the subject of international review. In 2015 parties of the Stockholm-Basel-Rotterdam Convention on Persistent Organic Pollutants voted to adopt recommendations to ban pentachlorophenol (and its salts) within 5 years from the date of enactment. This decision was made based on health and environmental reasons and adds these chemicals to the list of persistent organic pollutants (POPs) in Annex A of the Stockholm Convention. This adopted recommendation, specifically exempted (*i.e.,* continues to allow) the use of pentachlorophenol on utility poles and crossarms but banned reuse for any non-exempt use. This decision has no impact on regulated use in the United States, as it is not a ratifier.

The Treated Article exemption

Section 25 of FIFRA provides US EPA authority to exempt by regulation any pesticide determined to be: 1) Adequately regulated by another federal agency; or 2) Of a character which is unnecessary to be subject to the requirements of FIFRA. 40 CFR Part 152.25 defines the exemption for classes of pesticides the US EPA determines to be of a character not requiring regulation by FIFRA. Among this list are treated articles.

Treated Articles are defined as *"an article or substance treated with, or containing, a pesticide to protect the article or substance itself (for example, paint treated with a pesticide to protect the paint coating, or wood products treated to protect the wood against insect or fungus infestations), if the pesticide is registered for such use."*

Utility poles are treated with pentachlorophenol to protect them against pests that cause the wood to decay and are treated articles, exempt from FIFRA regulation. As treated articles, the Agency of Agriculture, Food and Markets does not have regulatory authority over pentachlorophenol-treated utility poles. So although the utility poles contain pesticidal material, they are not considered pesticides. Therefore, the installation/placement, distribution and storage of treated poles do not constitute the *use* of a pesticide as defined by FIFRA or Vermont State Law.

As described in the registration section above, the regulated *use* of pentachlorophenol occurs only at the facility where utility poles and other wood products (lumber) are treated.

Pentachlorophenol Wood Treatment Process

Heavy duty wood preservatives, such as pentachlorophenol, are applied to wood in specialized high pressure treatment cylinders at wood treatment facilities. There are no pentachlorophenol-treatment facilities in Vermont. An overview of pentachlorophenol-treatment process is presented in Figure 2. To ensure good and uniform penetration of the pentachlorophenol, de-barking and drying of the wood is important. Moisture in the wood limits the penetration of pentachlorophenol into the sapwood. With oil-borne preservatives such as pentachlorophenol, bleeding and oozing of the pentachlorophenol after application can occur. To reduce this, poles are vacuum-treated. Vacuum-treating the pole extracts excess treatment solution that has not been fixed in the wood. Performing a double vacuum treatment, or doubling the length of the vacuum treatment, is a standard practice for pentachlorophenol-treated wood intended for use in sensitive environments, such as open water locations. These vacuuming procedures reduce the chance that the pentachlorophenol and carrier solution will migrate into the environment.

Figure 2.

Overview of Wood Pole Treatment with Pentachlorophenol

Step 1 – Untreated, debarked wood poles are conditioned to remove water from the interior of the wood pole. Depending on the wood species, conditioning may be accomplished by one of several procedures: (1) kiln-drying, (2) air-drying, (3) steam conditioning, or (4) boiling under vacuum.

Step 2 – If conditioning is done outside the cylinder, the poles are then placed on small rail cars and rolled into a steel pressure cylinder.

Step 3 – The cylinder is filled to capacity with 5-9% pentachlorophenol-oil solution.

Step 4 – The cylinder is then placed under pressure to inject the pentachlorophenol-oil solution into the cells of the wood pole. After a specified time, the pressure is released.

Step 5 – The cylinder is then placed under a vacuum to remove any excess solution from the poles. After a specified time, the vacuum is removed, the cylinder is opened and the poles are rolled out of the cylinder onto a drip pad.

Step 6 – The poles remain on the drip pad until surface-dry, then removed to a storage yard awaiting shipment to customer. For Vermont, treaters meet American Wood Protection Association (AWPA) retention standard for poles in Deterioration Zone 2.

Photo from US EPA 2008 RED

Contaminants of Technical Grade Pentachlorophenol

During the manufacture of technical grade pentachlorophenol, several microcontaminants are formed including hexachlorobenzene (HCB), chlorinated dibenzodioxins and chlorinated dibenzofurans (commonly called dioxins and furans, respectively). These contaminants are toxic and environmentally persistent. In the 1980s, when the US EPA initially discontinued non-wood preservative uses of pentachlorophenol, the permissible amounts of contaminants in the technical grade product were also established: hexachlorodibenzodioxin to 2 parts per million (ppm), hexachlorobenzene to 75 parts per million (ppm), and 2,3,7,8-tetrachlorodibenzodioxin to below the analytical method detection limit of 1.0 parts per billion (ppb).

In 1989, the National Toxicology Program (NTP) analyzed technical pentachlorophenol from three manufacturers and found that the technical grade pentachlorophenol was of approximately 90.4% purity, with the impurities being a mixture of ethers, furans, chlorophenols, and 0.1% dioxins, primarily octachlorodibenzo-p-dioxin. In 1989, the amount of hexachlorodibenzodioxin in the composite of the technical grade mixtures was 10 times greater than the levels allowed.

In December 2014 the US EPA published the pentachlorophenol Preliminary Work Plan, and reported the levels detected in monthly samples from 2013 contained 0.55 parts per million (ppm) of hexachlorodibenzodioxin, 19.3 parts per million (ppm) of hexachlorobenzene, and non-detected results for 2,3,7,8-tetrachlorodibenzodioxin (at less than 1 parts per billion (ppb)). These results were an order of magnitude lower than levels previously reported, showing the decline in contaminant level over the past 20 years. Due to the presence of contaminants in pentachlorophenol, it is prudent to consider them in the assessment and mitigation process in the event of an environmental release of pentachlorophenol.

Health Risks of Pentachlorophenol

Cancer

Using a weight-of-evidence characterization, the US EPA determined pentachlorophenol is “likely to be carcinogenic to humans.” The cancer weight of evidence determination is based on evidence from studies in mice showing increases in various types of cancers in treated animals, and strong evidence from human epidemiological studies showing increased risks of non-Hodgkin’s lymphoma and multiple myeloma, some evidence of soft tissue sarcoma, and limited evidence of liver cancer associated with pentachlorophenol exposure. According to the US EPA’s 2010 updated Integrated Risk Information System (IRIS) assessment, an additional cancer risk of 1 in 1,000,000 would be seen at a level of .09 parts per billion pentachlorophenol in drinking water, which is based on a lifetime exposure scenario of a 70 kilogram person ingesting 2 liters of water per day.

In 2014, the National Toxicology Program, within the Department of Health and Human Services, issued the thirteenth edition of the Report on Carcinogens. The Report classified pentachlorophenol and its contaminants as “reasonably anticipated to be a human carcinogen.” This determination is based on limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. The determination is supported by mechanistic studies that support the biological plausibility of carcinogenicity in humans.

Non-cancer

For non-cancer effects, the US EPA determined the primary target for chronic pentachlorophenol exposure is the liver. Liver toxicity after chronic exposure to pentachlorophenol is observed in rats, mice and dogs, and is manifested as lesions and increased liver weight. A reproductive study showed that technical grade pentachlorophenol is associated with decreased fertility, delayed puberty, testicular effects, decreased litter size, decreased viability, and decreased pup weight.

Health risk assessments: occupational exposure

As summarized in the 2008 RED, the US EPA determined that the primary health risk was to workers treating the lumber with pentachlorophenol. The US EPA determined that there was potential cancer and non-cancer risk from dermal exposure to workers, as well as environmental risk from exposure to dioxin and furan contaminants. The US EPA stated that additional protective measures to reduce worker exposure to pentachlorophenol and its contaminants were required for pentachlorophenol pesticides to meet the “no unreasonable adverse effects” criteria of FIFRA.

Health risk assessments: residential exposure

In the 2008 RED for pentachlorophenol, the US EPA indicated that residential exposure was not a concern, and that occupational exposure presented the greatest risk. The RED presented a risk management decision that considered the results of both human health and ecological risk assessments conducted as specified by the Office of Pesticide Programs.

Information considered in the development of the decision to authorize pentachlorophenol for continued registration included an evaluation of the toxicity of pentachlorophenol and modeled estimates of the level of pentachlorophenol that could be present in groundwater and surface water based on certain use patterns under certain assumptions. Modeled estimates of pentachlorophenol concentrations in water were combined with estimates of toxicity and potential human exposure, again based on certain assumptions, in order to estimate the level of risk that may be associated with exposure. The modeling efforts conducted by US EPA estimated that there would be limited amounts of pentachlorophenol in water due to the use patterns considered and that human exposure, and thus risk, via ingestion of drinking water would be limited.

The US EPA's generic modeling assumptions did not adequately represent the acute exposure scenarios that were documented in Vermont. Also the health risk from the US EPA's 2008 RED relied on a cancer slope factor of 0.07 mg/kg/day, a factor that was subsequently updated in the 2010 IRIS document to 0.4 mg/kg/day. Thus, not only the exposure, but the risk was underestimated in the 2008 RED modeling. This is of concern because many Vermont homes and businesses have shallow drinking water sources as the domestic water supply.

Health advisory levels of pentachlorophenol in drinking water

The US EPA has set the federal maximum contaminant level (MCL) for pentachlorophenol in drinking water at 1 part per billion. The US EPA considers cost when setting the regulatory MCL. The MCL Goal, also established by the US EPA, is 0 parts per billion. The MCL goal is set based on the best science to prevent potential health problems. The Vermont Department of Health has established a Vermont Action Level in drinking water for pentachlorophenol at 0.1 parts per billion.

Given that the odor threshold of pentachlorophenol is 857 parts per billion, in warm water, pentachlorophenol may be present in drinking water above both the Vermont Action Level and the MCL, without any detectable odor. The odor thresholds of the petroleum carriers are similar to pentachlorophenol: fuel oil #2 0.7 parts per million, and light petroleum derivatives at about 1 part per million. In the Vermont cases, the oil-based carrier in the contaminated drinking water sources exhibited a very strong odor when pentachlorophenol levels were less than 10 parts per billion.

Health effects due to contaminants

Pentachlorophenol contains various amounts of contaminants described above that may be of concern for chronic exposure. However, not all toxicity observed in studies with technical grade pentachlorophenol can be attributed to contaminants. The US EPA concluded that the possibility of carcinogenic effects of pentachlorophenol resulting solely from the presence of contaminants was unlikely. In the epidemiological studies, the contaminants were not present in high levels in the blood from the study subjects, and the cancers reported in the studies were more strongly associated with pentachlorophenol than with the dioxin or chlorophenol exposures.

Overview of the Environmental Fate & Transport of Pentachlorophenol

The fate and transport of pentachlorophenol in the environment are primarily influenced by the pH of the media and exposure to sunlight. At pHs at or below 6.5, pentachlorophenol exists primarily as a phenol. At pHs above 6.5 it exists as phenolate anion. Generally, degradation and mobility of pentachlorophenol are more rapid at higher pHs, in its phenolate anion state.

In surface water, pentachlorophenol is hydrolytically stable from pH 4 to pH 9 and will not be a significant source of degradation products in the environment. Chemical degradation in surface water occurs mainly through photo-degradation. When exposed to direct sunlight, the degradation process may be rapid. Photo-degradation rates decrease with increasing depths of the water. The pH of the water also affects the photo-degradation rate. Half-lives in surface waters have been shown to range from less than an hour (20 minutes) to days, in part dependent on the exposure to sunlight. In aerobic aquatic environments pentachlorophenol may also be degraded by microbes.

The solubility of pentachlorophenol in water (at the standard value of 20^{o}C) is 0.014 g/L indicating that pentachlorophenol is only slightly soluble in water. This low water solubility value is supported by the K_{ow} of 5.12 (Octanol/Water Partitioning Coefficient). In comparison, pentachlorophenol is very soluble in organic solvents or media: methanol solubility is 1800 g/L and benzene solubility is 150 g/L. Therefore, if organic compounds, such as oil, with relatively high solubility for pentachlorophenol are present in soil or groundwater, the pentachlorophenol can preferentially dissolve into the compound instead of groundwater.

Pentachlorophenol has a high affinity for organic media. At lower pH, the organic partitioning coefficient K_{oc} (Soil/Organic Carbon Partitioning Coefficient, L/kg) for pentachlorophenol can range from a low of 706 in sandy soil to a high of 3420 for clay soil. Research done by Banerji and Bajpai in the early 1990's, showed that due to high K_{oc} values in soil with low pH and high organic content, degradation of the pentachlorophenol is retarded in these soil types.

The soil texture and pH also influence mobility of pentachlorophenol in the subsurface and the amount of adsorption to soil particles. In general, pentachlorophenol is more mobile in higher pH and low carbon content sandy soil, moderately mobile in sandy/silt loam soil, and relatively immobile in low pH and high carbon clay loam soil. Maximum soil adsorption occurs at pH values of 4.6 - 5.1, with minimal adsorption reported in soil with pH above 6.8 depending on soil type.

The presence of other organic contaminants in soil or groundwater can increase the mobility of pentachlorophenol by acting as cosolvents. Pentachlorophenol dissolved in an organic fluid such as oil will migrate with the oil and less will be retarded by the organic carbon in the soil.

Soil can contain organic and clayey colloidal particles. Pentachlorophenol can sorb to the colloids depending on the pH and organic carbon content of the colloids. As colloidal particles can migrate in groundwater (dependent on the soil texture and hydraulic conductivity), if pentachlorophenol is adsorbed to the colloidal particles, this can be an important transport mechanism in higher organic content soil where pentachlorophenol is expected to adsorb to the organic material. The presence of other organic contaminants can also enhance the creation of soil/organic matter colloids, further enhancing transport of pentachlorophenol by these particles.

In soil, the major degradation pathway for pentachlorophenol occurs by microbial degradation, with half-lives as low as fourteen (14) days under optimal (generally aerobic) conditions. Under saturated anaerobic soil conditions, the degradation of pentachlorophenol is slowed with observed half-lives of one to two months or longer. Photo-degradation of pentachlorophenol can readily occur at the soil surface of a mineral soil, but is not significant at depths greater than the top 1 mm. In the absence of light, such as in deep groundwater, the main degradation products are 2,3,4,6-tetrachlorophenol and carbon dioxide (CO_2).

In air, pentachlorophenol is a semi-volatile compound, with a vapor pressure of 0.00011 mmHg at 25° C. In air, pentachlorophenol photo-degrades with a half-life of about 1.5 months. Atmospheric pentachlorophenol associated with particulate matter or moisture will be re-deposited on the ground. Based on pentachlorophenol's relatively low Henry's law constant for volatility ($2.45 * 10^{-8}$ atm-m^3/mole at 22 ºC); it is unlikely to volatize from water.
These data indicate that pentachlorophenol degrades in the subsurface most quickly when exposed to light, oxygen, and microbes such as may be present in the shallow surface soil. It will degrade more slowly in deeper portions of the soil where there is less light to act on the compound and where there may be less oxygen than at the surface of the soil. Pentachlorophenol is readily adsorbed to organic carbon in the soil, which can retard its transport. It is most mobile in the subsurface in high pH, low carbon content soil.

Movement of Pentachlorophenol in the Utility Pole & Releases to the Environment

Pentachlorophenol may be released from the treated utility pole into the environment by three processes: surface flushing, volatilization and internal leaching. All three of these processes are affected by the oil-based carriers used in the original treatment. Surface flushing, the release of pentachlorophenol in aqueous solution by rainwater, is a less significant transport mechanism as the pentachlorophenol replenishment rate is limited at the outer pole surface. Volatilization from the pole surface is also unlikely to contaminate the soil. Movement down the pole is the primary transport mechanism to the soil. Studies show that oil-borne pentachlorophenol is more rapidly transported from the upper portion of the poles to the underground portion for the first few years of use, and then becomes relatively constant with time.

There are two sites that pentachlorophenol may move down the pole. It can move either at the surface or in the interior of the pole. This downward migration of the oil carrier along the vertical axis of the pole is referred to as Gravitational Induced Downward Migration of Oil (GIDMO). Experimental data show that GIDMO is the primary transport mechanism of pentachlorophenol in the pole and the primary path for migration to soil. Contamination of soil in the vicinity of treated utility poles may result from this downward movement of pentachlorophenol.

Once leached into the soil as a result of to GIDMO, pentachlorophenol can partition from the carrier oil into the soil, soil moisture, or groundwater, if it is present. The soil in the vicinity of treated utility poles may become contaminated either within the subsoil near the underground portion of the pole, or at the surface of the soil. When pentachlorophenol is released from treated poles, the simultaneous release of the carrier oil may affect the mobility of the pentachlorophenol as oil may be more mobile in the soil. Generally, concentrations of pentachlorophenol in soil decrease significantly within the first 20 centimeters from the pole. However, variability has been observed based on localized site and pole conditions.

Based on the tendency for pentachlorophenol to adsorb to soil and, under suitable aerobic conditions, the moderately rapid degradation of the compound in the environment, contamination of groundwater caused by migration of pentachlorophenol from treated utility poles is not likely to occur in most situations. The 2008 RED states a potential low risk may occur in situations where the bottoms of treated utility poles are in direct contact with the water table or come in contact with a fluctuating/seasonal water table. This condition creates a transport pathway from the pole to the groundwater and increases the risk for shallow groundwater contamination. Additionally, contaminated soil particles may migrate when contaminated areas around the poles are disturbed and exposed to wind or water.

If enough carrier oil is present in a pole to allow GIDMO to be significant, it is possible the carrier oil can migrate downwards through the pole under gravity, and potentially be released into the soil at the bottom of the pole. As pentachlorophenol is dissolved in the carrier oil for pole treatment, this can promote rapid movement of the pentachlorophenol through the pole into the soil at depth. If the soil at the bottom of the pole are sandy or coarse grained, and if enough pentachlorophenol-containing carrier oil is released, it may promote rapid movement of the pentachlorophenol dissolved in the carrier oil to the water table. If clayey, fine silt, or other fine grained soils are present in the soil at the bottom of the pole, the carrier oils may not be able to migrate quickly through these soil types. Some clay soil may also adsorb a portion of the pentachlorophenol. This mechanism may serve to slow migration of pentachlorophenol.

Overview of the Ecological Toxicity and Risk of Pentachlorophenol & Contaminants

Ecological toxicity data for pentachlorophenol have been collected from toxicity tests performed as required for the pesticide's registration. Toxicity tests are conducted by exposing indicator species to the chemical. These are conducted in laboratory settings and usually involve high percentages of the pesticide. Additional laboratory tests have been done by US EPA, USDA and US Fish and Wildlife Services. All toxicity test data are reviewed by the US EPA before they are used in the risk assessment process.

As the contaminants in pentachlorophenol are not registered pesticides there is less available toxicity data than if they were registered.

Ecotoxicity of pentachlorophenol

Ecological toxicity data is summarized the *Pentachlorophenol Final Work Plan*, published by the US EPA in June 2015. From these laboratory tests, pentachlorophenol is classified in both acute and chronic studies as highly toxic to very highly toxic to cold and warm water fish and moderately toxic to other freshwater and marine organisms. In bird dietary studies, pentachlorophenol is classified as practically nontoxic to slightly toxic. Administered acutely to birds it is rated as slightly to moderately toxic. Pentachlorophenol has been shown to bioaccumulate in fish, invertebrates and algae. Upon uptake, fish rapidly excrete a pentachlorophenol metabolite with a biological half-life of only 10 hours. Biomagnification in the food chain is not expected because of pentachlorophenol's rapid breakdown in living organisms. Sediments usually contain higher concentrations of pentachlorophenol than overlying waters.

Pentachlorophenol in surface waters

In its 1986 development of Ambient Water Quality Criteria for pentachlorophenol, the US EPA noted that the toxicity of pentachlorophenol is pH-dependent, the lower the pH, the more toxic it is. As such, the US EPA's and Vermont Water Quality Standards are calculated based on pH of the water. For example, at pH 7.8 the Vermont standards for pentachlorophenol are 19 parts per billion (ppb) and 15 parts per billion (ppb) for acute and chronic criteria, respectively. Data compiled in the 2001 *Toxicological Profile for Pentachlorophenol* by the Agency of Toxic Substances and Disease Registry (ATSDR) noted pentachlorophenol concentrations detected in rivers, streams, or surface water systems are generally very low. In June 2015, the US EPA released updated human health ambient water quality values, which may be to evaluate future Vermont standards. Nationally, acute lethal levels have been exceeded only during accidental spills. ATSDR also noted that most water data available was from the 1970s and 80s and with the cancellation of all non-wood preservative uses in the 1980s, they were likely to decrease. In June 2015

Ecotoxicity of contaminants

In the supporting ecological assessments of the 2008 RED and the Final Work Plan, the dioxin/furan contaminants of pentachlorophenol were identified as highly toxic to birds, mammals, and aquatic organisms. They also posed potential acute and chronic risks to birds, and chronic risks to mammals. The persistence and bioaccumulation potential of the compounds pose additional acute and chronic risks to aquatic and terrestrial organisms. The 2008 RED noted that hexachlorobenzene may also persist and bioaccumulate in the environment posing risks to aquatic and terrestrial organisms. Contaminants may bind to and accumulate in the sediment and result in toxic levels.

Ecological risk assessment of pentachlorophenol & contaminants

As the laboratory studies demonstrate, pentachlorophenol and its contaminants pose both acute and chronic toxic risks to aquatic and terrestrial organisms. Literature has shown that pentachlorophenol and its contaminants can leach from utility poles into the environment. Estimating the risk in the environment from utility poles can be challenging as there are many factors, including the amount of leachate from the pole, the amount of contaminants present in the leachate, environmental conditions around the pole, and the potential exposure pathways of plant and animal species. Another confounding factor is that data obtained in environmental studies done before the use pattern was restricted in the United States, or shortly thereafter, may not appropriately represent the current environmental levels.

Modeling exposures, estimating risk, and evaluating biota has been done to attempt to understand the potential impacts of treated wood in the environment. In 2001, the New York State Department of Environmental Conservation published a risk assessment on the use of pressure treated wood in water and concluded that the use of the pentachlorophenol-treated wood in freshwater environments was unlikely to present any long-lasting impacts to an ecosystem. The author cited the small amount of leaching from the pole decreases rapidly, in comparison to its degradation in the freshwater environment. The report also estimated the potential impacts associated with the use of pentachlorophenol-treated poles specifically in wetlands. The paper concluded that even in a worst case scenario, levels of pentachlorophenol in the water of an open water wetland would not exceed the State of New York's ambient water quality standards. Both Vermont and New York have the same ambient water quality standard. In the 2008 RED, the US EPA based on models and available data stated that typical pentachlorophenol concentrations from wood treatment uses were not expected to be of sufficient quantity or duration to have adverse impacts on the aquatic and terrestrial organisms. In 2000, The US Forest Service assessed the effects of treated wood bridges over sensitive ecosystems. Both chemical and biological assessments were done. The author concluded that there were no adverse biological effects related to the pentachlorophenol-treated bridges. However, both the New York State Department of Environmental Conservation and US Forest Service recommend BMPs for the use of treated wood in these environments.

There are toxic risks to terrestrial and aquatic species from the contaminants. However, their persistence and bioaccumulation in the environment poses additional risks. There is little way to determine the amount of hexachlorobenzene, dioxins and furans in the environment related to pentachlorophenol-treated poles, as these compounds are a result of many different sources (such as combustion and other chlorinated chemicals).

In its final work plan for pentachlorophenol, the US EPA stated that it had not received any information which would alter its 2008 environmental risk assessment for pentachlorophenol. It will however, be requesting additional toxicity studies and re-revaluating it with updated scientific framework and risk assessment. It will also reassess the ecological risk from the contaminants.

Livestock Exposure Assessment

The potential for livestock exposure to pentachlorophenol and contaminants through contact with, or access to, treated wood products in pastures, barnyards, animal housing, feeding areas or water sources was considered and investigated.

There are numerous citations and references to the toxicity and adverse effects of pentachlorophenol and its contaminants to livestock and other farm animals. Studies have looked at various species of livestock but most often focused on dairy and beef cattle, poultry and pork. The majority of these toxicity studies evaluated technical grade pentachlorophenol. In addition, there are reports, mostly from the late 1970s, of acute adverse health effects to livestock from direct exposure to treated wood used as sources of bedding (wood chips and sawdust), contaminated feed, and as construction materials in housing and feeding structures.

The most significant shift with respect to potential livestock exposure to pentachlorophenol and its contaminants occurred in 1984 when the US EPA issued its final *Position Document 4 for the Wood Preservative Pesticides: Creosote, Pentachlorophenol and Inorganic Arsenicals (PD4*). The pentachlorophenol-related regulatory actions taken as a result of PD4, effectively eliminated the potential for direct exposure to livestock. All previously allowed uses for pentachlorophenol except for commercial pressure wood treatment were cancelled, including the herbicidal, antimicrobial and low concentration use retail products. This removed the potential for do-it-yourself (DIY) applications by homeowners and farm operators for post-manufacture (maintenance and retreatment) applications. These types of post-manufacture applications, using retail products, were common on farms and in agricultural settings prior to the mid-1980s.

Also as a result of PD4, pentachlorophenol-treated wood could not be used in in building interiors or for use in direct contact with animals, food, feed or drinking water. These conditions are described in the Consumer Information Sheet and also included in the ANR Reuse fact sheet. Specifically, pentachlorophenol-treated wood is not allowed for use where it will come into contact with human or domestic animal drinking water and is only permitted for use in the construction of animal housing and feeding structures below ground level to prevent exposure from wood chewing behavior (cribbing). The current US EPA registration does allow for the use of treated wood for the construction of docks and bridges where incidental contact with human or animal drinking water may occur.

Practical experience at the AAFM indicates that on-farm water systems are predominantly dual use (human and animal) systems. Farm operators are reluctant to construct groundwater-based watering systems only for animals; they more frequently use surface water systems for single use (animal). The proposed BMPs targeted for the protection of human drinking water sources provides protection for livestock watering operations. The PD4 regulatory actions have eliminated the direct exposure through chewing and contaminated water and feed, however incidental contact with poles in fields is possible. AAFM feels that the risk from incidental contact with poles in pastures is consistent with the risk from incidental contact with animal drinking water (docks/bridges in surface water).

State Authority for Investigation & Cleanup of Pentachlorophenol Environmental Releases

Although pentachlorophenol is a pesticide, as described earlier in this document, utility poles are exempt from AAFM oversight as they are treated articles. However in Vermont, ANR’s Sites Management Section (SMS) of the Waste Management and Prevention Division is responsible for the review and approval of site investigations and response actions required when a release of hazardous materials has occurred. Environmental contamination from pentachlorophenol-treated utility poles is managed under state statutory authority.

Authority for hazardous materials releases and response is designated to ANR in 10 V.S.A. 159 §6617, "Any person who has knowledge of a release or a suspected release and who may be subject to liability for a release, as detailed in §6615 (*e.g.*, owners or operators of a facility), shall immediately notify the Agency." Releases of hazardous materials into the surface or groundwater or onto the land of the State are prohibited, according to 10 V.S.A. 159 §6616. The responsible party is required to take necessary response actions to address the release according to 10 V.S.A., 159, §6615b Corrective Action Procedures, which include determining the degree and extent of contamination present, assessing the need for corrective action, implementing the site remediation and monitoring to its completion. This may include sampling of various environmental media, monitoring over time, and/or more complex cleanup methods involving implementing remedial systems. The purpose of corrective action is to reduce or remove contaminants to the extent required by State and Federal regulations and to protect against adverse environmental and human health effects.

In the situations where pentachlorophenol-treated utility poles have resulted in environmental contamination (*e.g.*, contamination of shallow groundwater or extensive soil contamination beyond the immediate vicinity of the pole) the SMS has worked with the utilities and the AAFM, to implement ANR's *Investigation and Remediation of Contaminated Properties Procedure* (IROCPP: *effective 4/2012*). This procedure outlines the regulatory authorities and definitions, as well as the site investigation and remediation process, including relevant Vermont levels/standards used for comparison of contaminants measured in water, soil, sediment and other environmental media.

Vermont Environmental Releases

Vermont utilities first became aware of the potential for the contamination of shallow drinking water sources by pentachlorophenol-treated poles during the summer of 2009 when two shallow drinking water sources were impacted by newly installed poles. Both poles, along with several others that exhibited excessive sweating, were subsequently identified as isolated to a single treatment batch at a treatment facility. In 2010, after completing construction of a new utility line, another utility pole from a separate utility was also identified as exhibiting excessive sweating. Although this pole did not impact any drinking water sources, there were elevated concentrations of pentachlorophenol solution in the soil and within a small wetland located adjacent to the utility structure.

In 2014, a Vermont utility was performing a routine structure replacement. Prior to initiating the work, the utility had contacted the landowners. One of the landowners informed the utility they had a shallow groundwater supply, which was located downhill and adjacent to one of the structures to be replaced. The utility, being aware of the potential of new poles to exhibit excessive sweating (based on the incidents that occurred in 2009-2010), worked with the landowners and took numerous proactive steps to limit the risk of potential contamination from the new poles. Despite the actions taken by the utility during the replacement, the landowners identified an irregular odor coming from their tap water. Laboratory results confirmed that this shallow groundwater supply had been contaminated. After several rounds of soil and water testing, and in consultation with the ANR, it was determined that this source of contamination likely did not occur from the newly installed poles, but rather from contaminated soil that was excavated from around the old poles. These and the other environmental releases are described in more detail in Appendix 6.

Based on experience gained from these Vermont events and literature available, pentachlorophenol releases to the environment are most likely to occur as a result of poor pole treatment (poor penetration, low retention, over-treatment), the localized environmental site conditions (soil type, soil chemistry, distance to water table), and disturbance of the soil when removing existing utility poles.

Reuse

Vermont utility poles are generally removed after 40+ years of service life. Utility poles when removed and determined to not be a hazardous waste, may be disposed of in a landfill or be put to a secondary use. The ANR, which has authority over both household and hazardous waste management in Vermont, does not consider treated wood to be a waste when reused in a manner that does not pose an increased risk to human health or the environment. In general, appropriate reuse of treated wood is consistent with the same use restrictions of the original product. The ANR has identified that reuse of treated woods as support beams in open-air construction or as part of general landscaping such as terracing, fence posts, or property line demarcation is an appropriate reuse.

The ANR discourages reuse of creosote or pentachlorophenol-treated wood unless by the original owner. If ownership is transferred for reuse ANR strongly recommends that the original owner obtain a signed consent form indicating that the recipient understands the risk associated with the product, and provide the ANR fact sheet (Appendix 2). The ANR fact sheet advises that pentachlorophenol-treated wood should not be reused in a vegetable garden or in any location that children are likely to come in contact with the wood. For reuse that may occur in agricultural settings, AAFM recommends that reuse should occur in accordance with the restrictions described in the Consumer Information Sheet (Appendix 3).

Business-generated treated wood waste that is not reused by the original owner, or reused in accordance with the ANR policy must be evaluated to determine if it is hazardous waste under standard ANR procedures. Waste that is determined to be hazardous must be managed in accordance with the Vermont Hazardous Waste Management Regulations.

Development of the Best Management Practices

The utility members of this stakeholder group compiled a list of existing BMPs, and distilled them into a single set of practices, organized by the stages of the typical utility pole's life cycle: treatment/procurement, storage, installation/use, and retirement/disposal. These practices served as a starting point for the final set of recommendations issued by the working group, which are the end result of the collaborative effort and reflect many of the topics covered in this report. The final BMPs reflect a desire to provide safe, reliable, and affordable electric and communication services to Vermonters while protecting vulnerable drinking water sources, and are part of a continuously evolving examination of available alternative materials and practices.

Adoption and implementation of the BMPs will allow the continued responsible use of pentachlorophenol-treated poles, while Vermont utilities continue to research and field-test alternative products where allowed and appropriate. The table at the end of this document outlines the pentachlorophenol BMPs, the rationale behind each of the BMPs, and how the BMPs limit the risk of pentachlorophenol impacts to Vermonters and the environment. The BMPs are also outlined in a concise version in Appendix 1.

Proposed Best Management Practice and Rationale

Pentachlorophenol Proposed Best Management Practice	Rationale for BMP
Procurement, Delivery & Storage	
1. Require Traceable ID brand with plant location and year produced, which can be traced to the batch of treated poles.	If a pole is identified as exhibiting excessive sweating, it can be traced back to a specific batch of poles. This will allow for further evaluation of other poles from the same batch and provide additional information to the pole supplier for investigation.
2. Require all poles used in VT to be treated to AWPA specifications for use in deterioration zone 2.	All utility poles used in Vermont should meet industry standard for preservation, regardless of preservative type.
3. Require all poles used in VT to be double vacuum treated or extend vacuum cycle to twice the standard length prior to delivery to VT. In some cases, utilities may require immediate delivery of poles for emergency restoration activities, and that such poles may deviate from normal specifications.	Vacuum treatment of pressure treated wood is a standard practice throughout the wood treatment industry. Vacuum treating newly pressure treated wood, helps to extract excess treatment solution that has not fixed in the wood. Performing a double vacuum treatment or double length vacuum treatment, is a standard practice for pentachlorophenol-treated wood intended for use in sensitive environments, such as open water locations. This simple and cost effective step reduces the possibility of pentachlorophenol solution leaching from the pole.
4. Inspect poles on delivery – Retain the right to reject any pole that exhibits excessive sweating of preservative solution.	Ensuring that a potentially problematic pole does not get put into service is the most efficient way to ensure that there are no adverse impacts to human health and the environment. Inspecting poles upon delivery is the first step in this process. Ensuring that sufficient legal language is included in the contract will assist utilities by having defensible contract terms in order to reject non-conforming poles. Additionally, having clear pole specifications regarding treatment and retention requirements will add to the utilities commitment to limit non-conforming and potentially problematic poles.
Permanent Pole Storage Areas – Use for design of new construction or substantial reconstruction of existing pole storage areas.	
1. Locate 100 feet from drinking water sources and as far away as possible from residences.	Locating permanent pole storage areas at least 100 feet away from drinking water sources is a precaution to limit potential impact to water sources.
a. Design considerations should include:	
i. A low permeability surface material (compacted soil or asphalt) with absorbent/organic material; or	Low permeability surface material limits the pentachlorophenol from migrating into the surface soil and beyond. The addition of absorbent or organic materials provides a binding matrix for pentachlorophenol until the material can be collected and disposed of appropriately
ii. Other containment/migration prevention measures	Other containment and migration prevention measures may be just as appropriate. As such, other approaches which may be just as effective and/or cost efficient should also be considered as viable options.

2. Poles should be elevated off ground surface.	Storing poles off the ground keeps moisture off of the poles and limits precipitation runoff from coming in contact with poles, thus limiting the potential for such runoff to result in migration.
3. Ground surface should consist of a low erosion potential substance	Limiting erosion from the site will limit the potential for soil or substrate that has come in contact with potential contaminants from migrating to other areas of the site and/or offsite.
4. Maintain a yard slope of less than 10% throughout the pole storage area.	A yard slope of less than 10% throughout the area will limit precipitation runoff velocities and thus further limit erosion and potential contaminant migration.
5. Pole storage yards should be sited to limit odor impact to the public.	Off-gassing of preservative solutions can result in odors. Public exposure should be limited to the extent feasible.
6. Pole storage areas should be visually inspected when work is being done at a pole yard for excessively sweating poles, unusual staining, or other evidence of unusual releases of pentachlorophenol.	Routine inspections of all pole storage areas (temporary, permanent, new, or existing) by utility workers or contractors will identify any evidence of unusual releases of pentachlorophenol or problematic poles.
Pole Siting & Construction	
1. Onsite utility personnel and contractors should inspect all poles prior to installation to ensure no excessive release of preservative solution is occurring.	In addition to the inspection of poles upon delivery from the vendor, field crews should inspect all poles prior to installation for any evidence that the pole may lead to excessive release of preservative solution. As different times of year and weather conditions are related to the migration of the preservative solution, a pole that has been in storage for several weeks or months may exhibit different visual indicators at the time of installation than it did upon delivery. This step is an additional opportunity to inspect the poles for evidence of unusual release of preservative solution prior to installation.

2. Before installing any new pole, determine if there are any shallow drinking water sources within 50 feet of the pole location. Wherever feasible, poles should be located at least 50 feet away from shallow water sources; if this is not feasible utilities should in the following order:	Based on the information gathered from the recent incidents of unusual pentachlorophenol releases from newly installed poles and from migration of pentachlorophenol from disturbed soil around existing poles that have occurred in VT, it is reasonable to assume that pentachlorophenol could travel overland up to 50 feet away from a pole in certain conditions. Given that shallow water sources are the most vulnerable receptors and that most Right-of-Way corridors, which are the areas within the utilities control, are generally 30 to 150 feet wide (with certain exceptions), it is recommended that utilities inspect areas within 50 feet of placement of new poles or replacement of existing poles for the presence of shallow groundwater sources. If such a water supply is identified than it is recommended, that utilities maintain a minimum setback distance of 50 feet away from the shallow water sources. If the water supply is directly down gradient, additional separation distances may be warranted.
a. Use an alternative type of treated pole;	The use of an alternative type of treated pole would eliminate the potential for pentachlorophenol contamination of the shallow water supply; however care should be

	taken to review the treatment preservatives for any alternatively treated wood poles, as well as, any potential effects associated with alternative pole materials that may be used.
b. Use a containment structure or barrier (*e.g.,* pole sleeve);	The use of containment structures around pentachlorophenol-treated poles has shown to be effective in certain scenarios in VT. This option is specifically intended for use associated with the installation of new or replacement poles, to contain pentachlorophenol and to limit the possibility of pentachlorophenol impacting the shallow water supply. In the case of replacement structures this option would address the installation of the new replacement pole; however the additional work of decommissioning of the old pole should also be closely considered as discussed in the Decommissioning, Retirement, and Disposal section. Certain pole barriers claim to limit the migration of pole treatment solutions away from the pole. These barriers are intended to be installed on the pole immediately prior to pole installation. They are installed in the field over the bottom end of the pole, sealed to the pole just above the ground, and backfilled with native or select aggregate material. These barriers are subject to potential damage during the installation process and given that the barrier is intended to be sealed to the pole, it is unclear how the barrier would limit the migration of any pole treatment solution that moves down the outside of the pole, which is of particular concern with regard to shallow drinking water sources in close proximity to utility poles. There is currently no scientifically based information readily available on the effectiveness of these barriers; as such it is recommended that utilities and the regulatory community review the use of these barriers with discretion. In the meantime, the pole siting BMPs attached to this report – specifically, avoidance of vulnerable drinking water sources, use of non-pentachlorophenol poles, and other remedial actions – are all preferable to the use of pole barriers.
c. Work with landowner(s) to develop proactive plan to prevent contamination to the drinking water supply. Provide ANR response fact sheet.	In the event that the options listed above are not operationally feasible, are cost prohibitive, or if there are other benefits to the utility and/or the landowner, a site specific action plan developed in collaboration with the landowner to ensure compliance with the groundwater enforcement standards could provide alternative and effective options for all parties involved.
Decommissioning, Retirement, and Disposal	
1. Removal of poles (based on specific site characteristics)	Pentachlorophenol-treated poles leach preservative solution to the soil adjacent to the pole. Concentration of pentachlorophenol in soil immediately adjacent to poles (within a couple inches), can be relatively high, however these concentration levels decrease rapidly by several orders of magnitude with increased distance from the pole. Generally, these levels have been well within acceptable limits within approximately one foot away from the pole. Additionally, pentachlorophenol typically photodegrades by exposure to UV rays from sunlight and/or degrades by microbes relatively quickly. Given these characteristics and the fact the pentachlorophenol binds to organics in the soil and is relatively immobile once this occurs, unless the organic matter or the soil in general are disturbed, migration of

	pentachlorophenol beyond the average one foot diameter mark is not anticipated. However, disturbing the soil around these areas and creating the potential for erosion increases the risk of migration beyond the area immediately adjacent to the pole.
a. Cut pole and leave butt in ground: appropriate in remote locations & sensitive areas (*e.g.*, wetlands) where access by construction vehicles is difficult, unsafe, or poses significant environmental risk, including soil erosion.	Where site conditions are appropriate, and full pole removal is undesirable, it is acceptable for poles to be cut off at or slightly below ground surface and left in place. This practice limits soil disturbance and thus reduces the potential for migration from around the pole.
b. Pull pole butt and replace with clean fill, where appropriate: appropriate in locations accessible by construction equipment or where the utility or landowner determines that cutting the pole would pose an unacceptable risk of injury after the pole butt decays.	Pole butts in this scenario should be pulled directly out of the ground utilizing onsite equipment, if possible. Care should be taken to limit soil disturbance around the pole and areas of soil disturbance should be stabilized with seed and mulch or other approved erosion control measures, to limit the potential of soil migration.
c. If excavation is required to remove the pole, limit soil disturbance to the extent possible and implement soil management, and erosion and sediment control measures. Excavation should be delayed when there are extreme weather conditions which may lead to erosion (high sustained wind, heavy precipitation) and are within 50 feet of a sensitive area.	Certain situations require excavation of soil around the pole butts in order to free them for removal. In these situations, it is recommended the utilities limit the amount of soil disturbance to only what is needed to extract the pole butt. In addition, soil excavated from around the pole butt should be stockpiled or side cast as close to the excavation location as possible. Once the pole butt is extracted, the excavated soil should be replaced back in the excavation as backfill, with additional clean backfilled used to fill any additional void space created from the excavation and/or the hole left from the pole butt.
d. For work within 50 feet of a shallow drinking water source, excavated soil should be removed and disposed of in accordance with Vermont solid waste regulations.	
e. Grossly contaminated soil should be removed and disposed of in accordance with Vermont solid waste regulations.	
2. Reuse pentachlorophenol-treated wood poles in accordance with ANR Fact Sheet titled "Managing Treated Wood Waste (Appendix 2).	The reuse of pentachlorophenol-treated wood products in accordance with the ANR Fact Sheet provides recipients of the material with acceptable reuse benefits and risks.

3. If reuse is not feasible, dispose of pentachlorophenol-treated poles in accordance with all applicable regulations.	In certain cases such as large replacement projects, not all decommissioned treated wood products can be reused. Some may be so deteriorated that it may not be safe or appropriate for reuse or utilities may simply produce more than can be donated in a given duration. In such cases, utilities shall follow all applicable disposal regulations.
Training & Education	
1. In order to ensure compliance with these BMPs train appropriate personnel to:	Training of applicable personnel is imperative for the successful execution of these BMPs. It is recommended that applicable personnel receive training, including a comprehensive review of the BMPs and specific training related to the section(s) of the BMPs that are applicable to each individual or group.
a. Locate and identify shallow water sources.	
b. Identify environmentally-sensitive areas.	
c. Identify poles that are excessively sweating preservative solution.	
d. Ensure familiarity with proper handling and safety precautions.	
e. Identify & report potential releases from poles.	

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Appendices

Appendix 1 *Best Management Practices (BMPs) Associated with the Use of Pentachlorophenol-treated Utility Poles in Vermont*

Appendix 2 *ANR Reuse Fact Sheet*

Appendix 3 *US EPA Example Consumer Information Sheet*

Appendix 4 *State Response for Environmental Releases*

Appendix 5 *Public Response Sheet What to Do If You Suspect Drinking Water Contamination from Utility Poles*

Appendix 6 *Sites Management's Case Summaries*

Appendix 1

Best Management Practices (BMPs) Associated with the Use of Pentachlorophenol-treated Utility Poles in Vermont

Procurement, Delivery & Storage

1. Require Traceable ID brand with plant location and year produced, which can be traced to the batch of treated poles.
2. Require all poles used in VT to be treated to AWPA specifications for deterioration zone 2.
3. Require all poles used in VT to be double vacuum treated or extend vacuum cycle to twice the standard length prior to delivery to VT. In some cases, utilities may require immediate delivery of poles for emergency restoration activities, and that such poles may deviate from normal specifications. However, in all cases, reasonable efforts will be made to install poles in accordance with these BMPs.
4. Inspect poles on delivery – Retain the right to reject any pole that exhibits excessive sweating of preservative solution. This is more readily accomplished during the warmer months.

Permanent Pole Storage Areas *Use for design of new construction or substantial reconstruction of existing pole storage areas*

1. Locate 100 feet from drinking water sources and as far away as possible from residences.
    a. Design considerations should include:
        i. A low permeability surface material (compacted soil or asphalt) with absorbent/organic material; or
        ii. Other containment/migration prevention measures
2. Poles should be elevated off ground surface
3. Ground surface should consist of a low erosion potential substance
4. Maintain a yard slope of less than 10% throughout the pole storage area
5. Pole storage areas should be sited to limit odor impact to the public
6. Pole storage areas should be visually inspected when work is being done at a pole yard for excessively sweating poles, unusual staining, or other evidence of unusual releases of pentachlorophenol.

Pole Siting & Construction

1. Onsite utility personnel and contractors should inspect all poles prior to installation to ensure no excessive release of preservative solution is occurring
2. Before installing any new pole, determine if there are any shallow drinking water sources within 50 feet of the pole location. Wherever feasible poles should be located at least 50 feet away from shallow drinking water sources; if this is not feasible utilities should, in the following order;
    a. Use an alternative type of treated pole
    b. Use a containment structure or barrier (*e.g. ,*– pole sleeve)
    c. Work with landowner(s) to develop a proactive plan to prevent contamination to the drinking water supply. Also provide landowner ANR fact sheet, *What to Do If You Suspect Drinking Water Contamination from Utility Poles*

Decommissioning, Retirement, and Disposal of Pentachlorophenol-treated Poles

1. Removal of poles (based on specific site characteristics)
    a. Cut pole and leave butt in ground: appropriate in remote locations and sensitive areas (*e.g.,* wetlands) where access by construction vehicles is difficult or unsafe, or poses significant environmental risk, including soil erosion
    b. Pull pole butt and replace with clean fill, where appropriate: appropriate in locations accessible by construction equipment or where the utility or landowner determines that cutting the pole would pose an unacceptable risk of injury after the pole butt decays
    c. If excavation is required to remove the pole, limit soil disturbance to the extent possible and implement soil management, and erosion and sediment control measures. Excavation should be delayed when

there are extreme weather conditions which may lead to erosion (high sustained wind, heavy precipitation) and are within 50 feet of a drinking water well.

   d. For work within 50 feet of a shallow drinking water source, excavated soil should be removed and disposed of in accordance with Vermont solid waste regulations.
   e. Grossly contaminated soil should be removed and disposed of in accordance with Vermont solid waste regulations.

2. Reuse pentachlorophenol-treated wood poles consistently with the restrictions placed on the original product.
   a. Provide ANR fact sheet "Managing Treated Wood Waste" to all private parties that accept decommissioned poles for reuse.
   b. If reuse is not feasible, dispose of treated poles in accordance with all applicable ANR regulations

Training/Education

1. In order to ensure compliance with these BMPs train appropriate personnel to:
   a. Locate and identify shallow drinking water sources
   b. Identify environmentally-sensitive areas
   c. Identify poles that are excessively sweating preservative solution
   d. Ensure familiarity with proper handling and safety precautions
   e. Identify and report potential contaminant releases from utility poles

Environmental Fact Sheet

VERMONT

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

. Managing Treated Wood Waste

Wood products such as utility poles, railroad ties, and lumber for outdoor exposures are treated with chemical preservatives that create a barrier against insect attack and decay. These wood products can contain toxic constituents in sufficient concentrations to constitute a threat to public health and the environment if improperly reused, or cause the products to be regulated as hazardous waste when discarded. This Fact Sheet is intended to describe best management practices for treated wood reuse and allowable disposal options. As described below, treated wood waste disposal by businesses may be subject to regulation as a hazardous waste.

Wood preservatives fall into three broad categories which, in turn, dictate how the treated wood should be managed when removed from its original use. The categories are:

Water-borne preservatives: The most common water-borne preservatives used to treat wood include *Chromated Copper Arsenate* (CCA), *Ammoniacal Copper Quat* (ACQ), *Ammoniacal Copper Zinc Arsenate* (ACZA), as well as the less-toxic, inorganic borate compounds. The copper containing treated wood tends to be green in color and can weather to gray. Borate treated wood is colorless, but may be dyed blue. Wood treated with waterborne preservatives is used in a variety of outdoor residential, commercial, and industrial products and applications, such as decking and walkways, fences, gazebos, docks, playground equipment, highway noise barriers, utility poles and retaining walls. CCA treated wood is no longer available for residential use.

Creosote-treated wood: Wood treated with creosote is used mainly for bridge timbers, railroad tires, retaining walls, and docks. This wood has a dark brown color and may have a strong odor.

Oil-borne preservatives: Common varieties of oil-borne preservatives include chlorophenolic compounds, e.g., pentachlorophenol, or “penta,” and copper naphthenate. “Penta” is the most widely used oil-borne preservative, used to preserve utility poles and cross arms, railroad ties, and fence posts. Neither penta-containing products nor wood treated with penta are available for residential use. Pentachlorophenol-treated wood is dark in color and may have an odor, while copper naphthenate is green and weathers to brownish gray over time.

How can treated wood be reused?

The Waste Management and Prevention Division (WMPD) does not consider wood treated with a preservative to be waste when reused appropriately, i.e., reused in a manner that does not pose an increased risk to human health or the environment. In general, "appropriate reuse" of these types of treated woods does not increase the amount of surface area available to leaching, involve placement in or near environmentally sensitive areas, or involve combustion of any type.

Because of the greater toxicity of the preservative, and increased potential for environmental harm if misused, the WMPD discourages the reuse of chlorophenolic and creosote treated wood, except by the original owner. If these products are considered for reuse, the WMPD strongly recommends that the original owner provide the recipient with this Fact Sheet, and obtain a signed consent form indicating that the recipient understands the risk associated with the product, best management practices for the product's reuse, and end-of-life disposal options.

Examples of inappropriate and appropriate reuses of treated wood

Inappropriate	Appropriate
× Should not be reused in interiors of residential structures × Should not be reused in interiors of farm structures where livestock or animals are present or in farrowing or brooding facilities × Should not be reused in areas of farm structures that may come in contact with food or feed. × Should not be reused in bee hives × Do not burn × Should not be reused in areas where there is potential for frequent contact with skin (chairs, playgrounds, patios, decking) × Should not be reused near vegetable gardens × Should not be reused in areas that may come into indirect or direct contact with drinking water sources, except in incidental contact (docks, bridges)	✓ Use as support beams in open-air/outdoor construction ✓ Use for general landscaping in areas that are not in the vicinity of vegetable gardens. For example, terracing ✓ Use as fence posts or property line demarcation

How can treated wood waste be disposed of when it is <u>not</u> reused?

Household-generated waste is categorically exempt from regulation as hazardous waste; therefore, treated wood waste generated from a household may be disposed of at a lined, solid waste landfill.

Business-generated treated wood waste that is <u>not reused by the original owner,</u> must be evaluated to determine if it is hazardous waste. Waste that is determined to be hazardous must be managed in accordance with the Vermont Hazardous Waste Management Regulations. The owner or operator of a business can determine whether or not treated wood is hazardous waste based on either "generator knowledge" about the wood, or laboratory analysis.

Business-generated treated wood waste is considered hazardous waste when certain contaminants are present at or above specified limits. The test method used to make this determination (when the determination is not based on “generator knowledge”) is the Toxicity Characteristic Leaching Procedure, or TCLP. The regulatory levels for the contaminants generally associated with treated wood are specified in the following chart:

Types of Treated Wood / Distinguishing Characteristics	Hazardous Waste Number	Contaminant	Regulatory Level (mg/L)
Inorganic Preservatives: "greenish" in color.	D004	Arsenic	5.0
	D007	Chromium	5.0
Creosote Formulation: brown to dark brown in color; may be coated with tar; has a "smoky", chemical odor.	D023	o-Cresol	200.0[1]
	D024	m-Cresol	200.0[1]
	D025	p-Cresol	200.0[1]
	D026	Cresol	200.0[1]
Chlorophenolic Formulations: Similar characteristics to creosote.	D037	Pentachlorophenol	100.0

1 If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200.0 mg/l.

Treated wood that is not subject to regulation as a hazardous waste, i.e., treated wood from businesses that does not exhibit the toxicity characteristic and is therefore non-hazardous, may be disposed of in certified, lined landfills. (Analogous to household-generated treated wood.) Treated wood should not be shredded or ground prior to disposal.

Note that treated wood (hazardous waste or not) cannot be burned for either energy recovery or disposal unless it is burned in a device that has been permitted by the Agency for that purpose.

For Addition Information About...

...burning wastes, contact the **Air Pollution Control Division** at (802) 828-1288.

...this fact sheet, or other solid or hazardous waste management issues, contact the **Waste Management And Prevention Division** at (802) 828-1138, or visit the Division web site http://www.anr.state.vt.us/dec/wastediv/index.htm

...reducing the amount, and the toxicity, of waste produced, contact Vermont’s non-regulatory **Environmental Assistance Office** toll-free (in Vermont) at 1-800-974-9559.

Appendix 3 US EPA Example Consumer Information Sheet

Consumer Information Sheet

PENTACHLOROPHENOL PRESSURE-TREATED WOOD

CONSUMER INFORMATION

This wood has been preserved by pressure-treatment with an EPA registered pesticide containing pentachlorophenol to protect it from insect attack and decay. Wood treated with pentachlorophenol should be used only where such protection is important.

Pentachlorophenol penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to pentachlorophenol may present certain hazards. Therefore, the following precautions should be taken both when handling the treated wood and in determining where to use and dispose of the treated wood.

USE SITE PRECAUTIONS

Logs treated with pentachlorophenol should not be used for log homes.

Wood treated with pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied.

Pentachlorophenol-treated wood should not be used in residential, industrial, or commercial interiors except for laminated beams or building components which are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site.

Wood treated with pentachlorophenol should not be used in the interiors of farm buildings where there may be direct contact with livestock which may crib (bite) or lick the wood.

In interiors of farm buildings where domestic animals or livestock are unlikely to crib (bite) or lick the wood, pentachlorophenol-treated wood may be used for building components which are in ground contact and are subject to decay or insect infestation and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site.

Do not use pentachlorophenol-treated wood for farrowing or brooding facilities.

Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be structures or containers for storing silage or food.

Do not use treated wood for cutting-boards or counter-tops.

Only treated wood that is visibly clean and free of surface residue should be used for patios, decks and walk-ways.

Do not use treated wood for construction of those portions of beehives which may come into contact with the honey.

Pentachlorophenol-treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

Do not use Pentachlorophenol-treated wood where it may come into direct or indirect contact with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges.

HANDLING PRECAUTIONS

Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g. construction sites) may be burned only in commercial or industrial incinerators or boilers rated at 20 million BTU/hour or greater heat input or its equivalent in accordance with state and Federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.

Avoid frequent or prolonged skin contact with pentachlorophenol-treated wood; when handling the treated wood, wear long-sleeved shirts and long pants and use gloves impervious to the chemicals (for example, gloves that are vinyl-coated).

When power-sawing and machining, wear goggles to protect eyes from flying particles.

After working with the wood, and before eating, drinking, and use of tobacco products, wash exposed areas thoroughly.

If oily preservatives or sawdust accumulated on clothes, launder before reuse. Wash work clothes separately from other household clothing.

Urethane, shellac latex epoxy enamel and varnish are acceptable sealers for pentachlorophenol-treated wood.

Appendix 4 State Response for Environmental Releases

The ANR requires a response to environmental releases that impacts ground or surface water. These environmental releases are determined by visual observations, instrument readings, laboratory analyses, and/or visual/olfactory inspection of the water. The first step in the site assessment of a potential an environmental release from a utility pole is to identify the type of chemical preservative used, known contaminants of the preservative, and the carrier used to apply the preservative. Poles in Vermont are primarily treated with pentachlorophenol, but there may be creosote, Cu-Nap, or even un-treated poles in use. For pentachlorophenol-treated poles, levels of pentachlorophenol, its carrier and contaminants may be tested. During the site investigation it is important to note that there are many anthropogenic sources of the contaminants associated with pentachlorophenol: hexachlorobenzene and the dioxins/furans. Analytical methods for these, by matrix, are provided below. Equivalent environmental methods may be used at the discretion of the Sites Management Section, though drinking water samples should be analyzed only by drinking water methods.

Matrix	Compounds of Interest	Analytical Method
Drinking water	Pentachlorophenol	515 or 525
	Hexachlorobenzene	525
	Dioxins	1613 or 8290
	BTEX	524.2
	Naphthalene	524.2
	PAHs	525
Ground, Surface water	Pentachlorophenol	8151, SOM01.2 with SIM
	Hexachlorobenzene	8270
	Dioxins	8290
	BTEX	8260
	Naphthalene	8260, 8270
	PAHs	8270 ± SIM
Soil/sediment	Pentachlorophenol	8151, SOM01.2 with SIM
	Hexachlorobenzene	8270
	Dioxins	8290
	BTEX	8260
	Naphthalene	8260, 8270
	PAHs	8270 ± SIM
	Total Organic Carbon (TOC) for sediments	Lloyd Kahn

Environmental and drinking water samples should be collected, stored and shipped in accordance with the sampling, extraction and analytical method requirements and in compliance with the IROCPP. Testing of samples should be done at an appropriately certified laboratory. That is, drinking water samples should be tested at laboratories that are certified as such by the Vermont Department of Health. Other media should be tested at laboratories that can demonstrate appropriate quality systems based on the media type. For environmental samples this is generally, at a minimum, done by participation in the National Environmental Laboratory Accreditation Program with compound and matrix specific accreditations. The ANR as a policy does allow for other comparable performance based measures in its review of environmental media data.

If during the site assessment process, it is determined that hazardous compounds in water or soil exceed, or are likely to exceed, Vermont standards or requires mitigation to protect sensitive receptors (human/animal/environments) from the hazardous material, remediation will be required.

Environmental remediation measures may include:

- removal of the suspected pole(s),
- replacement with a new pentachlorophenol-treated pole,
- replacement with another type of pole, and/or

— relocation of the pole to a less sensitive area
— excavation and disposal of soil

The remediation measures will be determined based on the groundwater conditions, topography near the structure, level of contamination, and the condition of the suspect pole(s).

If pentachlorophenol is detected in a private drinking water supply, the ANR may require that the water supply be treated using an activated carbon treatment system to remove pentachlorophenol from the water supply at the point of entry into the residence. Depending on the extent of contamination in the water distribution system, replacement of the water source and/or plumbing fixtures may also be required.

Storage Yards

Upon closure or conversion of a pole storage yard, a site assessment should be conducted in conjunction with the SMS of ANR. It is expected that contaminated soil will be generated in the decommissioning of a pole storage yard, or at any time that a significant release of pentachlorophenol is observed in a pole storage yard. The typical cleanup at pole storage yards involves laboratory analyses to assess extent of contamination and then the subsequent removal of contaminated soil. Groundwater monitoring wells may be installed in areas where there is an interface with contaminated areas, or other strategic locations to protect off-site migration. SMS will make recommendations for groundwater monitoring based on the specific geographic location of the pole yard and on the findings of the cleanup reports. Again, the IROCPP will be used to guide the assessment and remediation process.

Appendix 5 Public Response Sheet

VERMONT

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

What to Do If You Suspect Drinking Water Contamination from Utility Poles

This document is intended as a guide for Vermonters to follow in the event you suspect that your drinking water has been contaminated by utility pole preservatives. ***It is important to note that this is very rare occurrence and only a few cases have ever been documented in Vermont.*** Additionally, poles that have been in service for several years and have had no recent excavation are less likely to create any issues. However, if you suspect there is an issue with your water supply or if there has been recent installation or replacement of utilities poles or excavation of soil within a few feet of existing utility poles near your water supply, please follow the steps outlined below.

What kinds of water sources are most at risk? Shallow drinking water sources, such as springs and dug wells, are most likely to be influenced by contaminants moving from utility poles, and other contaminants.

What are signs to look out for?

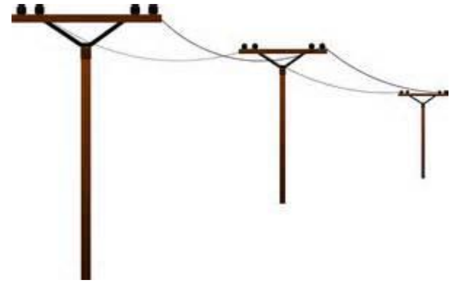
- Look for a utility pole that appears to be "sweating," or there is more than 12 inches of stained soil around the base of the pole on the soil, especially if it is very close to your water supply
- Gas or diesel-like odors coming from your water
- Note that health and environmental limits are lower than our ability to smell it: you may not be able to smell the contamination in your drinking water.

What should you do? If you suspect your water may be contaminated, do not drink or bathe in it until the situation can be assessed. Use a known safe source of water for these activities. Boiling the water will not remove these contaminants.

Who should you contact? Call the Vermont Department of Environmental Conservation Spill Response hotline during **office hours 1-802-828-1138** or **24 hour at 1-800-641-5005.** Staff members are trained to respond and will work with you to identify the next steps, which will include identifying and notifying the utility that owns the pole. Provide all parties with your name, address and the pole number located on the pole.

What will they test for? If it is determined to be necessary, state agencies and your utility will arrange for collection and testing of water samples for contaminants related to the wood preservatives in the pole. Based on the location and other characteristics of your water supply, the Department of Health may advise you to test for other contaminants as well.

Who will test the water? Only certified laboratories can test drinking water. A list of the Vermont-certified laboratories can be found here:
http://healthvermont.gov/enviro/ph_lab/documents/certified_labs.pdf
or ask the state agency that you are working with for a list of certified laboratories near you.



What will happen if the water is contaminated? The staff at the state agencies and your utility will work with you to come up with a remediation plan to fix the situation.

Appendix 6 Sites Management's Case Summaries[1]

Summary of specific pentachlorophenol releases in Vermont which led to contamination of drinking water sources

Clarendon Residence

A utility pole approximately 40 feet from the onsite drinking water spring was replaced in early 2009. Soon after the pole replacement, the residents of the property began to notice odors in the water supply similar to the utility pole odor. Under the directive of the Site Management Section (SMS), the utility oversaw the replacement of the pole (with a cedar pole), removal of soil surrounding the pole, and a new bedrock water supply well was installed approximately 80 feet from the original dug well. Monitoring wells were installed to measure any lingering impacts of pentachlorophenol on the property, but it was found that after the initial impact and replacement of the pole that the pentachlorophenol concentrations declined rapidly as verified by samples taken by both the utility's consultant and the Vermont Agency of Agriculture, Food & Markets (VAAFM). The utility elected to replace all of the piping and several appliances in the residence during the cleanup effort. This property received a Site Management Activity Completed (SMAC) designation after meeting regulatory requirements for soil, groundwater and drinking water.

Bennington Residence

Similar to the Clarendon Residence, a pole was replaced near a drinking water spring in 2009, and again an odor was detected in the spring water shortly thereafter. This was a very wet location with a surface water feature directly below the pole and very shallow groundwater conditions. Under the directive of the SMS, the utility oversaw the replacement of the pole (with a cedar pole), removal of soil surrounding the pole, and a carbon-based point of entry (POET) treatment system was installed to remove pentachlorophenol from the spring water influent. Pentachlorophenol concentrations were also found to drop rapidly at this site following removal of soil and pole replacement. The utility installed a new bedrock water supply well to give the owner more assurance about the safety of their water source. However, the new bedrock well was found to have levels of radium exceeding the Vermont Groundwater Enforcement Standards (VGES), so the homeowner decided to revert back to their use of the treated spring source. This spring treatment source was maintained for some time until several rounds of sampling confirmed that there were no detections of pentachlorophenol. The treatment system was eventually removed. At the time of the soil removal and pole replacement, elevated pentachlorophenol concentrations were noted at the bedrock interface at approximately 8 feet below grade. Additional supplemental subsurface investigations between the former utility pole and the spring are required by the DEC before issuing a SMAC designation. This has been delayed as the current property owner is not allowing site access.

Monkton Residence

A utility structure was replaced near a shallow water supply spring in Monkton in March of 2014. The spring was located approximately 45 feet down-gradient of the utility structure and within a seasonal surface water feature. The utility had conducted baseline water sampling prior to the replacement of the structure, and no pentachlorophenol was detected in the spring. During the replacement of the utility structure, odors were detected in the residence water. Upon this discovery the utility returned to the property and collected another sample from the water source. Pentachlorophenol was recorded in this sample in excess of the VGES. The utility had initiated the installation of a replacement bedrock water source be provided and SMS requested that an investigation of soil and groundwater be conducted in the areas surrounding the pole and the spring. Several soil borings and monitoring wells were established at this location and one area near the residences' leach field. No pentachlorophenol was detected in any of the shallow groundwater samples from the monitoring wells. Sheens were initially observed on the surface water near the spring, which was believed to related to the carrier oil compounds that are also present in the utility pole treatment (used as a 'binder' for pentachlorophenol in the

[1] As described in VTDEC Sites Management Section memo dated December 16, 2014.

preservative solution). Surface water samples collected from an area adjacent to the spring showed elevated levels of pentachlorophenol, though these concentrations were below the VGES and the concentrations for protection of aquatic biota. This is relevant as a large wetland complex is located to the west and down gradient of the utility pole structure. A new bedrock water supply well was installed over 150 yards from the former spring on the property and was found to be free of pentachlorophenol contamination. Several water system components within the residence were also replaced by the utility.

Summary of other confirmed or suspected pentachlorophenol releases in VT, which did not result in drinking water contamination

Middlesex Residence

In 2010, shortly after installation of new utility poles by a local utility near a residence, the owners began to notice odors in their water supply. No pentachlorophenol was ever detected in confirmatory samples from the water source, though pentachlorophenol was encountered in soil a short distance from the pole. Poles were replaced with cedar and impacted soil was removed from the vicinity of the poles in question.

Waterbury

A release from a newly installed utility pole was reported to VT DEC in 2010 by someone who spotted black liquid migrating from the pole on nearby I-89. Remedial actions included soil removal and installation of a containment vessel around the pole.

Pole Storage Yard, Bellows Falls

A pole storage yard was investigated in 2009 and found to have elevated levels of pentachlorophenol and other contaminants in soil in a former pole storage area. Over 1,000 tons of impacted soil was removed and transported for disposal. It appears that the bulk of contamination was effectively removed and there were no documented groundwater impacts.

Pole Storage Yard, Dummerston

A pole storage yard was investigated in 2007 and found to have elevated levels of pentachlorophenol and other contaminants in soil in a pole storage area. Over 2,000 tons of impacted soil was removed and transported for disposal. It appears that the bulk of contamination was effectively removed and there were no documented groundwater impacts.