

Fraser River Action Plan



Evaluation of Leachate Quality From Pentachlorophenol, Creosote and ACA Preserved Wood Products



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EVALUATION OF LEACHATE QUALITY FROM
PENTACHLOROPHENOL, CREOSOTE AND ACA
PRESERVED WOOD PRODUCTS

DOE FRAP 1993-36

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DISCLAIMER

This report was funded by Environment Canada under the Fraser River Action Plan through its Fraser Pollution Abatement Office. The views expressed herein are those of the authors and do not necessarily state or reflect the policies of Environment Canada.

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EXECUTIVE SUMMARY

This project, sponsored by Environment Canada, was initiated to evaluate the leachability characteristics of pentachlorophenol (PCP), creosote and ammoniacal chromium arsenate (ACA) wood preservatives from freshly treated wood products. The study was designed to reproduce the conditions found in a typical treated product storage yard and to determine the potential chemical concentration that may be found in rainfall-generated leachate. This study is the second of two studies to evaluate wood preservation leachate. The first study, completed in 1992, evaluated Chromated Copper Arsenate (CCA) treated wood products.

The test products included pentachlorophenol treated utility poles, creosote treated timbers, creosote treated marine pilings (poles), and ACA treated utility poles. Bundles of test products were placed over collection trays to collect the leachate generated by natural rainfall and by sprinklers with tap water. The sampling schedule was based on accumulated rainfall with samples taken at approximately 15 mm, 30 mm, 45 mm, 60 mm, 75 mm, 90 mm, 105 mm, 120 mm, 135 mm and 150 mm. The trays were drained and rinsed after each benchmark accumulation was sampled.

Analyses included pH, oil and grease, total organic carbon, ammonia, metals, polynuclear aromatic hydrocarbons (PAH), chlorinated and non-chlorinated phenols, resin acids and fish toxicity. A quality assurance and quality control (QA/QC) program was included to verify the validity of the analyses.

The study indicated that leachates from ACA, creosote and PCP freshly treated wood products have potential for aquatic toxicity if released to the environment. Ammonia releases did not show a trend as values fluctuated through the course of the study. However, a decreasing trend was noted in both the arsenic and copper releases as cumulative precipitation increased. Pentachlorophenol releases remained constant over the course of the study whereas PAH releases showed no significant trend. Total PAH showed no overall trend with respect to chemical concentration over time. Phenanthrene was found to be the main component in releases. A sample of the pole leachate obtained approximately 4 months after the end of the study showed that creosote and PCP releases remained in the same range as those found during the original study period.

This study represents a worst case scenario. The concentration values observed in this study should not be interpreted as representative of those found in surface runoff discharged from the site into a receiving environment because there are significant differences between the experimental setup and the actual conditions at the treatment facilities. The releases observed in this study are those from leachates produced by direct contact of water with the treated wood product whereas runoffs discharged from the site are subject to dilution and other retarding factors such as soil adsorption, biodegradation and volatilization.

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**EVALUATION OF LEACHATE QUALITY
FROM PENTACHLOROPHENOL, CREOSOTE AND
ACA PRESERVED WOOD PRODUCTS**

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EVALUATION OF LEACHATE QUALITY FROM PENTACHLOROPHENOL, CREOSOTE AND ACA PRESERVED WOOD PRODUCTS

1.0 INTRODUCTION

Envirochem Special Projects Inc. (Envirochem) was contracted by Environment Canada to evaluate the leachability characteristics of pentachlorophenol (PCP), creosote and ammoniacal chromium arsenate (ACA) wood preservatives from freshly treated wood products. The study was designed to reproduce the conditions found in a typical treated product storage yard and to determine the potential chemical concentration that may be found in rainfall-generated leachate.

Although controlled leachate tests of antisapstain treated wood have been conducted by Environment Canada, few studies have been conducted for wood treated with wood preservatives. In 1992, Envirochem completed a similar study on wood products treated with chromated copper arsenate (CCA). The protocols developed by Envirochem for the first study formed the basis of the protocols used in the study of rainfall-generated leachate from pentachlorophenol, creosote and ammoniacal copper arsenate treated wood products.

There is minimal stormwater quality data from wood preservation treatment facilities and little is known about the leaching characteristics of wood preservation chemicals from freshly treated products. Therefore, the purpose of this study was to provide preliminary data on the leachate characteristics from wood preservative treated products to both industry and regulatory agencies.

There are many products treated with ammoniacal copper arsenate (ACA), pentachlorophenol in oil (PCP), or creosote. In consultation with both the wood preservation industry representatives and with regulatory agency staff, it was agreed that this study would evaluate rainfall-generated leachates from the following treated products:

- Pentachlorophenol treated utility poles
- Creosote treated timbers
- Creosote treated marine pilings (poles)
- ACA treated utility poles

2.0 BACKGROUND

Wood preservation is the pressure or thermal impregnation of chemicals into wood to a depth that will provide effective long-term resistance to attack by fungi, insects and marine borers. By extending the service life of available lumber, wood preservation reduces the harvest of already stressed forest resources, reduces operating costs for utilities and railways and ensures safe working conditions where preserved timbers are used in structural applications.

The wood preservation process differs from the wood protection process by virtue of the length of time protection is sought and hence the difference between the chemicals and application methods used. The chemicals predominantly used in Canada for wood preservation are pentachlorophenol (PCP), creosote and aqueous formulations of arsenic, copper and chromium (CCA) or, ammonia, copper and arsenic (ACA).

A 1984 study funded by Environment Canada identified and reviewed operations at 15 wood preservation plants in British Columbia which were used for the application of chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), creosote or pentachlorophenol (PCP) (Henning and Konasewich, 1984). Since that time, at least four new wood preservation facilities have been built in British Columbia. The authors of the 1984 report recommended that a Code of Good Operating Practice be established for the wood preservation industry in B.C. The recommendation was motivated by "the potential gravity and permanency of environmental and/or human health impacts which can result from major releases of wood preservation chemicals."

Later in 1984, Environment Canada established a Wood Preservation Industry Steering Committee to develop a Technical Recommendations Document which would define wood preservation facility design and operational measures to reduce or eliminate the release of wood preservation chemicals to the environment and to eliminate harmful exposure of the workers to wood preservation chemicals. The members of the Committee included representatives of Federal and Provincial Government agencies, wood preservation companies and the forest industry labour unions. In 1988, a series of separate Technical Recommendations for the Design and Operation of Wood Preservation Facilities documents were produced by Envirochem and

published for each of the 5 distinct wood preservation processes (Konasewich and Henning, 1988 a, b, c, d, e).

In 1990, Environment Canada developed an evaluation process based on the Technical Recommendation Documents and evaluated each wood preservation facility in British Columbia with respect to the design and operation recommendations. Each of the facility managers were notified of the evaluations for their individual facilities.

In 1992, the B.C. Ministry of Environment, Lands and Parks (B.C. Environment) and Environment Canada retained Envirochem to further pursue studies of wood preservation operations, in part, as an overall assessment of industrial operations and environmental discharges to the Fraser River. This project included audits of the six wood preservation facilities operating in the Lower Mainland of B.C., and sampling and analyses of stormwaters from each facility (Envirochem, 1992a).

In 1992, Environment Canada with B.C. Environment initiated a program to evaluate chemical releases in rainfall-generated leachate from preserved wood products. The results of the first study are documented in the report, "Evaluation of Leachate Quality from CCA Preserved Wood Products" [Envirochem, 1992(b)]. Subsequently, in 1993, Environment Canada requested a similar assessment of chemical concentrations leached from ACA, PCP and creosote-treated pilings, timbers and railway ties. Envirochem Special Projects Inc. was contracted to undertake the work, and this document reports the results of the study.

As per the Environment Canada Request for Proposal, the intent of this information would be to:

- identify the need to develop remedial actions at Fraser River wood preservation plant storage yards,
- provide information to B.C. Environment for the possible development of appropriate stormwater discharge levels in a future Wood Preservation Chemical Waste Control Regulation under the Waste Management Act, and
- provide information to Agriculture Canada for the re-evaluation of the registration of wood preservation chemicals.

3.0 METHODOLOGY

The objectives of the study were to:

- (1) Characterize the leaching of ACA, PCP, and creosote wood preservation chemicals from stored treated wood products and to determine levels of contaminants over various leaching periods.
- (2) Determine acute aquatic toxicity to salmonid species of selected leachate samples.

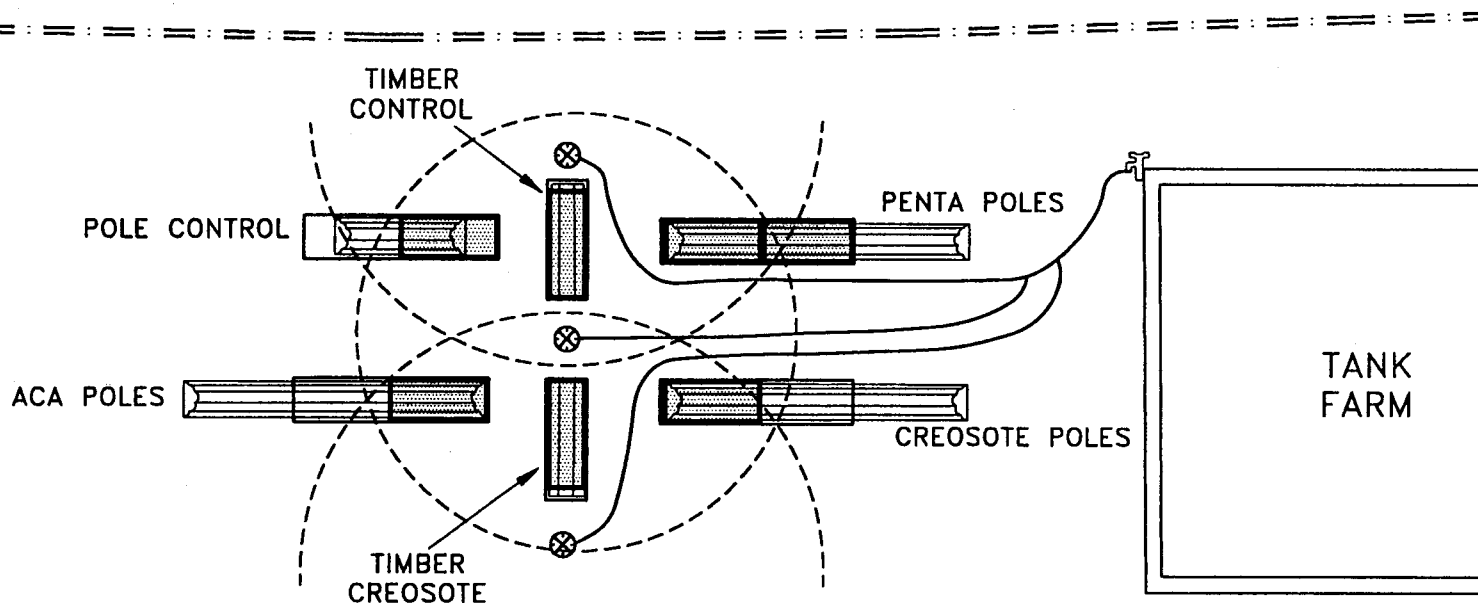
The sampling protocols followed for this study were based on protocols originally developed by Krahn and Strub (1990) for the study of leachates from wood treated with antisapstain chemicals. In general, the protocol calls for bundles of preserved wood products to be placed on steel frames that permit the collection of leachate. Leachate was generated either by rainfall on the bundles or artificially with a water sprinkler. Samples were obtained on the basis of accumulated precipitation as measured in rain gauges attached to the bundles.

The general layout of the test trays is shown in Figure 1. The main study was undertaken at Domtar Inc., Wood Preserving Division, (now Stella-Jones Inc.) in New Westminster, B.C. between March 1 and March 31, 1993. Additional samples of leachate from the same pentachlorophenol and creosote treated wood bundles were obtained July 19, 1993 to enable an assessment of leachate quality over a longer timeframe.

The detailed study set-up and sampling methodology is described in the following sections.

3.1 Wood Test Products

The test products were selected to represent products most commonly produced by Lower Mainland wood preservation facilities.



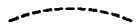
LEGEND



TRAIN TRACKS



SPRINKLER AND HOSE



APPROXIMATE AREA COVERED BY SPRINKLER



SUPPORT FRAME AND COLLECTION TRAY

0 5 10 15 20 25
APPROX. SCALE (FEET)

Envirochem

TITLE:

TEST AREA LAYOUT

SUPERVISOR:	DW/LL	DATE OF WORK:	1993
DRAWN BY:	PW	DATE DRAWN:	24-AUG-93
REVISED BY:	LL	DATE REVISED:	24-NOV-93
PROJECT NUMBER:	1256	DRAWING NUMBER:	1256-01

PROJECT: ENVIRONMENT CANADA
LEACHATE TRAY STUDY

FIGURE:

1

Six wood test product bundles were utilized for this study. Each of the products tested were Douglas Fir. Four of the test bundles were made up of round stock: one bundle was treated with ammoniacal copper arsenate (ACA) as would be used for foundation or construction timbers; one was treated with creosote as would be used for marine pilings; one was treated with pentachlorophenol as would be used for utility poles; and the remaining round stock bundle was untreated and used for control purposes. The remaining two test packages were sawn timbers. One package was treated with creosote as commonly used for railroad ties, landscaping and construction timbers, and the other was untreated for control purposes. The bundles consisted of normal lengths of treated products, and the configuration of the leaching tests is described in Section 3.2. Table 1 below details the specifications of each of the test products.

Table 1

**Wood Preservation Leachate Study
Test Product Specifications**

Test Bundle Type, Product Shape and Wood Type	# Items/ Test Bundle	Diameter (cm) Range & [Average]	Date Treated	Chemical Target & Retention	Treatment Pressure & Temperature
ACA Pilings (round sapwood)	15	16-25 [21.3]	March 1, 1993	20 kg/m ³ 12 kg/m ³ (A)	960 kPa 49°C
Creosote Pilings (round sapwood)	15	19-28 [24.9]	February 28, 1993	166 kg/m ³ 128 kg/m ³ (G)	820 to 960 kPa 88 - 91°C
Creosote Timber (sawn squares, heartwood)	12	25 by 28*	March 3, 1993	198 kg/m ³ 128 kg/m ³ (G)	820 to 960 kPa 88 - 91°C
Pentachlorophenol Poles (round sapwood)	15	16-27 [20.8]	February 15, 1993	15.7 kg PCP/m ³ 128 kg PCP soln/m ³ (A)	820 kPa 88°C
Control Poles (round sapwood)	15	18-25 [21.0]	untreated	-	-
Control Timbers (sawn squares, heartwood)	12	25 by 30*	untreated	-	-

* Width x height

G: gauge

A: assay

3.2 Leachate Tray Set-up

Four large and two smaller mild steel frames were used to support the wood test bundles and leachate collection trays. The large frames were used for supporting the poles, and the small frames supported the timbers. Within the frames, shallow mild steel leachate collection trays were designed for this project and arranged as shown in Figure 1. They were placed beneath the treated wood collecting approximately 52.4 litres (large tray) and 46.7 litres (small tray) of sample for every 15 millimetres of accumulated rainfall. With the exception of one tray under the center of the PCP treated poles, the other trays were placed to collect drippage from the end of the bundles. The pole bundles were slightly tilted away from the collection tray to prevent leachate from the end not underlaid by the collection tray from flowing into the tray.

The poles (fifteen per bundle) were laid out alternating "butts and ends" to form a pyramid shaped bundle which was strapped to prevent logs from rolling off the support frame. Bundle width was adjusted to correspond with that of the collection tray by tightening the metal straps. The bundles were subsequently placed on top of the support frame as to line up with the edge of the collection tray while ensuring the tray would extend approximately ten centimetres (10 cm) on all sides so that all drippings off the wood bundles would collect in the tray.

As the length of the tray was significantly shorter than of the test poles, the poles were positioned and supported to that the bundle "butt and end" part hung over the collection tray to obtain leachate from the end pieces of bundles. The pole bundles were slightly tilted away from the collection tray to prevent the collection of leachate from the end not underlaid by the collection tray.

The timbers bundles were arranged in packages of twelve (12) timbers strapped together with metal band. The timber bundles were installed on the support frame as to line up with the edge on the collection tray while enabling the tray to extend approximately ten centimetres (10 cm) on all sides.

The construction of stainless steel or glass-lined trays was the most preferable material for the leachate collection trays but their significant expense and difficulty of fabrication could not be accommodated by the project. Therefore, mild steel trays were fabricated. The trays were not coated with an epoxy sealant as originally intended because of concerns with potential paint leachate contamination of the samples and subsequent impacts on toxicity, particularly over the

short duration of the project. Various plastic liners were tested in the Envirochem laboratory but because of the significant adsorption of the organic compounds to the plastic liners, their use was ruled out. The ACA collection tray however, was lined with 10 mil black polyethylene sheet since ACA is not significantly retained on plastic.

Three sprinklers were set up at the test site to permit leachate generation by artificial rainfall. The main control parameter for the sampling program was accumulated precipitation. The sprinklers ensured that the project could proceed without undue delays even without rainfall. About 30% of the leachate samples for this project were produced as a result of sprinkling.

Photographs showing the configuration of the bundles mounted on the trays are shown in Appendix I.

3.3 Sampling Schedule

The sampling protocol called for collection after every 15 millimetres of accumulated rainfall. This sampling interval is thought to represent a typical rainfall event in the Lower Mainland region of British Columbia.

Leachate samples were collected on the basis of accumulated precipitation, with collection at approximately 15 mm, 30 mm, 45 mm, 60 mm, 75 mm, 90 mm, 105 mm, 120 mm, 135 mm and 150 mm. Data on accumulated precipitation was collected using field rain gauges mounted individually on each of six (6) test bundles. The original program specified analyses of only one half of the samples with the other one half being held in cold storage as archived samples.

In the absence of rainfall, the sprinklers were turned on and adjusted so that all bundles received uniform coverage.

3.4 Collection of Leachate Samples

As previously specified, samples were collected approximately at each increment of 15 mm of accumulated precipitation. The trays were drained and rinsed after each benchmark accumulation was sampled. The sampled volume and the excess volume of leachate were

measured and recorded at each sampling event. Measurements of pH were performed in the field.

Sample collection occurred according to the following procedure:

- (1) The leachate accumulated in the collection tray until the rain gauge indicated there had been 15 mm of precipitation. The accumulation time varied according to rainfall intensity.
- (2) Once the desired range of accumulated precipitation was reached, its actual value in the rain gauges was recorded. The collection tray drainage valve was then opened and the first fifty millilitres (50 ml) of leachate were wasted. This was done to avoid sampling leachate which had remained in the drainage pipe and that had not been thoroughly mixed with the entire sample.
- (3) Samples were collected directly from the collection tray drainage pipe into the sample bottle. Samples were collected in the following order:
 - a) samples to be analyzed for chemical parameters (metals, ammonia, PAH, chlorophenols, phenolics, TOC)
 - b) samples to be analyzed for oil and grease
 - c) samples to be tested for toxicity, including fish bioassay LC_{50} and LT_{50}
- (4) When all desired samples were obtained, the collected sample volume and the excess leachate volume were recorded.
- (5) Once measured, the excess leachate volume for the given accumulated precipitation increment was wasted by allowing it to drain for eventual collection in the site water treatment plant, which consists of flocculation and activated carbon treatment.
- (6) The trays were then rinsed to ensure that no carry over of chemicals took place between sampling events. Rinsing was done by spraying the trays with a high pressure garden hose nozzle while leaving the drainage pipe valve in the open position. After rinsing the

trays were squeegeed (one dedicated to each collection tray) to drain all excess rinsate water. Once the rinsate was all drained, the collection tray valve was closed to start another cycle of sample collection.

- (7) Field measurements of pH were performed on the sample collected for the fish bioassay test (LC_{50} toxicity).
- (8) The samples to be submitted for metal analysis were filtered and acidified in the field at the time of sampling. Filtration was performed by vacuum filtration of the sample through a 0.45 micron nitrate cellulose filter paper and acidification by addition of 3 to 5 ml of 10% nitric acid (HNO_3)
- (9) The sampling procedures for the ACA treated poles were similar to that described, however, due to the nature of ACA, the leachate needed to be collected in a plastic lined tray to avoid contact of the leachate with metal. Consequently, in step 6 of the above procedure instead of rinsing the tray, the plastic liner was removed and replaced following every sampling event.

3.5 Analyses

Organic and metals analyses were carried out by Analytical Services Laboratory (ASL) of Vancouver, bioassay testing by Beak Consultants of Richmond, B.C. with additional metals analyses carried out by Quanta Trace Laboratories of Burnaby B.C. Domtar obtained duplicates of some samples and had Cantest Labs of Vancouver, B.C. perform total oil & grease and some organics analyses. Domtar kindly provided this data for inclusion in this report.

The analytical program consisted of the following components:

- (a) demonstration, through analysis of a minimum of one method blank, that minimal contamination of apparatus and reagents is present,
- (b) analysis of 15% of the submitted samples in duplicate to provide an indication of reproducibility,

- (c) analysis of a minimum of two control materials or reference samples to provide an indication of analytical accuracy,
- (d) demonstration, through recovery of internal standards or spiking of relevant compounds, of the accuracy of the analysis, and
- (e) provision of full documentation of analytical and quality assurance procedures, including calibration data and estimates of method performance, i.e. precision, accuracy, detection limits, and quantification limits.

The analyses were conducted as per procedures outlined in the "methodology" section of chemical analysis reports produced by the contracted laboratories. The procedures are included below as presented in the laboratory reports.

Conventional Parameters in Water (pH, oil and grease, TOC, ammonia)

These analyses were carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 18th Ed. published by the American Public Health Association, 1992.

Metals in Water

These analyses were carried out in accordance with procedures described in "Standard Method for the Examination of Water and Wastewater" 18th Edition published by the American Public Health Association, 1992. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element.

Polynuclear Aromatic Hydrocarbons (PAHs) in Water

This analysis was carried out in accordance with U.S. EPA Method 3510/8270 (U.S. EPA, 1986). This method involved the extraction of the sample with methylene chloride followed by silica column chromatography cleanup. The resulting extract was analyzed by capillary column gas chromatography with mass spectrometric detection.

Chlorinated Phenols in Water

The analyses were carried out in accordance with U.S. EPA Methods 604 (EAP 1984 - 40 CFR Part 136, 49:209) and 3510/8040 (U.S. EPA, 1986). The sample was extracted with acidified methylene chloride followed by a ion-exchange cleanup. The final extract was derivatized and analyzed by capillary column gas chromatography with flame ionization detection and electron capture detection.

Non-Chlorinated Phenols in Water

The Standard Method 5530 4-aminoantipyrine colorimetric method was used to determine the concentration of "phenols". "Phenols" would include: phenol and, ortho-and meta-substituted phenols.

Resin Acids in Water

This analysis was carried out in accordance with EPS and Pacific Environmental Institute Methods. The procedure involves extraction of the sample with dichloromethane. The extract is concentrated and derivatized with TBDMS [N-methyl-N(t-butyldimethylsilyl)-trifluoroacetimide]. The TBDMS ester derivatives are cleaned up on a silica gel solid phase extraction (SPE) column and analyzed by capillary column gas chromatography with mass spectrometric detection.

QA/QC

For each batch of analyses the QA/QC consisted of analyses of a method blank for each parameter, a certified reference material for dissolved metals and organic parameters, and a spiked sample containing PAHs, chlorophenols and resin acids. "Blind" spikes prepared by Environment Canada were also submitted for analysis. The recoveries are reported in the analytical reports for each batch of analysis and are included in Volume II of this report.

Overall the PAH analyses were acceptable, with a comparison with a "blind QC" sample indicating a minimum of 69% recovery, with a high false positive for acenaphthene (4.9 µg/L reported versus a true value of "zero"), and 0.001 µg/L pyrene reported for a value of "zero".

The detection level for PAHs was reported by the laboratory as 0.0001 mg/L. The chlorophenol analyses, once properly conducted, had recoveries of at least 74%.

Recoveries of certified dissolved metal samples were reported to be within 95% confidence limits. All metal samples were analyzed twice to verify the absence of any computer logging errors which had occurred with a blind QC sample.

Completion of the study was delayed due to a laboratory technician's error, whereby an improper dilution factor had been reported for a series of analyses. Although the laboratory standard was reported with high recoveries, the standard itself was not diluted as were the leachate samples and the error was not discovered until the laboratory was questioned about the analytical results. As a result the uncertainty introduced to the results by the laboratory, the alternate leachate samples collected and archived by Envirochem were analyzed, followed by re-analyses of extra leachates which were in cold storage. Similar problems with PCP analyses have been experienced with other contract laboratories, suggesting that a rigorous QA/QC program, which includes known and blind duplicates and spiked samples, must always be applied in studies of this type.

All analytical data from the original submission, the additional samples from the alternate set of samples which had previously been archived along with the re-analysis of the original set of samples are included in Volume II of this report. The reports are compiled in chronological order of sample submission and result reporting.

3.6 Bioassay Test

Leachate toxicity was evaluated by the standard 96-hr LC_{50} bioassay using rainbow trout (*Oncorhynchus mykiss*) as per Environment Canada protocols.

As presented in the report of results from Beak Consultants, the LC_{50} is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality. Results are calculated using the method described by Stephan (1977).

The test method followed was as per protocols defined by Environment Canada (1990) and B.C. Environment (1984).

Essentially, the 96-hr LC_{50} bioassay test determines the concentration of leachate which will cause death to 50% of the test fish population over 96 hours. As an example, a 5% 96-hr LC_{50} implies that a 20-fold dilution of the runoff with clean water would be required to ensure that no more than 50% fish die over 96 hours exposure. The reported LC_{50} value is inversely related to toxicity - i.e. the higher the LC_{50} concentration, the less the toxicity.

4.0 RESULTS AND DISCUSSION

This section first describes the releases of wood preservatives from each type of treated product. Other chemical parameters, such as total organic carbon (TOC), phenolics, oil and grease, pH and resin acids were also monitored and are discussed separately in Section 4.4. In addition, data on chemical releases from untreated wood products which served as controls are included on all graphs.

The raw analytical data has been compiled and is presented in a separate volume. The data from parameters of interest have been plotted and are included in this section whereas data tables which were used to produce the plots are presented in Appendix II of this document.

4.1 ACA (Ammoniacal Copper Arsenate) Poles

4.1.1 Chemical Releases

The measured concentrations of ammonia, copper and arsenic in the leachates vs. accumulative rainfall are shown in Figures 2, 3, 4, and 5. Figure 6 plots the toxicity as measured by the LC_{50} vs. accumulative rainfall.

All metal concentrations are "dissolved concentrations". Total metals were not determined because of the presence of ACA wood debris washoff found in the collection tray following each precipitation event.

Ammonia

As shown in Figure 3, the total ammonia-nitrogen concentration was noted to have increased from 146 to 233 mg/L during the first 90 mm of precipitation. Subsequently, ammonia concentrations decreased to 102 mg/L by the end of the study. The pH of the initial leachate was 8.0, and the subsequent pH values were in the range of 7.5 ± 0.2 .

Ammonia and Metal Release in Leachate from ACA Treated Poles

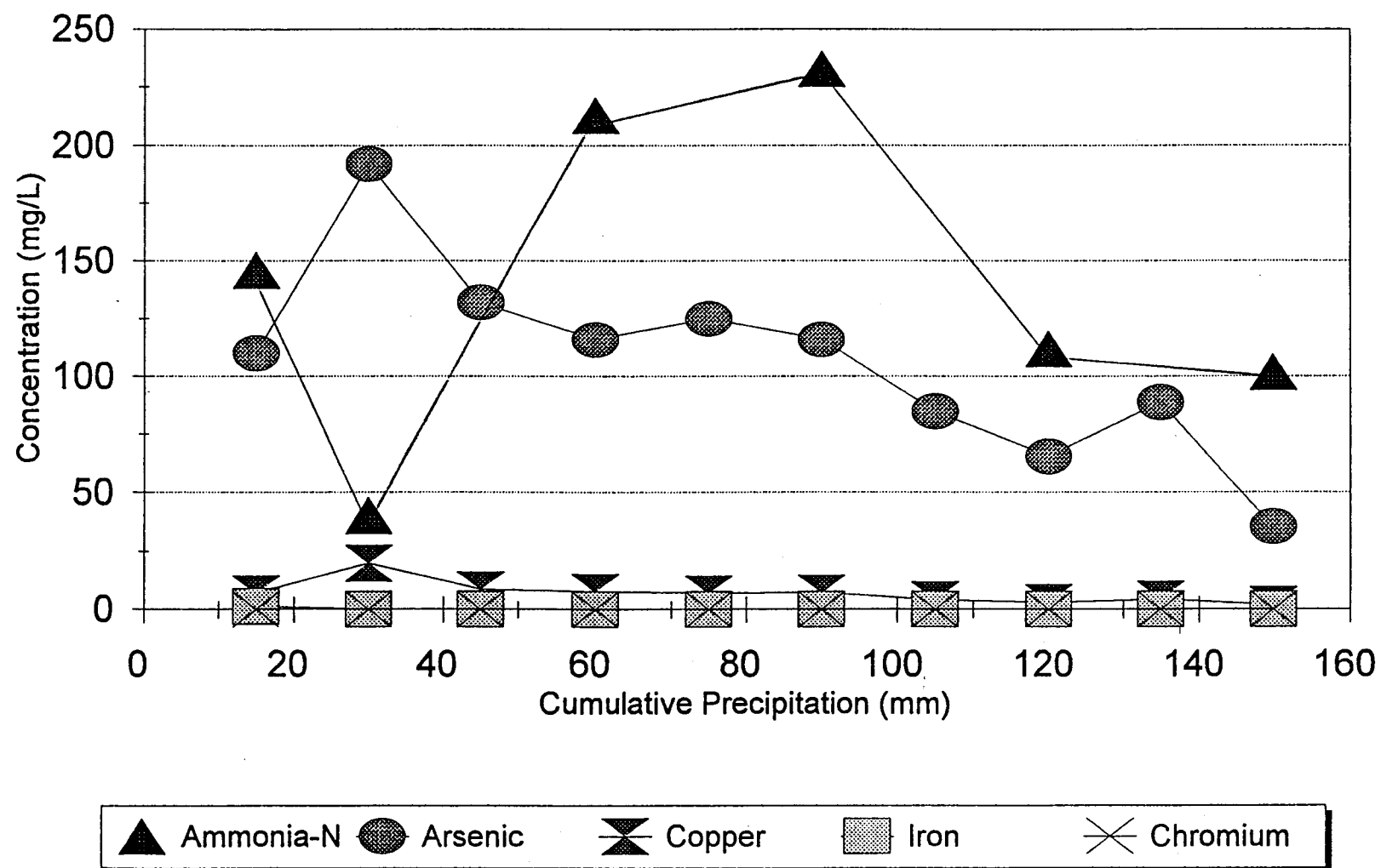


Figure 2

Ammonia Releases in Leachate from ACA Treated Poles

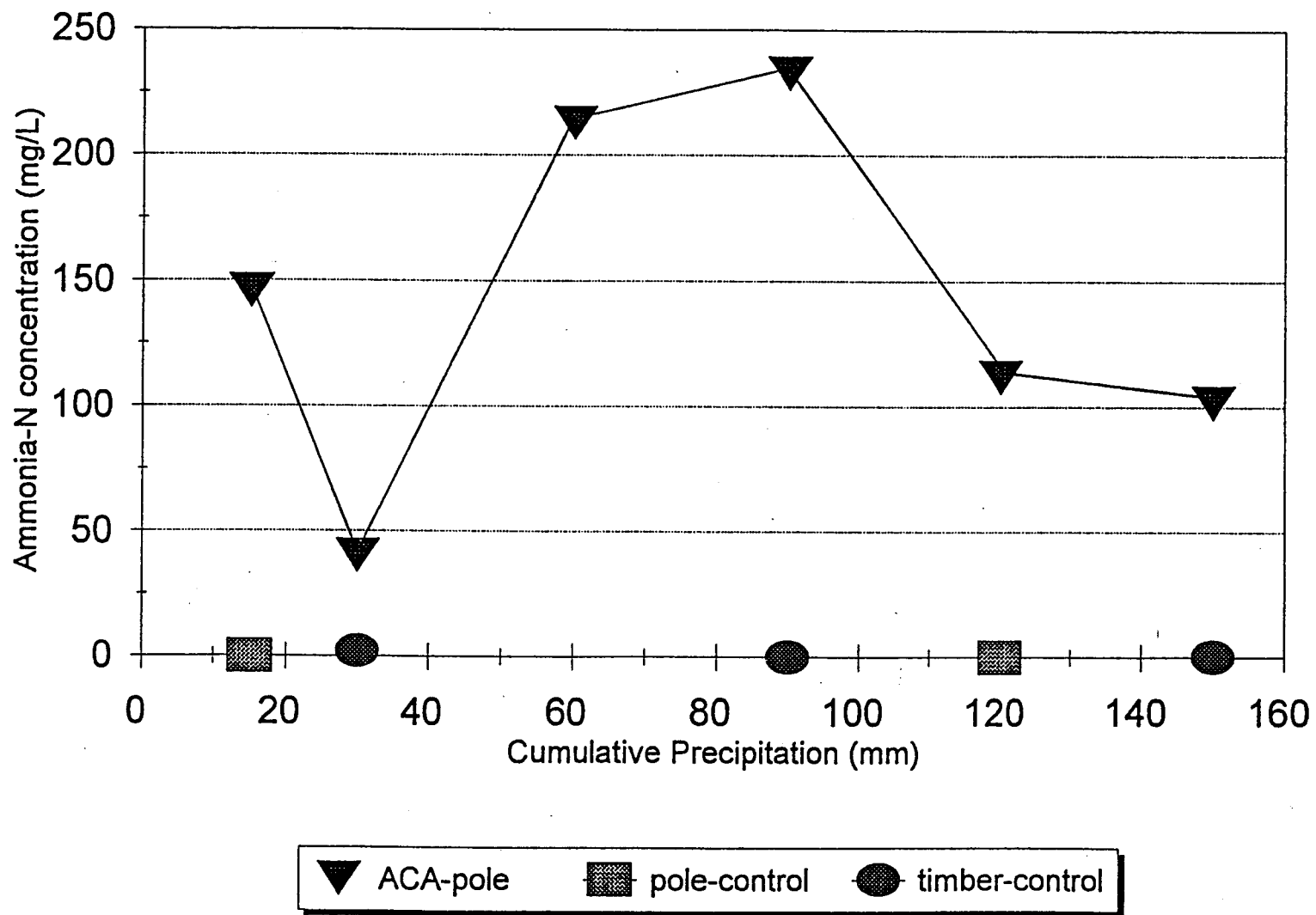


Figure 3

Arsenic Releases in Leachate from ACA Treated Poles

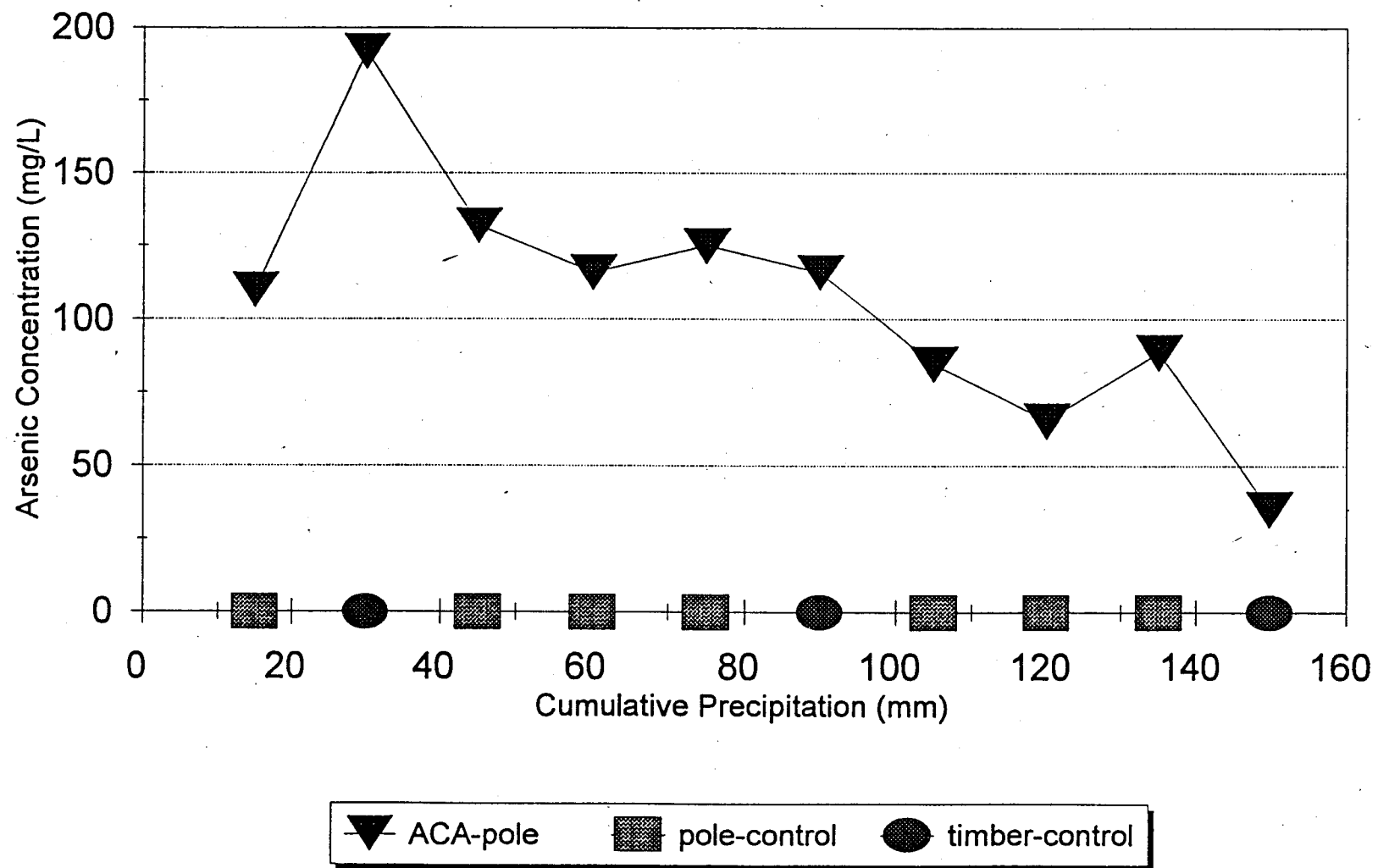


Figure 4

Copper Releases in Leachate from ACA Treated Poles

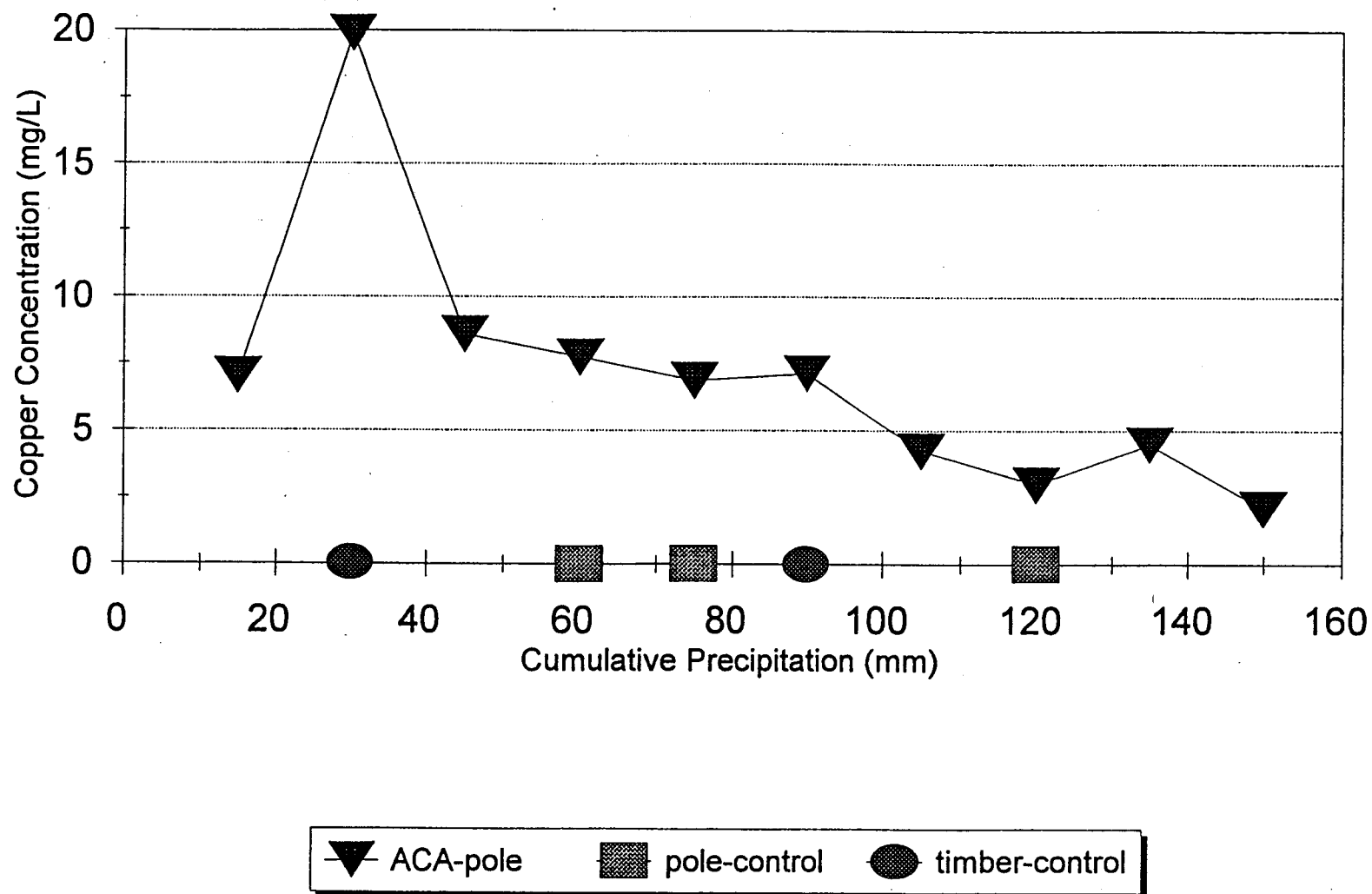
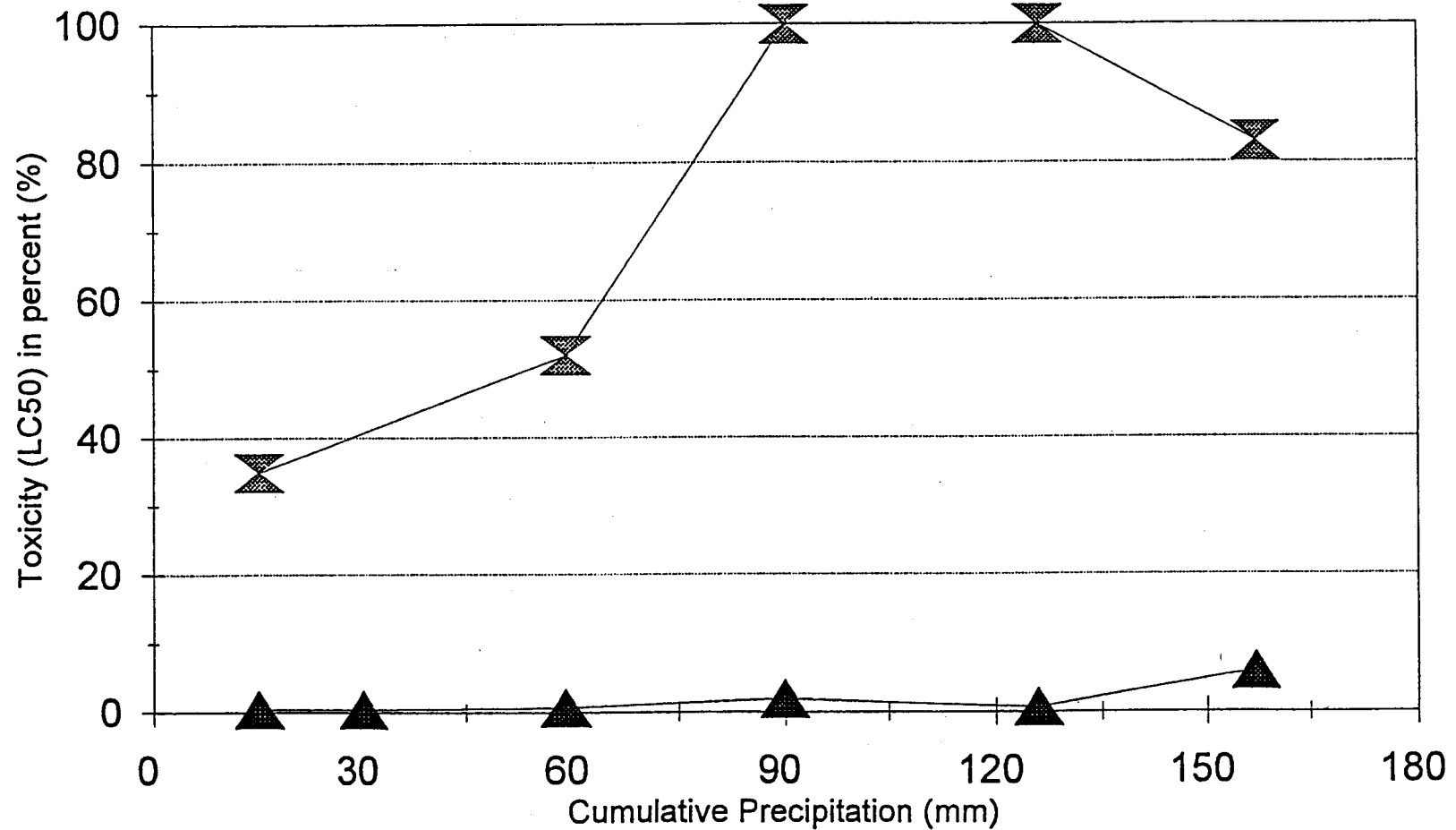


Figure 5

Toxicity (LC50) of Leachate from ACA Treated Poles



▲ ACA-pole X pole-control

The concentrations are in excess of the CCME guideline for ammonia for the protection of salmonids or other sensitive cold water species. The CCME guideline is 2.2 mg/L total ammonia at pH 7.5 at 10°C.

Arsenic

As shown in Figure 4, the arsenic release was initially in the order of 110 mg/L. An increase to 192 mg/L occurred at 30 mm of precipitation. The following sample showed a decrease to 132 mg/L back to the range of the initial sample. Subsequent releases showed a decreasing trend reaching 35 mg/L by the end of the study.

A U.S. EPA review of arsenic toxicity suggests that the inorganic arsenic (III) compound, sodium arsenite, has an LC_{50} (96 hr) ranging from 14 to 42 mg/L for various fish species. The LC_{50} for brook trout was reported as 15.0 mg/L [U.S. EPA, 1985 (a)]. The LC_{50} 's for the arsenic (V) compound, sodium arsenate, vary from 10.8 mg/L for rainbow trout to 49 mg/L for mosquito fish [U.S. EPA, 1985(a)].

Based on short-term effects on embryos and larvae of aquatic vertebrate species, the EPA has recommended that the four day average concentration of arsenic (III) should not exceed 0.190 mg/L and the one day average should not exceed 0.36 mg/L more than once every three years on average. There are no EPA criteria for arsenic (V). The form of arsenic in the leachate was not determined; however, the pentavalent form is used to formulate ACA.

The CCME guideline for total arsenic is 0.05 mg/L and is based on the protection of human health via drinking water (CCME, 1987).

Copper

As shown in Figure 5, the copper releases behaved similarly to the arsenic releases. The leachate concentration was initially in the order of 7 mg/L. There was an increase to 20 mg/L which occurred at 30 mm of precipitation. The following sample showed a decrease to 8 mg/L back to the range of the initial sample. Subsequent releases slowly decreased to 2 mg/L at the study completion.

Aquatic biota are extremely sensitive to copper with avoidance behaviour documented at concentrations as low as 0.002 mg/L, cough frequency increases in brook trout at 0.006 to 0.015 mg/L, and mortality of brook trout larvae at 0.01 to 0.02 mg/L [U.S. EPA, 1985 (b)]. The LC_{50} (96 hr) for juvenile test salmonids is approximately 0.1 mg/L. The CCME guidelines for total copper in water range from 0.002 mg/L in water of hardness of 0 to 60 mg/L (as $CaCO_3$) to 0.006 mg/L in water of hardness in excess of 180 mg/L hardness (as $CaCO_3$) (CCME, 1987).

4.1.2 Aquatic Toxicity

The chemical leachate data discussed in Section 4.1.1 are compared with the literature LC_{50} values in Table 2.

Table 2
Comparison of Leachate Concentrations with Literature LC_{50} Concentrations

	Ratios $\frac{\text{maximum leachate conc. (mg/L)}}{\text{literature } LC_{50} \text{ (mg/L)}}$	
	Beginning of Study	End of Study
Ammonia	$233/2.2 = 105$	$102/2.2 = 46$
Arsenic	$192/14 = 14$	$35/14 = 2.5$
Copper	$20/0.1 = 200$	$2/0.1 = 20$

The data suggest that copper releases in leachate would be of greatest concern with respect to fish toxicity, i.e., the concentrations in leachate exceeded reported LC_{50} values by 200 fold. The ratios suggest the dilutions which would be required for compliance with the LC_{50} bioassay test.

Figure 6 and the laboratory data in Appendix II indicates that the ACA leachates were extremely toxic with the LC_{50} as low as 0.5%. In other words, a 200 fold dilution of the leachate would be required so that no more than 50% of the test fish die over a 96 hour test period. At the end of the study, where 150 mm of precipitation had occurred, the toxicity decreased ($LC_{50} = 6\%$) to a value which indicates that a 17 fold dilution would be required to meet the LC_{50} test requirements.

The bioassay results parallel the predicted dilution factors in Table 2 which were calculated based on the comparison of observed copper concentrations versus reported LC_{50} 's.

4.1.3 Possible Impact

Typical dilution factors from yard runoff at wood preservation sites are not known, but wood preservation facility storage areas may be up to several hectares in size. The data from this study suggest that a 20 to 200 fold dilution of ACA leachate would be required prior to release from a paved site (assuming no interaction between the inorganic constituents of the leachate and the pavement material) so that a leachate sample collected from runoff discharged from the site does not fail the LC_{50} bioassay. (Note: The above statement should not be construed as counselling for dilution to meet regulatory discharge criteria. It recognizes that dilution of leachates does occur on a normal wood preservation site, and is provided as means of assessing potential impacts.)

In the case that the storage area is unpaved, there is potential for absorption of ACA to soils, hence chemical concentrations may be mitigated to some degree in stormwaters prior to their release off-site. Gerencher (1989) in a study of CCA mobilization reported that copper was highly retained in soils with high organic content and arsenic was likely retained by calcium and iron components in soil. Similar studies have not been conducted for ACA. Therefore, the potential fate of ACA is site dependent and generalizations regarding site contamination and impacts are not possible.

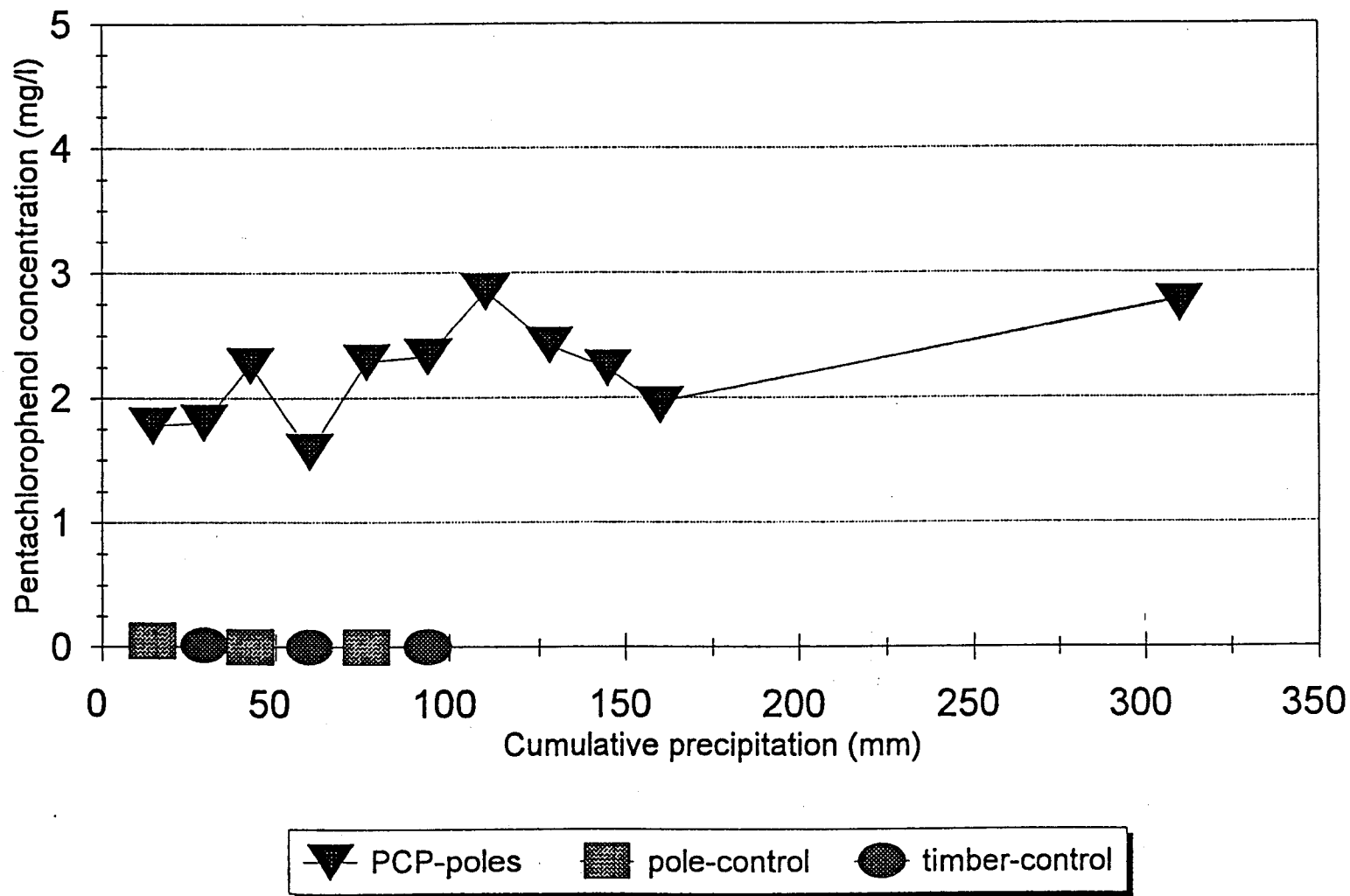
4.2 Pentachlorophenol (PCP) Poles

4.2.1 Chemical Releases

Pentachlorophenol

The results of analyses of leachates from the PCP treated poles are illustrated in Figures 7 and 8. The data show that the PCP releases were relatively consistent throughout the study period ranging from 1.57 to 2.85 mg/L. A leachate sample taken approximately 4 months after the original study period, indicated no decrease in the level of PCP released as the concentration was 2.75 mg/L.

Pentachlorophenol Releases in Leachate from PCP Treated Poles



PAH Releases in Leachate from Pentachlorophenol (PCP) Treated Poles

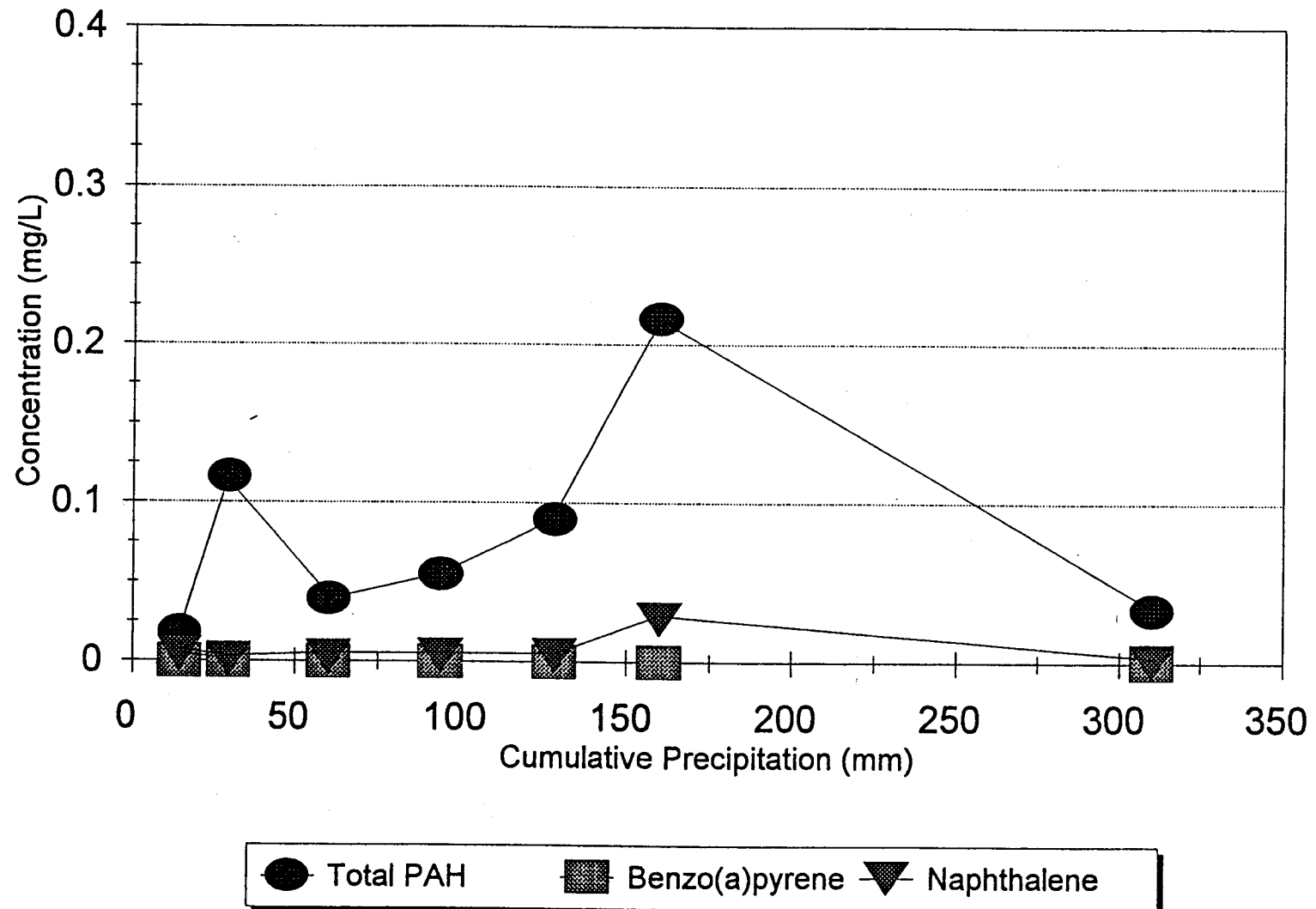


Figure 8

The LC_{50} toxicity of pentachlorophenol to salmonids ranges from 0.03 mg/L reported for coho salmon to 0.097 mg/L for rainbow trout (U.S. EPA, 1980). Pentachlorophenol is considered persistent and can bioaccumulate in biota. A safety factor of 0.01 is used by the CCME to derive a guideline of 0.0005 mg/L in water (CCME, 1987). The B.C. Environment uses a safety factor of 0.2 and has derived a criterion of 0.006 mg/L for effluents leaving antisapstain operations (B.C. Environment, 1988).

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) were also analyzed in leachates from the PCP treated poles. PCP is dissolved in a carrier oil which consists primarily of mono- and diaromatic hydrocarbons. Analysis reported by Imperial Oil identified naphthalene as the predominant hydrocarbon in the carrier oil (Imperial Oil, 1990). For this reason and also because of its high solubility in water relative to other PAHs, naphthalene is used as an indicator compound for this study.

Total PAH releases from the PCP treated poles were very low but nevertheless showed an slight increasing trend as the accumulated precipitation increased. Total PAH values ranged from 0.018 mg/L at the beginning of the study and increased to 0.22 mg/L at the end. Naphthalene concentrations also slightly increased with the accumulated precipitation. The releases were 0.0012 mg/L initially and increased to 0.0276 mg/L at the end of the study. The laboratory data suggest that benzo(a)pyrene releases increased from 0.00003 to 0.00008 mg/L during the course of the study; however, relative to current laboratory capabilities for accurately assessing such concentrations, it cannot be positively stated that the observed increases are real (U.S. EPA, 1986). The leachate sample obtained after 300 mm precipitation approximately 4 months after initiation of the study compared PAHs in the same range of concentrations as observed at the beginning of the study period.

Toxicity information for naphthalene is scarce. A 96-hr LC_{50} range of 1.6-2.3 mg/L has been reported for rainbow trout and a range of 0.77 to 3.22 mg/L for coho salmon (CESARS, 1993).

4.2.2 Aquatic Toxicity

The chemical release data suggest that PCP was present in leachates at concentrations up to 95 times greater than the literature reported LC_{50} 's for salmonids. Calculations of the required dilutions to satisfy the LC_{50} indicate that toxicity of the leachate from the PCP treated poles increased during the course of the study period. These calculations indicated that a 60 fold dilution would have been required at the beginning of the study period and a 90 fold dilution at the end so that no more than 50% of the test fish die over a 96 hour test period.

The releases of naphthalene from PCP treated poles appear relatively insignificant in terms of aquatic toxicity. A maximum of 0.0276 mg/L naphthalene was observed in the leachates versus the literature LC_{50} 's which range from 0.77 to 3.22mg/L.

The bioassays of leachates collected from the PCP treated poles as plotted on Figure 9 indicate that the LC_{50} 's range from 7% at the beginning of the study period to 3% at the end. In other words a 14-fold dilution would be required at the beginning of the study period and a 33 fold dilution at the end so that more than 50% of the salmonid test species survive after 96 hours exposure to the leachate.

The bioassay results indicate that the toxicity of the leachate from PCP treated poles was less than that which was predicted based on chemical concentrations.

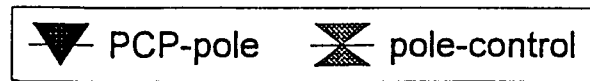
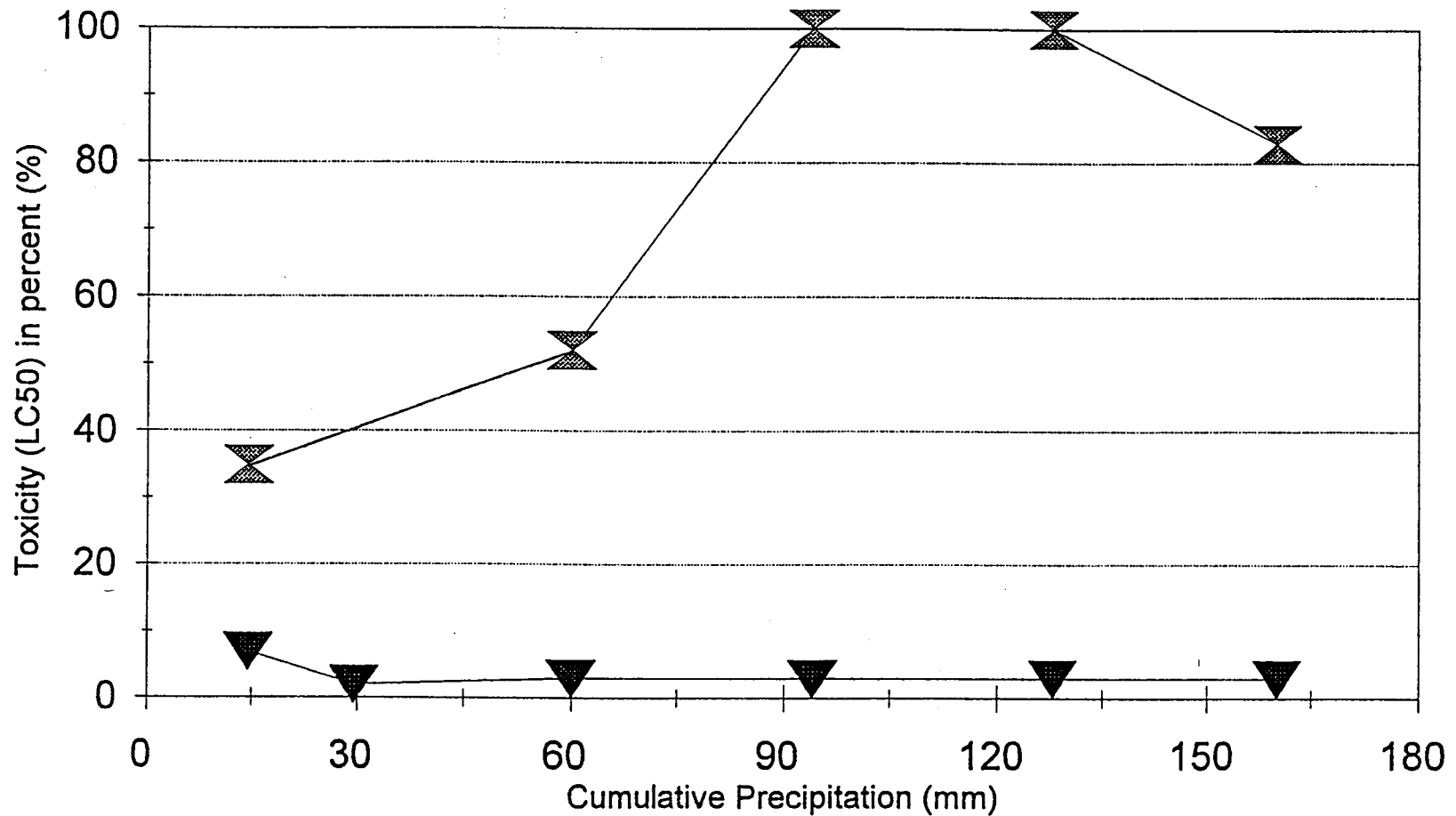
4.2.3 Possible Impact

Dilution factors of leachates from treated wood would vary, dependent upon the size of the treated wood storage yard. The bioassay test data suggest that a 14 to 33 fold dilution of PCP leachate would be required prior to release from a wood preservation facility, so that contravention of the LC_{50} bioassay does not occur.

The mobility of PCP would be dependent upon the organic content of soil and the soil pH. During the study the pH of the PCP leachate water varied from 4.5 to 6.2, a range at which PCP would be un-ionized and highly susceptible to adsorption.

In addition to adsorption, other fate mechanisms for PCP include biodegradation and photo-oxidation (Callahan et al., 1979). Therefore, the potential fate of pentachlorophenol is site dependent and generalizations regarding site contamination and impacts are not possible.

Toxicity (LC50) of Leachate from Pentachlorophenol (PCP) Treated Poles



4.3 Creosote

Creosote is derived from coal tar and consists of a large number of organic compounds. Polyaromatic hydrocarbons (PAHs) are the major components. Other components include tar acids (e.g. phenols, cresols and cresylic acid) and tar bases (e.g. pyridines, quinolines and acridines) [Konasewich and Henning, 1988 (c)].

Leachates from the creosote treated products were analyzed for 18 PAHs and phenol.

Figure 10 and 11 show PAHs releases from creosote treated wood products. Naphthalene and benzo(a)pyrene releases are also plotted on those figures.

4.3.1 Chemical Releases

Figure 10 shows that a range of 0.98 to 3.2 mg/L total PAHs (i.e. the sum of the 18 PAHs) was released from the creosote treated poles. Releases increased from the beginning of the test period to reach a peak value of 3.2 mg/L at 45 mm of cumulative precipitation. Then, a sharp drop to a minimum value of 0.98 mg/L was observed in the leachate at 60 mm precipitation. Overall, the value of releases fluctuated from one sampling event to the next so that no significant trend was noted. A leachate sample obtained from the creosote treated poles four months after completion of the initial study showed that total PAH values remained within the range observed previously.

Figure 11 shows a range of 0.6 to 2.3 mg/L total PAHs (i.e. the sum of the 18 PAHs) was released from the creosote treated timbers. Releases increased from the beginning of the test period to reach a maximum of 2.3 mg/L at 45 mm of cumulative precipitation. Then, a sharp drop to a minimum value of 0.6 mg/L was observed in the leachate at 60 mm precipitation. Subsequent levels showed a slow increase with increasing cumulative precipitation until the end of the study period, however still significantly below the initial release concentrations.

Naphthalene/Phenanthrene

The component in highest concentration in creosote is naphthalene (i.e. ~17.5%). Its concentration ranged from 0.08 to 0.3 mg/L in the leachate of creosote poles. Releases from the creosote timbers were slightly lower ranging from 0.03 to 0.3 mg/L. Naphthalene levels

PAH Releases in Leachate from Creosote Treated Poles

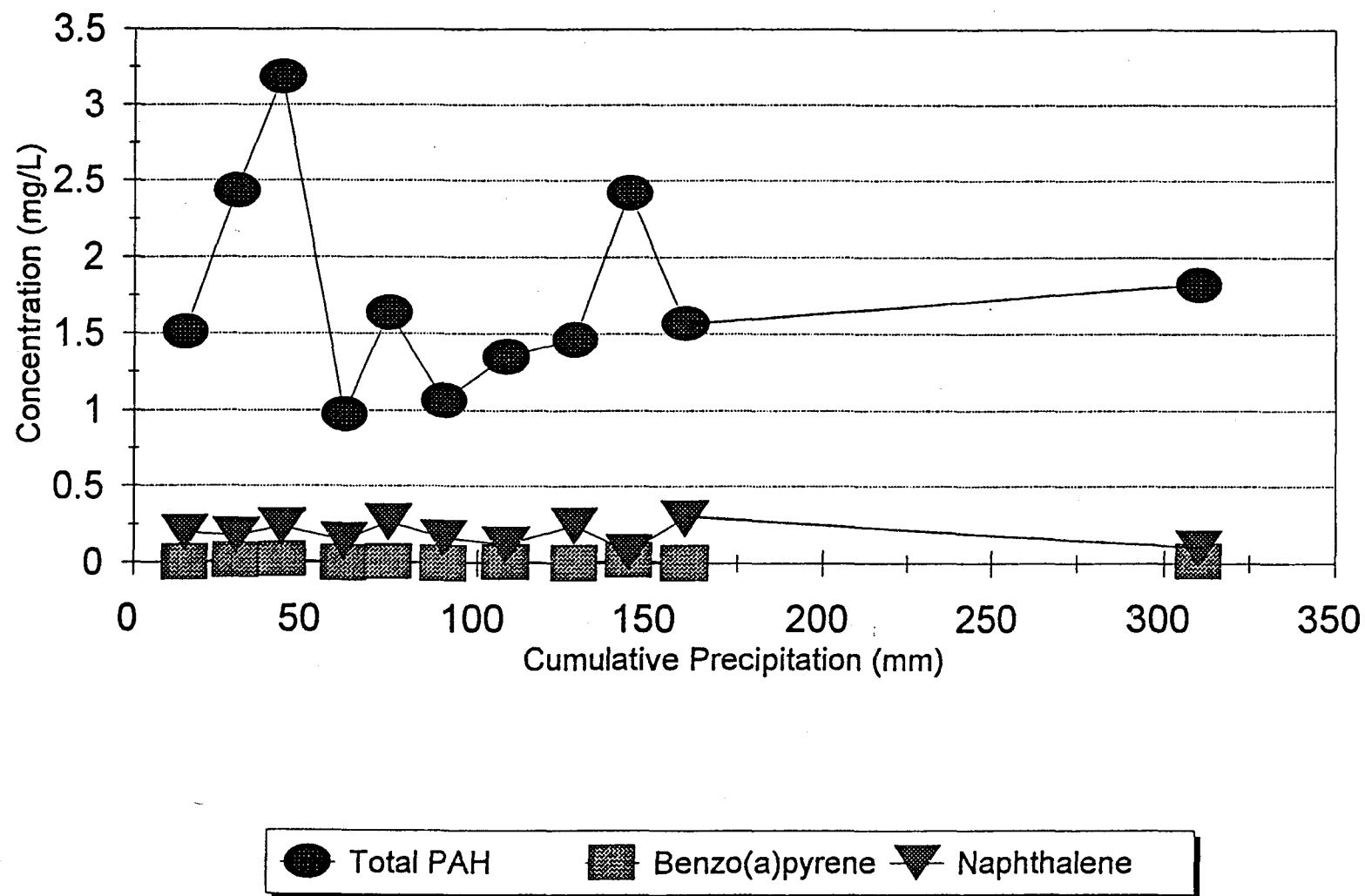


Figure 10

PAH Releases in Leachate from Creosote Treated Timber

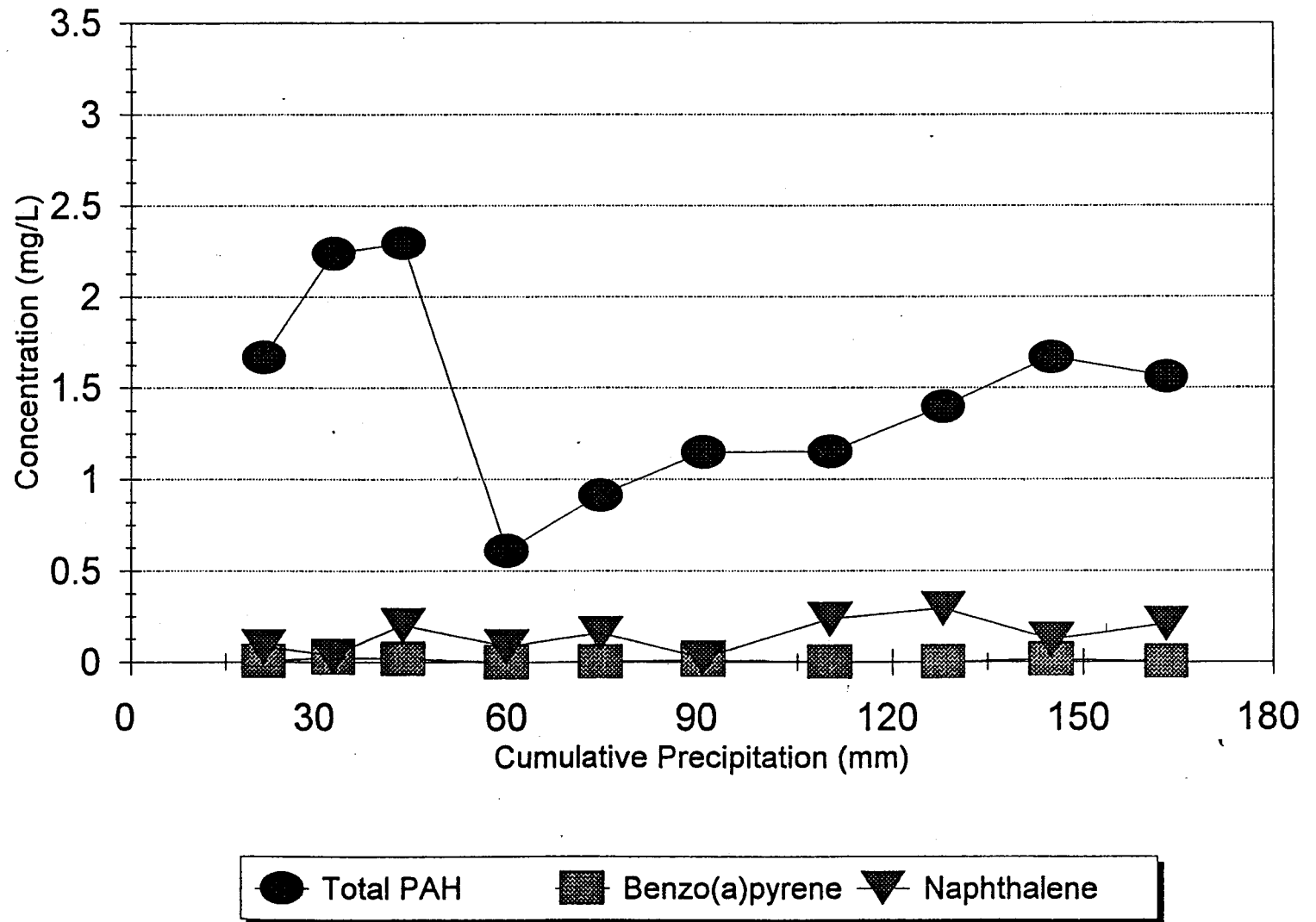


Figure 11

in the leachate of both wood products fluctuated during the course of the study and no trend could be noted with increasing cumulative precipitation.

Phenanthrene which has a lower water solubility than naphthalene (1.0 mg/L versus 34.4 mg/L) and which is usually found in creosote at lower concentrations was nonetheless the predominant PAH found in the leachate waters from both pole and timber treated wood. The concentrations of phenanthrene ranged from 0.3 mg/L to 1.1 mg/L in the leachate from creosote treated poles and were lower in the leachate from creosote treated timbers ranging from 0.2 to 0.7 mg/L. Phenanthrene levels in the leachate of both creosote treated wood products fluctuated within the specified range of values during the course of the study and, as was the case with naphthalene, no significant trend could be noted with increasing cumulative precipitation.

A leachate sample obtained from the creosote treated poles four months after completion of the initial study showed that both naphthalene and phenanthrene values remained within the original observed range.

McKee and Wolfe (1963) reported that the critical level for "fingerling silver salmon during 72-hour exposure to naphthalene is between 1.8 and 3.2 mg/L". The Michigan Dept. of Natural Resources/Ontario Ministry of Environment database notes 96 hour LC_{50} 's for naphthalene ranging from 1.6 - 2.3 mg/L for rainbow trout and 0.77 to 3.22 mg/L for coho salmon (CESARS, 1993). Aquatic toxicity data for phenanthrene are limited, but suggest that the 12-hour effect concentrations (LC_{50}) are in the order of 5.0 mg/L for salmonid species (CESARS, 1993).

Benzo(a)pyrene

Benzo(a)pyrene releases were evaluated because of designation of the compound as a carcinogen. The releases were generally low, ranging from 0.00093 to 0.026 mg/L in treated pole leachates and from 0.00066 to 0.026 mg/L in timber leachates. As was the case for naphthalene and phenanthrene, benzo(a)pyrene levels in the leachate of both wood products showed slight fluctuations during the course of the study and no significant trend could be noted with increasing cumulative precipitation.

There is a poor data base for aquatic toxicity of benzo(a)pyrene. Hose et al (1984) reported histological and skeletal abnormalities in rainbow trout alevins reared in aqueous solutions containing benzo(a)pyrene at concentrations of 0.00008 mg/L.

For the protection of human health, the World Health organization has recommended that benzo(a)pyrene should not exceed 0.00001 mg/L in drinking water (CCME, 1987).

Phenols

As mentioned previously, the analytical methodology determined in combination: phenols and, ortho-and meta-substituted phenols. The "phenol" releases are plotted in Figure 12 with higher releases noted for creosote treated poles. The range of "phenols" for treated poles varied from 13 mg/L at the start of the study to 4 mg/L after exposure to 150 mm of precipitation. The releases from treated poles showed a decreasing trend over the course of the study. Leachate of treated timbers resulted in releases which varied in "phenol" content from 0.7 to 6 mg/L with values which fluctuated throughout the test period so that no trend was noted.

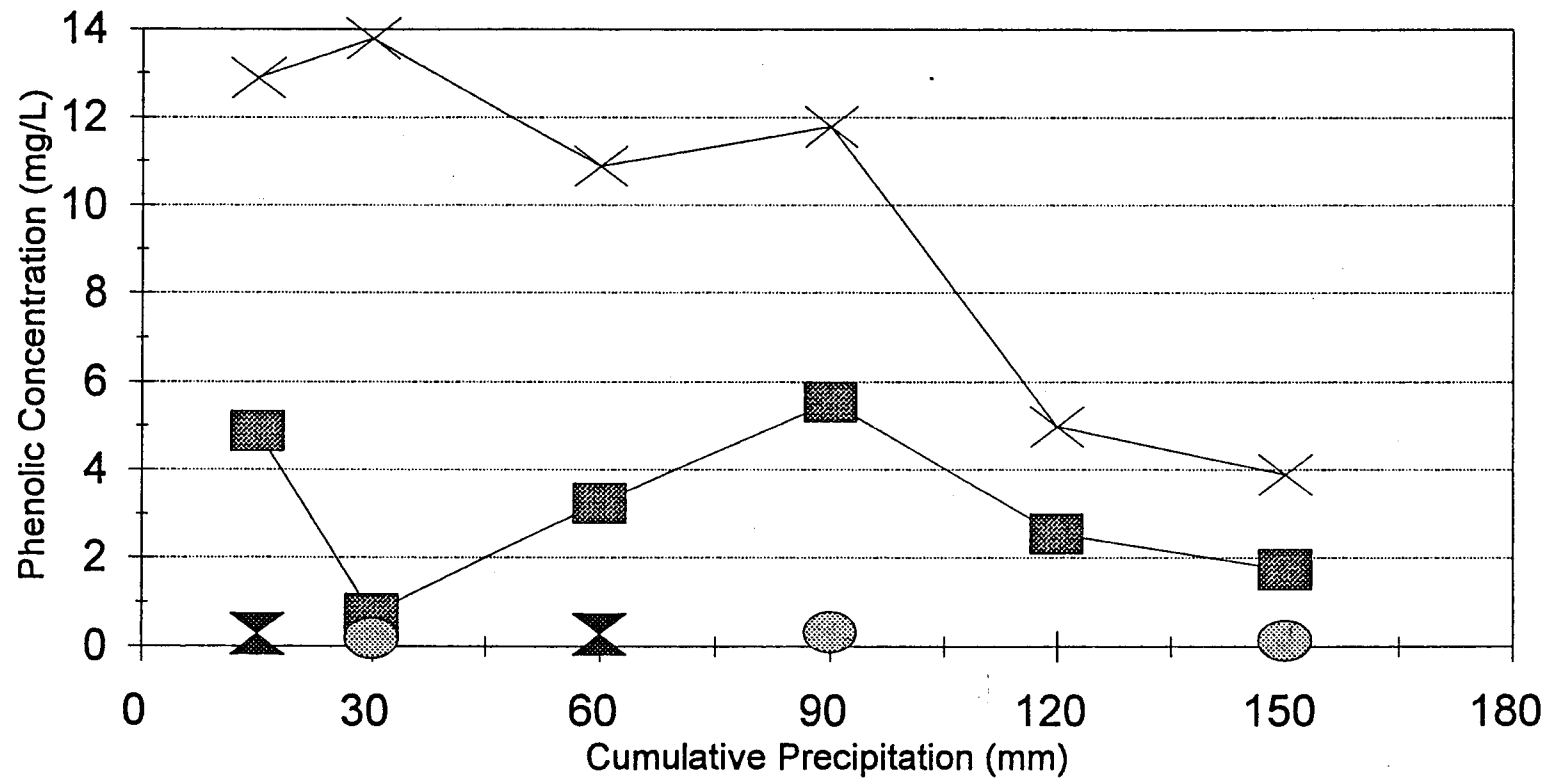
The 96-hr LC_{50} for phenol is in the order of 5 mg/L and 2 mg/L for ortho-cresol, using Rainbow trout (CCME, 1987). The CCME guideline of 0.001 mg/L is based on the prevention of tainting of fish flesh. The levels of phenolic compounds found in the leachate from creosote treated wood products suggest that the release of phenols may result in aquatic toxicity.

4.3.2 Aquatic Toxicity

Due to the poor aquatic toxicity data base for components of creosote and due to the large number of compounds in creosote, it is difficult to predict the potential toxicity of creosote contaminated leachates based only on chemical analyses.

In the EPS report on "Creosote Wood Preservation Facilities - recommendations for Design and Operation" it is noted that the 96-hr LC_{50} of creosote is 0.2 to 0.56 mg/L [Konasewich and Henning, 1988 (c)]. The total concentrations of PAH's in leachates from poles shown in Figure 10 exceed the creosote LC_{50} by factors of 8 to 16 whereas those from timbers shown on Figure 11 exceed the creosote LC_{50} by factors of 8 to 11.

Phenol Releases in Leachate from Treated and Untreated Wood Products



× CREO-pole ■ CREO-timber ⋈ POLE-control ● TIMBER-control

Figure 13 presents toxicity data for leachates from both creosote treated wood products. The 96-hr LC_{50} 's for leachates from creosote treated poles ranged from 3% at the start of the study to 13% at the termination of the study - indicating that 33 fold dilution of the initial leachate would be required to pass the 96-hr LC_{50} test and 8 fold dilution would be required for the leachate collected at the end of the study. Similar toxicities were observed for the leachates from creosote treated timbers, with an LC_{50} of 5% at the start of the study and 13% at the end. Essentially there were few differences in the toxicity of leachates from creosote treated timbers and poles.

Overall the bioassay data from creosote treated wood products suggest that dilutions from 8 to 33 fold would have to occur within a storage yard so that effluents discharged from the site can meet the 96-hr LC_{50} bioassay requirements. The bioassay results indicate that the toxicity of the leachate from creosote treated wood products is greater than that which was predicted based on comparison of 96-hr LC_{50} values with chemical concentrations. Given the large number of organic compounds in creosote and the potential for the combination of compounds to result in additive, synergetic or antagonistic toxicity effects, it is difficult to derive a correlation between the concentrations and proportion of preservative constituents in the leachate to an 96-hr LC_{50} .

4.3.3 Possible Impacts

The many compounds found in creosote are subject to varying chemical fates once exposed to the environment. Low molecular weight compounds such as naphthalene, phenanthrene and phenols are relatively soluble in water and readily biodegraded (Callahan, 1979). Other compounds such as benzo(a)pyrene are persistent with adsorption to substrates and/or bioaccumulation capabilities (Callahan, 1979).

In addition, the actual levels of creosote components present in runoff discharged from a site will be dependent upon site characteristics, including composition of storage yard surface, residence time in storage yard and dilution effects during collection of precipitation by the stormwater system. Therefore, the potential fate of creosote is site dependent and generalizations regarding site contamination and impacts are not possible.

Toxicity (LC50) of Leachate from Creosote Treated Wood Products

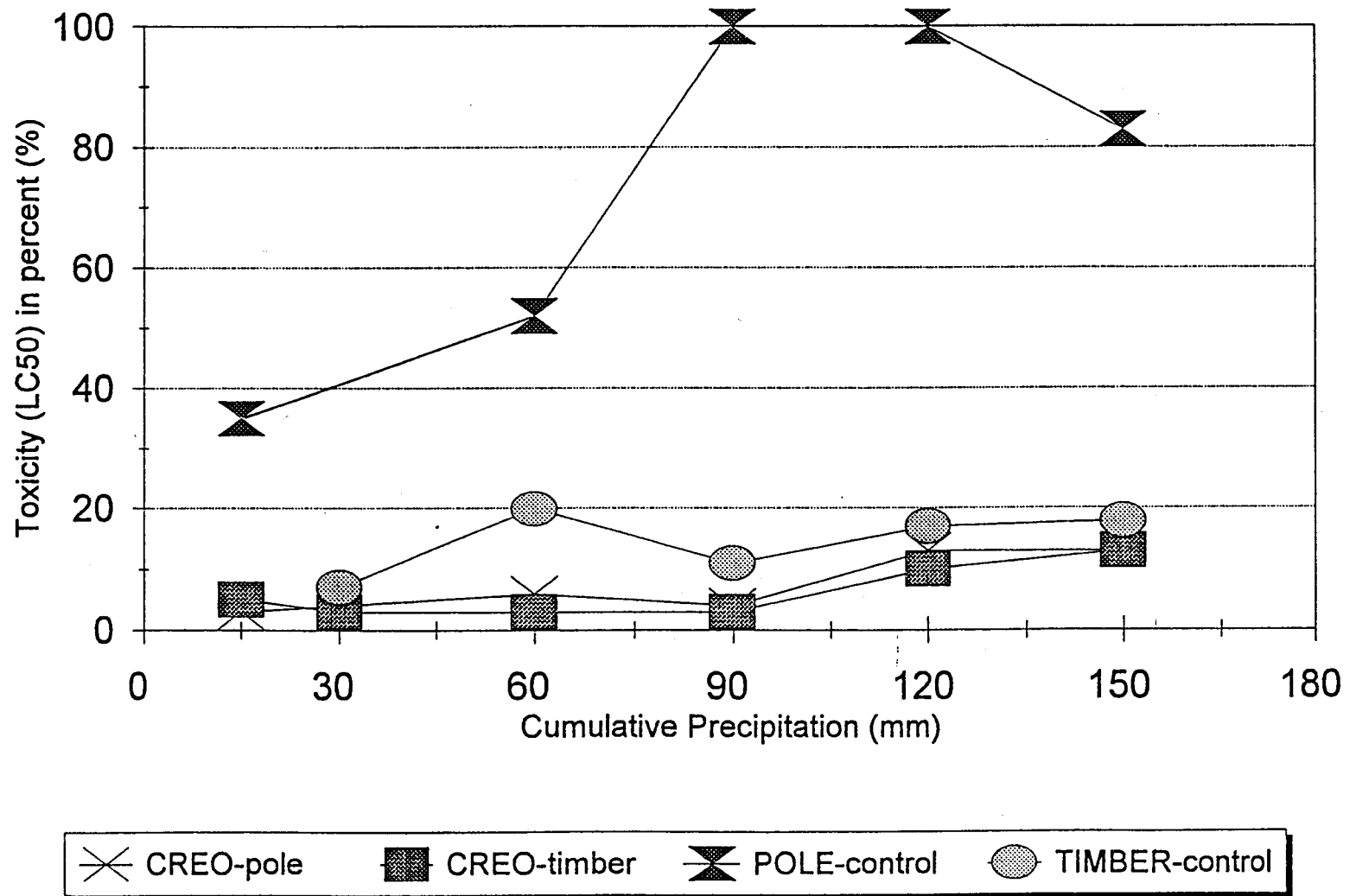


Figure 13

4.4 General Parameters

General parameters such as TOC (Total Organic Carbon), oil and grease, and pH readings were conducted for leachates from controls and test piles as shown in Figure 14, 15 and 16. Resin acid concentrations were analyzed for the control pole and timber piles.

Total Organic Carbon

As shown in Figure 14, the TOC concentrations decreased as the cumulative precipitation increased. Amongst the treated wood products, TOC releases were highest in the leachate of creosote treated poles and those from the creosote treated timbers were slightly lower than from the PCP treated poles. Releases ranged from 11 to 194 mg/L for treated wood products. The highest overall release (261 mg/L) was from the control timber at 30 mm of precipitation whereas releases from the control poles remained lowest ranging from 11 to 100 mg/L. Subsequent values from the timber control were within the range of those in leachate from treated products. The use of the gross parameter TOC, is therefore not considered capable of distinguishing leachates which are a function of chemical releases from preserved wood products.

Oil and Grease

Oil and grease concentrations were evaluated in leachates from creosote treated wood products and PCP treated poles. Releases of oil and grease in leachate from PCP treated poles increased from 17 to 25 mg/L; those from the control timber decreased from 5 mg/L to values below the detection limit; releases from the control poles increased from a value bordering the detection limit of 2 to a value of 4 mg/L, whereas releases from the creosote treated products showed no trend as they fluctuated in a range from 2 to 17 mg/L. As shown in Figure 15, higher concentrations were noted in leachates from PCP treated poles than from creosote treated wood products. Various explanations can be offered. Hydrocarbon releases from PCP may be more readily collected in comparison to those of creosote. The density of creosote is such that it would sink in water, while the density of the PCP carrier oil is less than 1.0 hence its presence in the surface layer of the leachate water. On the other hand, retention of the carrier oil in the treated product may be less than that of creosote.

TOC Releases in Leachate from Treated and Untreated Wood Products

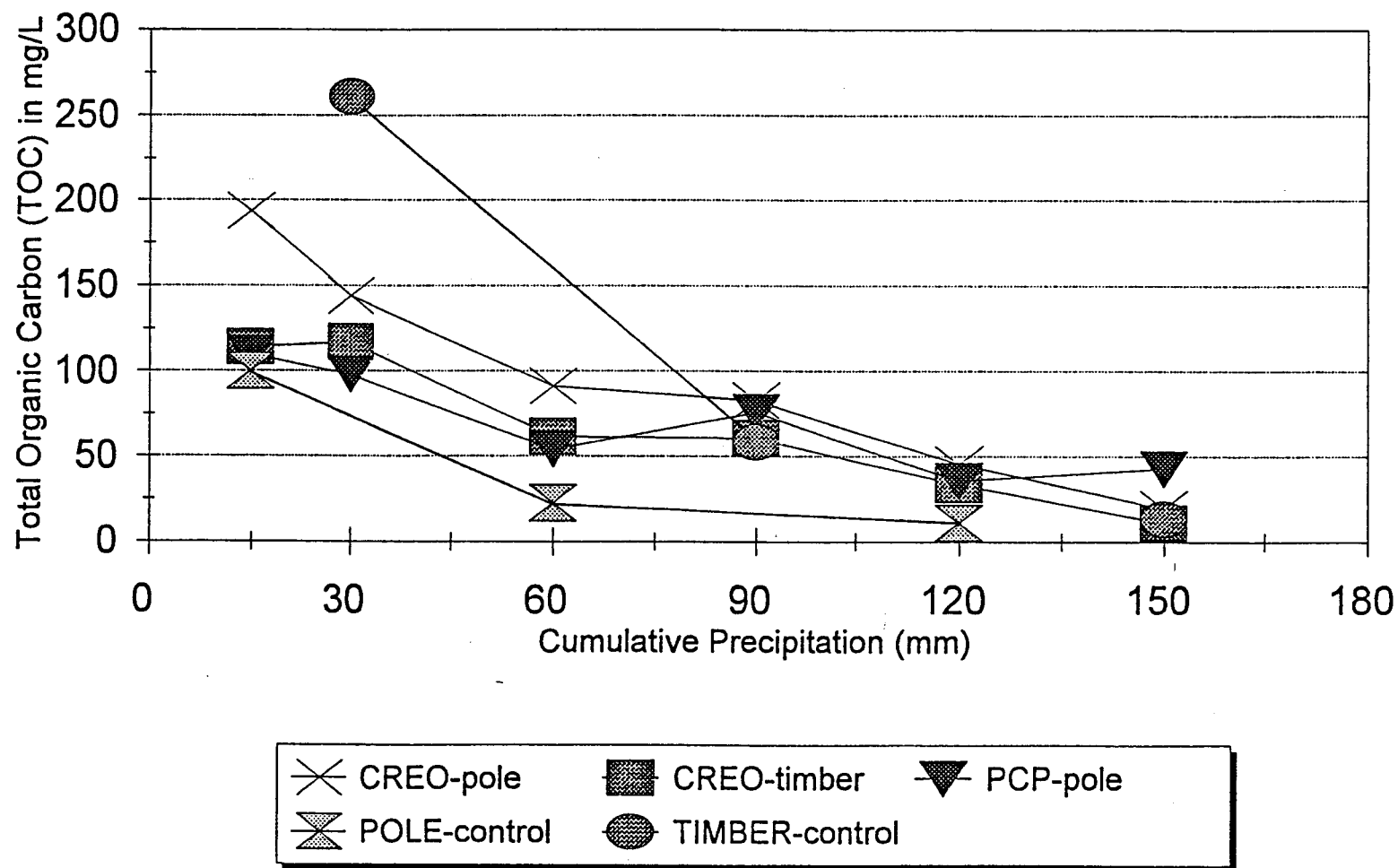


Figure 14

Oil & Grease Releases in Leachate from Treated and Untreated Wood Products

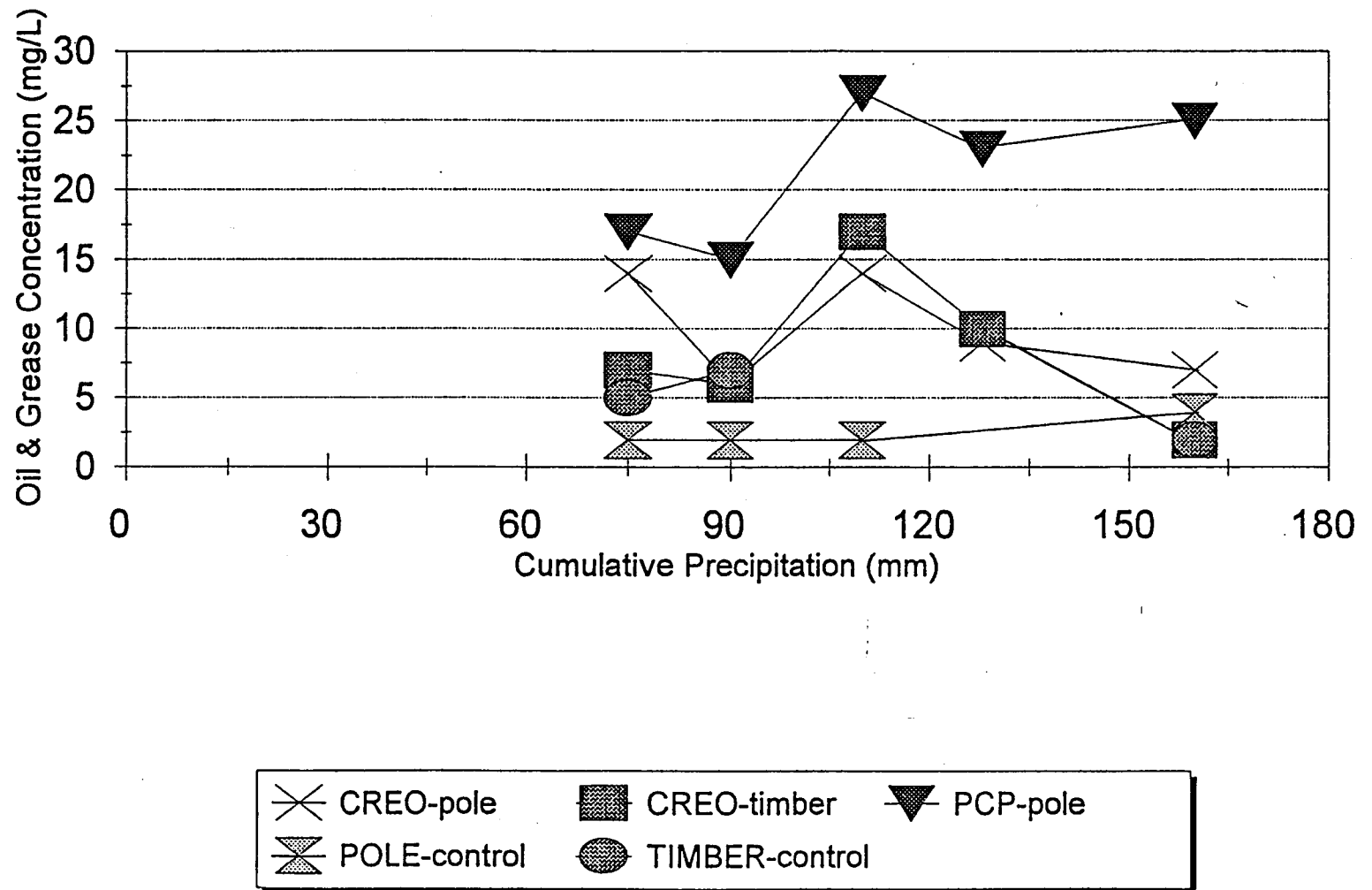
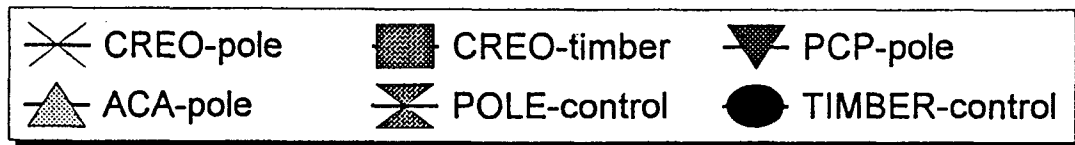
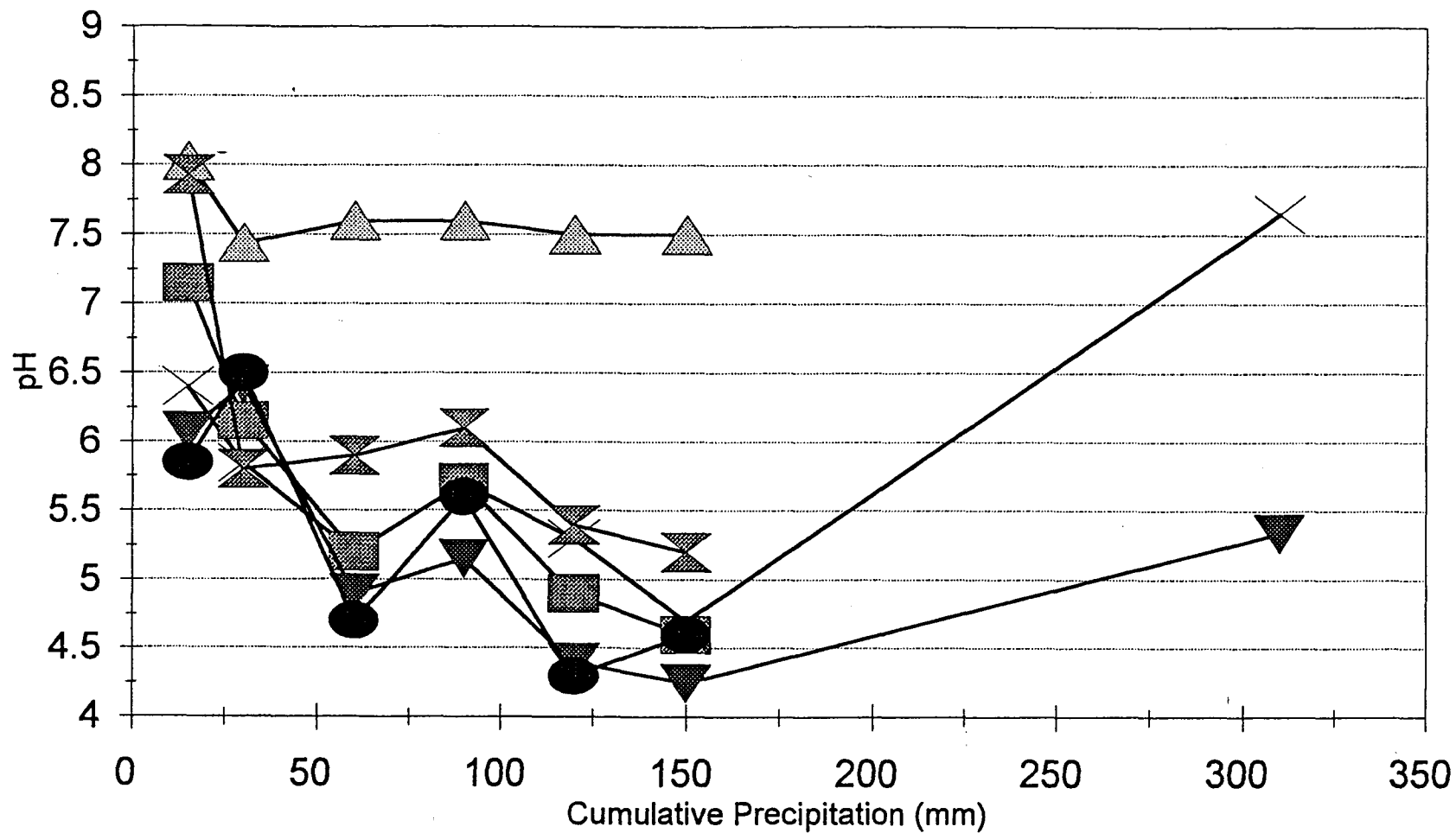


Figure 15

pH of Leachate from Treated and Untreated Wood Products



pH

The pH of the ACA leachate was slightly alkaline ranging from 7.4 to 8.0, as a result of the pH of ACA itself. A 2% solution of ACA has a pH of 10.2 [Konasewich and Henning, 1988 (a)].

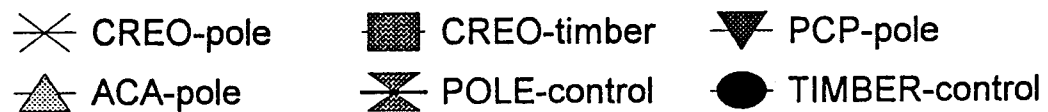
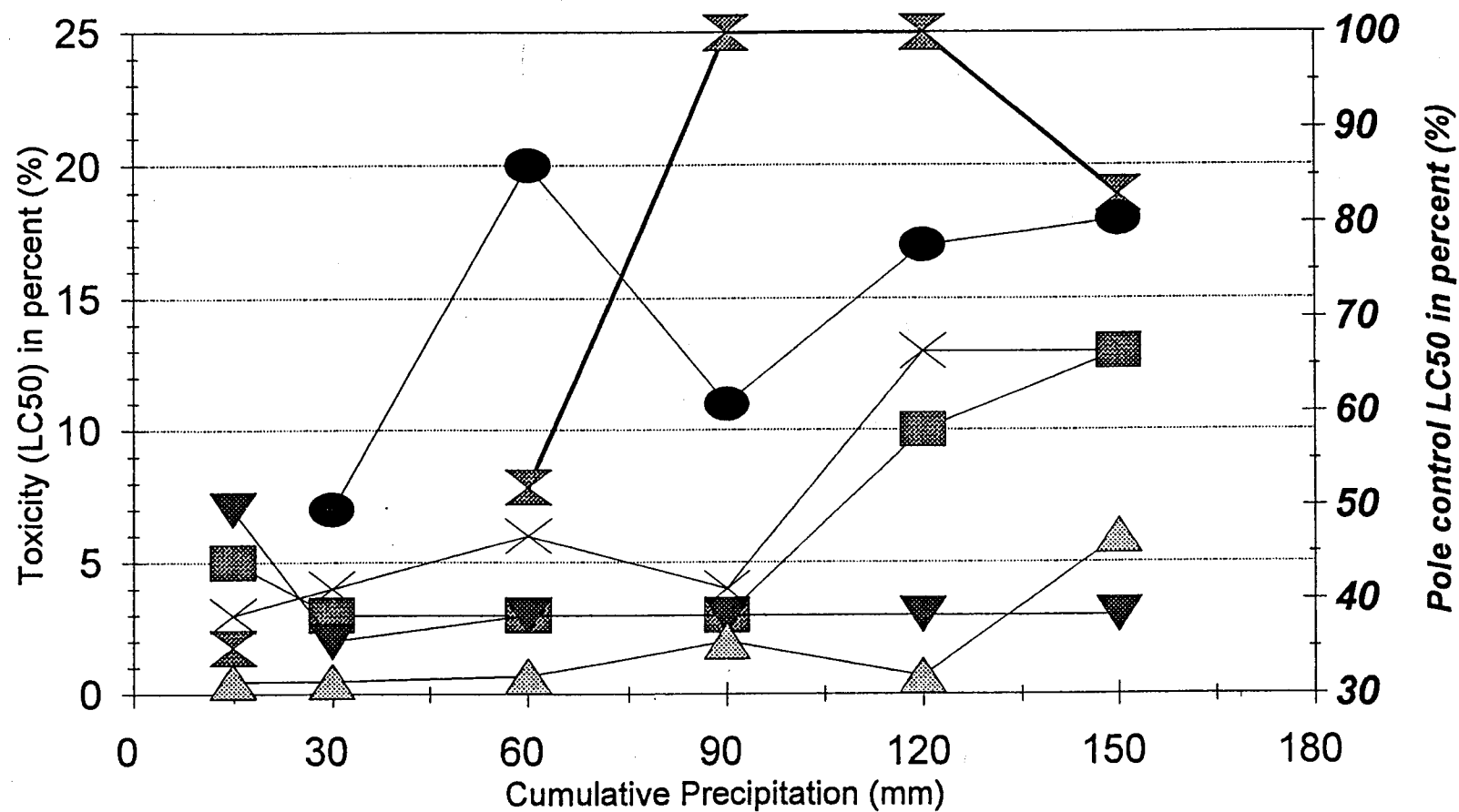
Decreases in pHs of leachates from creosote, PCP and control trays occurred over the span of the study. The pH of the artificial rain had a range from 5.8 to 6.0 and such water was used only for the first 30 mm of cumulative precipitation and for the additional set of samples collected approximately four months after the original test period (i.e., at 300 mm). The remaining precipitation consisted of rain water which was slightly more acidic at pHs of approximately 5. The observed decreases in pH in the leachate may be due to the oxidation of iron from the mild steel trays.

Resin Acids and Control-Tray Toxicity

Dehydroabietic and sandaracopimaric acids were the only resin acids detected (of seven for which the analysts focussed). The values measured were very low and generally in the same order of magnitude as the reported detection limits. Their presence could in part be correlated with toxicity. It is noted in Figure 17 that the toxicity of the untreated timbers was consistently higher than that of the untreated poles i.e., the LC_{50} for untreated timbers ranged from 6 to 20%, and the LC_{50} for untreated poles ranged from 50 to $>100\%$. The untreated timbers consisted primarily of heart wood while the exposed surface of the poles is sapwood. Heartwood normally contains more gums, resins, oils and tannins, which are more toxic to aquatic biota than sapwood (Smith, 1978).

The relationship between round or sawn products and surface runoff toxicity is not well understood. Monitoring of lumber storage yards will commonly find toxicity using the standard 96-hr LC_{50} bioassay test (Whiticar, 1992). The cause of the toxicity is suspected to be resin acids leached from the freshly exposed surfaces of sawn lumber. The observation of this study that the sawn timber produced a more toxic leachate than the round stock would seem to support this hypothesis but the analytical data is insufficient to quantify this correlation. Further study of the causes of toxicity in wood processing facility effluent is necessary.

Toxicity (LC50) of Leachate from Treated and Untreated Wood Products



5.0 CONCLUSIONS

A study was conducted to evaluate the leachability characteristics of wood preservatives from pentachlorophenol (PCP), creosote and ammoniacal chromium arsenate (ACA) treated wood products. It was designed to reproduce the conditions found in a typical preserved wood product storage yard in order to determine the potential chemical concentrations and resulting aquatic toxicity that may be found in rainfall-generated leachate. The purpose of this study was to provide preliminary data for both industry and regulatory agencies to assess the quality and potential significance of leachate releases from wood preservative treated products while in a storage yard.

The procedures followed for this study were based on protocols originally developed by Krahn and Strub (1990) for the study of leachates from wood treated with antisapstain chemicals. The general protocol called for bundles of treated wood to be placed on steel frames that permitted the collection of leachate following a precipitation event. The study utilized six metal trays to allow testing of four different products (ACA poles, PCP poles, creosote poles and timbers) and two untreated control products (pole and timbers), all Douglas Fir.

The leachate was generated either by rainfall or artificially with a water sprinkler. After contact with the wood surface it dripped into a collection tray placed under the bundles within the steel frames. Samples were collected on the basis of accumulated precipitation at predetermined "benchmarks" as measured in rain gauges attached to the bundles. The collected samples were analyzed for ammonia, metals (particularly arsenic and copper), polyaromatic hydrocarbons (PAHs), chlorinated phenols (penta, tetra and trichlorophenols), phenols, total organic carbon (TOC), and resin acids. pH measurements were made in the field. In addition, each leachate was submitted for a 96-hr LC_{50} bioassay to evaluate its toxicity to fish.

Ammoniacal Copper Arsenate (ACA)

Releases from ACA treated poles included ammonia ranging between 40 and 233 mg/L, arsenic between 36 and 192 mg/L and copper between 2 and 20 mg/L. Ammonia releases did not show a trend as values fluctuated through the course of the study. However, a decreasing trend was noted in both the arsenic and copper releases as cumulative precipitation increased.

Comparisons of releases with reported LC_{50} values for individual constituents suggest that copper would be of greatest concern with respect to fish toxicity. Test results for LC_{50} increased from 0.5% at the beginning of the study period to 6% by the end. Keeping in mind that the reported LC_{50} value is inversely related to toxicity - i.e. the higher the LC_{50} concentration, the less the toxicity, bioassay results indicated that the toxicity of ACA leachate slightly decreased as cumulative precipitation increased. Dilutions predicted by comparison of copper releases with the reported LC_{50} were comparable to those observed in the bioassay tests. Comparison with bioassay results from control poles indicated that the releases from untreated poles were significantly less toxic than those from ACA treated poles.

Pentachlorophenol (PCP)

Pentachlorophenol releases from the PCP treated poles ranged from 1.57 to 2.85 mg/L while the PAH releases (from the carrier oil) were minimal ranging from 0.02 to 0.2 mg/L total PAHs. Pentachlorophenol releases remained constant over the course of the study whereas PAH releases showed no significant trend. A sample collected four months after the original test had a pentachlorophenol concentration of 2.74 mg/l, at the high end of the range, and total PAHs of 0.03 mg/l, in the low end of the range of releases observed during the study period.

Bioassay LC_{50} results decreased from 7% to 3% after exposure to 150 mm of precipitation, indicating that toxicity slightly increased over the course of the study. The toxicity obtained from bioassay tests was lower than that predicted by comparison of concentrations found in releases and published LC_{50} values. For PCP when compared with bioassay results from control poles, results indicate that the releases from untreated poles were significantly less toxic than those from PCP treated poles.

Creosote

The major constituents from creosote treated wood products are polyaromatic hydrocarbons (PAHs). A total of 18 PAHs were analyzed. Total PAH showed no overall trend with values ranging from 0.98 to 3.2 mg/L in pole releases and from 0.6 to 2.3 mg/L in timber releases. Phenanthrene was found to be the main component in releases although naphthalene has a higher solubility in water and is present in greater proportion in creosote. A sample of the pole leachate obtained approximately 4 months after the end of the study showed that releases remained in the same range as those found during the original study period.

Bioassay results ranged from 3% to 13% in pole releases and from 5% to 13% in timber releases after exposure to 150 mm of precipitation, the results from both creosote treated products indicate that toxicity slightly decreased over the study period. The toxicity evaluated by bioassay tests was slightly higher than that predicted by comparison of actual concentrations found in releases and reported LC_{50} values for creosote. Comparison of results with bioassay performed on leachate from untreated wood indicated that the releases from untreated poles were significantly less toxic than those from creosote treated poles. However, in the case of timbers, the untreated controls were only slightly less toxic than the creosote treated product.

Other Parameters

Analysis of resin acids indicated values below detection limit in most samples. The measured values of dehydroabietic and sandaracopimaric acids were very low and generally in the same order of magnitude as the reported detection limits.

Overall

The study indicated that leachates from ACA, creosote and PCP freshly treated wood products have potential for aquatic toxicity if released to the environment. Comparison of both chemical releases and toxicity showed that the leachate from untreated products had lower chemical concentrations and less toxicity than the treated products except for the timber products where the toxicity of the leachates from creosote treated wood was only slightly higher than that from untreated timbers used as controls.

In the discussion of results the study emphasized the dilutions required for the leachate to satisfy the 96-hour LC_{50} (i.e. the dilution required so that more than 50% of the salmonid test species survive after 96 hours of exposure to the leachate). It is important to note that while the study does not advocate dilution as a means of reducing the toxicity of leachates, it does recognize the fact that dilution occurs in storage yards by nature of the operation. However, the actual impacts of releases on site contamination and on the aquatic environment would have to be assessed on a site-specific basis because of many factors such as composition of the storage yard surface, inventory and residence time in the storage yard, storage practice, treatment conditions, and dilution effects during collection of precipitation by the stormwater system which contribute to variability of the runoff quality from one site to another.

Limitation

This study represents a worst-case scenario of releases which may occur from a wood preservation facility storage area. The concentration values observed in this study should not be interpreted as representative of those found in surface runoff discharged from the site into a receiving environment because there are significant differences between the experimental setup and the actual conditions at the treatment facilities. The releases observed in this study are those from leachates produced by direct contact of water with the treated wood product whereas runoffs discharged from the site are subject to dilution and other retarding factors such as soil adsorption, biodegradation and volatilization.

In addition, consideration should be given to the short term nature of the study which dictates the need for caution in the extrapolation of results related to characteristics of long term releases.

Further studies

There is a need to undertake stormwater discharge monitoring programs in conjunction with leachate quality studies in order to determine the significance of leachate releases produced from various wood products in typical storage yards. Assessments of the actual environmental risk presented by the discharge of leachate require further study.

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APPENDIX I

Photos of Site Layout



Photo 1: Side view of the creosote treated poles bundle. Note the rain gauge mounted on the top part of the bundle.

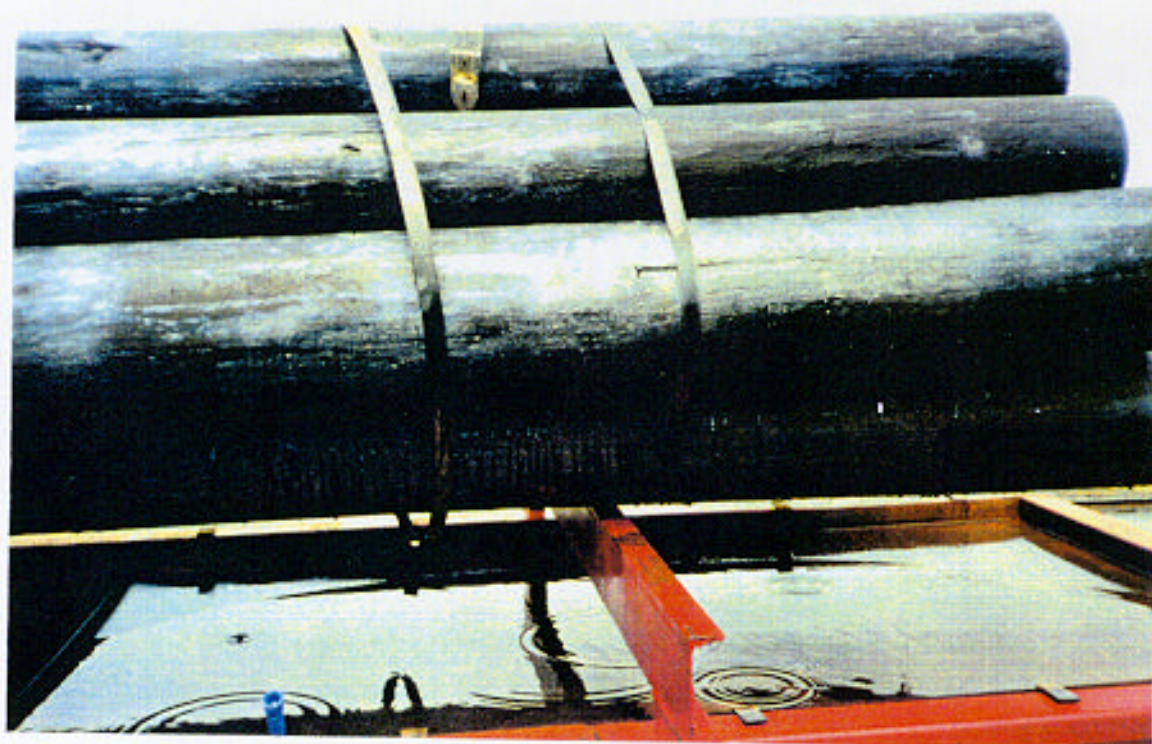


Photo 2: Close-up of creosote treated poles during rainfall event. Also note the wetting pattern on the surface of the poles.



Photo 3: End view of the creosote treated poles bundle. Note that the poles were stacked alternating the "butt" and "end" sections.

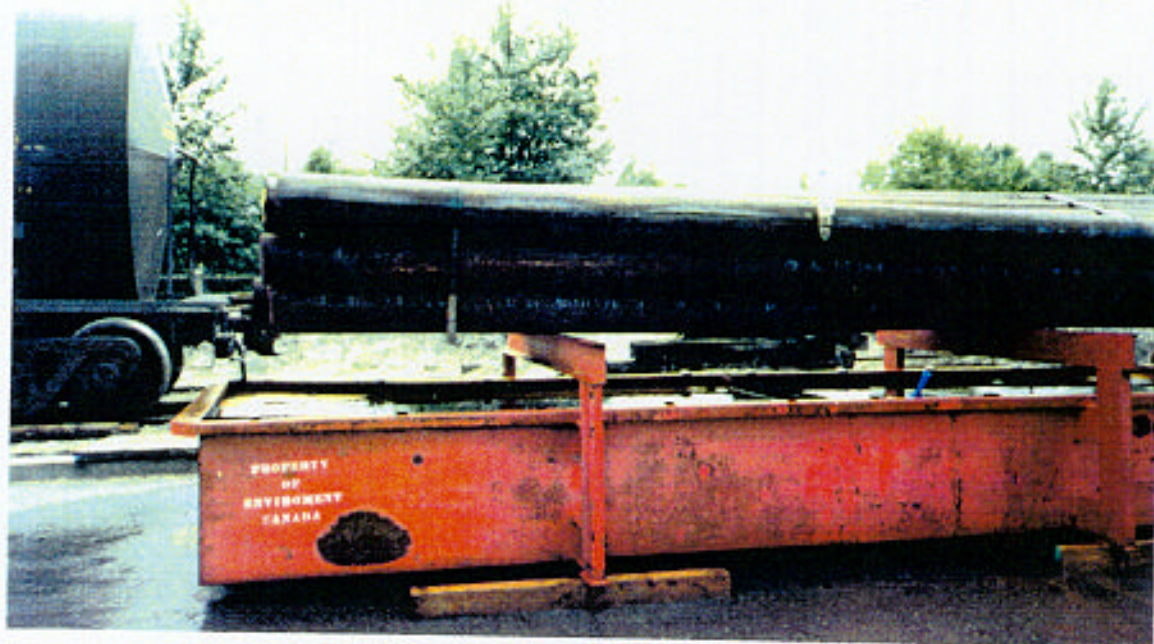


Photo 4: Side view of Pentachlorophenol treated poles. Note the presence of two collection trays: one for the "butt & ends" portion and one for the "centre" portion of the poles.

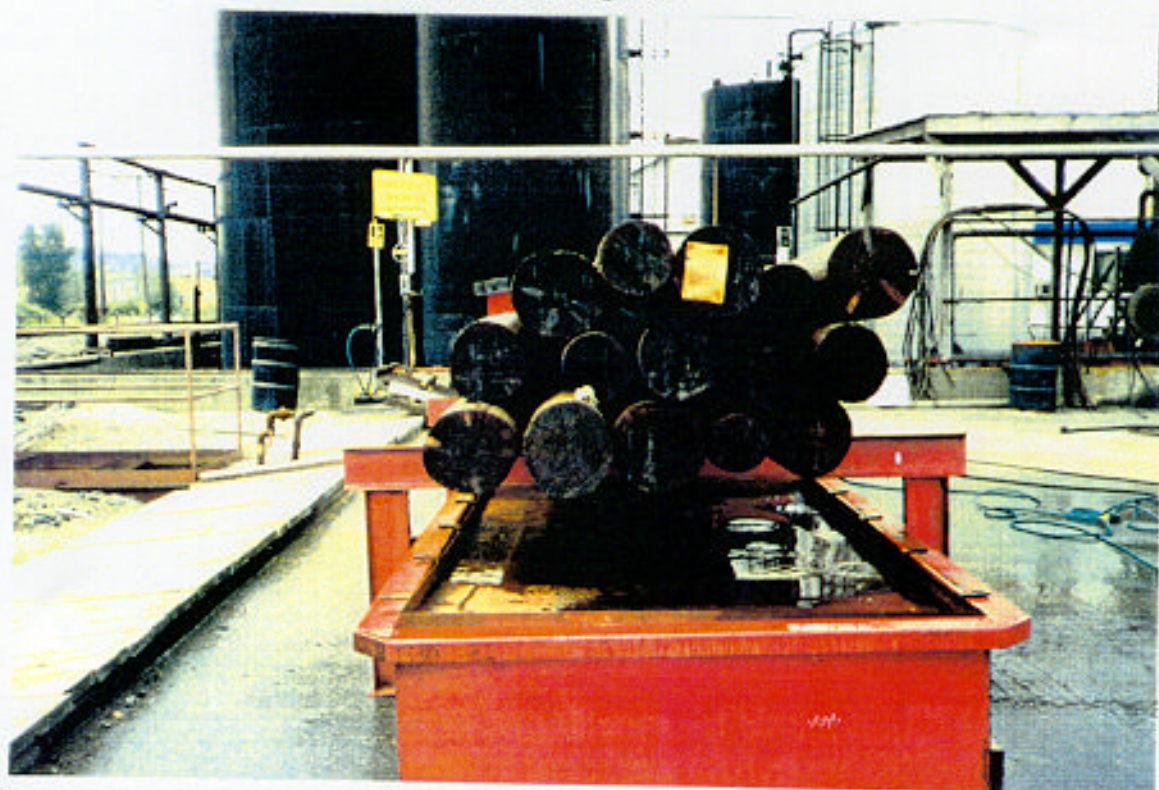


Photo 5: End view of Pentachlorophenol treated poles. Note that the poles were stacked to alternate the "butt" and "end" sections.



Photo 6: Overview of the test set-up.

- Right back: ACA treated poles
- Right front: Control poles (untreated)
- Front middle: Control timber (untreated)
- Left front: Pentachlorophenol treated poles
- Left back: Creosote treated poles
- Back Middle: Creosote treated timbers



Photo 7: Side view of the ACA treated poles. Note the presence of a plastic liner installed inside the collection tray. The plastic liner was made of 10 mil polyethylene cut to match tray length. The liner was changed after each sampling event. It was held down by placing five pieces of untreated 4x4 timbers individually wrapped in a plastic liner to prevent contact with the leachate. Also note the alignment of the ACA pole "butts and ends" section with the side of the collection tray.



Photo 8: Overview of the wood products. Preservative chemical storage tanks in the background. Right: side view of the ACA treated poles. Back right: creosote treated timbers. Back left: untreated timber (control). Left side: end view of the untreated poles (control).



Photo 9: Overview of the wood products. Right front corner: end view of pentachlorophenol treated poles. Right back corner: side view of untreated timber (control). Left back corner: side view of creosote treated timbers. Left front corner: creosote treated poles. Note that the pole bundles are tilted away from the collection tray.



Photo 10: Leachate samples from all wood product. These samples were submitted for fish toxicity tests (LC_{50}). From left to right: creosote pole, timber control, creosote timber, pole control, pentachlorophenol centre, pentachlorophenol ends, ammoniacal copper arsenate. Note the dark coloration of the untreated timber control, and the green tinge of the ACA leachate.

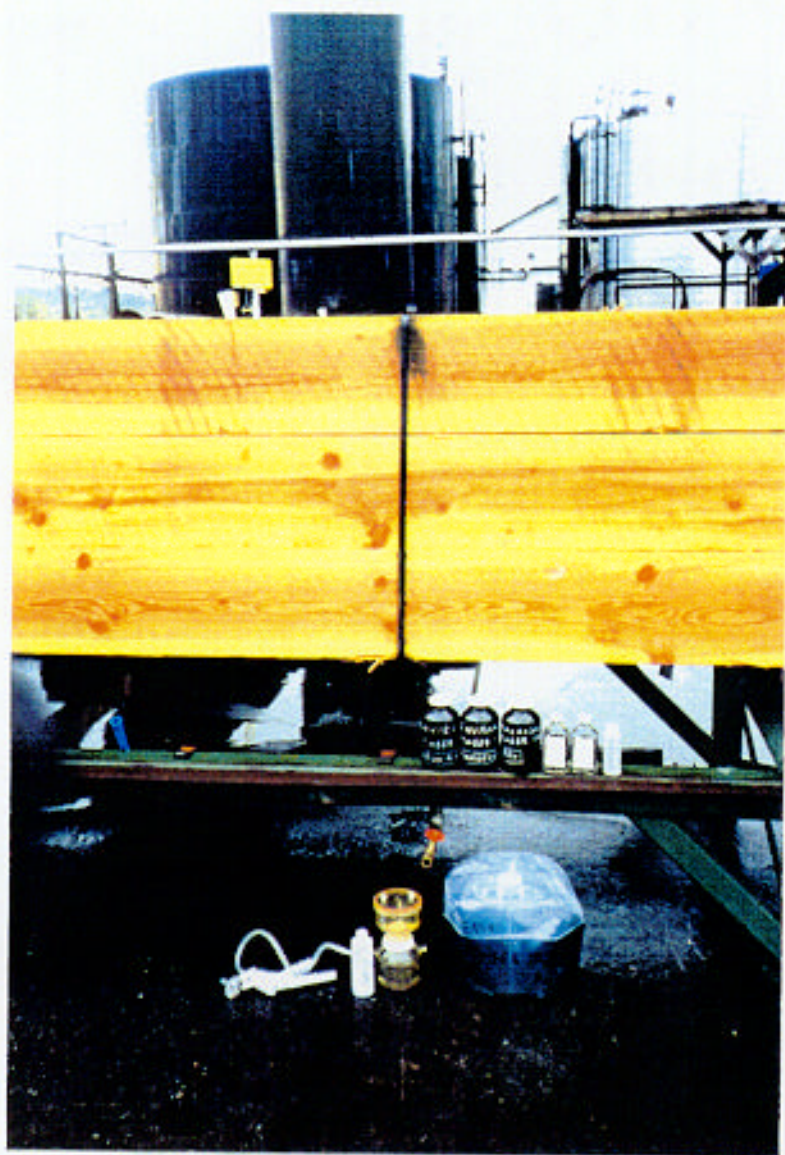


Photo 11: Leachate from the timber control. Including the field filter kit for the dissolved metal sample preparation. Note the dark coloration of the bioassay sample. Sampling jar designation: 1L amber glass jars were used for PAH, chlorophenol and resin acid samples, 250 ml clear glass for TOC and phenolics, 100ml plastic for ammonia and 250ml plastic for metals.

APPENDIX II

Analytical Data Tables

Table of PAH and Oil and Grease Data for Wood Products Treated with Creosote, PCP and for Controls

Sample Description	Cumm. Precip (mm)	pH	Total PAH (mg/L)	Benzo(a) pyrene (mg/L)	Naphthalene (mg/L)	Oil&Grease (mg/L)
Creosote Treated Poles (CREO-P)	15	6.4	1.51314	0.005345	0.198	n/a
	30	5.84	2.437205	0.018805	0.1825	n/a
	43	5.35	3.18834	0.026	0.239	n/a
	61	5.2	0.97874	0.00093	0.149	n/a
	74	5.5	1.638615	0.00965	0.2705	14
	90	5.7	1.0696	0.00216	0.165	6
	108	5.4	1.353725	0.00835	0.126	14
	128	5.3	1.46175	0.00418	0.247	9
	144	5.21	2.42844	0.0244	0.077	n/a
	160	4.7	1.57199	0.00504	0.295	7
	310	7.65	1.8254	0.0174	0.103	n/a
Creosote Treated Timbers (CREO-T)	21	7.15	1.67038	0.00721	0.0853	n/a
	32	6.15	2.239565	0.0264	0.0373	n/a
	43	5.3	2.29598	0.019	0.2015	n/a
	59	5.2	0.61062	0.00066	0.0854	n/a
	74	5	0.915145	0.003325	0.1605	7
	90	5.7	1.15072	0.0129	0.0265	6
	110	5.2	1.15392	0.00493	0.237	17
	128	4.9	1.39842	0.00387	0.294	10
	145	5.17	1.67045	0.0162	0.124	n/a
	163	4.6	1.56266	0.00374	0.208	2
PCP Treated Poles Composite (PCP-E and PCP-C)	14.5	6.075	0.01853	3E-05	0.0047	n/a
	29.5	6.415	0.11649	5E-05	0.0012	n/a
	43	4.34	n/a	n/a	n/a	n/a
	60	4.9	0.03972	4E-05	0.0029	n/a
	76.5	4.5	n/a	n/a	n/a	17
	94	5.15	0.05529	4E-05	0.0043	15
	110	4.75	n/a	n/a	n/a	27
	128	4.4	0.08994	7E-05	0.0046	23
	145	4.785	n/a	n/a	n/a	n/a
	160	4.25	0.21686	8E-05	0.0276	25
	310	5.34	0.03374	4E-05	0.0015	n/a
Untreated Poles (POLE-control)	16	7.93	0.0195	< 0.00001	0.0013	n/a
	30	5.8	n/a	n/a	n/a	n/a
	59	5.9	0.00991	< 0.00001	0.0003	n/a
	94	6.1	n/a	n/a	n/a	2
	128	5.4	0.01022	< 0.00001	0.0005	<2
	160	5.2	n/a	n/a	n/a	4
Untreated Timber (TIMBER-control)	21	5.85	n/a	n/a	n/a	n/a
	32	6.5	0.02142	3E-05	0.0024	n/a
	59	4.7	n/a	n/a	n/a	n/a
	90	5.6	0.00517	< 0.00001	0.0007	7
	128	4.3	n/a	n/a	n/a	<2
	163	4.6	0.04716	< 0.00001	0.0056	2

Table of Metal and Toxicity Data for ACA-poles and Controls

Sample Description	Cumm. Precip (mm)	pH	Ammonia (mg/L)	Arsenic (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	LC50 (%)
ACA	15	8.03	146	110	0.066	7.02	1.38	0.5
Treated	30	7.44	40.4	192	0.086	19.9	0.082	0.5
Poles	43	7.6		132	0.044	8.58	0.07	
	59	7.6	213	116	0.122	7.74	0.101	0.7
	74	7.7		125	0.067	6.87	0.139	
	90	7.6	233	116	0.058	7.14	0.169	2
	109	7.5		85	0.048	4.25	0.1	
	126	7.5	112	65.5	0.052	2.98	0.069	0.7
	143	7.35		88.9	0.047	4.48	0.078	
	157	7.5	102	35.6	0.023	2.09	0.129	6

Untreated	16	7.93	0.015	0.0025	< 0.015	< 0.01	2.07	35
Poles	30	5.8	n/a	n/a	n/a	n/a	n/a	n/a
	43	5.55		0.006	< 0.015	< 0.01	2.95	
(POLE-control)	59	5.9	< 0.005	0.0089	< 0.015	0.014	0.819	52
	76	6.3		0.062	< 0.015	0.028	3.16	
	94	6.1	n/a	n/a	n/a	n/a	n/a	100
	110	6.4		0.005	< 0.015	< 0.01	0.785	
	128	5.4	0.015	0.124	< 0.015	0.035	0.744	100
	146	5.82		0.087	< 0.015	< 0.01	0.943	
	160	5.2	n/a	n/a	n/a	n/a	n/a	83

Untreated	21	5.85	n/a	n/a	n/a	n/a	n/a	n/a
Timber	32	6.5	2.18	0.012	< 0.015	0.045	18.8	7
(TIMBER-control)	59	4.7	n/a	n/a	n/a	n/a	n/a	20
	90	5.6	0.11	0.0041	< 0.015	0.01	3.65	11
	128	4.3	n/a	n/a	n/a	n/a	n/a	17
	163	4.6	0.3	0.0033	< 0.015	< 0.01	2.2	18

Table of PAH and PCP Data for PCP-poles and Controls

Sample Description	Cumm. Precip. (mm)	pH	Total PAH (mg/L)	Benzo(a) pyrene (mg/L)	Naphthalene	Revisions QAQC PCP (mg/l)
PCP Treated Poles Composite centre & ends (PCP-pole)	14.5	6.075	0.01853	3E-05	0.0047	1.78
	29.5	6.415	0.11649	5E-05	0.0012	1.81
	43	4.34				2.26
	60	4.9	0.03972	4E-05	0.0029	1.57
	76.5	4.5			-	2.29
	94	5.15	0.05529	4E-05	0.0043	2.33
	110	4.75				2.85
	128	4.4	0.08994	7E-05	0.0046	2.42
	145	4.785				2.24
	160	4.25	0.21686	8E-05	0.0276	1.94
	310	n/a	0.03374	4E-05	0.0015	2.75
Untreated Poles (POLE-control)	16	7.93	0.0195	< 0.00001	0.0013	0.051
	30	5.8	n/a	n/a	n/a	n/a
	59	5.9	0.00991	< 0.00001	0.0003	0.002
	94	6.1	n/a	n/a	n/a	n/a
	128	5.4	0.01022	< 0.00001	0.0005	0.002
	160	5.2	n/a	n/a	n/a	n/a
Untreated Timber (TIMBER-control)	21	5.85	n/a	n/a	n/a	n/a
	32	6.5	0.02142	3E-05	0.0024	0.017
	59	4.7	n/a	n/a	n/a	n/a
	90	5.6	0.00517	< 0.00001	0.0007	0.001
	128	4.3	n/a	n/a	n/a	n/a
	163	4.6	0.04716	< 0.00001	0.0056	0.001

Table of pH and Toxicity Data

Sample Description	Cumm. Precip (mm)	pH	LC50 (%)
Creosote Treated Poles (CREO-pole)	15	6.4	3
	30	5.84	4
	61	5.2	6
	90	5.7	4
	128	5.3	13
	160	4.7	13
	310	7.65	n/a

Creosote Treated Timbers (CREO-timber)	21	7.15	5
	32	6.15	3
	59	5.2	3
	90	5.7	3
	128	4.9	10
	163	4.6	13

PCP Treated Poles Composite centre & end (PCP-poles)	14.5	6.075	7
	29.5	6.415	2
	60	4.9	3
	94	5.15	3
	128	4.4	3
	160	4.25	3
	310	5.34	n/a

ACA Treated Poles (ACA-poles)	15	8.03	0.5
	30	7.44	0.5
	59	7.6	0.7
	90	7.6	2
	126	7.5	0.7
	157	7.5	6

Untreated Poles (POLE-control)	16	7.93	35
	30	5.8	n/a
	59	5.9	52
	94	6.1	100
	128	5.4	100
	160	5.2	83

Untreated Timber (TIMBER-control)	21	5.85	n/a
	32	6.5	7
	59	4.7	20
	90	5.6	11
	128	4.3	17
	163	4.6	18

Table of Total Organic Carbon (TOC) and Phenol Data

Sample Description	Cumm. Precip (mm)	pH	Phenolics (mg/L)	TOC (mg/L)
Creosote Treated Poles (CREO-P)	15	6.4	12.9	194
	30	5.84	13.8	144
	61	5.2	10.9	91.2
	90	5.7	11.8	82.6
	128	5.3	4.99	45.6
	160	4.7	3.9	19.7
	310	7.65	n/a	n/a

Creosote Treated Timbers (CREO-T)	21	7.15	4.88	114
	32	6.15	0.738	117
	59	5.2	3.25	61.6
	90	5.7	5.55	60.6
	128	4.9	2.55	33.6
	163	4.6	1.75	11.1

PCP Treated Poles Composite (PCP-E and PCP-C)	14.5	6.075	n/a	110
	29.5	6.415	n/a	97.8
	60	4.9	n/a	54.2
	94	5.15	n/a	75.8
	128	4.4	n/a	35.8
	160	4.25	n/a	42.9
	310	5.34	n/a	n/a

Untreated Poles (POLE)	16	7.93	0.285	99.9
	30	5.8	n/a	n/a
	59	5.9	0.284	22.8
	94	6.1	n/a	n/a
	128	5.4	< 0.02	11
	160	5.2	n/a	n/a

Untreated Timber (TIMBER)	21	5.85	n/a	n/a
	32	6.5	0.183	261
	59	4.7	n/a	n/a
	90	5.6	0.32	58.4
	128	4.3	n/a	n/a
	163	4.6	0.15	13.7

APPENDIX II

Analytical Data Tables



MATERIAL SAFETY DATA SHEET

24 Hour Emergency Phone (316) 524-5751

Division of Vulcan Materials Company / P. O. Box 530390 • Birmingham, AL 35253-0390

I - IDENTIFICATION

CHEMICAL NAME Pentachlorophenol	CHEMICAL FORMULA C_6Cl_5OH	MOLECULAR WEIGHT 266.32
TRADE NAME GLAZD® Penta, Block Penta		
SYNONYMS Penta, PCP, Technical Grade PCP, Chloropnenols, Solid		DOT IDENTIFICATION NO. UN 2020

II- PRODUCT AND COMPONENT DATA

COMPONENT(S) CHEMICAL NAME * Pentachlorophenol 2, 3, 4, 6-Tetrachlorophenol Hydroxypolychlorodibenzo Ethers For additional information refer to note in Section VI, Chronic Toxicity. NOTE: The hazards of this product are based on studies on this or similar products. * Denotes chemical subject to reporting requirements of Section 313 of Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) and 40 CFR Part 372	CAS REGISTRY NO. 87-86-5 58-90-2	% (wt.) Approx. 90-94 0-1.5 4-7	OSHA PEL 0.5 mg/m ³ None None
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III - PHYSICAL DATA

APPEARANCE AND ODOR Light brown or tan flake or solid	SPECIFIC GRAVITY Flake bulk density = 70 lbs/ft ³
BOILING POINT 310°C (Melting Point: 190°C)	VAPOR DENSITY IN AIR (Air = 1) N/A
VAPOR PRESSURE N/A	% VOLATILE, BY VOLUME 0
EVAPORATION RATE N/A	SOLUBILITY IN WATER 14 ppm @ 20°C

IV - REACTIVITY DATA

STABILITY Stable	CONDITIONS TO AVOID Avoid contact with open flame, electric arcs, or other hot surfaces which can cause thermal decomposition.
INCOMPATIBILITY (Materials to avoid) Strong oxidizers and alkalies.	
HAZARDOUS DECOMPOSITION PRODUCTS Hydrogen chloride, chlorine, chlorinated hydrocarbons	
HAZARDOUS POLYMERIZATION Will not occur	

V - FIRE AND EXPLOSION HAZARD DATA

FLASHPOINT (Method used)

None

FLAMMABLE LIMITS IN AIR

None

EXTINGUISHING AGENTS

None

NEPA Hazard Ratings: Health 3, Flammability 0, Reactivity 0

UNUSUAL FIRE AND EXPLOSION HAZARDS

Toxic gases are formed by thermal decomposition. Firefighters should wear self contained positive pressure breathing apparatus, and avoid skin contact.

VI - TOXICITY AND FIRST AID

EXPOSURE LIMITS (When exposure to this product and other chemicals is concurrent, the exposure limit must be defined in the workplace.)

ACGIH Biological Exposure Indices

ACGIH: 0.5 mg/m³ 8 hour TWA

(2 mg/L urine)

OSHA: 0.5 mg/m³ 8 hour TWA

(5 mg/L plasma)

(skin absorption possible)

Effects described in this section are believed not to occur if exposures are maintained at or below appropriate TLVs.

Because of the wide variation in individual susceptibility, these exposure limits may not be applicable to all persons and those with medical conditions listed below.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Acute or chronic kidney or liver disease, asthma, bronchitis, chronic acne and other skin conditions.

ACUTE TOXICITY

Primary route(s) of exposure:

☒ Inhalation

☒ Skin Absorption

☐ Ingestion

Inhalation: Concentrations of 0.3 mg/m³ can cause nose irritation. Concentrations above 1 mg/m³ can cause irritation of upper respiratory tract with sneezing and coughing. Persons acclimated to pentachlorophenol can tolerate levels above 2 mg/m³. Symptoms of overexposure include rapid heart-beat and respiration, elevated temperature and blood pressure, muscular weakness, excessive sweating, dizziness and nausea. High concentrations can cause unconsciousness, convulsions and death generally from cardiac arrest.

Skin: Pentachlorophenol is readily absorbed through intact skin. Pentachlorophenol in solution can be readily absorbed through intact skin in toxic amounts, causing systemic poisoning and symptoms described in the Inhalation section. Pentachlorophenol on the skin can cause irritation.

Eyes: Pentachlorophenol causes irritation of the eyes at 1 mg/m³. If exposure is prolonged, slight transient corneal damage can occur.

Ingestion: Single dose toxicity is high. Symptoms of ingestion are those described in the Inhalation section.

Chloracne: In humans, the absorption of pentachlorophenol by any route may result in the development of the skin condition, chloracne. This usually appears as blackheads, whiteheads and yellow cysts over the temples and around the ears. In severe cases, involvement may be extensive. Mild cases may be similar in appearance to other forms of acne and to skin changes commonly seen with aging.

FIRST AID

Inhalation: Move victim to fresh air. If breathing has stopped, administer artificial respiration. Call a physician.

Skin: Remove contaminated clothing and shoes. Wash skin thoroughly with soap and water for at least 15 minutes. Wash contaminated clothing before reuse.

Eyes: Flush eyes immediately with water for at least 15 minutes. Contact a physician.

Ingestion: Call a physician or Poison Control Center immediately. If possible, vomiting should be induced under medical supervision. Drink one or two glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

NOTE TO PHYSICIAN: This product is a metabolic stimulant. Treatment is supportive. Forced diuresis may be effective to reduce total body burden. Treat hyperthermia with physical measures. Do not administer aspirin, phenothiazines, or atropine since they may enhance toxicity.

CHRONIC TOXICITY

The finding of chronic toxic effects in laboratory animals may indicate toxicity to humans. Overexposure should be avoided, failure to do so could result in injury, illness or even death. Chronic overexposure to technical grade pentachlorophenol has caused liver and kidney toxic effects in experimental animals.

Carcinogenicity: Technical Grade Pentachlorophenol has been evaluated for possible cancer causing effects in laboratory animals. The National Toxicology Program fed up to 400 ppm Technical Grade (TG) penta and up to 600 ppm "purified" penta to mice, 5 days a week for 106 weeks. A statistically significant increased incidence of liver tumors and endocrine tumors was observed in male mice. A significant increase in liver tumors was not seen in female mice fed TG penta and was seen only at the highest dose for "purified" penta. Vascular tumors were also observed in female mice. Rats exposed by ingestion to concentrations up to 30 mg/kg/day for 2 years and two strains of mice exposed by ingestion to concentrations up to 46.4 mg/kg/day did not show an increase incidence in tumors. Two strains of mice were also tested by having Technical Grade Pentachlorophenol subcutaneously injected. These mice did not show an increased incidence of tumors. Pentachlorophenol, 2,3,4,6-tetrachlorophenol and hydroxypolychlorodibenzo ethers are not listed on the IARC, NTP or OSHA carcinogen lists.

Reproductive Toxicity: Reproductive toxicity tests have been conducted to evaluate the potential adverse effects technical grade and purified pentachlorophenol may have on reproduction and offspring of laboratory animals. Both technical and purified pentachlorophenol have been found to be embryo and fetotoxic to rats, but not to hamsters. Neither technical grade nor purified pentachlorophenol caused teratogenic effects (birth defects), but did cause delays in normal fetal development. The U.S. EPA has expressed the opinion that pentachlorophenol can produce defects in the offspring of laboratory animals. Exposure to pentachlorophenol during pregnancy should be avoided.

Note: This product contains trace quantities of hexa, hepta and octachlorodibenzo-p-dioxins, hexa, hepta and octachlorodibenzofurans and hexachlorobenzene. The state of California has listed hexachlorodibenzo dioxin and hexachlorobenzene under Proposition 65 as chemicals known to the state to cause cancer. If further information is desired, contact Vulcan Chemicals Technical Service Department.

VII - PERSONAL PROTECTION AND CONTROLS

RESPIRATORY PROTECTION

Where concentrations of pentachlorophenol exceed or are likely to exceed .5 mg/m³, a NIOSH/MSHA approved organic vapor-dust filter type respirator is acceptable. A NIOSH/MSHA approved self-contained breathing apparatus or air line respirator, with full face piece, is required for concentrations above 150.0 mg/m³, or during emergency and spills. Follow applicable respirator use standards and regulations.

VENTILATION

Do not use in closed or confined space. Open doors and/or windows. Use ventilation to maintain exposure levels below 0.5 mg/m³

SKIN PROTECTION Wear PVC, neoprene, nitrile latex or equivalent gloves and tightly woven clothing including long sleeve shirt when handling flake or solid penta. When mixing penta solutions, wear protective clothing, gloves and boots or shoes, which are suitable for the solvent being used.

EYE PROTECTION

Wear safety glasses. Contact lenses should not be worn. When mixing penta solutions, wear chemical goggles and/or face shield.

HYGIENE

Avoid contact with skin and breathing dust. Do not eat, drink, or smoke in work area. Wash hands prior to eating, drinking or using restroom. Change into uncontaminated clothing before leaving work premises. (Refer to Section VIII).

OTHER CONTROL MEASURES

To determine the exposure level(s), monitoring should be performed regularly. Safety shower and eye wash station should be available. Note: Protective equipment and clothing should be selected, used, and maintained according to applicable standards and regulations. For further information, contact the clothing or equipment manufacturer or the Vulcan Chemicals Technical Service Department.

VIII - STORAGE AND HANDLING PRECAUTIONS

Follow protective controls set forth in Section VII when handling this product.

Store in properly labeled containers in dry, well ventilated secure area.

Thoroughly wash potentially contaminated clothing before reuse. Do not launder work clothes with other non-contaminated clothes and/or household laundry.

Contaminated clothing, boots or equipment should not be taken home.

Do not remove or deface label. Do not reuse drums for any purpose.

Container Disposal: Completely empty drum or liner into application equipment. Triple rinse or clean empty drums, liners and block wrappings in accordance with 40 CFR 261.7(b)(3) prior to offering for reconditioning, recycling or other disposal. For guidance, contact the nearest EPA regional office or State Agency authorized to administer the Resource Conservation and Recovery Act (RCRA).

SARA Title III Hazard Categories: Immediate Health, Delayed Health

IX - SPILL, LEAK AND DISPOSAL PRACTICES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Ventilate spill area and avoid breathing dust or vapors. Clean up spilled material (wear protective equipment - See Section VII) and place in closed container for normal use if possible or proper disposal. Penta is toxic to fish and wildlife; do not allow to contaminate ground or surface waters. Reportable Quantity (RQ) is 10 lbs. Notify National Response Center (800/424-8802) of uncontrolled spills in excess of RQ.

WASTE DISPOSAL METHOD

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA regional office for guidance.

X - TRANSPORTATION

DOT HAZARD CLASSIFICATION

Chlorophenols, Solid, 6.1, Un 2020, PG III, RQ (Pentachlorophenol)

PLACARD REQUIRED

KEEP AWAY FROM FOOD, 2020, Class 6

LABEL REQUIRED

KEEP AWAY FROM FOOD, Class 6

Label as required by EPA and by OSHA Hazard Communication Standard, and any applicable state and local regulations.

Medical Emergencies

Call collect 24 hours a day
for emergency toxicological
information 415/821-5338

Other Emergency information

Call 316/524-5751 (24 hours)

For any other information contact:

Vulcan Chemicals
Technical Service Department
P.O. Box 530390
Birmingham, AL 35253-0390
800/873-4898
8 AM to 5 PM Central Time
Monday Through Friday

DATE OF PREPARATION:

October 1, 1991

NOTICE: Vulcan Chemicals believes that the information contained on this Material Safety Data Sheet is accurate. The suggested procedures are based on experience as of the date of publication. They are not necessarily all-inclusive nor fully adequate in every circumstance. Also, the suggestions should not be confused with nor followed in violation of applicable laws, regulation, rules or insurance requirements.

NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE IS MADE.

Form 3239-710

MATERIAL SAFETY DATA SHEET

EMERGENCY PHONE NUMBER

(514) 848-5208

SECTION 1 - PRODUCT AND PREPARATION INFORMATION

Trade Name : PENTACHLOROPHENOL/OIL TREATING SOLUTION
Synonym : PENTA TREATING SOLUTION, PCP/OIL
Product Code : N/AP
Chemical Name
and synonym : N/AP
CAS Number : N/AP

Manufacturer

DOMTAR INC.
WOOD PRESERVING DIVISION

MSDS Code : MSDS-09
Preparation Date : 1992/10/31

Chemical Family : Hydrocarbon
Formula : 5 to 8% PCP, 95
to 92% Oil
PIN NUMBER : UN2021
TDG Shipping Name : Environmental
Hazardous
substance
TDG Hazard Classification : 9.2
WHMIS Classification : Class B
Division 3
Class D
Division 1
Sub-division

Name of Department Preparing MSDS

ENGINEERING DEPARTMENT

Information Tel (514)848-5604

Hazard Rating

Health : 3
Flammability : 2
Reactivity : 0

Product Use

Wood preservative

SECTION II - HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CAS NUMBER	PERCENT BY WEIGHT
Pentachlorophenol	87-86-5	5 TO 8
Pole Treating Oil	64741-59-9	95 TO 92

SECTION III - PHYSICAL DATA

Physical state (room temperature)	: Liquid
Odour and appearance	: Dark brown liquid with aromatic odour
Odour threshold	: N/AV
Boiling point	: 189°C - 369°C
Freezing point	: N/AV
Percent volatile by volume	: 95%
Specific gravity	: 0.95
Evaporation rate (ether=1)	: < 1
Vapour pressure	: 50 mm Hg at 38°C
Vapour density (air=1)	: N/AV
pH	: N/AP
Coefficient of water / oil distribution	: N/AV
Solubility in water	: Insoluble

SECTION IV - FIRE OR EXPLOSION HAZARDS

Conditions of flammability	: Can be ignited under oil/oxygen mixture (same as furnace oil)
Extinguishing media	: Foam, dry chemical carbon dioxide .
Hazardous combustion products	: Hydrogen chloride, chlorinated hydrocarbons.
Special fire fighting procedures	: Wear full protective equipment including a self-contained breathing apparatus.
Flash point & method of determination	: 79°C (Pensky-Martin)
Upper flammable limit	: N/AV
Lower flammable limit	: N/AV
Auto-ignition temperature	: N/AV
Explosion data sensitivity to mechanical impact	: No
Explosion data sensitivity to static discharge	: Yes i.e. fume/oxygen mixture

SECTION V - REACTIVITY DATA

Stability	: Stable
Conditions to avoid	: Strong oxidizing agent.
Incompatible substances	: Strong oxidizers and alkalies.
Hazardous decomposition products	: Chlorinated hydrocarbons, hydrogen chloride.
Hazardous polymerization	: Will not occur.

SECTION VI - TOXICOLOGICAL PROPERTIES

Route of entry : Skin contact X
 Skin absorption X
 Eye contact X
 Inhalation X
 Ingestion X

Effects of acute exposure : **Inhalation:** Concentration of 0.3 mg/m³ of pentachlorophenol can cause nose irritation. Concentration above 1 mg/m³ can cause irritation of upper respiratory tract with sneezing and coughing. Persons acclimated to PCP can tolerate levels above 2 mg/m³. Symptoms of over exposure include rapid heartbeat and respiration, elevated temperature and blood pressure, muscular weakness, excessive sweating, dizziness and nausea. High concentrations can cause unconsciousness, convulsion and death generally from cardiac arrest.
Skin: Skin irritation. PCP in a solution can be readily absorbed through intact skin in toxic amounts, causing systemic poisoning and symptoms described in the Inhalation section.
Eyes: Irritation of the eyes.
Ingestion: Single does toxicity is high. Symptoms of ingestion are those described in the Inhalation section.

Effects of chronic exposure . . : The finding of chronic toxic effects in laboratory animals may indicate toxicity to humans. Overexposure should be avoided, failure to do so could result in injury, illness or even death.

Chronic overexposure to technical grade PCP has caused liver and kidney toxic effects in experimental animals.

Exposure limits

CHEMICAL COMPONENT	ACGIH TWA	LC50	LD50
Pole Oil	5.0 mg/m ³	4000 mg/kg	8000 mg/kg
Pentachlorophenol	0.5 mg/m ³	300 mg/kg	50 mg/kg

Irritancy	: Skin, eyes - moderately irritating.
Sensitization	: Prolonged direct exposure can cause dermatitis.
Carcinogenicity	: Pentachlorophenol, 2,3,4,6-tetrachlorophenol and hydroxypolychlorodibenzo ethers are not listed on the IARC, NTP or OSHA carcinogen lists
Reproductive toxicity	: Fetotoxic, embryotoxic
Teratogenicity	: No
Mutagenicity	: No
Toxicologically synergistic products	: N/AV

SECTION VII - PREVENTIVE MEASURES

Hand protection	: Gloves: PVC, Neoprene, Nitrile latex or equivalent.
Eye protection	: Wear safety glasses. Contact lenses should not be worn. When mixing penta solution, wear chemical goggles and/or face shield.
Respiratory protection	: Where concentrations of PCP exceed or are likely to exceed 0.5 mg/m^3 , wear an approved organic vapour-dust filter respirator. Approved self-contained breathing apparatus or air line respirator, with full face piece, is required for concentrations above 150 mg/m^3 or during emergencies and spills.
Body protection	: Wear tightly woven clothing including long sleeve shirt when handling flake or solid penta. When mixing penta solutions, wear protective clothing, gloves and boots or shoes, which are suitable for the solvent being used. (Note Precautions).
Foot protection	: Safety boots: Viton PVC, neoprene, nitrile latex or equivalent. (Note precautions).
Ventilation controls	: Do not use in closed or confined space. Open doors and/or windows.

Steps to be taken in case of a leak or a spill:

Ventilate spill area and avoid breathing dust or vapours. Clean up spilled material (wear protective equipment - See above) and place in closed container for normal use if possible or proper disposal. Penta is toxic to fish and wildlife; do not allow to contaminate ground or surface water.

Waste disposal method:

Dispose of waste in accordance with government requirements.

Precautions to be taken in handling and storing:

Follow protective controls set out above when handling this product. Store in properly labelled containers in dry, well ventilated secure area. Thoroughly wash potentially contaminated clothing before reuse. Do not launder work clothes with other non-contaminated clothes and/or household laundry. Contaminated clothing, boots or equipment should not be taken home.

Special shipping requirements:

Not transported.

SECTION VIII - FIRST AID MEASURES

- Skin contact : Remove contaminated clothing and shoes. Wash skin thoroughly with soap and water for at least 15 minutes. Wash contaminated clothing before reuse.
- Eye contact : Flush eyes immediately with flowing water for at least 15 minutes, occasionally lifting the upper and lower lids. Contact a physician.
- Inhalation : Move victim to fresh air. If breathing has stopped administer artificial respiration. Call a physician.
- Ingestion : Call a physician or Poison Control Center immediately. Do not induce vomiting.

DISCLAIMER:

Domtar believes the above information to be reliable. Handling of this product shall be limited to qualified persons. Users must make their own tests when mixing this product with any other product or using it in any process which may alter its properties. Domtar assumes no responsibility whatsoever from any such usage.



MATERIAL SAFETY DATA SHEET

MSDS NUMBER: 645-900

SECTION 1

PRODUCT IDENTIFICATION

TRADE NAME: P.C P. SOLVENT

MANUFACTURER/SUPPLIER'S NAME: SHELL CANADA CHEMICAL COMPANY

ADDRESS: P.O. Box 100, Station M
Calgary, Alberta
Canada

T2P 2H5

PHONE: 403-691-3111

SHELL EMERGENCY TELEPHONE NUMBER

BUSINESS HOURS : (403) 691-2220

AT ALL OTHER TIMES : 1-800-661-7378

CANUTEC

24 HOUR EMERGENCY TELEPHONE

(613) 996-6666

CHEMICAL SYNONYMS

Petroleum distillate

PRODUCT USE

Wood Preservative Solvent

WHMIS CLASS AND DESCRIPTION

Class B3 Combustible Liquid

CANADIAN TDG DESCRIPTION (ROAD & RAIL)

SHIPPING NAME: PETROLEUM OIL, NOIBN - PCP SOLVENT

CLASS DESCRIPTION:

PACKING GROUP:

UN NUMBER:

THIS PRODUCT IS NOT REGULATED UNDER TDG

SECTION 2 INGREDIENTS & TOXICOLOGICAL PROPERTIES

LEGEND: CBI - CONFIDENTIAL BUSINESS INFORMATION

2A - PRODUCT & CONTROLLED INGREDIENTS

PRODUCT: P.C P. SOLVENT

CAS# : 64742-46-7

BENZENE

CAS# : 71-43-2

Rat

Oral

LD50

Inhal. LC50

>

5600,0 mg/kg

13700,0 ppm

4,00 hrs

100% VOL

WHMIS CONTROLLED: YES

< 10

PPM

WHMIS CONTROLLED: YES

**2B - TOXICOLOGICAL INFORMATION****RATIONALE FOR WHMIS TOXICITY CLASSIFICATION**

Exposure may occur via inhalation, ingestion or through skin contact.
Data is insufficient to further classify according to WHMIS criteria.

SUPPLEMENTAL HEALTH INFORMATION

Prolonged and repeated contact with skin can cause defatting and drying of the skin resulting in skin irritation and dermatitis. Vapours are moderately irritating to the eyes and respiratory passages. Prolonged exposure to high vapour concentration can cause headache, dizziness, nausea, and central nervous system depression. The liquid when accidentally aspirated into the lungs can cause a severe inflammation of the lung. In rare cases may sensitize heart muscle causing heart arrhythmia. Preexisting eye, skin and respiratory disorders may be aggravated by exposure to this product.

SECTION 3 EMERGENCY AND FIRST AID PROCEDURES

EYES

Flush eyes with water for at least 15 minutes while holding eyelids open. Obtain medical attention as soon as possible after first aid has been initiated and completed.

INHALATION

Remove victim from further exposure and restore breathing, if required. Obtain medical attention.

INGESTION

Do not induce vomiting. Guard against aspiration into lungs by having the individual turn on to their left side. Do not give anything by mouth to an unconscious person. If vomiting occurs spontaneously keep head below hips to prevent aspiration of liquid into the lungs. Obtain medical attention immediately.

SKIN

Start rinsing and remove contaminated clothing while rinsing. Wash contaminated skin with mild soap and water. If irritation occurs and persists, obtain medical attention.

NOTES TO PHYSICIAN

The main hazard following accidental ingestion is aspiration of the liquid into the lungs producing chemical pneumonitis. Cardiac arrhythmias have been reported with solvent exposure. If more than 2.0 mL/kg has been ingested, vomiting should be induced with supervision. If symptoms such as loss of gag reflex, convulsions or unconsciousness occur before vomiting, gastric lavage with a cuffed endotracheal tube should be considered.

SECTION 4 EMPLOYEE PROTECTION

THE FOLLOWING INFORMATION, WHILE APPROPRIATE FOR THIS PRODUCT, IS GENERAL IN NATURE. THE SELECTION OF PERSONAL PROTECTIVE EQUIPMENT WILL VARY DEPENDING ON THE CONDITIONS OF USE.

**OCCUPATIONAL EXPOSURE LIMITS - VALID 1991/1992**

Not available for product.

EYES AND FACE

Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes.

SKIN (HANDS, ARMS AND BODY)

Impervious gloves (viton, nitrile) should be worn at all times when handling this material. In confined spaces or where the risk of skin exposure is much higher, impervious clothing should be worn.

RESPIRATORY

If exposure exceeds occupational exposure limits, wear a NIOSH- approved respirator. Proper equipment includes an approved combination organic vapour/ particulate filter chemical cartridge respirator for low concentrations, or an atmosphere-supplied, positive pressure demand, self-contained or airline breathing apparatus for high concentrations.

MECHANICAL VENTILATION

Highly recommended for all indoor situations to control fugitive emissions. Electrical and mechanical equipment should be explosion-proof. Concentrations in air should be maintained below the recommended threshold limit value if unprotected personnel are involved.

For personnel entry into confined spaces (i.e. bulk storage tanks) a proper confined space entry procedure must be followed including ventilation and testing of tank atmosphere. Local ventilation recommended where mechanical ventilation is ineffective in controlling airborne concentrations below the recommended occupational exposure limit.

Make up air should always be supplied to balance air exhausted (either generally or locally).

SECTION 5 PREVENTATIVE MEASURES

STORAGE AND HANDLING

Combustible. Store in a cool, dry, well ventilated area, away from heat and ignition sources. Avoid breathing vapours and prolonged or repeated contact with skin. Vapours may accumulate and travel to distant ignition sources and flashback. Use explosion-proof ventilation to prevent vapour accumulation. Empty containers may contain hazardous product residues. Fixed equipment as well as transfer containers and equipment should be grounded to prevent accumulation of static charge. Launder contaminated clothing prior to reuse. Use good personal hygiene.

SPILL AND LEAK HANDLING PROCEDURES

Issue warning "Combustible". Eliminate all ignition sources. Handling equipment must be grounded. Isolate hazard area and restrict access. Try to work upwind of spill. Avoid direct contact with material. Wear appropriate breathing apparatus (if applicable) and protective clothing. Stop leak only if safe to do so. Dike and contain land spills; contain water spills by booming. Use water fog to knock down vapours; contain runoff. For large spills remove by mechanical means and place in containers. Absorb residue or small spills with absorbent material and remove to non-leaking containers for disposal. Flush area with water to remove trace residue. Dispose of recovered material as noted below. Notify appropriate environmental agency(ies).

**WASTE DISPOSAL METHODS**

Reclaim or dispose of at a licenced waste disposal company. Incinerate with approval of environmental authority. Landfill absorbed material in a government approved site.

SECTION 6 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE

Liquid

ODOUR AND APPEARANCE

Lightly Coloured Hydrocarbon Odour

AVERAGE ODOUR THRESHOLD	:	NOT AVAILABLE
BOILING POINT (DEG C)	:	205 - 369
FREEZING POINT (DEG C)	:	NOT AVAILABLE
DENSITY (KG/M3 @ DEG C)	:	918,00 @ 15
VAPOUR DENSITY (AIR=1)	:	NOT AVAILABLE
VAPOUR PRESSURE (MMHG @ DEG C):	:	NOT AVAILABLE
SPECIFIC GRAVITY (H2O=1)	:	NOT AVAILABLE
PH LEVEL	:	NOT AVAILABLE
VISCOSITY (CST @ DEG C)	:	2,63 @ 40
EVAPORATION RATE (NBUAC=1)	:	NOT AVAILABLE
PARTITION COEFFICIENT (KOW)	:	NOT AVAILABLE
WATER SOLUBILITY	:	Negligible
OTHER SOLVENT	:	Hydrocarbon Solvents
MOLECULAR WEIGHT (G)	:	NOT AVAILABLE
FORMULA	:	NOT APPLICABLE

SECTION 7 REACTIVITY, FIRE AND EXPLOSION HAZARD

7A - FIRE AND EXPLOSION HAZARD**FLASH POINT (DEG C) AND METHOD:**

86 Pensky-Martens CC

FLAMMABLE LIMITS / % VOLUME IN AIR

Not Available

AUTOIGNITION TEMP. (DEG C):

Not Available

EXTINGUISHING MEDIA

Dry Chemical

Carbon Dioxide

Foam

Water Fog

SPECIAL FIRE-FIGHTING PROCEDURES

Caution - Combustible. Do not enter confined fire space without adequate protective clothing and an approved positive pressure self-contained breathing apparatus. Do not use water except as a fog.

**7B - REACTIVITY DATA****HAZARDOUS COMBUSTION / DECOMPOSITION PRODUCTS**

Vapour forms a flammable/explosive mixture with air between upper and lower flammable limits.

Carbon monoxide and carbon dioxide are produced on combustion.

INCOMPATIBILITY

Strong oxidizing agents.

CONDITIONS OF REACTIVITY/INSTABILITY

Avoid excessive heat, open flames and all ignition sources.

STABLE : YES

SENSITIVITY TO MECHANICAL IMPACT : NO

HAZARDOUS POLYMERIZATION: NO

SENSITIVITY TO STATIC DISCHARGE : YES

SECTION 8 ENVIRONMENTAL DATA

REGULATIONS AND STANDARDS

No Canadian federal standards. May contain materials designated as "hazardous substances" by the U.S.Clean Water Act. This product, or all components, are listed on the Domestic Substances List, as required under the Canadian Environmental Protection Act.

ENVIRONMENTAL EFFECTS AND HAZARDS

Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams, or public waterways. Block off drains and ditches. May be harmful to aquatic life. No food chain concentration potential. Provincial regulations require and federal regulations may require that environmental and/or other agencies be notified of a spill incident. Spill area must be cleaned and restored to original condition or to the satisfaction of authorities.

BIODEGRADABILITY

Biodegradable.

SECTION 9 LABEL INFORMATION

TRADE NAME: P.C P. SOLVENT

WHMIS DESCRIPTION

Class B3 Combustible Liquid

HAZARD STATEMENTS

Combustible Liquid.

**SAFE HANDLING**

Eliminate all ignition sources. Avoid prolonged exposure to vapours. Wear suitable gloves and eye protection. Empty containers are hazardous, may contain flammable / explosive liquid residue or vapours. Keep away from sparks and open flames. Bond and ground transfer containers and equipment to avoid static accumulation.

FIRST AID

Wash contaminated skin with soap and water. Flush eyes with water. If overcome by vapours remove to fresh air. Do not induce vomiting. Obtain medical attention.

SECTION 10 PREPARATION AND SUPPLEMENTAL INFORMATION

10A - PREPARATION INFORMATION

PREPARED BY: TOXICOLOGY AND MATERIAL SAFETY SECTION OF SHELL CANADA LIMITED
MSDS EFFECTIVE DATE: 1991/10/25 SUPERCEDES MSDS DATED: 1990/12/18

10B - SUPPLEMENTAL INFORMATION**REVISIONS**

- As of October 23, 1991 the format of all Shell Canada Limited MSDS's has been changed.
- The status of Shell products with respect to the Domestic Substances List will be provided in Section 8, as the information becomes available.

DISCLAIMER

THE INFORMATION CONTAINED IN THIS FORM IS BASED ON DATA FROM SOURCES CONSIDERED TO BE RELIABLE BUT SHELL CANADA LIMITED DOES NOT GUARANTEE THE ACCURACY OR COMPLETENESS THEREOF. THE INFORMATION IS PROVIDED AS A SERVICE TO PERSONS PURCHASING OR USING THE MATERIAL TO WHICH IT REFERS AND SHELL CANADA EXPRESSLY DISCLAIMS ALL LIABILITY FOR LOSS OR DAMAGE, INCLUDING CONSEQUENTIAL LOSS, OR FOR INJURY TO PERSONS (INCLUDING DEATH) ARISING DIRECTLY OR INDIRECTLY FROM RELIANCE UPON THE INFORMATION OR USE OF THE MATERIAL.

REF.011991102599

MATERIAL SAFETY DATA SHEET

EMERGENCY PHONE NUMBER

(514) 848-5208

SECTION 1 - PRODUCT AND PREPARATION INFORMATION

Trade Name : ACA
Synonym : AMMONIACAL COPPER ARSENATE 2% TO 8% SOLUTION
CHEMONITE SOLUTION
Product Code : N/AP
Chemical Name
and synonym : N/AP
CAS Number : N/AP

Manufacturer

DOMTAR INC.
WOOD PRESERVING DIVISION

MSDS Code : MSDS-10
Preparation Date : 1992/10/31

Chemical Family : Arsenical
Compound
PIN NUMBER : 1556
TDG Hazard Classification : 6.1
WHMIS Classification : Class D
Division 2

Name of Department Preparing MSDS

ENGINEERING DEPARTMENT

Information Tel (514)848-5604

Hazard Rating

Health : 3
Flammability : 0
Reactivity : 0

Product Use

Wood preservative

SECTION II - HAZARDOUS INGREDIENTS

CHEMICAL IDENTITY	CAS NUMBER	PERCENT BY WEIGHT*	
		2% Sol'n	8% Sol'n
Arsenic pentoxide	1303-28-2	1.0	4.0
Copper oxide	1317-38-0	1.0	4.0
Ammonia	1336-21-6	1.8	7.2 (as NH ₃)

* approximate

SECTION III - PHYSICAL DATA

Physical State (room temperature)	: Liquid
Odour and appearance	: Dark blue liquid with characteristic sharp odour.
Odour threshold	: 50 ppm for ammonia
Boiling point	: ~100°C
Freezing point	: -3 to 5°C
Percent volatile by volume	: 1.5 - 6
Specific gravity	: 1.01 - 1.02
Evaporation rate	: Of water
Vapour pressure	: 2% - 21 mm Hg, 8% - 72 mm Hg
Vapour density (air = 1)	: N/AV
pH	: 2% - 10.2, 8% - 12
Coefficient of water / oil distribution	: N/AP
Solubility in water	: Insoluble

SECTION IV - FIRE OR EXPLOSION HAZARDS

Conditions of flammability	: None
Extinguishing media	: None
Hazardous combustion products	: This product does not burn. Fire from a separate fuel source may be intense enough to cause thermal decomposition releasing toxic gases.
Special fire fighting procedures	: Wear full protective equipment including a self-contained breathing apparatus. Water fog will reduce vapor concentration.
Flash point & method of determination	: N/AP
Upper flammable limit	: N/AP
Lower flammable limit	: N/AP
Auto-ignition temperature	: N/AP
Explosion data sensitivity to mechanical impact	: No
Explosion data sensitivity to static discharge	: No

SECTION V - REACTIVITY DATA

Stability	: Stable in closed containers.
Conditions to avoid	: Open containers will permit loss of ammonia
Incompatible substances	: Copper, tin, zinc, alloys and galvanized surfaces.
Hazardous decomposition products	: Thermal: Ammonia gas; under high temperature, arsenic trioxide.
Hazardous polymerization	: No

SECTION VI - TOXICOLOGICAL PROPERTIES

Route of entry : Skin contact X
 Skin absorption X
 Eye contact X
 Inhalation X
 Ingestion X

Effects of acute exposure : **Eyes:** Irritation.
Skin: Irritation, inflammation
Ingestion: Nausea, abdominal pain, vomiting, shock, coma, death may occur.
Inhalation: Severe irritation to nose and throat.

Effect of chronic exposure **Ingestion:** Potential carcinogenic action , possible liver and kidney damage, jaundice, reduced white blood cells upon long-term exposure.

Exposure limits

CHEMICAL COMPONENT	ACGIH TWA	LC50	LD50
Arsenic pentoxide	0.5 mg/m ³	N/AV	50 mg/kg
Ammonia	1.0 mg/m ³	N/AV	400 mg/kg
Copper oxide	18.0 mg/m ³	LC ₁₀ 7000 mg/kg	350 mg/kg

Irritancy : Skin, eyes - moderately irritating
 Sensitization : N/AV
 Carcinogenicity : No carcinogenicity was performed on the ACA solution but the arsenic pentoxide is carcinogenic.
 Reproductive toxicity : Yes
 Teratogenicity : Yes
 Mutagenicity : N/AV
 Toxicologically synergistic products : No

SECTION VII - PREVENTIVE MEASURES

Hand protection : Gloves: Neoprene or rubber.
Eye protection : Gas tight chemical goggles.
Respiratory protection : Canister-type respirators approved for ammonia are suitable when concentration is known to be < 1% by volume. Self-contained breathing apparatus must be worn when concentrations are higher or unknown.
Body protection : Wear apron, jackets, pants, coveralls: heavy duty lined polyvinyl chloride, vinyl coated, neoprene, rubber, NBR.
Foot protection : Safety boots: Neoprene or rubber.
Ventilation controls : Sufficient local exhaust ventilation to maintain the gas levels to less than half of the TLV.

Steps to be taken in case of a leak or a spill:

Stop leak if no risk involved. Stay upwind. Small spills: Absorb with absorbent or sawdust. Flush area with water. Dike large spills with soil, sand, etc. Contain runoff from fire control and dilute with water. Preferably use liquid recovery type vacuum cleaner to recover. Use an inert absorbent to complete clean-up.

Waste disposal method:

In accordance with government requirements.

Precautions to be taken in handling and storing:

Do not get on skin, in eyes or on clothing. Do not wear contaminated clothing. Do not use or handle until manufacturer's safety precautions have been read and understood. Safety showers and eye wash fountain should be present.

Special shipping requirements:

Not transported.

SECTION VIII - FIRST AID MEASURES

- Skin contact : Flush contaminated area immediately by use of flowing water. Subsequently remove soaked clothing or articles in contact with the skin. Continue to flush the contaminated skin for at least 15 minutes. Get prompt medical attention if the skin becomes inflamed (redness, itch or pain).
- Eye contact : Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids. Flush eyes for at least 15 minutes. Get medical attention.
- Inhalation : Immediately remove the exposed person to fresh air (coughing and sneezing occurs almost immediately after excessive inhalation of ammonia fumes). Apply artificial respiration if breathing has stopped (Do not use mouth to mouth method) Keep the affected person warm and quiet. Get immediately medical attention.
- Ingestion : Promptly drink a large quantity of salt solution or lime water. Never give liquid to an unconscious person. Call an industrial physician or the Poison Control Center immediately for subsequent advise.* (Stomach pumping by medical personnel is desirable).

*First aid personnel should periodically verify up-to-date response measures with the chemical suppliers and/or an industrial physician.

DISCLAIMER:

Domtar believes the above information to be reliable. Handling of this product shall be limited to qualified persons. Users must make their own tests when mixing this product with any other product or using it in any process which may alter its properties. Domtar assumes no responsibility whatsoever from any such usage.

K O P P E R S

MEDICAL EMERGENCIES: 1 800 553-5631

OUTSIDE U.S.A.: 412 227-2001

GENERAL INFORMATION: 412 227-2884

KOPPERS INDUSTRIES, INC.

436 SEVENTH AVENUE

PITTSBURGH, PA. 15219-1800

CHEMTREC ASSISTANCE 1 800 424-9300

CANUTEC: 1 613 996-6666

SECTION I - PRODUCT IDENTIFICATION

PRODUCT NAME: Coal Tar Creosote-Pressure/General Applications

COMMODITY NUMBER: 17300001

SYNONYM: P1/P13

PRODUCT USE: Wood preservative

CHEMICAL FAMILY: Coal tar distillate

FORMULA: Complex mixture of hydrocarbons

CAS NUMBER: 8001-58-9

DOT PROPER SHIPPING NAME: RQ, Hazardous Substance, Liquid, N.O.S. (Creosote)

DOT HAZARD CLASS: ORM-E

UN/NA NUMBER: NA 9188

NFPA 704M/HMIS RATING: 2/2 HEALTH 2/2 FLAMMABILITY 1/1 REACTIVITY

0 = Least 1 = Slight 2 = Moderate 3 = High 4 = Extreme

CANADIAN PRODUCT CLASSIFICATION: Class D, Division 2, Subdivision A, Very Toxic Material

SECTION II - HEALTH/SAFETY ALERT

CHRONIC OVEREXPOSURE (as defined by OSHA recommended standards)

MAY CAUSE CANCER

WARNING

MAY BE FATAL IF SWALLOWED

HARMFUL TO THE SKIN OR IF INHALED

CAUSES EYE AND SKIN IRRITATION

AVOID PROLONGED OR REPEATED CONTACT

OBSERVE GOOD HYGIENE AND SAFETY PRACTICES WHEN HANDLING THIS PRODUCT

DO NOT USE THIS PRODUCT UNTIL MSDS HAS BEEN READ AND UNDERSTOOD

WARNING: THIS PRODUCT CONTAINS A CHEMICAL KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

SECTION III - HEALTH HAZARD INFORMATION

EYE: Direct contact with liquid or vapor may cause moderate irritation.

SKIN: Contact with skin can result in severe irritation which when accentuated by sunlight may result in phototoxic skin reaction. This material or similar materials when administered throughout the major portion of their lifetime has

caused cancer in laboratory animals. Contact with heated material may cause thermal burns.

INHALATION: Acute overexposure to vapor may result in respiratory tract irritation. Repeated and/or prolonged contact to high concentrations of vapor may result in respiratory difficulties, central nervous system (CNS) effects characterized by headache, drowsiness, dizziness, weakness, incoordination, circulatory collapse, coma and possible death.

INGESTION: Ingestion of material may cause gastrointestinal disturbances including irritation, nausea, vomiting, abdominal pain. Systemic effects are similar to those described under INHALATION.

OTHER: See Section XII (Comments) for additional information on health effects.

SECTION IV - EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: Immediately flush with large amounts of water for 15 minutes. Seek medical aid.

SKIN CONTACT: Remove contaminated clothing. Wipe material from skin. Wash thoroughly with soap and water or waterless hand cleaner. If irritation persists, seek medical aid.

INHALATION: Remove from exposure. If breathing has stopped or is difficult, administer artificial respiration or oxygen as indicated. Seek medical aid.

INGESTION: If victim is conscious and alert, give 1-2 glasses of water or milk. Induce vomiting using ipecac syrup as directed on the label. After vomiting, the victim may be given a slurry of 100 g of activated charcoal in 8 oz. of water. Seek medical aid.

NOTE TO PHYSICIAN: Due to the possibility of sensitization of the myocardium following extreme acute overexposures, cardiorespiratory support should be available.

INGESTION: DO NOT INDUCE VOMITING OR GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

SECTION V - FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT & METHOD >93 C (>200 F) CC AUTOIGNITION TEMP: ND

FLAMMABLE LIMITS (% BY VOLUME/AIR): LOWER: ND UPPER: ND

TDG FLAMMABILITY CLASSIFICATION: None

EXTINGUISHING MEDIA: Use dry chemical, carbon dioxide, foam or water spray. Water or foam may cause frothing, if molten.

FIRE-FIGHTING PROCEDURES: Wear complete fire service protective equipment, including full-face MSHA/NIOSH approved self-contained breathing apparatus. Use water to cool fire-exposed container/structure/protect personnel. Toxic vapors may be given off in a fire.

FIRE AND EXPLOSION HAZARDS: When heated (fire conditions), vapors/decomposition products may be released forming flammable/explosive mixtures in air. Closed

containers may explode when exposed to extreme heat(fire).

SENSITIVITY TO MECHANICAL IMPACT: ND

SENSITIVITY TO STATIC DISCHARGE: ND

SECTION VI - SPILL, LEAK AND DISPOSAL INFORMATION

SPILL OR LEAK PROCEDURES (PRODUCT): Stop leak if no risk involved. Stay upwind. Solidified spills: Shovel into dry containers and cover. Flush area with water. Small wet spills: Take up with sand or other noncombustible absorbent material. Flush area with water. Dike large spills for later disposal. Contain runoff from fire control and dilution water. This product released into the environment must be reported to the National Response Center (1 800-424-8802). When this product is spilled or leaked, the reportable quantity is 1 lb. or more.

----- DOT REPORTABLE QUANTITIES -----

1 lb. Creosote
10 lbs. Benzene

WASTE DISPOSAL: This product is a US EPA defined toxic waste. Dispose of as a toxic waste in accordance with local, state and federal regulations.

SECTION VII - RECOMMENDED EXPOSURE LIMIT/HAZARDOUS INGREDIENTS

EXPOSURE LIMIT (PRODUCT): None established.

*For coal tar pitch volatiles, OSHA-PEL is 0.2 mg/m3 averaged over an 8 hour work shift, benzene soluble fraction.

**(8 Hr TWA)

***Action level 0.5 ppm; NIOSH - 0.1 ppm (8 Hr TWA), 1 ppm (15 min ceiling)

HAZARDOUS INGREDIENTS	CAS NUMBER	%BY WT.	EXPOSURE LIMIT (PPM;MG/M3)		
Creosote	8001-58-9	*	ACGIH-TWA	-	0.2
Indene	95-13-6	<10	ACGIH-TWA	10	48
			OSHA-TWA	10	45
Naphthalene	90-20-3	<15	ACGIH-TWA	10	50
			ACGIH-STEL	15	75
			OSHA-PEL	10	50
			OSHA-TWA	10	50
			OSHA-STEL	15	75
Biphenyl	95-52-4	<5	ACGIH-TWA	0.2	1.5
			ACGIH-STEL	0.6	4
			OSHA-TWA	0.2	1
Benzene***	71-43-2	<1	ACGIH-TWA	10	30
			OSHA-PEL	1**	
			OSHA-STEL	5	
Alkyl Naphthalene		<10	none		

----- SARA TITLE III SECTION 313 CHEMICALS -----
(SEE SECTION VII FOR CAS NUMBERS AND PERCENTAGES)

Creosote

SECTION VIII - PERSONAL PROTECTION INFORMATION

EYE PROTECTION: Industrial safety glasses, minimum. As necessary to comply with 29 CFR 1910.133 and work area conditions: use side shields, goggles or face shield. Chemical goggles; face shield (if splashing is possible).

SKIN PROTECTION: As required, industrial resistant flexible-type gloves. Depending on working conditions, i.e., contact potential, wear impervious protective garments such as head/neck cover, aprons, jackets, pants, coveralls, boots, etc. See Section XII - Comments for additional information on skin protection recommendations.

RESPIRATORY PROTECTION: Not required under normal use conditions. If ventilation does not maintain inhalation exposures below TLV(PEL), use MSHA/NIOSH approved units as per current 29 CFR 1910.134 and manufacturers' "Instructions" and "Warnings". Combination filter/organic vapor cartridges or canister may be used.

VENTILATION: Provide sufficient general/local exhaust ventilation in pattern/volume to control inhalation (molten) exposures below current exposure and areas below flammable vapor concentrations. Local exhaust is necessary for use in enclosed or confined spaces. See OSHA Requirement/NIOSH Pub. 80-106 "Working in a Confined Space".

SECTION IX - PERSONAL HANDLING INSTRUCTIONS

HANDLING: Avoid prolonged or repeated breathing of vapors, mists or fumes. Avoid prolonged or repeated contact with skin or eyes. Observe good personal hygiene practices and recommended procedures. Application of certain protective creams (sun screens for coal tar products) before working/several times during work may be beneficial.

STORAGE: Keep in a closed, labeled container within a cool (well shaded), dry -ventilated area. Protect from physical damage. Keep containers closed when material is not in use. Maintain good housekeeping.

OTHER: Not for use or storage in or around the home. DO NOT TAKE INTERNALLY. Do not use until manufacturer's precautions have been read/understood. Wash exposed areas promptly and thoroughly after skin contact and before eating, drinking, using tobacco products or rest rooms.

SECTION X - REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY: Overheating

INCOMPATIBILITY: none known

HAZARDOUS REACTIONS/DECOMPOSITION/COMBUSTION PRODUCTS: Oxides of carbon

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION: none

SECTION XI - PHYSICAL DATA

BOILING POINT: >180 C (>355 F) SPECIFIC GRAVITY: 1.050*(min.)

MELTING POINT: NA % VOLATILE BY VOL: NA

VAPOR PRESSURE: 1 mm @ 30 C EVAPORATION RATE(ETHER=1): slow

VAPOR DENSITY(AIR=1):>1 VISCOSITY: ND

SOLUBILITY slight pH: ND
(WATER):

VOC: NA

COEFFICIENT OF WATER/OIL DISTRIBUTION: slightly H2O soluble

APPEARANCE/ODOR: brown to black liquid with creosote or tarry odor
*lbs/gal

SECTION XII - COMMENTS

Persons with pre-existing disease in or a history of ailments involving the skin or blood-forming organs may be at a greater risk of developing adverse health effects when exposed to this material.

The IARC monographs (Vol. 35) states that there is sufficient evidence for the carcinogenicity of creosote in experimental animals. The NTP Annual Report on Carcinogens states that creosote oils are carcinogenic in experimental animals. Creosote does not appear in the OSHA Subpart Z Table.

Epidemiological studies of workers in the woodtreating industry have shown no significant health effects due to occupational exposure to creosote. The application of a commercially available sun-blocking lotion is recommended to greatly reduce the phototoxicity of coal tar associated sun burning. The lotion should be applied prior to the application of the barrier cream and should have a sun protection factor(SPF) greater than 15. Application of barrier creams, i.e., Ply 9 Gel, Fend A-2 Cream, Kerodex 51 to prevent coal tar containing products from contacting skin before working/several times during work may be beneficial.

EPA Reg. No. 61468-1 & 61468-5.

This product contains benzene. The IARC monographs (Vol. 29) states that there is sufficient evidence for the carcinogenicity in humans and limited evidence for the carcinogenicity in animals. Benzene is also listed in the NTP Annual Report on Carcinogens and in the OSHA Subpart Z Table (Specifically Regulated Substances).

No known ingredients which occur at greater than 0.1%, other than those listed above, are listed as a carcinogen in the IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, the NTP Annual Report on Carcinogens or OSHA 29 CFR 1910.1001-1047 subpart Z Toxic and Hazardous Substances (Specifically Regulated Substances).

SKIN PROTECTION (protective material): Permeation/degradation values of chemical mixtures cannot be predicted from pure components or chemical classes.

Thus, these materials are normally best estimates based on available pure component data. A significant difference in chemical breakthrough time has been reported for generically similar gloves from different manufacturers (AIHA

J., 48, 941-947 1987).

Do not use until manufacturer's precautions have been read/understood. Wash exposed areas promptly and thoroughly after skin contact from working with this product and before eating, drinking, using tobacco products or rest rooms.

Do not wear contact lens without proper eye protection when using this product.

Prepared By: Occupational Health and Product Safety Department

REVISION DATE: 01/92

CODE NUMBER: IND00003JA9224

SPECIFICATION SHEET NUMBER: TP-1203-10

REPLACES SHEET: IND00003NO9123

COMMODITY NUMBER: 17300001

SUPPLIER INFORMATION: Same as manufacturer.

NOTICE: While the information and recommendations set forth herein are believed to be accurate as of the date hereof, Koppers Industries makes no warranty with respect thereto and disclaims all liability from reliance thereon.