Evaluation of the Effectiveness of Coatings in Reducing Dislodgeable Arsenic, Chromium, and Copper from CCA Treated Wood

Wipe Comparison Report

Category III/Sampling and Analysis

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Acronym List

As	Arsenic
CCA	Chromated Copper Arsenate
CLP	Contract Laboratory Program
CPSC	Consumer Product Safety Commission
DA	Dislodgeable CCA Wood Analytes
DAs	Dislodgeable Arsenic
DCr	Dislodgeable Chromium
DCu	Dislodgeable Copper
DI	Deionized Water
DQI	Data Quality Indicator
EPA	United States Environmental Protection Agency
ERC	Environmental Research Center
H&S	Health and Safety
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
ID	Identification
MS	Matrix Spikes
MS/MSD	Matrix Spikes and Matrix Spike Duplicates
MSD	Matrix Spike Duplicates
OLS	On-Site Laboratory Support
OPP	Office of Pesticide Programs
PFA	Perfluoroalkoxy
PM	Project Manager

Acronym List

PTFE	Polytetrafluoroethylene
QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
STL	Severn Trent Laboratory
SYP	Southern Yellow Pine
TFE	Tetrafluoroethylene
U.S.	United States
WA	Work Assignment

1. Project Description and Organization

1.1 Overall Project Objectives

This study was undertaken in support of existing CCA-treated wood mitigation studies being conducted by the United States Environmental Protection Agency (EPA) and Consumer Products Safety Commission (CPSC) staff, including the study described in EPA's publicly-available outdoor testing protocol established in the QAPP entitled, "Evaluation of the Effectiveness of Coatings in Reducing Dislodgeable Arsenic, Chromium, and Copper from CCA Treated Wood" (U.S. EPA, 2003). Additional background information on the on-going efforts to mitigate potential exposure to CCA chemicals from the surfaces of CCA treated wood can be found in the referenced test plan.

Two series of tests were conducted to determine the relationship between dislodgeable arsenic, chromium, and copper measurements obtained using several related, but different, wipe sampling methods on the surfaces of chromated copper arsenate (CCA) treated wood. Several wipe sampling methods have been employed in mitigation studies being conducted by EPA and CPSC, collaboratively under interagency agreement CPSC-I-03-1235, to determine the efficacy of coatings in reducing dislodgeable arsenic (DAs), chromium (DCr), and copper (DCu), collectively called "DA", from the surfaces of CCA treated wood. The primary objective of this wipe comparison study was to determine factors to correlate the wipe methods that have been employed for mitigation and field screening studies.

1.2 Background

The primary objective of the overall project is to evaluate the ability of selected coatings to reduce the amount of DA on the surfaces of CCA-treated wood. The ability of the coatings to reduce DA as the wood and coatings weather is being evaluated by periodically measuring the amount of DA removed from the surface of the wood specimens using a wipe sampling technique. For the purposes of this study, DA is defined as the amount of CCA analyte removed from the surface of the test specimen by the dermal wipe procedure (with minor modifications) developed and demonstrated by CPSC staff, which is a collaborator on this project via an interagency agreement (CPSC-I-03-1235) between the United States Environmental Protection Agency (EPA) and CPSC staff. Note that measured DA values are dependent upon the specific wipe procedure utilized (e.g., number of passes, device

used, sampling material). For the purposes of this study, DA is expressed in units of mass per surface area wiped (μg/cm^2).

The data obtained will be used by EPA and CPSC staff in support of efforts to inform the public regarding the use and maintenance of existing CCA-treated wood products, such as decks and playground equipment. A supplemental objective of this study is to evaluate and demonstrate the use of the test protocol and to begin to understand its utility and realism, and to identify future research needs. This second objective is relevant because there are currently no standardized protocols for determining the efficacy of coatings to reduce DA from CCA-treated wood. In this regard, the test is a pilot study that may set the stage for systematic development of standardized test methods that will promote development, evaluation, and demonstration of products that mitigate the potential for dermal contact with DA from CCA-treated wood.

1.3 Data Quality Objectives

The critical measurements for the natural weathering tests are total arsenic, total chromium, and total copper concentrations, which are subsequently converted to dislodgeable arsenic, chromium, and copper, which are reported on a mass per unit area basis. Data quality indicator (DQI) goals for concentration in terms of accuracy, precision, and completeness, as established in the QAPP for this project, are shown in Table 1-1.

Table 1-1. Data Quality Indicator Goals for Critical Measurements

Analyte	Method	Accuracy (%Recovery)	Precision (%RSD/RPD)	Completeness (%)
Arsenic (total)	SW-846 Method 6020 (modified)	90-110	10	90
Chromium (total)	SW-846 Method 6020 (modified)	90-110	10	90
Copper (total)	SW-846 Method 6020 (modified)	90-110	10	90

1.4 Project Organization and Responsibilities

The EPA Work Assignment Manager for this project is Mark Mason, who coordinates involvement by other EPA staff and CPSC staff via an interagency agreement (CPSC-I-03-1235) between EPA and CPSC staff, as appropriate. Paul Groff, EPA's QA Officer for this project reviews project QAPPs and reports, audits

sampling methodology, and has stop-work authority on the project. Key CPSC staff includes Jacque Ferrante, Dave Cobb, and Joel Recht. Key EPA-Office of Pesticide Programs (OPP) staff includes Jack Housenger, Norm Cook, Nader Elkassabany, Timothy Leighton, and Jonathan Chen. The ARCADIS Work Assignment Leader is Victor D'Amato, who is intimately involved with most facets of the project including test plan development, data analysis, data reporting, project and fiscal management, and regular reporting tasks. Libby Nessley, with ARCADIS, serves EPA by providing quality assurance and quality control (QA/QC) management services, while Todd Thornton and Jerry Revis, both with ARCADIS, serve EPA by providing health and safety management services. Kevin Bruce, with ARCADIS, is the overall on-site laboratory support (OLS) project manager. Johannes Lee, with ARCADIS, is the assistant project manager for the OLS contract, and, as such, provides a variety of administrative support functions. Matt Clayton, with ARCADIS, procured, characterized, cut, prepared and coated wood samples, in addition to coordinating preparation of the test site. Peter Kariher, Michele Addison, and Sara Easterly, all with ARCADIS, have taken samples, prepared samples via digestion, and shipped digested wipe and control samples to the subcontract analytical laboratory, Severn Trent Laboratory (STL)-Savannah (Angie Weimerskirk, Project Manager). Michele Addison also manages the data generated via this study in addition to supporting other key project tasks. Krich Ratanaphruks, with ARCADIS, provides relational database and data management support and was responsible for producing many of the data analysis report graphics in this report. Len Stefanski, an EPA contractor at North Carolina State University, provides detailed statistical support to the analysis and interpretation of the data. An organizational chart is provided as Figure 1-2. Table 1-2 provides contact information for project staff.

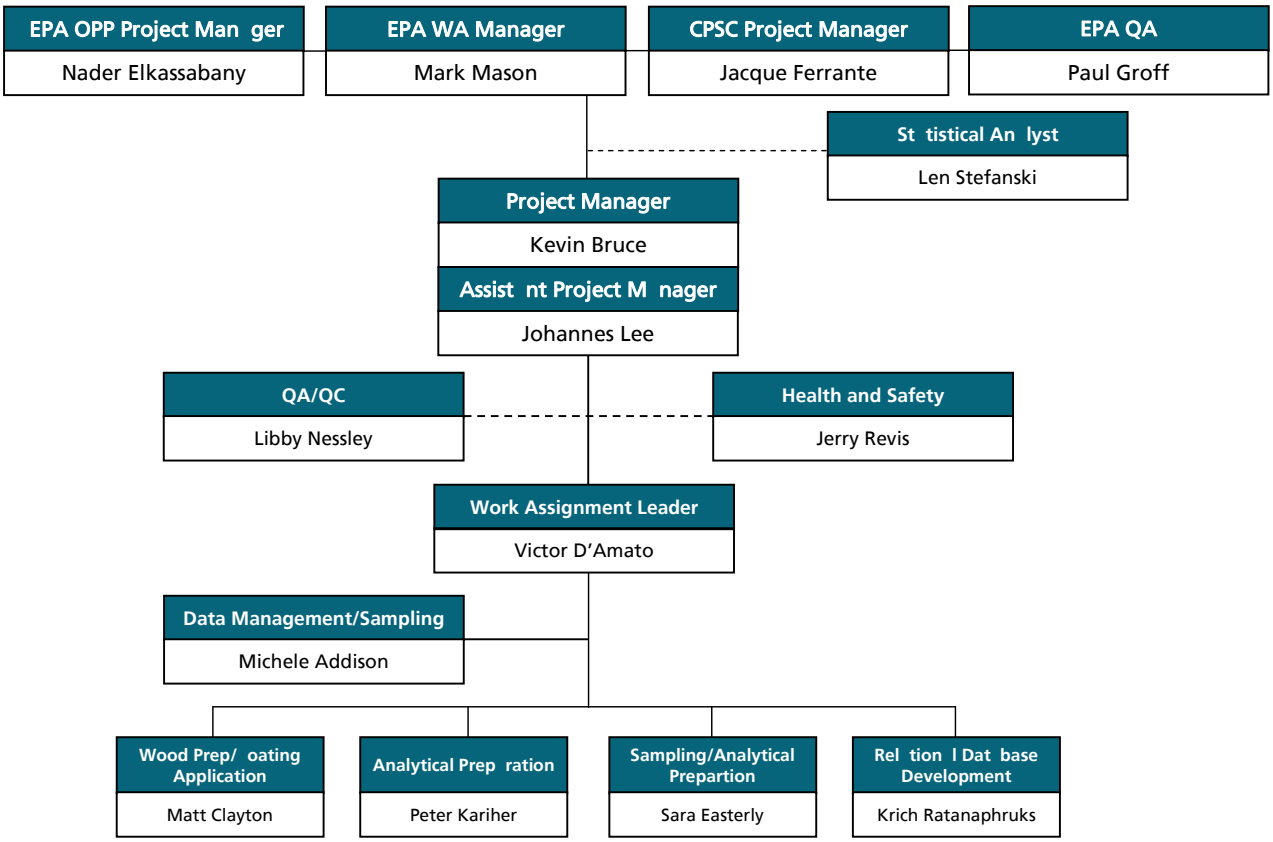

Figure 1-2. Organizational Chart for Weathering Testing

Table 1-2. Contact Information for Key Project Staff

Staff Contact	Organization	Responsibility	Phone Number	E-mail Address
Mark Mason	EPA	Work Assignment (WA) Manager	(919) 541-4835	Mason.Mark.@ epa.gov
Paul Groff	EPA	EPA QA Manager	(919) 541-0979	Groff.Paul@epa.gov
Jacque Ferrante	CPSC	Health Sciences	(301) 504-7259	jferrante@cpsc.gov
Dave Cobb	CPSC	Lab Sciences	(301) 421-6421	dcobb@cpsc.gov
Joel Recht	CPSC	Lab Sciences	(301) 421-6421	jrecht@cpsc.gov
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Tim Leighton	EPA-OPP	Exposure Assessor	(703) 305-7435	Leighton.Timothy@epa.gov
Norm Cook	EPA-OPP	Branch Chief	(703) 308-8253	Cook.Norm@epa.gov
Nader Elkassabany	EPA-OPP	Project Manager	(703) 308-8783	Elkassabany.Nader@epa.gov
Jonathan Chen	EPA-OPP	Toxicologist	(703) 305-1287	Chen.Jonathan@epa.gov
Victor D'Amato	ARCADIS	WA Leader	(919) 544-4535	vd'amato@arcadis-us.com
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Todd Thornton	ARCADIS	Health & Safety (H&S) Manager	(919) 544-4535	tthornton@arcadis-us.com
Jerry Revis	ARCADIS	H&S Manager	(919) 544-4535	jrevis@arcadis-us.com
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Matt Clayton	ARCADIS	Lab Scientist	(919) 544-4535	mclayton@arcadis-us.com
Krich Ratanaphruks	ARCADIS	Database Analyst	(919) 544-4535	kratanaphruks@arcadis-us.com
Michele Addison	ARCADIS	Data Management	(919) 544-4535	maddison@arcadis-us.com
Angie Weimerskirk	STL-Savannah	Analytical Manager	(912) 354-7858	aweimerskirk@stl-inc.com
Len Stefanski	NCSU	Statistician	(919) 515-1945	stefanski@stat.ncsu.edu

2. Test Methods

The methodologies used during these tests are described below, but more detailed testing procedures are included in the approved QAPP entitled, CCA Wood Wipe Method Comparison Testing, Revision 3, dated January 19, 2004 (EPA 2004).

2.1 Terminology

Before proceeding further, it is essential to review the terminology for this project as applied in this report. Wood nomenclature used in this report is defined in Figure 2-1. Note that a "board" is defined as the unit of wood purchased or removed from an existing structure, while "sampling area" refers to the segments of each board that were wipe sampled using the three methods to be tested. Reiterating, a "block" consists of three adjacent wipe areas on one single board, where each of the three wipe techniques were matched with one of the three wipe areas within each block. Two blocks per board were sampled for the January 2004 study, but for the earlier study, wipe sampling techniques were randomized across each entire board (single block design).

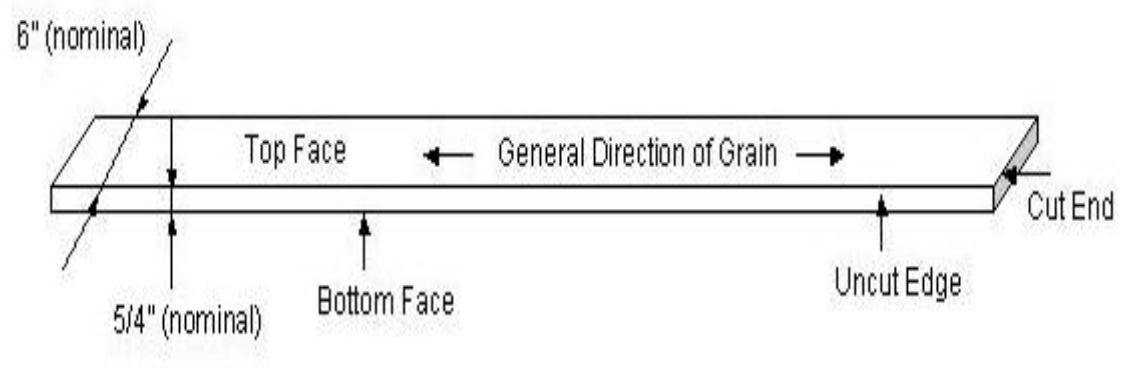

Figure 2 1. Wood Board Nomenclature

Note that all sampling was done on the top faces of the boards; that is, the face of the board that was originally exposed, facing up, on the source deck. Furthermore, note that a "grain-up" or "bark side up" board is defined as one where the tree rings, evident on the cut end of the board, form a convex pattern (a "hill") when observed with the face of the board that was exposed on the source deck facing up. Likewise, a "grain-down" or "bark side down" board is defined as one where these rings form a

concave (a "valley") pattern when the exposed face is facing up. Since wood tends to deform along these ring lines, grain orientation may be an important variable in the measurement and mitigation of DA on surfaces of CCA-treated wood. Grain-down boards tend to deform in a manner which "cups" and holds water or moisture, while grain-up boards tend to deform in a manner which sheds water from the surface of the board. For this reason, it is typically recommended to build outdoor structures, like decks, with boards oriented grain-up, though it appears that many contractors do not control this particular variable and grain-up and grain-down boards are commonly found randomly located within a single deck.

2.2 Sources of Wood

The wood used was aged southern yellow pine (SYP) that had been originally CCA-C treated to 0.40 pcf, in nominal 5/4" x 6" cross-sectional dimensions.

Two excellent sources of aged wood which were selected and are being used in the aforementioned mini-deck study were utilized for these experiments. The two structures have the following characteristics:

"Environmental Research Center (ERC) Deck" - This structure was located outside of the cafeteria of EPA's old (leased) Research Triangle Park facility. It was a stand-alone deck with generally full exposure (except for several boards – which were not used – located under attached benches), with only moderate shading by adjacent buildings during low sun positions. Given its open, stand-alone nature, abrasion patterns appeared very consistent and the boards were visually similar to one another. Additional information on this source was gathered as it was being dismantled under the supervision of ARCADIS. The deck was constructed of SYP, treated to 0.40 pound per cubic foot (pcf) with Ground Contact CCA-C. This source was approximately 7 years old and was believed to have received one application of a standard deck sealant near the beginning of its use (over 5 years ago). The overall condition of the wood was considered fair: the coloration was gray and there was slight-to-moderate splintering. Specific locations and orientations of individual boards were documented during dismantling of the source structure; a map of the structure showing the location of each specimen tested was prepared. This map is shown in Figure 2-2. Photos are provided in Figure 2-3. This deck is referenced as the "A" source.

"New Hill Deck" - This source, donated for use during this project, was taken from an outdoor deck on a private residence. It represents an ideal source of relatively new, good-condition, aged CCA-treated wood. The coloration of the wood was light

brown and relatively bright and there was minimal splintering. The New Hill Deck was an exposed, attached structure. There was no noticeable biological growth or other dampness-related defects. The deck was constructed of SYP, treated to 0.40 pcf with Ground Contact CCA-C, had been in service for just over one year, and had never been cleaned or treated. Specific locations and orientations of individual boards were documented during dismantling of the source structure; a map of the structure showing the location of each specimen tested was prepared. This map is shown in Figure 2-4. Photos are provided in Figure 2-5. This deck is referenced as the "C" source.

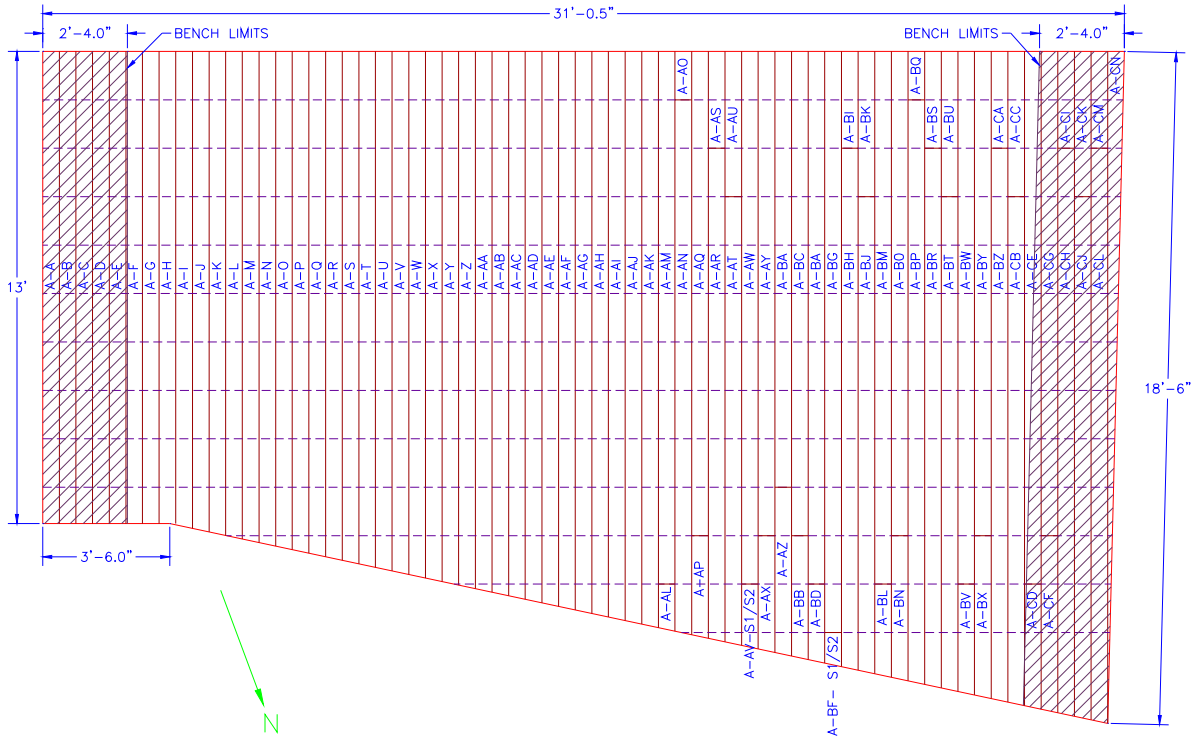

Figure 2-2. ERC Deck Map

Figure 2-3. Views of ERC Deck (note that moisture stains were temporary and that boards under benches were not used to construct minidecks)

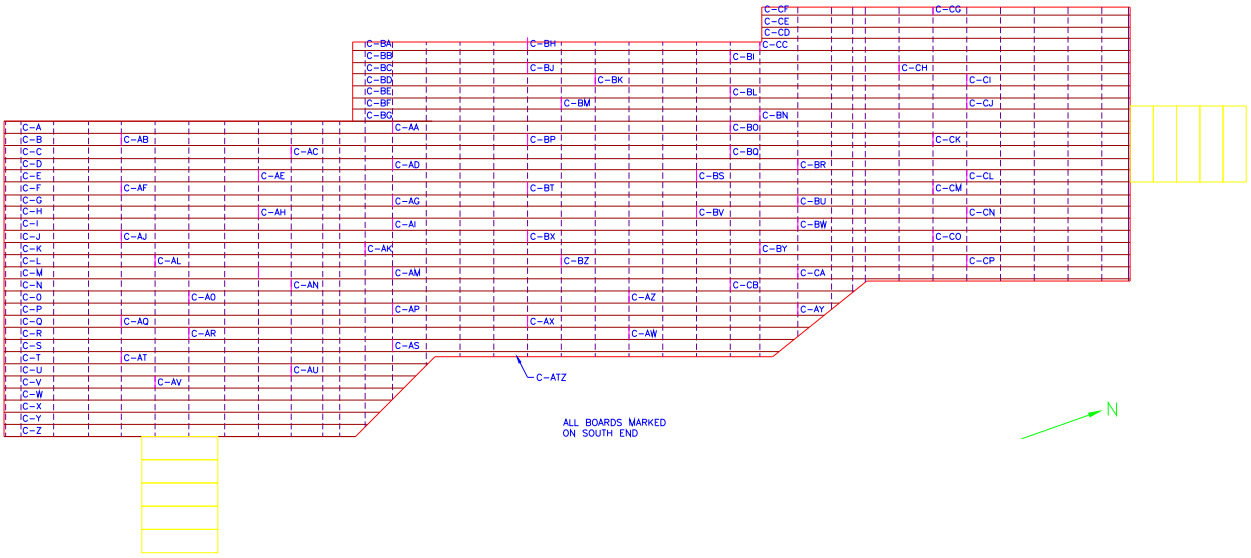

Figure 2-4. New Hill Deck Map

Figure 2-5. Views of New Hill Deck

Boards from these two sources are identified as shown in Figures 2-2 and 2-4, with the first letter corresponding to the source (either "A" for the ERC Deck or "C" for the New Hill Deck), followed by a dash ("-"), followed by a letter, or letter sequence, to identify the specific board from that source.

2.3 Study Design

Two series of tests were conducted to determine the relationship between dislodgeable arsenic, chromium, and copper measurements obtained using several related, but different, wipe sampling methods on the surfaces of CCA-treated wood. Several wipe sampling methods have been employed in mitigation studies being conducted by the United States Environmental Protection Agency (EPA) and the Consumer Products Safety Council (CPSC), collaboratively under interagency agreement CPSC-I-03-1235, to determine the efficacy of coatings in reducing dislodgeable arsenic, chromium, and copper (collectively, "DA") from the surfaces of CCA-treated wood. The primary objective of this wipe comparison study was to determine factors to correlate the wipe methods that have been employed for mitigation and field screening studies.

All of the wipe sampling methods tested employ the use of a moistened polyester wipe applied using a wiping apparatus developed and built by CPSC staff. However,

the methods differ in the preparation of the polyester wipes before sampling and in sample preparation and analysis. EPA, through its contractor ARCADIS, used acid-washed wipes for baseline sampling in an on-going study to determine whether commercially-available coatings can mitigate exposure to dislodgeable arsenic, chromium, and copper from the surfaces of CCA-treated wood. Wipes were acid-washed to ensure their cleanliness for trace metals analysis, rinsed, and then wetted with deionized (DI) water to a saturated condition, which was subsequently measured to be approximately three times the dry weight of the wipe (i.e., wetted with about 2x the dry wipe weight of DI water). However, it was later determined that rinsing efforts were insufficient at removing all of the nitric acid used to wash the wipes. Thus, subsequent sampling for this project was conducted using out-of-the-bag wipes (unwashed) wetted with DI water to a weight three times the dry weight of the wipe. CPSC staff wets wipes with a 0.9% saline solution to two times the dry weight of the wipe (i.e., wetted with 1x dry wipe weight of 0.9% saline). These wipe preparation procedures are detailed in Section 2.5.

In August 2003, a series of tests was conducted to compare the use of EPA's acid washed wetted wipe method (hereinafter, called "A2") and EPA's non-acid washed wetted wipe method (hereinafter, called "2X"). An additional "1X" wipe method was also tested, but the results are of no consequence to the objectives of this report are thus are not presented herein.

After informally reviewing the data from the August experiments, it was concluded that a more exhaustive series of tests be conducted in January 2004, comparing the three wipe methods that have actually been used by researchers on this project (A2, 2X and CPSC staff's 1X, saline-wetted wipe method, hereinafter called "CPSC"). These three methods were tested by sampling adjacent areas of a common board in the same manner and by the same personnel as typically done, in a randomized block design, where blocks were defined as three adjacent wipe areas on a common board, and the locations of the areas wiped using the three wipe techniques were randomized within each block. Additionally, since EPA and CPSC staff utilize different (but similar) extraction and analysis procedures, half of the samples taken during this study were prepared and analyzed by EPA and half by CPSC staff to ascertain whether the sample preparation and analysis methods produce different results. Furthermore, a subset of the samples taken for this study was simply split between the two labs to directly compare analytical results. Additional control samples were conducted to further assess comparability of analytical results between laboratories, in addition to determining analytical precision and accuracy for each laboratory.

Other important variables were controlled and tested during these studies including wood source (the two sources, A and C were tested), grain orientation (grain-up versus grain-down), and board preparation (rinsed versus unrinsed).

In addition to the wipe samples discussed, a series of quality control samples were also tested. These are discussed in Section 2.6.

2.3.1 Randomized Block Design

Because it was believed that intraboard (within board) DA variability would be considerably less than interboard (board-to-board) variability, the design of this experiment was such that the three wipe techniques (including preparation and sampling) tested in each study were each tested on adjacent surface areas on a single board (considered a "block" for this study) for direct comparison. As such, the boards had to be of suitable, consistent quality, and sufficient length to accommodate adjacent (end-to-end) wipe techniques (wipe areas were selected randomly within each block).

2.3.1.1 August 2003 Study

For the August 2003 experiments, two sets of the two wipe methods were randomly assigned to four wipe areas on each board. So, four discrete wipe areas would be randomly assigned the following wipe methods: 2X, 2X, A2, A2. In other words, each board was considered a single block.

In addition to comparing wipe techniques, other variables were secondarily explored in this testing, including:

- Wood source (both sets of experiments)
- Grain-up versus grain-down board orientation (both sets of experiments)

Five A source boards (two grain up and three grain down) and six C source boards (three grain up and three grain down) were tested. All of the boards were used "as is"; that is, none were pre-rinsed prior to sampling. Again, for this study, each board (six sampling areas) was considered a block and two sets of the three wipe methods were randomized within each block. Each wipe method utilized EPA's "between nailhole" wipe length of 38 cm. All wipes were prepared, sampled, and extracted by EPA. All EPA wipe sample extracts are analyzed by STL-Savannah for total As, Cr, and Cu.

A summary of the test blocks is provided in Table 2-1. Figure 2-6 provides clarification on the random block test design for the two sets of tests conducted.

Table 2-1. Summary of Test Blocks (note each block equals six samples) for August 2003 Tests

Wood Source	**Grain-up orientation**	**Grain-down orientation**
"A"	2	3
"C"	3	3

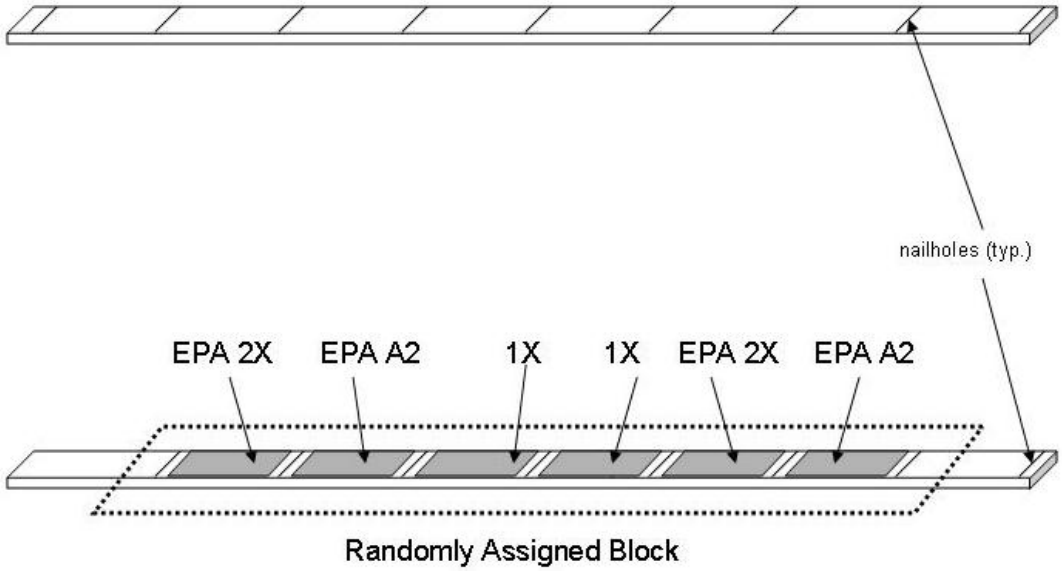

Figure 2-6. Randomized Block Design: August 2003 tests – top sketch is a typical board, bottom sketch is same board showing example block (dashed line) and example locations of wipe areas (shaded)

2.3.1.2 January 2004 Study

For the January 2004 experiments, one set of the three wipe methods tested was randomly assigned to three areas on one-half of each board, while another set of the three wipe methods was randomly assigned to the three wipe areas on the other half of the board. In other words, each board was split into two blocks.

The three wipe techniques that were compared are described in detail later in this section and are designated as follows:

- EPA acid-wash, rinse, wetted to saturation (approx. 2x dry wipe weight) with DI water = “A2”
- EPA out-of-bag wipe, wetted with 2x weight of DI water = “2X”
- CPSC staff out-of-bag wipe, wetted with 1x weight of 0.9% saline = “CPSC”

In addition to comparing wipe techniques, other variables were secondarily explored in this testing, including:

- Wood source
- Grain-up versus grain-down board orientation
- Pre-rinsed versus as-is boards
- EPA versus CPSC staff preparation techniques
- EPA versus CPSC staff analytical techniques

Five boards or ten blocks were tested for each of the two sources of wood (10 boards or 20 blocks, total). Boards selected for this study had at least nine sets of nail holes spaced on approximately 16-inch centers. This allowed for a total of at least eight, 16-inch spaces on each board. Because the two EPA wipe methods (both having a 38 cm wipe length) utilize the area between nail holes for sampling, while CPSC staff’s method (having a 50 cm wipe length) crosses over one set of nail holes, four 16-inch spaces were required for each block (replicate). Since 10 blocks were tested for each of the two sources of wood, five boards per wood source were required. Two of these boards were tested as-is, while three were rinsed with tap water using a light pressure wash (or relatively hard garden hose nozzle) setting, then allowed to dry, undisturbed, for at least 48 hours before testing. Additionally, for each source of wood, both grain-up and grain-down oriented boards were tested and half of the samples were prepared and analyzed per EPA’s method, while half were prepared and analyzed using CPSC staff’s method. Finally, 20% of the sample extracts generated by this project were split for testing by both laboratories, in order to directly compare analytical results.

A summary of the test blocks is provided in Table 2-2. Figures 2-7 provides clarification on the random block test design for the two sets of tests conducted.

Table 2-2. Summary of Test Blocks (note each block equals three samples) for January 2004 Tests

	Unrinsed Boards				Rinsed Boards			
	Grain-up orientation		Grain-down orientation		Grain-up orientation		Grain-down orientation	
Wood Source	EPA Lab	CPSC Lab	EPA Lab	CPSC Lab	EPA Lab	CPSC Lab	EPA Lab	CPSC Lab
"A"	2	2	1	1	1	1	1	1
"C"	2	2	1	1	1	1	1	1

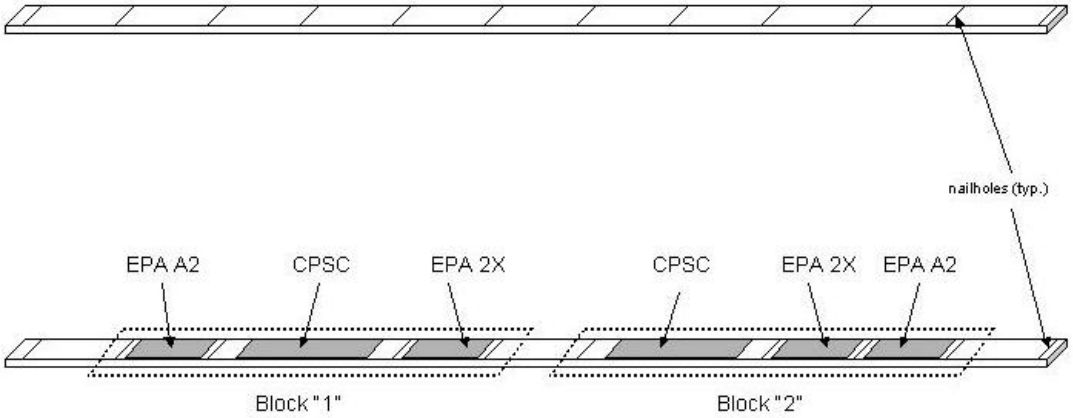

Figure 2-7. Randomized Block Design: January 2004 Tests – Top Sketch is a Typical Board, Bottom Sketch is Same Board Showing Example Blocks (Dashed Lines) and Example Locations of Wipe Areas (Shaded)

2.4 Characterization of Wood Sources

For the January 2004 tests, digital photos were taken of each board at the beginning of the test (i.e., prior to wipe sampling) and archived. All boards were qualitatively and semi-quantitatively characterized for visually-observable wood condition characteristics, with data recorded on a standardized wood characterization data sheet. The characteristics recorded included knotting (number of knots for that specimen was recorded), splintering, cracking, and rotting (for these last three, a rating of 1 to 5, with 5 being like new wood and 1 being complete failure, was assigned).

For each aged CCA-treated board, visually-observable source wood characteristics were recorded, including predominant grain orientation (up versus down), predominant grain type (percent flat versus percent edge grain), predominant ring spacing (tight, medium, wide), predominant wood season (percent early versus percent late wood), and predominant wood type (percent heartwood versus percent sapwood). The percentages of the various grain characteristics, where reported, were gross visual observations and should only be considered estimates.

Grain orientation was assessed by viewing the end of a board and noting the shape of the grain pattern. A concave or "U" shape would be considered "grain down", while a convex or "hill" shape would be considered "grain up". The significance is that boards will tend to deform or warp over time in the direction of their grain. That is, a grain down board will tend to "cup" and may hold water, while a grain up board will tend to shed water.

Grain type was assessed by noting whether the board was cut across the grain (flat grain) or perpendicular through it (edge grain).

Ring spacing was determined by viewing the spacing of the tree's rings and recording whether they were spaced tightly, widely, or in-between (medium).

Wood season was determined based on the prevalence of large cells, or small dense cells within a growth ring. If a majority of each concentric growth ring were light in color, a high percentage of early wood (springwood) would be indicated. If, on the other hand, the dark and light-colored portions of the growth ring were of equal thickness, 50% of the wood would be late wood (summerwood).

The *wood type* was determined by noting the relative color of the wood grain, with darker colors reflecting heartwood (from the center of the tree) and lighter colors reflecting sapwood (from the outer rings of the tree).

2.5 Wipe Sampling

Wipe sampling techniques utilized are based on the method developed and documented by CPSC staff, using the wipe sampling device designed and constructed by CPSC staff. The CPSC staff wipe sampling device utilizes a 1.1 kg disc that is approximately 8.65 cm in diameter as the wiping block (note that the actual width of 5/4" x 6" decking is approximately 5.5" or 14 cm). With the 38-cm wipe length utilized, the sampling area is approximately 314 cm^2. The referenced CPSC staff method has been described previously (CPSC staff 2003b). There are several differences between the procedures employed by EPA and those employed by CPSC staff. The EPA wipe technique is described in detail below, along with wipe preparation and sample extraction and analysis procedures for both researchers, while the differences between techniques are enumerated in Section 2.5.7.

2.5.1 EPA Wipe Method (Adaptation of Referenced CPSC Staff Method)

The wipe method employed by EPA for the referenced minideck study is as follows:

1. Prior to starting a new wipe sample, the sampler puts on a new pair of disposable nitrile or latex gloves. Then, the rubber-coated side of the steel rubbing disk is covered with plastic wrap (SaranWrap or similar). The wetted wipe is then removed from the PTFE tube, folded in half, and placed over the plastic wrap and secured with a plastic tie-wrap strap.

2. The disk is lowered so that it is in contact with the wood.

3. The sampler slides the disc along the tracks forward and backward for five 5 38-cm (15-inch) strokes between nail holes while another person holds the end of the wiping device in place. A stroke consists of one forward and back movement. The speed of sampling is variable depending on the quality of the area being wipes, with rougher wipe areas requiring longer sampling times (slower speeds). Smooth wipe areas may take one second to wipe in each direction, while rough areas may take up to 30 seconds.

4. The wipe is rotated 90° on the rubbing disk, which is then slid forward and back for five more strokes, for a total of 10 front-and-back strokes.

5. The sampler then removes the wipe from the disk and places it back into its PTFE extraction vessel. Wood splinters larger than a grain of rice are removed prior to placing the wipe in the extraction vessel.

6. After the sample is taken, the plastic wrap is discarded and the wiping apparatus is decontaminated by wiping the rails which were in contact with the wood surfaces with lint-free wipes wetted with DI water. Then the apparatus is checked for structural integrity and any loose bolts are tightened. Finally, the sampler removes and discards their gloves and, for the next sample, items 1 through 6 are repeated.

2.5.2 EPA Acid-Wash, Rinse, and Saturate with DI Water Wipe Preparation Technique (A2 Method)

For the baseline samples, the following acid-wash wipe preparation procedure was employed:

1. Wipes (TexWipes TX1009 cleanroom wipes, 100% continuous filament polyester) are cut in half using a new razor blade that had been cleaned using acetone and a lint-free wiper (i.e., Kimwipe) on a lab bench which has also been cleaned with acetone.

2. After cutting, the half-wipes are placed in a wide mouth glass bottle and soaked in a 10% solution of Trace Metals Grade Nitric Acid.

3. The bottle is placed in an oven at 85 ºC overnight.

4. The bottle is removed from the oven, nitric acid solution is decanted, and wipes are rinsed in the bottle five times with deionized H_2O.

5. After the final rinse, each wipe is then removed and squeezed by hand so that they are damp but no more water could be removed. This technique was subsequently determined to yield moisture contents of 2.1 ± 0.1 (1 standard deviation) times the dry wipe weight.

6. The damp wipes are individually placed into individual Digitubes until they are used for wipe sampling.

Note that nitrile gloves are worn during all handling of wipes.

2.5.3 EPA 2X DI Water Wipe Preparation Technique (2X Method)

The EPA wipe preparation procedure for subsequent sampling events (taken at 1, 3, 7, 11 months after coating) for the referenced minideck study was as follows:

1. Wipes (TexWipe TX1009 cleanroom wipes, 100% continuous filament polyester) are cut in half using a new razor blade or scissors cleaned using acetone and a lint-free wipe (i.e., Kimwipe) on a lab bench which has also been cleaned with acetone.

2. After cutting, the half-wipes are inserted into PTFE tubes, into which two times the wipe weight in DI water is added to be soaked up by the wipe. Therefore the wet wipe, as used, is three times its dry weight.

3. Wetted wipes are stored in their sealed PTFE tubes until use. Sampling staff cutting, transferring, and wetting the wipes wear nitrile or latex gloves.

2.5.4 CPSC Staff 1X 0.9% Saline Wipe Preparation Technique (CPSC Method)

The wipe method employed by CPSC staff for their related minideck study was as follows:

1. Wipes (TexWipes TX1009 cleanroom wipes, 100% continuous filament polyester) are cut into quarters using scissors cleaned with acetone and a lint-free wiper (e.g., Kimwipe).

2. After cutting, the wipes are weighed and then soaked in 0.9% saline solution. The wipes are squeezed and shaken until the wipe has absorbed an equal weight (1X) of saline solution.

3. Wetted wipes are stored in sealed glass test tubes until use. The sampler cutting, transferring, wetting and sampling the wipes wears nitrile or latex gloves.

4. The rubber-coated side of the steel rubbing disk is covered with a clean piece of Parafilm for each sample wipe. The wetted wipe is removed from the test tube and placed over the Parafilm. The wipe is secured to the disk with a rubber band and hose clamp. The wipe should be smoothly stretched over the disk.

5. The wipe-covered disk is attached to the lower arm of the sampler.

6. The wipe covered rubbing disk is placed at one end of the wiper. Then the wiper is placed over the area of the board to be sampled. The rubbing disk is then slid along the tracks of the wiper forward and back for five 50-cm strokes. The rubbing disk is lifted from the board, rotated 90°, and slid forward and back five more strokes for a total of 10 strokes. As for the EPA method, the speed of sampling is variable depending on the quality of the area being sampled.

7. The wipe is removed from the disk. Any wood splinters larger than a grain of rice are removed. The edges of the wipe that did not contact the board during sampling are cut and the wipe is placed back in the glass test tube, and covered. Any splinters are noted.

8. After the sample is taken, the Parafilm strip is discarded and the wiping apparatus is decontaminated by wiping the rails that are in contact with the wood surfaces with lint-free wipes wetted with DI water. Then the apparatus is checked for structural integrity and any loose bolts are tightened. Finally, the sampler removes and discards their gloves and for the next sample, items 4 through 7 are repeated.

2.5.5 EPA Laboratory Wipe Extraction and Analysis Techniques

Wipe samples were prepared for analysis using techniques similar to those employed by other researchers including CPSC staff (2003) and Stilwell, et al. (2003), adapted for use with laboratory equipment available for this project. As such, a microwave- or heat-assisted extraction procedure comparable to that used in prior studies, and similar to SW-846 Methods 3051 and 3052, was employed. Steps involved in the extraction procedure are outlined following:

1. Pre-cleaned disposable digestion vessels are used for sample collection and digestion. All volumetric glassware is prepared by acid cleaning. Volumetric glassware is cleaned by leaching with hot 1:1 nitric acid for a minimum of two hours, then rinsed with deionized water and dried in a clean environment.

2. 30 ± 0.1 mL 10% nitric acid (trace metal grade HNO_3, DI H_2O) is added slowly to the digestion vessel containing the wipe sample to allow for pre-extraction. Once any initial reaction has ceased, the sample is capped and introduced into the HotBlock. Using the Environmental Express HotBlock System, 54 samples may be digested in a single batch.

3. Using temperature and pressure curves developed under other research programs for EPA as a guide, the vessels are placed into the HotBlock and heated for 1 hour at 95 °C.

4. After HotBlock extraction, sample vessels are allowed to cool for a minimum of 5 min. prior to removing them from the system. Then the liquid is poured off into a 100 mL volumetric flask. As much extraction liquid as possible is squeezed by hand from each wipe; the funnels and flask necks are rinsed with DI H_2O.

5. The extracted wipe is then placed back into the extraction flask with an additional 30 mL of 10% HNO_3.

6. Again, the vessels are placed into the HotBlock and heated for 1 hour at 95 °C.

7. After extraction, the liquid is poured off into the aforementioned 100 mL volumetric flask. As much extraction liquid as possible is squeezed by hand from each wipe and the funnels and flask necks are rinsed with DI H_2O.

8. The wipe is placed back into the extraction vessel and 20 mL of 10% HNO_3 is added to each extraction vessel before the HotBlock cycle is repeated.

9. The extract is then poured into the 100 mL volumetric flask. Deionized water is used to rinse the extraction vessel; rinsate is added to the 100mL volumetric flask. If necessary, deionized water is added to take the contents to the 100 mL level.

10. Samples are stored in plastic tubes with plastic caps as manufactured by SCP Science. These tubes are certified contaminant-free. Duplicate tubes (split samples) for each sample are stored. One is sent to a contract laboratory for analysis, while the other is archived.

Note that nitrile or latex gloves are worn during all handling of wipes.

Per the specified analytical method, the hold time for all metals other than mercury is 6 months, and samples are stored at 4 °C until analysis. Sample containers are of tetrafluoroethylene (TFE) or perfluoroalkoxy (PFA) in accordance with the analytical method recommendations.

Analyses for total arsenic, chromium, and copper are conducted by STL in Savannah, Georgia, using a modification of SW-846 Method 6020 (ICP-MS). STL utilizes ICP-MS for arsenic analysis, modifying the technique to utilize hydrogen plasma, rather than argon as classically performed. This modification eliminates concerns over the formation of $Ar^{40}Cl^{35}$, which can create a positive bias when measuring As. STL-Savannah's analytical method has reporting limits of 0.10 µg/L for all three CCA analytes (this corresponds to a DA of 0.000032 µg/cm^2)

STL is an accredited laboratory, participating in the Contract Laboratory Program (CLP), as well as numerous state programs. In addition to prequalifying the laboratory for use in the minideck study, each set of samples submitted includes blind blanks and spiked samples, allowing for continued monitoring of laboratory performance.

2.5.6 CPSC Staff Technique Laboratory Wipe Extraction and Analysis Techniques

The extraction and analysis procedures used by CPSC staff are outlined as follows:

1. After sampling, the wipes are carefully rolled up and placed back in the glass test tube in which the wipe was stored prior to sampling.

2. 20 ± 0.1 mL of 10% nitric acid (trace metal grade HNO_3, DI H_2O) is added to each test tube containing a sample wipe. The test tubes are covered.

3. The test tubes are placed in a hot water bath at 60 °C overnight (approximately 15-24 hours). The test tubes are removed from the water bath and allowed to cool to room temperature.

4. The test tubes are vortexed prior to analysis to ensure mixing. The wipe remains in the test tube throughout the extraction and analysis process.

5. Analysis for total arsenic, chromium, and copper are conducted at the CPSC laboratory in Gaithersburg, Maryland using a modification of EPA Method 200.7. CPSC staff utilizes ICP for analysis.

2.5.7 Differences between EPA and CPSC Staff Wipe and Sample Preparation Procedures

Differences between the CPSC staff and EPA 2X methods for collection and analysis of surrogate wipes on CCA-treated wood are as follows:

1. ARCADIS uses plastic wrap to cover the rubber-coated side of the rubbing disk rather than Parafilm.

2. C-clamps are not used by EPA to secure the horizontal wiper (because the boards being wiped are part of a deck structure). An assistant holds the wiper in place.

3. In the EPA method, poly wipes are immediately placed directly into the vessels in which extraction will take place.

4. A three-step extraction and digestion procedure, as detailed above, is used by EPA rather than CPSC staff's one-step water bath extraction and digestion.

5. EPA uses a 2x DI water spike (wetted wipe weight is three times the dry wipe weight) to pre-wet the wipes while CPSC staff uses a 1x 0.9% saline solution spike (wetted wipe weight is two times the dry wipe weight).

6. EPA uses a 38-cm (15-in) wipe length (nominal 314 cm^2 sampling area) and samples between nail holes of boards supported 16 inches on-center, while CPSC staff uses a 50-cm (19.7-in) wipe length (nominal 386 cm^2 sampling area).

2.5.8 Wipe Sampling Method Limitations and Recommendations for Improvements

Wipe sampling is typically a relatively imprecise method of sampling. During this study, several notable observations have been made regarding the wipe sampling procedure. Most notably, the apparatus does not always appear to apply even wipe sampling pressure during sampling, particularly if the wood member is even slightly deformed, warped, or cupped. It appears that the rigid structure of the weighted disc to which the wipe is affixed does not allow for much in the way of "form-fitting" the wood member being sampled. The use of a less rigid face for the weight (perhaps something like a beanbag or gel-filled pad) may allow the wipe to fit better to the areas being sampled.

2.6 Quality Control Samples

In addition to the wipe samples discussed, a series of quality control samples were also tested. These include samples to assess blank contamination and laboratory quality control. Note that two analytical techniques and laboratories were involved in the January 2004 experiments as mentioned. EPA subcontract analyses to STL-Savannah, while CPSC staff conducts their analyses in-house.

Blank contamination was assessed by testing one blind field blank (extracted unused wet wipe) per wipe preparation procedure per laboratory, and one blind blank (extraction fluid only) per laboratory. For these samples, EPA provided CPSC staff with two or more unused wet wipes for each of the two EPA wipe methods being tested. Likewise, CPSC staff provided EPA with two or more unused wet wipes prepared using the CPSC staff method.

Laboratory quality control was assessed by testing one set of four-concentration spiked samples per laboratory:

- 1.0 µg/l As, Cr, and Cu in digestion fluid,
- 50 µg/l As, Cr, and Cu in digestion fluid,
- 1,000 µg/l As, Cr, and Cu in digestion fluid,
- 10,000 µg/l As, Cr, and Cu in digestion fluid.

These spiked standards were prepared by EPA and provided to CPSC staff so that both labs could verify analytical results to the same standard.

Wood dust spike samples were also prepared and analyzed by each lab. The CCA wood dust was provided by CPSC staff and used to spike unused, wetted wipes which were then extracted and analyzed by each lab. Spiking was done in accordance with standard CPSC staff procedures. Extraction and analysis was done consistent with the methods described earlier in this section. At least one wood dust spike was conducted for each of the three wipe preparation methods.

Approximately 20% of the EPA prepared samples (three for each wood source) were randomly selected for analysis by both laboratories and, likewise, 20% of the CPSC staff prepared samples were randomly selected for analysis by both laboratories.

Precision (relative standard deviation) was assessed by analyzing duplicates (split samples) for approximately 5% (three per lab) of the wipe sample digestates analyzed.

In addition to the external quality control samples listed, the analytical laboratories will conduct standard internal control samples including matrix spikes and matrix spike duplicates (MS/MSD) for each analyte, and equipment blanks run on each batch of samples analyzed for this project.

3. Data Reduction

3.1 Calculation of DA from Extraction and Digestion Fluid Concentrations

Raw data from the subcontract analytical laboratory is reported in units of µg/L and represents the mass of analyte per unit volume of extraction and digestion solution sent to the laboratory. For standard wipe sample results, data is reduced in order to characterize the mass of analyte per unit surface area wipe sampled, in units of µg/cm^2, using the following equation:

$$C_{DA} = \frac{C_{DF} \times \frac{V}{1000}}{A} \qquad \text{(Equation 3.1)}$$

Where: C_{DA} = DA of a sample (µg/cm^2)

C_{DF} = Concentration of analyte in extraction fluid (µg/L)

V = Total volume of extraction fluid (mL)

A = Area of wiped surface (cm^2)

4. Results and Discussion

4.1 Wipe Comparison Data

The complete data set is provided at the end of this appendix. Since the primary objective of this wipe comparison study was to generate equations to correlate the various wipe sampling methods utilized, only the results of the associated statistical analyses are presented here.

4.1.1 Converting A2 DA Measurements to 2X DA Measurements

Statistical model selection was used to identify calibration equations for predicting method 2X DA measurements from method A2 DA measurements and the other factors, including grain orientation (up, down), source deck (A, C), sample date (1 month, 3 months, 7 months, 11 months), rinse (rinsed, unrinsed), and prep lab (EPA, CPSC). Based on these analyses, separate calibration equations are suggested for rinsed and unrinsed boards, but not for any of the other factors. In other words, when models for predicting DA using 2X wipes from DA using A2 wipes, grain, source deck, sample date, rinse, and prep lab are considered, the identified prediction model depends only on DA using A2 wipes and rinse.

The wipe method correction factors are simple, no-intercept linear calibrations, and are summarized as follows:

For arsenic:

Rinsed Specimens: DAs-2X = 1.42 (DAs-A2), 95% Confidence Interval: (1.18, 1.66)
Unrinsed Specimens: DAs-2X = 0.80 (DAs-A2), 95% Confidence Interval: (0.72, 0.88)
The R-square value for the combined models is 0.78

For chromium:

Rinsed Specimens: DCr-2X = 1.31 (DCr-A2), 95% Confidence Interval: (1.05, 1.57)
Unrinsed Specimens: DCr-2X = 0.81 (DCr-A2), 95% Confidence Interval: (0.73, 0.89)
The R2 value for the combined models is 0.62.

For copper:

Rinsed Specimens: DCu-2X = 1.18 (DCu-A2), 95% Confidence Interval: (0.94, 1.42)
Unrinsed Specimens: DCu-2X = 0.83 (DCu-A2), 95% Confidence Interval: (0.75, 0.91)
The R2 value for the combined models is 0.81

The need for the different equations is evident in Figure 4-1, which is a plot of DAs-2X vs. DAs-A2 using different symbols for rinsed and unrinsed boards.

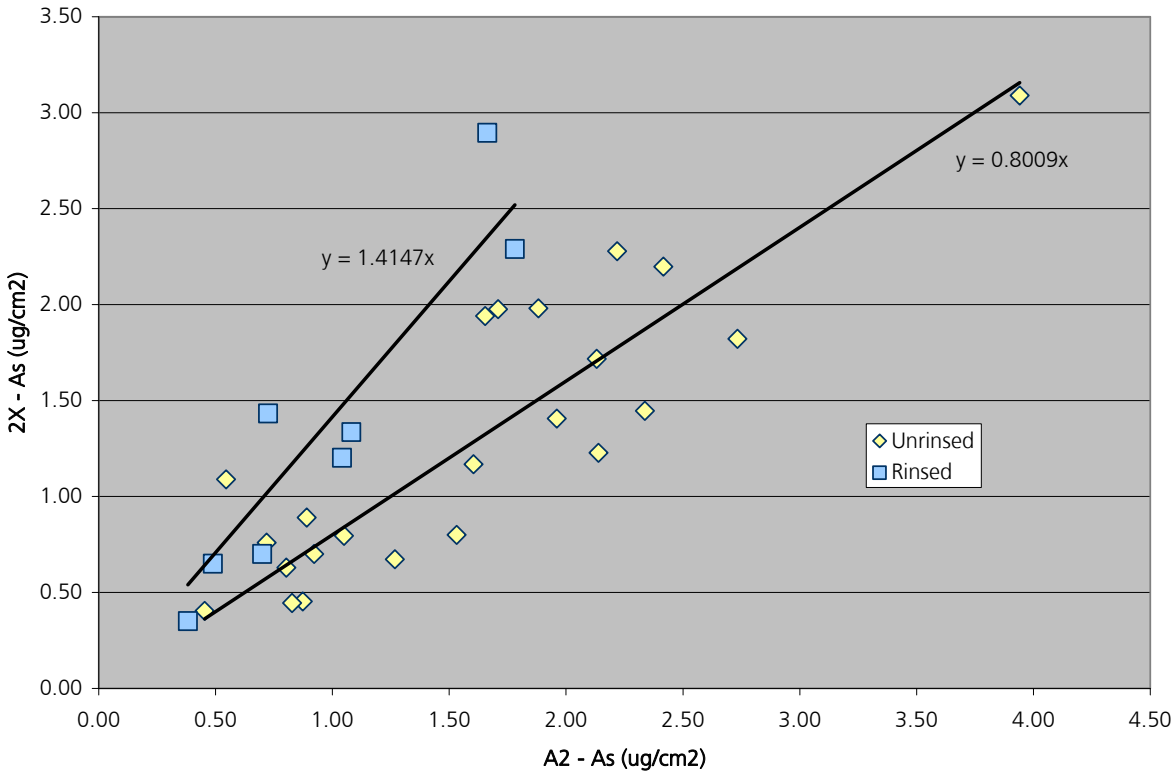

Figure 4-1. As-2X versus As-A2 for Rinsed and Unrinsed Wood Specimens

4.1.2 Converting CPSC Measurements to 2X DA Measurements

The same approach used to identify the DAs-A2 to DAs-2X calibration equation was used to identify a DAs-CPSC to DAs-2X calibration equation. Compared to the former calibration relation, the latter relationship is not as strong. Rinse does not manifest itself as a significant predictor, but there is statistical evidence that source deck does. However, statistical evidence suggesting the relevance of source deck should be discounted because of the tendency for the C-deck values to be lower than the A-deck values. This has the effect of confounding source deck with DAs-CPSC. Combined with the lack of theoretical support for a source-deck effect, the suggested calibration equation is:

DAs-2X = 3.18 DAs-CPSC
For this model, $R^2 = 0.25$

The data set contains one possibly outlying DAs-2X value (2.895). If this value is removed from the data, the calibration equation changes to

DAs-2X = 2.96 DAs-CPSC
with $R^2 = 0.47$

Of course, the latter equation should only be considered if there is some external supporting evidence explaining the outlying 2X value, which there isn't.

For DCr, the correlation equation is:

DCr-2X = 3.24 (DCr-CPSC)
with $R^2 = 0.08$ (Note this is very low).

For DCu, the correlation equation is:

DCu-2X = 2.56 (DCu-CPSC)
For this model $R^2 = 0.17$.

With the one possible outlier removed, the equation changes to:

DCu-2X = 2.43 (DCu-CPSC)
For this model $R^2 = 0.55$.

In summary, the DA-CPSC and DA-2X measurements are on very different scales (the regression coefficient is not close to 1), and the correlation between the methods is not all that strong (low R^2 values).

5. References

U.S. CPSC staff. 2003. Memorandum from David Cobb to Patricia Bittner, "CCA-Pressure Treated Wood Analysis – Exploratory Studies Phase I and Laboratory Studies Phase II," in the Briefing Package, "Petition to Ban Chromated Copper Arsenate (CCA)-Treated Wood in Playground Equipment (Petition HP 01-3), U.S. Consumer Product Safety Commission, Washington, D.C., February 4, 2003. pp 229. http://www.cpsc.gov/LIBRARY/FOIA/FOIA03/brief/briefing.html. April 27, 2005.

U.S. EPA. 2003. "Evaluation of the Effectiveness of Coatings in Reducing Dislodgeable Arsenic, Chromium, and Copper from CCA Treated Wood. Revision 6." U.S. EPA, Research Triangle Park, NC, September 24, 2003.

U.S. EPA. 2004. "CCA Wood Wipe Method Comparison Testing, Revision 3." U.S. EPA, Research Triangle Park, NC, January 19, 2004.

APPENDIX A. WIPE COMPARISON DATA

ID	Sample Date	Wipe Method	Grain	Rinse	Prep Lab	As (ug/cm2)	Cr (ug/cm2)	Cu (ug/cm2)
C-AF	8/20/2003	1X	Up	Unrinsed	EPA	0.59	0.67	0.23
C-AF	8/20/2003	2X	Up	Unrinsed	EPA	0.71	0.83	0.32
C-AF	8/20/2003	2X	Up	Unrinsed	EPA	1.74	1.82	0.63
C-AF	8/20/2003	A2	Up	Unrinsed	EPA	1.90	2.10	0.67
C-AF	8/20/2003	A2	Up	Unrinsed	EPA	2.38	2.69	0.91
C-AF	8/20/2003	1X	Up	Unrinsed	EPA	1.11	1.35	0.51
C-BB	8/20/2003	A2	Down	Unrinsed	EPA	1.11	1.74	1.15
C-BB	8/20/2003	1X	Down	Unrinsed	EPA	0.87	1.35	0.83
C-BB	8/20/2003	2X	Down	Unrinsed	EPA	1.74	2.22	0.99
C-BB	8/20/2003	1X	Down	Unrinsed	EPA	1.70	1.86	2.22
C-BB	8/20/2003	A2	Down	Unrinsed	EPA	2.65	3.37	3.01
C-BB	8/20/2003	2X	Down	Unrinsed	EPA	2.22	3.41	2.89
C-G	8/20/2003	2X	Up	Unrinsed	EPA	0.40	0.51	0.21
C-G	8/20/2003	1X	Up	Unrinsed	EPA	0.32	0.48	0.21
C-G	8/20/2003	A2	Up	Unrinsed	EPA	0.87	1.19	0.40
C-G	8/20/2003	A2	Up	Unrinsed	EPA	0.22	0.27	0.09
C-G	8/20/2003	1X	Up	Unrinsed	EPA	0.30	0.38	0.13
C-G	8/20/2003	2X	Up	Unrinsed	EPA	1.78	2.22	0.55
C-K	8/20/2003	2X	Down	Unrinsed	EPA	1.11	1.54	0.79
C-K	8/20/2003	A2	Down	Unrinsed	EPA	1.78	2.30	0.99
C-K	8/20/2003	1X	Down	Unrinsed	EPA	1.19	1.54	0.67
C-K	8/20/2003	A2	Down	Unrinsed	EPA	2.89	3.45	1.43
C-K	8/20/2003	2X	Down	Unrinsed	EPA	1.78	2.14	0.91
C-K	8/20/2003	1X	Down	Unrinsed	EPA	1.35	1.62	0.55
C-P	8/20/2003	2X	Down	Unrinsed	EPA	1.86	2.34	1.03
C-P	8/20/2003	A2	Down	Unrinsed	EPA	3.41	3.68	1.70
C-P	8/20/2003	2X	Down	Unrinsed	EPA	1.78	2.06	0.75
C-P	8/20/2003	1X	Down	Unrinsed	EPA	1.19	1.51	0.55
C-P	8/20/2003	A2	Down	Unrinsed	EPA	2.06	2.46	0.87
C-P	8/20/2003	1X	Down	Unrinsed	EPA	1.15	1.54	0.55
A-AM	8/29/2003	2X	Down	Unrinsed	EPA	2.42	2.10	1.23

ID	Sample Date	Wipe Method	Grain	Rinse	Prep Lab	As (ug/cm2)	Cr (ug/cm2)	Cu (ug/cm2)
A-AM	8/29/2003	A2	Down	Unrinsed	EPA	4.75	3.68	2.06
A-AM	8/29/2003	1X	Down	Unrinsed	EPA	2.38	1.19	0.71
A-AM	8/29/2003	A2	Down	Unrinsed	EPA	3.13	1.58	0.99
A-AM	8/29/2003	1X	Down	Unrinsed	EPA	1.54	1.23	0.83
A-AM	8/29/2003	2X	Down	Unrinsed	EPA	3.76	2.22	1.31
A-BA	8/29/2003	A2	Up	Unrinsed	EPA	1.58	1.66	0.63
A-BA	8/29/2003	1X	Up	Unrinsed	EPA	0.71	0.83	0.40
A-BA	8/29/2003	2X	Up	Unrinsed	EPA	1.19	1.35	0.51
A-BA	8/29/2003	1X	Up	Unrinsed	EPA	0.79	0.87	0.36
A-BA	8/29/2003	2X	Up	Unrinsed	EPA	1.15	1.15	0.59
A-BA	8/29/2003	A2	Up	Unrinsed	EPA	1.62	2.02	0.67
A-BJ	8/29/2003	A2	Down	Unrinsed	EPA	2.53	2.38	1.27
A-BJ	8/29/2003	A2	Down	Unrinsed	EPA	1.90	1.82	1.19
A-BJ	8/29/2003	1X	Down	Unrinsed	EPA	1.47	1.31	0.91
A-BJ	8/29/2003	2X	Down	Unrinsed	EPA	2.93	2.85	1.90
A-BJ	8/29/2003	2X	Down	Unrinsed	EPA	1.62	1.19	0.91
A-BJ	8/29/2003	1X	Down	Unrinsed	EPA	1.94	1.58	1.11
A-H	8/29/2003	1X	Up	Unrinsed	EPA	0.99	1.23	0.63
A-H	8/29/2003	A2	Up	Unrinsed	EPA	1.94	2.46	1.54
A-H	8/29/2003	2X	Up	Unrinsed	EPA	1.35	1.58	1.11
A-H	8/29/2003	2X	Up	Unrinsed	EPA	1.47	1.94	1.27
A-H	8/29/2003	A2	Up	Unrinsed	EPA	1.98	2.22	1.15
A-H	8/29/2003	1X	Up	Unrinsed	EPA	1.35	1.58	0.87
A-K	8/29/2003	2X	Down	Unrinsed	EPA	2.14	2.02	1.07
A-K	8/29/2003	A2	Down	Unrinsed	EPA	2.50	2.65	1.43
A-K	8/29/2003	A2	Down	Unrinsed	EPA	2.34	2.34	1.43
A-K	8/29/2003	2X	Down	Unrinsed	EPA	2.26	2.26	1.35
A-K	8/29/2003	1X	Down	Unrinsed	EPA	1.07	1.11	0.71
A-K	8/29/2003	1X	Down	Unrinsed	EPA	1.03	1.19	0.63
C-BF	8/29/2003	2X	Up	Unrinsed	EPA	0.48	0.63	0.26
C-BF	8/29/2003	1X	Up	Unrinsed	EPA	0.48	0.48	0.27
C-BF	8/29/2003	2X	Up	Unrinsed	EPA	0.87	1.03	0.71
C-BF	8/29/2003	A2	Up	Unrinsed	EPA	1.35	1.70	1.11
C-BF	8/29/2003	A2	Up	Unrinsed	EPA	1.19	1.62	0.91
C-BF	8/29/2003	1X	Up	Unrinsed	EPA	0.55	0.71	0.63

ID	Sample Date	Wipe Method	Grain	Rinse	Prep Lab	As (ug/cm2)	Cr (ug/cm2)	Cu (ug/cm2)
A-AI	1/21/2004	2X	up	rinsed	CPSC	1.20	0.94	0.45
A-AI	1/21/2004	A2	up	rinsed	CPSC	1.04	0.81	0.38
A-AI	1/21/2004	CPSC	up	rinsed	CPSC	0.31	0.26	0.15
A-AI	1/21/2004	CPSC	Up	rinsed	EPA	0.52	0.44	0.22
A-AI	1/21/2004	2X	Up	rinsed	EPA	1.34	1.02	0.51
A-AI	1/21/2004	A2	Up	rinsed	EPA	1.08	0.95	0.48
A-AQ	1/21/2004	2X	up	unrinsed	CPSC	1.98	1.95	0.77
A-AQ	1/21/2004	A2	up	unrinsed	CPSC	1.71	1.76	0.80
A-AQ	1/21/2004	CPSC	up	unrinsed	CPSC	0.55	0.38	0.28
A-AQ	1/21/2004	CPSC	Up	unrinsed	EPA	0.47	0.42	0.30
A-AQ	1/21/2004	2X	Up	unrinsed	EPA	1.72	1.65	0.73
A-AQ	1/21/2004	A2	Up	unrinsed	EPA	2.13	1.75	1.02
A-BJ	*1/21/2004*	*2X*	*down*	*unrinsed*	*CPSC*	*0.40*	*0.43*	*0.26*
A-BJ	*1/21/2004*	*A2*	*down*	*unrinsed*	*CPSC*	*0.45*	*0.44*	*0.30*
A-BJ	*1/21/2004*	*CPSC*	*down*	*unrinsed*	*CPSC*	*0.26*	*0.26*	*0.16*
A-BJ	*1/21/2004*	*CPSC*	*Down*	*unrinsed*	*EPA*	*0.35*	*0.30*	*0.30*
A-BJ	*1/21/2004*	*2X*	*Down*	*unrinsed*	*EPA*	*0.45*	*0.57*	*0.27*
A-BJ	*1/21/2004*	*A2*	*Down*	*unrinsed*	*EPA*	*0.83*	*0.83*	*0.54*
A-BR	1/21/2004	2X	down	rinsed	CPSC	3.01	2.40	1.22
A-BR	1/21/2004	2X	down	rinsed	CPSC	2.78	2.21	1.08
A-BR	1/21/2004	A2	down	rinsed	CPSC	1.66	1.42	0.86
A-BR	1/21/2004	CPSC	down	rinsed	CPSC	0.31	0.23	0.14
A-BR	1/21/2004	CPSC	Down	rinsed	EPA	0.44	0.42	0.20
A-BR	1/21/2004	2X	Down	rinsed	EPA	2.29	1.94	0.83
A-BR	1/21/2004	A2	Down	rinsed	EPA	1.78	1.65	0.70
A-BZ	1/21/2004	2X	up	unrinsed	CPSC	0.80	0.87	0.49
A-BZ	1/21/2004	A2	up	unrinsed	CPSC	1.53	1.56	0.98
A-BZ	1/21/2004	CPSC	up	unrinsed	CPSC	0.52	0.45	0.27
A-BZ	1/21/2004	CPSC	Up	unrinsed	EPA	0.49	0.52	0.35
A-BZ	1/21/2004	2X	Up	unrinsed	EPA	1.94	1.91	1.08
A-BZ	1/21/2004	A2	Up	unrinsed	EPA	1.65	1.75	0.89
C-AB	1/21/2004	2X	down	rinsed	CPSC	1.43	1.85	0.83
C-AB	1/21/2004	A2	down	rinsed	CPSC	0.72	1.03	0.50
C-AB	1/21/2004	CPSC	down	rinsed	CPSC	0.61	0.71	0.35
C-AB	1/21/2004	CPSC	Down	rinsed	EPA	0.25	0.32	0.16

ID	Sample Date	Wipe Method	Grain	Rinse	Prep Lab	As (ug/cm2)	Cr (ug/cm2)	Cu (ug/cm2)
C-AB	1/21/2004	2X	Down	rinsed	EPA	0.70	0.95	0.45
C-AB	1/21/2004	A2	Down	rinsed	EPA	0.70	0.99	0.48
C-AL	1/21/2004	2X	up	unrinsed	CPSC	0.63	0.83	0.36
C-AL	1/21/2004	A2	up	unrinsed	CPSC	0.80	0.96	0.55
C-AL	1/21/2004	CPSC	up	unrinsed	CPSC	0.32	0.37	0.27
C-AL	1/21/2004	CPSC	Up	unrinsed	EPA	0.37	0.40	0.22
C-AL	1/21/2004	2X	Up	unrinsed	EPA	0.80	1.02	0.51
C-AL	1/21/2004	A2	Up	unrinsed	EPA	1.05	1.30	0.70
C-AO	1/21/2004	2X	down	unrinsed	CPSC	0.45	0.51	0.25
C-AO	1/21/2004	A2	down	unrinsed	CPSC	0.87	0.93	0.46
C-AO	1/21/2004	CPSC	down	unrinsed	CPSC	0.35	0.29	0.16
C-AO	1/21/2004	CPSC	Down	unrinsed	EPA	0.32	0.35	0.20
C-AO	1/21/2004	2X	Down	unrinsed	EPA	0.70	0.76	0.31
C-AO	1/21/2004	A2	Down	unrinsed	EPA	0.92	1.08	0.38
C-BG	1/21/2004	2X	up	rinsed	CPSC	0.65	0.86	0.44
C-BG	1/21/2004	A2	up	rinsed	CPSC	0.49	0.66	0.50
C-BG	1/21/2004	CPSC	up	rinsed	CPSC	0.13	0.19	0.14
C-BG	1/21/2004	CPSC	Up	rinsed	EPA	0.08	0.13	0.09
C-BG	1/21/2004	2X	Up	rinsed	EPA	0.35	0.41	0.23
C-BG	1/21/2004	A2	Up	rinsed	EPA	0.38	0.51	0.38
C-BQ	1/21/2004	2X	up	unrinsed	CPSC	0.76	1.05	0.37
C-BQ	1/21/2004	A2	up	unrinsed	CPSC	0.72	1.02	0.37
C-BQ	1/21/2004	CPSC	up	unrinsed	CPSC	0.20	0.20	0.09
C-BQ	1/21/2004	CPSC	Up	unrinsed	EPA	0.27	0.32	0.20
C-BQ	1/21/2004	2X	Up	unrinsed	EPA	0.89	1.11	0.38
C-BQ	1/21/2004	A2	Up	unrinsed	EPA	0.89	0.92	0.38

Note: A-BJ results from 1/21/2004 not used in data analysis as it had already been wipe sampled during the 8/29/2003 test