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

Quality Assurance Project Plan
Category II/Sampling and Analysis
Revision 6

U.S. Environmental Protection Agency
Air Pollution Prevention and Control Division
September 2003

Contract No. 68-C99-201
Work Assignment No. 4-41
Project No. RN992014.0041

Prepared for:

U.S. Environmental Protection Agency
Air Pollution Prevention and Control Division
Research Triangle Park, NC 27711

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QAPP
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CONTENTS

List of Tables

List of Figures

List of Acronyms

ACV	Applied Coating Volume
ANOVA	Analysis of Variance
CCA	Chromated Copper Arsenate
CPSC	Consumer Product Safety Commission
DA	Dislodgeable CCA Wood Analytes
DAS	Dislodgeable Arsenic
DCR	Dislodgeable Chromium
DCU	Dislodgeable Copper
DQI	Data Quality Indicator
EPA	Environmental Protection Agency
FPL	Forest Products Lab
IPN	Interpolymer Network Coating
MS/MSD	Matrix spikes and Matrix Spike Duplicates
NCDC	National Climate Data Center
NOAA	National Oceanic and Atmospheric Administration
OPP	Office of Pesticide Programs
PEA	Performance Evaluation Audit
QA/QC	Quality Assurance/Quality Control
RSD	Relative Standard Deviation
USDA	US Department of Agriculture
USW	Uncoated Specimen Weight
WFT	Wet Film Thickness

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1 Project Description and Organization

1.1 Overall Project Objectives

The primary objective of this project is to evaluate the ability of selected coatings to reduce the amount of dislodgeable chromated copper arsenate (CCA) wood analytes (DA) on the surfaces of CCA treated wood. Selected coatings will be applied to weathered CCA treated Southern Yellow Pine (SYP) removed from in-service decks. Dislodgeable arsenic (DAS), chromium (DCR), and copper (DCU) will be measured. The coated lumber will be subjected to natural weathering out of doors. The ability of the coatings to reduce DA as the wood and coatings weather will be evaluated by periodically determining the amount of DA removed from the surface of the wood specimens using a wipe 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 the Consumer Product Safety Commission (CPSC), which is a collaborator on this project via an interagency agreement (CPSC-I-03-1235) between EPA and CPSC. Note that measured DA values are dependent upon the specific wipe procedure utilized (e.g., number of passes, device used, sampling material). Previous studies indicate that DA measured via the wipe sampling procedures to be utilized in this study is directly proportional to the surface area wiped. Therefore, for the purposes of this test plan, DA will be expressed in units of mass per surface area wiped ($\mu g/cm^2$).

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/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.

Note that few products are currently manufactured explicitly for the purpose of reducing DA from CCA treated wood. Hence, EPA is primarily evaluating the efficacy of products to perform a task that is not necessarily related to the manufacturer's design or intent. As such, the test results should not be construed to represent an evaluation of a product's effectiveness for those purposes for which it was designed and warranted by the manufacturer.

1.2 Background

CCA is a wood preservative registered under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) by EPA Office of Pesticide Programs (OPP) and impregnated under pressure to protect wood from decay and insect damage. In October 2001, EPA-OPP prepared a preliminary deterministic exposure assessment for selective internal/external peer review comments as an interim report intended to address child residential "playground" exposures. In addition, EPA requested guidance from the FIFRA Scientific Advisory Panel (SAP) for risk mitigation measures such as sealants and coating processes. The SAP Panel made "recommendations regarding the need for additional studies in this area..." because "weight-of-evidence from available studies indicates that certain coatings can substantially reduce dislodgeable and leachable CCA chemicals". The Panel also recommended that "EPA inform the public of the ability of certain coatings to substantially reduce leachable and dislodgeable CCA chemicals…"

In March, 2003, the registrants of CCA wood preservatives signed an agreement with EPA for voluntary cancellation of CCA-treated wood for residential uses (such as playsets and decks) effective beginning January 1, 2004. However, existing decks and playsets made of CCA treated wood will still be in use. Therefore, the potential remains for dermal contact with arsenic, chromium, and copper residues on treated surfaces, and the risk, especially to the most susceptible subpopulation, infants and small children, due to their close contact with surfaces and hand-to-mouth activities, is a concern. A recent field survey of CCA treated surfaces indicated that widely used deck sealants are often not effective at preventing or reducing DAS on surfaces beyond six months. This project will provide EPA with information that can be used to provide the public with guidance on the use of coatings to prevent contact with DA from CCA treated wood.

To provide consumers with effective guidance, EPA must have a basic understanding of the impact of key variables on the efficacy of coating/sealant systems. Key environmental variables include exposure to natural weathering phenomena including UV radiation, condensation, precipitation, and thermal shock. Efficacy of coatings may also be impacted by level and fixation of CCA treatment, age and condition of the wood at the time of coating, and type and dimensions of the treated wood. Due to the large number of variables, and EPA's desire to provide guidance quickly for in-service wood, this project will evaluate selected coatings applied to aged CCA treated wood (Southern Yellow Pine, SYP) exposed to natural outdoor weathering at a site in North Carolina. Accelerated chamber weathering testing was originally contemplated as a component of this study, but the decision was made based on available resources and peer review comments to focus on the more realistic outdoor testing strategy. An accelerated weathering chamber testing protocol may be developed as a companion piece to this research, although a number of technical and logistical issues must first be resolved. Accelerated weathering has the potential to allow an evaluation of the impact of weathering on efficacy of coatings in reducing DA in a relatively short time period (less than one year).

Before proceeding further, it is essential to define terminology as applied in this test plan. Wood nomenclature used in this test plan is defined in Figure 1-1. Note that a "board" is defined as the unit of wood purchased or removed from an existing structure, while "specimen" refers to the pieces of each board cut for this project (note that "specimens" are sometimes called "coupons" in weathering testing jargon).

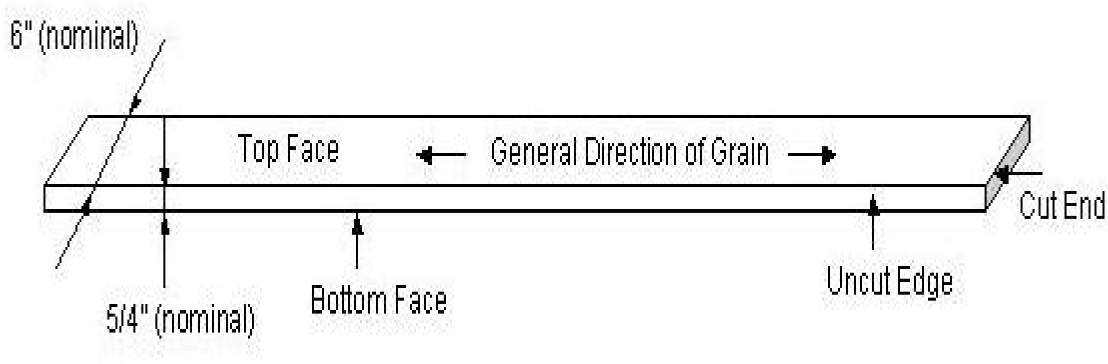

Figure 1-1. Wood Board/Specimen Nomenclature

1.3 Experimental Design, Scope, and Limitations

Weathering tests will be conducted using small decks (mini-decks) which will be exposed to natural weathering conditions outdoors at a site in North Carolina. Because no standard outdoor weathering protocols for testing the efficacy of coatings in reducing DA exposure currently exist, the project can be thought of as a pilot study: it is hoped that the results gained through its execution not only support EPA's goals of evaluating and reducing risk of contact with chemicals dislodged from CCA-treated wood, but also provide a framework of methodology to inform the design of future studies, in addition to identifying areas needing future study.

While the primary objective of the testing described herein is to evaluate coatings for their efficacy in reducing DA when coated wood is subjected to weathering, available resources are limited and dictate that the project be focused in a way that precludes the ability to answer all of the myriad questions raised in the development and evaluation of this test plan. Difficult choices have had to be made in a number of important areas in order to meet the resource and time constraints posed by this project. The objective of the following discussion in this section is to better define the scope of the proposed test plan, its limitations, and unanswered questions that may be applicable as a focus for future research work. Where applicable, discussion of such limitations and decision rationale are additionally included in the text of sections that follow this introduction.

1.3.1 Selection of Test Coatings

The selection of coatings to be tested for efficacy is obviously critical and because of the number and variety of potentially applicable coatings on the market and the budgetary constraints of testing programs, is likely to be a limitation of any such evaluation study to be conducted. To put the task into perspective, the goal of selecting coatings is to distill a universe of hundreds or even thousands of potentially applicable coatings to 12 to be fully tested via the weathering testing protocol. While well beyond the scope of this project, a thorough review of available coatings and their formulations and application techniques is needed to more completely understand the characteristics that may impact surface concentrations of CCA-treated wood analytes (this could include more focused involvement by the wood coating industry). For this project however, the approach was to gather basic formulation and, to a lesser extent, application information, for a number of products with reasonable availability to the project team in North Carolina (where the project site is located). This survey of available products was primarily conducted using Internet searches and visits to local retail hardware and home improvement stores. These searches allowed for the development of a “master list” of specific products. This master list of potential products includes approximately 125 entries, including some products that are broadly intended for outdoor wood use, as well as some products that are not necessarily intended for such uses, but that were identified by the project team as promising.

The list is in spreadsheet format and includes fields for manufacturer, product name, product type, cover, base, and main ingredients. It must be noted that there are various levels of classifications for coatings and that no single standard can be applied to adequately categorize each and every product identified. Additionally, many products overlap categories. Nevertheless, in order to communicate effectively about the products tested, and maintain the confidentiality of product names, an attempt has been made to classify the products considered. As such, several main descriptors of coatings were used. These include: base (oil vs. water), cover (clear, semi-transparent, opaque), and product type, which for this exercise, has been broken out into the following: paints, primers, sealants, stains, and other. The “other” category embodies a vast variety of products, including, but not limited to: varnishes, epoxies, lead encapsulation products, rubber coatings, fiberglass coatings, elastic vinyl coatings, preservatives, and other plastic coatings. Additional classification descriptors include: ingredients (primarily alkyd or acrylic) and surface (penetrating vs. film-forming).

The master list of about 125 products includes roughly 25 paints, 5 primers, 20 wood sealants, 50 stains, and 25 “other” products. Out of the paints, approximately 2/3 are water-based with the balance oil-based. Likewise, for the primers, 2 are oil-based while 3 are water-based. For the wood sealants and stains, most products are oil-based with a handful water-based. The cover for each of these product types is quite variable, and in fact, one “type” of coating may be available in a range of covers from clear to opaque (note that existing research on coating efficacy suggests that opaque coatings may be more effective). Likewise, the surface for each of the listed product types may also be variable, depending on the product (note that existing research on coating efficacy suggests that film-forming coatings may be more effective, though they may also be more subject to deterioration via abrasion). Paints and primers will almost invariably be considered film-forming products, while sealants, stains, and certainly “other” products may be penetrating or film-forming depending on their specific formulation.

From the master list, 12 distinct products have been selected for further evaluation based on the following criteria:

1. Products that are commonly used for outdoor wood treatment (i.e., decks), with preference given to those that either have been tested and/or identified as promising by other researchers. These primarily include stains and sealants.

2. Products that are not widely available, but that have been identified by their manufacturers to prevent DA exposure from CCA treated wood.

3. Products that are relatively straightforward for consumers to apply (i.e., products that require professional application have been disqualified). Multiple product systems have generally not been considered, although it is recognized that some common products (e.g., paints) may require the application of another product as a primer. These situations were considered on a case-by-case basis.

4. Although there are concerns that film-forming sealants (e.g., paints) may perform well at first, but have significant potential for failure over time and exposure to weathering and abrasion, in addition to not being widely used as deck coatings, it was decided to include one representative from the water- and oil-based classes of these sealants. A number of paint products are in fact explicitly intended for use in outdoor "porch and patio" applications.

Thus, in addition to the two paints selected (refer to #4 above) and two products specifically marketed to prevent DA exposure (refer to #2 above), eight (8) representatives of the stains/sealants categories were selected based on having four oil-based products and four water-based products, with one representative of the four specifying alkyd as the main ingredient, one specifying acrylic, one specifying both alkyd and acrylic as the main ingredients, and one specifying neither. Using these criteria to select products resulted in two products in each of the water- and oil-based subsets being classified as "sealants," with the other two classified as "stains."

Table 1-1 generically (to preserve required product confidentiality) lists and characterizes the 12 products selected for the study.

1.3.2 Natural Weathering Tests

Objective

The objective of the natural weathering test is to evaluate the effects of weathering in an actual outdoor environment on the efficacy of selected coating products in reducing DA from aged, in-service CCA treated wood.

Table 1-1. Selected Products for Evaluation

#	Product Type	Base	Cover	Main Ingredients	Comments
1	Sealant	Oil	Clear		
2	Sealant	Oil	Clear	Acrylic, alkyd, urethane	
3	Stain	Oil	Opaque	Acrylic	
4	Stain	Oil	Semi	Alkyd	
5	Sealant	Water	Clear		
6	Sealant	Water	Clear	Acrylic, alkyd	
7	Stain	Water	Semi	Alkyd	
8	Stain	Water	Semi	Acrylic	
9	Paint	Water	Opaque	Acrylic	Latex, designed for porches and floors
10	Paint	Oil	Opaque	Alkyd, polyurethane	Designed for porches and floors
11	Other			Elastic vinyl	Designed for CCA encapsulation
12	Other			Polymer	Designed for CCA encapsulation

<u>Scope</u>

The twelve (12) coatings previously described will be applied to miniature decks constructed using two sources of aged CCA-treated wood, as well as new untreated wood as blank/cross-contamination controls. Each mini-deck will contain nine decking specimens: two specimens from each of the aged wood sources (one specimen with bark side up grain orientation and one with bark side down orientation), separated by specimens of new untreated wood (all positioned bark side up) to prevent cross-contamination and to serve as blank controls to assess cross-contamination potential as a result of splash-over, for example. The minidecks will be constructed with each of the aged wood specimens facing up; that is with the same top face as the specimen had during its exposure on its source structure. Each of the twelve coatings will have three (i.e., triplicate) mini-decks constructed. Additionally, three uncoated minidecks will be used as controls. Each aged wood specimen will be wipe sampled from the same area at 1, 3, 6, 9, 12, 18, and 24 months after coating. The time = 1 month wipe will essentially yield an “initial efficacy” result which may provide some information on the relationship between initial and longer-term efficacy and could thus inform the design of a screening study if appropriate. Coated mini-decks will be exposed to natural weathering conditions at a controlled site in North Carolina for which high quality meteorological data is routinely collected; this data will be used to support weather monitoring data collected during this project. Additionally, three identical, but uncoated, mini-decks and one, untreated, uncoated mini-deck will be included as controls. The position of each mini-deck on the site will be randomized at the start of the test, though their directional orientation will be the same. DA will be determined via wipe sampling at time intervals prescribed previously. These DA results will be compared with baseline DA determined by wipe sampling adjacent specimens prior to coating application, in order to determine monthly percent reductions in DA for each specimen.

The outdoor weathering test offers a means of evaluating the efficacy of coatings on horizontal surfaces with stresses on the specimens resulting from their attachment to the mini-deck support members and of course, per exposure to natural weathering conditions.

The natural outdoors weathering study methods are described in more detail later in this test plan.

Data Product and Use

The efficacy of each coating in reducing DA on aged CCA-treated wood will be evaluated as a function of time exposed to natural weathering outdoors.

Post-coat DA will be determined by wipe sampling triplicate specimens of each coating on each of two aged wood sources with two different bark orientations. Percent reduction in DA will be determined monthly, calculated as the difference between the baseline DA established for each test specimen prior to coating and that month's DA measurement.

Weathered coatings will be ranked following each sampling event according to their efficacy based on average percentage reduction of DA from new and aged CCA treated wood.

Although the observed character of the data will affect the specific types of analysis, it is expected that the following statistical methods will be employed:

Analysis of data for each given sampling event. A variety of analysis of variance (ANOVA) studies will be undertaken, determined by the types of model likely to be valid from preliminary data examination. It is expected that these will include:

Display of the data and calculation of summary statistics for each coating / wood combination for the purpose of checking the assumption of constant variation among treatment combinations, and identifying appropriate transformations (e.g., logarithmic) as needed.

A separate 1-way ANOVA of coatings for each wood type with mini-decks entering as blocks. These analyses will provide additional information on the validity of the assumption of constant variance between wood types.

A full analysis of the 3-replicate split-plot design to include all coatings, wood (and mini-decks). This will provide the most complete and detailed conclusions regarding coatings and their interactions with wood types, again assuming the prior calculations indicate model validity.

Time histories of degradation. A similar approach will be taken to model changes in coating efficacies over the study time period, involving linear and non-linear regressions as suggested by the appearance of the data. The very simplest of these - individual coating histories for individual wood - seem likely to be the most informative and useful. However, more complex (multivariate) analyses involving both wood sources or two or more coatings, will be undertaken as perceived desirable for applications.

Limitations

Stress factors. Due to the relatively small size of the mini-decks, the stress factors generated by attached specimens during weathering may not be representative of those generated in full-sized structures.

Application technique. It is possible that the method of applying coatings may contribute to measured DA levels. For example, applying coating using a brush may cause physical displacement of dislodged analytes and subsequent mixing with the applied coating and/or displacement of the analyte to the finished coated surface. As such, a pre-qualification study to evaluate coating application techniques (e.g., brush versus spray) was considered as a screening test component, but later determined to be outside of the scope and resource allocation available for this project. Wood will be prepared and coatings will be applied per manufacturer's instructions. If a choice of application method is given by the manufacturer, brush application will be used.

Type and condition of aged wood. Only two sources of aged CCA-treated wood will be tested, which is not likely to be completely representative of the universe of CCA wood structures currently in service.

Because of the large number of variables that affect the weathering of existing CCA-treated wood structures, establishing a consistent and representative source of aged wood for these tests is relatively challenging. It is expected that different sources of aged wood may have considerably different characteristics which are likely to impact coating performance. Because resources for this project are limited, only two sources of aged wood shall be used, each taken from a single existing outdoor structure (e.g., deck).

Predetermined criteria were established in order to rank and accordingly select from candidate aged wood source structures. It was preferred that one aged wood source be relatively highly weathered, in service for between 5 and 10 years with no washing solutions or coatings having been applied within the past 5 years. The second wood source was preferably in relatively good condition, up to 5 years old, and with no history of washing or coating. To the extent possible, wood from the selected structures shall be taken from areas of the structure that have been exposed to similar abrasion/traffic and weathering patterns. Of utmost concern is testing sources of consistent, aged wood. The following are important characteristics to be considered with respect to the source of aged wood used:

- Location/site
- Type of use (e.g., residential deck, etc.)
- Age
- Abrasion pattern
- Exposure orientation (directional)
- Exposure level (shading vs. direct exposure, etc.)
- Treatment history
- General condition (qualitative)
- Nailhole spacing
- Lengths and number of boards
- Grain orientation of boards

Information on these characteristics was gathered for multiple candidate sources which were then critically analyzed by EPA and ARCADIS for conformance with specified criteria and completeness of specified information about the source, in order to select aged wood sources. Two excellent sources of aged wood have been selected. The two structures have the following characteristics:

"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 will not be used – which were located under attached benches), with only moderate shading by adjacent buildings during low sun positions. Given its open/stand-alone nature, abrasion patterns appear very consistent and the boards are visually similar to one another. Additional information on this source was gathered as it was being dismantled under the supervision of ARCADIS. The deck is constructed of Southern Yellow Pine, treated to 0.40 pound per cubic foot (pcf) with Ground Contact CCA-C. This source is approximately 7 years old and is 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 is considered fair: the coloration is gray and there is slight 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 1-2.

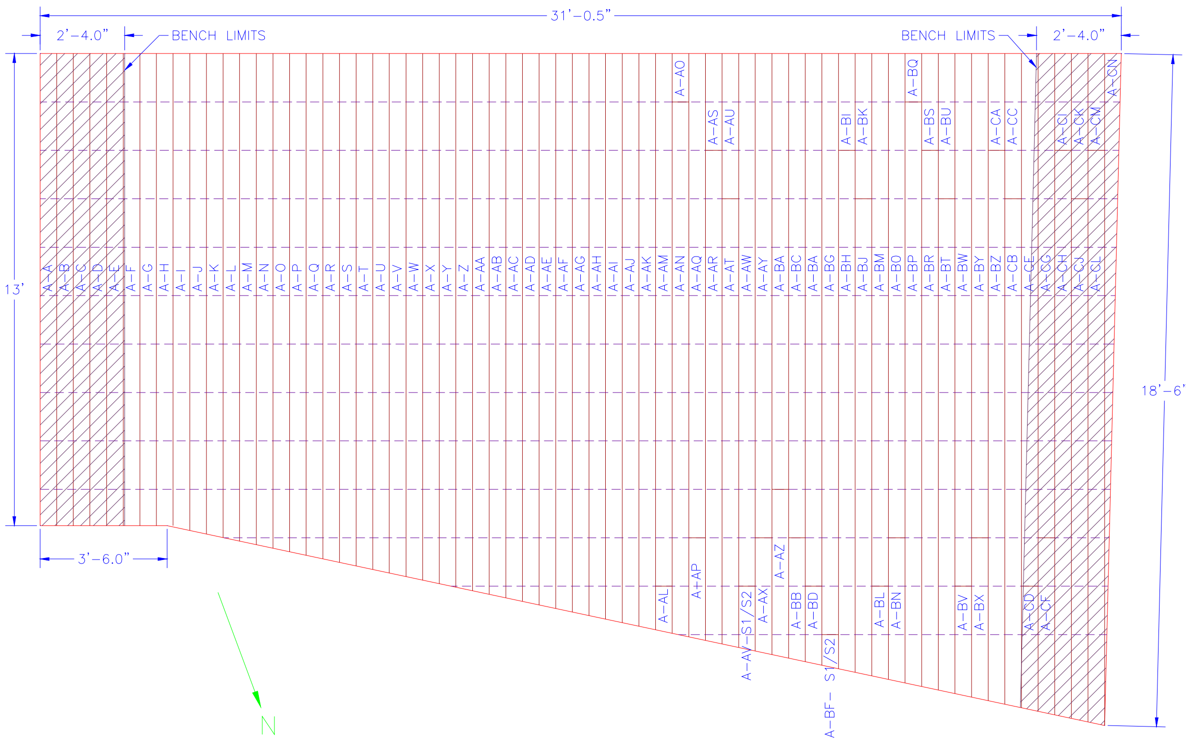

Figure 1-2. ERC Deck Map

<u>"New Hill Deck."</u> 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 is light brown and relatively bright and there is minimal splintering. The New Hill Deck is an exposed, attached structure. There is no noticeable biological growth or other dampness-related defects. The deck is constructed of Southern Yellow Pine, treated to 0.40 pcf with Ground Contact CCA-C, has been in service for just over one year, and has 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 1-3.

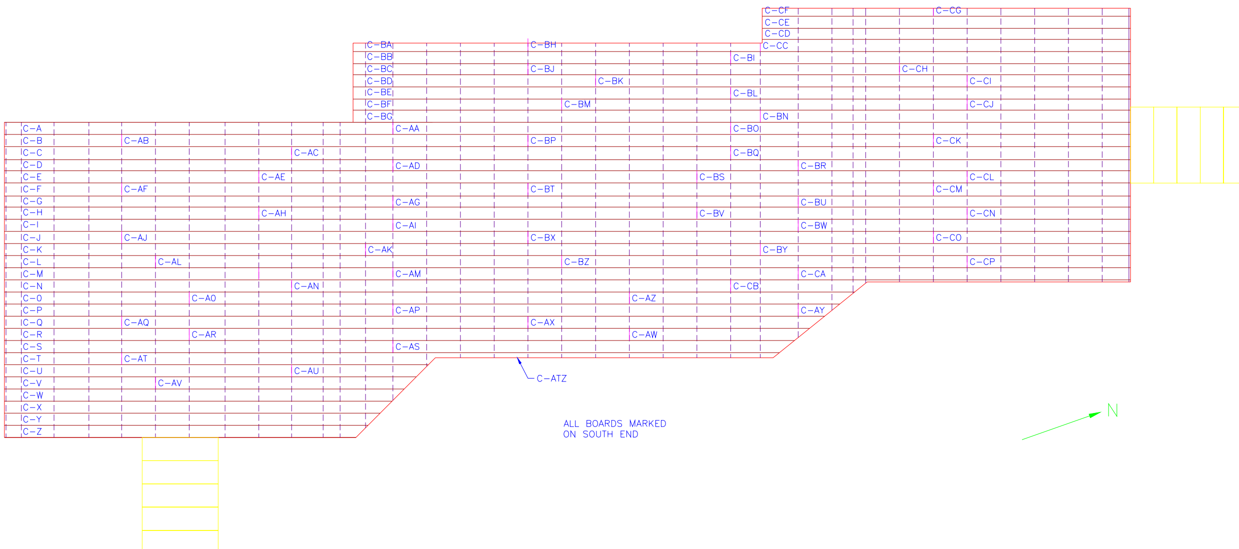

Figure 1-3. New Hill Deck Map

<u>Re-rubbing Effects and Baseline Sampling</u>

A significant practical issue arises as a result of the sampling process itself. Ideally, initial surface wipe samples would be taken from each specimen to be further tested. However, a recent study by CPSC suggests that, as could be expected, the act of sampling the surfaces of CCA-treated wood removes a considerable amount of the DA from a test specimen. Furthermore, wipe sampling is a form of “abrasion” which is suspected to be a significant variable in determining both uncoated DA as well as durability and efficacy of tested coatings. Clearly, there is virtually no alternative to wipe sampling coated surfaces to determine DA (except perhaps leachate sampling for which no transfer relationships have been developed that relate mass leached from a sample to amount transferred to a hand). While it may be possible to attempt to artificially correct DA results for the effects of rerubbing (i.e., per the analysis of appropriate control samples and subsequent modification of measured DA on individual specimens), the decision has been made to not wipe sample surfaces to be coated prior to coating, as such an approach could cause data analysis and coating efficacy complications.

Individual baseline values of DA will be determined for each specimen to be coated and tested by averaging the DAs from the two adjacent locations on either side of the test specimen area to be wiped.

This step will avoid any data analysis and coating efficacy complications that may arise from coating pre-rubbed test specimens.

Some consideration was given to wipe sampling surfaces to be coated prior to coating and then waiting or even exposing the specimen to weathering to induce more migration of CCA analytes to the surface of the specimen prior to coating. While this concept may be sound, there is simply no data of which we are aware to support the design of such a method. That is, it is not known how much time must elapse and/or under what conditions specimens must be maintained to allow surficial CCA analyte concentrations to rebound to pre-wipe conditions.

Two other options have been seriously considered to resolve this issue. The first possible resolution would be to "sacrifice" a certain number of specimens to provide only baseline surficial concentration data. That is, use one or more specimens per board to establish average baseline surficial concentrations. However, it was thought that this option would not provide the level of data resolution and statistical power required to adequately establish coating efficacy data for this project. The other option would be to wipe sample the undersides of the test specimens to establish the baseline DA of each specimen. This was seen as a potentially good option for new CCA-wood specimens, but not for aged specimens, as their top faces are well defined and of much greater interest than their bottom faces. The top faces of aged CCA wood specimens would be expected to have considerably different characteristics than their bottom faces. While the same is not necessarily true of new CCA wood, CPSC data suggests that sample variability along the length of a given board is less that the variability between top and bottom faces of a specimen, even for new CA-treated lumber. As such, and as previously indicated, the weathering test will employ a method whereby the DA of adjacent sampling areas are averaged in order to establish the baseline DA for each individual sampling area.

Effects of Nailholes and Other Surface Irregularities

Nailholes, knots, and other surface irregularities can be expected to have an impact on the measured DA of a particular wipe sampled area. As such, these surface features will be avoided to the extent possible. In particular, nailholes will be completely avoided during wipe sampling events. Furthermore, existing aged wood specimen nailholes will be reused when assembling mini-decks. Other surface irregularities will be avoided as much as possible when selecting specimens to be used for assembling mini-decks. To the extent that such irregularities cannot be avoided, each specimen/wipe area will be characterized visually in two ways: by filling out a specimen characterization form (described later in this test plan and included as Appendix B) and via a photo record of each specimen (to be continually maintained after coating, by photographing specimens/mini-decks prior to regular sampling events).

Test Specimen Lengths

For the outdoor natural weathering mini-decks, specimen lengths of 86 cm (34 inches) will be employed, with a 38-cm (15-inch) sampling length so that wipe samples can be taken from the area between existing nailholes spaced approximately 16-inches on-center. This is a shorter wipe length than that employed in the CPSC protocol. While it is unclear what effect wipe length has on measured DA, previous studies indicate that measured DA is in fact directly proportional to wipe length. Nevertheless, adjustments may need to be made by EPA and CPSC to establish the appropriate correlation between hand and wipe data.

Abrasion Effects

The effects of abrasion (e.g., by repeated contact/walking) will not be rigorously tested in this project, as it is beyond the scope achievable per the available resources, although some indication of its impact can be derived via comparisons of measured DA from the routine sampling areas with those from adjacent areas not routinely wiped. Clearly, abrasion effects on DA concentrations as well as on coating efficacy and durability is a major issue that should be addressed in future study efforts. Additionally, the transfer of CCA analytes via shoes/feet, pets, and other potential contact routes may be important but cannot be addressed in this study.

CCA Analytes and Speciation

The speciation of CCA analytes could be an important determinant of contact risks. Only total arsenic, total chromium, and total copper will be routinely measured in this study, due to resource limitations, as speciating CCA analytes is significantly more complex and costly.

Other Limitations

The following issues, among others, will not be rigorously addressed by the proposed study:

- Performance of coatings on wood of different dimensions that may be encountered
- Directional exposure effects
- Performance in different climatic regions (NE, NW, SW US)
- Performance on members oriented vertically or at angles
- Performance following various wood preparation techniques
- Recoat performance

1.4 Data Quality Objectives

The critical measurements for the accelerated and natural weathering tests are total arsenic, total chromium, and total copper concentrations. Data quality indicator goals for concentration in terms of accuracy, precision, and completeness are shown in Table 1-2.

Table 1-2. 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

1.5 Project Organization and Responsibilities

The EPA Work Assignment Manager for this project is Mark Mason, who will coordinate involvement by other EPA staff and CPSC via an interagency agreement (CPSC-I-03-1235) between EPA and CPSC, as appropriate. Key CPSC staff include Jacque Ferrante and Warren Porter. Key EPA-Office of Pesticide Programs (OPP) staff include Jack Housenger, Norm Cook, Winston Dang, Nader Elkassabany, Timothy Leighton, and Jonathan Chen. ARCADIS' Work Assignment Leader is Victor D'Amato. Libby Nessley, with ARCADIS, serves EPA by providing Quality Assurance/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, ARCADIS, is the overall OLS Project Manager. He will support this project by helping coordinate the wood preparation, coating, sampling, and analytical tasks. Johannes Lee, ARCADIS, is the Assistant Project Manager for the OLS contract, and, as such, provides a variety of administrative support functions. Matt Clayton, ARCADIS, will procure, characterize, cut, prepare and coat wood samples, in addition to coordinating preparation of the test site. Peter Kariher, ARCADIS, will take samples, prepare samples via digestion protocol, and ship digested wipe and control samples to the subcontract analytical laboratory, STL-Savannah (Angie Weimerskirk, Project Manager). Michele Addison, ARCADIS, will manage the data generated via this study in addition to supporting other key project tasks. Krich Ratanaphruks, ARCADIS, will provide relational database support. Bobby Sharpe, PE, will support the electrical and mechanical engineering tasks associated with the project, including setting up weather monitoring equipment and coordinating data downloads. An organizational chart is provided as Figure 1-4. Table 1-3 provides contact information for proposed staff.

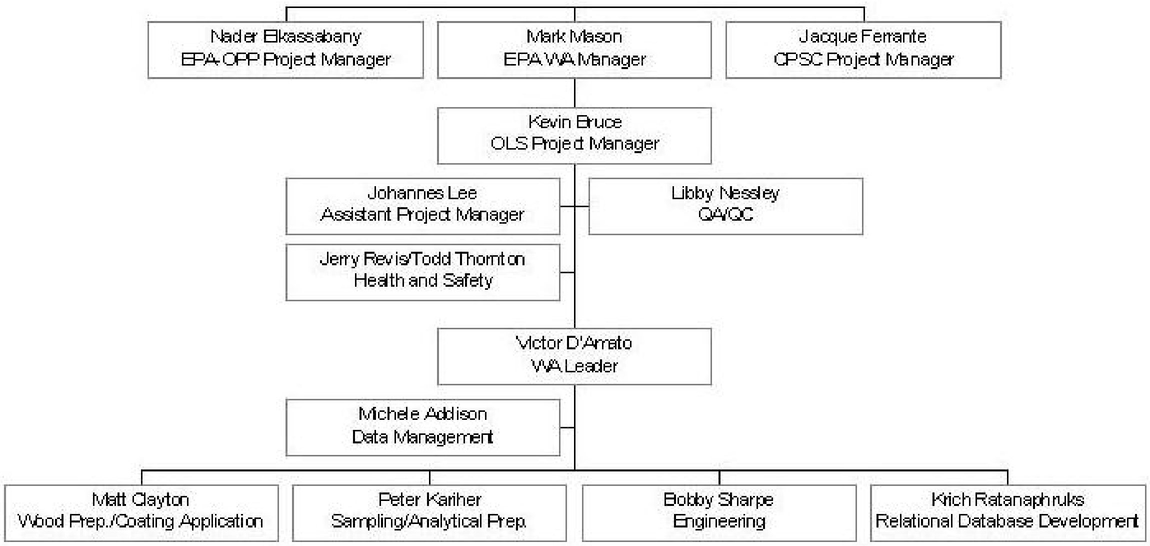

Figure 1-4. Organizational Chart for Weathering Testing

Table 1-3. Contact Information for Key Project Staff

Staff Contact	Organization	Responsibility	Phone Number	E-mail Address
Mark Mason	US EPA	WA Manager	(919) 541-4835	Mason.Mark.@ epa.gov
Paul Groff	US EPA	EPA QA Manager	(919) 541-0979	Paul.Groff@epa.gov
Jacque Ferrante	CPSC	Health Sciences	(301) 504-7259	jferrante@cpsc.gov
Warren Porter	CPSC	Lab Sciences	(301) 421-6421	wporter@cpsc.gov
Jack Housenger	EPA-OPP	Associate Director	(703) 308-8163	Housenger.Jack@epa.gov
Winston Dang	EPA-OPP	Senior Scientist	(703) 308-6216	Dang.Winston@epa.gov
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
Libby Nessley	ARCADIS	QA Manager	(919) 544-4535	lnessley@arcadis-us.com
Todd Thornton	ARCADIS	H&S Manager	(919) 544-4535	tthornton@arcadis-us.com
Jerry Revis	ARCADIS	H&S Manager	(919) 544-4535	jrevis@arcadis-us.com
Kevin Bruce	ARCADIS	PM, Advisor	(919) 544-4535	kbruce@arcadis-us.com
Peter Kariher	ARCADIS	Lab Scientist	(919) 544-4535	pkariher@arcadis-us.com
Matt Clayton	ARCADIS	Lab Scientist	(919) 544-4535	mclayton@arcadis-us.com
Bobby Sharpe	ARCADIS	Engineering	(919) 544-4535	bsharpe@arcadis-us.com
Krich Ratanaphruks	ARCADIS	Database Technician	(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

2 Sampling Approach

Under this test plan, baseline measurement of DA (as previously described), as well as routine wipe sampling for measurement of DA after coating application and as weathering progresses, will be the primary samples taken. Supporting samples to be collected include wood core samples, and liquid samples of the coatings applied, among others.

The following subsections describe in detail the selection of materials for testing, application of selected coatings to the CCA treated substrates, weathering details, and sampling procedures. A project-specific health and safety plan (HSP) is appended to this QAPP as Appendix A.

2.1 Preparation and Characterization of Wood Specimens

Wood specimens will be prepared using aged southern yellow pine that has been originally CCA-C treated to 0.40 pcf, in nominal 5/4" x 6" cross-sectional dimensions. New southern yellow pine that has not been treated will be used for blank control specimens. Care will be taken to minimize handling and abrasion of the primary (i.e., 6" width) faces of the board, with the short edges of the board preferentially held during transport and cutting.

Two consistent sources of aged wood are required for all of the weathering testing proposed. A full description of the aged wood selection and characterization is provided in Section 1.3.2.

Aged boards will be cut using a circular table saw (or other similar cutting device) into lengths required for use as test specimens for the weathering tests. The outdoor, natural weathering tests will require specimens of approximately 86 cm (34") lengths. These lengths will be cut in such a manner as to capture three sets of existing nailholes on each aged wood specimen, provided that the nailholes are spaced on 16-inch centers as is typical. Of utmost concern is that regular wipe sample be taken from segments of the specimen which has 38-cm (15-in) clear distance between adjacent nailholes. Nailholes are not to be wiped during either the baseline or monthly wipe sampling events. The saw will be decontaminated between cutting the different types of wood utilized (aged CCA, untreated) and the untreated wood will be cut separately (after installation of a new blade) to prevent cross-contamination of samples. Decontamination will follow a similar protocol to that used to clean the wipe sampling device between samples (a DI water moistened cloth wipe). Where possible, the ends of each board will be removed and archived and segments between each 86-cm test specimen will be removed and archived, with some of these interior segments used to characterize the source wood via moisture content and core sampling for total arsenic, chromium, and copper analyses. 86-cm wood specimens will be visually inspected and those exhibiting excessive amounts of deformities, presence of heartwood, knots, resin pockets, and other defects will be disqualified for use in the screening testing. Each segment will be identified with a unique alphanumeric code as follows:

- Aged board codes will be prefixed by the letter “A” for source A, the ERC Deck source, and “C” for source C, the New Hill Deck (note that a source B was harvested but subsequently disqualified)

- Each aged board will be identified with a letter (A, B, C,…)

- Each space between adjacent nailholes will be identified with an alphanumeric code, where the prefix “BL” will refer to segments used for establishing baseline characteristics, while the prefix “M” will refer to segments to be regularly wiped. These codes will be suffixed with sequential numbering (1, 2, 3,…).

- Unused segments will be designated with the prefix “X”.

The specimen identification criteria presented above is shown in Figure 2-1. Specimen IDs will be cross-referenced with their mini-deck and coating as described in subsequent subsections. In this example, BL1, BL2, BL3, BL4, and BL5 would be wipe sampled before cutting Board A. These results would be used to establish baseline DA concentrations for M1, M2, and M3. After cutting the boards to harvest 86-cm specimens for mini-deck construction, BL2 and BL5 would be subsequently used for taking one core sample each for total arsenic, chromium, and copper analyses, as well as moisture content. Moisture content will be measured as described in section 3.8. M1, M2, and M3 would be wipe sampled during routine sampling events to determine coating efficacy. BL1, BL3, and BL4 would be wipe sampled only periodically to determine the effects of abrasion (i.e., via regular wipe sampling of adjacent specimens) on coating efficacy and DA.

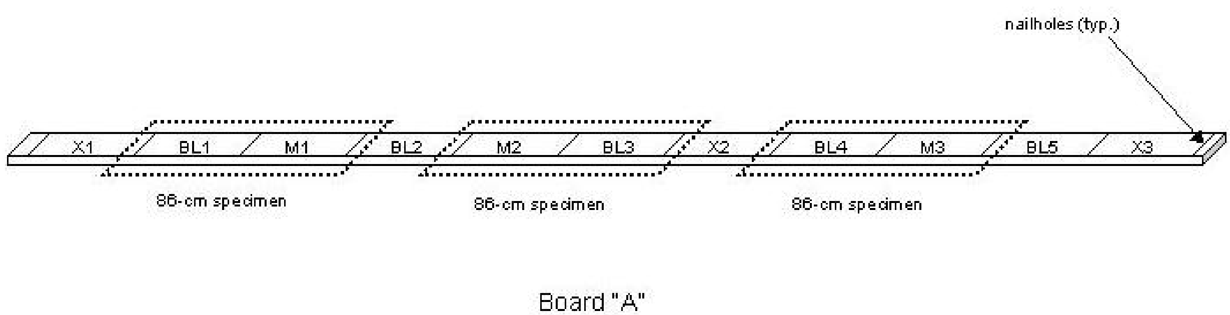

Figure 2-1. Specimen identification and baseline sampling scheme example.

All cut specimens will be identified on one cut end or uncut edge with its identification code, as well as with its “top” side using permanent marker. Documentation will be kept identifying and qualitatively and semi-quantitatively characterizing all numbered specimens taken from each original board of CCA treated wood. Additionally a photo record will be made of all specimens at the beginning of the test (i.e., prior to mini-deck construction) and for each specimen, a wood characterization data sheet will be completed (Appendix B). Remaining segments of wood will be retained and archived.

2.2 Mini-Deck Construction

After cutting and identification marking, source wood specimens will be transported to the mini-deck host site, where mini-decks will be constructed per the drawing in Figure 2-2, after which the mini-deck specimens will be prepared in strict accordance with the particular coating manufacturer's recommendations for coating of aged wood. Where practical, rinsate water will be collected, preserved using nitric acid, and stored in TFE or PFA vessels in case needed for future subsampling and analysis.

A schedule for the mini-decks and 86-cm specimens to be wipe sampled is additionally provided in Table 2-1. Not shown on this table is one mini-deck to be constructed similarly, except that its five specimens shall each be untreated wood. Its three center specimens shall be wipe sampled at the prespecified regular sampling event intervals as blank controls.

Table 2-1. Schedule of Mini-Decks and Specimens for Outdoor, Natural Weathering Tests

	Aged CCA Wood Source "A"		Aged CCA Wood Source "C"		Untreated Wood	
Coating	Mini-decks	86-cm specimens	mini-decks	86-cm specimens	mini-decks	86-cm specimens
Coating 1	3	2	3	2	3	5
Coating 2	3	2	3	2	3	5
Coating 3	3	2	3	2	3	5
Coating 4	3	2	3	2	3	5
Coating 5	3	2	3	2	3	5
Coating 6	3	2	3	2	3	5
Coating 7	3	2	3	2	3	5
Coating 8	3	2	3	2	3	5
Coating 9	3	2	3	2	3	5
Coating 10	3	2	3	2	3	5
Coating 11	3	2	3	2	3	5
Coating 12	3	2	3	2	3	5
Uncoated	3	2	3	2	3	5

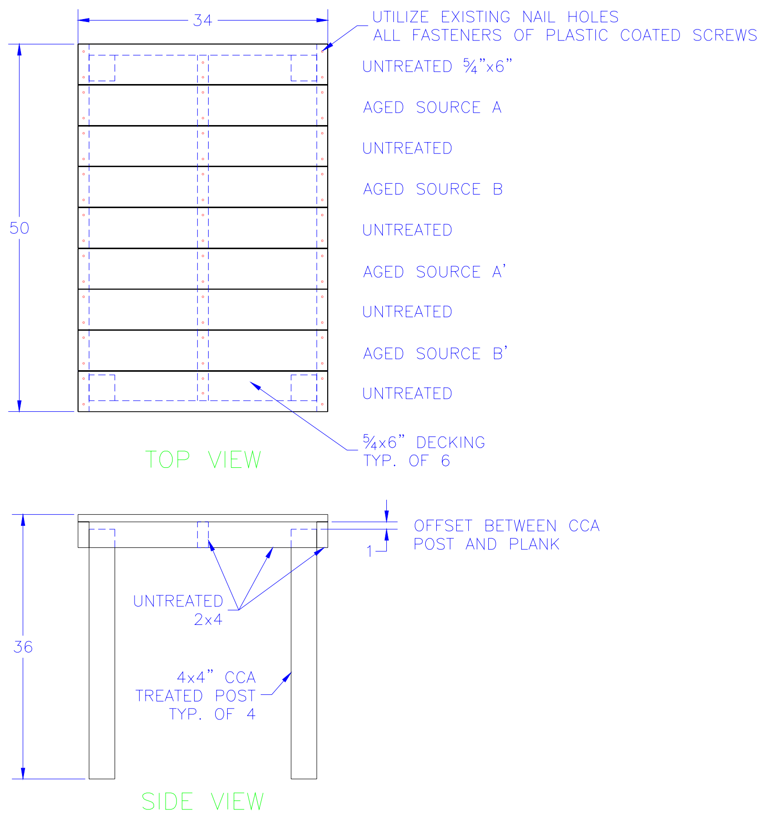

Figure 2-2. Schematic of Mini-Deck Construction
(note that untreated 34" specimens shall be planed so that 1/8" of space is provided between each pair of specimens)

Posts (4" x 4") to be used in the mini-deck construction will be new CCA-C treated for all of the mini-decks. 2" x 4" supports to which decking is nailed will be untreated southern yellow pine. Additionally these supports will be slightly offset above the tops of the posts to ensure that the treated posts do not have the opportunity to contact wood specimens used as mini-deck decking. Bracing will also be untreated wood. Plastic-coated screws will be advanced through existing nailholes, where applicable, in order to secure decking specimens to the mini-deck frames. The mini-decks will be free-standing (i.e., posts will not be set into the ground), though some means of securing the decks may be considered, particularly if severe weather (e.g., hurricane, tropical storm) is expected.

A table to match specimen identification code with mini-deck ID is provided as Appendix C. Specimens and mini-decks have been matched randomly.

2.3 Selection of Coatings

Twelve coatings to be tested have been selected and specified per the discussion in Section 1.3.1.

2.4 Coating Application

Mini-decks will be constructed as described in Section 2.2 above. After construction and baseline characterization of DA (also described above), all exposed surfaces of the decks shall be coated in accordance with coating manufacturers' recommendations, including any wood preparation procedures (beyond light-setting pressure washing which shall be used for all minidecks) explicitly instructed by the manufacturer as stated in its product literature. Specific wood preparation procedures are provided for each coating in Appendix D. Coatings will be applied to fully cover the top faces, exposed uncut edges, and cut ends (to be coated after all other surfaces have been; top faces will be coated first) of CCA treated wood specimens in accordance with manufacturers' recommendations. Because each of the coating's manufacturers recommend that application not be done during periods of direct sunlight, a tent will be set-up on-site temporarily to allow for coating mini-decks in the shade. After 24-hours initial coating drying in the shade, mini-decks will be manually relocated to additional drying in exposed conditions.

Individual/dedicated brushes will be used to apply each coating to each substrate (wood type) on each deck. In other words, a different brush will be used to apply coating to each of the aged wood sources and to the new untreated wood surfaces. Thus, three brushes will be used for each mini-deck. Untreated surfaces will be coated first, followed by the aged CCA surfaces. Brushes will be prepared for initial coating application in accordance with brush manufacturer's recommendations. After a particular coating has been applied to a given group of triplicate mini-decks, used brushes will be archived. Fresh cleaning solution will be used for each coating. Each type of brush used shall be prequalified for use per a set of four control samples whereby two unused brushes shall be agitated in separate 200 ml deionized water baths. After agitation, each bath shall be split into two samples to be preserved and then shipped to STL-Savannah for total arsenic, chromium, and copper analysis. Additionally, unused aliquots of each coating tested shall be sampled in duplicate, prepared, and analyzed in accordance with methods specified in Section 3.0.

Separate aliquots of coating liquid will be used for each mini-deck to be coated with a given coating, in order to prevent cross-contamination of coating liquid by re-dipping the brush applicator. In addition, to prevent cross-contamination, separate aliquots will be used for each of the aged CCA treated and new untreated boards. Thus, three aliquots of coating will be used for each mini-deck. Separate aliquots of coating liquid will be poured into disposable plastic graduated volumetric beakers, which will be discarded after application of that coating to each given specimen. The disposable beakers will be acid-washed using a procedure similar to that specified in Section 3.2 prior to use. Coating remaining in similar beakers (i.e., the three beakers for each substrate/coating replicate) will be composited so that one sample is retained for each coating/wood type (new/untreated and the two, aged, CCA-treated sources). These samples will be stored in sealed, unused paint containers and then archived for possible future analyses. Application procedures and any notable observations will be documented for each coating.

The weight of coating applied to each substrate on each mini-deck will be determined. Weight applied will be determined as follows. A 200 to 300-ml aliquot of coating will be transferred directly from the original coating container into a 400-ml graduated beaker. This container along with a new brush to be used for applying a given coating to a given substrate on a given mini-deck will be pre-weighed. After coating has been applied, the final weight of beaker and brush will be measured and recorded. The weight applied will thus be calculated as the difference between the initial and the final weights.

A coating application data sheet shall be completed for each coating. A sample sheet is provided as Appendix E.

The sequence for mini-deck construction, preparation, and sampling is summarized as follows:

1. Map, harvest, and label boards from source structure
2. Transport boards to staging area
3. Identify and characterize each wipe area/specimen
4. Conduct baseline sampling
5. Cut specimens to specified lengths
6. Construct mini-deck tops
7. Wash mini-deck tops in accordance with coating manufacturer's recommendations
8. Transport mini-deck tops to test site
9. Fasten mini-deck tops to posts
10. Coat mini-deck tops in the shade in accordance with manufacturer's recommendations
11. Allow to dry in shade for 24 hours, then allow full exposure

2.5 Outdoor Weathering

Outdoor weathering tests will simply involve exposing the mini-decks described previously to natural outdoor climatic conditions at a test facility in Research Triangle Park (RTP), North Carolina. Mini-decks will be arranged on-site in a grid with specific mini-decks randomly assigned to gridded blocks at the start of testing with the following qualifications: mini-decks featuring the same coating shall not be allowed in the same row, column, or diagonally immediately adjacent to one another. Mini-deck arrangement/layout on the site will be documented.

The site shall be prepared for testing by:

- Setting up deposition samplers (constructed of new untreated wood) on-site and periodically wipe sampling them to assess the potential for atmospheric deposition of CCA analytes, in order to qualify site.

- Delineating a currently grassed, relatively remote area for testing mini-decks, and preparing the area by tilling the ground to 6" total depth, leveling it to remove potholes, lightly rolling it to prevent dust/erosion and prepare for graveling, but not overly compacting it. This area will then be gridded using landscaping fabric and crushed stone (precharacterized to assess cross-contamination potential) to prevent vegetative growth, which would require maintenance, such as mowing, that might result in unacceptable impacts to the decks (e.g., dust/grass clippings). The site layout is shown in Appendix F. Note that the space underneath the mini-decks will not be covered with landscape fabric or gravel. Vegetation in these areas will be controlled manually, by hand.

- Flagging perimeter of mini-deck test area to alert landscape maintenance staff to avoid area. Note that the site is sufficiently remote that vandalism is not anticipated to be a problem. In fact, the site currently hosts valuable atmospheric monitoring equipment that has not received any extraordinary security.

- Clearance of saplings from the area may be warranted to prevent unwanted shading, though this is expected to be a minor task, if required at all.

- After placement within their assigned gridded spots, mini-decks shall be leveled in both directions. Level placement shall be confirmed using an engineer's level, with untreated 2" x 4" spacer blocks to prevent direct contact between the level and the untreated end pieces of the mini-decks.

Weather data shall be collected for the outdoor weathering tests using a Davis Instruments weather monitoring station, Vantage ProPlus. The station shall be located as shown on the site plan in Appendix F. Any differences in exposure across the mini-deck layout shall be documented qualitatively and/or quantitatively. Through the use of available software, (WeatherLink for VantagePro), data from the weather station will easily be compiled and manipulated. This software allows the user to store data in the Vantage Pro console and download to a computer at his/her convenience. The software allows the data to be graphed daily, weekly, or monthly. Data can also be posted to a website if warranted. Data to be collected using the Vantage ProPlus are listed in Table 2-2.

The National Oceanic and Atmospheric Administration (NOAA) in RTP, NC collects data on wind speed and direction, temperature, precipitation amount, direct solar radiation and total solar radiation at the site to be used for mini-deck weathering. Other parameters are collected by the National Climate Data Center (NCDC), RDU, and should be available in monthly summaries, detailing specified conditions on a daily basis. The weather data available from NOAA, however, is collected on strip charts which are only available every 45-50 days.

NOAA-generated data will be compared to data from the weather monitoring station dedicated for use during this project. NOAA generated data available to the site are listed in Table 2-3. Spot checks of all parameters measured will be conducted at least quarterly.

The NOAA metrology instrumentation is calibrated against working standards that are traced to world standards at Eppley Laboratories. This calibration is done periodically based on the stability of the instrument. The temperature system is checked against RDU (official NWS weather station) on stable days and also with a sling psychrometer. The weighing rain gage is calibrated with weights and also against a manual rain gage with each precipitation event. The Aerovane wind system records wind speed in mph and only begins to register at 3 mph. It is also checked against RDU on stable windy days. The operators of the weathering monitoring equipment have a great deal of experience and their involvement and oversight is critical for QA/QC.

Table 2-2. Vantage ProPlus Weather Station Data

	Units			
Barometric Pressure	in Hg	mm Hg	hPa (Tor)	mb
Inside Humidity	%			
Outside Humidity	%			
Dew Point	°F	°C		
Rainfall	in	Mm		
Rate of Rainfall	in/hr	mm/hr		
Solar Radiation	W/m2			
UV Index & Dose	index	Meds		
Inside Temperature	°F	°C		
Outside Temperature	°F	°C		
Apparent Temperature	°F	°C		
Wind Speed	mph	m/s	km/h	
Wind Direction	some variation/combination of N,E,S,W			
Wind Chill	°F	°C		

The data can be archived at 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, or 2 h.

Data will be archived at 30-minute intervals.

All data points are discrete except for Rate of Rainfall and UV Dose.

Table 2-3. NOAA-Generated Weather Data

PARAMETER	UNIT	REMARKS
Required		
Irradiance (UV)	W/m2	Direct and total radiation is available.
Temperature	°F	
Precipitation, Duration	hours	Can be determined from strip chart, although certain losses may occur due to evaporation.
Precipitation, Amount	inches	Automated rain gage.
Dew Point (Measure of dew formation)	°F	Dew point could be used to calculate dew point depression (diff. with temp.) If DPD is small, there is likely to be dew overnight.
Wind direction + speed		

2.6 Sampling

2.6.1 Wipe Sampling

Wipe sampling shall be conducted and samples prepared and analyzed in accordance with the methods established in section 3.0.

Wipe samples shall be taken from the top faces of the four aged specimens per mini-deck by wiping the specimens per the procedures described in Section 3.0 directly, on-site. Wipe samples will be taken between nailholes, with care not to wipe over nailholes. Each specimen will have three sets of nailholes and thus two possible sampling areas. One sampling area will have been used to help establish baseline DA concentrations. The other sampling area, which will not have been wipe sampled prior to coating, will be used as the regular wipe sampling area. Wipe samples shall be taken from the top faces of each specimen only. The length of wipe shall be 15 inches to avoid contact with nailholes which are typically spaced 16 inches on-center.

Screening testing has revealed that wipes with higher moisture contents (i.e., DI water spikes) yield higher DA values than do dryer wipes. Thus, the surface moisture of the mini-deck specimens when they are wiped may be expected to also impact DA. It is difficult to adequately ascertain the surface moisture of a specimen, particularly quantitatively. The interior moisture content of a specimen may be measured using techniques described in Section 3.8, including oven-drying and moisture probe methods. However, both of these quantitative measures would compromise the integrity of the specimen, and perhaps more importantly, it's coating. Furthermore, allowing wipe sampling to commence based on recent weather conditions is wrought with complications and limitations given the infinite combination of climatic conditions which may affect surface moisture. Therefore, for this project, several measures will be taken to qualify and document wipe sampling events:

- Wipe sampling events will only be conducted when specimens appear dry and when weather forecasts indicate that there is a reasonable likelihood that consistent, relatively dry weather (i.e., no rain) will prevail for the entire sampling event. Of course, weather/climatic conditions will be recorded and well-documented throughout the entire study including sampling events.

- During each sampling event, each mini-deck shall be digitally photographed, with wiped and unwiped areas identified, in a running photolog.

- The field data sheet (Appendix G) which shall be completed for each mini-deck during each sampling event will also include a rating documenting the visual dryness of each mini-deck specimen, with a rating of 1 being "more dry", 2 being "dry", and 3 being "less dry" (humid). Under no circumstances will wet specimens be wipe sampled.

- Moisture content will be measured on sacrificial areas of uncoated specimens during each sampling event. At least one moisture content will be measured on each of the four raw wood variables under consideration here: source "A", bark up; source "A", bark down; source "C", bark up; source "C", bark down.

Individual baseline values of DA will be determined for each specimen to be coated and tested. The baseline DA of a specimen will be determined by averaging the DAs from the two adjacent specimens on either side of the test specimen, as indicated in Section 2.1.

As previously indicated, routine wipe sampling of test specimens shall be conducted at 1, 3, 6, 9, 12, 18, and 24 months after coating.

Furthermore, a variety of routine control samples will be taken. These include:

- Three blank control wipe samples taken from the blank control minideck constructed using a total of five untreated, uncoated specimens. These control measurements will provide an indication of whether there is significant atmospheric deposition of CCA analytes at the site.

- One mini-deck per coating shall have its baseline-sampled areas on each of its aged specimen additionally sampled during successive routine sampling events. In other words, one of the triplicate mini-decks will have its baseline areas wipe sampled at time = 1, 9, and 24 months, one will have its baseline areas wipe sampled at time = 3, and 12 months, and one will have its baseline areas wipe sampled at time = 6 and 18 months. These samples will provide useful information on "rerubbing effect," as discussed in Section 1, and may, upon comparison with results from adjacent areas wiped more frequently, provide information on the effects of abrasion induced by wipe sampling, on coating efficacy and DA.

- During each wipe sampling event, one untreated specimen from each mini-deck shall be wipe sampled. Since there will be five untreated specimens on each mini-deck, there will be a total of 10 potential wipe areas. The specific area sampled during each routine sampling event shall be randomly selected for each mini-deck and shall be a different area for each event.

2.6.2 Wood Sampling

Two interior wood specimens from each board (refer to Figure 2-1) shall be sampled, digested, and analyzed for total arsenic, chromium, and copper in accordance with the procedures described in Section 3.0.

2.6.3 Photographs

Digital photographs of each specimen and mini-deck will be made before coating, and during monthly sampling events. Visual observations per the inspection of each specimen shall be documented in writing.

2.6.4 Miscellaneous Samples

Other miscellaneous samples to be collected, and archived and/or analyzed have been previously described and are summarized in Table 2-4.

Table 2-4. Miscellaneous Samples to be Collected

Sample Description	# Samples to be Analyzed	# Samples to be Archived
Unaltered coating	2 for each coating	Leftover coating to be stored
Leftover brush-applied coating	N/A	1 for each coating/wood type
Brush wash water	4 for each brush type	Brushes shall be retained
Wood	2 per board	Leftover wood to be stored

Unless otherwise stated, all samples indicated in Table 2-4 to be archived shall be held at least until the initial report of results has been finalized. Longer archiving times for certain samples may be warranted upon further consideration.

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3 Testing and Measurement Protocols

3.1 Wipe Sampling

Wipe sampling will be conducted in general accordance with the method developed and documented by CPSC (with the following modifications: plastic wrap is used to cover the rubber-coated side of the steel rubbing disk rather than Parafilm®, and the wipes are placed into extraction vessels after removing from the disk), using the wipe sampling device designed and constructed by CPSC. The CPSC wipe sampling device utilizes a 1.1 kg disc that is 8.9 cm in diameter as the wiping block. The referenced CPSC method is described in (US CPSC, 2003 c) in the list of Key References provided as Appendix I to this document. Additionally, the wipes utilized for this project are wetted with DI water only to a final wipe weight three times the dry wipe weight, while CPSC uses a 0.9% saline solution to pre-wet wipes to a final weight of two times their dry weight.

Wipe Preparation and Sampling Procedure are as follows:

1. Wipes (TexWipe® TX1009 cleanroom wipes, 100% continuous filament polyester) are cut in half using a new razor blade cleaned using acetone and a lint-free wiper (i.e., Kimwipe®) on a lab bench which has also been cleaned with acetone. 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. Wetted wipes are stored in the sealed PTFE tubes until use. The person doing the cutting, transferring, and wetting of the wipes wears nitrile or latex gloves.

2. Prior to starting a new wipe sample, the person doing the wipe 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.

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

4. The person doing the wiping slides the disc along the tracks forward and backward for five (5) strokes while another person holds the end of the wiping device in place. A stroke constitutes one forward and back movement.

5. The wipe is rotated 90^o on the rubbing disk which is then slid forward and back for 5 more strokes, for a total of 10 front-and-back strokes.

6. The person doing the wiping (and wearing gloves) 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. Any splinters removed shall be noted.

7. After the sample is taken, and the PTFE sample container resealed, the wiping apparatus is placed into a large plastic tray. In the tray, the wiping apparatus is then decontaminated by wiping the rails which 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 person doing the wiping removes and discards their gloves and, for the next sample, items 2 through 7 are repeated.

8. Wipe samples are directly transferred to extraction vessels with no intermediate sample containers employed.

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

3.2 Sample Preparation (Digestion/Extraction)

Wipe samples will be prepared for analysis using techniques similar to those employed by other researchers including CPSC and Stilwell, et al., 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, shall be employed. Steps involved in the extraction procedure are outlined following:

Extraction Procedure

1. Pre-cleaned disposable digestion vessels will be used for sample collection and digestion. All volumetric glassware will be prepared by acid cleaning. Volumetric glassware will be 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 allow for pre-extraction. Once any initial reaction has ceased, the sample will be capped and introduced into the HotBlock. Using the Environmental Express HotBlock System, 54 samples may be digested in a single batch.

3. Using temperature/pressure curves developed under other research programs for EPA as a guide, the vessels will be placed into the HotBlock and heated for 1 hour at 95^{o}C.

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

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

6. Again, the vessels will be placed into the HotBlock and heated for 1 hour at 95 ^oC.

7. After extraction, the liquid will be poured off into a 100 mL volumetric flask. As much extraction liquid as possible will be squeezed from each wipe; the funnels and flask necks will be rinsed with DI H_2O.

8. 20 mL of 10% HNO_3 will be added to each extraction vessel before the HotBlock cycle is repeated.

9. The extract will then be poured into a clean 100 mL volumetric flask. Deionized water will be used to rinse the extraction vessel; rinsate shall be added to the 100mL volumetric flask. If necessary, deionized water will be added 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 for each sample are stored. One is sent to a contract laboratory for analysis. ARCADIS retains one digested sample.

* 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 shall be stored at 4 degrees C until analysis. Sample containers shall be of TFE or PFA in accordance with the Method specified in Section 3.3.

3.3 Analysis by ICP-MS

Analyses for total arsenic, chromium, and copper shall be conducted by STL in Savannah, GA 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 is an accredited laboratory, participating in the CLP program, as well as numerous state programs. In addition to obtaining specific information on laboratory qualifications, each sample set submitted will include blind blanks and spiked samples, allowing for continued monitoring of laboratory performance.

3.4 Differences with CPSC Procedures

Differences between CPSC and ARCADIS 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. As the boards to be wiped will be part of a deck structure, C-clamps will not be used by ARCADIS to secure the horizontal wiper. An assistant will hold the wiper.

3. Poly wipes will be immediately placed into extraction vessels.

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

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

3.5 Preparation and Analysis of Coating Samples

Total arsenic, chromium, and copper in coatings material will be determined in a manner similar to that used to analyze the wipe samples (acid digestion/extraction followed by ICP-MS). The coating to be analyzed will be thoroughly shaken to ensure homogeneity and then an aliquot will be transferred to a tared PTFE digestion vessel and allowed to dry. Following loss of volatiles through drying, the residue will be digested using concentrated nitric acid as described in EPA SW-846 Method 3052. Hydrofluoric acid may be added if necessary to ensure complete digestion in accordance with the method. The digestate will be quantitatively transferred to a volumetric flask and diluted to a known volume prior to submission to the contract laboratory for ICP-MS analysis (SW-846 Method 6020).

3.6 Preparation and Analysis of Wood Samples

Wood samples will be analyzed for total arsenic, chromium, and copper content using ICP-MS. Wood borings and/or ground wood of known weight will be digested using the same protocol defined earlier for the wipe samples (SW-846 Methods 3051 and 3052). This procedure is consistent with American Wood Preservers Association (AWPA) Standard A7-93 (microwave assisted nitric acid digestion). Digestates will be analyzed by ICP-MS in a manner identical to that described for the wipe samples (SW-846 Method 6020). This is consistent with AWPA Standard A21-00.

3.7 Archiving of ICP-MS Samples

Analysis of the samples by ICP-MS will consume only a fraction of the submitted sample. ARCADIS shall archive an aliquot of each digestate until the completion of the project. Samples will be archived by storing them in TFE or PFA containers under refrigeration. Additionally, any remaining sample volume at the contract analytical laboratory will be archived until results are confirmed.

3.8 Moisture Analysis of Wood Specimens

Moisture content will be measured using a hand-held meter, but only after the technique has been qualified and calibrated via side-by-side testing with the drying oven technique, ASTM D4442 (Primary Oven Drying). Per ASTM D4442, a small representative sample will be weighed prior to drying overnight at 103^{o} C in a forced air oven. After 24 hours, the sample will be cooled in a desiccator, weighed, then returned to the oven. The process will be repeated until weight changes between weighings is within ± 5%.

3.9 Sampling and Analysis Prequalification

Wipe sampling, and sample preparation and analysis procedures have been prequalified for use during this project. Recoveries of spiked/wiped chemicals have been confirmed to be over 90% for each CCA analyte. Control samples, similar to those used in prequalification studies, are additionally critical in ensuring the continued validity of the sampling and analysis techniques employed in this project. Required control samples are discussed in the following section.

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4 QA/QC Checks

A variety of control samples shall be taken as described in Section 2.6.1. These include the following: 1) cross-contamination controls, 2) untreated blank controls, 3) unwiped controls. Each are discussed briefly below.

4.1 Cross-Contamination Controls

The untreated specimens separating test specimens on each deck shall serve as sources for cross-contamination control samples. One wipe area per mini-deck will be sampled during each monitoring event. These will assess the level of cross-contamination expected for adjacent samples as a result of, for example, splash-over of rainwater from one specimen to the next.

4.2 Untreated Blank Controls

The single uncoated minideck consisting of five untreated specimens will be used to routinely take blank samples to assess atmospheric deposition of analytes. Wipe samples will be taken from the same areas of the middle three boards during each monitoring event, similarly to samples taken from the test mini-decks.

4.3 Unwiped (Abrasion) Controls

In general, areas on test specimens that have been prewiped for baseline DA sampling shall not be routinely sampled. As such, the coatings on these sections of lumber will not be abraded by wiping to the same extent as those test specimens that are routinely wiped. In order to assess the effect that wiping has on coating efficacy in reducing DA, a subset of these baseline areas shall be sampled during routine sampling events for comparison with the DA results from its adjacent test area. Additionally, time = 1 rewipes may provide useful information on the effect of prewiping (for baseline determination) on initial coating efficacy.

4.4 Analytical (Contract Laboratory) Control Samples

Additionally, a series of laboratory control samples shall be sent with each batch of samples tested by the subcontract analytical laboratory. Each set of digested wipe samples submitted to the subcontract analytical laboratory will include 5% additional blind field blanks (extracted unused wet wipes), one blind blank (extraction fluid only), one set of three-concentration spiked samples, and duplicates (split samples) for 5% of the wipe sample digestates being analyzed to assess laboratory performance. Control samples shall not be identified as such to the contract laboratory performing the analyses. So, for example, assuming that a total of 200 wipe samples will be taken for this study, shipped to the subcontract laboratory in a single batch, the following additional samples will be included:

- ten (10) field blank samples prepared by taking unused wetted wipes and extracting them in accordance with the procedures previously specified

- one (1) blank consisting of extraction fluid only

- one (1) digestion fluid sample spiked to 1.0 µg/l (0.015 µg in 15 ml digestion fluid) with As, Cr, and Cu

- one (1) digestion fluid samples spiked to 50 µg/l (0.75 µg in 15 ml digestion fluid) with As, Cr, and Cu

- one (1) digestion fluid samples spiked to 1000 µg/l (15 µg in 15 ml digestion fluid) with As, Cr, and Cu

- ten (10) duplicates (selected split samples of digested wipes from actual samples generated)

Furthermore, the subcontract analytical laboratory will conduct analyses on project-specific post-digestion spiked samples, as well as standard matrix spikes and matrix spike duplicates (MS/MSD) for each analyte, in addition to equipment blanks run on each batch of samples analyzed for this project.

5 Data Reductions and Reporting

5.1 Data Reduction

5.1.1 Calculation of DA from Extraction/Digestion Fluid Concentrations

Raw data from the subcontract analytical laboratory will be reported in units of µg/l and will represent the mass of analyte per unit volume of extraction/digestion solution sent to the laboratory. For standard wipe sample results, data will be 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:

$$C_{DA} = \frac{C_{DF} \times \frac{V}{1000}}{A} \qquad \text{(Equation 5.1)}$$

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

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

V = Total volume of extraction/digestion fluid (ml)

A = Area of wiped surface (cm^2)

5.1.2 Calculation of Percent Reduction of DA

Raw data from the subcontract analytical laboratory will be reported in units of µg/l and will be converted to DA (the mass of analyte per unit surface area wipe sampled), in units of µg/cm^2, per the calculation described in section 5.1.1. Percent reduction will be calculated for each sample using the following equation:

$$R_{DA} = \frac{C_{initial} - C_{final}}{C_{initial}} \times 100 \qquad \text{(Equation 5.2)}$$

Where: R_{DA} = Reduction in DA (%)

$C_{initial}$ = Baseline DA (µg/cm^2)

C_{final} = Final DA (µg/cm^2)

5.1.3 Assessing DQI Goals

In general, data quality indicator goals are based on either (1) published specifications, (2) related quantities (e.g., drift for precision), or (3) engineering judgment based on previous experience with similar systems.

Precision

In order to evaluate the precision of a measurement, it is necessary to make replicate measurements of a relatively unchanging parameter. Precision can then be expressed as the relative standard deviation (RSD) of the replicated measurement. RSD is calculated using Equation 5.3 and is typically expressed in percent.

$$RSD = \frac{\sqrt{\sum_{i=1}^{n} (Y_i - \overline{Y})^2}}{\sqrt{n-1}\ \overline{Y}} \qquad \text{(Equation 5.3)}$$

Precision will be calculated using the results of duplicates specified as control samples.

Accuracy/Bias

The accuracy of a measurement is expressed in terms of percent bias, or, in some cases recommended by the EPA standard methods, in terms of absolute difference. Percent bias is defined as:

$$Percent\ Bias = \frac{R - C}{C}\ x\ 100 \qquad \text{(Equation 5.4)}$$

Where: R = instrument response or reading

C = calibration standard or audit sample value

Accuracy can take on the units of the measurement, it can be expressed as a percentage of the average measurement, or it can be expressed as a percentage of the measurement range. Accuracy will be calculated using the results of matrix spike sample analyses as described for QA/QC.

Completeness

The ratio of the number of valid data points taken to the total number of data points planned is defined as data completeness. All measured data are recorded electronically or on data sheets or project notebooks.

5.2 Data Validation

The subcontract laboratory will be required to submit calibration and QC data along with each data package. ARCADIS QA Officer, Libby Nessley will validate at least 10 percent of reported data by reviewing raw data and data calculations. In addition, at least one spiked performance evaluation audit (PEA) sample for arsenic will be submitted blind to the laboratory with each sample set. Reported results for this PEA sample must agree within 10 percent with the known value. Failure to agree will result in the entire data set being flagged for re-evaluation up to and including repeat analysis.

5.3 Data Reporting

For each series of tests, raw and reduced data shall be reported, as applicable. Coating efficacy results will be expressed in terms of DA ($\mu g/cm^2$) and percent reduction. All data validation criteria will be reported along with the associated data.

5.4 Relational Database Development

Data will be compiled using a relational database that includes a variety of information. A schematic of the database design is provided in Appendix H.

5.5 Regular Reporting

ARCADIS will provide the EPA WAM with weekly verbal progress updates as well as monthly written progress reports. Data reports will be prepared and shall include all sampling and analysis data, quality control data, and a data quality evaluation.

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6 Assessments

Assessments are integral parts of a quality system. This project is assigned a QA Category II and will require planned technical systems and performance evaluation audits. The EPA QA Manager will coordinate any audits with the EPA WAM. The ARCADIS QAO will also perform at least one internal technical systems audit in the early stages of this project. This audit will be coordinated with the ARCADIS WAM. In addition, the ARCADIS QAO will perform an audit of data quality prior to the release for any formal reports. This audit will review at least 10% of the data from collection to reporting. Calculations will be checked, laboratory analytical reports will be reviewed, and hand-entered data will be validated.

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Appendix A

Health and Safety Plan

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HEALTH AND SAFETY PROTOCOL
Environmental Research Center
Research Triangle Park, North Carolina

Evaluation of CCA Treated Wood, Coatings, and Arsenic Dermal Exposure

Title of Project

Mark Mason

Work Assignment Manager

Victor D'Amato

Work Assignment Leader

E-377-A, Long Bay, Outdoor Weathering Location

Project Location

APPROVALS

Victor D'Amato **Work Assignment Leader** **ARCADIS G&M**	**Date**
Todd Thornton **Health and Safety Officer** **ARCADIS G&M**	**Date**

Prepared by:
ARCADIS G&M
4915 Prospectus Dr., Suite F
Durham, NC 27713

CONTENTS

PART A. INTRODUCTION

All work on this project will be carried out in compliance with ARCADIS G&M's Health and Safety Manual, the U.S. EPA's Safety Manual (ERC), and U.S. EPA's Chemical Hygiene Plan (ERC). Specific safety information for the project is contained in this Health and Safety Protocol (HSP). All personnel working on hazardous operations or in the area of hazardous operations shall read and be familiar with this HSP before doing any work. All project personnel shall sign the certification page acknowledging that they have read and understand this HSP. Drastic changes in the scope of the project or introduction of new hazards to the project shall require revision of the HSP by the Work Assignment Leader and approval by the ARCADIS Safety Department.

PART B. PERSONNEL

1. List all personnel who will be working on the project:

Vic D'Amato
Kevin Bruce
Peter Kariher
Matt Clayton
Jerry Revis
Bobby Sharpe
Libby Nessley
Michele Addison

2. Will subcontractors be used in this study, excluding off-site analytical labs? If so, please specify.

No

3. Do all personnel have appropriate training (i.e. HAZWOPER, Confined space, etc.)? Specify.

All personel have completed core safety training including Hazard Communication, Hazardous Waste Handling, Personal Protective Equipment, and EPA Chemical Hygiene Plan. All ARCADIS personnel will attain 8 hours of safety training annually.

PART C. PROJECT DESCRIPTION

1. Please give a brief description of the scope of work.

The primary objective of this project is to evaluate the ability of selected coatings to prevent potential dermal exposure to arsenic from the surfaces of aged, previously uncoated, in-service Chromated Copper Arsenate (CCA) treated wood. Factors that impact efficacy of coatings (UV degradation, condensation, thermal shock, erosion due to precipitation, and abrasion) will be evaluated by subjecting CCA treated boards, coated with selected deck sealants or other suitable coatings, to UV light, condensation, thermal shock, and precipitation in artificial weathering chambers and outdoors during natural weathering tests. The potential for dermal exposure through contact with coated surfaces will be periodically evaluated by determination of the amount of arsenic removed from the surface of the coated samples by wipe sampling.

The project will consist of the following tasks: (1) preparation of the test chambers (furnished by EPA), (2) selection and qualification of As analysis subcontractor(s), (3) preparation of the test/QA plan, (4) presentation the test/QA plan, and revision as necessary, (5) conducting the tests, and (6) preparation of timely data reports that organize and present the data and evaluate data quality.

The selected coatings will be applied to weathered CCA treated wood. Twelve coatings will be tested on southern yellow pine that has been CCA treated to 0.4 pounds per cubic foot. Wipe samples will be collected from each board, digested, and analyzed by graphite furnace AA or other suitable technique (e.g., ICP/AA or ICP/MS) to determine total arsenic.

2. Describe all potentially hazardous operations (i.e. mixing chemicals, operating combustors).

The project will require the installation of several weathering chambers which may require heavy lifting.

All wood will be cut to a specified length. This will possibly disperse arsenic into the air in the breathing zone. Additionally, samples (wipe and leachate) may contain arsenic and chromium VI. Sampling and collecting activities may result in possible exposure to these metals. There may be potential for exposure to VOCs from various sealants during the application process. The task also involves dismantling two old decks and assembling small decks. The laboratory digestion process has hazards associated with working with strong acids.

PART D. **CHEMICAL/PHYSICAL HAZARDS**

1. List all Hazardous Agents that will be used in the project (attach MSDS, if appropriate).

Hazardous agents, specifically, are not being used in this project; however, the pressure treated wood is presumed to have dermally accesible arsenic. All leachate collected from the weathering chambers should be treated as if it contains arsenic until testing proves otherwise. There will be some exposure to VOCs from various sealants. Strong acids will be used in the digestion process.

2. Characteristic Hazards present include:

Toxic:	**Yes**	☒	**No**	☐
Carcinogen:	**Yes**	☒	**No**	☐
Mutagen:	**Yes**	☐	**No**	☒
Teratogen:	**Yes**	☐	**No**	☒
Absorbs into skin:	**Yes**	☒	**No**	☐
Sensitizer:	**Yes**	☐	**No**	☒
Corrosive:	**Yes**	☒	**No**	☐
Inhalation:	**Yes**	☒	**No**	☐
Other:	**Yes**	☐	**No**	☐

Please Specify:

3. Describe any physical hazards associated with this project (i.e. extreme heat/cold, heavy lifting).

Potential physical hazards will be lifting of the pressure treated boards, cutting the boards, and assembling/disassembling of the decks.

PART E. HAZARD ABATEMENT

1. **Is protective equipment required for this project:** **Yes** ☒ **No** ☐
   If yes, what type:

Head/Face Protection
- ☒ **Safety Glasses**
- ☐ **Splash Goggles**
- ☐ **Face Shield**
- ☐ **Hard Hat**
- ☐ **Other:**

Hand Protection (gloves)
- ☐ **Latex**
- ☐ **Cotton**
- ☒ **Leather**
- ☒ **Chemical (*specify*):** Nitrile
- ☐ **Double Gloves**
- ☐ **Thermal**

Protective Clothing
- ☒ **Lab Coat**
- ☐ **Lab Apron**
- ☐ **Jumpsuit**
- ☐ **Tyvek suit**
- ☒ **Steel-toed shoes/boots**
- ☐ **Other:**

Respiratory Protection
- ☐ **Air Purifying-full face***
- ☐ **Air Purifying-half mask***
- ☐ **Surgical Mask**
- ☒ **Dust mask**

***Specify cartridge type needed:**

2. **Engineering controls to be used (e.g. controlled access, fume hoods, etc.)**:

QUV weathering chambers; controlled access to the outdoor site; fume hoods will be used when possible during the laboratory work

3. **Describe plans for containment to prevent the spread of any agents from the immediate area, decontamination procedures and monitoring methods to assure decontamination.**

Wood cutting and prep will be done outdoors; the coating applications will be done either outdoors or in a well ventilated area; wastewater from the QUV chambers will be below EPA RTP Campus effluent limits or will be captured via filters.

4. **List all additional safety equipment needed (e.g. fire extinguisher, spill kits, etc.).**

Spill kits for coatings, safety training course on QUVs

PART F. EMERGENCY PROCEDURES

1. Emergency procedures in the event of an exposure:

In the event that an employee is over-exposed to chemicals used during this project, the employee will be removed from the immediate area. If symptoms or injuries are life threatening, call for emergency assistance.

EPA Security	**1-2900**
Ambulance	**911**
Carolina's Poison Control Center	**1-800-848-6946**
Duke Medical Center	**684-8111**
CHEMTREC	**1-800-424-9300**

The ARCADIS G&M, Inc. Safety Department shall be notified promptly by using the following numbers:

Name	Office Number	Pager Number	Cell Phone Number
Jerry Revis	544-2260 ext. 243	565-7482	616-4168
Todd Thornton	544-2260 ext. 287	393-3102	616-4126
Sara Easterly	544-2260 ext. 290	565-3323	616-6294

If emergency attention is not needed but professional medical attention is necessary, the employee will be taken to Duke Occupational Health (Slater Road) or Duke Medical Center.

2. Emergency procedures in the event of a spill or loss of control:

For any spills, employees should immediately contact the APPCD Safety Officer, Richard Valentine, at 541-4437 and the ARCADIS G&M Safety Department. Employees will then follow procedures contained in the ARCADIS G&M Safety Manual or applicable Contingency Plans.

3. Additional emergency procedures specific to the project:

None

PART G. <u>HAZARDOUS WASTE</u>

1. What types of hazardous waste will be generated?

Leachate water potentially contaminated with arsenic, copper, and chromium VI.

2. How will hazardous waste be collected and disposed?

All leachate will be collected for sampling. Collected leachate will be stored as samples until results are obtained regarding arsenic levels in the water. If any leachate measures 5 mg/L of arsenic or greater the leachate will be designated hazardous waste (D004). All leachate measuring less than the threshold quantity will be deemed non-hazardous waste and will be disposed of by sending to sewer while flushing with tap water.

PART H. <u>OTHER</u>

1. Will any materials, chemicals, gases, samples, etc. need to be transported/shipped during this experiment? If so, list the materials and explain how they will be transported/shipped (via placarded vehicle, etc.).

Samples will be sent to an outside laboratory for analysis. These samples are dangerous goods (nitric acid) and must be shipped according to IATA regulations if shipped via air.

2. Will animals be used in this study? **Yes** ☐ **No** ☒
If yes, has this study been coordinated with animal care? **Yes** ☐ **No** ☐

3. Other hazard concerns. Mark all that apply to the work being performed.

☐ **Confined Space**
☒ **Lockout / Tagout**
☐ **Bloodborne Pathogens**
☐ **Fall Protection**
☒ **Metals Exposure**
specify: arsenic
☒ **Other**
specify: UV exposure, VOC exposure

4. Will this project function under additional protocols not previously mentioned (e.g. specific facility manual, radiation protocol, etc.)? Please specify.

No

5. Additional measures or procedures:

Following completion of the study, CCA treated wood used in the study will be disposed of according to both the City of Durham and State of North Carolina regulations.

PART I. **HSP PERSONNEL CERTIFICATION**

I certify that I have read, understand, and will abide by the safety requirements outlined in this HSP.

Printed / Typed Name	Signature	Date
Vic D'Amato		
Kevin Bruce		
Libby Nessley		
Jerry Revis		
Peter Kariher		
Matt Clayton		
Bobby Sharpe		
Michele Addison		

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Appendix B

Wood Characterization Data Sheet

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Board Rating Data Sheet

CCA Wood Study

ARCADIS Project No. RN992014

Board ____________ Length ____________

Flat-Grained ________
or
Edge-Grained ________

Bark Face Up ________
or
Bark Face Down ________
or
Neither ________

Heartwood ________
or
Sapwood ________

Early ________
or
Late ________

On a scale of 1-5, 5 being like new wood and 1 being complete failure, rate:

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

Specimen

App. Number of Knots:		
Splintering		
Cracking		
Rotting/Loose Knots		

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Appendix C

Mini-Deck/Specimen Cross-Reference List

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#	Product Type	Base	Cover	Main Ingredients	Deck ID	A – up	A – down	C – up	C - down
1	Sealant	Oil	Clear		1-A	A-AE-M1	A-Z-M1	C-N-M1	C-BO-M2
					1-B	A-V-M3	A-AT-M3	C-BE-M2	C-CC-M1
					1-C	A-AJ-M1	A-BW-M4	C-S-M2	C-AA-M2
2	Sealant	Oil	Clear	Acrylic, alkyd, urethane	2-A	A-O-M3	A-BY-M2	C-BZ-M3	C-E-M3
					2-B	A-BC-M2	A-AH-M4	C-BI-M1	C-AN-M1
					2-C	A-AR-M1	A-P-M1	C-BY-M2	C-BX-M3
3	Stain	Oil	Opaque	Acrylic	3-A	A-T-M1	A-L-M3	C-N-M3	C-CE-M2
					3-B	A-AG-M3	A-AF-M1	C-BJ-M2	C-AN-M3
					3-C	A-AD-M2	A-BW-M2	C-CD-M1	C-AA-M1
4	Stain	Oil	Semi	Alkyd	4-A	A-T-M2	A-BG-M4	C-CD-M2	C-AD-M2
					4-B	A-BC-M1	A-AH-M1	C-BM-M2	C-AM-M2
					4-C	A-I-M3	A-Q-M2	C-AC-M1	C-BT-M4
5	Sealant	Water	Clear		5-A	A-U-M2	A-L-M2	C-AC-M2	C-CE-M1
					5-B	A-AD-M1	A-Z-M3	C-BM-M3	C-BO-M1
					5-C	A-AR-M3	A-BG-M3	C-CA-M1	C-AD-M3
6	Sealant	Water	Clear	Acrylic, alkyd	6-A	A-U-M1	A-BY-M1	C-BZ-M2	C-AA-M3
					6-B	A-AC-M2	A-AN-M3	C-AJ-M1	C-AI-M1
					6-C	A-BC-M3	A-P-M2	C-S-M3	C-CC-M2
7	Stain	Water	Semi	Alkyd	7-A	A-O-M2	A-Y-M2	C-N-M2	C-AM-M3
					7-B	A-V-M1	A-AH-M3	C-BY-M1	C-BX-M1
					7-C	A-AJ-M3	A-BW-M1	C-BZ-M4	C-E-M2
8	Stain	Water	Semi	Acrylic	8-A	A-AR-M2	A-BY-M3	C-BE-M1	C-AE-M3
					8-B	A-I-M1	A-AT-M1	C-AC-M3	C-AM-M1
					8-C	A-AG-M4	A-Z-M2	C-CA-M2	C-BX-M2
9	Paint	Water	Opaque	Acrylic	9-A	A-T-M3	A-P-M3	C-AP-M1	C-BW-M1
					9-B	A-AC-M1	A-AE-M2	C-BI-M2	C-AN-M2
					9-C	A-AG-M2	A-AN-M1	C-BZ-M1	C-AE-M2
10	Paint	Oil	Opaque	Alkyd, polyurethane	10-A	A-AD-M3	A-BG-M2	C-AP-M3	C-AD-M1
					10-B	A-X-M1	A-Y-M1	C-BJ-M1	C-AK-M4
					10-C	A-AJ-M2	A-Q-M3	C-BU-M2	C-BT-M2
11	Other			Elastic vinyl	11-A	A-U-M3	A-Q-M1	C-AP-M2	C-AI-M3
					11-B	A-X-M2	A-AH-M2	C-BE-M3	C-BW-M2
					11-C	A-AJ-M4	A-BW-M3	C-BJ-M3	C-AE-M1
12	Other			Polymer	12-A	A-O-M1	A-AN-M2	C-AJ-M2	C-AM-M4
					12-B	A-AC-M3	A-AE-M3	C-BI-M3	C-AD-M4
					12-C	A-V-M2	A-L-M1	C-BM-M1	C-BT-M1
13	CONTROL				13-A	A-AG-M1	A-Y-M3	C-S-M1	C-E-M1
					13-B	A-I-M2	A-AT-M2	C-AJ-M3	C-AI-M2
					13-C	A-X-M3	A-BG-M1	C-BU-M1	C-BT-M3

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Appendix D

Wood Preparation Flow Sheets

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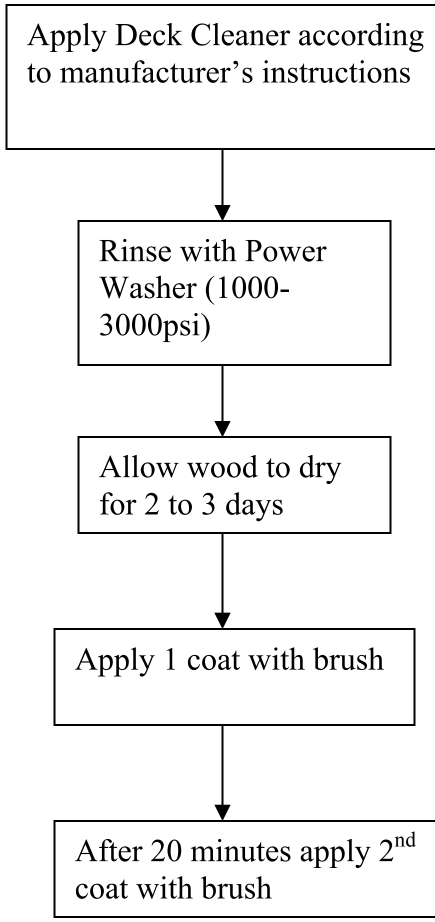
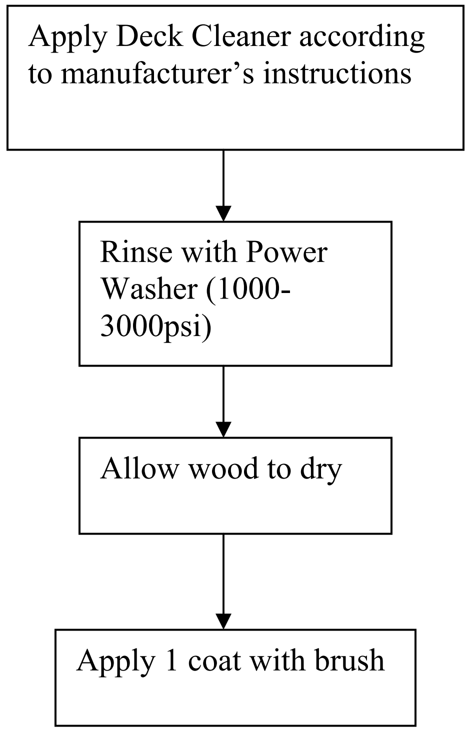
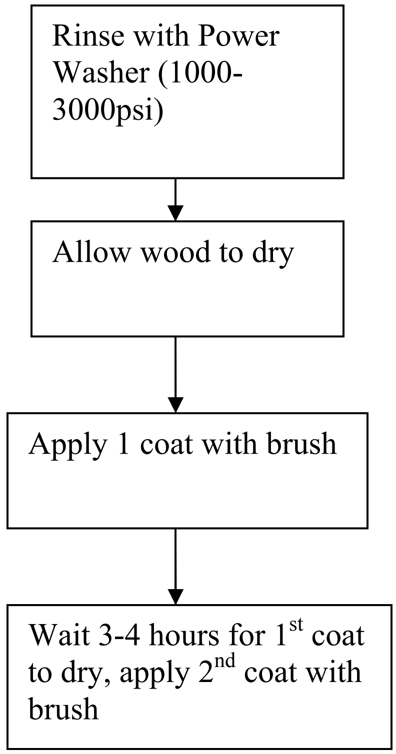
Coatings # 1, # 8


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Allow wood to dry for 2 to 3 days
Apply 1 coat with brush
After 20 minutes apply 2nd coat with brush

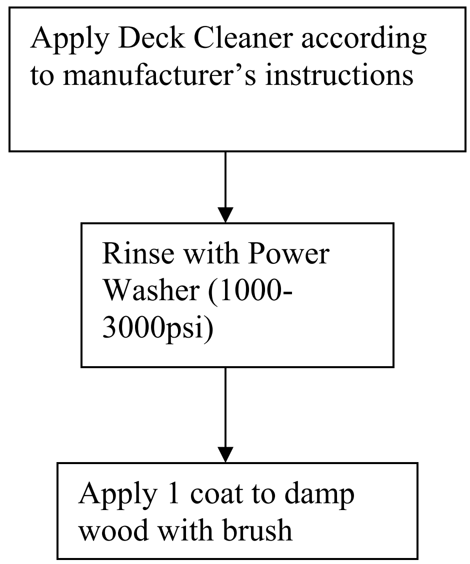
Coatings # 2, # 4, # 5



Coating #3


Rinse with Power Washer (1000-3000psi)
Allow wood to dry
Apply 1 coat with brush
Wait 3-4 hours for 1st coat to dry, apply 2nd coat with brush

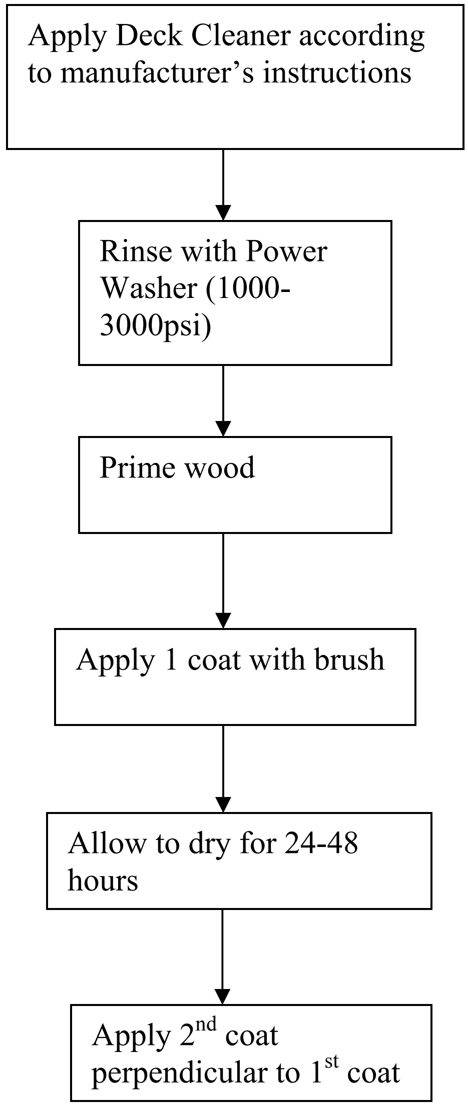
Coating # 6


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Apply 1 coat to damp wood with brush

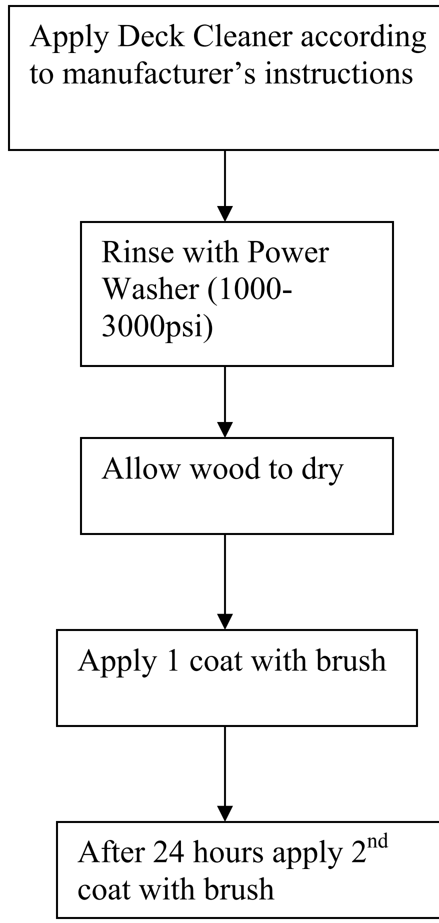
Coating # 7

Apply 1 coat to weathered wood using brush

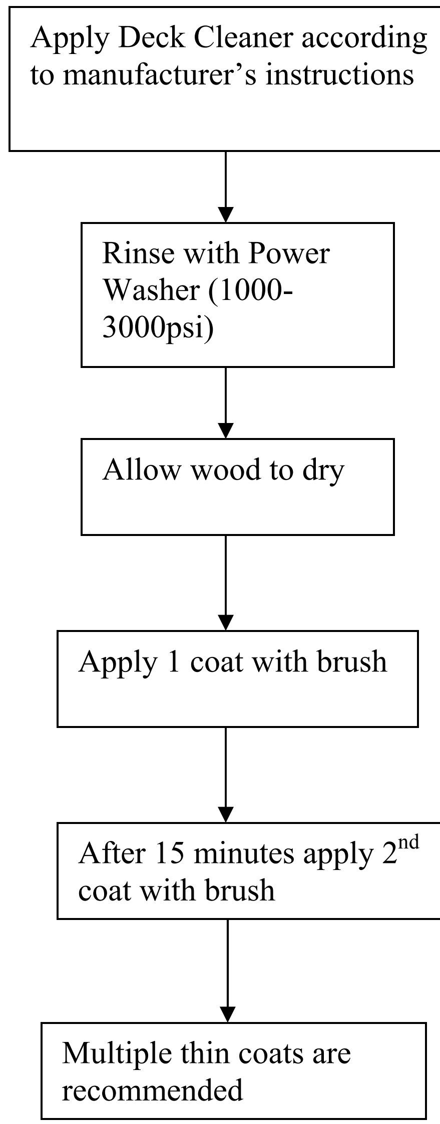
Coating # 9


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Prime wood
Apply 1 coat with brush
Allow to dry for 24-48 hours
Apply 2nd coat perpendicular to 1st coat

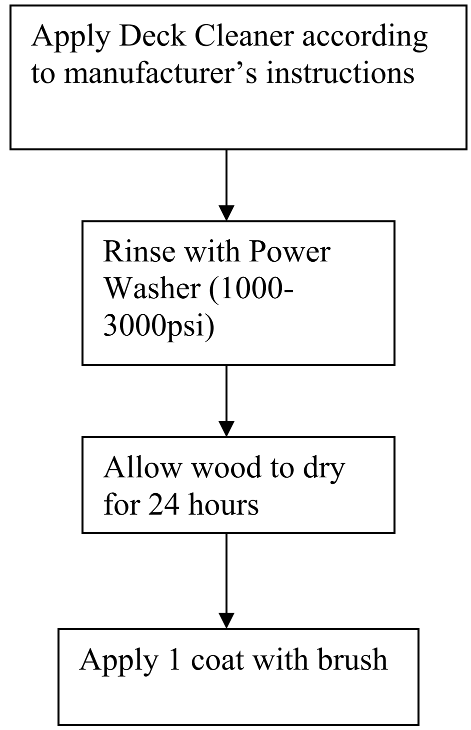
Coating # 10


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Allow wood to dry
Apply 1 coat with brush
After 24 hours apply 2nd coat with brush

Coating # 11


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Allow wood to dry
Apply 1 coat with brush
After 15 minutes apply 2nd coat with brush
Multiple thin coats are recommended

Coating # 12


Apply Deck Cleaner according to manufacturer's instructions
Rinse with Power Washer (1000-3000psi)
Allow wood to dry for 24 hours
Apply 1 coat with brush

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Appendix E

Coating Application Data Sheet

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Coating Application Data Sheet

CCA Wood Study

ARCADIS Project No. RN992014

Application Date ____________

Coating ID 1

Deck Number 1A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 1B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 1C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-AE-M1		A-V-M3		A-AJ-M1	
A-Z-M1		A-AT-M3		A-BW-M4	
C-N-M1		C-BE-M2		C-S-M2	
C-BO-M2		C-CC-M1		C-AA-M2	

Coating ID 2

Deck Number 2A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 2B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 2C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-O-M3		A-BC-M2		A-AR-M1	
A-BY-M2		A-AH-M4		A-P-M1	
C-BZ-M3		C-BI-M1		C-BY-M2	
C-E-M3		C-AN-M1		C-BX-M3	

Coating ID 3

Deck Number 3A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 3B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 3C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-T-M1		A-AG-M3		A-AD-M2	
A-L-M3		A-AF-M1		A-BW-M2	
C-N-M3		C-BJ-M2		C-CD-M1	
C-CE-M2		C-AN-M3		C-AA-M1	

Coating ID 4

Deck Number 4A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 4B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 4C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-T-M2		A-BC-M1		A-I-M3	
A-BG-M4		A-AH-M1		A-Q-M2	
C-CD-M2		C-BM-M2		C-AC-M1	
C-AD-M2		C-AM-M2		C-BT-M4	

Coating Application Data Sheet

CCA Wood Study

ARCADIS Project No. RN992014

Application Date ____________

Coating ID 5

Deck Number 5A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 5B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 5C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-U-M2		A-AD-M1		A-AR-M3	
A-L-M2		A-Z-M3		A-BG-M3	
C-AC-M2		C-BM-M3		C-CA-M1	
C-CE-M1		C-BO-M1		C-AD-M3	

Coating ID 6

Deck Number 6A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 6B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 6C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-U-M1		A-AC-M2		A-BC-M3	
A-BY-M1		A-AN-M3		A-P-M2	
C-BZ-M2		C-AJ-M1		C-S-M3	
C-AA-M3		C-AI-M1		C-CC-M2	

Coating ID 7

Deck Number 7A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 7B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 7C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-O-M2		A-V-M1		A-AJ-M3	
A-Y-M2		A-AH-M3		A-BW-M1	
C-N-M2		C-BY-M1		C-BZ-M4	
C-AM-M3		C-BX-M1		C-E-M2	

Coating ID 8

Deck Number 8A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 8B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 8C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-AR-M2		A-I-M1		A-AG-M4	
A-BY-M3		A-AT-M1		A-Z-M2	
C-BE-M1		C-AC-M3		C-CA-M2	
C-AE-M3		C-AM-M1		C-BX-M2	

Coating Application Data Sheet

CCA Wood Study

ARCADIS Project No. RN992014

Application Date ____________

Coating ID 9

Deck Number 9A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 9B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 9C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-T-M3		A-AC-M1		A-AG-M2	
A-P-M3		A-AE-M2		A-AN-M1	
C-AP-M1		C-BI-M2		C-BZ-M1	
C-BW-M1		C-AN-M2		C-AE-M2	

Coating ID 10

Deck Number 10A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 10B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 10C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-AD-M3		A-X-M1		A-AJ-M2	
A-BG-M2		A-Y-M1		A-Q-M3	
C-AP-M3		C-BJ-M1		C-BU-M2	
C-AD-M1		C-AK-M4		C-BT-M2	

Coating ID 11

Deck Number 11A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 11B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 11C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-U-M3		A-X-M2		A-AJ-M4	
A-Q-M1		A-AH-M2		A-BW-M3	
C-AP-M2		C-BE-M3		C-BJ-M3	
C-AI-M3		C-BW-M2		C-AE-M1	

Coating ID 12

Deck Number 12A Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 12B Vol A (mL) Vol C (mL) Vol New (mL)		Deck Number 12C Vol A (mL) Vol C (mL) Vol New (mL)	
Board Number	Thickness (mm)	Board Number	Thickness (mm)	Board Number	Thickness (mm)
A-O-M1		A-AC-M3		A-V-M2	
A-AN-M2		A-AE-M3		A-L-M1	
C-AJ-M2		C-BI-M3		C-BM-M1	
C-AM-M4		C-AD-M4		C-BT-M1	

Appendix F

Site Plan

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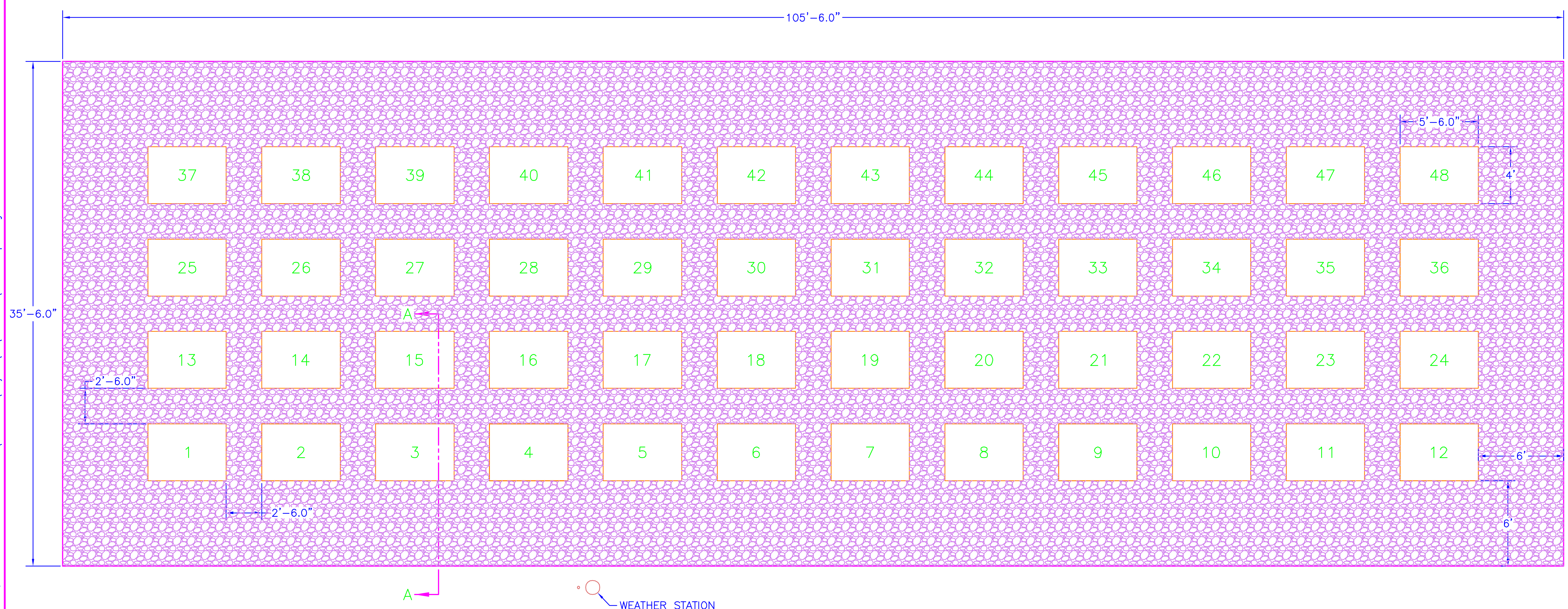
NOTES

1. SHADED AREAS ARE LANDSCAPE FABRIC COVERED WITH GRAVEL.
2. PERIMETER IS 6' WIDE, PATHS ARE 2'-6" WIDE.
3. BLOCKS ARE 5.5x4.0'

0' 8' 16' 24'

1/8"=1'



REV.	ISSUED DATE	DESCRIPTION
1	8/4/03	ISSUED FOR REVIEW

ARCADIS
4915 Prospectus Dr., Suite F
Durham, NC 27713
Tel: 919-544-4535 Fax: 919-544-5690
www.arcadis-us.com

PROJECT TITLE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CCA TREATMENT

SHEET TITLE

FIELD TEST LAYOUT

PROJECT MANAGER V. D'AMATO	DEPARTMENT MANAGER C. LUTES
LEAD DESIGN PROF. V. D'AMATO	CHECKED BY V. D'AMATO
TASK/PHASE NUMBER 00001	DRAWN BY R. SHARPE
PROJECT NUMBER RN992014.0041	DRAWING NUMBER C-1.1

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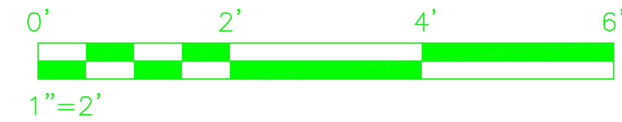
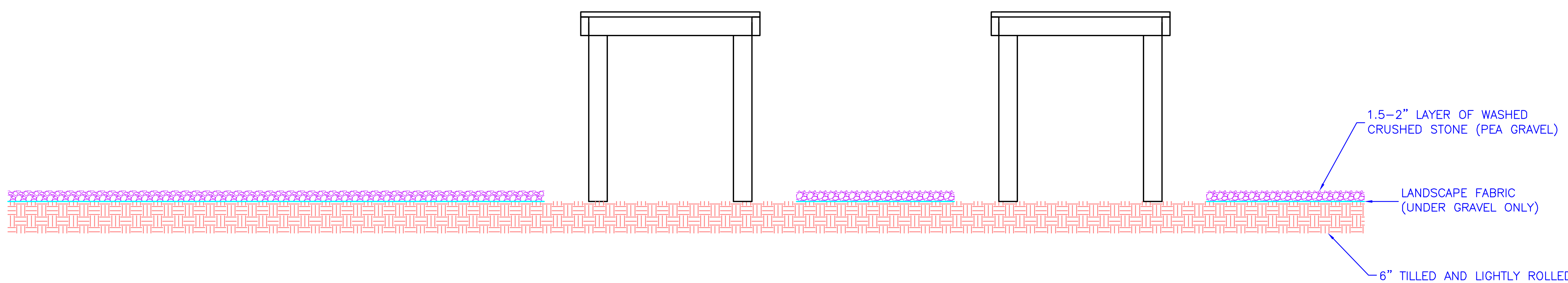
Acad Version : R15.06
User Name : bsharpe



NOTES

1. GROUND SURFACE TILLED TO 6" DEPTH.
2. LEVELED TO REMOVE POTHOLES.
3. LIGHTLY ROLLED TO PREVENT DUST/EROSION, BUT NOT OVERLY COMPACT SOIL.
4. CONTRACTOR MUST PROVIDE SAMPLE OF STONE PRIOR TO COMMENCING WORK.



SECTION A-A/C-1.1

REV.	ISSUED DATE	DESCRIPTION
1	8/4/03	ISSUED FOR REVIEW

ARCADIS
4915 Prospectus Dr., Suite F
Durham, NC 27713
Tel: 919-544-4535 Fax: 919-544-5690
www.arcadis-us.com

PROJECT TITLE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CCA TREATMENT

SHEET TITLE

FIELD TEST LAYOUT
WALKWAY SECTION

PROJECT MANAGER V. D'AMATO	DEPARTMENT MANAGER C. LUTES
LEAD DESIGN PROF. V. D'AMATO	CHECKED BY V. D'AMATO
TASK/PHASE NUMBER 00001	DRAWN BY R. SHARPE
PROJECT NUMBER RN992014.0041	DRAWING NUMBER C-1.2

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Acad Version : R15.06
User Name : bsharpe

Appendix G

Monthly Sampling Datasheets

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Sampling Event Data Sheet

CCA Wood Study
ARCADIS Project No. RN992014

Sampling Date ____________

Deck	1A		Deck	1B		Deck	1C	
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-AE-M1			A-V-M3			A-AJ-M1		
A-Z-M1			A-AT-M3			A-BW-M4		
C-N-M1			C-BE-M2			C-S-M2		
C-BO-M2			C-CC-M1			C-AA-M2		
A-AE-BL			Untreated			Untreated		
A-Z-BL								
C-N-BL								
C-BO-BL								
Untreated								

Deck	2A		Deck	2B		Deck	2C	
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-O-M3			A-BC-M2			A-AR-M1		
A-BY-M2			A-AH-M4			A-P-M1		
C-BZ-M3			C-BI-M1			C-BY-M2		
C-E-M3			C-AN-M1			C-BX-M3		
A-O-BL			Untreated			Untreated		
A-BY-BL								
C-BZ-BL								
C-E-BL								
Untreated								

Deck 3A			Deck 3B			Deck 3C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-T-M1			A-AG-M3			A-AD-M2		
A-L-M3			A-AF-M1			A-BW-M2		
C-N-M3			C-BJ-M2			C-CD-M1		
C-CE-M2			C-AN-M3			C-AA-M1		
A-T-BL			Untreated			Untreated		
A-L-BL								
C-N-BL								
C-CE-BL								
Untreated								

Deck 4A			Deck 4B			Deck 4C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-T-M2			A-BC-M1			A-I-M3		
A-BG-M4			A-AH-M1			A-Q-M2		
C-CD-M2			C-BM-M2			C-AC-M1		
C-AD-M2			C-AM-M2			C-BT-M4		
A-T-BL			Untreated			Untreated		
A-L-BL								
C-N-BL								
C-CE-BL								
Untreated								

Deck 5A			Deck 5B			Deck 5C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-U-M2			A-AD-M1			A-AR-M3		
A-L-M2			A-Z-M3			A-BG-M3		
C-AC-M2			C-BM-M3			C-CA-M1		
C-CE-M1			C-BO-M1			C-AD-M3		
A-U-BL			Untreated			Untreated		
A-L-BL								
C-AC-BL								
C-CE-BL								
Untreated								

Deck 6A			Deck 6B			Deck 6C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-U-M1			A-AC-M2			A-BC-M3		
A-BY-M1			A-AN-M3			A-P-M2		
C-BZ-M2			C-AJ-M1			C-S-M3		
C-AA-M3			C-AI-M1			C-CC-M2		
A-U-BL			Untreated			Untreated		
A-BY-BL								
C-BZ-BL								
C-AA-BL								
Untreated								

Deck 7A			Deck 7B			Deck 7C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-O-M2			A-V-M1			A-AJ-M3		
A-Y-M2			A-AH-M3			A-BW-M1		
C-N-M2			C-BY-M1			C-BZ-M4		
C-AM-M3			C-BX-M1			C-E-M2		
A-O-BL			Untreated			Untreated		
A-Y-BL								
C-N-BL								
C-AM-BL								
Untreated								

Deck 8A			Deck 8B			Deck 8C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-AR-M2			A-I-M1			A-AG-M4		
A-BY-M3			A-AT-M1			A-Z-M2		
C-BE-M1			C-AC-M3			C-CA-M2		
C-AE-M3			C-AM-M1			C-BX-M2		
A-AR-BL			Untreated			Untreated		
A-BY-BL								
C-BE-BL								
C-AE-BL								
Untreated								

Deck	9A		Deck	9B		Deck	9C	
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-T-M3			A-AC-M1			A-AG-M2		
A-P-M3			A-AE-M2			A-AN-M1		
C-AP-M1			C-BI-M2			C-BZ-M1		
C-BW-M1			C-AN-M2			C-AE-M2		
A-T-BL			Untreated			Untreated		
A-P-BL								
C-AP-BL								
C-BW-BL								
Untreated								

Deck	10A		Deck	10B		Deck	10C	
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-AD-M3			A-X-M1			A-AJ-M2		
A-BG-M2			A-Y-M1			A-Q-M3		
C-AP-M3			C-BJ-M1			C-BU-M2		
C-AD-M1			C-AK-M4			C-BT-M2		
A-AD-BL			Untreated			Untreated		
A-BG-BL								
C-AP-BL								
C-AD-BL								
Untreated								

Deck	11A		Deck	11B		Deck	11C	
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-U-M3			A-X-M2			A-AJ-M4		
A-Q-M1			A-AH-M2			A-BW-M3		
C-AP-M2			C-BE-M3			C-BJ-M3		
C-AI-M3			C-BW-M2			C-AE-M1		
A-U-BL			Untreated			Untreated		
A-Q-BL								
C-AP-BL								
C-AI-BL								
Untreated								

Deck 12A			Deck 12B			Deck 12C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-O-M1			A-AC-M3			A-V-M2		
A-AN-M2			A-AE-M3			A-L-M1		
C-AJ-M2			C-BI-M3			C-BM-M1		
C-AM-M4			C-AD-M4			C-BT-M1		
A-O-BL			Untreated			Untreated		
A-AN-BL								
C-AJ-BL								
C-AM-BL								
Untreated								

Deck 13A			Deck 13B			Deck 13C		
Board	Wiped	Date Extracted	Board	Wiped	Date Extracted	Board	Wiped	Date Extracted
A-AG-M1			A-I-M2			A-X-M3		
A-Y-M3			A-AT-M2			A-BG-M1		
C-S-M1			C-AJ-M3			C-BU-M1		
C-E-M1			C-AI-M2			C-BT-M3		
A-AG-BL			Untreated			Untreated		
A-Y-BL								
C-S-BL								
C-E-BL								
Untreated								

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Appendix H

Database Design Flowchart

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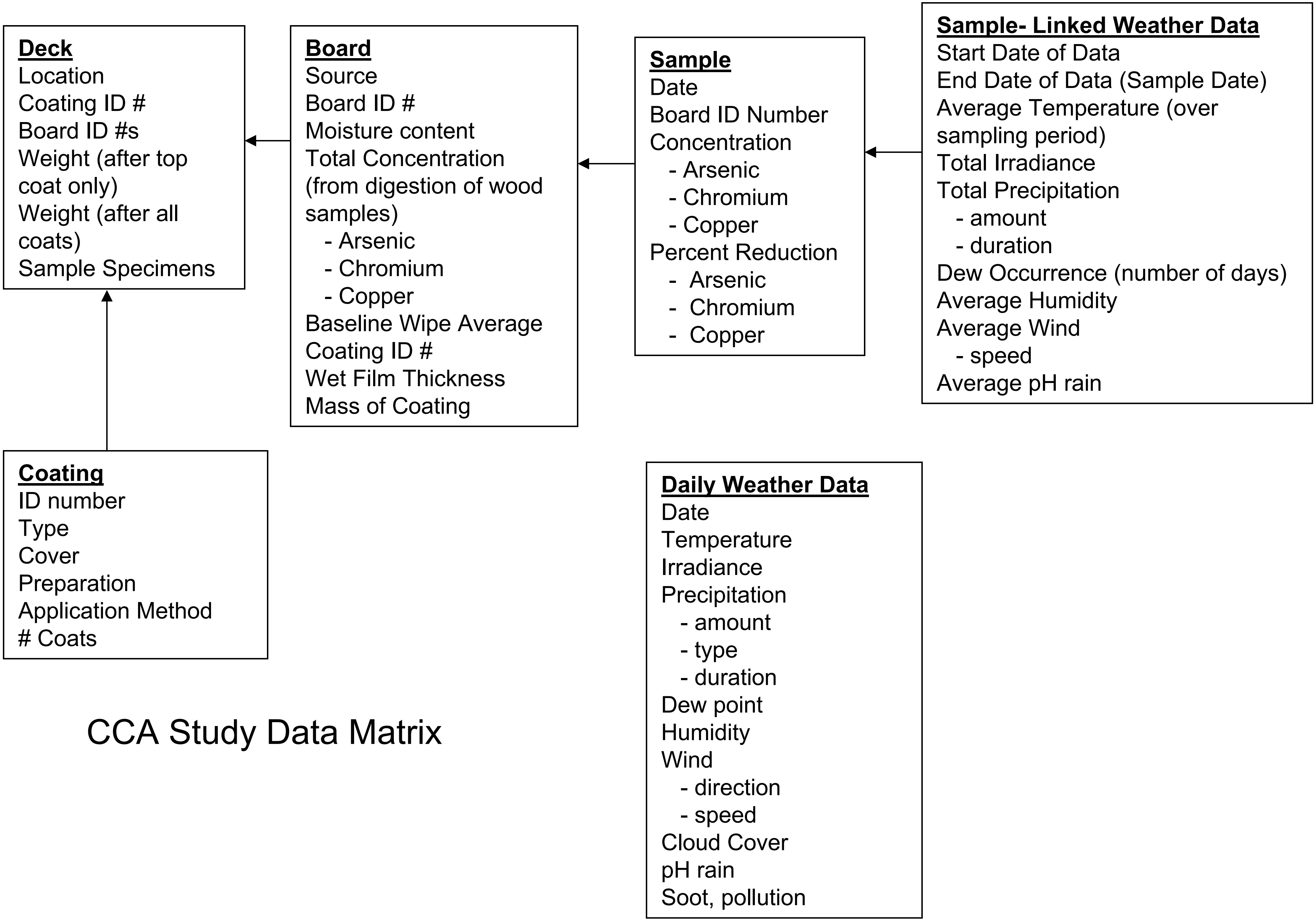

CCA Study Data Matrix

QA/QC Data Matrix- CCA Study

Sample Date
Number of Samples
Number of Duplicates
Number of Spikes

Blank
TA concentration

Spikes
Spike concentration
Results
RSD

Duplicates
ID
Results
Percent Bias

Appendix I

List of Key References

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