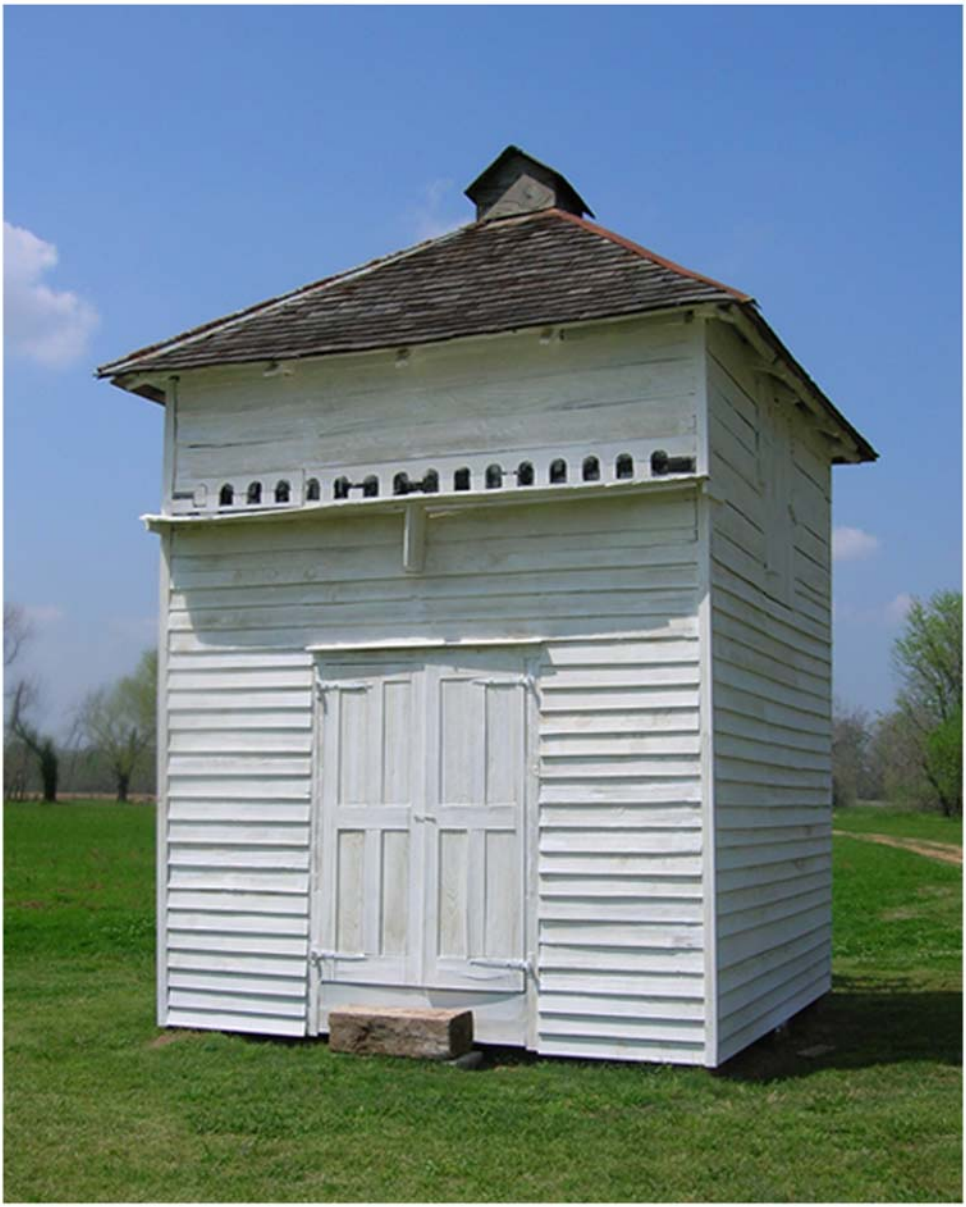
National Park Service
U.S. Department of the Interior

National Center for Preservation Technology and Training
Natchitoches, Louisiana

Study on the Durability of Traditional and Modified Limewash



Durability of Traditional and Modified Limewash

In 2004, NCPTT partnered with Cane River Creole National Park (CARI) and Quality Finish to study the durability of limewash for use on buildings in the Park.

NCPTT partnered with CARI to determine the durability of traditional and modified limewash recipes. CARI wanted to identify a lasting, low-cost limewash that was applied in approximately three layers and would last three to five years. Quality Finish, a local paint contractor, joined the project to ensure that limewash could be applied by local craftsmen outside of a laboratory setting.

The study looked at traditional and modified limewashes made from four different lime sources. Traditional additives such as salt, alum, molasses and others were tested. Different limewashes were applied to hand-made brick, modern brick, weathered wood, rough sawn wood, and epoxy fill materials.

Standard test methodologies were used as defined by the American Society for Testing and Materials (ASTM) standards. We measured abrasion, adhesion, and color change on samples before and after artificial weathering. The amount of solids applied to the samples was estimated by weighing. Next we developed numerical ranking system to take into consideration performance on various tests.

Brick cabins at Magnolia Plantation at CARI. Photograph by Sarah Jackson

The Laboratory Tests

Abrasion testing was based on ASTM D 968-96, allowing us to rank how a limewash might stand up over time to abrasion from wind and rain borne particles. The results were averaged for each wash and the best performers were those samples that required the highest amount of sand, indicating that they had formed a harder, more cohesive finish.

Adhesion testing was performed to evaluate how firmly the limewash bonded to the samples, following ASTM D 3359-95.The results were averaged and the best performers were the samples with the least limewash loss, indicating the limewashes that bonded most tightly to the material.

Limewash Recipes

	Lime, Water, Table Salt, Alum, Unsulphured Molasses, and Laundry Bluing	Lime, Water, Clove Oil, Unsulphered Molasses, Laundry Bluing, and Casein Binder	Lime, Water, and Acrylic Binder	Lime and Water
Graymont Ivory Hydrated Lime.	Wash A	Wash D	Wash G	Wash L
Graymont Niagara Lime Putty	Wash B	Wash E	Wash H	Wash M
Virginia Limeworks Lime Putty	Wash C	Wash F	Wash I	Wash K
Mississippi Lime Architectural Lime Putty				Wash N

	Applied to handmade brick, modern brick, weathered wood, and rough- sawn new wood.
	Applied to handmade and modern brick.
	Applied to handmade brick and weathered wood.

History of Limewash

Limewash was the traditional finish for centuries on both the exterior and interior surfaces worldwide. Lime is one of the world's oldest building materials. It was readily available at most job sites. Limewash was applied to surfaces for both it's protective and aesthetic qualities.

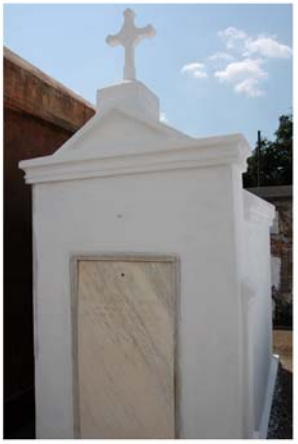
Quicklime slaking after water was added to the pan. Steam rising above the pan was created by the exothermic reation of the quicklime slaking.

Closeup of quicklime slaking. As water is added the quicklime releases heat creating calcium hydroxide, better known as lime.

Limewash is a mixture of slaked lime and water that, as it dries, reacts with carbon dioxide in the air carbonating creating a tough, "rock" like coating. Lime begins as limestone that is burned (heated) at high temperatures removing the carbon dioxide and moisture from the stone creating calcium oxide (quicklime). The quicklime is then slaked, water is added, to create a workable material. Hydrated lime is a dry powder that is created when a minimum amount of water is added to quicklime. Lime putty is created when an excess amount of water is added to quicklime.

Limewash is often considered to be a tactful historic building material because it allows a greater water transfer than most modern finishes. If a structure suffers from rising damp, where water moves up the interior of walls before evaporating, a modern paint often does not allow for moisture transfer. Thus the moisture becomes trapped in the wall creating a environment that could lead to damage or material deterioration.

Above limewash is shown as it is about to be used. To the right, limewash is being applied to a tomb at St. Louis Cemtery No. 1 in New Orleans, La in July 2008.



Limewash was traditionally prepared on site by skilled craftsmen and applied in the spring or fall for optimal temperatures. Additional ingredients may be included in limewash to provide additional chemical or physical properties. Additives require careful consideration due to the possible adverse affects.

Pigments were a common additive included in limewash to vary the color of the finish. Earth pigments are recommended to maintain consistent color and limit changes from the alkalinity of the limewash. Moderation was necessary when adding pigments to limit the weakening effect of excessive amounts of additives.

Brick fireplace at Oakland Plantation, part of CARI, which was limewashed with a colorwash after color analysis. Photograph by Sarah Jackson

To maintain consistency in the limewash an amount large enough to complete the project was mixed and agitated throughout application. If the limewash dried too quickly, carbonation would be disrupted, forming a finish that tended to crack, powder, and lose strength.

Limewash was applied in thin layers, constantly maintaining a wet edge. Multiple layers were applied with sufficient time to dry between applications. Drying times were 24 hours or longer depending on exterior conditions such as humidity and temperature.

Three or more layers were recommended for the initial limewashing. Annual reapplication was necessary to counter weathering from exposure. Successive limewashings required fewer layers.

Beginning in the 1900's limewash became less used in urban areas while its popularity continued in rural settings until as late as mid-20th century. An increase in modern, long-lasting buildings materials and the rising cost of labor may have contributed to its waning popularity.

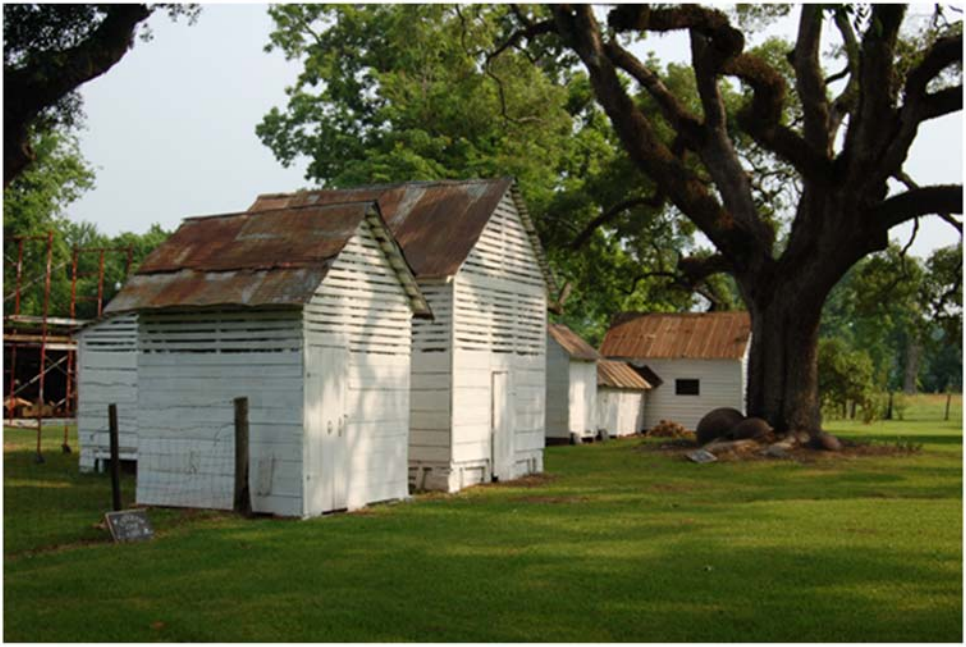
Results of Study

A variety of limewash recipes were tested on multiple sample materials for possible use at CARI. Based on the results, the most important distinction among the recipes tested was the additives used, rather than the type of lime. The adhesion of the limewash was also greatly affected by the substrate to which it was applied.

The more porous material, brick, allowed for a better adhesion of the limewash, creating a more cohesive coat and increased durability. On porous materials such as brick, soluble salts can be very detrimental. Therefore, limewash prepared with a salt additive may be detrimental to porous materials. Washes with salt did not perform better than limewash prepared without additives after artificial weathering. On the handmade brick, Wash M performed almost twice as well on all tests after artificial weathering.

The porous structure of handmade brick makes a primer unnecessary to assist in the adhesion of limewash to the surface. For application on handmade or historic brick Wash M, Graymont Niagara lime putty and water, would likely provide the best results in field applications.

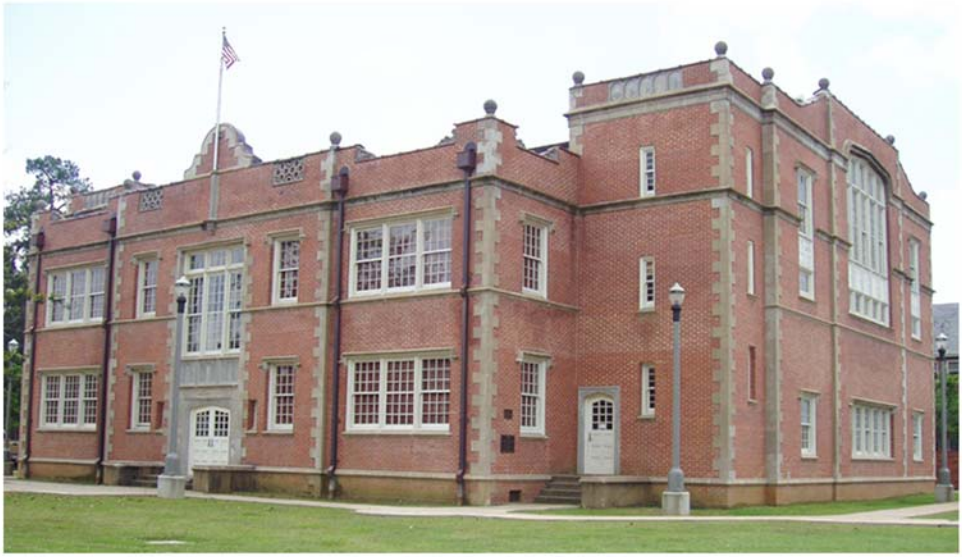
None of the limewashes tested were long-lasting on the wood samples, which could be attributed to using only three layers of limewash on the wood samples. The wood itself has been unfinished for numerous years, which most likely contributed to the poor adhesion and would have affected any finish applied to it. However, there was a noticeable difference in performance between the washes applied after Edison Coatings Primer #342 and those that were applied to bare wood.



Wood outbuildings at Oakland Plantation after limewashing. Photograph by Sarah Jackson

The limewashes applied to wood samples after primer performed better during the study. In applications where an acrylic primer is deemed an inappropriate treatment on wood, Wash E with Graymont Niagara lime putty and casein would likely be a good choice for use. Epoxy samples experienced results that were comparable to the same recipes on the wood samples. Wash E was the best performer on the wood and epoxy samples.

Additional research is needed on the physical and chemical properties of limes commercially available in the United States and Europe in order to gain a clearer understanding of its role in limewash. Application of a greater number of coats of thin layers and investigation of the effects of temperature and humidity on carbonation may provide greater insight into the durability of limewash.



Lee H. Nelson Hall, Home of NCPTT

National Center for Preservation Technology and Training

NCPTT advances the application of science and technology to historic preservation. Working in the fields of archeology, architecture, landscape architecture and materials conservation, the Center accomplishes its mission through training, education, research, technology transfer and partnerships.

NCPTT was created by Congress in 1992 to develop and disseminate preservation technologies and to train practitioners in new technologies. NCPTT promotes preservation technologies in the fields of archeology, historic architecture, historic landscapes, and materials conservation.

NCPTT emphasizes preservation technology research. We support the use of innovative technologies in the preservation of cultural properties and the transfer of technology from arenas not readily identified within historic preservation.

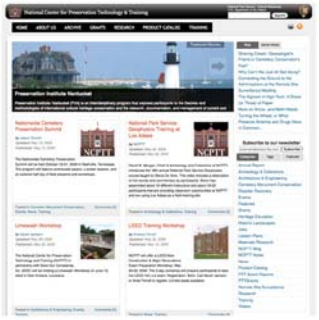
NCPTT conducts preservation technology research

NCPTT undertakes research at its in-house laboratories, which include an environmental chamber that allows researchers to test the effects of pollutants on cultural materials. More widely, the Center stimulates new research through its nationwide grants program.

NCPTT provides grants, creates partnerships

NCPTT maintains a broad partnership base that includes National Park Service sites; other federal agencies; state and tribal historic preservation offices; universities; private corporations; and local, state, national and international non-profit organizations. The Center provides direct and competitive grants to promote research and training opportunities in preservation technology.

Participants visiting site at Built for the Bayou: Environmental Adaptations in Design Workshop in Lafayette, La. Photograph by Sarah Jackson



The NCPTT website

NCPTT serves as a trainer and convener

The Center develops and conducts regional seminars and workshops on topics like cemetery monument conservation. NCPTT promotes excellence in preservation by promoting historic preservation training and education opportunities for professionals.

NCPTT's online presence uses the web to feature preservation research

NCPTT's website and publications enable the Center to deliver the latest news about preservation technologies to a variety of audiences. Also, NCPTT supports the distribution of preservation information through its grants and partnerships.

NCPTT is currently focused on six research priorities:

1. Conserve cultural resources of the "recent past"

2. Monitor and evaluate preservation treatments

3. Investigate minimally invasive techniques to inventory and assess cultural resources

4. Protect cultural resources against natural and human threats

5. Preserve cemeteries and places of worship

6. Safeguard resources from effects of pollution and climate

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Tips for Great Limewash Application!

- Brush down surface to be limewashed with stiff natural-bristle or a soft plastic-bristle brush and water to remove any debris, biological growth, or chemicals
- Dampen with water until the surface glistens, but there is no beaded water
- After the surface is dampened wait a few minutes to make sure the material is no longer drawing water
- Using a limewash brush, apply the first coat of limewash onto dampened surface
- Work the limewash into cracks or joints, always working from a wet edge
- Limewash should be agitated frequently during application to maintain consistency
- Limewash will be translucent during application and become opaque as it dries
- After 24 hours the first coat of limewash should be a coherent opaque surface
- To apply subsequent coats, dampen the wall and follow the same directions as the first coat

Literature Recommendations

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