PRESERVATION MATTERS: DISASTERS

REMOVAL OF WILDLAND FIRE CHEMICALS FROM CULTURAL RESOURCES

Topics covered in this brief:

FIRE SUPPRESSANTS

ASSESSMENT

SAFETY

DOS AND DON'TS

CLEANING

National Center for Preservation Technology and Training
www.nps.gov/ncptt

During the suppression of a wildland fire, cultural resources may be accidentally or intentionally exposed to a fire chemical. Some materials and fire chemicals require immediate attention to prevent significant damage to cultural resources, yet it may not be safe or practical to clean a resource quickly after exposure to fire chemicals. Consequentially, weathering of the fire chemical would likely take place before a resource could be cleaned. Negative impacts to a material's color and surface roughness that are caused by the fire chemicals often persist after weathering. The appropriate removal of fire chemicals from sensitive materials is therefore required.

This document serves as an instructional guide for individuals who are responsible for the management and preservation of cultural resources. The information presented here is based on research executed by the National Center for Preservation Technology and Training (NCPTT). To find details regarding why specific heritage materials would require the removal of fire chemicals, reference the Preservation Matters Brief on Cultural Resources and Wildland Fire Chemicals.

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Discussed here are cleaning methods for defined types of cultural resource materials. This includes brick, calcareous sandstone, and softwood that is not painted or treated in any way. Not all cleaning methods or products are appropriate for each material listed here. Further, the instructions and recommendations provided are not applicable to materials that are not listed. Seek professional guidance or assistance when preparing to clean other material types.

ASSESSMENT

Identify the Fire Chemical: Fire chemicals are grouped into three classes, each with different chemical properties that factor into removal methods. It is beneficial to determine which specific product a resource was exposed to, but it may be difficult to obtain this information. For reference when a product is unknown the guidance below can assist.

- Long-term retardant: can be pink or orange, has a dull appearance when dried but may have a few shiny flecks in a linear crystalline pattern, sits on the surface of a material, or in some places the retardant may be cracked and raised above the surface of the material.
- Foam: can appear as a water stain, is not visible on the surface of materials.
- Water enhancer: can appear as a consistent matte blue stain, or faint white streaking that has a subtle sheen when viewed from different angles, can also appear as a water stain on wood resources, may sit on top of the surface of a material in angular clumps, or may not be visible at all.

Evaluate the Impacted Substrate: Prior to cleaning, the resource should be evaluated for aspects that may require more sensitive methods or special considerations.

- Are there sensitive areas beneath the fire chemical, such as cracks or missing exterior surface that would further degrade through cleaning actions?
- Are there features beneath the fire chemical, such as pigment, tool marks, or biological growth, that would be removed through cleaning?

Determine the Appropriate End Result of Cleaning: Ask yourself what the goal of cleaning is, specific to individual resources and within the context of the site.

- From a preservation standpoint the purpose of cleaning is to revert the condition of a resource to its state prior to contamination, without causing additional harm. In the case of fire chemicals, the goal is to remove the chemical to prevent harmful effects to the color and surface characteristics of a material, without producing similar harmful effects in the process.
- A “like-new” appearance is typically not appropriate for cultural resources; cleaning should strive to

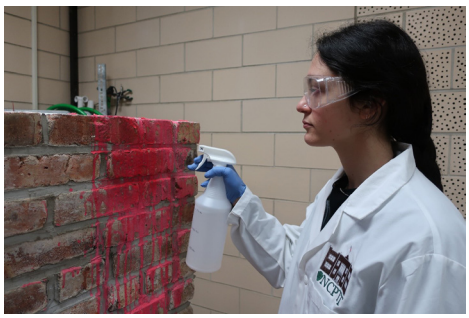
remove the fire chemical only, and not the effects of time that give a resource its authentic appearance.

- Formulating a detailed decision plan and process for cleaning is recommended. This can be referenced later to determine if cleaning was successful, or if unintended effects occurred. Such documentation should be retained for the benefit of future research and interpretation of the cultural resource

SAFETY

Protect Yourself

- Wear safety glasses and disposable gloves
- Long sleeves are also recommended
- Read the Safety Data Sheet (SDS) of chemical cleaners and follow instructions outlined in their safety section



Prioritize safety while cleaning a surface exposed to a fire chemical. (Vrinda Jariwala, NPS)

- Some chemical cleaners may have strong odors which can be harmful to some individuals

Protect the Resource and Surrounding Area

- Cover areas of the resource that were not impacted by the fire chemical to prevent contamination that might result from cleaning actions
- Collect wastewater from cleaning, particularly when using chemical cleaners, and dispose of it appropriately at a separate location
    - Water containing fire chemicals and chemical cleaners is harmful to wildlife and pets that might drink from standing water. Wastewater should not be allowed to enter waterways as it may alter the water salinity, harming aquatic life.
    - The combination of surfactants or solvents and residual fire chemicals in pools of water can harm building foundations.

DOS AND DON'TS

Do

- Test the cleaning method and chemical cleaner (if used) in a small, inconspicuous area before committing to cleaning a larger area.
- Use distilled or deionized water. These types of water will not deposit minerals which can be harmful to the resource being cleaned.
- Begin with the least aggressive method of cleaning. For the materials considered here, that is rinsing with low pressure (300 psi or less) water.
- Clean manageable areas of a resource at a time, such as 1-2 square feet.

Do Not

- Abrade the surface of historic wood or other soft materials.
- Sand blast or power wash any cultural resource.
- Use untested cleaning chemicals without prior testing on non-cultural resources.

PROCEDURE

BRICK AND SANDSTONE

Brick and sandstone differ in appearance and texture and are affected differently by the fire chemicals. Through our experiments it was found that brick and sandstone were cleaned effectively with the same method.

The components of a stone type should be considered when cleaning a resource. Calcareous sandstone is a type of sedimentary rock in which calcite is the glue that holds all other particles together. Calcite is sensitive to acids and therefore this type of sandstone should not be cleaned with acidic chemical cleaners. Additionally, stones containing iron oxide should not be cleaned with bleach, as this will permanently discolor the resource.

While our experiments included brick and sandstone, mortar was not assessed alongside these materials. Lime mortars can be cleaned in the same way as the brick or masonry. For earth-based mortars a much gentler approach should be taken. Should cleaning prove ineffective, replacement of mortar consistent with historic recipes is relatively simple.

Long-term Retardant

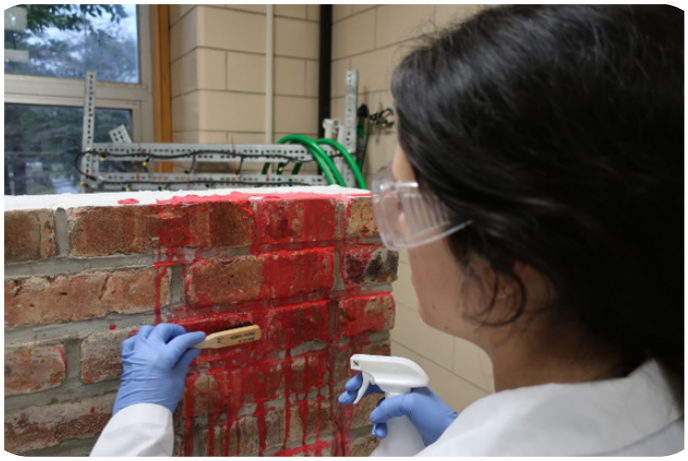
- Cleaning brick or sandstone exposed to a long-term retardant is easier and more successful the sooner it is done, but this type of fire chemical can still be removed after weathering. Always prioritize safety of yourself when deciding when to clean a resource. Even when flames have passed, many hazards remain in burned areas.

- Begin cleaning with distilled or deionized water and a soft bristled brush (natural fibers are preferred) by repetitively **spraying and agitating** the contaminated surface:

  - First wet the surface of the resource and let it sit for 10 minutes.
  - Rinse the surface.
  - Gently brush the surface in a circular motion for about 30 seconds, followed by thorough rinsing. On vertical surfaces such as walls, begin cleaning at the top and work down.
  - Repeat brushing and rinsing as necessary.
  - Using clean water rinse the resource very well once cleaning is finished.
  - Note: Frequently rinse the brush with clean water to remove the fire chemical or surface material that has been collected in the bristles.

- If after three repeated brushings the retardant is still visible, a 10% solution of borax can be used. Ensure that the resource is rinsed completely when using any chemical cleaner. To clean brick or sandstone with a borax solution:

  - Mix 1 ¼ cups of borax into 8 cups of hot water. Allow the water to cool to a temperature comfortable to touch.
  - Wet the surface with distilled or deionized water and let it rest for 10 minutes.
  - Dip your brush into the borax solution and gently brush the resource for 30seconds, followed by rinsing the surface with water.



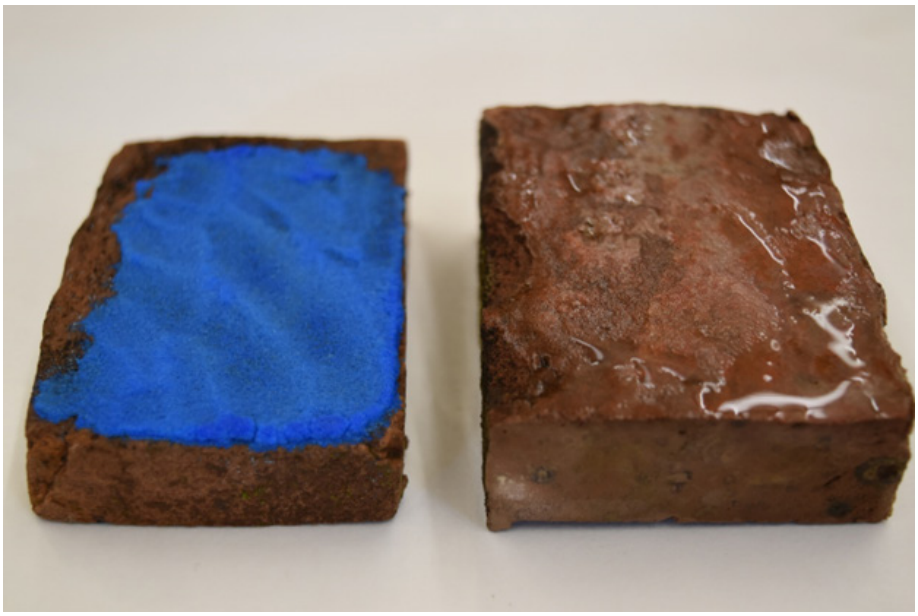
Gently brush brick or sandstone in a circular motion, using a spray bottle to rinse away removed fire chemical. (Vrinda Jariwala, NPS)

Foam

- Brick and sandstone exposed to a foam fire chemical can be cleaned before or after weathering. Note that after the water has evaporated from the foam, it will be very difficult to see on these substrates.
- Foam fire chemicals can be removed easily with distilled or deionized water. Use the same "spray and agitate" method described above.
- If water lines from a foam persist, a 10% borax solution could be used on these materials. Remember to rinse brick and sandstone thoroughly if using a chemical cleaner.

Water Enhancer

- It is easiest and most effective to remove water enhancers from brick and sandstone after the fire chemical has been weathered. It is acceptable to wait weeks or months before cleaning such resources that have a water enhancer on them. Keep in mind that weathering alone is not enough to remove water enhancers from porous materials like brick and sandstone.
- Begin cleaning with distilled or deionized water and a soft bristled brush, using the "spray and agitate" method described above.
    - Note: After first wetting the substrate and letting it sit for 10 minutes, a change in appearance of the water enhancer will occur. You should be able to see that the water enhancer has swelled on the surface and has a lumpy appearance. The water enhancer would also be visible during brushing and in wastewater.
- If after three repeated brushings the water enhancer is still visible, a chemical solvent can be used. A solvent is a substance that dissolves particles and creates a solution. The chemistry of the polymers in the water enhancers makes them insoluble in water, but chemical solvents such as D-Limonene were found to be effective. When using this type of chemical cleaner, it is vital to use the least amount possible and rinse very thoroughly. If used in excess these chemical cleaners can stain a resource and become trapped within porous materials. D-Limonene has a strong citrus odor, which some individuals may be sensitive to. To use a chemical cleaner on water enhancers:
    - After first wetting the surface with water and letting it sit for 10 minutes, spray a small amount of solvent on the area to be cleaned and let it sit for another 10 minutes. One squeeze of a spray bottle trigger should be enough chemical solvent for an area of about 6 square inches.
    - Follow brushing and rinsing steps for the "spray and agitate" method above.
    - Extremely thorough rinsing is necessary when using a solvent. When in contact with water, D-Limonene appears milky white. Rinsing should be conducted until wastewater appears completely clear.



Subtle lumpy appearance of water enhancers after being rewetted. (Kaitlyn Eldredge, NPS)

WOOD

Extra care and consideration needs to be taken when cleaning cultural resources constructed of untreated wood. All wood resources should be cleaned immediately after exposure to any class of fire chemicals, providing for the safety of personnel first. Here, immediate cleaning refers to cleaning before the fire chemical can dry completely. For long-term retardants, the time before they dry completely is approximately 1 hour. The water from foam fire chemicals evaporates in about 30 minutes. Unless applied heavily, water enhancers dry within 1 hour. Use these windows of time as reference in response actions.

If a wood resource cannot be immediately cleaned, the schedule for cleaning should be based on forecasted relative humidity and precipitation. Because brushing is inappropriate for wood resources, a great amount of water is used to remove fire chemicals from this material. If the wood resource does not have ample time to dry after being cleaned a loss of strength can occur. Wood that is wet for long periods can become warped and is prone to destruction through rot and increased growth of mold or algae.

Long-term retardant

- Rinsing is the best method for removal of long-term retardants from untreated wood resources:
  - Wet the surface of the wood and let it sit for 10 minutes.
  - Rinse using low-pressure distilled or deionized water.
  - Repeat rinsing until desired cleaning is achieved.

Foam

- Wood resources exposed to foam fire chemicals should be rinsed with distilled or deionized water using the rinsing method described above. Foam fire chemicals can be removed easily with distilled or deionized water. Use the same spray and agitate method described above.

Water Enhancer

- For wood exposed to water enhancers, rinsing is the best option for cleaning.
- If water enhancers remain on small areas of wooden cultural resources after repeated rinsing, use of a poultice may be appropriate. A poultice is a wet material applied to a surface and left for a specified period. A diluted chemical solvent, such as D-Limonene, could be used with shredded cotton linter to form a poultice. This cleaning method is recommended for small problem areas. Attempting to clean an entire wooden resource with a poultice could become time consuming. The ratios provided below create enough poultice to cover about 16 square inches.

Top: Wood exposed to an uncolored water enhancer has a tide line and light stain. (Kaitlyn Eldredge, NPS)

Bottom: After wetting the area where the light stain was, the water enhancer has swelled above the wood surface. (Kaitlyn Eldredge, NPS)

- Prepare the poultice:
  - Using a quarter gallon (4 cups) of distilled or deionized water, mix in 3.2 fluid ounces of solvent concentrate.
  - Shred 95 grams of cotton linter into a fine and fluffy texture, you will need a total of 13 ¾ cups of shredded linter (not packed down).
  - Mix the diluted solvent with the linter to make a wet pulp.

- Apply the poultice:
  - Before applying the poultice, thoroughly wet the surface of the wood with distilled or deionized water.
  - Place the mixed poultice onto the area to be cleaned so that the poultice forms a 0.4 inch (1 cm) thick layer on the wood.
  - Cover the poultice with saran wrap and secure the edges with painter's tape so no air can enter. To be effective the poultice needs to remain wet while on the wood.
- Remove the poultice:
  - After leaving the poultice for 1-2 hours, carefully remove the cellophane.
  - If the poultice has dried it may resist falling off the wood. In this case, proceed to rinsing. Do not attempt to brush or pick off the remaining poultice.
  - Thoroughly rinse the surface of wood to remove excess poultice and the chemical cleaner.

CONCLUSION

Wildland fires pose many threats to cultural resources. When threats come from wildfire suppression actions like the application of fire chemicals, cleaning a cultural resource helps protect it from further degradation. The removal of fire chemicals is a necessary step in preserving cultural resources as markers of specific places and time.

Comparison of a brick wall before and after cleaning to remove Phos-Chek MVP-Fx (Kaitlyn Eldredge, NPS)

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ABOUT NCPTT

The National Center for Preservation Technology and Training (NCPTT) is the leading research, technology and training center within the National Park Service.

NCPTT helps preservationists find better tools, better materials, and better approaches to conserving historic buildings and landscapes, archaeological sites, and museum collections. It conducts research and testing in its laboratories, provides cutting edge training around the U.S., and supports research and training projects at universities and nonprofits. NCPTT pushes the envelope of current preservation practice by exploring advances in science and technology in other fields and applying them to issues in cultural resource management.

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