



A Consumer Guide for the Recovery of Water-Damaged Traditional and Digital Prints

Created by Image Permanence Institute with support from Creative Memories

Disasters caused by fire and water threaten the preservation of photographic prints. Fire often results in the complete destruction of photographs, with no chance of recovery.¹ The only practical way to reduce the chances of fire loss is to equip the storage area with adequate fire protection, such as sprinklers, or to store records in fire-protection safes. Water damage is another story and is the focus of this publication.

Problems caused by water are fairly common. They may result from relatively minor disasters like spills, leaky roofs, burst water pipes, plumbing leaks, and sewer backups. They also may result from major disasters, such as extinguishing a fire, a broken water main, earthquake, and flood.

When a home is flooded, many problems must be addressed, such as the removal of possible health hazards, home cleanup, utilities restoration, and the like. These are discussed in some detail in an American Red Cross publication, *Repairing Your Flooded Home*.³ Recovery of water-damaged papers, books, and photographs is another important concern. These materials can sometimes be saved by taking prompt and appropriate action.

PREVENTING WATER DAMAGE

Because water damage to photo albums is likely to be catastrophic, the best defense is prevention. Strategies include the use of appropriate printing technologies, journaling supplies, and album materials; the creation of image file backups or duplicate prints; and the selection of proper storage locations within the home.

The Right Storage Materials

Store photographs in enclosures made from materials that conform to ISO Standard 18902.² Meeting this standard doesn't mean that the materials themselves are flood-resistant. It does mean that they will not be chemically reactive with enclosed photos, even when wet. Use journaling pens and colored papers that are made with pigment colorants and that are waterproof, so their colors will not bleed onto prints.

Duplicates

Keep backup images in a separate location. Having backups in the form of original negatives or on electronic storage media such as CD-Rs is important.

Storage Location

Determining a storage location for your albums is simple. In general, if an area in your home feels comfortable year round, then it will be comfortable for your albums. Don't store albums and photographs under water pipes or directly on the floor. Closed cabinets may offer more protection than open shelving. Never store your photos in the basement. Even if your basement feels dry, water will collect there first in a major water emergency. If you live in a flood-risk area, have a general flood response plan that includes your photos and albums. This may simply mean keeping your photos and albums on high shelves or on the second floor of your home. During a flood watch, move valuables to higher areas of the house.

GENERAL RECOMMENDATIONS

While there has been considerable experience with the salvage of photographic prints and paper, little has been reported regarding the salvage of digital prints. Some water-damaged digital prints from home computer printers or commercial photofinishers behave very differently from traditional photographic prints. Recent laboratory investigations at the Image Permanence Institute have shed some light on the relative susceptibility to water damage of ink jet, dye diffusion, and traditional photographic prints and on their recovery. What was learned from these investigations can provide general guidance for the home consumer but should not be taken as definitive for all products and circumstances. Regardless of the nature of the print, the following basic rules apply.⁴⁻¹¹

■ Start Treatment as Soon as Possible

This is the most important action you can take. The longer prints remain wet, the more susceptible they will be to permanent damage. Delay may result in loss or blurring of the image as well as disintegration of the paper support. Mold is a major concern if prints remain wet for more than two or three days.^{12,13} Mold eventually will destroy all pictorial information. If mold is already present, dry the material before further treatment. (See

drying options, starting on p. 4.) Mold removal must be complete and must be done with care, since some molds are toxic and can be health hazards. Mold removal is best done by an expert, but it may be costly. If professional treatment is too expensive, consider discarding the prints.

■ Remove Dirt First

When a flood or other dirty water has caused the damage, it is important to remove dirt and debris first.¹⁴ This is not always easy, and it may involve some trial and error. Clean the prints while they are still wet. If they are allowed to dry, dirt particles may become permanently embedded in them. First, try submerging the dirty prints in cold, clean water. Gentle agitation may be helpful. If this doesn't remove all of the dirt, gently dab or rub the image with a damp cotton ball or a soft cloth. Do this carefully. The image layer may be fragile and may be damaged by vigorous rubbing. It's a good idea to first test this treatment on a less important print of the same type to see what might happen. If possible, use distilled or purified water for the final rinse. Bottled distilled water is sold in most supermarkets.

■ Handle Materials with Care

Because wet prints are fragile and easily torn, handle them very gently, preferably supporting them on the non-image side.

WATER DAMAGE OF PRINTS

Test albums containing five types of print were immersed in river water containing suspended dirt particles for periods ranging from several minutes to one day. Prints were mounted on album pages both with and without plastic page protectors. Prints mounted on pages without page protectors faced either plastic page protectors or pages containing identical prints. After the albums were taken from the water, the prints were examined for damage, and different drying methods were tested. The effect of the plastic page protectors also was observed.

Traditional photographic prints are fairly stable in water. Dye diffusion thermal transfer prints (see p. 3) are the most robust of the digital prints and show almost no damage after immersion. Some types of digital print are completely destroyed when they become wet, while some are more water-resistant. Other types of print stick to adjacent prints or contacting surfaces when wet.

In general, prints immersed in water for one hour show the same effects as prints immersed for one day. Prints that are in water for only a few minutes show much less damage than prints left in the water for longer periods. However, dye-based ink jet images show serious degradation after even short immersion times.

Plastic page protectors prevent water from damaging the entire print during brief immersions, although the edges of the print become wet. Plastic page protectors also provide excellent resistance to spills.

■ Traditional Photographic Prints

Black-and-white heritage photographic prints consist of a metallic silver image within a gelatin layer. When properly processed and stored, these are the most stable images available. They are also very resistant to water damage. Even after a day in water, silver images show no discernible change. A slight discoloration in white



Color photographic test print, after being immersed in water and air-dried.

or highlight areas can occur, however, and there can be other problems as well. If a black-and-white print is in contact with another print on an adjacent page in an album, the two may stick together. Another significant problem is the waviness and distortion of black-and-white prints after they dry. More recent black-and-white prints are typically printed on a resin-coated base and should be treated in the same way as color photographic prints.

Color photographic prints are similar to black-and-white prints, except that the image in color prints consists of dyes within the gelatin layer. When wet, color prints behave in

much the same way as black-and-white prints, but they show less distortion after they dry. Because color prints have a plastic layer between the image and the paper, they are less likely than black-and-white prints to become discolored in the white areas. A wet color print, like a black-and-white print, will stick to an adjacent print.

■ Dye Diffusion Thermal Transfer Prints

This process differs from traditional photography in that heat transfers the dye image from a donor ribbon to the paper support. These prints may be produced at photo kiosks or on some home color photo printers. The prints are generally quite resistant to water damage, but if they are immersed for more than a day, slight image transfer to an adjacent print may occur. After drying, these prints show some distortion, but it is generally less severe than that observed in traditional photographic prints.

■ Ink Jet Prints

This is the most common technology employed by home photo-quality printers. There are several types of ink jet print available, differing in the nature of the colorants and the characteristics of the papers used. There are two types of colorant: dyes, such as those used in water-soluble food coloring, and pigments, which are the colorants typically used in paints. Regular uncoated paper and coated papers are available. Coated paper can be either *swellable* or *microporous*. Swellable paper features a layer that can absorb moisture and thus absorb the water-soluble dye that forms the image. Microporous paper has a surface of very small inert particles, and the colorants are deposited in the numerous cavities between them.

Dye images on swellable paper are severely damaged by immersion in water, even if the immersion time is very short. The dyes will bleed into adjacent areas on the print surface and will transfer to other surfaces with which they have contact. The prints usually are severely distorted after they dry.

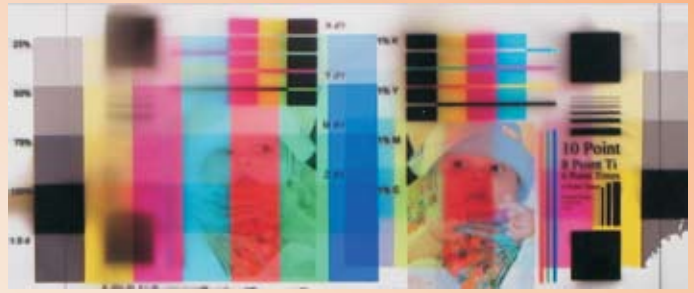
Dye images on microporous paper also are badly damaged by water immersion, but in a different way. The dyes in these images also bleed, but, in addition, large areas of the image flake off. Flaking is particularly severe when there is contact between two image surfaces, as in an album. Distortion of prints on microporous paper is similar to that on swellable paper.

Pigment images on microporous paper are also susceptible to water damage, although the extent of damage varies from paper to paper, depending on the manufacturer. These images flake off when only lightly rubbed or when physically separated from an adjacent print, but the colors do not bleed.

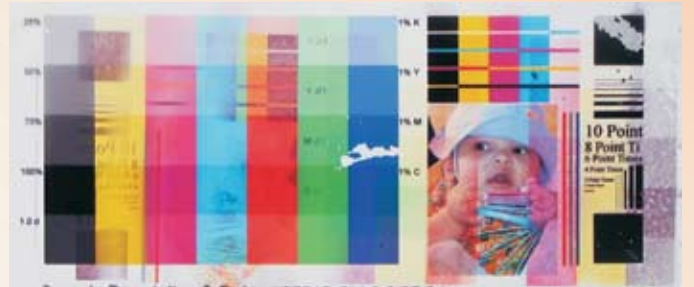
WATER DAMAGE OF ALBUMS

Albums not only protect prints, they also make it easier to organize and view them. However, many problems can occur when the entire album becomes wet. If an album has been wet for only a few minutes, it may be saved, but this depends on its materials and construction.

Water damage to some albums can be very severe. Frequently, the album cover will come loose and lose its shape, or it may simply disintegrate. The outer layer



Ink jet dye print on swellable paper, after immersion in water and air-drying. Dye bleeding can be seen, as well as image transfer resulting from contact with a similar image on the facing album page. A portion of the transferred image (lower right) was lifted off when the facing prints were pulled apart.



Ink jet dye print on microporous paper, after immersion in water and blotter-drying. Some flaking, dye bleeding, and image transfer are evident.



Ink jet pigment print on microporous paper, after immersion in water and blotter-drying. Flaking of image can be seen. Image shows no dye bleeding.

IDENTIFICATION OF INK JET PAPERS

- **Uncoated paper** does not produce photo-quality prints. It may have blurred images and loss of color intensity.
- **Swellable paper** generally has a high gloss and feels smooth. A water droplet on dry paper will be absorbed and the paper will feel slippery.
- **Porous paper** feels slightly sticky. A water droplet on dry paper will cause little change in the paper surface. May be advertised as "rapid-drying."



Water-soaked album showing cover damage.



Water-soaked album showing cover damage and page distortion.

of fabric, plastic, paper, or leather may separate from the cover's cardboard core. The adhesive securing the pages within the album cover may dissolve.

Although some pens used for labeling and journaling are water-resistant, many are water-soluble and will run, causing identifying information to be lost and possibly damaging the prints. Dyes from

the cover, embellishments, or memorabilia also may bleed and discolor the prints. When albums have been flooded by cloudy or dirty water, sediment can collect between the pages.

Other problems associated with wet albums are possible image transfer and the sticking together of prints mounted on facing pages.

While page protectors facilitate the handling of album pages and prevent damage from spilled liquids, they can cause problems when the entire album becomes wet. Sediment can become embedded between the prints and the page protector. In addition, prints—ink jet prints in particular—may stick to the protector. Page protectors do not protect the prints from water contact when the immersion time is longer than about one hour, but they do provide some protection for immersions of a few minutes.

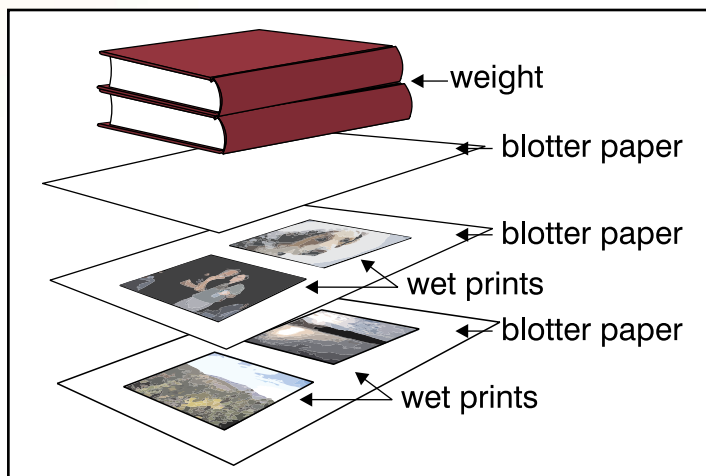
DRYING OF UNMOUNTED PRINTS

Album storage is recommended for optimum preservation of photographs and digital images. Still, many consumers keep their prints in paper envelopes or shoeboxes. Serious problems may result when these enclosures and the prints within them become wet. Prints that are stacked or are otherwise in close contact are likely to stick to each other when they become wet. This is especially serious when the prints are packed tightly together, and it is a greater problem for glossy prints and ink jet prints than for other types.

It is important to separate stacked prints *before* they dry. Allowed to dry, the prints may be permanently stuck together. If time or circumstances make it impossible to separate stacked prints, place the prints, while they are still wet, in plastic bags and freeze them (see p. 6). If a print stack already has dried, soak it in water before attempting to separate the prints. Prints should be restacked only after they are completely dry and are no longer tacky to the touch.

■ Blotting

The recommended procedure for drying black-and-white photographic prints, dye diffusion thermal transfer prints, and ink jet prints on microporous paper is to place them between sheets of blotting paper under uniform pressure.



Black-and-white photographic prints, dye diffusion transfer prints, and ink jet prints on microporous paper may be dried and flattened between sheets of blotter paper with a weight placed on top.

This dries the prints and flattens them as well. Blotting paper can be obtained at an office supply store. You may use non-textured paper toweling as an alternative to blotting paper, but it does not have the same water-absorption capacity. (Note: The pattern from a heavily textured paper towel may transfer to the print.) When the blotting paper becomes saturated with water, it must be replaced. If drying space is limited, prints can be interleaved with blotting paper and dried in stacks. Remember, however, that some color photographic prints and ink jet dye prints on swellable paper will stick to other surfaces and should not be dried in stacks, even with blotting-paper interleaving. Air drying is recommended for these prints (see below).

■ Air Drying

Air drying can be used for all print types if interleaving isn't appropriate or can't be done immediately. This drying procedure is the least likely to do any damage.¹⁵ However, prints dried in this way will display cockling, wrinkling, and distortion. To air dry prints, first drain off any excess water. You can carefully blot color photographs to remove excess water. If ink jet dye prints on swellable paper must be blotted, do it very gently on the non-image side only, remembering that touching the wet image may damage it. Lay prints flat with the image side up. Allowing air to reach both surfaces of the prints will accelerate drying. You can do this by placing the prints on screening material (available at most hardware stores) fastened to a simple homemade frame. Use plastic or aluminum screening to avoid rust stains. A plastic or aluminum window screen would work as well. Using a fan to create air movement will further speed print drying, but don't aim the fan directly at the prints to avoid blowing them about. Since mold will grow if prints remain damp, air drying should be done in a relatively dry environment.

DRYING OF MOUNTED PRINTS

Prints mounted in albums should be removed and dried separately. If prints are dried while fastened to album pages, cockling of the album pages themselves will further distort the prints. Prints are easily removed from albums if water-soluble adhesives were used to mount them. Water-soluble adhesives can present a problem, however. Prints that have become unglued from the pages may move about in the album, becoming disorganized and, in some cases, separated from important identifying information. If the adhesive used is not water-soluble, prints may be damaged upon removal. Commercial adhesive removers can be used in such cases, but these products may be toxic and flammable. They should only be used outdoors or in well-ventilated areas.

In cases where salvage of the album page is important because of identification information or other attached mementos, less page distortion may result if the prints are first removed, dried separately, and then remounted. If the only reason for salvaging the album pages is to retain the information written on them, it is usually best to cut the pages from the album and air dry them. You can then transfer the information to a new album and discard the damaged pages.

Water spilled on album pages and/or prints presents much less of a problem than complete immersion. Spills usually can be removed with blotting paper or non-textured paper toweling. Apply uniform pressure when blotting to avoid distorting the prints.

DRYING OF ALBUMS

Drying of entire albums can be very problematic and should be attempted only if the album itself is of significant historical or sentimental value.

If you wish to save the album, disassemble it if possible. Prints on facing pages must be separated with great care. Ink jet images may flake off. If the materials have even partially dried, separating them without causing damage can be very difficult. If the album is kept intact, the pages may stick together as it dries. After disassembly, you can air dry the pages and then reassemble the album. Removing any mounted prints will reduce distortion of the album pages. If the prints are left in place, blotting paper can be used for pages containing black-and-white photographic prints, dye diffusion thermal transfer prints, or ink jet prints on microporous paper. The album cover presents an additional problem. In general, covers are relatively thick and, when water-soaked, require a long drying time.

Page protectors should be removed from the album pages as soon as possible after the album has been taken

from the water. If left in place, the page protectors will slow the drying process, and after several days mold will grow on the wet prints.

If the album cannot be disassembled, insert sheets of blotting paper between the pages. This drying method is very slow, increasing the risk of mold growth. Because the blotting paper must be replaced after it becomes wet, it is also labor-intensive and requires close attention. A further drawback is that the added thickness of the blotting paper increases album distortion.

PRINT RECOVERY DON'Ts

- Don't dry prints while they are still mounted to album pages, if it is possible to remove them.
- Don't allow stacked prints to dry, even partially, before trying to separate them.
- Don't attempt to clean, flatten, or apply any treatment without first testing on less important prints.
- Don't use a microwave oven to dry prints.
- Don't use hot air to dry prints, pages, or albums.
- Don't use a steam iron to flatten prints.
- Don't thaw frozen prints inside a closed plastic bag.

Drying of entire albums is extremely difficult and generally does not give a satisfactory result. A more attractive option would be to remount flattened prints in new albums.

■ Microwave Drying

While drying photographs in a specially designed microwave oven has been suggested as a possible option,¹⁶ it is not recommended for the home consumer. If there are water droplets on the surface of the print, they can cause blisters to form. The presence of staples, metal fasteners, or eyelets can cause a fire or damage the microwave unit. Plastic mementos may melt or become distorted.

■ Hot Air Drying

A hair dryer or space heater may dry prints or album pages unevenly or overdry them. This will increase cockling and distortion. Overdrying may also cause blistering. This technique is discouraged.

FREEZING

Freezing wet prints is recommended when immediate drying is not possible. As previously mentioned, prints that remain wet are susceptible to further damage and will eventually be destroyed by mold. If the number of wet albums or prints is so large that proper drying procedures cannot be started within 48 hours, or if there are other constraints, the wet materials may be frozen in plastic bags and later thawed and dried when time and facilities permit.^{17,18} A regular home freezer can be used for this purpose. Before thawing the materials, remove them from the plastic bags to prevent mold growth. Prints can be kept in a frozen state for a long time. Prints in stacks or in close contact need not be separated prior to freezing. This procedure does have some potential drawbacks. Plastic page protectors must be removed before freezing to keep them from sticking to some types of print material. Contact between prints and page protectors also can cause a change in the surface gloss of dye diffusion thermal transfer prints, although this change is preferable to the damage that can result from prolonged wetting.

PRINT FLATTENING

Curl or distortion is generally a problem when wet paper prints are air dried. Such prints may require flattening. Wet prints that are dried under pressure will be relatively flat. This procedure can be used for traditional black-white-prints, dye diffusion transfer prints, and ink jet prints on microporous paper, but not for color photographic prints and ink jet prints on swellable paper, which will stick to the materials used to apply pressure. Color photographic prints and dye diffusion thermal transfer prints can be flattened after they have been dried by placing them under a heavy weight for several days. This is not effective for other materials. It is possible to reduce distortion of heritage black-and-white photographic prints by lightly brushing water on the non-image side or by placing them in a humid environment, which can be created by running a vaporizer in a small room. The moistened prints may then be dried flat under pressure. This method can be used with marginal success for ink jet prints on microporous paper but not for those on swellable paper.

Another technique that has been suggested is heating prints with a steam iron, but this is not recommended. Applying too-high heat or applying heat for too long can further damage prints.

Test the flattening procedure you decide to use on a few less important prints first, to determine whether it will work for the rest.

SUMMARY OF OPTIONS

Recovery of water-soaked albums is generally not an option. Prints should first be removed from the pages. Several approaches can then be used to dry the wet prints.

■ Blotting Paper

Place wet prints between sheets of blotting paper under uniform pressure. This eliminates or minimizes print distortion. Because prints can be stacked using this method, it does not require a large drying area. If the blotting paper becomes saturated, it should be replaced. This can be labor-intensive. This method is not appropriate for color photographic prints or ink jet dye prints on swellable paper.

■ Air Drying

This treatment is appropriate for color photographic and ink jet dye prints on swellable paper. It can also be used as a temporary and immediate procedure for other types of print if they cannot immediately be interleaved with blotting paper. This is the most benign treatment, the easiest to apply, and the one that is least likely to do further damage. When air drying prints other than ink jet dye prints on swellable paper, use blotting paper to gently remove the surface water. Air drying a large number of prints requires a large treatment area. This method may result in print cockling and distortion.

■ Freezing

This should be used when the number of wet prints is so large that drying cannot be started within 48 hours. Fortunately, further degradation and mold growth are arrested at freezing temperatures. Freezing buys time until prints can be properly washed and dried. While freezing involves more handling than the other methods and requires a freezer, it may be the only practical option in some cases.

FACTORS TO CONSIDER

Because successful salvage of water-damaged prints depends upon the specific situation, it isn't possible to recommend exact, universal procedures that should always be followed. Consider the following critical factors before beginning the salvage operation.

1. *Availability of replacement prints.* First, determine if new prints can be made, either from the original negative or from a digital file. This would save labor and would result in a more satisfactory print.
2. *Time constraints.* If the number of damaged albums or prints is so great that they cannot all be treated within 48 hours, or if there are other constraints that prevent quick treatment, the wet materials should be frozen until salvage can be started.
3. *Extent of damage.* Contaminated or soiled prints must be washed before they are dried and before any salvage activities begin. If they are not saturated with water but are wet only at the edges, it may be possible to employ relatively mild drying techniques such as air drying.
4. *Storage mode.* Prints stored in boxes or envelopes must be immediately separated and then washed (if necessary) and dried using either the blotter-paper or air drying technique.
5. *Print removal.* If the prints were mounted in the album, they should be removed from the pages before drying to prevent additional print distortion.
6. *Types of print.* Traditional photographic, dye diffusion thermal transfer, and pigment ink jet images can withstand considerable water exposure. However, ink jet materials featuring dye images are very susceptible to damage. You will have to decide if enough image remains to justify a time-consuming salvage operation or if the prints should be discarded. Color photographic prints and ink jet dye prints on swellable paper should be air dried with nothing touching the image surface. Black-and-white photographic, dye diffusion thermal transfer, and ink jet images on microporous paper should be dried between blotting paper under uniform pressure.
7. *Optimum result.* Generally, the most satisfactory result will be obtained if water-damaged prints are removed, dried, flattened, and then remounted in new albums.

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