Fort Union National Monument

National Park Service
U.S. Department of the Interior

UNDERSTANDING THE DETERIORATION OF ADOBE WALLS

WHY IS THIS STUDY IMPORTANT?

Construction began in 1863 on the adobe buildings of Fort Union, which housed a military post and supply depot along the Santa Fe Trail. At the time of the initial construction, tight military budgets prevented proper maintenance and repair. By 1887 walls were already eroded and cracked. The U.S. Army abandoned the fort in 1891. Until Fort Union National Monument was established in 1954, the adobe buildings stood exposed to the harsh weather of the high plains of eastern New Mexico. Thanks to intensive stabilization and annual maintenance, the rate of deterioration has slowed since then, but erosion and deterioration of the earthen walls and brick and stone elements continues.

Past research at Fort Union, which contains the largest concentration of adobe ruins in the United States, has provided a general understanding of why the ruins have deteriorated to their present configuration. However, no research had been done to establish either the rate of deterioration or where the worst deterioration can be expected to occur. Because of this, preservation of the ruins has proceeded in a reactive manner, as adobe walls collapse, rather than in a proactive manner, guided by a real understanding of the location and rate of deterioration. Only with knowledge can we design interventions to counteract the effects of the environment and prolong the life of these important cultural artifacts.

WHAT WERE THE PROJECT GOALS?

The goals of the project were to:

- use historic and contemporary photographs to create a series of scaled images documenting the transformation of adobe wall elevations from intact walls to a series of fragments
- calculate the total rate of adobe loss and the rate of adobe loss from erosion using the scaled images
- make observations about deterioration through time, not only across the entire wall elevation but at specific features, which appear to deteriorate at different rates—corners, window sills and jambs, wall tops—and calculate average rates of loss from these areas
- establish the present dimensions of walls in cross section by taking extensive field measurements, and create graphic images to illustrate their appearance
- assess the relative impact of variables that are believed to affect the rate of adobe deterioration (including original wall thickness, orientation, exposure, height above ground, and repairs) by comparing loss from localized areas of walls (including wall bases, wall tops, sills, and lintels)
- interpret the results of the above research to identify which walls, or which areas of walls, are most vulnerable to deterioration and why.

HOW WERE THE RUINS STUDIED?

Changes in walls, both in elevation and in cross section, were documented. Photographs can be used to illustrate changes in elevation area and calculate the rate of loss through time for the elevations of walls. This is essentially a measure of loss in two dimensions, height and length. To understand these changes, walls were selected for study with adequate photographic documentation. Images were culled from occupation-era photographs, photographs taken by tourists between 1925 and the 1950s, and official photographs taken between 1968 and 1998. Photographs were scanned electronically to create composite images. Special computer software allowed researchers to diminish the differences in perspectives between the photographs to accurately track changes.

It is more difficult to calculate the change in wall width (or thickness) because photographs of wall ends do not consistently or accurately represent the configuration of the wall throughout its length. Instead, extensive measurements were taken to create graphic cross

sections, depicting present wall widths at critical areas along selected walls. To illustrate the change in the walls, cross sections were superimposed upon graphic images of the walls as they probably appeared immediately after construction. The cross sections provide an accurate measure of the amount of material lost to date. They provided a better understanding of the impact of orientation and exposure on the deterioration of the walls. The cross sections also allowed researchers to document and analyze localized erosion at wall bases, wall tops, sills, and lintels.

WHAT DID WE LEARN?

The results of the research indicate that an average adobe wall at Fort Union has lost 48 percent of its original area in elevation (facing the wall). Walls with north and east exposures are at greatest risk. In fact, almost no walls that originally formed the east exterior walls of buildings have survived. Because most east exterior walls of buildings have been lost, the east interior faces of west exterior walls have become more vulnerable. Also, the upper sections of all walls are at greater risk because they are more exposed to wind and rain.

In cross section, an average adobe wall at Fort Union is about two-thirds its original height and two-fifths its original area, assuming it still exists. If the number of entirely destroyed walls were included in these calculations the average losses would be much higher.

Rates of loss for all orientations have decreased since 1960, when the walls were first stabilized and capped with soil-cement blocks. Rates of loss prior to 1960 were more variable and usually faster, probably because wall tops were uncapped and complete collapse of large sections of walls was more common.

The rate of erosion from the elevation of an average adobe wall at Fort Union since 1960 was 0.07 percent per year. In other words, over the past 38 years the average wall has lost 2.7 percent of its area in elevation. The rate does not account for erosion in wall width, or thickness. Thus, the total amount of adobe lost to erosion is actually much greater.

It was also observed that thinner walls deteriorate more rapidly than wider walls. In support of this conclusion is the fact that almost all walls which were originally 18.0"-20.0" wide (and which originally constituted about half the walls of the Fort), have been completely lost. Most of the walls that survive today were originally about 30" wide. As they erode, walls may reach a critical width at which they become exponentially more vulnerable to environmental stresses, resulting in much more rapid deterioration and collapse.

Wall bases are particularly vulnerable to erosion due to the impact of rising damp, accumulated snow, and the weight of the walls they support above them, and often exhibit a condition called "basal erosion." The research results indicate that most sheltered and exposed wall faces exhibit the same patterns of deterioration at the wall bases, but that the wall's orientation determines how much was actually lost. Exposed north and east faces have lost the most, sheltered south and west faces have lost the least. And although wall base erosion is a prevalent condition at Fort Union, its effects have been kept in check by the repeated applications of shelter coats to the eroded areas by adobe masonry crews.

An increase in erosion is also a prevalent condition at the tops of walls, which are more exposed to the weather. This often results in a condition called "coving," where the adobe wall weathers and causes the harder cap material to protrude beyond the wall plane. This can be observed both beneath the original brick cornices and beneath the more modern soil-cement caps installed on the tops of most walls. Initially it was thought that the harder caps accelerated the erosion of the adobe, but these research results proved otherwise. In essence, the adobe walls simply continue to weather while the more durable soil-cement caps remain unchanged; the coving that has been observed is a result of increased exposure to the weather rather than of any adverse effects of the caps. Capped walls have lost no height and only some of their width over time. Case in point are the adobe walls which retain their original brick cornices: these are the only walls of full original height in the Fort. Caps reduce rather than accelerate the rate of erosion of wall tops at Fort Union, and should be maintained.

It was also observed that lintels provide some measure of protection for windowsills and jambs, and should be maintained not only for this reason but because they are critical markers in interpreting the original appearance of the buildings.

This lay report summarizes results of a research project conducted by Anne Oliver and Robert Harzler and funded by Southwest Parks and Monuments Association. The complete technical report is on file at Fort Union National Monument. Copies of this bulletin are available free of charge.

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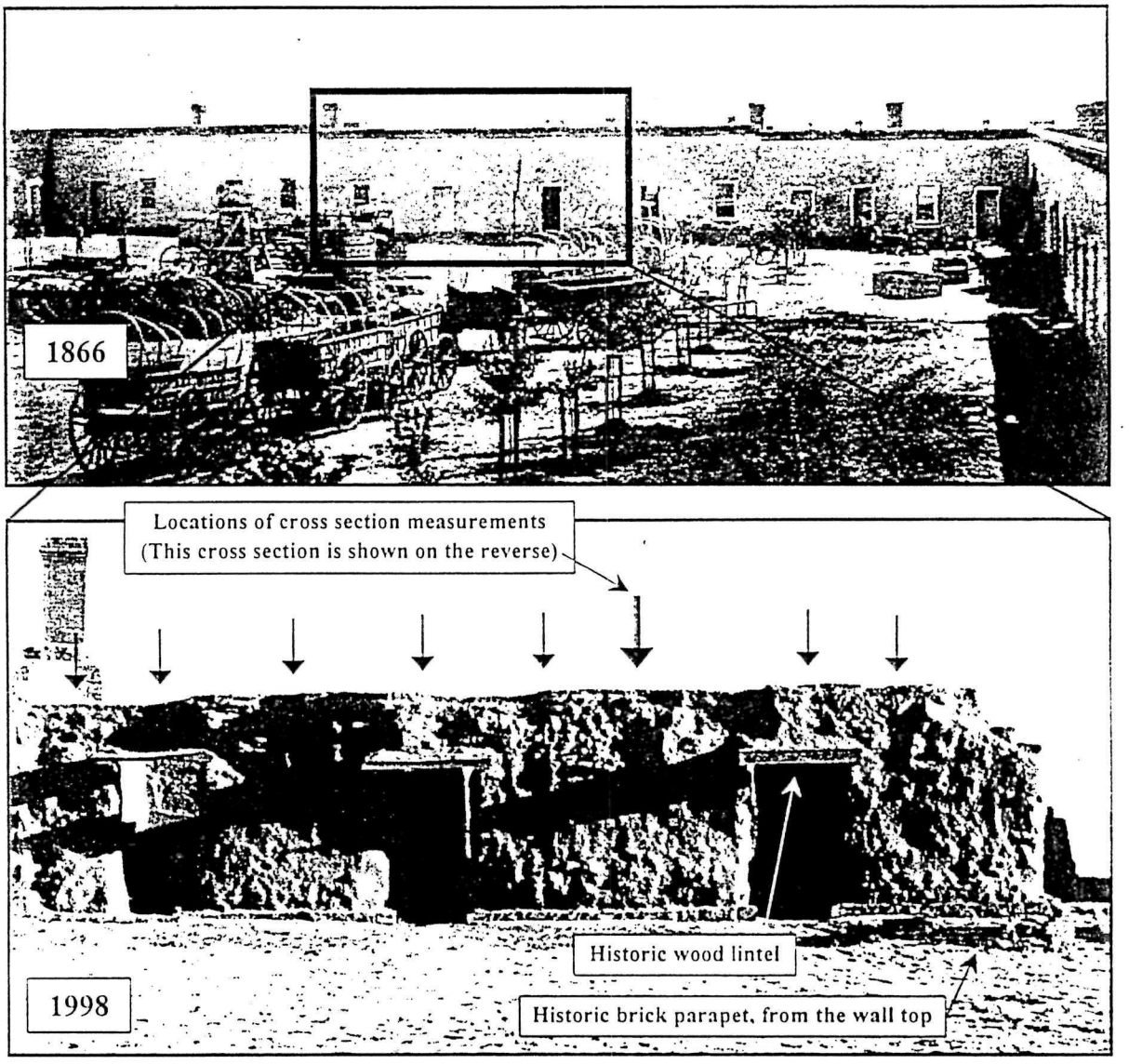
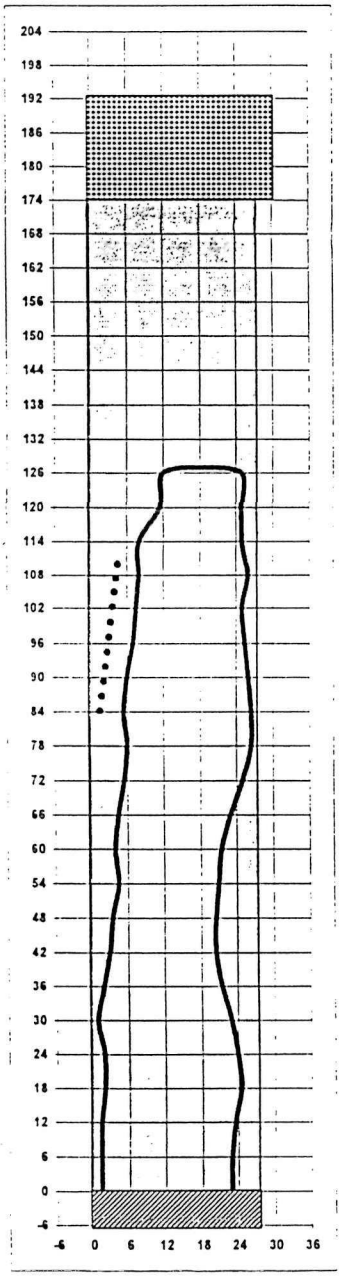


Mechanics' Corral

(Look for this wall directly in front of the audio wayside within the Mechanics' Corral.)

Part of the research project sponsored by Southwest Parks and Monuments Association was to find a way to see what an adobe wall looked like in cross section – how thick, how thin, how badly does it lean, how much is it deformed by weather and time? It's difficult to tell what's going on within a wall just by looking at one side and then the other. But by using low-tech materials such as ladders, levels, long straight edges, and measuring tapes, and slightly higher-tech computers and office software, conservators were able to draw a picture of a wall in cross section. These illustrations will allow the park to better care for the adobe ruins; to know where to add adobes, where to brace a wall, and whether or not a wall is in critical condition. And by comparing present views with historic photos, the park can begin to determine the rate of loss of adobe. On the reverse of this page is one of the 99 cross section data sheets produced as a result of the Fort Union reserch.

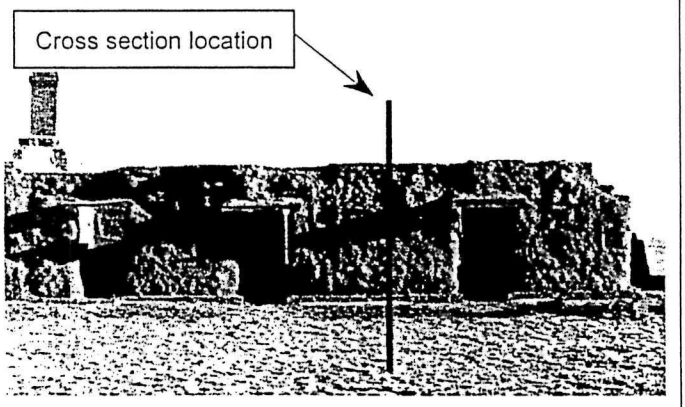
Fort Union National Monument — Adobe Wall Cross Section



Dimensions in Inches

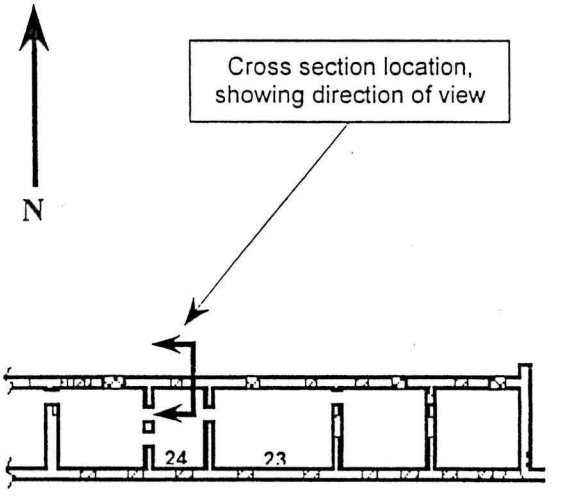
S ⟷ N

- Historic brick parapet location (approx.)
- Original adobe wall
- Stone foundation (depth not to scale)
- Present adobe wall outline
- Extent and location of remaining historic plaster
- Location of original window or door (approx.)



HS 36, Mechanics' Corral
North Elevation
(rooms 23 and 24, #6)

The heavy black line on the illustration at left shows the present cross section of the eroded adobe wall of HS 36 at the location shown on the photograph, above, and plan, below. It is overlaid on a shaded field illustrating a cross section of the original adobe wall.



- Stone foundation
- Approximate location of original window
- Approximate location of original door
- Existing adobe all