Preservation and Maintenance Manual

DART Police Headquarters at Illinois Station/Monroe Shops

February 2012

Prepared by URS Corporation

Prepared for Dallas Area Rapid Transit

General Planning Consultant Managed by URS Corporation

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EXECUTIVE SUMMARY

DART has contracted URS Corporation (URS) to prepare a Preservation and Maintenance Manual that will support the ongoing maintenance of the current headquarters of the DART Police at Monroe Shops. The headquarters is located in the historic Monroe Shops building, which is listed on the National Register of Historic Places, and is subject to review under Section 106 of the National Historic Preservation Act. Pursuant to Section 106 of the National Historic Preservation Act, Monroe Shops was the subject of Stipulation 3b of the 1993 *Amended Memorandum of Agreement* [MOA] *Among the Federal Transit Administration, the Texas State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding the South Oak Cliff Light Rail Transit Project, Dallas, Texas*. All repair and maintenance activities to date have been performed in accordance with this MOA, as well as the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (Weeks and Grimmer, 1995).

Prior to conducting maintenance or repair activities, this Preservation and Maintenance Manual should be referenced, the DART Rail Planning Department be consulted and the Texas Historical Commission (THC) should be informed on a project-by-project basis. Repair and maintenance activities that impact the character defining features of the building as listed in 1.3 Overview of Character Defining Features and Maintenance Concerns will require consultation with DART Rail Planning Department and notification of the THC. All work must be performed in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*.

This manual is prepared subsequent to the following previously written reports:

- Current and Historic Conditions: Monroe Shops, 2111 South Corinth Street, Dallas, Texas. Dobson-Brown, Deborah, Sherry N. DeFreece Emery, and Renee L. Hutter, Dallas Area Rapid Transit Technical Series Report of Investigations Number 2. Prepared for DART by LGGroup, March 2006.

- National Register of Historic Places Registration Form: Monroe Shops, Dallas, Texas. Sherry N. DeFreece Emery and Renee L. Hutter, March 2007.

- LBP Stabilization and Reduction Specifications: DART Monroe Shops. Prepared for DART by Benchmark Environmental Consultants, November 2008.

- Dallas Area Rapid Transit-Monroe Shops Police Headquarters: Existing Masonry Investigation, Dallas, Texas. HVJ Associates. Prepared for Track 3 Team, March 8, 2010.

- Preliminary Paint Analysis: Monroe Shops, 2111 South Corinth Street, Dallas, Texas. Emery, Sherry N. DeFreece and Sarah E. Brown; URS Miscellaneous Reports, Report of Investigations Number 119. Prepared for DART by URS, May 2009.

- Monroe Shops, Dallas, Texas; MOA and Secretary of the Interior's Standards Compliance, Construction Monitoring Progress. Electronic reporting on compact disc. Prepared for DART by URS; 7 December 2009, 26 February 2010, 30 July 2010, and 16 May 2011.

These reports should be referenced as needed by future project teams, and are on file with DART, as well as the Texas Historical Commission. In addition, the Construction Document Package Numbers 1-3 from the 2010-2011 renovation of Monroe Shops into the DART Police Headquarters, as well as all Change Order documents from that project should also be referenced.

This manual is intended to provide building occupants and those who may perform maintenance and repairs to the building with guidance as to important historic elements of the building, so particular care will be taken to preserve these elements and the building as a whole. This manual should be supplied to future architects, engineers, and historians that may be part of future project teams. This manual should be used in conjunction with other manuals prepared for maintenance and repair of the Monroe Shops building, and is not intended to supersede other maintenance procedures. The maintenance checklist should be utilized annually to assess specific and overall conditions of the building.

Recommendations in this manual are based on building conditions at the time of the production of this document, as well as the GPC's knowledge of and experience with Monroe Shops. The goals and objectives of this manual are to provide DART with:

- Identification of character-defining historic elements and materials of the Monroe Shops building
- A maintenance timeline
- A checklist for annual inspection
- Basic guidelines regarding the treatment of the building, in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (Weeks and Grimmer, 1995).

ACKNOWLEDGMENTS

URS Corporation would like to acknowledge those who contributed to all aspects of the stabilization, rehabilitation and adaptive reuse of Monroe Shops relating to the 1993 Memorandum of Agreement 3(b) and Section 106. Sherry N. DeFreece Emery, Erica L. Howard, and Kate Singleton conducted background research, conditions and materials assessments, and construction monitoring. Preparation of the manual was conducted by Ms. Emery, Ms. Singleton and Deborah Dobson-Brown.

URS Corporation would like to thank the staff of the Texas Historical Commission for their input and guidance on this project.

URS Corporation would also like to acknowledge Steve Salin, Ron Maddox and Steve Bourn, DART, for their assistance with this project.

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ACRONYMS

DART- Dallas Area Rapid Transit

DMN- Dallas Morning News

MOA- Memorandum of Agreement

NHPA- National Historic Preservation Act of 1966

NRHP- National Register of Historic Places

SHPO- State Historic Preservation Officer

THC- Texas Historical Commission

THSA- Texas Historic Sites Atlas

TSHA- Texas State Historical Association

USGS- United States Geological Survey

1.0 INTRODUCTION

1.1 Objectives and Methodology

The general objective of the preservation and maintenance manual is to offer guidance on how the historic character defining features within the DART Police Headquarters/Monroe Shops may be maintained in such a way as to preserve and/or restore historic integrity to the maximum extent that is practicable. The entire manual seeks to address three issues about each character defining feature: significance; integrity; and maintenance needs. Significance is the historical importance of the character defining element, i.e., why it deserves preservation. Integrity is the historical authenticity of the resources, i.e., what about it is historical and what is of more modern origin. Maintenance needs are simply perceived problems with a building and/or character defining elements which need to be addressed to preserve, not only the historic value but the structural integrity of the building.

Recommendations in this manual are based on building conditions at the time of the production of this document, as well as the GPC's knowledge of and experience with Monroe Shops. The goals and objectives of this manual are to provide DART with:

- Identification of character-defining historic elements and materials of the Monroe Shops building;
- A checklist for annual inspection; and
- Basic guidelines regarding the treatment of the building, in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties (Weeks and Grimmer, 1995).

The Secretary of Interior has set standards and guidelines for:

- Preservation: the process of applying measures necessary to sustain the existing form, integrity, and materials of a historic property;
- Rehabilitation: the process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values;
- Restoration: the process of accurately depicting the form, features and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period; and
- Reconstruction: the process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location [Weeks, Kay and Anne E. Grimmer, 1995].

For purposes of this report, rehabilitation and preservation will be the main standards.

1.2 History of Monroe Shops

1.2.1 The Texas Electric Railway[1]

Monroe Shops was constructed in 1914 as the repair shops for the Texas Electric Railway, one of the primary interurban systems in Dallas. The Texas Electric Railway, at one time the longest interurban railway west of the Mississippi River, officially operated from 1917 until 1948. It provided both passenger and freight service to North Central Texas. Centered in Dallas, the Interurban line, as it was known, serviced 226 miles of track along three lines; these went to Denison and Sherman, Ennis and Corsicana, and to Hillsboro and Waco, bringing buyers to Dallas markets and transporting workers to downtown (Spurr 2001; Solamillo 1999: item 13, page 1).

The Texas Electric Railway was part of the state of Texas's 500-mile electric interurban railway industry. Most of the track was in place by 1913, supplementing the need for passenger service between cities and larger towns that were inaccessible by steam railroad (TSHA 2005a). In addition to passenger and freight service, the rail provided streetcar service to surrounding towns. Streetcar tracks were used to reach the downtown Dallas terminal at 1316 Commerce Street, and this detail was detrimental to the success of the Interurban. The use of streetcar rails prevented the use of freight cars once the Texas Electric began to develop a carload freight business in 1928 (Dallas Public Library 1992:140-141).

The use of the Interurban system in Dallas peaked in the 1920s when 250 local and limited interurban cars passed through the Interurban Terminal. Ridership declined during this period, however as the affordability of the personal automobile increased. In 1921 the Texas Electric lost $500,000.00. To help recover the losses in ridership the line began transporting freight and offering mail service, and by offering express cars and parlor cars, but this did not have the necessary effect, and by the late 1920s the company annually lost over $1,000,000.00 (Myers 1982:61, 80; Solamillo 1999: item 13, page 9). After the stock market crash of 1929 and the ensuing depression that followed until 1933, the Texas Electric Railway's income decreased further and passenger figures continued to decrease. The company went into receivership in 1931, and in 1936 sold their electric generating facilities and became the Texas Electric Railway Company (Brewer 1989:11; Dallas Public Library 1992:140-141). Business slowed even more on the Interurban in the early 1940s, and in 1941 the Corsicana branch was abandoned (Myers 1982: 95). The rest of the system operated through World War II, which with the resulting rationing of gasoline had a positive effect on the Interurban. By 1942, however, the Texas Electric Railway was the only independent interurban line still operating in Texas. With an increase in bus travel and automobile traffic, the use of the Interurban continued to decline until it made its final run on 31 December 1948 (TSHA 2005b). The Interurban Terminal was converted to a union bus terminal (Solamillo 1999: item 13, page 10) while Monroe Shops participated in converting many of the Texas Electric cars to scrap (Myers 1982:113).

[1] This history is an adaptation of the application for nomination of Monroe Shops to the National Register of Historic Places (NRHP) (Emery and Hutter, 2006).

1.2.2 The Construction of Monroe Shops and the Development of the Trinity Heights Neighborhood

In addition to the railroad lines and the Interurban stations, repair shops were necessarily constructed to house the daily operations of repairing and maintaining the electric railroad cars. Monroe Shops, completed in 1914, was built to serve the Southern Traction Company and Strickland's Texas Traction Company, predecessors to the Texas Electric Railway. The shops were located at the junction of the Waco and Corsicana lines, four miles south of Dallas (Varney 1988: 15). The location was at an elevation that commanded a panoramic view of Dallas, Oak Cliff and the surrounding area (DMN 1913a). Monroe Shops was designed to employ one hundred to two hundred men and was the site of all heavy general repair work (DMN 1913b; Varney 1988; 15).

The property in which the Monroe shops were built is part of the C.M. Miller survey, Abstract 882. The land was granted to C.M. Miller by the state of Texas in July of 1857 (DCC July 28, 1984: (F)20). C.M. Miller sold the land to T.W. Atwood in June of 1889. Atwood died in 1899 and left the land to his wife Mary Atwood. By 1911 Dallas Southern Traction Company (later to become Texas Electric Railway) acquired a trust deed worth $2 million that included 32 miles of roadbed, stations, substations, and other property (DMN 1911a). Two years later it was announced that repair shops would be built at the intersection of the Corsicana and Waco lines where it still stands (DMN 1913c).

The Fred A. Jones Construction Company was chosen to be in charge of all construction related to the Interurban line running throughout Dallas and its suburbs, including Monroe Shops. The involvement of the Fred A. Jones Construction Company began in June 1908 when the company won the contract to construct the sixty-five miles of track from Sherman to Dallas along with the central power station, four substations, and all the associated buildings and stations (DMN 1908). After the work on the Interurban the Fred A. Jones Construction Company also had a hand in other prominent buildings in Dallas including the 1911 White Rock Reservoir and Dam, the Dallas Country Club (ca. 1912) and the 1914 Dallas City Hall (now the Municipal Building) (DMN 1911b; 1911c; and 1913d).

Monroe Shops was built south of the city of Dallas in an area known as Trinity Heights. Historically, the area surrounding Monroe Shops was mostly populated with railroad workers, many of whom worked at the shops. The railroad workers typically had low wages and subsequently, the area was dubbed “Hungry Heights” (Myers 1982:42). Prior to the shops being constructed in 1914 there was very little housing in the area. In 1913 land was being purchased by development companies with the intention of subdividing into city lots (DMN 1913e). Among them were Seay, Cranfill & Company, who purchased land south of Oak Cliff along the right-of-way of the Interurban for the purpose of creating a high-class residential district. This land near the station and shops were thought to be “a good beginning for a new suburb.” Seay, Cranfill & Company planned to lay out a system of parks, paved streets and sidewalks, gutters, and curbs in their suburb (DMN 1913c). With the initiation of the convenient Southern Traction line to Trinity Heights in 1914, the area quickly developed. Cars along Southern Traction's Oak Cliff line left downtown Dallas for Oak Cliff Junction, and as it looped through Oak Cliff it traveled along Hutchins Street, proceeded past Monroe Street to the Worsham wye, to the Zang line, to Jefferson Boulevard, and then to Oak Cliff Junction and back to downtown. The route was made possible by 1200-volt and 600-volt direct current lines, since the cars themselves were dual-voltage cars (Myers 1982:49). Texas Electric scholar Johnnie Myers (1982:49-50) states:

> With the completion of Southern Traction, Dallas was more accessible to the major corridors of population and commerce south and southeast and to the areas served by Texas Traction to the north and Northern Texas Traction to the west. Texas regulatory authorities allowed a maximum fare of three cents a mile; and while the Northern Texas Traction line to Fort Worth used the maximum on its premier runs, Southern Traction averaged a cent and a half. This low fare, coupled with several other factors such as poor roads, the infancy of the auto, the infrequency of competing steam road service, and the cleanliness of electric cars when compared to steam cars all made for optimistic profit predictions for the new interurban. Most important, the sum of these advantages gave a mobility never before enjoyed to rural people.

The street railroad companies and the interurbans that followed were vital in the development of the city of Dallas. Real estate speculation along the new and proposed lines extending from the core of the city provided opportunities for growth, and supported the idea of suburban life where a person could easily commute to work, but return home to a pleasant and calm residential community. Large sections of land in the neighborhoods that became Oak Cliff, North Dallas, South Dallas, and East Dallas were purchased for speculation; and real estate developers were often the largest promoters of the rail lines that provided improved access to the new communities and increased the property values of the houses (Solamillo 1999: item 13, page 2). In a draft of a city of Dallas Landmark Nomination Form for the Interurban Building, a 1916 issue of Texas Electric is quoted as stating:

> The great "Black Land Belt" of Texas is pierced by interurban lines running out of Dallas, this section being densely populated and almost unrivaled in fertility. The country is essentially agricultural, with "King Cotton" as the principle crop, however, large quantities of corn, wheat, oats, feed stuffs, truck products, fruits, etc. are [also] produced. Stock raising, horse raising, hog raising and poultry raising are pursued in connection with the farming. In fact, a circle drawn around Dallas includes ONE-THIRD OF THE POPULATION of the State…and producing 38 PERCENT OF THE FARM PRODUCTION…It is this prosperous, wealth-producing territory which is reached in every direction by the interurbans which run in and out of Dallas. Many industries of varied and extensive nature are located in the cities and towns. The interurban lines have done much to increase the development in this section. Suburban development in many places has been rapid and extensive, many beautiful suburban and country homes being found along the lines outside the cities of Dallas, Waco, and Fort Worth (Solamillo 1999: item 13, page 8).

Following the final run of the Texas Electric, the function of Monroe Shops changed. The ownership of Monroe Shops stayed in the hands of the Texas Electric Railway until the Flemming & Son Papermill Company took over the property between 1954 and 1958 (Bracey 1954:251; Bracey 1958:251). During the Fleming & Son period of ownership, the building became a storage facility for rolls of paper (Johnnie J. Myers, personal communication with authors, 16 March 2006).

It is unknown when the Guaranty Bank of Dallas acquired the property but they transferred the deed to the land to the U-Haul Company in March 1978 (DCC March 1, 1978:[78042]1797). The City of Dallas then obtained ownership in June 1980 (DCC June 18, 1980:[801121]4886). The property was then transferred to David Grayson in April 1984 (DCC April 5, 1984:[84069]4886). Dallas Rapid Area Transit (DART) acquired the building in April 1994 and has owned the property since that time (DCC April 13, 1994: [93072]2748).

Monroe Shops is significant for its association with the influential period of interurban railway travel in Dallas, Texas and the surrounding suburbs from 1914 to 1948. Expansion of the city was due, in part, to the existence of the Interurban. It was a unique building when constructed, as it was built on a colossal scale compared to other interurban maintenance buildings built in the country at the time. It is a significant example of a utilitarian building built with Art Deco influences. Monroe Shops is the only remaining example of an interurban railway maintenance facility in Texas. Monroe Shops, built in 1914, remains a visual reminder of the era of interurban rail travel and continues its association with that theme as light rail travel begins its resurgence in the city of Dallas.

1.2.3 Section 106 Compliance/Memorandum of Agreement for DART Projects

Pursuant to Section 106 of the National Historic Preservation Act, Monroe Shops was the subject of Stipulation 3b of the 1991 Memorandum of Agreement [MOA] Among the Federal Transit Administration, the Texas State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding the South Oak Cliff Light Rail Transit Project, Dallas, Texas. The MOA was amended in 1993. The 1993 Amended MOA stated:

> DART will take all reasonable steps to stabilize the Monroe Shops from further deterioration as soon as practicable after the acquisition, and will fund a rehabilitation report which will examine adaptive reuse opportunities for the structure… the proposed actions to stabilize the building from further deterioration/ and the rehabilitation report, including its scope of work, will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment… After the completion of the rehabilitation report, DART will take steps to market the property for adaptive reuse…

The MOA assumed that the building would be sold by DART and as part of any sales agreement, the MOA further required:

> Notification that the recipient(s) will be required to rehabilitate and maintain the property in accordance with the recommended approaches in the [Secretary of the Interior's] Standards; and…notification of the requirement of the inclusion of a preservation covenant or easement in the transfer documents that will be recorded in the County's official property records…[to] require maintenance of those aspects of the property that make it eligible for inclusion in the National Register; designate a monitoring party; and be in perpetuity.

Instead of selling Monroe Shops, DART officially acquired Monroe Shops in 1994. Prior to the acquisition and during the attempt to find a buyer, deterioration had taken place and changes had been made to the interior of the building.

Annotated History of Section 106 Preservation Efforts (Appendix A)

In 1991 DART was asked by the THC to investigate the level of effort that would be required to stabilize the building until future reuse and rehabilitation could take place. ArchiTexas prepared a Preliminary Structural Conditions Assessment and Stabilization Recommendations for Monroe Shops in April 1991. A second stabilization report was developed by Espey, Huston, and Associates.

The THC reviewed the 95% plans on March 22, 1993 (the THC had previously reviewed and commented on the 30 and 65 percent plans), and had no objections to the plans for the stabilization of Monroe Shops if certain provisions were met. In 1996 a TXDOT/ISTEA Grant funded an Adaptive Reuse/Tax Certification project for Monroe Shops.

In 1998, the THC completed a review of the rehabilitation work conducted to that date in response to an application for preservation incentive tax credits. The THC noted that during the

1996 effort, the building interior had been gutted, historic features had been removed, and historically incompatible modifications had been made during the renovation efforts that had taken place. The THC recommended:

- installation of new steel windows replicating the original steel windows
- replacement of entry doors and transoms with historically compatible units
- removal of canopies from all train openings on the north and south elevations
- removal of the canopy on the east façade
- replacement of dark green glass in doors, sidelights, and metal windows with historically compatible clear glass
- replacement of conductor heads with historically compatible units
- replacement of the new metal parapet cap with a stone or cast stone parapet cap
- removal of the modifications that obscure the open space and volume of the machine room [Historic Preservation Certification Application, Project Number TX-98-00799].

DART documented the history of the project in a letter to which the THC replied the following month, which further recommended that DART nominate the building to the National Register of Historic Places (letter, Oaks to Snoble, 4 August 1999).

Efforts to address the THC comments were begun in 2000. A consultant assessed the modifications that had taken place to date. Several mitigation measures were proposed:

- complete the repair to the masonry and mortar, and reverse the treatments that adversely affect the historic fabric
- nominate the building to the National Register of Historic Places
- prepare an exhibit that includes historic photographs of the building prior to rehabilitation
- reinstall a pair of historic fire doors that were removed and stored in the building
- remove metal coping cap and restore the historic cap or replace with historically compatible cap
- replacement of the downspout conductor heads with historically compatible units
- replace aluminum windows with historically compatible steel windows
- install historically compatible transoms
- remove at least a portion of the new mezzanine
- remove or replace canopies
- replacing the green glass with clear glass was recommended as a low priority since the different glass helps distinguish the replacement storefront openings from the original building details

- consider adding a simulated wood roof deck under the new steel deck [memorandum McCoy to Barrier, 5 February 2001].

The THC and DART discussed these items in April 2001, and the following items were agreed upon:

- wood windows – repair damage to wood windows throughout the building
- steel windows – no action other than including in painting scheme
- remove solid panels and steel pedestrian door west of the main entrance and reinstall doors with window transoms
- install additional canopy
- paint canopies a dark color to distinguish them from the historic building details
- dark green glass – no further work
- conductor heads – replace with units more closely resembling the historic units
- remove two brick bollards at the north entrance
- parapet cap – no further work
- exhibit – develop an on-site exhibit presenting the history and significance of the building and documenting the alterations
- reinstall two historic sliding fire doors
- columns in southeast room – no further work
- machine room mezzanine – no further work
- crane support beam – no further work
- repair downspout and drain tile joints [letter, Salin to Roark, 11 April 2001].

DART initiated a dialogue with THC (letter, Salin to Childs, 7 July 2004) in order to resolve the rehabilitation of Monroe Shops, which began the phase of rehabilitation efforts that were concluded in 2011.

A National Register of Historic Places Nomination form was completed for Monroe Shops in 2006. The building was formally listed on the NRHP on March 26, 2007.

A structural assessment and repair recommendations report and a lead-based paint sampling report were prepared in 2006. Lead-based paint was removed using the THC-approved dry ice blast cleaning method on the interior brick in 2008.

The remainder of the rehabilitation efforts were begun in 2010 and completed in 2011. This rehabilitation phase involved the adaptive reuse of the building for the use as the headquarters for the DART Police. All repair and maintenance activities to date have been performed in accordance with the MOA, the 11 April 2001 letter, as well as the Secretary of the Interior's Standards for the Treatment of Historic Properties (Weeks and Grimmer, 1995).

1.2.4 Adaptive Reuse Plan for Monroe Shops

The adaptive reuse plan for Monroe Shops involved its conversion from a former interurban maintenance shop into the headquarters of the DART Transit Police. As such, the rehabilitation of the building took into account a higher level of security as well as functionality. The DART Transit Police Department was founded in 1989. The department has grown to over 300 positions with a chief, two captains, five lieutenants, three civilian managers, twenty-two sergeants, officers and support staff at the time this document was written. The DART Police force functions like any other peace officers under Texas State law. As it pertains to DART and DART property, the police officers have the power to make arrests, issue citations, conduct searches and seizures, and file criminal charges. The building must accommodate the various uses defined by DART Police and function like a police facility as well as serve as a community court. For the needs of the police department the building has controlled access and secured areas. The evidence storage room must have the highest security and controlled access. Other areas used for storage of equipment and guns must also be secure. Further, to meet the needs of the police, the building must have functional workspaces for support staff, training and meeting rooms, staff offices, and break rooms. The use of the building also required areas for bicycle storage, showers and lockers and exercise facilities. It was imperative that the training and meeting rooms accommodate state of the art digital and computer technology for use by the staff. One of the meeting rooms on the first floor is also a community court.

It was the desire of DART to achieve Leadership in Energy and Environmental Design (LEED) certification. In order to achieve this, DART used a number of strategies and materials that are energy efficient and LEED compliant, while maintaining the Secretary of the Interior's Standards (Appendix D). It is important to note that Monroe Shops is a remediated brownfield site. DART chose to use an existing building next to public transportation as part of their commitment to environmental sustainability. In the rehabilitation of Monroe Shop, the following methods and materials were used to ensure long term viability of the building as well as energy efficiency:

Water Efficiency

- Water efficient faucets, shower heads, urinals, and water closets are used in the building to reduce potable water use by 44% compared to conventional plumbing fixtures. This is equivalent to saving approx. 251,912 gallons of potable water per year.

Energy & Atmosphere

- Building mechanical systems use zero chlorofluoro-carbon - based refrigerants to protect ozone layer.
- Building achieves 36% lighting power reduction by using efficient light fixtures & occupancy sensors. This strategy reduces the environmental & economic impact associated with excessive energy use.
- 98% total power demand of eligible appliances in the building is attributed to the use of Energy Star® rated equipment & appliances. This strategy reduces electricity use by reducing appliance plug loads.
- High reflectance, Energy Star® qualified, and cool roof reduces the heat island effect.

Materials & Resources

- 90% of construction waste was diverted from landfills.
- 24% (based on cost) of total value of the building materials have recycle content to reduce environmental impacts associated with virgin materials.
- 42% (based on cost) of total value of building materials are regional to reduce the environmental impacts associated with transportation & associated pollution.

Indoor Environmental Quality

- Used low emitting paints, sealants, adhesives, and carpet to provide improved levels of Indoor Air Quality.
- Furniture that meets LEED standards

Additionally, this intensive reuse required the removal of the mezzanine installed in the 1990s (other partitions and gypsum board walls installed during that time period had already been removed), and the installation of three floors and the creation of several individual rooms inside the building to accommodate the numerous functions and security requirements of the police. Other work included, but is not limited to:

- masonry repair and restoration
- cleaning of walls that tested positive for the presence of lead containing paint with carbon dioxide (dry ice) blasting
- replacement of the parapet coping with historically appropriate coping
- replacement of non-historic windows with steel windows that closely match the historic windows while providing increased energy efficiency
- replacement of non-historic storefront openings and doors with more historically appropriate and efficient units
- roof repair and restoration, and replacement of downspout headers and boots with historically appropriate units
- removal of the floor slab and installation of new floor slabs
- plaster preservation
- preservation of the historic crane support rails and beams
- preservation of historic signs
- preservation of historic metal attachments and fire doors
- installation of new HVAC systems and construction of a mechanical pit to be located north of the eastern bay

- removal of some non-historic canopies
- relocation of the historic trolley housed in the building to the new lobby space at the north end of the main bay
- installation of sign walls on the building exterior
- landscaping and hardscaping for ADA accessibility
- installation of two elevators
- removal of non-historic bollards and installation of historically appropriate bollards for protection of the police facility

All work done at Monroe Shops in association with its redevelopment was in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (Weeks and Grimmer, 1995) and was reviewed by the Texas Historical Commission.

1.3 Overview of Character Defining Features and Maintenance Concerns

During the rehabilitation of Monroe Shops, the following historic character defining features were identified. These features were identified as important by the SHPO during the coordination process for Monroe Shops (Appendix A). The preservation and in some cases, restoration, of these features were of particular importance, and will continue to be so as future maintenance is performed at the building. In the next sections of this document, their maintenance is discussed in further detail. The features are:

- historic signage on the building interior
- historic metal covered fire doors and hardware (found detached from the building when DART acquired the building, two fire doors remain and have been relocated within the building)
- historic masonry and mortar
- windows (replaced during the 2010-2011 rehabilitation)
- historic door and window openings
- parapet cap (replaced during the 2010-2011 rehabilitation)
- columns in the southeast wing (current gymnasium area)
- historic crane support beams and rails
- historic roof trusses
- historic interior plaster
- historic interior walls

Each of the following sections provides a character defining feature description, general maintenance concerns, and maintenance recommendations for each character defining feature. The online versions of the briefs are provided in the Standards and Guidelines Appendix. These documents are also available to order directly from the National Park Service.

1.4 Maintenance Checklists (Appendix C)

Annual, six-month, and regular maintenance and housekeeping checklists, located in Appendix C, have been developed as a reference tool for building occupants and/or Facilities Management personnel. These documents will serve to direct personnel in the correct means and methods for future maintaining of Monroe Shops and the building's historic materials. This maintenance checklist should be supplied to maintenance personnel, cleaning staff, building occupants as well as architects, engineers, and historians that may be part of future project teams. Completed maintenance checklists and photographs should be submitted for review to DART Facilities Management and DART Rail Planning and should be kept on-site and at the DART Rail Planning office. Additionally, the 6 month and annual maintenance checklist should be conducted by an architect and engineer who both have extensive experience with historic buildings. They should be accompanied by the DART Chief Architect, Manager Facility Services, Facility & System Engineer (director or designee), Police Manager, Rail Planning Environmental Planner, Building Engineer (TRIAD/Maintenance Contractor), and, when warranted, GPC General Planning Consultant (GPC) Architectural Historian. Photographs should be taken of features and/or areas that show deterioration or maintenance issues. The location of the feature or maintenance issue should be identified on a floor plan and detailed on the checklist. These photographs should be part of the maintenance checklists and record.

1.5 Applicable Secretary of the Interior Standards and Preservation Briefs (Appendix D)

The Secretary of the Interior Standards are the guidelines that the State of Texas and the United States uses to insure that historic buildings are properly preserved and maintained. The Monroe Shops building is subject to these standards (see Appendix D for applicable standards). In all maintenance and repair work that impact the character defining features of the building as listed in 1.3 Overview of Character Defining Features and Maintenance Concerns, and if any modifications to the building are proposed in the future, these standards will be applicable. Preservation Briefs, also provided by the Secretary of the Interior, are recommended maintenance and repair guidelines for historic buildings. Applicable Preservation Briefs are also provided in Appendix D. It is important to note that Preservation Briefs are updated periodically to address changes in available technology; the latest Preservation Briefs can and should be reviewed and added to this manual as they are made available by the National Park Service.

1.6 Maintenance Activities Quality Control

Prior to conducting maintenance or repair activities that impact the character defining features of the building as listed in 1.3 Overview of Character Defining Features and Maintenance Concerns, this Preservation and Maintenance Manual should be referenced, the DART Rail Planning Department consulted, and the Texas Historical Commission be made informed on a project-by-project basis. All work must be performed in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties (Weeks and Grimmer, 1995, Appendix D).

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2.0 PRESERVATION OF CHARACTER DEFINING FEATURES

2.1 Historic Signage

2.1.1 Description

The historic signs on the interior of Monroe Shops are character defining features that were identified during the SHPO coordination process as being important to preserve. The SHPO directed DART to retain the signage for use on the building interior (Appendix A). The signs date from the time of the Texas Electric Railway, and are to be preserved (Figures 1-4, Appendix B). Historic signage at Monroe Shops consists of five metal painted signs that were present in the building to either provide instruction or were intended to encourage customer service. They are reminders of the building's original purpose and contribute to the historic feeling of the building. The signs were retained and preserved, as encouraged by the Texas Historical Commission during the rehabilitation of Monroe Shops into the DART Police Headquarters. They have been retained in or near their original locations.

2.1.2 General Conditions

The historic signs are in conditions ranging from good to fair. The historic signs shown in Figures 1 and 2 are in good condition. The historic signs shown in Figures 3 and 4 are in fair condition with some rust. Since the historic signs are indoors and are no longer subject to weathering, the rust should remain stable. Should the rust become unstable or advance in severity, or if the signs are damaged, a metals or objects conservator should be consulted. Qualified conservators can be located through the American Institute for Conservation of Historic and Artistic Works (AIC).

2.1.3 Maintenance Recommendations (Appendix C)

1) It is recommended that the historic signs at Monroe Shops are maintained in place.
2) They should be cleaned every six months. For general cleaning, light dusting with a lint-free cotton cloth is sufficient.
3) Particular care should be taken on the historic signs shown on Figures 3 and 4 so as to not dislodge paint or remove rust. Since the rust is not active, it should not continue under normal circumstances, and can be protective of the sound metal beneath the rust layer.
4) Should the historic signs become soiled; the historic signs in Figures 1 and 2 can be cleaned lightly with a lint-free cloth that has been dampened with plain water.
5) The historic signs in Figures 3 and 4 should not come in contact with water. If cleaning with water cannot be avoided, the historic signs should be immediately dried with a soft lint-free cotton cloth.
6) None of the historic signs should be cleaned using any kind of chemical solvents or cleaners.

Applicable Secretary of Interior Standards for Rehabilitation (Appendix D)

- Distinctive materials will be preserved.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Figure 1: Historic Sign located on the east wall of the former Carpenter Shop (original location)

Figure 2: Historic sign located on the south wall of the former store room (original location)

Figure 3: Historic Sign on the south wall

Figure 4: Historic sign located on the west wall of the former Inspection Pit area

2.2 Fire Doors and Hardware

2.2.1 Description

The historic fire doors and hardware on the interior of Monroe Shops are features that have been identified as important by the SHPO during the coordination process. The SHPO directed DART to retain the doors and rehang them in Monroe Shops in an inoperable state (Appendix A). The doors date from the time of the Texas Electric Railway (Figures 5-6). The interior metal-covered wood fire doors and their iron support hardware served as early fire protection. Originally, there were approximately 12 fire doors of various sizes in Monroe Shops, two of which remain. The metal-covered wood doors hung on the wall supported by an iron track and clips that moved the doors. In the event of a fire, the doors would be moved along the tracks and closed. This would contain the fire and prevent it from spreading to other areas of the building. The two remaining fire doors measure 88 ½ inches (sloping to 91 inches) high by 56 inches wide, and 91 ½ inches (sloping to 94 ½ inches) high by 51 inches wide. The two historic fire doors and hardware have been reinstalled in an inoperable state (Appendix B).

2.2.2 General Conditions

The reinstalled fire doors and hardware are in good condition. There is some rust evident on the metal covering at the bottom of both doors as well as other small areas of the door surfaces. The metal hardware shows signs of rust, but this rust is stable. Since the doors are in a climate controlled dry building, these conditions should not worsen. If the conditions of the doors or hardware do worsen, or damage to the doors or hardware occurs, a qualified objects conservator should be consulted. Qualified conservators can be located through the American Institute for Conservation of Historic and Artistic Works (AIC).

2.2.3 Maintenance Recommendations (Appendix C)

1) It is recommended that the doors and hardware be cleaned every six months or as needed.
2) For general cleaning, light dusting with a lint-free cotton cloth is sufficient.
3) Should the historic doors or hardware become soiled; they can be cleaned lightly with a lint-free cloth that has been dampened with plain water. All moistened areas should be dried immediately.
4) Care should be taken during this light cleaning to not remove any of the paint that is remaining on the doors.
5) The historic doors and hardware should not be cleaned with any kind of chemical solvents or cleaners.

Applicable Secretary of Interior Standards for Rehabilitation

- Distinctive materials will be preserved.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Figure 5: Fire Door and Mechanism reinstalled

Figure 6: Fire Door reinstalled

2.3 Historic Masonry and Mortar

2.3.1 Description

The historic masonry and mortar on the exterior and interior of the building are significant character defining features that were identified as such by the SHPO during the coordination process (Appendix A). The masonry and mortar are the most prominent historic features of the Monroe Shops building as the design of the building was meant to convey the importance of the Texas Electric Railway. Using masonry for the building signaled the company's prominence and stability. The masonry walls are loading bearing and unfinished on the exterior. There is a patterned brick frieze below the parapet cap. The building also features concrete sills and headers. During the coordination process, the SHPO directed DART to protect the masonry during all cleaning and construction activities, and reviewed all repairs (Appendix A). The masonry and mortar must be properly maintained and preserved (Figure 7).

2.3.2 General Conditions

The masonry has been cleaned in various areas and the mortar has been repaired and repointed on the interior and exterior. Repairs have been made to the concrete window sills and headers.

Work of particular note for the purposes of this report is the cleaning of walls that have tested positive for the presence of lead containing paint. Lead containing paint was removed during a previous environmental cleanup of Monroe Shops in the 1990s, but in the subsequent years, additional areas had become exposed and tested positive for lead. The current project involved cleaning any remaining lead containing paint from walls that tested positive through the use of carbon dioxide (dry ice) blasting. This technique was tested for any potential for damage to the historic brick walls (Benchmark Environmental Consultants 2008). The technique was found to be satisfactory for use at Monroe Shops, and was approved by the Texas Historical Commission. The paint cleaning was undertaken in March and April 2009, after the historic paint sampling described in this report was performed. The cleaning was regularly monitored by qualified personnel of URS Corporation for any potential for damage; throughout the cleaning process, no damage to the brick walls occurred.

2.3.3 Maintenance Recommendations (Appendix C)

1) It is important to monitor the condition of the masonry and mortar on an annual basis. It is important that the mortar and masonry remain intact. Conditions to monitor include new cracking of brick, widening of existing cracks, separation of the mortar from the brick, loss of brick units, flaking or delaminating brick, loss of cohesion of mortar, and mortar loss.

2) Cleaning methods for proper maintenance of the masonry and mortar are described in the Preservation Brief in Appendix D. In the event that masonry and mortar should become soiled, light cleaning is recommended. Prior to using any chemical cleaning products, clean excessive soiling with plain water with no pressure. If soiling is persistent, first clean with plain potable water and soft natural bristle brushes with low water pressure at no more than 600 psi. Do not use abrasive cleaning methods, such as wire bristle brushes, sandblasting, etc. Prior to water cleaning, mortar joints should be

inspected to make sure they are water tight. If joints are open, cracked, or deteriorated, they should be repaired prior to cleaning.

3) If soiling is not removed using water cleaning, the type of soiling should be analyzed prior to the use of any chemical cleaners. Soiling such as graffiti, carbon deposits, or biological growth may not be removed with water. These types of soiling should be removed using chemicals appropriate for historic masonry and mortar, such as ProSoCo masonry restoration and conservation products. Products to be used should be evaluated on a case-by-case basis. The gentlest effective products should always be used.
4) Chemical solvents and cleaners used in other areas of the building (i.e., all-purpose cleaners, carpet and floor cleaners, disinfectants, etc.) should not come in contact with the masonry and mortar. If accidental contact with these chemicals occurs, the masonry and mortar should be rinsed with plain water and dried.
5) Nails, hooks and the like should not be drilled or hammered into the mortar or bricks.
6) The masonry and mortar should not be painted.
7) Any repairs to the masonry and mortar should be undertaken as specified in the Preservation Brief located in Appendix D of this document. Replacement mortar should match the original in composition, texture, and color. Analysis of the original mortar was performed during the 2010-2011 renovation. Replacement mortar identified during the renovation was **Light Buff 10X Quikrete Type S mortar**. Replacement mortar will be suitable if it follows the guidelines set forth in the mortar analysis report, or in the construction documents. A qualified mason should perform all mortar replacement.
8) The building should be inspected to make sure that water is not penetrating the brick or mortar at any point.
9) The brick, especially around window and door frames, the roof and parapet and foundation should be monitored for cracks and/ or holes where moisture can get in.
10) If masonry is repointed or repaired, the mortar should be of the same color and composition as is in the joint being repaired. **Light Buff 10X Quikrete Type S mortar** is appropriate for this use.
11) The concrete window sills and headers should be monitored for cracks. These should be repaired with concrete that is the same color and texture as the existing concrete.
12) Exterior landscaping sprinkler systems should be aimed away from the masonry and building to prevent the intrusion of water that can cause cracking, spalling and other maintenance issues.
13) The gutters and leader boxes should be kept in good condition and kept clean of debris.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.

- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Grimer, Anne E.

1979 Preservation Brief #6: Dangers of Abrasive Cleaning to Historic Buildings. Electronic document, http://www.nps.gov/hps/tps/brief06.htm, accessed October 30, 2008.

Jandl, H.Ward

1988 Preservation Brief #18: Rehabilitating Interiors in Historic Buildings Identifying and Preserving Character-Defining Elements. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Mack, Robert C. and Anne Grimmer

2000 Preservation Brief #1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Mack, Robert C. and John P. Speweik

1998 Preservation Brief #2: Repointing Mortar Joints in Historic Masonry Buildings. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Park, Sharon C.

1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Weaver, Martin E.

1995 Preservation Brief #38: Removing Graffiti from Historic Masonry. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Figure 7: Masonry after cleaning and repointing.

2.4 Windows

2.4.1 Description

The windows that are currently in the building were installed in 2009-2010 as part of the rehabilitation of the building by DART. The original wood windows had been replaced with matching wood windows during the 1996 renovation, but they had deteriorated and were not able to be reused. The SHPO, while originally directing that the wood windows be replaced in kind, approved the use of steel replacements that matched the original as closely as possible in profile, color, and glazing because of the security needs of the DART Police (Appendix A). The original windows were nine over nine and twelve over twelve wood double-hung sash windows Figures 8-11).

2.4.2 General Conditions

The windows are newly installed and are in very good condition.

2.4.3 Maintenance Recommendations (Appendix C)

1) The windows and caulk around them should be monitored on an annual basis.

2) It is important that the caulk remains intact and that there is a tight seal between the window and the brick. This will ensure that moisture does not penetrate into the brick or wood blocking behind the metal window frames.

3) Moisture penetration could cause issues with the brick, the concrete sills, the mortar, the wood blocking beneath the windows and the wood framing on the interior of the windows.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.

- New additions will not destroy historic integrity.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Park, Sharon C.

1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Smith, Baird M.

1978 Preservation Brief #3: Conserving Energy in Historic Buildings. Electronic document, http://www.nps.gov/hps/tps/briefs/brief03.htm, accessed October 30, 2008.

Figure 8: Historic photograph of Monroe Shops ca. 1916 note original windows.

Figure 9: Replacement steel windows on east facade

Figure 10: Replacement steel windows on north facade

Figure 11: New interior wood window sills and surrounds

2.5 Historic Door and Window Openings

2.5.1 Description

The original historic door and window openings are character defining features of the building. During the coordination process, the SHPO directed DART to maintain the historic window and door openings on the exterior of the building, and as much of the interior as possible (Appendix A and B). The building has repeating pattern of windows on the upper story which create visual impact and historically served as ventilation for the building. On the first floor, the west facade also has a repeating window pattern. The north (front) and south (rear) facades of the building have large openings that were used to bring the interurban cars into the building for maintenance. The east façade, on the south end, has large fixed multi-pane windows. The doors and windows have been replaced per the SHPO directives. The large garage type openings have also been infilled with glazing so that the openings can still be seen. These historic openings should be maintained. Alterations to the openings may affect the historic integrity of the building (Figures 12-14).

2.5.2 General Conditions

The original door and window openings have been maintained and delineated in the design of the rehabilitation of the building. The openings have been repaired where they were damaged and are in good condition.

2.5.3 Maintenance Recommendations (Appendix C)

- Alterations of these openings may impact the historic integrity of the building and create access issues.
- No additional openings may be in-filled unless the Texas Historical Commission is consulted.
- No additional openings may be created without consultation with the Texas Historical Commission.
- It is recommended that the areas around the openings be monitored. These openings should be regularly inspected for cracks, holes and water penetration.
- Cracks around the door and window frames should be immediately addressed and filled appropriate material.
- Caulk and other sealants around the door and window frames should be maintained. If it begins to crack, shrink, crumble or in any way deteriorate, the caulk should be removed immediately and replaced.
- Any penetrations should be repaired to maintain the building in a weather-tight condition.
- Any holes or missing brick or frame features should be addressed immediately.
- The concrete window sills need to be monitored for cracks. It the sills are cracked, even a hairline crack, moisture can seep in and the brick around the opening can deteriorate.

Any such cracks should be repaired immediately with concrete of the same color and texture as the original.

- Like with all the masonry on the building, moisture penetration can cause significant damage. Make sure the leader boxes and gutters are clean and working properly.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Park, Sharon C.

1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Figure 12: South façade with historic openings

Figure 13 and 14: North façade with historic openings

2.6 Parapet Cap and Roof

2.6.1 Description

Portions of the roof and roof structure on the building have been replaced, including a new deck and purlins, and the central low gable, which were addressed during the 1996 renovation. A new roof was installed over existing deck and purlins as part of the 2009-2011 campaign to replace the 1996 roof, which had deteriorated.

The original parapet cap consisted of a cement slurry over brick. This parapet cap had deteriorated prior to the acquisition of the building by DART. A new cast stone parapet cap and flashing were placed during the 2009-2011 rehabilitation of the building, as recommended by the SHPO (Appendix A). The new parapet cap replaced a galvanized sheet metal cap that was installed during the 1996 renovation (Figures 15-16).

2.6.2 General Conditions

The roof includes both flat roof structures and a low gable roof. A new roof membrane was applied to the flat roof areas. The parapet cap was removed and a new parapet cap of cast-stone integrally colored concrete was installed per the design approved by the Texas Historical Commission. A high-albedo (white) membrane roofing has been installed.

2.6.3 Maintenance Recommendations (Appendix C)

- It is extremely important that the roof and parapet cap are maintained so that moisture does not leak into the building or the brick and cause damage.
- The roof should be inspected annually and the new parapet cap and mortar should be monitored for any cracks or damage, and for loss or deterioration of caulking.
- The flashing beneath the cap should be monitored.
- The flashing at the base of the parapet wall and any other flashing around roof penetrations should be monitored closely to ensure that there are no leaks which could damage the historic masonry.
- Gutters, roof drains, and leader boxes should be cleaned and kept free of debris so that they drain correctly and water does not pool on the roof.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.
- New additions will not destroy historic integrity.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Nelson, Lee H.
1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Park, Sharon C.
1988 Preservation Brief #16: The Use of Substitute Materials on Historic Building Exteriors. Electronic document, http://www.nps.gov/hps/tps/brief16.htm, assessed October 30, 2008.

Park, Sharon C.
1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Sweetser, Sarah M.
1978 Preservation Brief #4: Roofing for Historic Buildings. Electronic document, http://www.nps.gov/hps/tps/briefs/brief04.htm, accessed October 30, 2008.

Figure 15: Parapet Cap during repair

Figure 16: Parapet Cap after repair

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2.7 Columns (southeast wing in the gymnasium area)

2.7.1 Description

The concrete columns in the southeast wing of the building are original to the building. In the 1990s, concrete was added to the base of the columns to ensure structural stability of the concrete roof (Figures 17-18). In a letter from the SHPO dated February 20, 2009, they approved the columns remaining where they are to maintain structural stability of the building. The columns are one foot by one foot square and do not have any ornamentation or cap. They extend full height from floor to ceiling and support the concrete roof in the southeast wing, now the gymnasium. As stated above, a 3 ½ layer of concrete was added at the base of the columns to address structural stability issues.

2.7.2 General Conditions

The columns are in good condition and have been cleaned.

2.7. 3 Maintenance Recommendations (Appendix C)

- The columns should be maintained and inspected annually for cracks, erosion, pitting, chipping and/or spalling.
- Any roof leaks that might affect the columns should be dealt with immediately.
- Any signs of erosion, chipping or spalling should be addressed as soon as possible.
- Minor cracks or damage should be repaired with concrete of the same color and texture as the original.
- Large cracks should be examined by a structural engineer.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.
- New additions will not destroy historic integrity.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Gaudette, Paul and Deborah Slaton

2007 Preservation Brief #15: Preservation of Historic Concrete. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Jandl, H.Ward

1988 Preservation Brief #18: Rehabilitating Interiors in Historic Buildings Identifying and Preserving Character-Defining Elements. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Park, Sharon C.

1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Figure 17: Columns after cleaning

Figure 18: Close-up of historic concrete column

2.8 Crane Rail Support Beam

2.8.1 Description

The crane rail support beam is a large steel beam that runs on both the east and west interior walls of the central portion of the building. The crane rail is considered an important historic element of the building, as it once supported a large crane that transported machinery and rail vehicles through the central bay of the building as noted in the National Register nomination (Appendix A). The building had a 15-ton box crane driven by three direct current motors was mounted in the upper story and was moved along a steel I-beam craneway or the crane rail that extended the length of the building and was mounted 21 feet, eight inches above the floor. The box crane has since been removed however portions of the crane rail are still evident on the east and west interior walls of the building (Figures 19-22, Appendix B).

2.8.2 General Conditions

The crane rail is in good condition and can been seen in several areas in the building as seen in Figures 21 and 22.

2.8.3 Maintenance Recommendations (Appendix C)

- It is recommended that the crane rail beam be cleaned every six months to remove dust and dirt.
- A vacuum or broom can be used to remove loose dirt and dust.
- It should not be painted or sealed.
- The crane rail may not be cut, drilled through, or otherwise altered or removed from the building.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Jandl, H.Ward

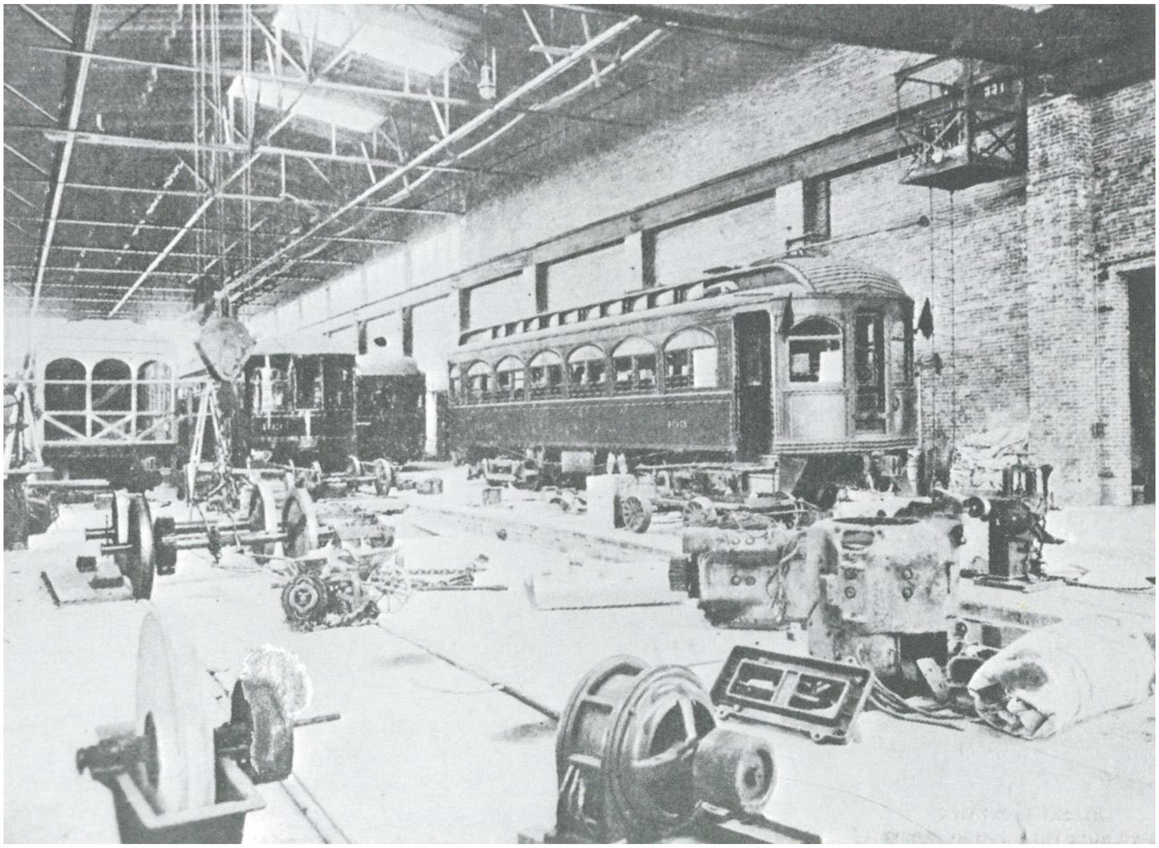
1988 Preservation Brief #18: Rehabilitating Interiors in Historic Buildings Identifying and Preserving Character-Defining Elements. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Photograph courtesy of: John J. Myers

Figure 19: Historic photograph of Monroe Shops shows the crane rail



Photograph courtesy of: John J. Myers

Figure 20: Historic photograph of crane rail

Figure 21: Crane Rail Support Beam

Figure 22: Crane Rail Support Beam (arrow)

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2.9 Historic Interior Roof Trusses

2.9.1 Description

The historic interior Warren and Pratt steel roof trusses are an integral part of the building and are considered a character defining features that were identified as such by the SHPO during the coordination process (Appendix A). They are spaced twenty-one feet apart across the central bay of the building (Figure 23, Appendix B). The original Warren and Pratt trusses are spaced at 21-foot intervals throughout the length of the bay. Three lines of cross-braces run the length of the bay to help support the roof and protect against damage from strong winds.

2.9.2 General Conditions

The historic trusses were examined during the rehabilitation of the building. They are in very good condition and are painted. The green color of the trusses is original and should be maintained. Paint specifications are provided in Appendix D.

2.9.3 Maintenance Recommendations (Appendix C)

1) It is recommended that the historic trusses be inspected every six months. Inspection every six months will help determine if any weather events such as snow or high winds have damaged or weakened the trusses.
2) Any conditions that may impact the structural integrity of the historic trusses should be addressed immediately. This may include weather events such as tornados or heavy snowfall, excessive wind, roof leaks (water/moisture on the trusses) and excessive rust at main members.
3) In the future, if the historic trusses need to be re-painted, they should be inspected for rust, sanded only where needed and painted.
4) The color of the historic trusses is their historic color, and should remain the same color and gloss.

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Jandl, H.Ward

1988 Preservation Brief #18: Rehabilitating Interiors in Historic Buildings Identifying and Preserving Character-Defining Elements. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

Nelson, Lee H.

1988 Preservation Brief #17: Architectural Character Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

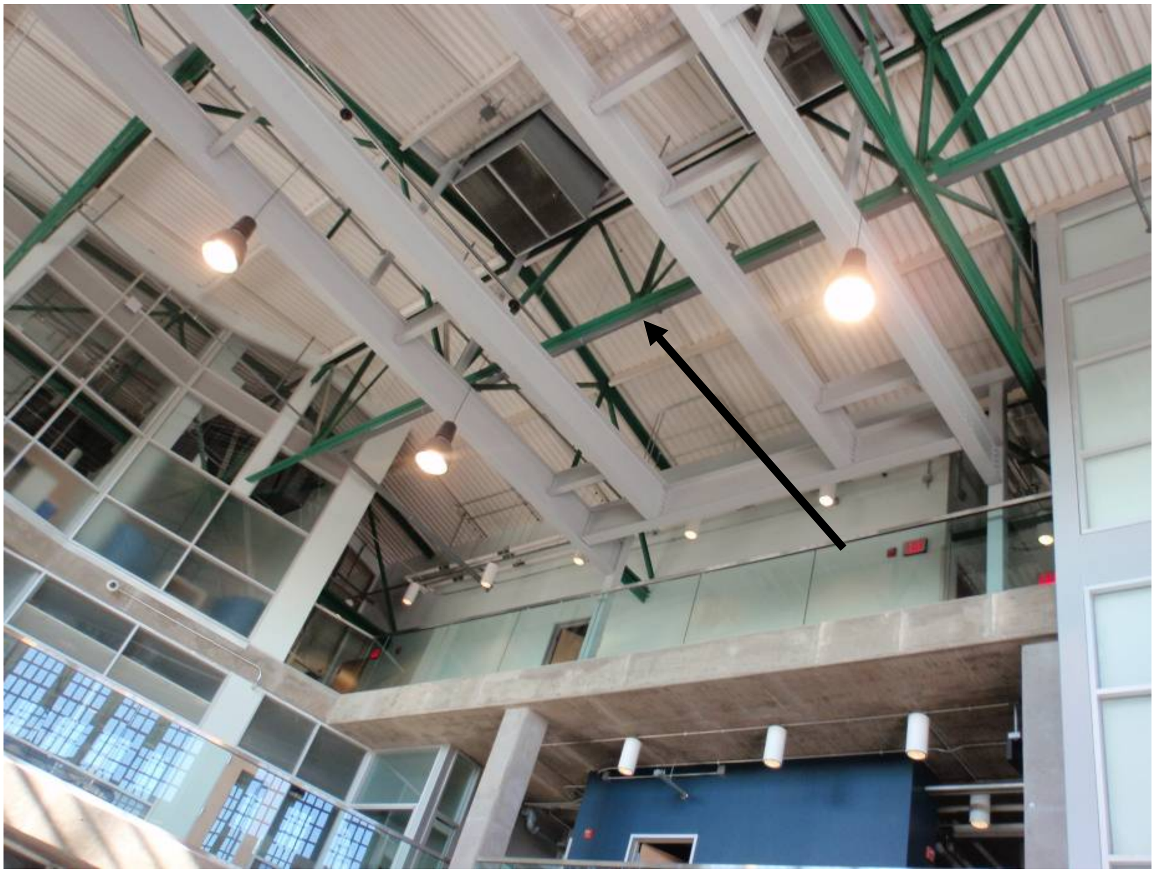

Figure 23: Historic trusses (painted green)

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2.10 Interior Plaster

2.10.1 Description

Portions of the interior of the west wing of Monroe Shops originally had plastered walls. The plaster consists of a ¾ inch horsehair scratchcoat, a ¼ inch browncoat, and a smooth ¼ inch white plaster finish coat. In areas that were formerly restrooms, the finish coat was scored to simulate the appearance of "subway tiles". Paint remnants remain on portions of the plaster (Emery and Brown 2009). The plaster had deteriorated prior to the acquisition of the building by DART, and the plaster remains in a state of deterioration. Remnants of the original plaster are a character defining feature of the building, and were identified by the SHPO during the coordination process as being important and to be preserved (Appendix A). The remnants of the interior plaster have been preserved as found (Figures 24-25, Appendix B).

2.10.2 General Conditions

The interior plaster remnants are in poor condition. Conditions present include flaking, sanding, exposed edges where loss has taken place, cracking, and blistering.

2.10.3 Maintenance Recommendations (Appendix C)

1) It is recommended that the plaster be retained and inspected every six months to access any changes in the plaster condition or advancement of deterioration.
2) Plaster should not be dusted or brushed. No water or chemical cleaners should be applied to the plaster. Chemical solvents and cleaners used in other areas of the building (i.e., all-purpose cleaners, carpet and floor cleaners, disinfectants, etc.) should not come in contact with the interior plaster. If accidental contact with these chemicals occurs, the masonry and mortar should be carefully rinsed with plain water and allowed to dry.
3) Nails, hooks and the like should not be drilled or hammered into the plaster. Sticky-backed hooks should be avoided.
4) Plaster should not be painted, sealed, or stained.
5) The plaster should not be replaced, but should be repaired as needed.
6) Care should be taken to not remove any of the plaster.
7) If plaster begins to detach from walls or begin to powder, it should be addressed using the methods described in the SOI Standards in Appendix D. Repairs should be undertaken by a qualified plaster contractor with historic materials experience or a qualified architectural conservator. Qualified conservators can be located through the American Institute for Conservation of Historic and Artistic Works (AIC).

Applicable Secretary of Interior Standards for Rehabilitation

- The historic character of a property will be retained and preserved.

- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

MacDonald, Mary Lee

1989 Preservation Brief #21: Repairing Historic Flat Plaster Walls and Ceilings. Electronic document, http://www.nps.gov/hps/tps/brief21.htm, accessed October 30, 2008.

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1996 Preservation Brief #39: Holding the Line: Controlling Unwanted Moisture in Historic Building. Electronic document, http://www.nps.gov/hps/tps/brief39.htm, accessed October 30, 2008.

Figure 24: Historic plaster (arrow) on wall in break room at northwest end of building

Figure 25: Historic plaster (arrow) on second floor

2.11 Historic Interior Walls

The historic interior walls defined the spaces within the building and later walls delineate additions that were made in later years (Figures 26-27, Appendix B). These features were identified as important by the SHPO during the coordination process for Monroe Shops (Appendix A).

2.11.1 Description

The interior walls of the building are load bearing brick. These walls define the original uses within the building, such as the machine shop area, blacksmith shop, etc. They are important to the overall integrity of the building.

2.11.2 General Conditions

The masonry has been cleaned in various areas and the mortar has been repaired and repointed with mortar that matched the original in color and texture, and that was compatible with the original mortar composition. New in-fill walls have not been attached to the existing walls. Work of particular note for the purposes of this report is the cleaning of walls that have tested positive for the presence of lead containing paint. Lead containing paint was removed during a previous environmental cleanup of Monroe Shops in the 1990s, but in the subsequent years, additional areas had become exposed and tested positive for lead. The current project involved cleaning any remaining lead containing paint from walls that tested positive through the use of carbon dioxide (dry ice) blasting. This technique was tested for any potential for damage to the historic brick walls (Benchmark Environmental Consultants 2008). The technique was found to be satisfactory for use at Monroe Shops, and was approved by the Texas Historical Commission. The paint cleaning was undertaken in March and April 2009, after the historic paint sampling described in this report was performed. The cleaning was regularly monitored by qualified personnel of URS Corporation for any potential for damage; throughout the cleaning process, no damage to the brick walls occurred.

2.11.3 Maintenance Recommendations (Appendix C)

- These interior walls should not be removed or altered.
- Any new walls should not be attached to the historic walls.
- Cleaning methods for proper maintenance of the bricks and mortar are described in the Preservation Brief located in Appendix D.
- It is important that the mortar and masonry remain intact.
- Nails, hooks and the like should not be drilled or hammered into the brick walls.
- These walls should not be painted.
- Any repairs to the masonry and mortar should be undertaken as specified in the Preservation Brief located in Appendix D.
- Mortar should be of the same color, texture, and composition as is in the joint being repaired.

Applicable Secretary of Interior Standards for Rehabilitation

- A property will be used as it was intended or given a new use that requires minimal change
- The historic character of a property will be retained and preserved.
- Distinctive materials will be preserved.
- Deteriorated historic features will be repaired rather than replaced.
- Chemical and physical treatments will be undertaken using the gentlest means possible.
- New additions will not destroy historic integrity.

Applicable Secretary of the Interior Preservation Briefs (Appendix D)

Jandl, H.Ward

1988 Preservation Brief #18: Rehabilitating Interiors in Historic Buildings Identifying and Preserving Character-Defining Elements. Electronic document, http://www.nps.gov/hps/tps/brief17.htm, accessed October 30, 2008.

MacDonald, Mary Lee

1989 Preservation Brief #21: Repairing Historic Flat Plaster Walls and Ceilings. Electronic document, http://www.nps.gov/hps/tps/brief21.htm, accessed October 30, 2008.

Figure 26: Historic wall on second floor runs north to south in the building

Figure 27: Interior Brick Wall on second floor runs north to south in the building

2.12 Historic Interurban Trolley Car

The historic Number 746 Interurban trolley car was placed in the atrium of Monroe Shops during construction. This car signifies the type of vehicle that would have been repaired and serviced at Monroe Shops.

2.12.1 Description

Car # 746 was constructed in May of 1926 by American Car Company. It has been restored and placed in Monroe Shops as a display. The exterior is painted with the historic colors of the trolley cars of the post war era. The interior has wood trim and wood seats and has been restored. The car is fifty (50) feet in length, eleven (11) feet in height and eight feet six inches (8' 6") wide. The trolley car had eight (8) wheels with Brill 177E1 trucks and a 160-horsepower engine. The car was used from 1926 to 1956.

2.12.2 General Conditions

The Interurban has been restored and is not accessible to the general public. The restoration was performed under the auspices of the McKinney Avenue Transit Authority (MATA) and John Landrum, chief operating officer. The exterior paint, the same used by DART for their current trains, is in good condition. The interior which is not accessible to the public has also been restored.

2.12.3 Maintenance Recommendations (Checklist)

- Clean the exterior and interior of the car twice a year
- For the exterior, use a soft cloth or soft bristle brush to remove dirt and dust. Compressed air on a low setting may also be used.
- The paint should be monitored and areas repainted when necessary. MATA staff should be consulted in reference to paint colors and methodology.
- The interior floor should be vacuumed twice a year to remove dust.
- The interior wood work should be cleaned with a non-wax furniture polish.
- The glass can be cleaned with ammonia based glass cleaner or white vinegar and water. Any excess cleaner should be wiped up immediately including any that drips onto the wood or metal.
- The advertising sign on the exterior should be cleaned with a soft cloth like the other historic signs in the building are cleaned.

Figures 28 and 29: Historic Interurban Trolley Car #746

3.0 REFERENCES

A 151-Mile, 1200-Volt Line in Texas

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Dallas Morning News (DMN)

1908 "Stockholders to See New Interurban Line." 28 June: 6. Dallas, Texas.

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1911b "Gives a Luncheon at the New Dam." 8 October :(7). Dallas, Texas.

1911c "Dallas Country Club Building New Home." 28 July: 4. Dallas, Texas.

1913a "Steel Being Laid From Two Directions." 29 August: 4. Dallas, Texas.

1913b "Shrine Preparations Affect Real Estate." 11 May :(3)10. Dallas, Texas.

1913c "Dallas Will Have Fine New Addition." 27 April :(4)16. Dallas, Texas.

1913d "Contract Awarded For New City Hall." 4 February: 4. Dallas, Texas.

1913e "More Suburban Property." 22 March :(4). Dallas, Texas.

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APPENDIX A
TEXAS HISTORICAL COMMISSION COORDINATION

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SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
001	signage on building interior	retain signage for use	unknown	signs on walls have been photographed and catalogued; they will be protected prior to LBP cleaning	signs were protected and/or removed prior to LBP cleaning	included in Contract 3	all signage reinstalled in or near original locations on building interior per Contract 3
002	interior fire doors	retain and rehang in inoperable state	Linda Roark 9/11/1996; NPS/Linda Roark 4/3/98; Quana Childs 2/10/2006	doors have been removed to storage facility	no change from 30% submittal	included in Contract 3	interior fire doors reinstalled in inoperable state per Contract 3
003	lead based paint (LBP) cleaning	CO2 method approved where lead paint is present; approved for interior spaces only	approved by Quana Childs 11/16/2007; 12/18/2007	specs sent to SHPO for comment January 2009; scheduled for completion Feb./March 2009	specs were approved by SHPO on 2/23/2009; cleaning scheduled for completion April 2009	task complete	Task complete per specifications approved by SHPO.
004	steel windows	retain steel window frames	Linda Roark 6/21/1996; NPS/Linda Roark 4/3/98	replacement of non-historic steel windows approved for LEED by Adam Alsobrook	preliminary design presented in 65% submittal package		steel windows installed per Contract 2

[1] 100% Design Documents for Contracts 1, 2, and 3 were approved by SHPO on June 15, 2009 (Alsobrook to Salin, June 15, 2009).

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
				8/21/2008; Window design to be approved by SHPO		steel windows to be installed in Contract 2	
005	doors and transom west of main entrance	restore to historic appearance	Linda Roark 5/6/1996; Linda Roark 6/21/1996	currently researching appropriate replacements; design to be approved by SHPO	preliminary design presented in 65% submittal package	doors and transom to be replaced in Contract 2	Plain metal doors installed. Doors lead to storage area and mechanical room respectively
006	brick bollards	remove bollards	Linda Roark 6/21/1996	some security measure will be necessary for security of police facility; currently investigating appropriate method; final details TBD	preliminary design presented in 65% submittal package; to be finalized	to be removed in Contract 1; new bollards to be installed in Contract 2	brick bollards removed per Contract 1, new bollards installed per Contract 2
007	parapet cap	replace metal cap with cast stone to match original	12/31/1997; NPS/Linda Roark 4/3/98	architect will design new cast stone cap to be historically appropriate and functional; final details TBD	preliminary design presented in 65% submittal package	to be replaced in Contract 2	parapet cap replaced per Contract 2, sample approved by SHPO (Alsobrook to Salin June 30, 2010)
008	columns in southeast wing	address changes in columns from	NPS/Linda Roark 4/3/98;	added concrete in 1990s for structural	columns to be retained for structural	task resolved	task resolved, columns retained

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
		historic	Quana Childs 2/10/2006	stability of concrete roof; propose to retain	stability; approved by SHPO 2/20/09		
009	1990s mezzanine	do not expand mezzanine; retain space between mezzanine floor and wall	Linda Roark 4/9/1997; NPS/Linda Roark 4/3/98	current mezzanine to be removed; new floors to be removed from wall and be smaller floor plate than current; final design TBD	preliminary design presented in 65% submittal package	This has been removed in Contract 1	removed per Contract 1 and new floor plate constructed per SHPO approved plans
010	crane support beams	retain	Quana Childs 2/10/2006	Crane support beam to be retained; crane rail on top of beam may need to be removed to allow for floor-to-floor heights between new 2nd and 3rd floors	preliminary design presented in 65% submittal package; SHPO direction sought regarding removal and relocation of crane rail resting on top of beam	crane support beam to remain; segments of crane rail to be removed in Contract 1, location of storage TBD	Crane rail support beam maintained; portions removed per Contract 1
011	exterior canopies	remove exterior canopies	NPS/Linda Roark 4/3/98	canopies at doors necessary for building function;	non-historic canopies above non-functioning	Work to occur in Contract 2 - existing canopies to	worked performed per Contract 2

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
				propose new historically appropriate soffits; design to be presented to SHPO	doors to be removed; approved by SHPO 3.4.09; preliminary design presented in 65% submittal package	remain except for one to be removed on west elevation; to be painted; lighting has been submitted to and approved by SHPO	
012	wood windows	retain wood windows; updated directive: replacement of wood windows with compatible steel windows approved for security of police facility; must match historic in design, scale, proportion, and color; SHPO to	Linda Roark 1/30/1997; Gary Sachau, NPS, 1/8/2007; Adam Alsobrook 8/21/2008	researching appropriate replacements; final detail TBD	steel windows approved for use by SHPO 8/21/08; preliminary design presented in 65% submittal package	steel windows to replace wood windows in Contract 2	steel windows installed per Contract 2, details approved by SHPO (Alsobrook to Salin, February 16, 2010)

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
		review samples					
013	roof	recent deck and purlins can remain	Adam Alsobrook 8/21/2008	new roof to be installed over existing deck and purlins; details and location of smoke evacuation unit TBD	preliminary design presented in 65% submittal package	Contract 2 - new roof to be installed over existing deck and purlins; smoke evacuation units are located above existing trusses with a new structural system	work performed per Contract 2

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
014	window glazing	to be as light of a tint as possible; sample to be reviewed by SHPO	Linda Roark 7/10/1996; Linda Roark 3/31/1997; NPS/Linda Roark 4/3/98	to be transparent glass with lightest tint available	preliminary design presented in 65% submittal package	to be installed in Contract 2	glazing sample approved by SHPO (Alsobrook to Emery, September 22, 2009); installed per Contract 2
015	HVAC	THC to review plans	Linda Roark 6/21/1996; Linda Roark 7/10/96; 12/18/2007	design TBD	preliminary design presented in 65% submittal package	to be installed in Contract 2	installed per Contract 2
016	MEP	THC to review plans	12/18/2007	design TBD	preliminary design presented in 65% submittal package	to be installed in Contract 2	installed per Contract 2
017	interior lighting	N/A	N/A	TBD	preliminary design presented in 65% submittal package	to be installed in Contract 2	installed per Contract 2
018	exterior lighting	N/A	N/A	final details TBD	design TBD	Site lighting to remain, exterior building lighting to be added at existing canopies., lighting has been	light fixtures approved by SHPO (Alsobrook to DeFreece, July 31, 2009)

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
						submitted to and approved by SHPO	
019	adjacent new construction	THC to review plans and elevations	12/18/2007	design of emergency generator and dumpster enclosure TBD	preliminary design presented in 65% submittal package	to be installed in Contract 2	installed per Contract 2
020	masonry cleaning	NPS requested good quality and close-up photos before and after cleaning	Gary Sachau, NPS, 1/8/2007	to be conducted as part of LBP cleaning; to be vacuumed or wiped clean; specs sent to SHPO for comment January 2009	specs were approved by SHPO on 2/23/2009; cleaning scheduled for completion April 2009	task complete	task complete per SHPO approved specifications
021	repointing	NPS requested good quality and close-up photos before and after repointing, plus specs and samples of repointing	Linda Roark 5/6/1996; Gary Sachau, NPS, 1/8/2007	final details TBD	preliminary design presented in 65% submittal package; samples to be provided to architect by masonry contractor	to be performed in Contract 2	work performed per contract 2

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
022	interior plaster	NPS requested spalled plaster should be replastered or have gypsum board installed for the historic finished appearance; good quality overall photos of walls before and after resurfacing to be submitted	Gary Sachau, NPS, 1/8/2007	interior walls that were previously plastered will be replastered; final details TBD	final details TBD	to be performed in Contract 2	interior plaster remnants have been preserved as found
023	leader boxes and gutters	replace leader boxes with historically appropriate	NPS/Linda Roark 4/3/98	researching appropriate replacements; final detail TBD	preliminary design presented in 65% submittal package	to be replaced in Contract 2	replaced per Contract 2

SHPO Issues Tracking Sheet

Item Number	Item	SHPO Directive	Date(s) Directive Provided by SHPO	30% Design Comments	65% Design Comments	Contract 3 95% Design Comments	Final Status[1]
024	interior walls	N/A	N/A	due to functional and security requirements, walls of evidence storage area will need to be enclosed	preliminary design presented in 65% submittal package	Contract 2 – in-fills will not attach to existing walls.	work performed per Contract 2
	history of Monroe Shops	develop history of Monroe Shops to be available to public, THC, and Dallas Public Library					historic photographs to be hung in public lobby; video presentation to be shown in public lobby; National Register of Historic Places nomination is available for public view on the internet, and also at the THC

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MEMORANDUM OF AGREEMENT
AMONG THE URBAN MASS TRANSPORTATION ADMINISTRATION,
THE TEXAS STATE HISTORIC PRESERVATION OFFICER,
AND THE ADVISORY COUNCIL ON HISTORIC PRESERVATION
REGARDING THE SOUTH OAK CLIFF LIGHT RAIL
TRANSIT PROJECT, DALLAS, TX

WHEREAS, the U.S. Department of Transportation, Urban Mass Transportation Administration (UMTA) has determined that construction of the South Oak Cliff Light Rail Transit Project in Dallas, TX (Project) will have an effect upon properties which are included in or have been determined to be eligible for inclusion in the National Register of Historic Places, and has consulted with the Texas State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (Council) pursuant to 36 CFR Part 800, regulations implementing Section 106 of the National Historic Preservation Act (16 U.S. C. 470f);

WHEREAS, the Project consists of the construction of a two-track, surface, light rail line extending from the tunnel portal associated with the locally-funded North Central Light Rail project near the North Central Expressway and Routh Street in the Dallas Central Business District (CBD) through the CBD as a transit mall then along existing railroad properties to a new bridge crossing the Trinity River near the Santa Fe Railroad trestle along a new transit right-of-way adjacent to a Texas Utilities Electric transmission line in South Oak Cliff to the area of Illinois Avenue then in the median of reconstructed Lancaster Road to a point south of Ledbetter Drive. Future construction will extend the above described undertaking along a new right-of-way to south of Camp Wisdom Road. The Project also includes a West Yard Lead along existing Santa Fe railroad property to a Service and Inspection Facility which will be constructed on the former Santa Fe Railroad freight yard and a Vehicle Assembly Plant which will be located to the south of the Camp Wisdom Road. Alignment plans and profiles for the Project are included as "Attachment A" to this Agreement;

WHEREAS, to the extent feasible the Project will be designed to meet current American Public Transit Association Noise and Vibration Criteria; and

WHEREAS, the City of Dallas through the Dallas Landmark Commission and the Dallas Area Rapid Transit (DART) participated in the consultation, and DART has been invited to concur in the Memorandum of Agreement;

NOW, THEREFORE, UMTA, the SHPO, and the Council agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties.

Stipulations

UMTA will ensure that the following measures are carried out:

1. DART will incorporate noise and vibration requirements into the trackwork, equipment, vehicle specifications, and official operating rules to minimize the potential of adverse effects to historic properties.

2. UMTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have no adverse effect on the following historic properties: Roger's Garage, 2310 S. Lancaster Road; Commercial Building, 2101-2105 S. Denley Drive; Dealey Plaza at Main and N. Houston Streets; the South Rock Island/Texas Book Depository Building, 411 Elm Street; the John Deere Addition, 208-214 N. Houston Street; the Kingman-Texas Co. Building, 209-211 N. Record Street; the Parlin-Orrendorff Building, 601 Elm Street; the MKT Freight Station, 303-309 N. Record Street; the MKT Freight Station, 555 Ross Avenue; the Interstate Forwarding Building, 301-307 N. Market Street; the Sanger Bros. Garage, 711 Elm Street; the U.S. Post Office, 400 N. Ervay Street; and the John F. Kennedy Assassination Historic District, pending designation as a National Historic Landmark.

3. UMTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have no adverse effect on historic properties provided that certain conditions outlined below are fulfilled:

   a. **The Dallas Veterans Administration Hospital, Building 1, 4500 South Lancaster Road:** The adjacent transit station will be located in the median of Lancaster Road south of Mentor Avenue. The design of this station will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. Lighting for the station will be compatible with the historic character of Building #1 and will not adversely affect the view corridor from Lancaster Road to this building. Additionally, DART will provide the Department of Veterans Affairs (VA) with the opportunity to assist in the development of the station design and to review and comment on the proposed design. DART shall consider any comments provided by the VA and take steps to accommodate any concerns raised by these comments.

   b. **The Texas Electrical Railway/Monroe Shops, 2020 S. Denley Drive:** DART will acquire this historic property for Project purposes. DART will take all reasonable steps to stabilize the Monroe Shops from further deterioration as soon as practicable after the acquisition, and will fund a rehabilitation report which will examine adaptive reuse opportunities for the structure. The design for the new transit station to be located to the west of the Monroe Shops; the design of the Project-related parking lot to the north; the proposed actions to stabilize the building from further deterioration; and the rehabilitation report, including its scope of work, will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. After the completion of the rehabilitation report, DART will take steps to market the property for adaptive reuse according to the provisions set out in Stipulations 6. to 8. below.

c. **The Interurban Railway Bridge at the ATSF Railway:** DART will take all feasible steps to minimize damage to the bridge that may be caused during the construction of light rail tracks and retaining walls in the vicinity of the Interurban Railway Bridge.

d. **The ATSF Railroad Trestle at the Trinity River:** DART will take all feasible steps to minimize damage to the bridge that may be caused by its use of this property during the construction of a new bridge to cross the Trinity River. If DART determines to acquire the trestle, DART will maintain and protect it from damage until title has been transferred to a third party. DART will take steps to market the property according to the provisions set out in Stipulations 6. to 8. below, and agrees to take all reasonable steps to transfer or sell this structure to an appropriate third party for a period of 10 years from the date of this Agreement. If, at the end of this ten-year time period, DART is unsuccessful in efforts to transfer or sell this structure, UMTA and DART will reinitiate consultation with the SHPO and the Council. DART will review the status of its marketing efforts with the SHPO on an annual basis.

e. **The South Control Tower #18, located in the 800 block of Memorial Drive:** If negotiations between DART and the owner of this property result in DART's purchase of the tower, DART will reuse it as a communications facility for the Project. DART will provide the SHPO with the opportunity to review and comment on any plans for the rehabilitation and adaptive reuse of this structure according to the provisions set out in Stipulation 5. below.

f. **The Union Terminal, 401 S. Houston Street:** The Project will necessitate the development of a transit station at Union Terminal. This will require the introduction of station platforms and canopies and will necessitate modifications to the existing track configuration. The design of these additions and modifications will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

g. **The Railroad Switch Control Tower #17, located near Pacific Avenue at the MKT Railroad:** DART will occupy and maintain this structure as a communications facility for the Project. Any plans for this use will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

h. **The Union Terminal Company Underpass (Triple Underpass), located over the intersection of Main, Elm, and Commerce Streets:** DART will utilize space formerly used for the two most eastern railroad tracks on the underpass for light rail use. DART will use catenary wire across the underpass to eliminate the need for poles on the underpass. The necessary poles at the ends of the underpass will be located so as to minimize changes to this structure. DART will provide a sidewalk between the easternmost track and the east facade of the underpass so visitors to Dealey Plaza can view it from the underpass. The design of these modifications will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. Additionally, DART will provide the National Park Service (NPS) with the opportunity to review and comment on these modifications to this contributing feature of the proposed National Historic Landmark District. DART shall consider any comments provided by NPS and take steps to accommodate any concerns raised by these comments.

i. **Dallas High School, 2214 Bryan Street:** DART proposes to locate a center platform transit station in the center of Bryan Street to the west of this historic property. The design of this station will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

j. **The West End Historic District:** DART proposes to construct a transit station on Pacific between Market and Lamar Streets and provide various amenities in conjunction with the light rail as it passes through the West End Historic District including a transit mall on Pacific between Houston and Lamar Street. The design of these features will be developed by DART in consultation with the SHPO and provided ~~to the SHPO for review and comment pursuant to Stipulation 5.~~ below.

4. UMTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have an adverse effect on 1334 Lynn Haven Avenue; the Roger Q. Mills Elementary School, 1515 Lynn Haven Avenue; and the ATSF RR Control Tower #19 on the ATSF

Railway Line at the MKT Line. The parties have developed the following measures to reduce or mitigate the identified adverse effects of the Project:

a. DART will minimize the audible effects of the warning devices at the Lynn Haven Avenue grade crossing by limiting their operation to the shortest period of time possible during gate arm raising and lowering. This grade crossing is approximately 75 feet west of residence located at 1334 Lynn Avenue and approximately 200 feet east of the Mills Elementary School. The warning devices will not be sounded while the gate arms are fixed in the lowered position. DART has agreed to operate trains through this crossing at no more than 45 mph to avoid exceeding the American Public Transit Association Noise Criteria for this land use. If it is determined after the Project is operational that the DART operating speeds exceed 45 mph at the Lynn Haven Avenue grade-crossing, DART will construct noise barrier walls to mitigate the unacceptable noise levels. The design of any such noise barrier walls will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

b. The light rail line will be elevated in the vicinity of Control Tower #19 in order to cross over the mainline tracks of the Union Pacific. As this necessitates the removal of the structure from its original location, DART proposes to relocate the tower for transit-related purposes as a communications facility. Plans for the relocation of this structure as well as plans for its rehabilitation will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. If reuse by DART is not feasible, DART will fund relocation costs and will take steps to market the property according to the provisions set out in Stipulations 6. to 8. below. DART shall complete documentary recordation of Control Tower #19 prior to its relocation pursuant to Stipulation 9. below. DART shall notify the SHPO within 90 days after the tower has been relocated and will reevaluate it on the new site in consultation with the SHPO to determine its National Register eligibility.

5. DART will make every effort to ensure that the design of light rail structures, including station platforms, canopies, artworks, tracks and overhead traction power systems, traction power substations, and communications bungalows, which may have an effect on historic properties will be designed to be compatible with the affected historic property and conform to the guidance contained in the Secretary of the Interior's Standards and Guidelines for Rehabilitation Historic Buildings (U.S. Department of the Interior, National Park Service, 1983 amended 1990). DART will use directional lighting fixtures in those areas adjacent to

historic properties so that light and glare from DART facilities will not extend beyond the functional use of the facility. DART will provide the SHPO with the opportunity to review and comment on the proposed design at the 30%, 65%, and 95% design stages. DART shall provide the SHPO with the opportunity to review and comment on the Scope-of-Work, Interim Draft, and if needed, Final Draft of any report required by this Agreement.

6. DART shall prepare and implement a marketing plan for each historic property which will be relocated and/or sold according to the terms of this Agreement in consultation with the SHPO. This plan will, at a minimum, include the following information about the property:

a. photographs of the property, a parcel map and information on the property's historic significance;

b. information on each property's purchase price, if any; a good faith estimate of the cost of properly moving the structure; and a statement regarding which party will be responsible for the various costs associated with this move;

c. information on possible financial assistance and Federal, state, or local tax benefits for the rehabilitation of historic properties;

d. notification that the recipient will be required to move the structure in accordance with the recommended approaches to moving in the Department of the Interior's <u>Moving Historic Buildings</u> utilizing the services of a professional mover who has the capability to move historic structures properly;

e. notification that the recipient(s) will be required to rehabilitate and maintain the property in accordance with the recommended approaches in the Standards; and

f. notification of the requirement for the inclusion of a preservation covenant or easement in the transfer documents that will be recorded in the County's official property records. This restriction will be similar to the covenant included in "Attachment B" to this Agreement and is intended to restrict development; require maintenance of those aspects of the property that make it eligible for inclusion in the National Register; designate a monitoring party; and be in perpetuity. If the historic property will be relocated, DART will ensure that the covenant is recorded as soon as practicable after the improvement is permanently situated on its new site.

7. Prior to the acceptance of any offer, DART shall review all offers in consultation with the SHPO and shall identify a preferred offer for each property. The SHPO shall be afforded thirty days to review and comment on each preferred offer and the new site proposed for the relocation of the property.

8. If DART receives no offer conforming to the requirements cited in Stipulation 6. above for moving, relocating, rehabilitating, and maintaining a historic property, DART, with the written concurrence of the SHPO, may transfer a property subject to other requirements or lesser restrictions.

9. Prior to the alteration or relocation of Control Tower #19, DART shall contact the Rocky Mountain Regional Office of the National Park Service, HABS/HAER to determine the level and kind of recordation required for the property. Unless otherwise agreed to by the National Park Service, the Service shall ensure that all required recordation measures for the affected property are completed and accepted by the National Park Service prior to its alteration or relocation, and that copies of this documentation are made available to the SHPO and any appropriate local archives designated by the SHPO.

10. DART shall provide the City of Dallas, Dallas Landmark Commission with the opportunity to review and comment on all aspects of the Project that may affect a locally designated landmark through the process set out in the City of Dallas Development Code, 51A-3.103 (Landmarks Commission).

11. DART has completed approximately 80% of the intensive survey program for archeological historic properties within the corridor of the Locally Preferred Alternative design. This survey will be completed as soon as reasonably possible after DART has acquired unconditional access to all tracts of land within the corridor. When the intensive survey is complete, DART will provide the SHPO with a copy of the final report documenting the research and findings. Additionally DART will conduct further archival research on the Brady farmstead located to the south of the proposed Camp Wisdom Station and the late 19th Century farmhouse site located in the proposed Ledbetter Station area. Although it has been determined that these properties are not eligible for inclusion under National Register Criterion D, DART and the SHPO have determined that this archival research should be conducted to determine if the property may be eligible under National Register Criteria A and B.

12. DART shall consult with the SHPO if archeological properties are discovered during the completion of the intensive survey program to determine if any such property may be eligible for inclusion in the National Register. DART shall notify the SHPO as soon as practicable after such a property has been identified, and the SHPO shall review the assessment of eligibility and all

supporting documentation within 21 calendar days of DART's notice. If the property is determined to be eligible for inclusion in the National Register, DART shall consult with the SHPO to identify project alternatives that may allow the site to be preserved in place. If preservation in place is not feasible, DART will consult further with the SHPO to develop a data recovery plan for the recovery of archeological data from the property. This plan will be prepared by a professional archeologist who meets the Secretary of the Interior's Professional Qualifications Standards (48 FR 44738-9). The plan shall be consistent with the Secretary of the Interior's Standards and Guidelines for Archeological Documentation (48 FR 44734-37) and take into account the Council's publication Treatment of Archeological Properties and any relevant SHPO guidance. The plan shall be submitted to the SHPO and the Council for 30 days review, and unless the SHPO or Council objects within 30 days after receipt of the plan it shall be implemented as proposed. The data recovery plan shall specify, at a minimum:

a. the property or properties on which data recovery will be carried out;

b. the research questions to be addressed through the data recovery, with an explanation of their relevance and importance;

c. the methods to be used, with an explanation of their relevance to the research questions;

d. the treatment of any human remains that may be encountered during data recovery; and

e. a plan for dissemination of results of the work and curation of recovered material consistent with 36 CFR Part 79.

13. In the event that the Project will affect a previously unidentified property that may be eligible for inclusion in the National Register or affect a known historic property in an unanticipated manner, DART shall require work in the area of the discovery to cease until actions that will take into account the effects of the undertaking on the property can be implemented. DART shall immediately notify UMTA of the discovery and provide UMTA with the information required to request the SHPO's and Council's comments pursuant to 36 CFR 800.11()b)(2)(ii).

14. Should the SHPO or Council object within 30 days to any reports, plans, specifications, or other documentation provided for review pursuant to this Agreement, DART shall consult further with the objecting party to resolve the objection. If DART determines that the objection cannot be resolved, DART shall notify UMTA which may forward all documentation relevant to the

dispute to the Council. Within 30 days after receipt of all pertinent documentation, the Council will either: 1) provide UMTA with recommendations, which UMTA will take into account in reaching a final decision regarding the dispute; or 2) notify UMTA that it will comment pursuant to 36 CFR 800.6(b) and proceed to comment. Any recommendation or comment provided by the Council will be understood to pertain only to the subject of the dispute, and UMTA's responsibility to ensure the completion of all actions required under this Agreement that are not the subject of the dispute will remain unchanged.

15. At any time during the implementation of the measures stipulated in this Agreement, should an objection to any such measure or its manner of implementation be raised by a member of the public, UMTA shall take the objection into account and consult as needed with the objecting party, the SHPO, or the Council to resolve the objection.

16. UMTA shall immediately notify the SHPO and Council of any substantial changes to the Project as described in Final Environmental Impact Statement. UMTA will provide the SHPO and Council with copies of any reports developed pursuant to this Agreement. UMTA will also provide these reports to interested parties upon request.

17. Any party to this Agreement may request that it be amended, whereupon the parties will consult in accordance with 36 CFR 800.5(e)(5) to consider such amendment.

18. If UMTA cannot carry out the terms of the Agreement, it shall not take or sanction any actions or make any irreversible commitment that would result in an adverse effect to a historic property or would foreclose the Council's consideration of modifications or alternatives to the Project that could avoid or mitigate the adverse effect until UMTA has again requested the Council's comments in accordance with 36 CFR Part 800.

EXECUTION OF THIS MEMORANDUM OF AGREEMENT and implementation of its terms evidences that the Urban Mass Transportation Administration has afforded the Council an opportunity to comment on the South Oak Cliff Light Rail Transit Project and the effect of this undertaking on historic properties, and that the Urban Mass Transportation Administration has taken into account the effect of the undertaking on historic properties.

URBAN MASS TRANSPORTATION ADMINISTRATION

By: Lee Waddleton Date: 7/31/91
Lee Waddleton
Midwestern Area Director

TEXAS STATE HISTORIC PRESERVATION OFFICER

By: Curtis Tunnell Date: 7/29/91
Curtis Tunnell
Executive Director, Texas Historical Commission and
State Historic Preservation Officer

ADVISORY COUNCIL ON HISTORIC PRESERVATION

By: Robert D. Bush Date: 8-8-91
Dr. Robert Bush
Executive Director

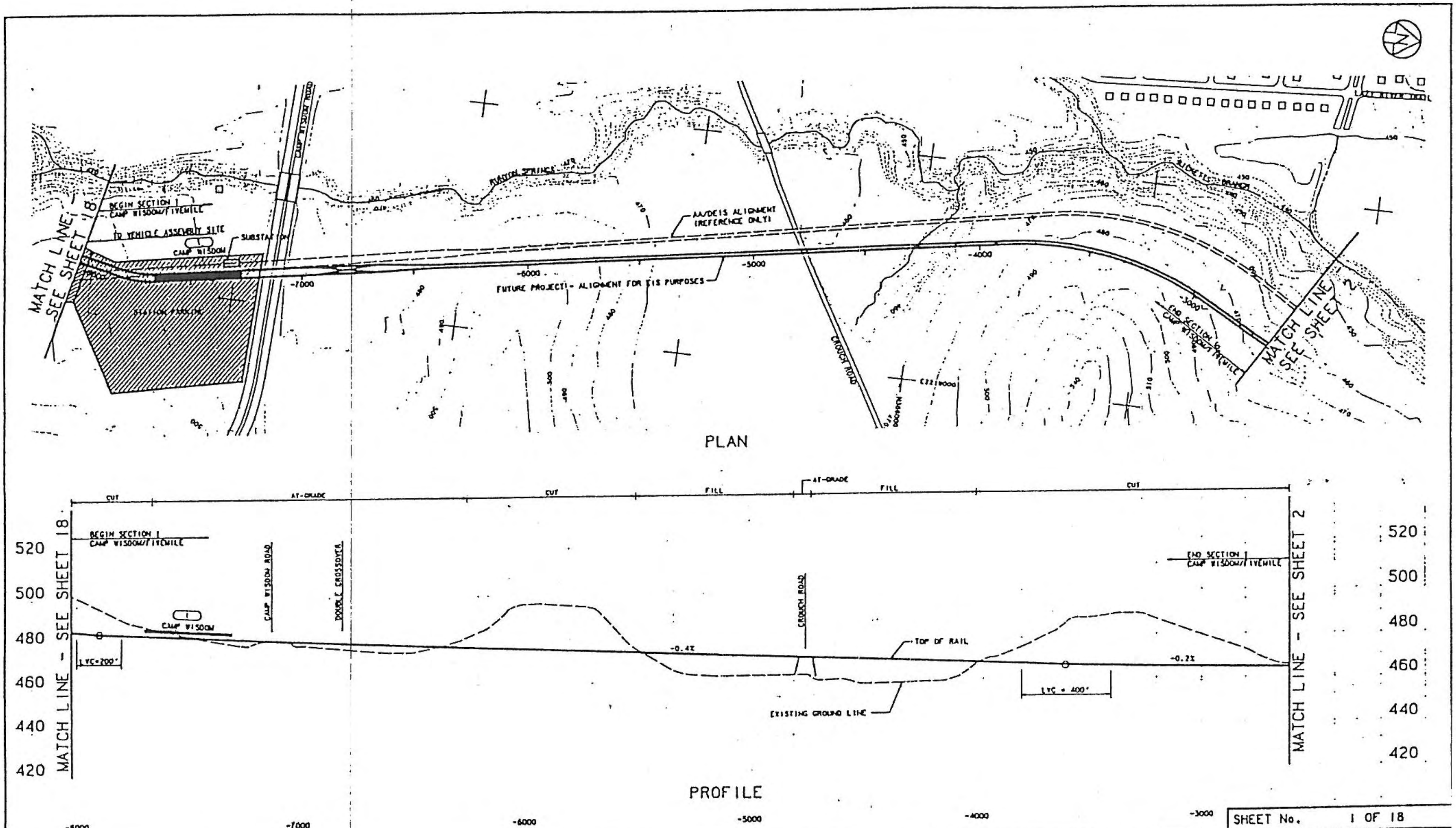
CONCUR:
DALLAS AREA RAPID TRANSIT

By: Date: 7/24
Charles S. Anderson
Executive Director

South Oak Cliff Corridor

SECTION 106 MEMORANDUM OF AGREEMENT

Attachment A



SHEET No.	1 OF 18

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

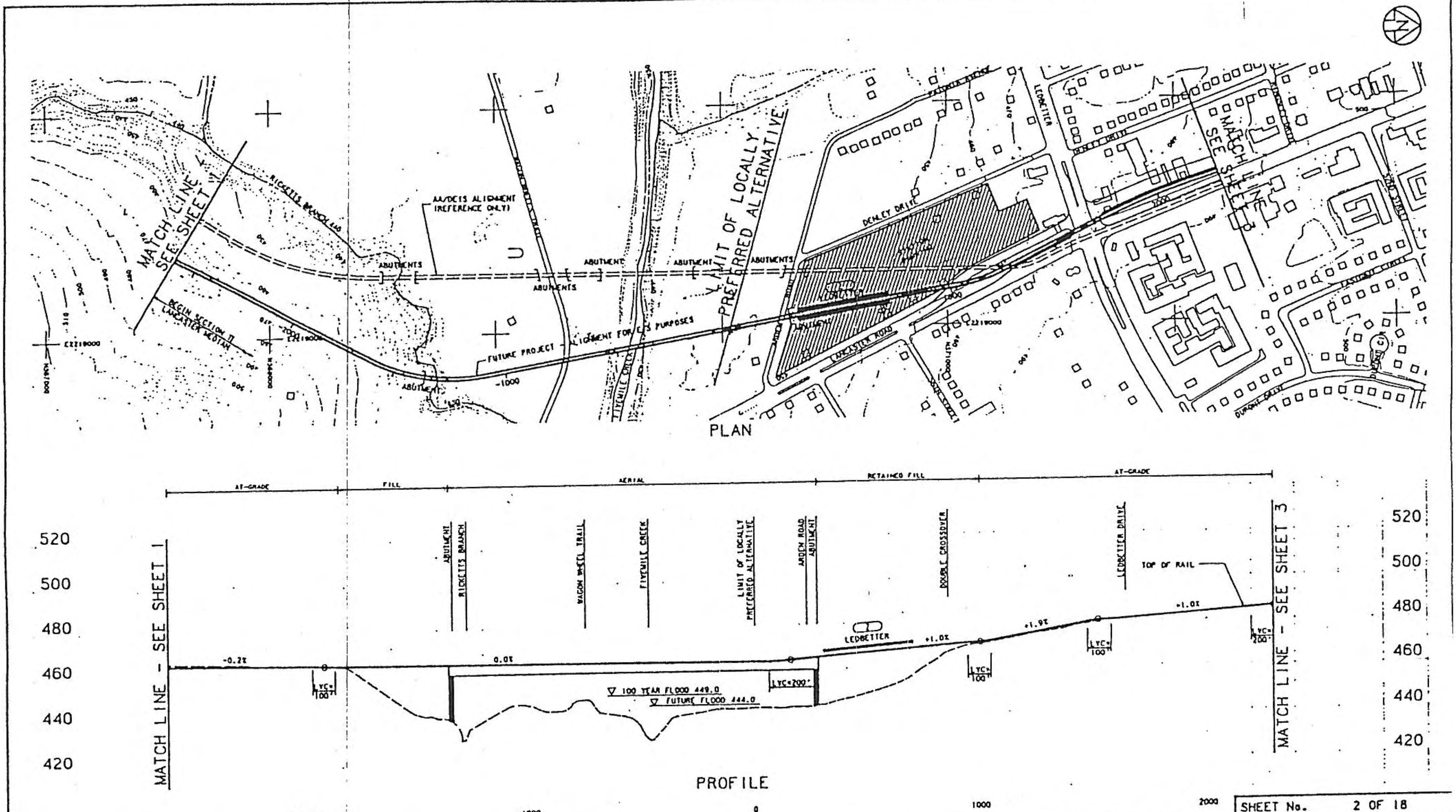
DART

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. WATUMTUTA
DESIGNED	C. BLEYING
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
CAMP WISDOM / FIVEMILE
FROM -8,020 TO -2,600

DRAWING No. GX3-0001



SHEET No.	2 OF 18

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

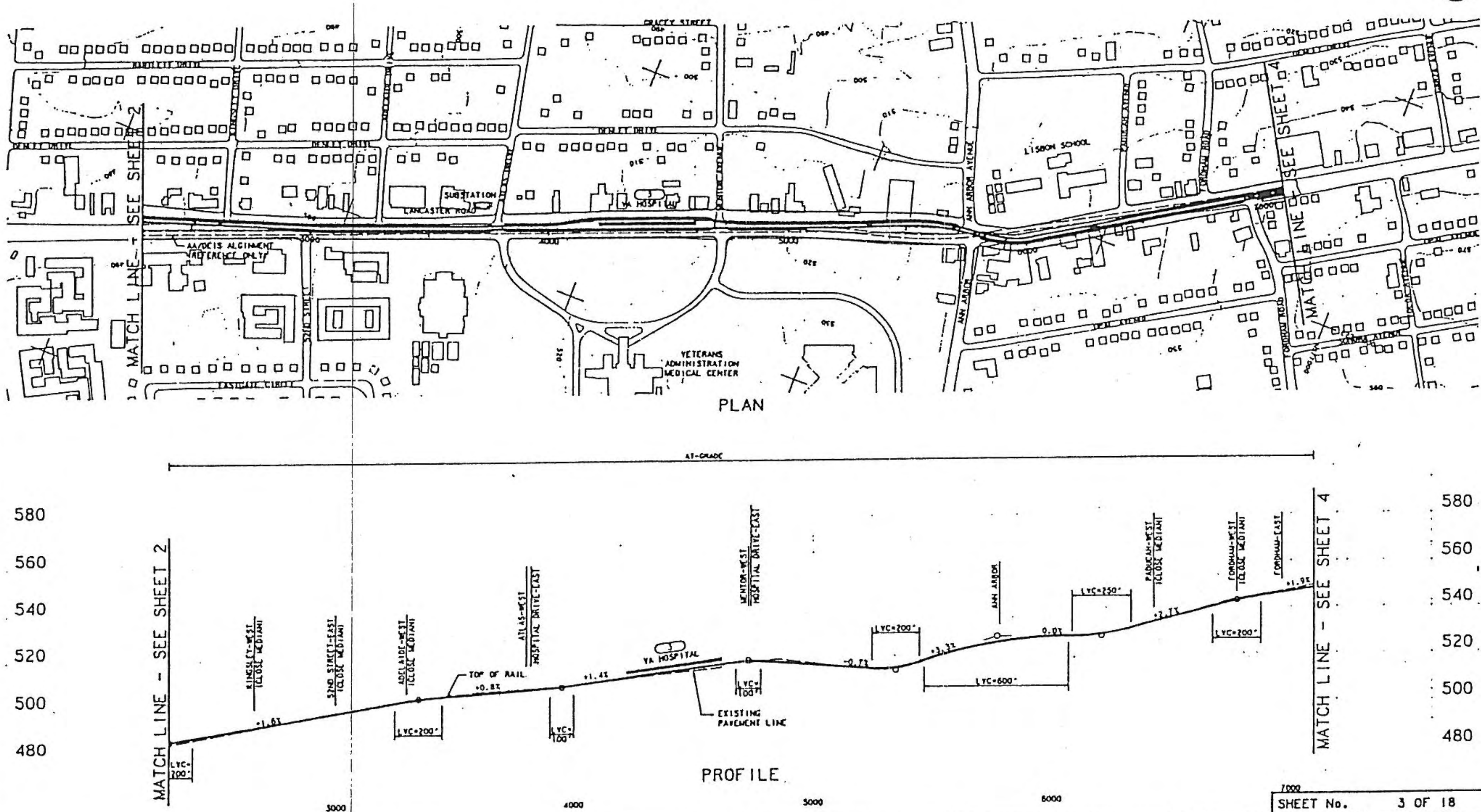
DART

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE AS SHOWN
DRAWN P. MATSUMURA
DESIGNED C. BLEVINS
CHECKED T. VON BRIESEN
IN CHARGE D. ALLEN
DATE JULY, 1991

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
FIVEMILE/LANCASTER MEDIAN
FROM -2,600 TO 2,290

DRAWING No. GX3-0002



SHEET No.	3 OF 18

DART

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR

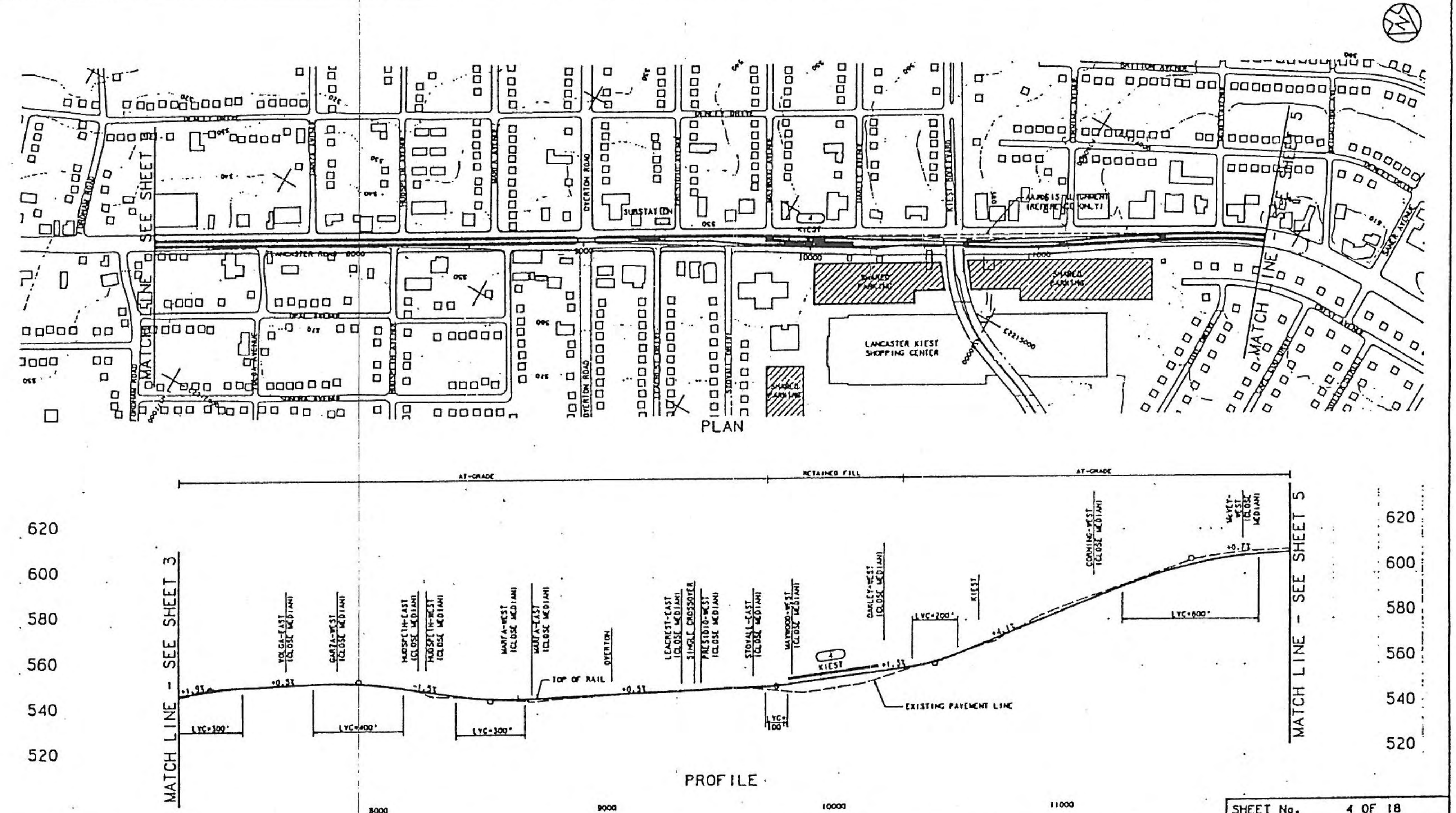
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. BATUNYUTA
DESIGNED	M. MITCHELL
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
LANCASTER MEDIAN
FROM 2,290 TO 7,100

DRAWING No. GX3-0003



SHEET No.	4 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
LANCASTER MEDIAN
FROM 7,100 TO 12,000

DRAWING No. GX3-0004

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR

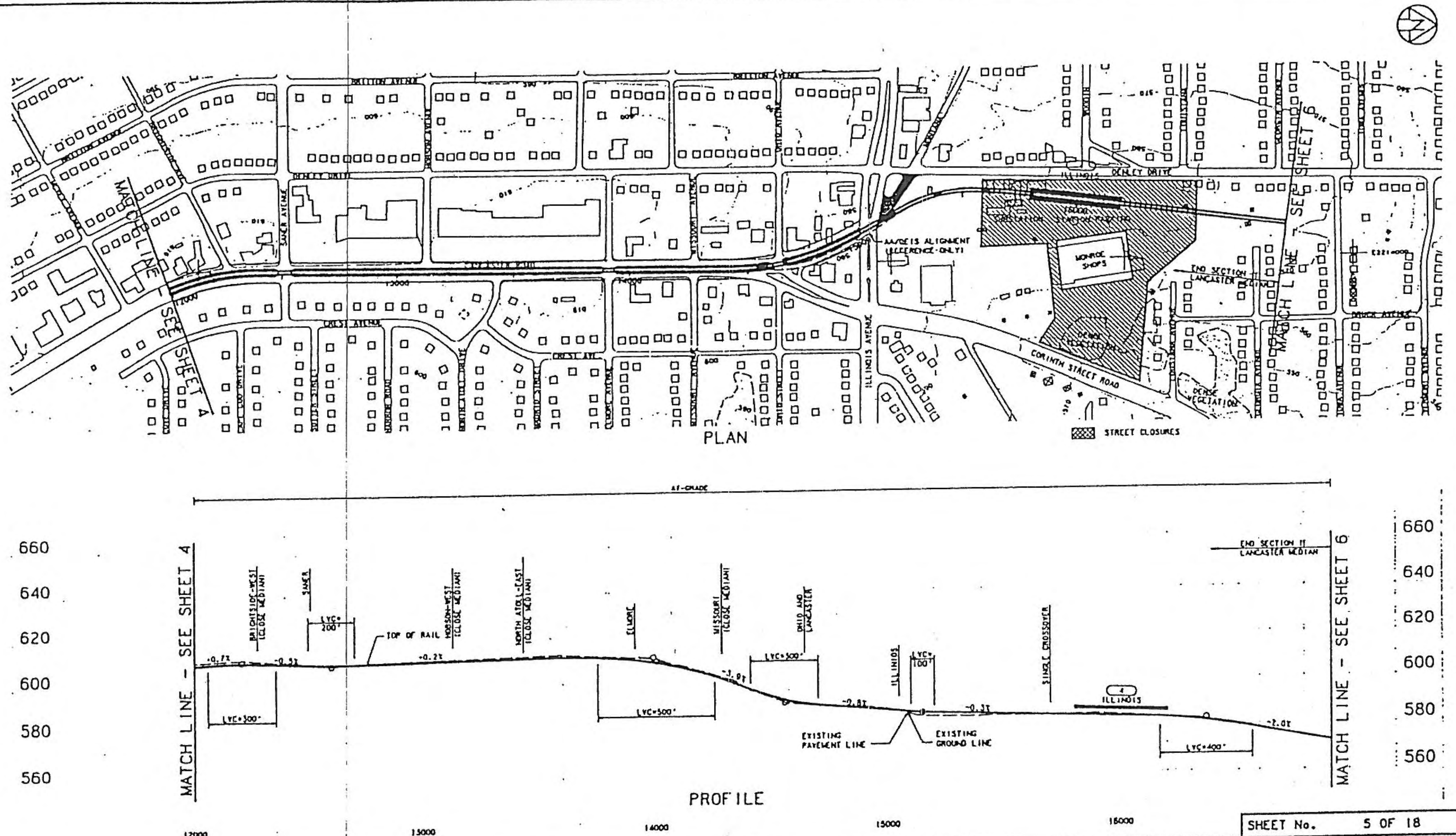
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DART

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. MATUMYUTA
DESIGNED	M. MITCHELL
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991



SHEET No.	5 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
LANCASTER MEDIAN
FROM 12,000 TO 16,920

DRAWING No. GX3-0005

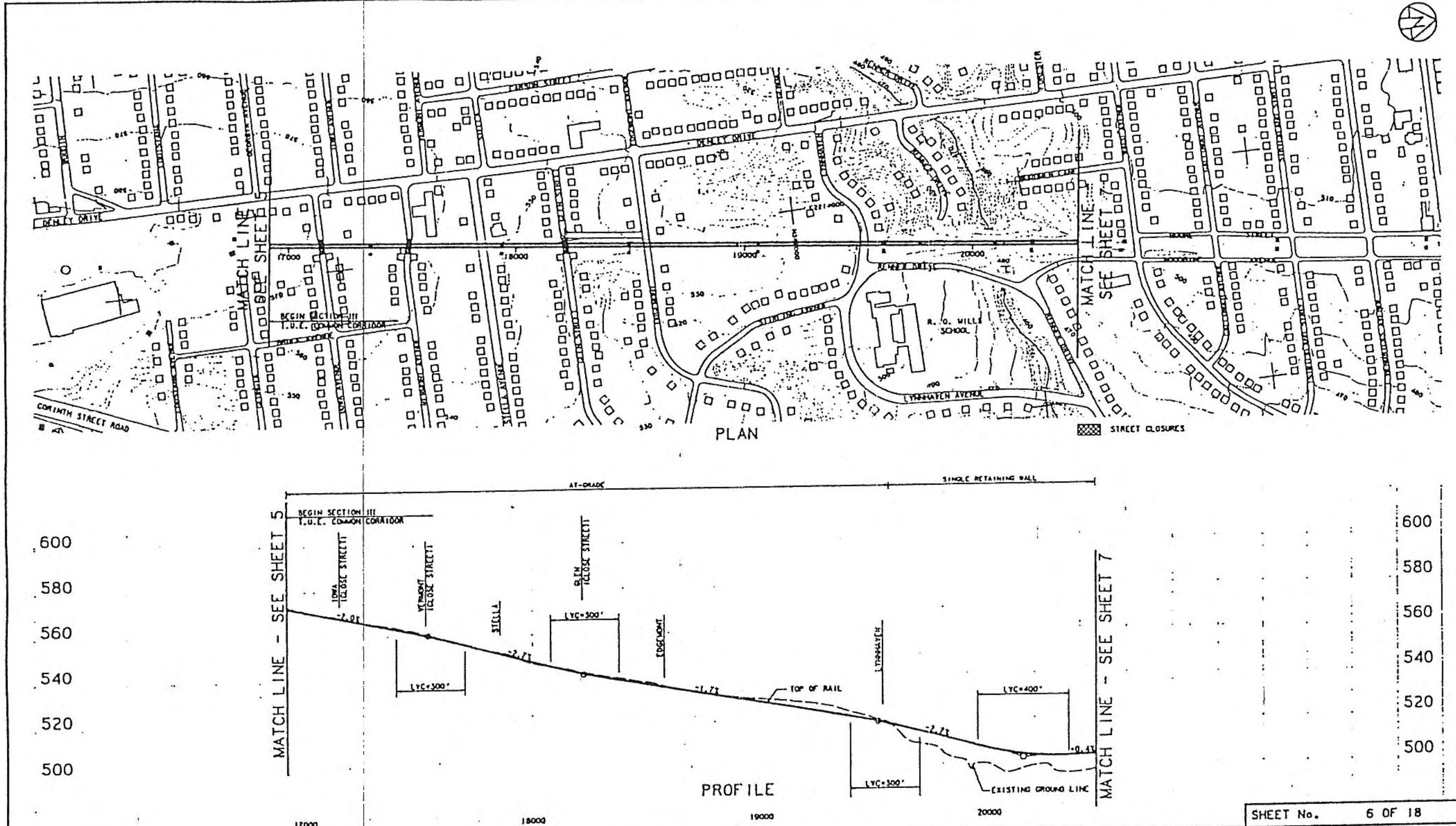
SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	M. MITCHELL
CHECKED	T. VON BRIESCH
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DART



DART

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

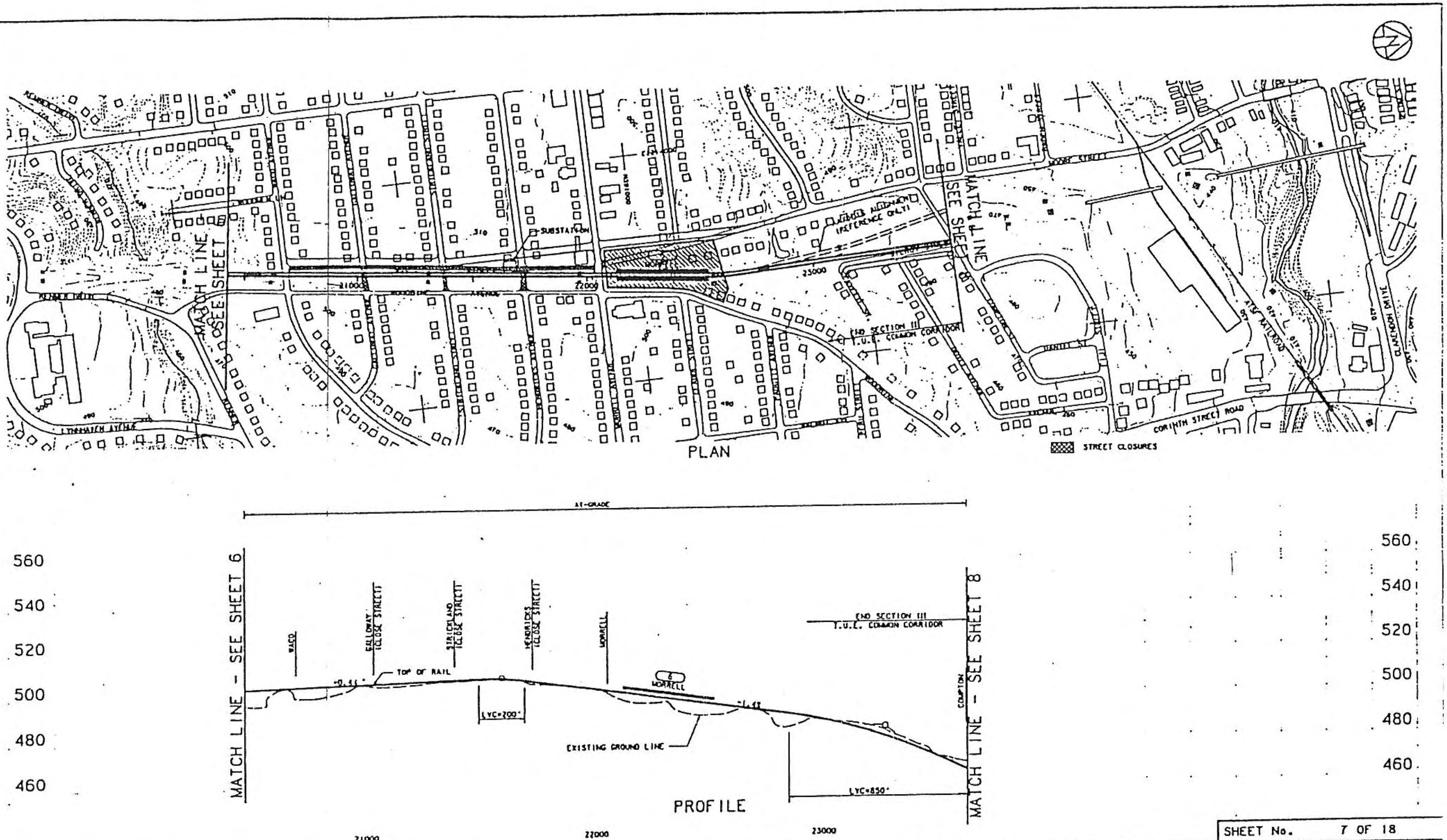
SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	R. LEAR
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SHEET No. 6 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
T.U.E. COMMON SECTION
FROM 16,920 TO 20,460

DRAWING No. GX3-0006



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	**DALLAS AREA RAPID TRANSIT PROJECT** **SOUTH OAK CLIFF CORRIDOR** FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

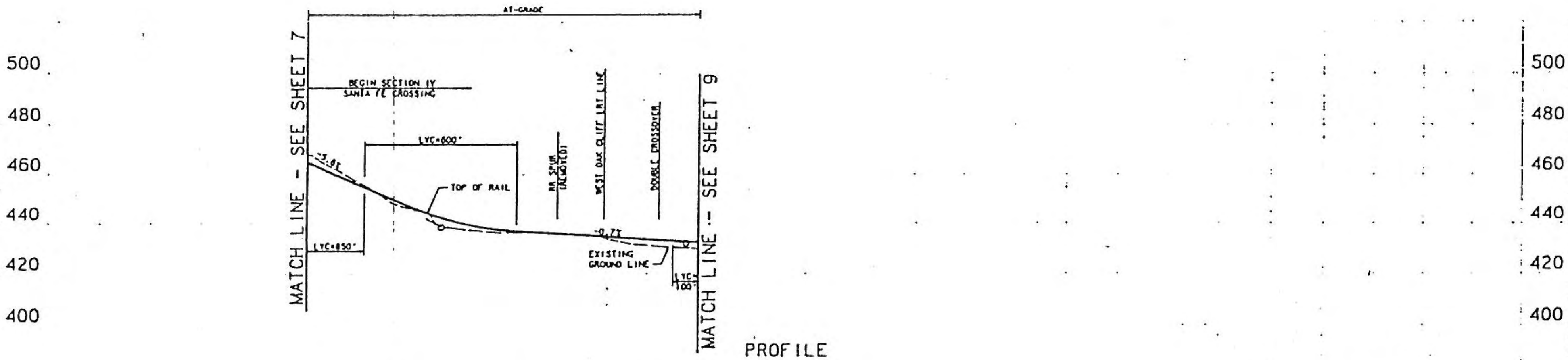
SCALE	AS SHOWN
DRAWN	P. WATUNYUTA
DESIGNED	J. KLINE
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SHEET No. 7 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
T.U.E. COMMON SECTION
FROM 20,460 TO 23,620

DRAWING No. GX3-0007

PLAN



PROFILE

SHEET No.	8 OF 18

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

DART

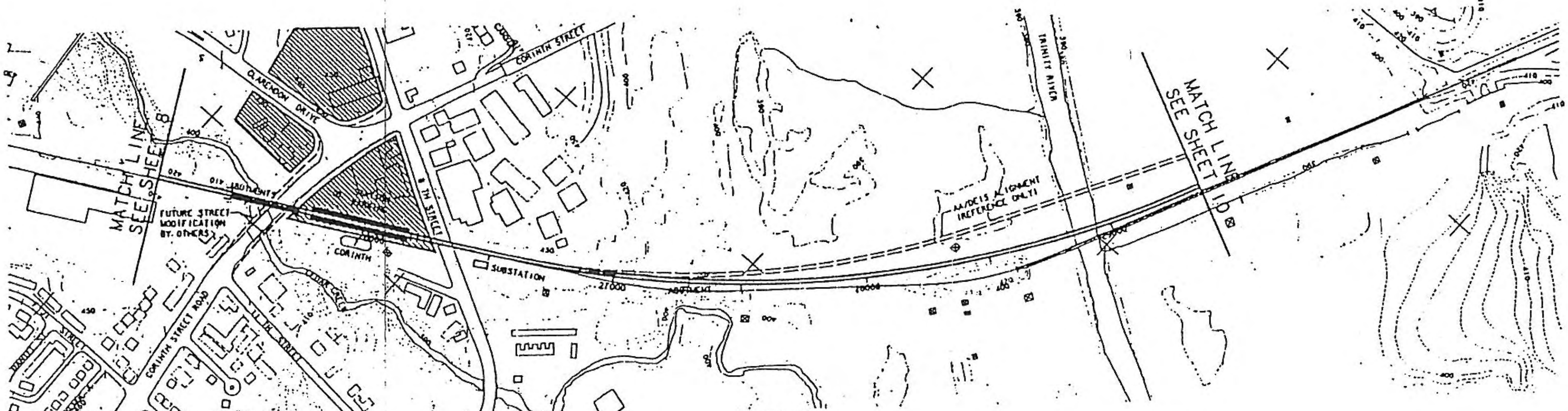
Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

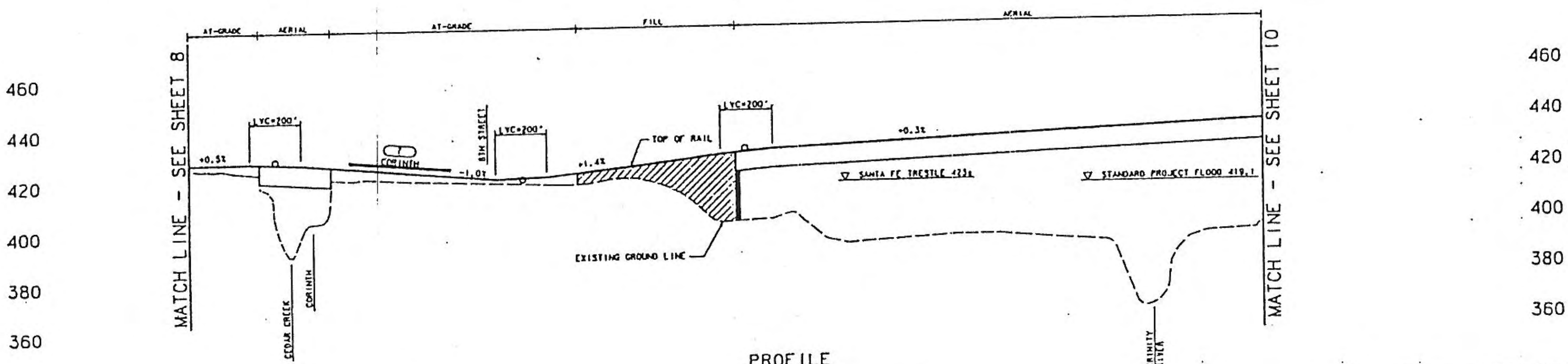
SCALE AS SHOWN
DRAWN P. RATANYUTA
DESIGNED N. MITCHELL
CHECKED T. VON BRIESEN
IN CHARGE D. ALLEN
DATE JULY, 1991

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
SANTA FE CROSSING
FROM 23,620 TO 25,160

DRAWING No. GX3-0008



PLAN



PROFILE

SHEET No.	9 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
SANTA FE CROSSING
FROM 25,160 TO 29,370

DRAWING No. GX3-0009

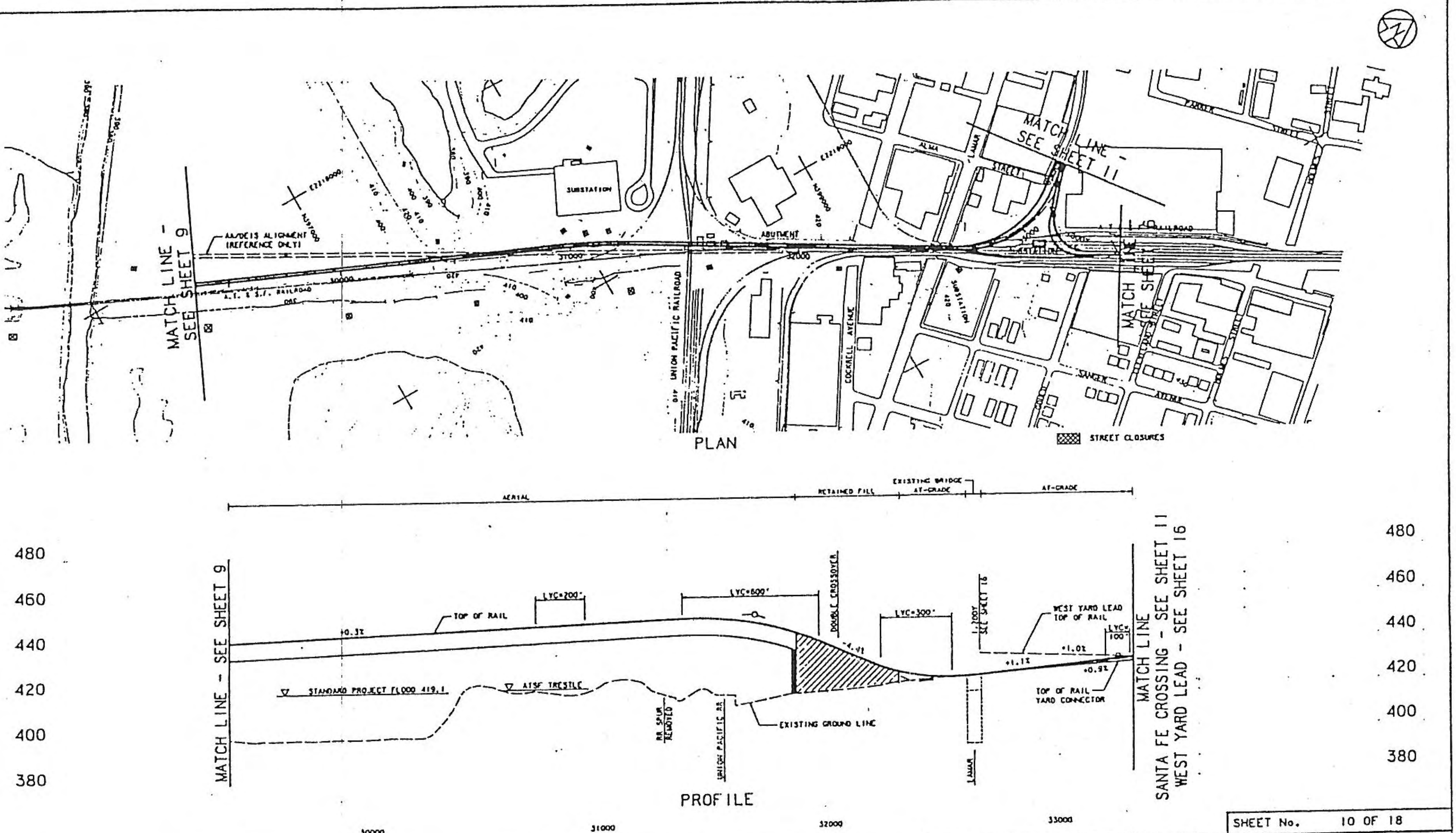
SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	T. SOSEBEE
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DART



DART

Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

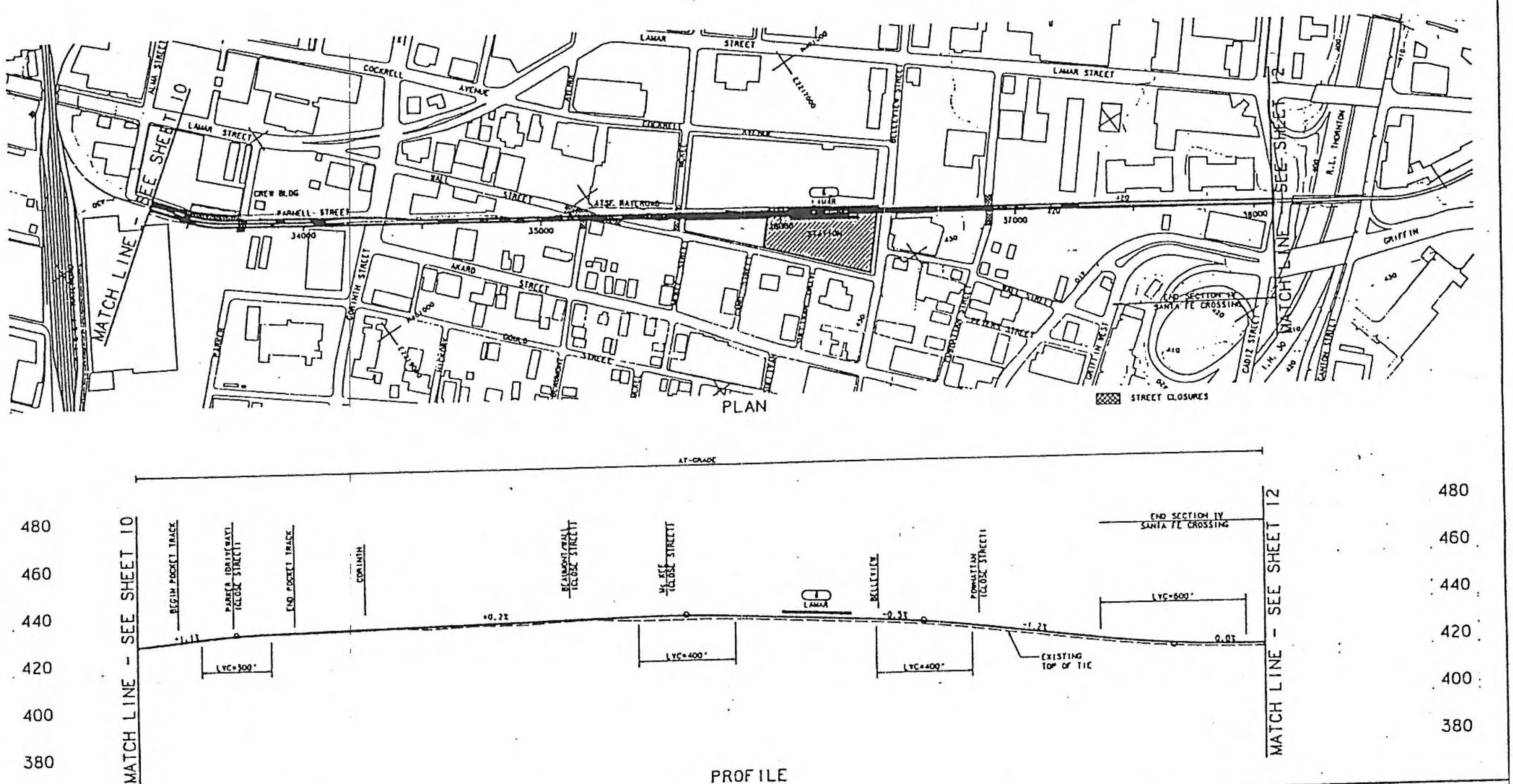
SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. VATUNYUTA
DESIGNED	T. SOSEBEE
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SHEET No. 10 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
SANTA FE CROSSING
FROM 29.370 TO 33.320

DRAWING No. GX3-0010



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	**DALLAS AREA RAPID TRANSIT PROJECT** **SOUTH OAK CLIFF CORRIDOR** FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE

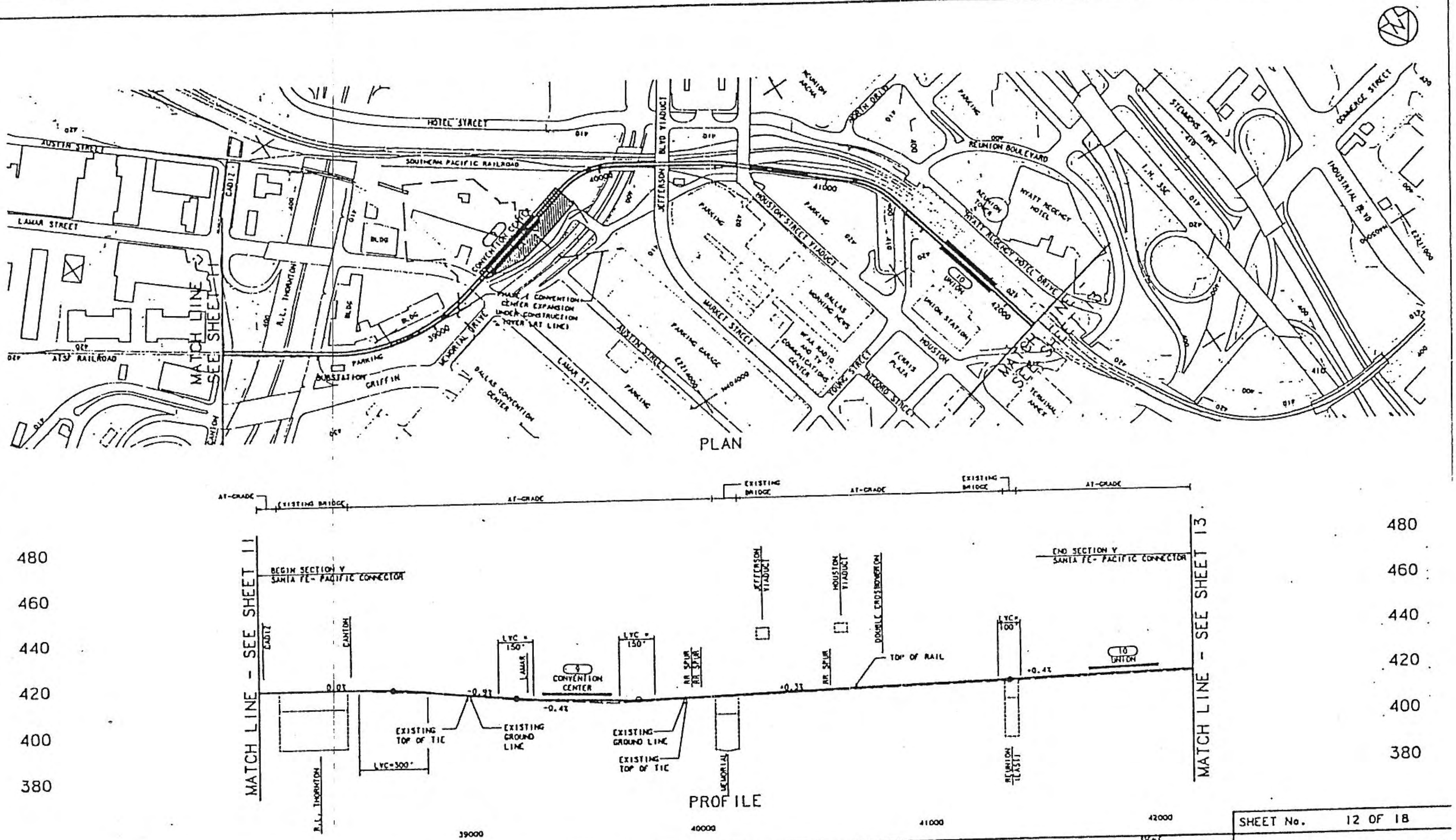
SCALE (IN FEET) HORIZ 0 200 400 VERT 0 10 20 30 40

SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	E. BRANTLEY
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SHEET No. 11 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
SANTA FE CROSSING
FROM 33,320 TO 38,080

DRAWING No. GX3-0011

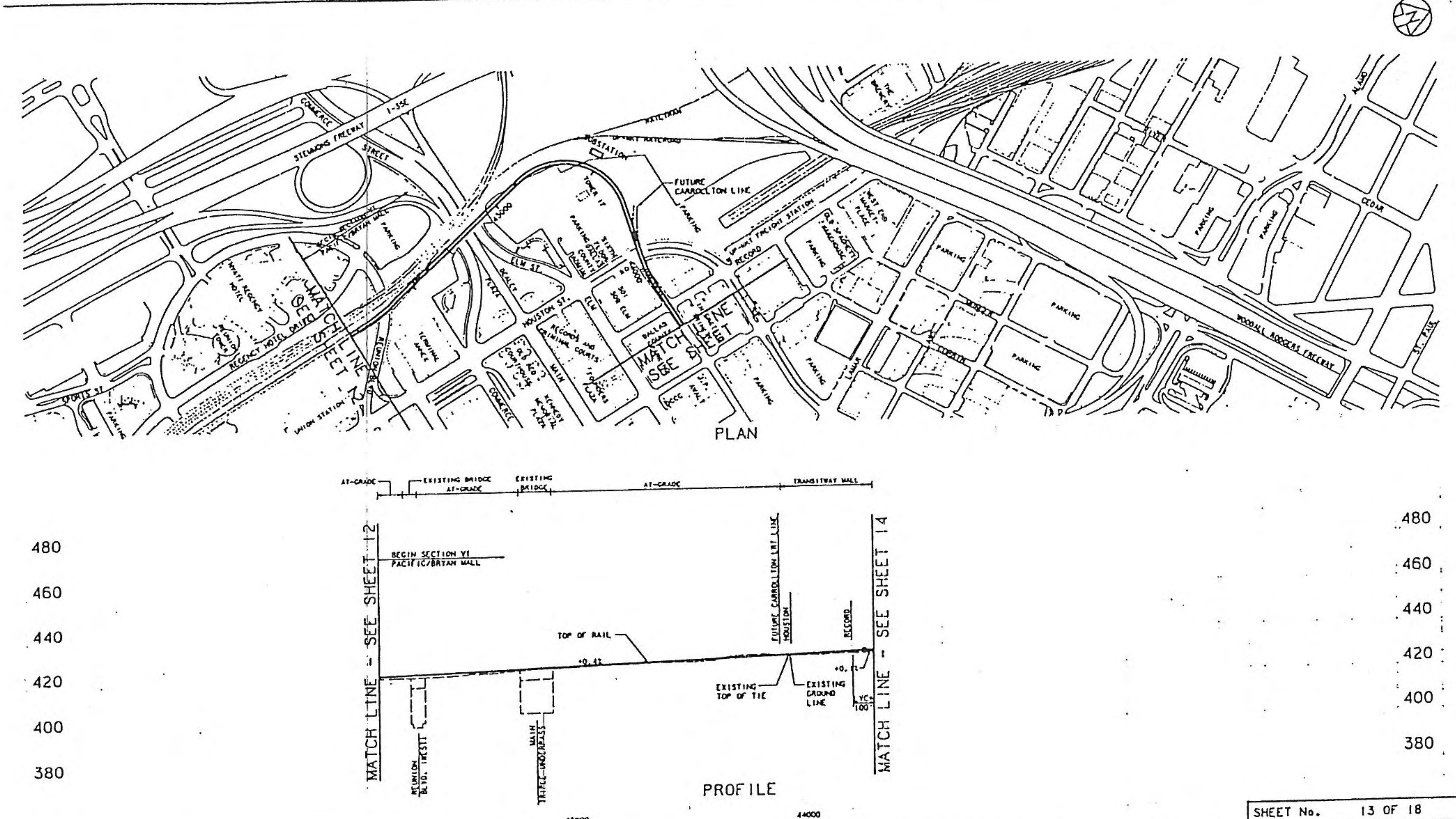


DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	DALLAS AREA RAPID TRANSIT PROJECT SOUTH OAK CLIFF CORRIDOR FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE	SCALE (IN FEET) HORIZ 0 200 400 VERT 0 10 20 30 40	SCALE AS SHOWN DRAWN P. WATUMYUTA DESIGNED R. LEAR CHECKED T. VON BRIESEN IN CHARGE D. ALLEN DATE JULY, 1991

SHEET No. 12 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
SANTA FE / PACIFIC CONNECTOR
FROM 38,080 TO 42,150

DRAWING No. GX3-0012



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

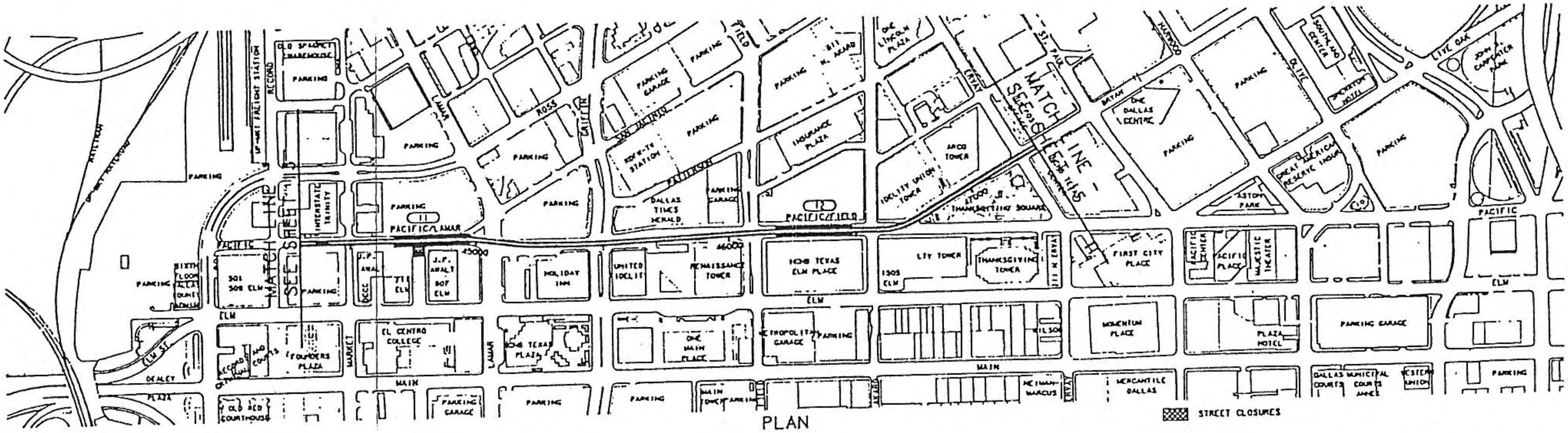
SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

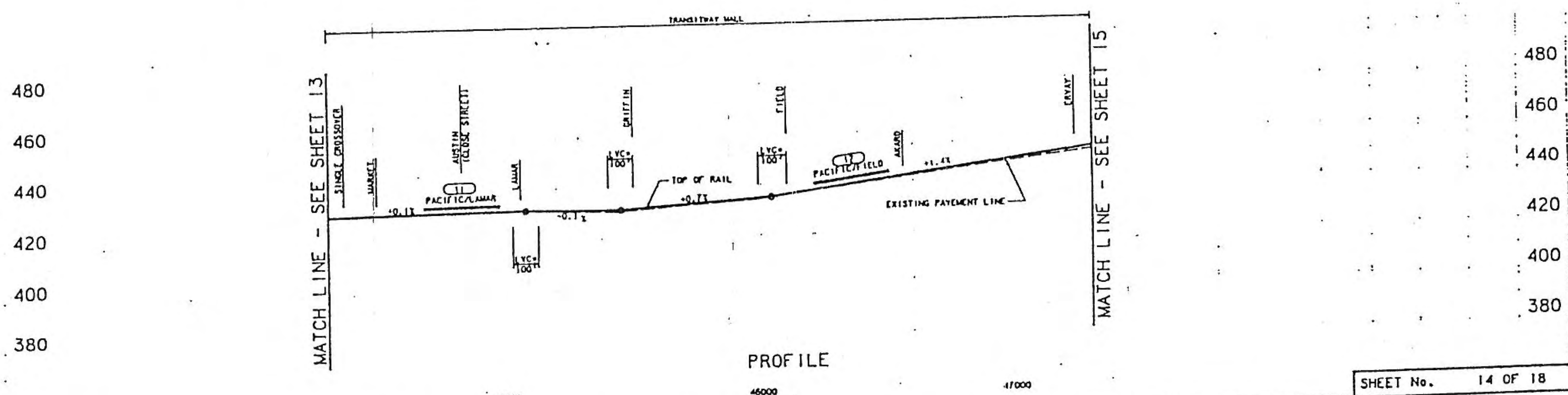
SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	P. BAKAS
CHECKED	T. VON BRIESCH
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SHEET No. 13 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
PACIFIC / BRYAN MALL
FROM 42,150 TO 44,300

DRAWING No. GX3-0013



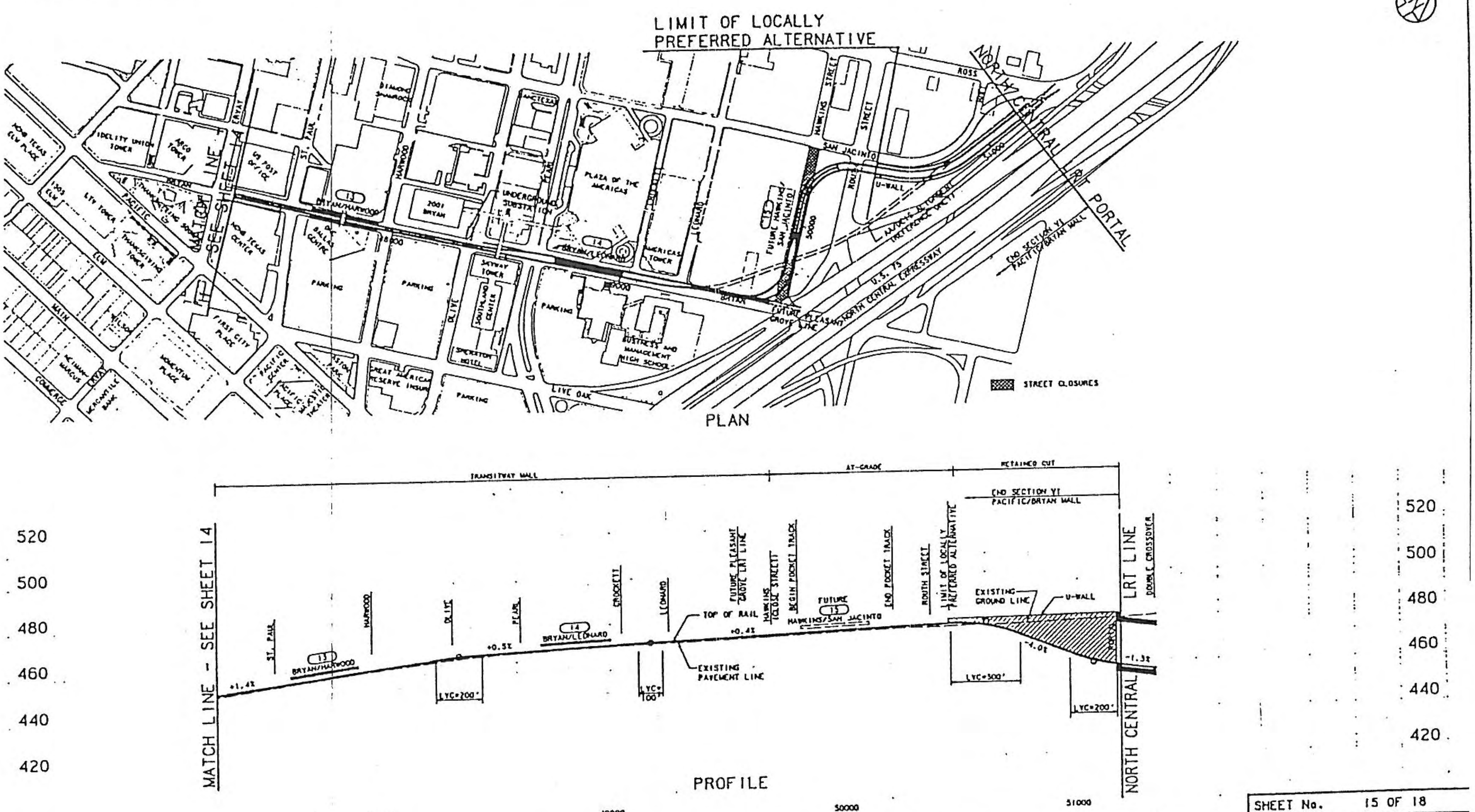


DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	DALLAS AREA RAPID TRANSIT PROJECT SOUTH OAK CLIFF CORRIDOR FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE	SCALE (IN FEET) HORIZ 0 200 400 VERT 0 10 20 30 40	SCALE AS SHOWN DRAWN P. WATUMTUTA DESIGNED P. BAKAS CHECKED T. VON BRIESEN IN CHARGE D. ALLEN DATE JULY, 1991

SHEET No. 14 OF 18

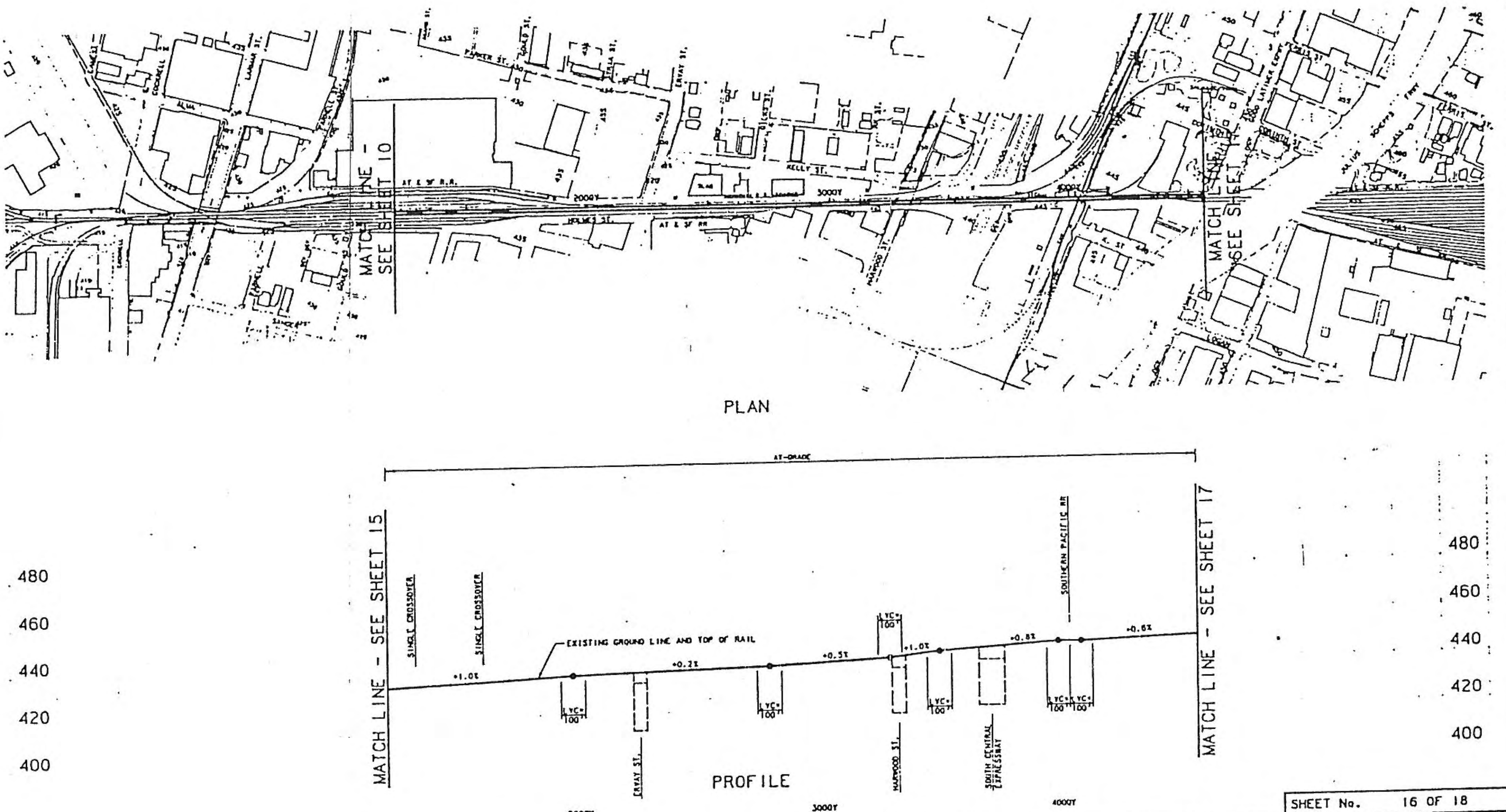
REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
PACIFIC / BRYAN MALL
FROM 44,300 TO 47,300

DRAWING No. GX3-0014



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	**DALLAS AREA RAPID TRANSIT PROJECT** **SOUTH OAK CLIFF CORRIDOR** FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE	SCALE (IN FEET) HORIZ 0 100 200 400 VERT 0 10 20 30 40	SHEET No. 15 OF 18 REFERENCE PLAN AND PROFILE LIGHT RAIL TRANSIT SYSTEM PACIFIC / BRYAN MALL FROM 47,380 TO 51,190 DRAWING No. GX3-0015

SCALE	AS SHOWN
DRAWN	P. MATUMTUTA
DESIGNED	D. CRICE
CHECKED	T. VON BRIESEN
IN CHARGE	B. ALLEN
DATE	JULY, 1991



SCALE	AS SHOWN
DRAWN	P. WATUMYUTA
DESIGNED	B. BOLDUC
CHECKED	T. VON BRIESEN
IN CHARGE	D. ALLEN
DATE	JULY, 1991

SCALE (IN FEET)
HORIZ 0 200 400
VERT 0 10 20 30 40

DALLAS AREA RAPID TRANSIT PROJECT
SOUTH OAK CLIFF CORRIDOR
FINAL ENVIRONMENTAL IMPACT STATEMENT
LOCALLY PREFERRED ALTERNATIVE

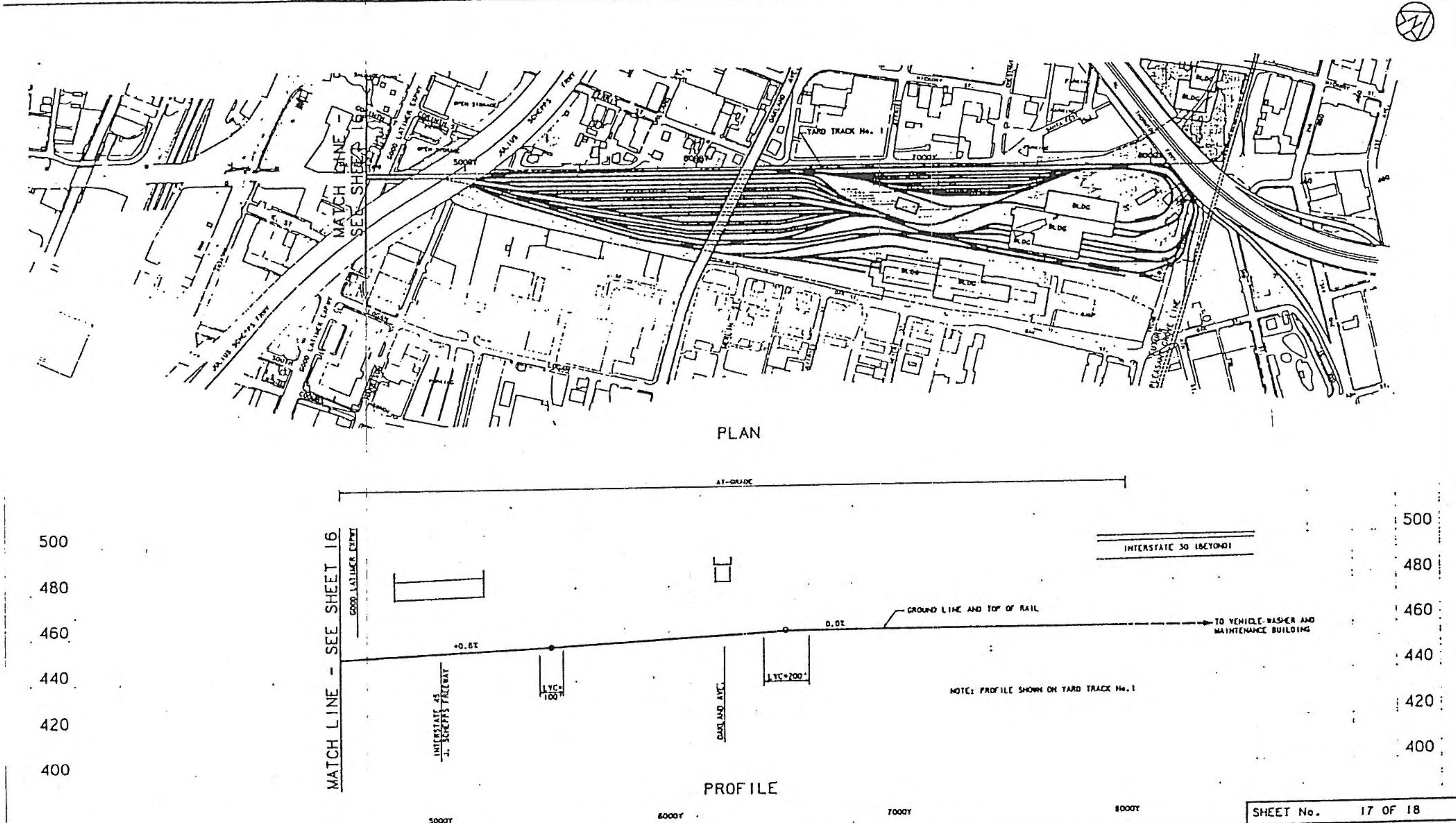
Parsons Brinckerhoff
1701 N. MARKET ST.
DALLAS, TEXAS 75202

DART

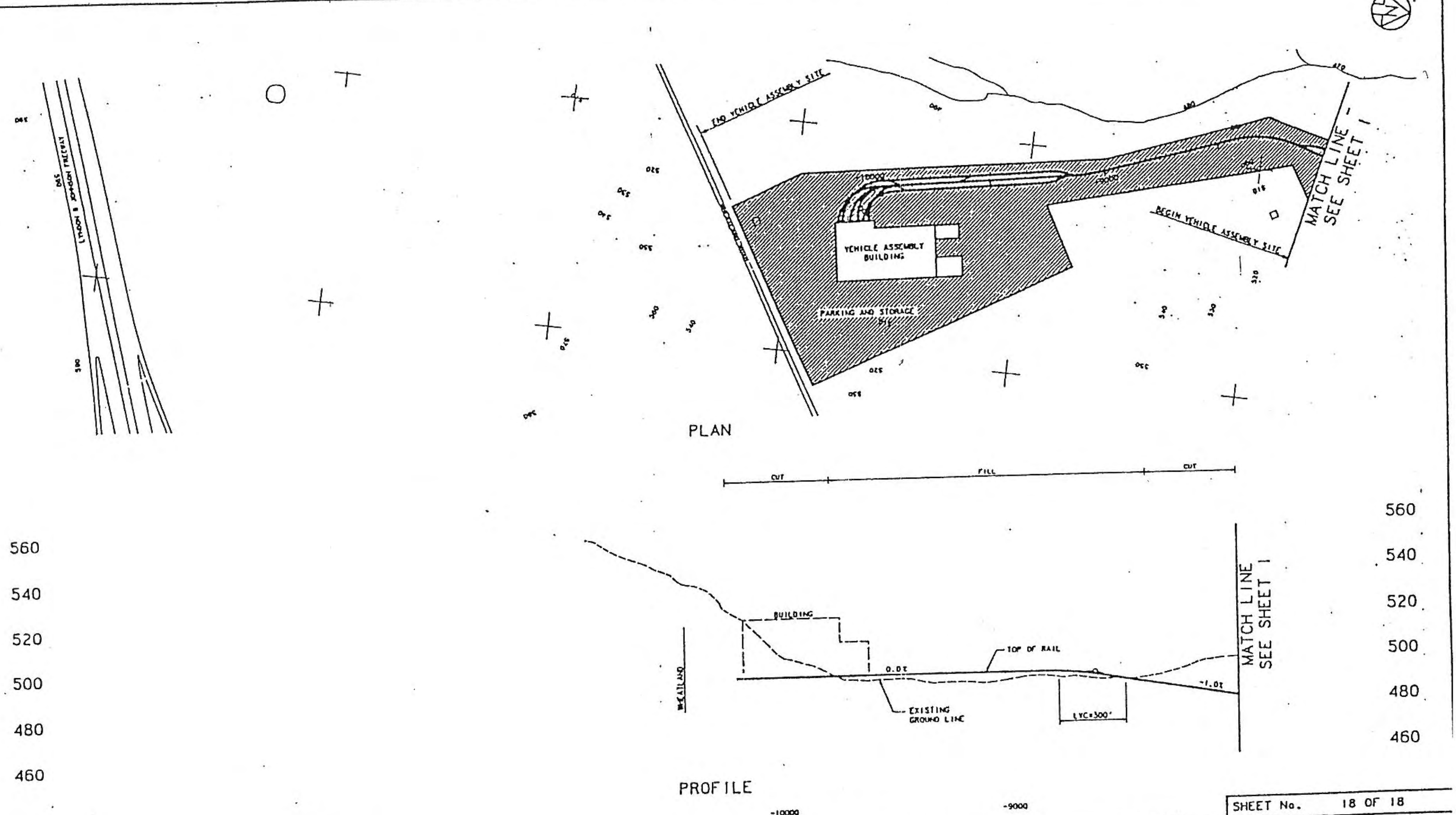
SHEET No. 16 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
WEST YARD LEAD
FROM 1,200Y TO 4,570Y

DRAWING No. GX3-0016



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	**DALLAS AREA RAPID TRANSIT PROJECT** **SOUTH OAK CLIFF CORRIDOR** FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE	SCALE (IN FEET) HORIZ 0 200 400 VERT 0 10 20 30 40	SCALE AS SHOWN DRAWN P. WATANYUTA DESIGNED GANNETT FLEMING CHECKED T. VON BRIESEN IN CHARGE D. ALLEN DATE JULY, 1991	SHEET No. 17 OF 18 REFERENCE PLAN AND PROFILE LIGHT RAIL TRANSIT SYSTEM SERVICE AND INSPECTION YARD FROM 4,570 TO 8,000 DRAWING No. GX3-0017



DART	Parsons Brinckerhoff 1701 N. MARKET ST. DALLAS, TEXAS 75202	DALLAS AREA RAPID TRANSIT PROJECT SOUTH OAK CLIFF CORRIDOR FINAL ENVIRONMENTAL IMPACT STATEMENT LOCALLY PREFERRED ALTERNATIVE	SCALE (IN FEET) HORIZ 0 200 400 VERT 0 10 20 30 40	SCALE AS SHOWN DRAWN P. WATUMYUTA DESIGNED J. HOPPIE CHECKED T. VON BRIESEN IN CHARGE D. ALLEN DATE JULY, 1991

SHEET No. 18 OF 18

REFERENCE PLAN AND PROFILE
LIGHT RAIL TRANSIT SYSTEM
VEHICLE ASSEMBLY SITE
AT CAMP WISDOM ROAD
FROM -8,020 TO -10,250

DRAWING No. GX3-0018

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South Oak Cliff Corridor

SECTION 106 MEMORANDUM OF AGREEMENT

Attachment B

SAMPLE PRESERVATION COVENANT

As additional consideration for the conveyance of the Property, Grantee, for itself, its successors and assigns, hereby covenants that all of the Property shall henceforth be held, sold and conveyed subject to the following covenants and restrictions, which are for the purpose of protecting and preserving the specific historic features or improvements located on the Property (the "Improvements"), said Improvements being specifically described in Exhibit B, attached hereto and incorporated herein by reference. Said covenants and restrictions shall run with the Property and be binding on all parties having or hereafter acquiring any right, title or interest in the Property or any part thereof, their heirs, personal representatives, successors and assigns, as follows:

1. Grantee shall preserve and maintain the Improvements in accordance with the recommended approaches in the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (National Park Service, 1983), incorporated herein by reference, as the same may be from time to time amended.

2. No construction, alteration, remodeling, disturbance of the ground surface or any other thing shall be undertaken or permitted to be undertaken on the Property which would affect the structural integrity or the appearance of the Improvements without the express prior written permission of the Texas State Historic Preservation Officer (SHPO), signed by a fully authorized representative thereof.

3. DART, the Urban Mass Transportation Administration, (" UMTA"), the President's Advisory Council on Historic Preservation (President's Council), the SHPO, and their duly authorized representatives, shall be permitted at all reasonable times to inspect the Improvements in order to ascertain if the above conditions are being observed.

4. In the event of a violation of this covenant, and in addition to any remedy now or hereafter provided by law, DART, UMTA, SHPO, or the President's Council may, following reasonable notice to Grantee, institute suit to enjoin said violation or to require the restoration of the Improvements. The prevailing party who asserted the action shall be entitled to recover all costs or expenses incurred in connection with such a suit, including all court costs and attorney's fees.

5. Grantee agrees that DART, UMTA, SHPO or the President's Council may, at its discretion, without prior notice to Grantee, convey and assign all or part of their respective rights and responsibilities contained herein to a third party or parties.

6. This covenant is binding on Grantee, its heirs, personal representatives, successors, and assigns, in perpetuity. All of the restrictions, stipulations and covenants contained herein shall be inserted by Grantee verbatim or by express reference in any deed or other legal instrument by which it divests itself of either the fee simple title or any other lesser estate in the Property or any part thereof.

7. The failure of DART, UMTA, SHPO, or the President's Council, to exercise any right or remedy granted under this instrument shall not have the effect of waiving or limiting the exercise of any other right or remedy or the use of such right or remedy at any other time.

The covenant shall be a binding servitude upon the Property and shall be deemed to run with the land. Execution of this covenant shall constitute conclusive evidence that Grantee agrees to be bound by the foregoing conditions and restrictions and to perform to obligations herein set forth.

MCF

RS

SYSTEM PLANNING

NOV 11 1992

RECEIVED
DALLAS AREA RAPID TRANSIT

THE STATE OF TEXAS

CURTIS TUNNELL
EXECUTIVE DIRECTOR

TEXAS HISTORICAL COMMISSION

P.O. BOX 12276
AUSTIN, TEXAS 78711
(512)463-6100

November 2, 1992

cc: Nick Novick
Espey, Huston + Assoc.
Tony Sosebee
ArchiTexas
PSD Rec'd 11/11/92
cc: P.F. 4-0218-01
P.F. 4-0222-__(SOC-1)
A. Zreet M. Franks
D. Kelly C. Melde
S. Brown

DEPARTMENT OF ARCHITECTURE

Mr. Kyle Keahey
Dallas Area Rapid Transit
601 Pacific Avenue
Dallas, Texas 75202

Re: *South Oak Cliff Corridor Light Rail Project, 30% plans, DART, Dallas, Dallas County, Texas (UMTA/106)*

Dear Mr. Keahey:

Thank you for sending the subject documents for our review and comment. We have conducted a review and have some comments and recommendations. We understand that some work has been done towards revising the proposed scope of work from this information which we reviewed.

The project Memorandum of Agreement stipulates that DART will acquire and stabilize the Monroe Shops, to prevent further deterioration, as soon as practicable after acquisition. Have the shops been acquired by DART, and if so, when were they acquired?

We are concerned that the Espy Huston report is directed towards "temporary stabilization" rather than stabilization and rehabilitation (as stipulated in the MOA) and restoration, rehabilitation and maintenance (as stipulated in the Final Environmental Impact Statement). As stabilization of the building has already been delayed for over a year, with the resulting deterioration, it is imperative that appropriate stabilization take place as soon as possible.

We do not concur that the proposed work would appropriately stabilize the building. We recently requested and received a copy of the ArchiTexas' "Preliminary Structural Conditions Assessment and Stabilization Recommendations of the Monroe Shops." Considering the deterioration which has already taken place, THC strongly recommends that work more closely aligned with the ArchiTexas report, options two and three, be proposed. It is most important that the roof be repaired/replaced, and that building not be left without a roof for any significant period of time.

Any woodwork removed, due to an unsafe condition, should be carefully documented prior to removal. Woodwork that can safely remain in place, such as windows, window and door frames, etc., should remain in place for future rehabilitation or replication. If doors must be removed, they should be carefully stored or documented for future replication. A careful definition of "ancillary buildings" and other elements proposed for demolition should be made in the proposal.

Methods for sealing doors and windows should also be defined. Drawings will be needed for review of proposed parapet caps, roof systems, etc. We look forward to reviewing a revised stabilization proposal for the Monroe Shops. A commitment has been made to stabilize the building. The proposal to bid the work on a unit cost basis and allow as much or as little work to be done as the budget will allow, is not consistent with this commitment.

Concerning other aspects of this 30% plan, there is not really enough design information for THC to comment on the appropriateness of design. We are concerned about the visibility of the Monroe Shops Building in conjunction with the station design, three hundred foot canopy and enclosed areas. Is design information available? We note the reference to the DART Design Criteria and Architectural Directive Drawings in the public art section. Would this information assist our office regarding the design? Once again, we are concerned that THC be involved in the process as agreed in the MOA.

Thank you for your interest in the cultural heritage of Texas, and for the opportunity to comment on this federally funded project in accordance with the Memorandum of Agreement and the National Historic Preservation Act, as amended. If you have any questions or concerns about this review please contact Linda Roark in the Department of Architecture at 512/463-6094.

Yours truly,

Stan Graves, AIA, DSHPO
Director
Department of Architecture

SG/LR
c: Jim Anderson, Dallas CLG
Claudia Nissley, Advisory Council on Historic Preservation

3,6,7 1993

**AMENDED MEMORANDUM OF AGREEMENT
AMONG THE FEDERAL TRANSIT ADMINISTRATION,
THE TEXAS STATE HISTORIC PRESERVATION OFFICER,
AND THE ADVISORY COUNCIL ON HISTORIC PRESERVATION
REGARDING THE SOUTH OAK CLIFF LIGHT RAIL
TRANSIT PROJECT, DALLAS, TX**

WHEREAS, the U.S. Department of Transportation, Federal Transportation Administration (FTA), formerly Urban Mass Transportation Administration, has determined that construction of the South Oak Cliff Light Rail Transit Project in Dallas, TX (Project) will have an effect upon properties which are included in or have been determined to be eligible for inclusion in the National Register of Historic Places, and has consulted with the Texas State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (Council) pursuant to 36 CFR Part 800, regulations implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f);

WHEREAS, the Project consists of the construction of a two-track, surface, light rail line extending from the tunnel portal associated with the locally-funded North Central Light Rail project near the North Central Expressway and Routh Street in the Dallas Central Business District (CBD) through the CBD as a transit mall then along existing railroad properties to a new bridge crossing the Trinity River near the Santa Fe Railroad trestle along a new transit right-of-way adjacent to a Texas Utilities Electric transmission line in South Oak Cliff to the area of Illinois Avenue then in the median of reconstructed Lancaster Road to a point south of Ledbetter Drive. Future construction will extend the above described undertaking along a new right-of-way to south of Camp Wisdom Road. The Project also includes a West Yard Lead along existing Santa Fe railroad property to a Service and Inspection Facility which will be constructed on the former Santa Fe Railroad freight yard and a Vehicle Assembly Plant which will be located to the south of the Camp Wisdom Road. Alignment plans and profiles for the Project are included as "Attachment A" to this Agreement;

WHEREAS, to the extent feasible the Project will be designed to meet current American Public Transit Association Noise and Vibration Criteria; and

WHEREAS, the City of Dallas through the Dallas Landmark Commission and the Dallas Area Rapid Transit (DART) participated in the consultation, and DART has been invited to concur in the Memorandum of Agreement;

WHEREAS, the consulting parties amended the MOA as a result of DART's decision to make changes to the Project, and the parties agree to the proposed changes;

NOW, THEREFORE, FTA, the SHPO, and the Council agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties.

Stipulations

FTA will ensure that the following measures are carried out:

1. DART will incorporate noise and vibration requirements into the trackwork, equipment, vehicle specifications, and official operating rules to minimize the potential of adverse effects to historic properties.

2. FTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have no adverse effect on the following historic properties: Commercial Building, 2101-2105 S. Denley Drive; Dealey Plaza at Main and N. Houston Streets; the South Rock Island/Texas Book Depository Building, 411 Elm Street; the John Deere Addition, 208-214 N. Houston Street; the Kingman-Texas Co. Building, 209-211 N. Record Street; the Parlin-Orrendorff Building, 601 Elm Street; the MKT Freight Station, 303-309 N. Record Street; the MKT Freight Station, 555 Ross Avenue; the Interstate Forwarding Building, 301-307 N. Market Street; the Sanger Bros. Garage, 711 Elm Street; the U.S. Post Office, 400 N. Ervay Street; and the John F. Kennedy Assassination Historic District, pending designation as a National Historic Landmark.

3. FTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have no adverse effect on historic properties provided that certain conditions outlined below are fulfilled:

a. **The Dallas Veterans Administration Hospital, Building 1, 4500 South Lancaster Road:** The adjacent transit station will be located in the median of Lancaster Road south of Mentor Avenue. Subsequent to the project's Final Environmental Impact Statement, the alignment of the light rail line and the location of the VA hospital station has been shifted to the east a distance of approximately 50 feet. This shift in alignment requires the use of VA Hospital property, and eliminates substantial business displacement on the west side of Lancaster Road. This revised alignment is illustrated in Attachment C. The design of this station will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5 below. Lighting for the station will be compatible with the historic character of Building #1 and will not adversely affect the view corridor from Lancaster Road to this building. Additionally, DART will provide the Department of Veterans Affairs (VA) with the opportunity to assist in the development of the station design and to review and comment on the proposed design. DART shall consider any comments provided by the VA and take steps to accommodate any concerns raised by these comments.

b. **The Texas Electrical Railway/Monroe Shops, 2020 S. Denley Drive:** DART will acquire this historic property for Project purposes. DART will take all reasonable steps to stabilize the Monroe Shops from further deterioration as soon as practicable after the acquisition, and will fund a rehabilitation report which will examine adaptive reuse opportunities for the structure. The design for the new transit station to be located to the west of the Monroe shops; the design of the Project-related parking lot to the north; the proposed actions to stabilize the building from further deterioration; and the rehabilitation report, including its scope of work, will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. After the completion of the rehabilitation report, DART will take steps to market the property for adaptive reuse according to the provisions set out in Stipulations 6. to 8. below. Pg. 6 → 7

c. **The Interurban Railway Bridge at the ATSF Railway:** DART will take all feasible steps to minimize damage to the bridge that may be caused during the construction of light rail tracks and retaining walls in the vicinity of the Interurban Railway Bridge.

d. **The ATSF Railroad Trestle at the Trinity River:** DART will take all feasible steps to minimize damage to the bridge that may be caused by its use of this property during the construction of a new bridge to cross the Trinity River. If DART determines to acquire the trestle, DART will maintain and protect it from damage until title has been transferred to a third party. DART will take steps to market the property according to the provisions set out in Stipulations 6. to 8. below, and agrees to take all reasonable steps to transfer or sell this structure to an appropriate third party for a period of 10 years from the date of this Agreement. If, at the end of this ten-year time period, DART is unsuccessful in efforts to transfer or sell this structure, FTA and DART will reinitiate consultation with the SHPO and the Council. DART will review the status of its marketing efforts with the SHPO on an annual basis.

e. **The South Control Tower #18, located in the 800 block of Memorial Drive:** If negotiations between DART and the owner of this property result in DART's purchase of the tower, DART will reuse it as a communications facility for the Project. DART will provide the SHPO with the opportunity to review and comment on any plans for the rehabilitation and adaptive reuse of this structure according to the provisions set out in Stipulation 5. below.

f. **The Union Terminal, 401 S. Houston Street:** The Project will necessitate the development of a transit station at Union Terminal. This will require the introduction of station platforms and canopies and will necessitate modifications to the existing track configuration. The design of these additions and modifications will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

g. **The Railroad Switch Control Tower #17, located near Pacific Avenue at the MKT Railroad:** DART will occupy and maintain this structure as a communications facility for the Project. Any plans for this use will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

h. **The Union Terminal Company Underpass (Triple Underpass), located over the intersection of Main, Elm, and Commerce Streets:** DART will utilize space formerly used for the two most eastern railroad tracks on the underpass for light rail use. DART will use catenary wire across the underpass to eliminate the need for poles on the underpass. The necessary poles at the ends of the underpass will be located so as to minimize changes to this structure. DART will provide a sidewalk between the easternmost track and the east facade of the underpass so visitors to Dealey Plaza can view it from the underpass. The design of these modifications will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. Additionally, DART will provide the National Park Service (NPS) with the opportunity to review and comment on these modifications to this contributing feature of the proposed National Historic Landmark District. DART shall consider any comments provided by NPS and take steps to accommodate any concerns raised by these comments.

i. **Dallas High School, 2214 Bryan Street:** DART proposes to locate a center platform transit station in the center of Bryan Street to the west of this historic property. The design of this station will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

j. **The West End Historic District:** DART proposes to construct a transit station on Pacific between Market and Lamar Streets and provide various amenities in conjunction with the light rail as it passes through the West End Historic District including a transit mall on Pacific between Houston and Lamar Street. The design of these features will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

4. FTA has determined, in consultation with the SHPO and the Council, that the construction of the Project on the alignment set out in "Attachment A" will have an adverse effect on 1334 Lynn Haven Avenue; the Roger Q. Mills Elementary School, 1515 Lynn Haven Avenue; the ATSF RR Control Tower #19 on the ATSF Railway Line at the MKT Line; and Roger's Garage, 2310 S. Lancaster Road. The parties have developed the following measures to reduce or mitigate the identified adverse effects of the Project:

a. DART will minimize the audible effects of the warning devices at the Lynn Haven Avenue grade crossing by limiting their operation to the shortest period of time possible during gate arm raising and lowering. This grade crossing is approximately 75 feet west of residence located at 1334 Lynn Avenue and approximately 200 feet east of the Mills Elementary School. The warning devices will not be sounded while the gate arms are fixed in the lowered position. DART has agreed to operate trains through this crossing at no more than 45 mph to avoid exceeding the American Public Transit Association Noise Criteria for this land use. If it is determined after the Project is operational that the DART operating speeds exceed 45 mph at the Lynn Haven Avenue grade-crossing, DART will construct noise barrier walls to mitigate the unacceptable noise levels. The design of any such noise barrier walls will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below.

b. The light rail line will be elevated in the vicinity of Control Tower #19 in order to cross over the mainline tracks of the Union Pacific. As this necessitates the removal of the structure from its original location, DART proposes to relocate the tower for transit-related purposes as a communications facility. Plans for the relocation of this structure as well as plans for its rehabilitation will be developed by DART in consultation with the SHPO and provided to the SHPO for review and comment pursuant to Stipulation 5. below. If reuse by DART is not feasible, DART will fund relocation costs and will take steps to market the property according to the provisions set out in Stipulations 6. to 8. below. DART shall complete documentary recordation of Control Tower #19 prior to its relocation pursuant to Stipulation 9. below. DART shall notify the SHPO within 90 days after the tower has been relocated and will reevaluate it on the new site in consultation with the SHPO to determine its National Register eligibility.

c. The light-rail line will be elevated in the vicinity of Rogers Garage to cross over Illinois Avenue. As this introduces visual and audible elements that alter the setting, DART will photograph Rogers Garage and the immediate surrounding area. No less than five, 8 X 10 inch black and white photographs will be taken by DART and provided to the SHPO and the Texas Dallas History Collection at the Dallas Public Library.

5. DART will make every effort to ensure that the design of light rail structures, including station platforms, canopies, artworks, tracks and overhead traction power systems, traction power substations, and communications bungalows, which may have an effect on historic properties will be designed to be compatible with the affected historic property and conform to the guidance contained in the Secretary of the Interior's Standards and Guidelines for Rehabilitation Historic Buildings (U.S. Department of the Interior, National Park Service, 1983 amended 1990). DART will use directional lighting fixtures in those areas adjacent to historic properties so that light and glare from DART facilities will not extend beyond the functional use of the facility. DART will provide the SHPO with the opportunity to review and comment on the proposed design at the 30%, 65%, and 95% design stages. DART shall provide the SHPO with the opportunity to review and comment on the Scope-of-Work, Interim Draft, and if needed, Final Draft of any report required by this Agreement.

6. DART shall prepare and implement a marketing plan for each historic property which will be relocated and/or sold according to the terms of this Agreement in consultation with the SHPO. This plan will, at a minimum, include the following information about the property:

a. photographs of the property, a parcel map and information on the property's historic significance;

b. information on each property's purchase price, if any; a good faith estimate of the cost of properly moving the structure; and a statement regarding which party will be responsible for the various costs associated with this move;

c. information on possible financial assistance and Federal, state, or local tax benefits for the rehabilitation of historic properties;

d. notification that the recipient will be required to move the structure in accordance with the recommended approaches to moving in the Department of the Interior's Moving Historic Buildings utilizing the services of a professional mover who has the capability to move historic structures properly;

e. notification that the recipient(s) will be required to rehabilitate and maintain the property in accordance with the recommended approaches in the Standards; and

f. notification of the requirement for the inclusion of a preservation covenant or easement in the transfer documents that will be recorded in the County's official property records. This restriction will be similar to the covenant included in "Attachment B" to this Agreement and is intended to restrict development; require maintenance of those aspects of the property that make it eligible for inclusion in the National Register; designate a monitoring party; and be in perpetuity. If the historic property will be relocated, DART will ensure that the covenant is recorded as soon as practicable after the improvement is permanently situated on its new site.

7. Prior to the acceptance of any offer, DART shall review all offers in consultation with the SHPO and shall identify a preferred offer for each property. The SHPO shall be afforded thirty days to review and comment on each preferred offer and the new site proposed for the relocation of the property.

8. If DART receives no offer conforming to the requirements cited in Stipulation 6. above for moving, relocating, rehabilitating, and maintaining a historic property, DART, with the written concurrence of the SHPO, may transfer a property subject to other requirements or lesser restrictions.

9. Prior to the alteration or relocation of Control Tower #19, DART shall contact the Rocky Mountain Regional Office of the National Park Service, HABS/HAER to determine the level and kind of recordation required for the property. Unless otherwise agreed to by the National Park Service, the Service shall ensure that all required recordation measures for the affected property are completed and accepted by the National Park Service prior to its alteration or relocation, and that copies of this documentation are made available to the SHPO and any appropriate local archives designated by the SHPO.

10. DART shall provide the City of Dallas, Dallas Landmark Commission with the opportunity to review and comment on all aspects of the Project that may affect a locally designated landmark through the process set out in the city of Dallas Development Code, 51A-3.103 (Landmarks Commission).

11. DART has completed approximately 80% of the intensive survey program for archeological historic properties with in the corridor of the Locally Preferred Alternative design. This survey will be completed as soon as reasonably possible after DART has acquired unconditional access to all tracts of land within the corridor. When the intensive survey is complete, DART will provide the SHPO with a copy of the final report documenting the research and findings. Additionally DART will conduct further archival research on the Brady farmstead located to the south of the proposed Camp Wisdom Station and the late 19th Century farmhouse site located in the proposed Ledbetter Station area. Although it has been determined that these properties are not eligible for inclusion under National Register Criterion D, DART and the SHPO

have determined that this archival research should be conducted to determine if the property may be eligible under National Register Criteria A and B.

12. DART shall consult with the SHPO if archeological properties are discovered during the completion of the intensive survey program to determine if any such property may be eligible for inclusion in the National Register. DART shall notify the SHPO as soon as practicable after such a property has been identified, and the SHPO shall review the assessment of eligibility and all supporting documentation within 21 calendar days of DART's notice. If the property is determined to be eligible for inclusion in the National Register, DART shall consult with the SHPO to identify project alternatives that may allow the site to be preserved in place. If preservation in place is not feasible, DART will consult further with the SHPO to develop a data recovery plan for the recovery of archeological data from the property. This plan will be prepared by a professional archeologist who meets the Secretary of the Interior's Professional Qualifications Standards (48 FR 44738-9). The plan shall be consistent with the Secretary of the Interior's Standards and Guidelines for Archeological Documentation (48 FR 44734-37) and take into account the Council's publication Treatment of Archeological Properties and any relevant SHPO guidance. The plan shall be submitted to the SHPO and the Council for 30 days review, and unless the SHPO or Council objects within 30 days after receipt of the plan it shall be implemented as proposed. The data recovery plan shall specify, at a minimum:

a. the property or properties on which data recovery will be carried out;

b. the research questions to be addressed through the data recovery, with an explanation of their relevance and importance;

c. the methods to be used, with an explanation of their relevance to the research questions;

d. the treatment of any human remains that may be encountered during data recovery; and

e. a plan for dissemination of results of the work and duration of recovered material consistent with 36 CFR Part 79.

13. In the event that the Project will affect a previously unidentified property that may be eligible for inclusion in the National Register or affect a known historic property in an unanticipated manner, DART shall require work in the area of the discovery to cease until actions that will take into account the effects of the undertaking on the property can be implemented. DART shall immediately notify FTA of the discovery and provide FTA with the information required to request the SHPO's and Council's comments pursuant to 36 CFR 800.11(b) (2) (ii).

14. Should the SHPO or Council object within 30 days to any reports, plans, specifications, or other documentation provided for review pursuant to this Agreement, DART shall consult further with the objecting party to resolve the objection. If DART determines that the objection cannot be resolved, DART shall notify FTA which may forward all documentation relevant to the dispute to the Council. Within 30 days after receipt of all pertinent documentation, the Council will either: 1) provide FTA with recommendations, which FTA will take into account in reaching a final decision regarding the dispute; or 2) notify FTA that it will comment pursuant to 36 CFR 800.6(b) and proceed to comment. Any recommendation or comment provided by the Council will be understood to pertain only to the subject of the dispute, and FTA's responsibility to ensure the completion of all actions required under this Agreement that are not the subject of the dispute will remain unchanged.

15. At any time during the implementation of the measures stipulated in this Agreement, should an objection to any such measure or its manner of implementation be raised by a member of the public, FTA shall take the objection into account and consult as needed with the objecting party, the SHPO, or the Council to resolve the objection.

16. FTA shall immediately notify the SHPO and Council of any substantial changes to the Project as described in Final Environmental Impact Statement. FTA will provide the SHPO and Council with copies of any reports developed pursuant to this Agreement. FTA will also provide these reports to interested parties upon request.

17. Any party to this Agreement may request that it be amended, whereupon the parties will consult in accordance with 36 CFR 800.5(e) (5) to consider such amendment.

18. If FTA cannot carry out the terms of the Agreement, it shall not take or sanction any actions or make any irreversible commitment that would result in an adverse effect to a historic property or would foreclose the Council's consideration of modifications or alternatives to the Project that could avoid or mitigate the adverse effect until FTA has again requested the Council's comments in accordance with 36 CFR Part 800.

EXECUTION OF THIS MEMORANDUM OF AGREEMENT and implementation of its terms evidences that the Federal Transit Administration has afforded the Council an opportunity to comment on the South Oak Cliff Light Rail Transit Project and the effect of this undertaking on historic properties, and that the Federal Transit Administration has taken into account the effect of the undertaking on historic properties.

This amended Memorandum of Agreement encompasses the entire agreement between the parties and replaces any agreements previously negotiated regarding this undertaking.

FEDERAL TRANSIT ADMINISTRATION

By: Wilbur E. Hare Date: 9/8/93
Wilbur E. Hare
Regional Administrator

TEXAS STATE HISTORIC PRESERVATION OFFICER

By: Curtis Tunnell Date: 9/27/93
Curtis Tunnell
Executive Director, Texas Historical Commission and State Historic Preservation Officer

ADVISORY COUNCIL ON HISTORIC PRESERVATION

By:______________________ Date:____________
Dr. Robert Bush
Executive Director

CONCUR:

DALLAS AREA RAPID TRANSIT

By: Victor H. Burke Date: 9/20/93
Victor H. Burke
General Manager

OK

TEXAS HISTORICAL COMMISSION
P.O. BOX 12276 AUSTIN, TEXAS 78711-2276 (TELEPHONE) 512/463-6094 (FAX) 512/463-6095

DATE: 2.17.95 **TIME OF MEETING:** 2:00 p.m.

ATTENDING: Kyle Keahey, DART
Lyle Bergen and Brent Byers, Corgan Assoc.
Dennis Henning, project engineer
Linda Roark, THC

SUBJECT, PROJECT NO., ETC.:
Monroe (Interurban) Shops, Dallas Area Rapid Transit, Dallas, Dallas County

CASE HISTORY:

DART acquired this building as part of its South Oak Cliff light rail line, now under construction. They have asked that Corgan Associates develop an outline plan for potential developers on appropriate work for the facility.

DETAILS OF DISCUSSION:

We discussed cutting a new opening, for entry into the main room. The main room is planned as an exhibit area.

- The stabilized metal parapet cap may be left in place.
- New windows should match the historic window configuration, but may be of a different material.
- They would like to get an old Interurban car for display within the building, and lay some railing.
- Infill large bay openings with partially shut rolling door and glass set back of the opening.
- Entry canopy/pavilion should be compatible, simple, and not connected to the building.
- Signage should be compatible, simple, and have framework attachment for changeable signs to reduce multiple attachments to the building.

I asked for a copy of the request for proposals for our review. Kyle said that THC would get one.

REPORT BY: Linda Roark

TITLE: Project Reviewer **OFFICE:** Division of Architecture

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TEXAS HISTORICAL COMMISSION

George W. Bush • *Governor*
John L. Nau, III • *Chairman*
Curtis Tunnell • *Executive Director*

The State Agency for Historic Preservation

DEPARTMENT OF ARCHITECTURE

January 30, 1997

Mr. Kyle Keahey
Dallas Area Rapid Transit
P.O. Box 660163
Dallas, Texas 75266-0163

Re: *Monroe Shop Building, replacement wood windows, Dallas Area Rapid Transit, Dallas, Dallas County, Texas (FTA & FHWA-ISTEA/106)*

Dear Mr. Keahey:

Thank you for having the information regarding the subject project sent for our review. As the State Historic Preservation Office (SHPO), Texas Historical Commission reviews federal undertakings in accordance with the National Historic Preservation Act. The Department of Architecture reviews determinations of effect for federal projects on National Register eligible buildings, structures, objects, and districts.

We are not able to offer a determination of effect for the overall project, since full project information has not been received. However, we have reviewed the information on the proposed wood replacement windows and have the following comments and recommendations regarding the proposed project changes:

- The proposed wood replacement windows, and all other windows in this project should have clear glazing, and not green tinted glass as proposed. A clear low-e glass may be acceptable; please provide us with a review sample and product data sheet if you wish to propose low-e glass.
- Our office has never received the documentation (photographs, section and elevation detail drawings) of the deteriorated historic wood windows removed from the building during the previous stabilization effort. This documentation was required as part of the conditions for approval of the stabilization work. However, we understand that this documentation was not done, and does not exist. Therefore, if the light configuration of the proposed replacement wood windows will match the light configuration of each historic window in each opening, we concur with the use of the proposed wood windows as compatible with the historic character of the building, with the exception of the proposed tinted glass as noted above.

Thank you for the opportunity to comment on this project in accordance with the National Historic Preservation Act, as amended. We look forward to receiving and reviewing the additional information requested. If you have any questions or concerns about this review please contact Linda Roark in the Department of Architecture at 512/463-9122. This letter does not indicate review or approval for rehabilitation tax credits (Historic Preservation Certification).

Yours truly,

Stan Graves, AIA, DSHPO
Director
Department of Architecture

SG/LR
c: Tom Dohearty, Corgan Associates, Inc.
Jean Sims, Dallas County Historical Commission
Jim Anderson, Dallas CLG
Tom Eisenhour, TxDOT Environmental Affairs Division

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DART

Dallas Area Rapid Transit
P.O. Box 660163
Dallas, Texas 75266-0163
214/749-3278

JUL 22 1999

July 9, 1999

F. Lawrence Oaks
State Historic Preservation Officer
Texas Historical Commission
108 West 16th Street
Austin, TX 78701

Attn: Ms. Linda Roark

RE: Status of 1991 Memorandum of Agreement under Section 106 of the National Historic Preservation Act; Dallas Area Rapid Transit (DART) South Oak Cliff Light Rail Project

Dear Mr. Oaks:

On August 8, 1991, *the Memorandum of Agreement Among the Urban Mass Transportation Administration* [now the Federal Transit Administration (FTA)], the *Texas State Historic Preservation Officer* (THC), and the *Advisory Council on Historic Preservation* (Council) *Regarding the South Oak Cliff Light Rail Transit Project, Dallas, TX* (MOA) was fully executed. Now that the South Oak Cliff Light Rail Project has been constructed and is fully operational, DART has reviewed its implementation of the terms in the MOA. On behalf of the FTA, DART has prepared this letter to report to the THC and the Council on the current status of MOA compliance and to open consultation for its successful termination.

This letter summarizes the content of the attached matrix which presents in detail:

1) the complete text of each numbered stipulation in the MOA;
2) a breakdown of each related task and its responsible party and;
3) a summary of the compliance record for each task, including dated references to related activities and correspondence.

Several of the stipulations were resolved within months of execution of the MOA when design specifications were formally incorporated into FTA's Record of Decision for the South Oak Cliff Light Rail Project, dated October 25, 1991. The design specifications included noise and vibration mitigation (#1) and criteria to maintain low operating speeds near the ***Residence at 1334 Lynn Haven*** (#4a) and the ***Roger Q. Mills Elementary School*** (#4a). The ***Interurban Railway Bridge*** (#3c) was avoided entirely by the selection of Alternative Curve C, which provided a curvature that prevented the partial damage that would have been caused by selection of Alternative Curves A or B.

Unanticipated effects on several historic properties resulting from design changes implemented after execution of the MOA were all resolved through consultation with the THC by February 3, 1993. The need for a grade separation at Illinois Avenue in the vicinity of ***Roger's Garage*** (#2) resulted in THC's concurrence with a finding of No Adverse Effect. DART adopted the design recommended by the THC for a transit station in the center of Bryan Street to avoid potential effects on ***Dallas High School*** (#3i). The transit station location near the ***Veteran's Administration Hospital Building 1*** (#3a), was shifted from the median to the edge of Lancaster Road, requiring partial acquisition of the Veteran's Administration (VA) property. Although THC concurred with a finding of No Adverse Effect, the issue became moot when the VA built new buildings between the historic property and the site of the then unbuilt DART station.

In 1992-1993, DART consulted with THC on its design near the dense group of historic properties in Dallas' west end by submitting the *CBD Transitway Mall Presentation and CBD Transitway Mall 100% Design* booklets and the *Preliminary Union Station and West End Historic District Art and Design Program Summary Report.* The City of Dallas is a Certified Local Government, therefore, DART also held numerous meetings with the City of Dallas Landmark Commission (#10) and the West End Task force, who unanimously approved the design presented to the THC. Several of the historic properties in this area also contribute to the Dealy Plaza National Historic Landmark, so DART consulted with the National Park Service to minimize project effects. All design issues were resolved with THC by March 5, 1993, including: the transit station and amenities in the ***West End Historic District*** (#3j); the transit station design at the ***Union Terminal*** (#3f); the modification and use of the ***Union Terminal Company Underpass*** (#3h); and the acquisition and rehabilitation of ***South Control Tower #18*** (#3e) and ***Railroad Switch Control Tower #17*** (#3g) and their incorporation into the South Oak Cliff Light Rail Project as communications and signal facilities.

Stipulation #3b required that DART acquire, stabilize, and prepare a rehabilitation report for the ***Texas Electric Railway Monroe Shops***, develop a compatible transit station and parking lot design, and market the historic property for adaptive reuse. DART acquired the property, but the THC raised several concerns about the stabilization plans and transit station design during its review of the 30% and 65% plans. THC reviewed the 95% plans on March 22, 1993, had no objection to the plans for the stabilization of *Monroe Shops* if certain provisions were met, and made no objections to the transit station design. Following stabilization, DART successfully marketed the *Monroe Shops* for adaptive reuse, and in 1996 a TXDOT/ISTEA Grant funded an Adaptive Reuse/Tax Certification project.

On April 3, 1998, the National Park Service accepted Part I of the Tax Certification Application, indicating that the Monroe Shops were still eligible for the National Register after stabilization. Technically, the successful marketing of the *Monroe Shops* would have completed the requirements of Stipulations #3b, #5, #6,# 7, and #8 in the MOA. Unfortunately, the subsequent TXDOT/ISTEA-funded adaptive reuse project on DART's property was not done in accordance with the THC's recommendations. Con-Real Development did not submit the adaptive re-use designs to THC until April 3, 1996, when they were at 100% completion. Although there was a great deal of consultation, Con-Real Development proceeded with the work without incorporating the THC's recommendations to DART. The THC has stated its objection to the adaptive reuse project as constructed, and consultation among THC, DART, and Con-Real Development is continuing in the hope of resolving this issue.

Stipulations #6, #7 & #8 presented procedures for marketing historic properties that would be sold or moved. The only property sold or moved by DART was ***AT&SF Control Tower #19*** (#4b). DART prepared HAER documentation for this historic property, which was accepted by the National Park Service on March 4, 1992 (#9) and won an Award in Architecture from THC the following year. On August 14, 1996, *Tower 19* was relocated to the Age of Steam Museum in Dallas' historic Fair Park, where it is a permanent exhibit and is now undergoing an extensive restoration program. The only property still requiring marketing is the ***ATSF Railroad Trestle*** (#3d). DART minimized damage to the *Trestle* because it provided an essential service during construction--it was used to send equipment and materials across the Trinity River while DART constructed a new, parallel bridge. The *Trestle* was rehabilitated by AT&SF shortly before acquisition by DART, remains in good repair, and has its river debris cleared by DART as routine maintenance. DART was also required to market the *Trestle* for a ten year period in an attempt to find a suitable third party owner, and recently a good prospect has emerged. The Trinity River Corridor Citizens Committee Status Report, dated January 20, 1999, recommends that the AT&SF trestle be incorporated into the design of the Marsalis/Santa Fe/Fair Park Trail funded through the State Transportation Enhancement Program (STEP), with matching funds approved by the voters on May 2, 1998. DART staff was contacted by City of Dallas staff in June of this year regarding the transfer of the *Trestle* to the City for its use in this regional trail project.

The final non-procedural Stipulations, #12 and #13, regard DART's treatment of ***archaeological resources***. On October 12, 1996, DART completed its archaeological requirements when the THC accepted the Final Report for Antiquities Permit #1443, South Oak Cliff Investigations. No archaeological properties were discovered after the MOA was executed.

As shown above, DART has successfully completed all the terms of the MOA with the exception of two historic properties which require continuing consultation with the THC: the *Monroe Shops* and the *AT&SF Trestle*. These remaining issues will be resolved if THC and Con-Real can agree on a mutually acceptable design solution for the Monroe Shops, and if the AT&SF Trestle is incorporated into the design, or acquired for use in the Marsalis/Santa Fe/Fair Park Trail, or other appropriate project. Therefore, DART is now requesting the opinion of the THC, Council, and FTA on the best way to resolve these remaining two issues and to successfully terminate the South Oak Cliff Light Rail Project MOA.

If you have any questions, please feel free to call Dr. Reed Everett-Lee at (214) 749-2828.

Sincerely,

Roger Snoble
President/Executive Director

RS:REL:fp

enclosure: DART South Oak Cliff Light Rail Project MOA Compliance Matrix

c: John M. Fowler, Executive Director, Council
Lee Keatinge, Program Analyst, Western Office of Review, Council
Lee Waddleton, Director Region VI, FTA
Joe Ossi, Office of Grants Management, FTA
Myra Frank, Myra L. Frank & Associates, Inc.
Richard Starzak, Myra L. Frank & Associates, Inc.
Dr. Reed Everett-Lee, Ph.D., AICP, DART
Beverly LaBenske, DART

file copy

INTEROFFICE MEMORANDUM

DATE: March 21, 2006

TO: Doug Allen

FROM: Steve Salin

SUBJECT: Status of Monroe Shops

In order to finalize the terms of the agreement of the 1991 South Oak Cliff (SOC) Memorandum of Agreement (MOA) as incorporated in the Final Environmental Impact Statement (FEIS); Dallas Area Rapid Transit (DART) is making efforts to resolve all outstanding issues in the MOA. Pursuant to this, it is DART's intent to complete the process of bringing the structure into Texas Historic Commission (THC) compliance and establish an adaptive reuse for the historic property.

In April of 1994, a Surface Transportation Enhancement Program (STEP) Grant was awarded in the amount of $2,126,000 for the rehabilitation of Monroe Shops. In September of 1995, with all parties in agreement, these funds were transferred to FTA control. In May of 1998, after rehabilitation of the structure, FTA refunded to TxDOT the unused portion of the STEP Grant funds in the amount of $165,040.

Since the initial renovation of the structure, several modifications have been made to the building that did not comply with THC standards for rehabilitation. DART is working with the State Historic Preservation Office (SHPO) to determine what work has been completed and is deemed acceptable and what work remains outstanding. Based on on-going coordination with the SHPO the following constitutes the remaining outstanding issues:

- Execute a new MOA between FTA, DART and SHPO
- Determine what is feasible to address the issue with the steel windows
- Address issues with doors and transom west of the main entrance
- Address issue concerning the brick bollards at the north entrance
- Address issue concerning the parapet cap
- Develop a history of Monroe Shops for donation to THC and Dallas Public Library
- Reinstall two historic sliding doors
- Address issue concerning the columns in the southeast room
- Ensure that the mezzanine has not expanded
- Ensure that the remaining crane tracks are not removed
- Remove the door awnings

In March 2005, DART initiated a requests for proposal (RFP) process for the adaptive reuse of Monroe Shops. The intent of the RFP was to sell the building to a development team that will develop the building for a transit oriented use. In October 2005, the DART Board authorized entering into negotiations with a development team for the adaptive reuse project.

DART has been working with the SHPO and the developer to establish the roles and responsibility of bring the project into compliance. Complicating the issue was September 9, 2005 letter from Texas Department of Transportation (TxDOT) expressing concerns regarding the STEP grant requirements associated with the Monroe Shops. This letter indicated that failure to bring the project into compliance by March 30, 2006 would result in cancellation of the project and withdrawal of the funds.

Normally, TxDOT would have oversight responsibilities for STEP Grant projects; however, DART has asserted that the 1995 action to transfer the funds to FTA should have eliminated TxDOT of responsibility for this project. In a March 13, 2006 meeting TxDOT acknowledged that DART's position was accurate for the bulk of the funds, but maintained that the unused portion of the original funds remain in TxDOT oversight.

In a May 17, 2006 letter to TxDOT, DART relinquished any claim to the unused $165,040 that were originally returned to TxDOT in May of 1998. This action eliminates TxDOT from involvement in the Monroe Shops project and allows DART to continue working with the SHPO and the developer without additional encumbrances.

Stephen L. Salin, AICP
Assistant Vice President
Capital Planning and Development

SS/vi

C: Jack Wierzenski
John Hoppie
Victor Ibewuike

TEXAS HISTORICAL COMMISSION
The State Agency for Historic Preservation

RICK PERRY, GOVERNOR
JOHN L. NAU, III, CHAIRMAN
F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

August 1, 2006

Dallas Area Rapid Transit
Attn: Victor Ibewuike
1401 Pacific Avenue
Dallas, Texas 75202

Re: Nomination to the National Register of Historic Places, Dallas, Dallas County, Texas

Monroe Shops, *2111 South Corinth Street*

Dear Mr. Ibewuike:

We are pleased to inform you that the above-mentioned property will be considered by the State Board of Review for nomination to the National Register of Historic Places at their meeting on September 30, 2006 at 8:30 a.m. in the Grace United Methodist Church, at 4105 Junius, Dallas, Texas.

The National Register is the federal government's official list of historic properties worthy of preservation. Listing in the National Register provides recognition, assists in preserving our nation's heritage and results in the following for historic properties:

1. Consideration in planning for federal, federally licensed, and federally assisted projects. Section 106 of the National Historic Preservation Act of 1966 requires that federal agencies allow the Advisory Council on Historic Preservation to have an opportunity to comment on all federally related projects affecting historic properties listed in the National Register. For further information on this federal regulation, please refer to 36 CFR 800 promulgated under the authority of the National Historic Preservation Act of 1966 (as amended). Copies are available through the Texas Historical Commission, the National Park Service, or online at www.cr.nps.gov/linklaws.htm.

2. Eligibility for federal tax provisions. If a property is listed in the National Register, certain federal tax provisions may apply. The Tax Reform Act of 1986 revises the historic preservation tax incentives authorized by Congress in the Tax Reform Act of 1976, the Revenue Act of 1978, the Tax Treatment Extension Act of 1980, the Economic Recovery Tax Act of 1981, and the Tax Reform Act of 1984. As of January 1, 1987, the Tax Reform Act provides for a 20% investment tax credit for rehabilitating historic commercial, industrial, and rental residential buildings. The former 15 % and 20 % Investment Tax Credits (ITCs) for rehabilitations of older commercial buildings are combined into a single 10 % ITC for commercial or industrial buildings built before 1936. The Tax Treatment Extension Act of 1980 provides federal tax deductions for charitable contributions for conservation purposes of partial interests in historically important land areas or structures. Whether these provisions are advantageous to a property owner is dependent upon the particular circumstances of the property and the owner. Because tax aspects as outlined above are complex, individuals should consult legal counsel of the appropriate local Internal Revenue Service office for assistance in determining the tax consequences of the above provisions. For further information on this federal regulation, please refer to 36 CFR 67, which implements the federal tax incentives. Copies are available through the Texas Historical Commission, the National Park Service, or online at www.cr.nps.gov/linklaws.htm.

P.O. BOX 12276 • AUSTIN, TX 78711-2276 • 512/463-6100 • FAX 512/475-4872 • TDD 1-800/735-2989
www.thc.state.tx.us

3. Consideration in issuing a surface coal mining permit: In accordance with the Surface Mining Control and Reclamation Act of 1977, there must be consideration of historic values in the decision to issue a surface coal mining permit where coal is located. For further information on this federal regulation, please refer to 30 CFR 700 et seq promulgated under the authority of the Surface Mining and Reclamation Act of 1977. Copies are available through the Texas Historical Commission, the National Park Service, or online at www.cr.nps.gov/linklaws.htm

4. Qualification for federal grants for historic preservation when funds are available.

National Register listing does not:

1. require the owner to provide public access,
2. obligate the owner to maintain the property,
3. require notification of changes in ownership, or
4. impose restrictive covenants (unless grant assistance is received or tax credits are taken.)

Owners of private properties nominated to the National Register of Historic Places have an opportunity to concur in or object to listing in accordance with the National Historic Preservation Act and 36 CFR 60. Any owner or partial owner of private property who chooses to object to listing may submit to the State Historic Preservation Officer a notarized statement certifying that the party is the sole or partial owner of the private property and objects to the listing. If a majority of the owners object to the listing, the property will not be listed. Each owner or partial owner of private property has one vote regardless of how many properties or what part of the property that party owns. If the property cannot be listed because a majority of owners object prior to the submission of a nomination by the State, the State Historic Preservation Officer shall submit the nomination to the Keeper of the National Register for a determination of eligibility of the property for listing in the National Register. If the property is then determined eligible for listing, although not formally listed, federal agencies will be required to allow the Advisory Council on Historic Preservation an opportunity to comment before the agency may fund, license, or assist a project which will affect the property. If you choose to object to the listing of your property, the notarized objection must be submitted to F. Lawerence Oaks, State Historic Preservation Officer, Texas Historical Commission, P.O. Box 12276, Austin, TX, 78711, by September 29, 2006.

If you wish to comment on the nomination of the property to the National Register, please send your comments to the State Historic Preservation Officer before the State Board of Review considers this nomination on September 30, 2006. A copy of the nomination and information on the National Register and federal tax provisions are available upon request. If you have any questions, please contact Gregory W. Smith, National Register Coordinator, at (512) 463-6013.

Sincerely,

Cynthia J. Beeman

Cynthia J. Beeman
Director, History Programs Division

CJB/jgg

TEXAS
HISTORICAL
COMMISSION

The State Agency for Historic Preservation

RICK PERRY, GOVERNOR

JOHN L. NAU, III, CHAIRMAN

F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

March 26, 2007

Dallas Area Rapid Transit
1401 Pacific Avenue
Dallas, Texas 75266-7213

RE: Monroe Shops
2111 South Corinth Street
Dallas, Dallas County, Texas
March 7, 2007

Dear property owner:

Congratulations! The National Park Service listed your property in the National Register of Historic Places on the date referenced above. As the nation's official list of historically significant properties, National Register listing denotes that your property is especially worthy of preservation. Your property joins some 2700 properties in Texas with this designation.

Various historic preservation programs may be available to aid in the preservation of your property, including investment tax credits for certain income producing properties. Although funding is limited, grants may also be available to aid in the further preservation of your property. For more information regarding grant programs, contact the THC's Division of Architecture at 512/463-6094.

Enclosed is a certificate of listing and an application for a National Register plaque should you wish to purchase one through the Texas Historical Commission.

Thank you for all your efforts to recognize this historic property. Your continued interest in the preservation of Texas' heritage is greatly appreciated.

Sincerely,

F. Lawerence Oaks
State Historic Preservation Officer

Enclosures

P.O. BOX 12276 • AUSTIN, TX 78711-2276 • 512/463-6100 • FAX 512/475-4872 • TDD 1-800/735-2989
www.thc.state.tx.us

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TX.DL.0060

(Oct. 1990)
United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
REGISTRATION FORM

RECEIVED 2280

JAN 2 3 2007

NAT. REGISTER OF HISTORIC PLACES
NATIONAL PARK SERVICE

1. NAME OF PROPERTY

HISTORIC NAME: Monroe Shops
OTHER NAME/SITE NUMBER: N/A

2. LOCATION

STREET & NUMBER: 2111 South Corinth Street
CITY OR TOWN: Dallas
STATE: Texas **CODE:** TX **COUNTY:** Dallas

NOT FOR PUBLICATION: N/A
VICINITY: N/A
CODE: 113 **ZIP CODE:** 75216

3. STATE/FEDERAL AGENCY CERTIFICATION

As the designated authority under the National Historic Preservation Act, as amended, I hereby certify that this (x nomination) (__ request for determination of eligibility) meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property (x meets) (_ does not meet) the National Register criteria. I recommend that this property be considered significant (_ nationally) (_ statewide) (x locally). (__ See continuation sheet for additional comments.)

Signature of certifying official — Date: 1-9-07

State Historic Preservation Officer, Texas Historical Commission
State or Federal agency and bureau

In my opinion, the property ___meets ___does not meet the National Register criteria. (__ See continuation sheet for additional comments.)

Signature of commenting or other official — Date

State or Federal agency and bureau

4. NATIONAL PARK SERVICE CERTIFICATION

I hereby certify that this property is:

	Signature of the Keeper	Date of Action
✓ entered in the National Register ___ See continuation sheet.	for Edson H. Beall	3.7.07
___ determined eligible for the National Register ___ See continuation sheet		
___ determined not eligible for the National Register		
___ removed from the National Register		
___ other (explain): ____________		

5. CLASSIFICATION

OWNERSHIP OF PROPERTY: Public-local

CATEGORY OF PROPERTY: Building

NUMBER OF RESOURCES WITHIN PROPERTY:

CONTRIBUTING	NONCONTRIBUTING	
1	0	BUILDINGS
0	0	SITES
0	0	STRUCTURES
0	0	OBJECTS
1	0	TOTAL

NUMBER OF CONTRIBUTING RESOURCES PREVIOUSLY LISTED IN THE NATIONAL REGISTER: 0

NAME OF RELATED MULTIPLE PROPERTY LISTING: N/A

6. FUNCTION OR USE

HISTORIC FUNCTIONS: TRANSPORTATION/rail-related

CURRENT FUNCTIONS: VACANT

7. DESCRIPTION

ARCHITECTURAL CLASSIFICATION: NO STYLE

MATERIALS:

FOUNDATION	CONCRETE
WALLS	BRICK
ROOF	ASPHALT, METAL, CONCRETE
OTHER	GLASS, METAL, WOOD

NARRATIVE DESCRIPTION (see continuation sheets 7-5 through 7-10).

8. STATEMENT OF SIGNIFICANCE

APPLICABLE NATIONAL REGISTER CRITERIA

_X_ **A** PROPERTY IS ASSOCIATED WITH EVENTS THAT HAVE MADE A SIGNIFICANT CONTRIBUTION TO THE BROAD PATTERNS OF OUR HISTORY.
___ **B** PROPERTY IS ASSOCIATED WITH THE LIVES OF PERSONS SIGNIFICANT IN OUR PAST.
___ **C** PROPERTY EMBODIES THE DISTINCTIVE CHARACTERISTICS OF A TYPE, PERIOD, OR METHOD OF CONSTRUCTION OR REPRESENTS THE WORK OF A MASTER, OR POSSESSES HIGH ARTISTIC VALUE, OR REPRESENTS A SIGNIFICANT AND DISTINGUISHABLE ENTITY WHOSE COMPONENTS LACK INDIVIDUAL DISTINCTION.
___ **D** PROPERTY HAS YIELDED, OR IS LIKELY TO YIELD, INFORMATION IMPORTANT IN PREHISTORY OR HISTORY.

CRITERIA CONSIDERATIONS: N/A

AREAS OF SIGNIFICANCE: TRANSPORTATION

PERIOD OF SIGNIFICANCE: 1914-1948

SIGNIFICANT DATES: 1914

SIGNIFICANT PERSON: N/A

CULTURAL AFFILIATION: N/A

ARCHITECT/BUILDER: Texas Electric Railway/Fred A. Jones Construction Company

NARRATIVE STATEMENT OF SIGNIFICANCE (see continuation sheets 8-11 through 8-17).

9. MAJOR BIBLIOGRAPHIC REFERENCES

BIBLIOGRAPHY (see continuation sheets 9-18 through 9-20).
PREVIOUS DOCUMENTATION ON FILE (NPS): N/A
_ preliminary determination of individual listing (36 CFR 67) has been requested.
_ previously listed in the National Register
_ previously determined eligible by the National Register
_ designated a National Historic Landmark
_ recorded by Historic American Buildings Survey #
_ recorded by Historic American Engineering Record #
PRIMARY LOCATION OF ADDITIONAL DATA:
x State historic preservation office *(Texas Historical Commission, Austin, Texas)*
_ Other state agency
_ Federal agency
_ Local government
x University (*The University of Texas at Arlington, Arlington, Texas*)
_ Other -- Specify Repository

10. GEOGRAPHICAL DATA

ACREAGE OF PROPERTY: approximately 7.25 acres

UTM REFERENCES

Zone	Easting	Northing
14	705777	3622654

VERBAL BOUNDARY DESCRIPTION: City Block 3713, Tract 1, Dallas, Dallas County, Texas, recorded in Dallas County deeds Vol93072/2748 Ex41393.

BOUNDARY JUSTIFICATION: The boundaries include all property historically associated with the building.

11. FORM PREPARED BY (with assistance from Bob Brinkman, historian, Texas Historical Commission)

NAME/TITLE: Sherry N. DeFreece Emery and Renee L. Hutter

ORGANIZATION: LopezGarcia Group **DATE:** March 28, 2006

STREET & NUMBER: 1825 Market Center Boulevard **TELEPHONE:** (214) 741-7777

CITY OR TOWN: Dallas **STATE:** Texas **ZIP CODE:** 75207

ADDITIONAL DOCUMENTATION

CONTINUATION SHEETS (see continuation sheets FIGURE-23 through FIGURE-25)

MAPS (see continuation sheets MAP-21 through MAP-22 and topographic map)

PHOTOGRAPHS (see continuation sheet PHOTO-26)

ADDITIONAL ITEMS

PROPERTY OWNER

NAME: Dallas Area Rapid Transit

STREET & NUMBER: 1401 Pacific Avenue **TELEPHONE:** (214) 749-3278

CITY OR TOWN: Dallas **STATE:** Texas **ZIP CODE:** 75266-7213

Monroe Shops is a large railroad maintenance facility located on a 7.5-acre parcel of land in Dallas, Texas bound by Denley Drive on the west, the South Corinth Street Viaduct on the east, a Texas Utilities (TXU) outdoor substation on the south, and Louisiana Avenue on the north. When the first phase of construction on the shops was complete in 1914, the building was used as a maintenance shop for the Texas Traction Company and the Southern Traction Company, which merged to create the Texas Electric Railroad (T & E, or Interurban Railway) in 1917. Monroe Shops served as the site of all heavy repair work on the T & E rail cars. The shops contained a machine shop and car repair barn, a paint shop, offices, and lecture hall. Originally, an 40-by-50-foot brick and concrete electric substation was located just north of the building along the tracks, a 50,000 gallon steel water tower with a 70-foot head was located just west of the main building, and several miscellaneous buildings were located throughout the site. A loop track was originally built to connect the shop tracks with the main line, which was protected by a short track with Hayes derails and a switch that would, if necessary, send a runaway car up an incline and into a pile of soil. These ancillary structures have been demolished, but the main building remains intact.

General building description

Monroe Shops is set among Dallas Area Rapid Transit's (DART's) Illinois Station park-and-ride facility. The station platform extends along the western side of the site. Parking lots for the station and DART bus lanes occupy the north side and east side of the building. The site is minimally landscaped, but small trees and grass fill the green spaces of the site. A TXU (electric utility) substation is located just to the south of the building. The site remains a transportation facility, in keeping with its original purpose. Monroe Shops is an industrial building comprised of three rectangular bays, which combined measure 255 feet long and 138 feet wide. The building is oriented toward the north, and rests on concrete footings. The north to south orientation of the building allowed for southern breezes during the hot Texas summers (Myers 1982:42). The building is constructed of load-bearing brick, which has remained unfinished on the exterior. Windows consist of nine-over-nine and twelve-over-twelve wood sash units with simple millwork and concrete sills, matching the configuration of the original wooden double-hung sash windows, which are fixed steel units with concrete lintels containing replacement glass with a green tint. The doors consist of modern units with a variety of light configurations with corrugated metal panels above that resemble roll-up metal doors that were used in the original construction phase. Other entry points to the building have been completely enclosed with corrugated metal panels resembling roll-up metal entry doors. Surrounding the building walkways are brick bollards with cast stone caps and bases. These bollards are not original to the building.

The western bay of Monroe Shops is two stories high. Built in 1914, it has a flat roof with a parapet consisting of a patterned brick frieze and metal parapet cap covering the original concrete cap. The original wooden roof (with a tar and gravel covering and containing wire-glass skylights) has been replaced. The main, or central, bay is two stories high, and has a gabled roof with a parapet consisting of a patterned brick frieze and metal parapet cap. The original wooden roof deck (with a tar and gravel covering and containing wire-glass skylights) has been replaced, but the original Warren and Pratt truss system remains, along with one replacement skylight. The eastern bay is one story high. An addition to the structure dating to ca. 1920, the eastern bay has a flat roof with a parapet consisting of a patterned brick frieze and metal parapet cap covering the original concrete cap.

The roof deck, original to the building, is concrete. The entire building is constructed of masonry, and is industrial or utilitarian. The exterior brick walls of the building are left unfinished, except for traces of white paint on the lower 15 feet of the south façade at the location of a non-historic lean-to addition that has been removed. Recently installed rectangular galvanized metal leader boxes with galvanized metal piping carry rainwater from the three roofs along the east and west façades.

Description of the western bay

The south end of the 1914 western bay originally served as paint and carpenter shops on the south section, and a paint store, trainmen's room, locker room, boiler room, and restroom and shower room on the north (Monroe [Tex.] Maintenance Shops 1915:177). A rail spur led to exterior openings on the south façade that provided access to the shop interior where cars could be repaired. The original openings in the south façade have been infilled with modern metal roll-up doors from Overhead Door. The western door measures 12 feet, six inches wide and 17 feet tall, and the eastern door measures 12 feet wide and 17 feet tall. A doorway on the east side of the south façade, which was originally a wooden door with a nine-light transom altogether measuring slightly over 12 feet high, has been infilled with a metal door measuring three feet wide and seven feet tall. The five-foot-high area above the modern door has been infilled.

The west façade of the south end of the 1914 western bay contains three entry doors. The original doors on this façade have been replaced. The southernmost door has been replaced with a ten-light metal door with a fixed metal panel and a four-light false transom with a metal canopy. The central door has been replaced with a ten-light metal door with a fixed metal panel and a four-light false transom. The northernmost door on the west façade of the south end of the western bay has been replaced with ten-light metal doors with a sidelight, and a fixed metal panel and a four-light false transom with a metal canopy. The original configuration of the twelve-over-twelve double-hung wooden sash windows has been retained, although the units are replacement wooden sash units. The original concrete sills remain.

A brick wall originally divided the interior of the south end of the 1914 western bay into two rooms along its north-to-south axis and the bay was, in turn, separated from the main bay by an additional brick wall. The brick wall dividing the rooms of the south end of the western bay has since been perforated with seven openings with steel lintels that are painted dark green. The wall dividing the south end of the western bay from the main bay originally contained four openings into the main bay that have been infilled with gypsum board walls with metal studs.

The interior brick walls of the south end of the western bay were at one time painted white. In the room on the east, a dark green wainscot was painted on the lower six feet, four inches of the walls. The painting scheme dates to after the original period of construction, however, as evidenced by areas of inconsistent painting. Just north of these rooms are offices and restrooms. Mechanical systems have been installed on the roof of the south end of the western bay. These, however, are nearly obscured from the street-level view of the building.

The north end of the 1914 western bay is two stories high. The first floor originally contained offices of the master mechanic, a restroom, an emergency hospital, an armature winding room, a 40-foot by 80-foot storeroom, and blacksmithing tools, with each shop separated from the others and the maintenance bay by brick walls and Durand's tin-covered fire doors. A 40-foot by 62-foot lecture hall, a restroom, and offices, including the dispatcher's office (providing a full view of the main tracks) were located on the second floor (Monroe [Tex.] Maintenance Shops 1915:176-177). The west façade of the north end of the western bay contains a single entry door. The original door has been infilled with a corrugated metal panel resembling a metal roll-up door. The original configuration of the twelve-over-twelve wooden windows has been retained, although the units are replacement wooden sash units. The original concrete sills remain. A doorway on the north façade of the western bay was originally a wooden door with a nine-light transom, altogether measuring slightly over 12 feet high. This doorway has been infilled with a metal door measuring three feet wide and seven feet tall, and the five-foot-high area above the modern door has been infilled. The original configuration of the twelve-over-twelve wooden windows on the façade has been retained, although the units are replacement wooden sash units. The original concrete sills remain.

The interior of the north end of the 1914 western bay originally contained a staircase leading to a second floor supported by wooden columns. The staircase and original wood floor has been removed and replaced with a concrete floor supported by steel columns. A recently constructed pass-through from the mezzanine in the main shop now provides access to the second floor of the western bay. The walls of the first and second stories of the bay are finished in three-coat plaster, which is missing on several of the interior walls, leaving the brick exposed. Brick walls that originally divided the space on the northern section of the north end of the western bay have been removed, and a new concrete floor has been added in the area. The brick walls of the north end of the western bay were at one time painted white. In the southern part of the room, a dark green wainscot was painted on the lower six feet, four inches of the walls. The painting scheme dates to after the original period of construction, however as evidenced by areas of inconsistent painting. There is evidence that shelves or a narrow platform were once mounted into the southern wall of the room. A doorway originally leading from the north end of the western bay to the south end has been infilled with gypsum board supported by metal studs. The location of the original door on the west façade is infilled with gypsum board on the interior wall. Pieces of the original hardware for this door remain mounted on the interior wall. The interior of the second floor of the north end of the 1914 western bay shows evidence of the repairs recently made to the southern and western parapet. Above the window frames on these walls, concrete masonry units (CMUs) replace the original interior brick wythes.

Description of the central bay

The central bay of Monroe Shops originally served as the machine shop. The 273-foot long, 60-foot wide, 31-foot high space extends the entire length of the building. A rail spur led to exterior openings on the south façade and metal roll-up doors on the north façade, providing access to the shop interior where cars could be repaired. The north end of the shop contained repair equipment such as drills, lathes, a turning mill, and a wheel press, and the south end contained an inspection pit. The north façade of the machine shop bay originally featured two metal roll-up doors and a doorway (Monroe [Tex.] Maintenance Shops 1915:177). The doorway on the west side of the north façade was originally a wooden door with a nine-light transom, altogether measuring slightly over 12 feet high. It has been infilled with a metal panel. The westernmost roll-up door has been replaced with a ten-light metal door with a fixed metal panel and a twelve-light false transom and sidelights. A metal awning has been installed above the door. The easternmost roll-up door has been replaced with a 15-light metal framed window with a fixed metal panel and a twelve-light false transom. The original configuration of the twelve-over-twelve double-hung wooden sash windows on the façade has been retained, although the units are replacement wooden sash units. The original concrete sills remain.

The east façade of the machine shop originally featured two doors in the center of the wall. The doors have been replaced with two ten-light metal doors, each with a sidelight and a fixed metal panel and a four-light false transom with a metal canopy. An additional entry on the north end of the east façade has been infilled with brick. The façade originally featured at least two downspouts encased in brick that carried water from the roof to the ground. These brick downspouts were not a part of the wall, but were mounted against it with metal straps. These downspouts were removed at an unknown date, but the mounting hardware remains attached to the building at the location of the northernmost downspout, which was located in front of a window bay. The eastern façade of the machine shop was originally the eastern terminus of the Monroe Shops building. Around 1920, a paint shop was added to the eastern façade, extending the width of the building and providing the impetus for alterations to the eastern façade. The south façade of the central machine shop bay originally featured three openings in the brick wall leading to the interior. The westernmost opening has been infilled with a corrugated metal panel that resembles a metal roll-up door. The central opening has been infilled with a ten-light metal door with a fixed metal panel and a twelve-light false transom and sidelights. The easternmost opening has been infilled with a corrugated metal panel that resembles a metal roll-up door. The original configuration of the twelve-over-twelve double-hung wooden sash windows has been retained, although the units are replacement wooden sash units. The original concrete sills remain.

The interior of the machine shop was originally a 31-foot high span that housed machinery used to repair the cars brought to the shop for maintenance. A 15-ton box crane driven by three direct current motors was mounted in the upper story and was moved along a steel I-beam craneway that extended the length of the building and was mounted 21 feet, eight inches above the floor (Monroe [Tex.] Maintenance Shops 1915:177). The box crane has since been removed, along with portions of the craneway. The floor of the machine shop originally featured three sets of railroad track and a 34-wide, 120-foot long maintenance pit with a concrete stair at each end and a wooden floor that provided access to the undercarriage of the cars brought to the building for service (Monroe [Tex.] Maintenance Shops 1915:177). In the mid- to late-1990s a U-shaped partial concrete mezzanine was added in the machine shop, creating two floors. Two steel staircases provide access to the north end and south end of the mezzanine. On the north wall of the first floor of the machine shop, the location of the former door is infilled with gypsum board on the interior wall. Pieces of door hardware remain mounted on the interior wall. The original Warren and Pratt trusses are spaced at 21-foot intervals throughout the length of the bay. Three lines of cross-braces run the length of the bay to help support the roof and protect against damage from strong winds (Monroe [Tex.] Maintenance Shops 1915:178).

An original entry on the north end of the interior east wall has been infilled with brick on the exterior, and with plywood on the interior. An entry on the south end of the east wall was infilled with CMU at an unknown date, but may have been contemporary with the addition of the ca. 1920 paint shop. The entry remains infilled. On the interior south wall, the location of the former opening into the building is infilled with gypsum board. The interior west wall features seven passageways into the north end of the western bay of the building. Four additional passageways on the south end have been enclosed with gypsum board on metal studs, providing a dividing wall between the machine shop and the western bay. The western interior wall of the upper story of the machine shop has been cut through to provide access to the second floor of the western bay. A lateral hallway running along the east-to-west axis of the machine shop bay was added during a recent remodeling of the interior of Monroe Shops. This addition, along with the mezzanine addition, effectively divided the formerly open interior of the machine shop bay into four distinct spaces.

Description of the eastern bay

The eastern bay of Monroe Shops was added to the building ca. 1920, and served as a paint shop. The one-story addition extends along the southern half of the eastern façade of the maintenance shop bay. The north façade of the eastern bay originally contained three doors with a concrete lintel extending the length of the three doors. The lintel remains, although the central door has been replaced with a ten-light double metal door with sidelights and a false transom constructed of a corrugated metal panel resembling a metal roll-up door. An awning has been placed over the door. The eastern and western doors have been replaced with a 15-light metal and glass windows with fixed corrugated metal panel false transoms resembling the metal roll-up doors.

The eastern façade of the eastern bay originally featured a door or opening with a concrete lintel on the south end of the façade. The concrete lintel remains, but the door or opening has been infilled with a corrugated metal panel resembling a metal roll-up door. The façade contains six fixed 78-light steel windows with concrete lintels and sills. These are original to the building, although the glazing has been replaced with green-tinted glass.

The southern façade of the eastern bay of Monroe Shops originally featured two hinged wooden doors with concrete lintels above. The easternmost door has been replaced with a ten-light double metal door with sidelights and a false transom constructed of a corrugated metal panel resembling a roll-up door. The westernmost door has also been infilled with a corrugated metal panel resembling a roll-up door. The southern façade of the eastern bay retains traces of white paint, where a non-historic lean-to structure was once mounted against the building.

The interior of the north end of the eastern bay of Monroe Shops has been converted into a medical office. Currently vacant, the medical office is accessed by an interior hallway of recent construction that transects the entire building along its east-to-west axis. A contemporary hollow-core door leading from the southern section of the bay also accesses it. The medical office is finished with contemporary finishes, millwork, and systems. The interior of the south end of the eastern bay of Monroe Shops remains unfinished. At the north wall of the south end of the bay are three openings. The western opening is topped with a concrete lintel and formerly supported sliding fire doors that have since been removed, but have been stored in the room along with various pieces of hardware. The doors are solid wood with a stamped metal covering. The manufacturer's stamp on the fire doors reads "DU[RA]ND's Specification Fire Door Plate 20 Pounds Coating." The iron hardware is stamped "Allith Mfg. Co. Chicago, Ill." The door mounting hardware remains above the opening in the brick wall. The central opening in the north wall is also topped with a concrete lintel. The opening has been infilled with a partially constructed gypsum board wall with metal studs, and a hollow-core door in a metal frame leading to the medical facility. The eastern opening in the north wall is also infilled with a partially constructed gypsum board wall with metal studs.

The eastern wall of the interior of the eastern bay contains the location of the former door infilled with gypsum board on the interior wall. The remainder of the wall is filled with six fixed 78-light steel windows with concrete lintels. The southern wall contains a recently constructed double door on the east, and a mechanical room of gypsum board walls with metal studs conceals the location of the infilled western door. The south end of the western wall contains an opening into the maintenance bay that was infilled with CMU at an unknown date. An opening at the north end of the wall leads into the maintenance bay. Concrete columns measuring one square foot support the concrete ceiling of the eastern bay. During rehabilitation efforts conducted in the mid-1990s, structural damage throughout the concrete ceiling was sympathetically repaired, and the bases of the concrete columns were encased in an additional three and one-half-inch thick layer of cement to provide additional support to the ceiling.

Monroe Shops is significant for its association with the influential period of interurban railway travel in Dallas, and surrounding cities. Monroe Shops is a significant example of a utilitarian building, constructed on a colossal scale compared to other interurban maintenance buildings built in the country at the time. Monroe Shops is the only remaining example of an interurban railway maintenance facility in Texas. Built in 1914, it remains a visual reminder of the era of interurban rail travel and continues its association with that theme as light rail travel begins its resurgence in the city of Dallas. It is nominated for listing in the National Register of Historic Places under Criterion A in the area of Transportation, with a period of significance from 1914 to 1948.

The Texas Electric Railroad

The introduction of rail travel in North Texas in the early 1870s played a vital role in the expansion of the transportation industry, and made previously inaccessible areas part of a larger network of trade and development. Prior to the arrival of railroad transportation, Dallas mainly served as a prosperous agriculture-based town. The key to economic expansion in Dallas in the 1870s was better transportation into and out of the city. Since early attempts to navigate the Trinity River were unsuccessful, businessmen turned to securing rail service. The first two railroads to come to Dallas were the Houston and Texas Central (H. & T. C.) in 1872 with its 122-mile line from Bremond, and the Texas and Pacific (T. & P.) in 1873 with its vital line from Houston and Galveston (Solamillo 1999:item 13, page 1; TSHA 2006). The H. & T. C. finished an additional 74-mile line to Sherman and Denison in 1873 where it connected with the Missouri, Kansas & Texas (M. K. & T.) Railroad, which extended to St. Louis. The same year, the T. & P. completed an 82-mile section from Longview to Dallas that intersected the H. & T. C. line at North Central and Pacific avenues. The location of the railroad crossroads led to the construction of the Union Depot at the H. & T. C. rail yard. By 1881 two other railroad lines extended service to Dallas. The Gulf Coast & Santa Fe (G. C. & S. F.) Railroad, and the M. K. & T. through the acquisition of the Dallas & Wichita (D. & W.) Railroad, each began direct service to the city (Solamillo 1999:item 13, page 1).

Dallas became one of the first rail crossroads in Texas and found itself in a strategic location for the transportation of products to northern and eastern destinations (TSHA 2006). Dallas established itself as a center of commerce, providing a hub for trade in cotton, wheat, buffalo hides, and other raw materials. By 1885, Dallas supported five railroads carrying both passengers and freight (Dallas Public Library 1992:138). As the businesses, trades, and railroad grew, so did the population of Dallas and nearby towns such as Denison, Sherman and McKinney to the north, and Corsicana, Ennis, Waxahachie, Hillsboro, Hutchins, and Waco to the south. Included in the population boom were farmers wishing to relocate to the area, and immigrants hoping to find work in the expanding market (Dallas Public Library 1992:64). The nearby agricultural towns established a symbiotic relationship with the city of Dallas. Increased economic opportunity allowed farmers to increase production, and the increase in farming brought greater prosperity to the city (Dallas Public Library 1992:128).

In the late nineteenth century, local businessmen sought to compete with the steam-powered locomotive business that was flourishing in and around Dallas and help the city in achieving its goal of establishing itself as the primary railroad hub of North and Central Texas. Waco was also becoming a major hub of railroad transportation and was providing competition for Dallas in the lucrative cotton market. These factors, along with the real estate development opportunities that followed, provided the incentive for locals to begin the construction of a local or "interurban" rail system (Solamillo 1999:item 13, page 1).

Shortly after the establishment of the first railroad line through Dallas, the first streetcars were run in the city. The Dallas City Railroad, built by charter in 1871 and inaugurating service on 7 February 1873, completed a one and one-third-mile line running along Main Street from the Dallas County Courthouse to the H. & T. C. station. Mules operated the two streetcars on the Main Street Line, which when founded had an operating capital of $1000.00 (Dallas Daily Times Herald 1919; Dallas Public Library 1992:140; Solamillo 1999:item 13, page 1). Other streetcar companies operating interurbans, included the Dallas Street Railroad Company (1875), the Ervay Street Railroad Company operating the Commerce & Ervay Line (1876), and the Dallas Belt Street Railway Company operating the Belt Lines (1884). These first four companies merged in 1887 into the Dallas Consolidated Street Railway Company (Dallas Public Library 1992:140). Other companies including the Dallas & Oak Cliff Railroad Company (1887), the Dallas Rapid Transit Railroad Company (1888), and the North Dallas Circuit Railroad Company (1889) utilized steam locomotives to move streetcars. Electrified streetcars began being utilized in 1890 with the development of an electric and traction system by Frank Sprague, a former assistant to Thomas Edison. Sprague's system introduced overhead catenary poles that carried an electrical current throughout the rail line (Solamillo 1999:item 13, page 2). The Dallas lines were run by a direct suspension system within the city limits and towns, and simple catenary poles were used along private right-of-way. The trolley wire used was 000 gauge grooved copper wire suspended 19 feet above the rails (Myers 1982:15).

Most of the investment capital raised to develop the many Dallas streetcar lines was local, but as the opportunity for financial gain was recognized, outside investors became increasingly involved in the transportation business. Stone & Webster was an electrical engineering firm out of Boston that became directly involved in the expansion of the electric streetcar system throughout the Dallas area. Stone & Webster was formed in late 1889 by Massachusetts Institute of Technology graduates Edwin S. Webster and Charles A. Stone. By 1910, the company had financed, engineered, constructed, and managed electrical generating facilities in Texas, Georgia, and Washington and "claimed the design, engineering, and construction of some fourteen percent of the nation's total electric generating capacity in addition to managing a large number of small electric light companies and street railway systems" (Solamillo 1999:item 13, page 2).

The first electric interurban streetcar system to be used within the city limits of Dallas was operated by the Northern Texas Traction Company (N. T. T.), formed in 1902 (Dallas Public Library 1992:140). The N. T. T., which also operated the street railway system in Fort Worth, was owned and operated by Stone & Webster. The line extended from Dallas and Forth Worth, and was later extended to Cleburn (Brewer 1989:1). It also served the towns of Oak Cliff, Cockerell Hill, Arcadia Park, Grand Prairie, Arlington, and Handley. The establishment of the rail lines operated by Stone & Webster brought competition to J.F. Strickland. Strickland, who concentrated his efforts in North Texas and constructed, owned, and operated electric generating plants in Bonham, Cleburne, Hillsboro, Sherman, Temple, and Waxahachie, also established Texas Power & Light (T. P. & L.) in 1912 (Myers 1982:35; Solamillo 1999:item 13, page 2).

In a natural shift from operating electric power plants to electric railway lines, the J.F. Strickland Company, later known as the Texas Traction Company (1906), began promoting an electrical railway to connect Dallas and Sherman in 1905 (Myers 1982:15). The company bought controlling stock in the Denison and Sherman (D. & S.) Railway in 1909. The D. & S. Railway had been chartered in August of 1900, and by 1901 a line ran from Denison to Sherman (Varney 1975:5). With Strickland's purchase a complete rail connection was made from Denison (approximately 75 miles by rail north of Dallas) through Howe, Van Alsytne, Anna, Melissa, McKinney, Allen, Plano, and Richardson to downtown Dallas. This line was designed and constructed by Fred A. Jones Company of Dallas, with Stone & Webster acting as the consulting engineers (Myers 1982:15).

Stone & Webster's Dallas Southern Traction Company, later shortened to Southern Traction, won a bid against Strickland to extend a line south of Dallas to Waxahachie, but Strickland bought this for $1,000,000.00 in 1912 and carried out the plans to extend the rail line to the south. In 1913 two lines extended south: one line to Waco, and one line to Corsicana (Brewer 1989:4; Myers 1982:38). Stops along the 151-mile line included Lancaster, Hillsboro, West, Ferris, and Ennis (Solamillo 1999:item 13, page 2). Southern Engineering & Construction Company of Dallas did most of the actual construction of the Waco and Corisicana lines, with Burr Martin president, and Luther Dean vice-president and chief engineer (A 151-Mile, 1200-Volt Line in Texas 1914:10).

Three stations serviced riders of the Dallas interurban streetcars. A terminal at 1316 Commerce Street served Strickland's Texas Traction line. Stone & Webster operated the N. T. T. terminals at St. Paul and Commerce Streets and at Jefferson and Wood Streets (Myers 1982:29; Solamillo 1999:item 13, page 2). In 1912, Strickland purchased the G. C. & S. F. Depot for $750,000.00 with the intention of renovating the building for use as an interurban union terminal building that would serve all of the interurban lines in the city. In keeping with the competitive nature between the two companies, Stone & Webster through the Dallas Interurban Terminal Association built a new union terminal building on a site bound by Jackson, Wood, Young, and Browder (Market) Streets. The interurban union station at 1500 Jackson Street (now known as the Interurban Building) was designed by Stone & Webster architects and began construction in 1915. Completed on 1 September 1916, the eight-story Beaux Arts building featured a passenger station, offices for Stone & Webster and the other interurban companies operating in Dallas, retail space, and a power substation in the basement. Among the 62 corporate tenants in the building listed in the 1917 Dallas City Directory, were Stone & Webster, Dallas Electric Light & Power Company, Dallas Consolidated Electric Street Railway Company, Rapid Transit Railway Company, Metropolitan Street Railway Company, the Interurban Terminal Association, Southwest General Electric, T. P. & L., Rio Grande Development Company, Empire Realty Company, Texas Land Securities Company, Southern Products Company, and the former Texas Traction and Southern Traction companies that merged to form the Texas Electric Railway (T. & E.) in 1917 (Solamillo 1999:item 13, page 2-3; Varney 1975:6). One month after the Interurban terminal opened, the Dallas Union Terminal opened its doors to serve the seven steam railroads that had lines through the city (Solamillo 1999:item 13, page 3).

Mergers and purchases took place throughout the life of the Dallas interurban system. Not the least of these was the merger of Texas Traction and Southern Traction companies to form the Texas Electric Railway. Chartered in July 1916, Texas Electric was overseen by president J.F. Strickland. The Texas Electric used Monroe Shops extensively in one of its first major endeavors, the re-lettering of the cars to reflect the Texas Electric name, and the adaptation of Dallas Southern Traction passenger cars into Texas Electric parlor cars (Myers 1982:53).

In 1917, only three carriers operated in the city. These were the N. T. T., the T. & E., and the Texas Interurban Railway Company (T. I.) which all together operated on 334 miles of track (Solamillo 1999:item 13, page 3). By 1919, the electric railway system utilized 188 cars for active operation, employed 1,050 people, and was valued at $8,763,259.07 (Dallas Daily Times Herald 1919). Additional companies were added later, including the Dallas Railway & Terminal Company, which established a line from Dallas to Terrell (1923) and a line from Dallas to Denton (1924) (Dallas Public Library 1992:140).

The Texas Electric Railway, at one time the longest interurban railway west of the Mississippi River, officially operated from 1917 until 1948. It provided both passenger and freight service to North Central Texas. Centered in Dallas, the Interurban line, as it was known, serviced 226 miles of track along three lines. These went to Denison and Sherman, Ennis and Corsicana, and to Hillsboro and Waco, bringing buyers to Dallas markets and transporting workers to downtown (Spurr 2001; Solamillo 1999:item 13, page 1).

The Texas Electric Railway was part of the state of Texas's 500-mile electric interurban railway industry. Most of the track was in place by 1913, supplementing the need for passenger service between cities and larger towns that were inaccessible by steam railroad (TSHA 2005a). In addition to passenger and freight service, the rail provided streetcar service to surrounding towns. Streetcar tracks were used to reach the downtown Dallas terminal at 1316 Commerce Street, and this detail was detrimental to the success of the Interurban. The use of streetcar rails prevented the use of freight cars once the Texas Electric began to develop a carload freight business in 1928 (Dallas Public Library 1992:140-141).

The use of the Interurban system in Dallas peaked in the 1920s when 250 local and limited interurban cars passed through the Interurban Terminal. Ridership declined during this period, however as the affordability of the personal automobile increased. In 1921 the Texas Electric lost $500,000.00. To help recover the losses in ridership the line began transporting freight and offering mail service, and by offering express cars and parlor cars, but this did not have the necessary effect, and by the late 1920s the company annually lost over $1,000,000.00 (Myers 1982:61, 80; Solamillo 1999:item 13, page 9). After the stock market crash of 1929 and the ensuing depression that followed until 1933, the Texas Electric Railway's income decreased further and passenger figures continued to decrease. The company went into receivership in 1931, and in 1936 sold their electric generating facilities and became the Texas Electric Railway Company (Brewer 1989:11; Dallas Public Library 1992:140-141). Business slowed even more on the Interurban in the early 1940s, and in 1941 the Corsicana branch was abandoned (Myers 1982: 95). The rest of the system operated through World War II, which with the resulting rationing of gasoline had a positive effect on the Interurban. By 1942, however, the Texas Electric Railway was the only independent interurban line still operating in Texas. With an increase in bus travel and automobile traffic, the use of the Interurban continued to decline until it made its final run on 31 December 1948 (TSHA 2005b). The Interurban Terminal was converted to a union bus terminal (Solamillo

1999:item 13, page 10) while Monroe Shops participated in converting many of the Texas Electric cars to scrap (Myers 1982:113).

Construction of Monroe Shops and development of the Trinity Heights neighborhood

In addition to the railroad lines and the Interurban stations, repair shops were necessarily constructed to house the daily operations of repairing and maintaining the electric railroad cars. Monroe Shops, completed in 1914, was built to serve the Southern Traction Company and Strickland's Texas Traction Company. The shops were located at the junction of the Waco and Corsicana lines, four miles south of Dallas (Varney 1975: 15). The location was at an elevation that commanded a panoramic view of Dallas, Oak Cliff and the surrounding area (DMN 1913a). Monroe Shops was designed to employ one hundred to two hundred men and was the site of all heavy general repair work (DMN 1913b; Varney 1975; 15).

The property in which the Monroe shops were built is part of the C.M. Miller survey, Abstract 882. The land was granted to C.M. Miller by the state of Texas in July of 1857 (DCC July 28, 1984:(F)20). C.M. Miller sold the land to T.W. Atwood in June of 1889. Atwood died in 1899 and left the land to his wife Mary Atwood. By 1911 Dallas Southern Traction Company (later to become Texas Electric Railway) acquired a trust deed worth $2 million that included 32 miles of roadbed, stations, substations, and other property (DMN 1911a). Two years later it was announced that repair shops would be built at the intersection of the Corsicana and Waco lines where it still stands (DMN 1913c).

The Fred A. Jones Construction Company was chosen to be in charge of all construction related to the Interurban line running throughout Dallas and its suburbs, including Monroe Shops. The involvement of the Fred A. Jones Construction Company began in June 1908 when the company won the contract to construct the sixty-five miles of track from Sherman to Dallas along with the central power station, four substations, and all the associated buildings and stations (DMN 1908). After the work on the Interurban the Fred A. Jones Construction Company also had a hand in other prominent buildings in Dallas including the 1911 White Rock Reservoir and Dam, the Dallas Country Club (ca. 1912) and the 1914 Dallas City Hall (now the Municipal Building) (DMN 1911b; 1911c; and 1913d).

Monroe Shops was built south of the city of Dallas in an area known as Trinity Heights. Historically, the area surrounding Monroe Shops was mostly populated with railroad workers, many of whom worked at the shops. The railroad workers typically had low wages and subsequently, the area was dubbed "Hungry Heights" (Myers 1982:42). Prior to the shops being constructed in 1914 there was very little housing in the area. In 1913 land was being purchased by development companies with the intention of subdividing into city lots (DMN 1913e). Among them were Seay, Cranfill & Company, who purchased land south of Oak Cliff along the right-of-way of the Interurban for the purpose of creating a high-class residential district. This land near the station and shops were thought to be "a good beginning for a new suburb." Seay, Cranfill & Company planned to lay out a system of parks, paved streets and sidewalks, gutters, and curbs in their suburb (DMN 1913c). With the initiation of the convenient Southern Traction line to Trinity Heights in 1914, the area quickly developed. Cars along Southern Traction's Oak Cliff line left downtown Dallas for Oak Cliff Junction, and as it looped through Oak Cliff it traveled along Hutchins Street, proceeded past Monroe Street to the Worsham wye, to the Zang line, to Jefferson Boulevard, and then to Oak Cliff Junction and back to downtown. The route was made possible by 1200-volt and 600-volt direct current lines, since the cars themselves were dual-voltage cars (Myers 1982:49). Texas Electric scholar Johnnie Myers (1982:49-50) states:

> With the completion of Southern Traction, Dallas was more accessible to the major corridors of population and commerce south and southeast and to the areas served by Texas Traction to the north and Northern Texas Traction to the west. Texas regulatory authorities allowed a maximum fare of three cents a mile; and while the Northern Texas Traction line to Fort Worth used the maximum on its premier runs, Southern Traction averaged a cent and a half. This low fare, coupled with several other factors such as poor roads, the infancy of the auto, the infrequency of competing steam road service, and the cleanliness of electric cars when compared to steam cars all made for optimistic profit predictions for the new interurban. Most important, the sum of these advantages gave a mobility never before enjoyed to rural people.

The street railroad companies and the interurbans that followed were vital in the development of the city of Dallas. Real estate speculation along the new and proposed lines extending from the core of the city provided opportunities for growth, and supported the idea of suburban life where a person could easily commute to work, but return home to a pleasant and calm residential community. Large sections of land in the neighborhoods that became Oak Cliff, North Dallas, South Dallas, and East Dallas were purchased for speculation. Real estate developers were often the largest promoters of the rail lines that provided improved access to the new communities and increased the property values of the houses (Solamillo 1999:item 13, page 2). In a draft of a city of Dallas Landmark Nomination Form for the Interurban Building, a 1916 issue of Texas Electric is quoted as stating:

> The great "Black Land Belt" of Texas is pierced by interurban lines running out of Dallas, this section being densely populated and almost unrivaled in fertility. The country is essentially agricultural, with "King Cotton" as the principle crop, however, large quantities of corn, wheat, oats, feed stuffs, truck products, fruits, etc. are produced. Stock raising, horse raising, hog raising and poultry raising are pursued in connection with the farming. In fact, a circle drawn around Dallas includes ONE-THIRD OF THE POPULATION of the State…and producing 38 PERCENT OF THE FARM PRODUCTION…It is this prosperous, wealth-producing territory which is reached in every direction by the interurbans which run in and out of Dallas. Many industries of varied and extensive nature are located in the cities and towns. The interurban lines have done much to increase the development in this section. Suburban development in many places has been rapid and extensive, many beautiful suburban and country homes being found along the lines outside the cities of Dallas, Waco, and Fort Worth (Solamillo 1999: item 13, page 8).

Following the final run of the Texas Electric, the function of Monroe Shops changed. The ownership of Monroe Shops stayed in the hands of the Texas Electric Railway until the Flemming & Son Papermill Company took over the property between 1954 and 1958 (Bracey 1954:251; Bracey 1958:251). During the Fleming & Son period of ownership, the building became a storage facility for rolls of paper (Johnnie J. Myers, personal communication with authors, 16 March 2006).

It is unknown when the Guaranty Bank of Dallas acquired the property but they transferred the deed to the land to the U-Haul Company in March 1978 (DCC March 1, 1978:[78042]1797). The City of Dallas then obtained ownership in June 1980 (DCC June 18, 1980:[801121]4886). The property was then transferred to David Grayson in April 1984 (DCC April 5, 1984:[84069]4886). Dallas Rapid Area Transit (DART) acquired the building in April 1994 and has owned the property since that time (DCC April 13, 1994:[93072]2748).

Prior to DART's acquisition of Monroe Shops in 1994, deterioration had taken place and changes had been made to the interior of the building as well. Upon DART's purchase the building was stabilized and efforts to preserve its original appearance were begun. To date, Monroe Shops retains its historic integrity and much of its original appearance.

Conclusion
The Monroe Shops are an early twentieth century building type that was once ubiquitous throughout north Texas along interurban rail lines that radiated out from Dallas. Now located along a Dallas Area Rapid Transit (DART) commuter rail line, the building remains associated with transportation. The property possesses integrity of location, setting, design, materials, workmanship, feeling and association to a high degree. Monroe Shops is nominated for listing in the National Register of Historic Places under Criterion A in the area of Transportation at the local level of significance. The period of significance runs from 1914 to 1948, the years of operation of the interurban in Texas.

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Bracey
1958 *Block Maps of the City of Dallas.* On file, Texas/Dallas History and Archives Division, Dallas Public Library, Dallas, Texas.

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1989 *Eastern Texas Traction Company.* Unpublished report, on file, "Interurban Railways", Preservation Dallas, Dallas, Texas.

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Various Real Property Conveyance Records. On file, Dallas County Clerk, Dallas, Texas. These records include Warranty Deeds, Trust Deeds and other instruments related to land ownership and transfer of ownership, all filed in the same multivolume series of records. In-text citations follow the format: DCC 5 April 1984:[84069]4886, where the parenthetic number refers to the volume, and the last number the page. The date given is the date the instrument was drafted.

Dallas Daily Times Herald
1902 Inter-Urban Lines Making Regular Trips. 6 July:16, column 7.

1893 Street Car Lines. 24 June:5, columns 1-2.

1919 "History of Local Street Car System From Mules to Skip-Stop is Romance." 13 July:(II)11, columns 1-5.

Dallas Morning News (DMN)
1908 "Stockholders to See New Interurban Line." 28 June:6. Dallas, Texas.

1911a "Two Million Dollar Trust Deed is Filed." 30 December:14. Dallas, Texas.

1911b "Gives a Luncheon at the New Dam." 8 October:(7). Dallas, Texas.

1911c "Dallas Country Club Building New Home." 28 July:4. Dallas, Texas.

1913a "Steel Being Laid From Two Directions." 29 August:4. Dallas, Texas.

1913b "Shrine Preparations Affect Real Estate." 11 May:(3)10. Dallas, Texas.

1913c "Dallas Will Have Fine New Addition." 27 April:(4)16. Dallas, Texas.

1913d "Contract Awarded For New City Hall." 4 February:4. Dallas, Texas.

1913e "More Suburban Property." 22 March:(4). Dallas, Texas.

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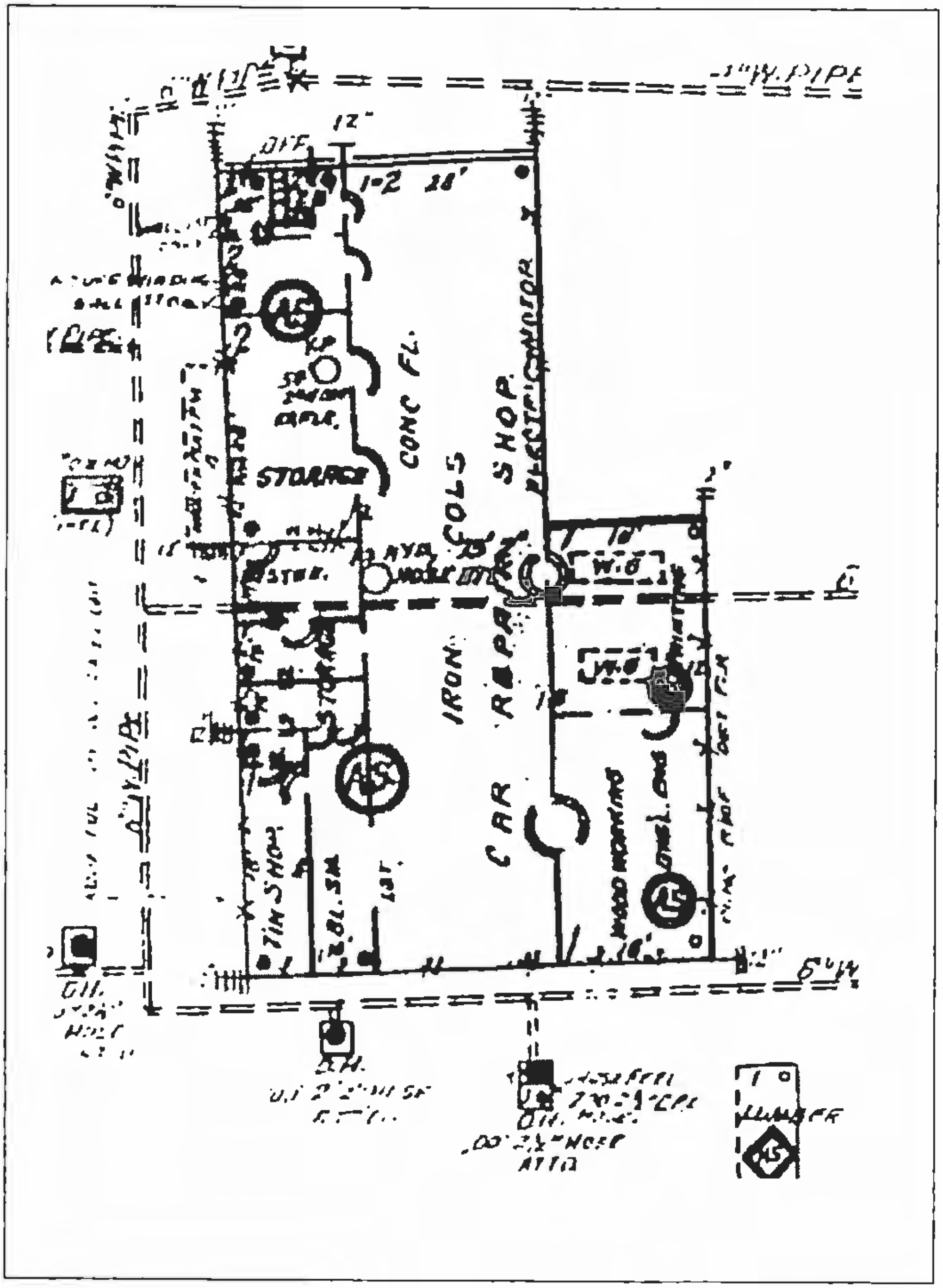
NPS Form 10-900-a
(8-86)

OMB Approval No. 1024-0018

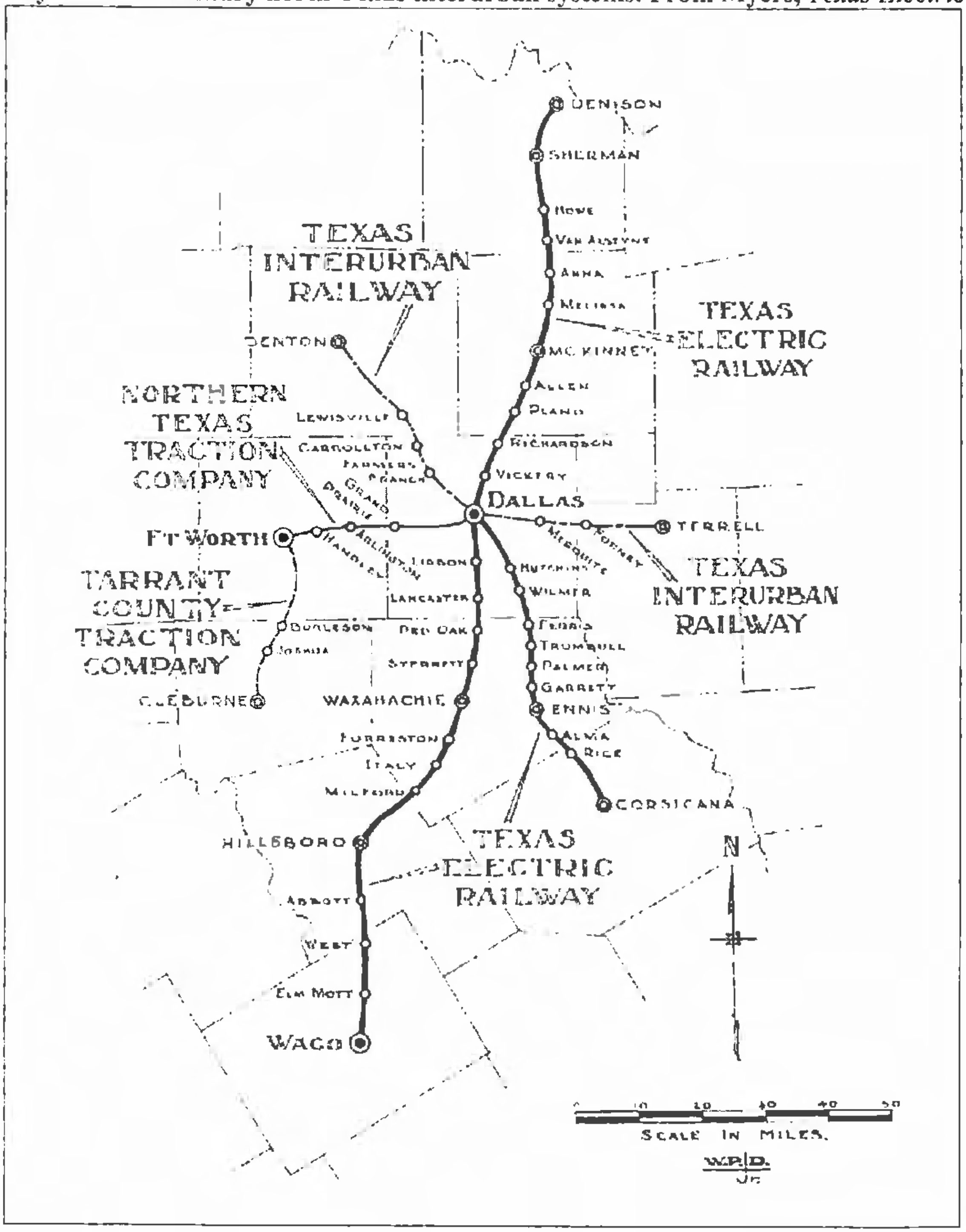
United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Monroe Shops, Sanborn Fire Insurance Company map of Dallas, Texas, 1922, Volume 5, sheet 560 detail.



Map of early twentieth century north Texas interurban systems. From Myers, *Texas Electric Railway*.



United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Figure 1. Monroe Shops, north elevation, 1919. From John J. Myers Collection.

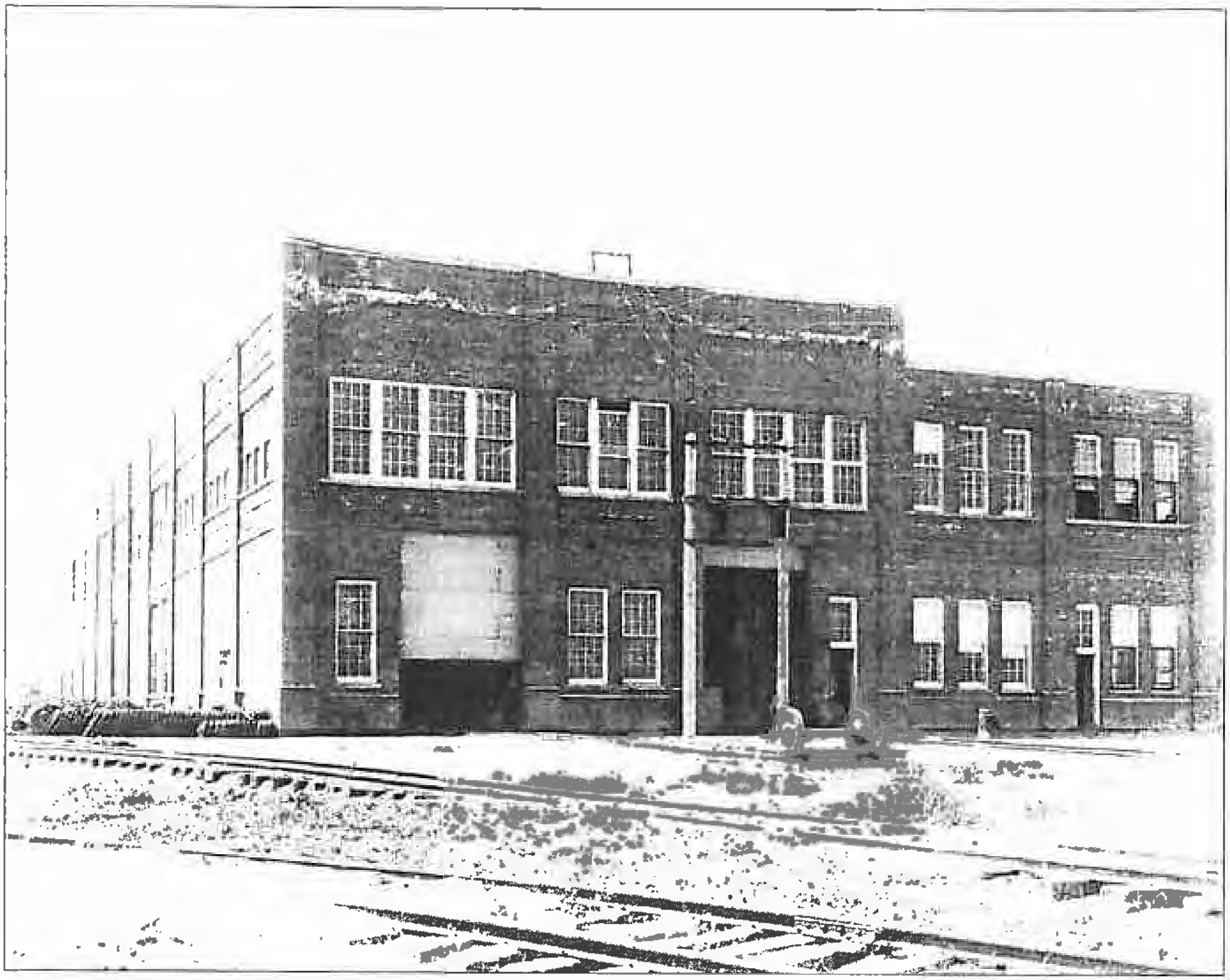
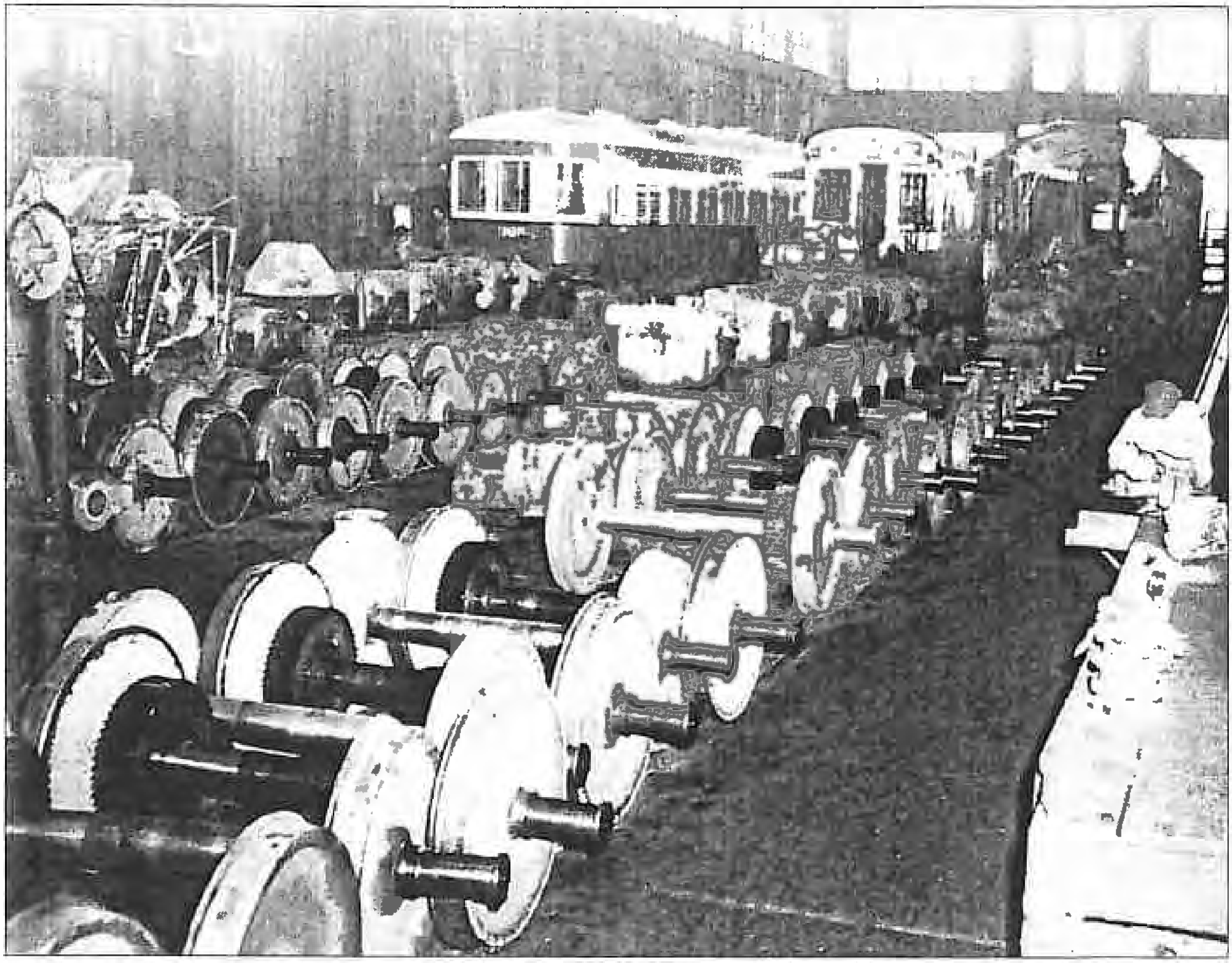


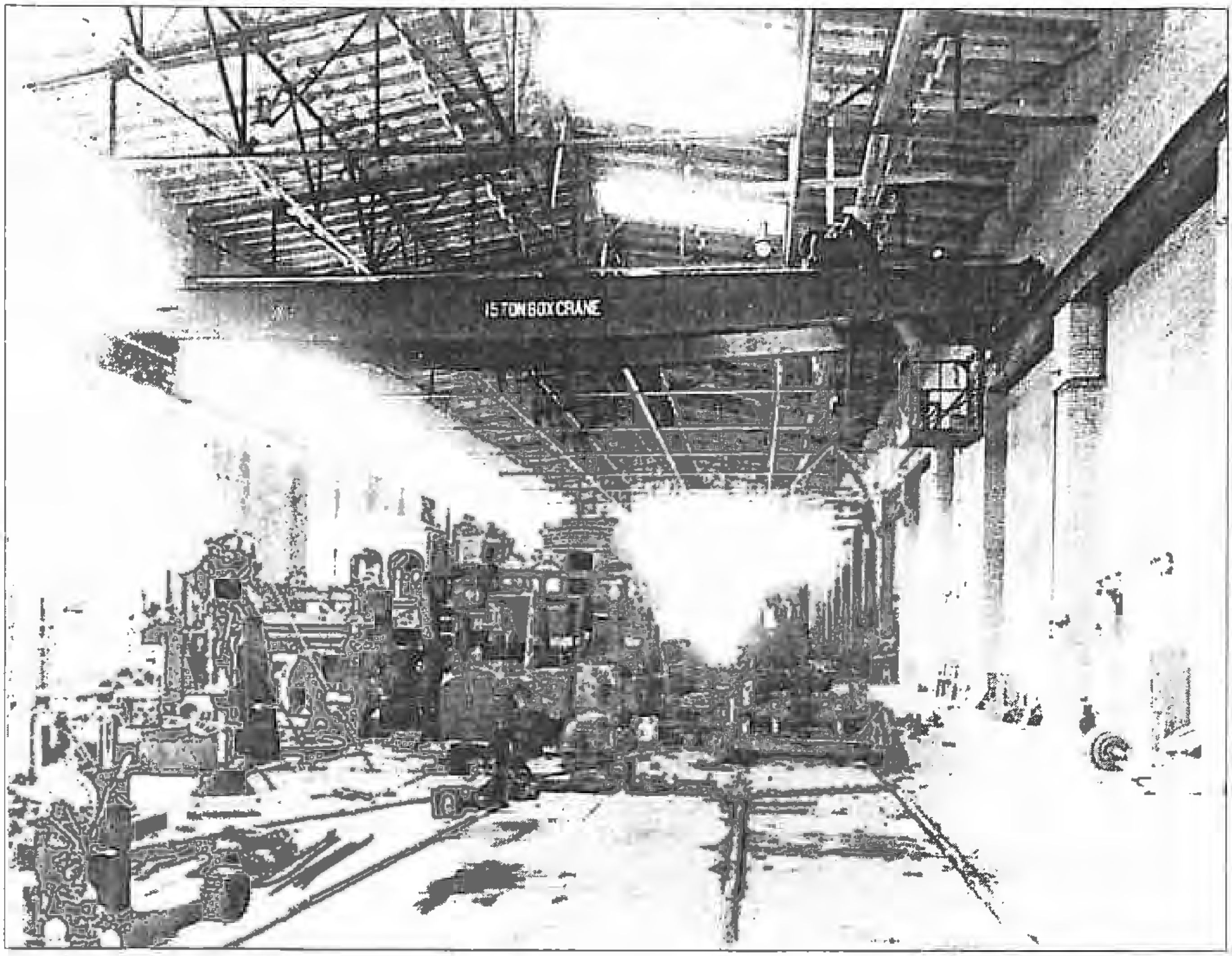
Figure 2. Monroe Shops interior, camera facing south, date unknown. From John J. Myers Collection.



United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Figure 3. Monroe Shops interior, camera facing south, date unknown. From John J. Myers Collection.



PHOTOGRAPH INVENTORY

Monroe Shops
2111 South Corinth Street
Dallas, Dallas County, Texas
Photographs by LopezGarcia Group, Dallas, Texas.
Negatives at LopezGarcia Group.

Photo 1: North elevation, camera facing south
Photo 2: North elevation, camera facing south
Photo 3: Northwest oblique, camera facing southeast
Photo 4: West elevation, camera facing east

Photo 5: West elevation, camera facing east
Photo 6: Southwest oblique, camera facing northeast
Photo 7: South elevation, camera facing northeast
Photo 8: South elevation, camera facing northwest

Photo 9: East elevation, camera facing southwest
Photo 10: East elevation, camera facing southwest
Photo 11: Secondary north elevation, camera facing south
Photo 12: North elevation, camera facing southwest


MONRO


MONRO


SHOPS


MONR

TEXAS HISTORICAL COMMISSION

The State Agency for Historic Preservation

RICK PERRY, GOVERNOR

JOHN L. NAU, III, CHAIRMAN

F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

February 23, 2009

Stephen L. Salin, AICP
Vice President, Rail Planning
Dallas Area Rapid Transit
P.O. Box 660163
Dallas, TX 75266-0163

Re: *Project review under Section 106 of the National Historic Preservation Act of 1966, as amended: Dallas Area Rapid Transit (DART) Monroe Shops Lead Paint Cleaning, South Oak Cliff Corridor Memorandum of Agreement (FTA/106)*

Dear Mr. Salin:

Thank you for your correspondence of January 27, 2009 describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Adam Alsobrook, has completed its review of the information provided. We are in receipt of your letter and attachments that document the proposed cleaning of lead paint at the Monroe Shops. This information was provided according to Stipulation 3b set forth in the September 1993 South Oak Cliff Corridor Light Rail Transit Project Memorandum of Agreement (MOA) between the Texas State Historic Preservation Officer (SHPO) and the Federal Transit Administration (FTA). The lead paint removal proposal appears to meet the *Secretary of the Interior's Standards for Rehabilitation* and therefore adequately satisfies Stipulation 3b set forth in the September 1993 MOA. The lead paint removal at Monroe Shops may proceed. We look forward to discussing the continued efforts of DART to rehabilitate the Monroe Shops for use by the DART Transit Police.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Adam Alsobrook at 512/463-6183.**

Sincerely,

Adam Alsobrook, Project Reviewer
For: F. Lawerence Oaks, State Historic Preservation Officer

cc: Melinda (Lindy) Thomas, Chair, Dallas County Historical Commission
FLO/aa

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TEXAS
HISTORICAL
COMMISSION

The State Agency for Historic Preservation

RICK PERRY, GOVERNOR

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F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

DALLAS AREA RAPID TRANSIT
CAPITAL PLANNING & DEVELOPMENT

MAR 11 2009

RECEIVED

February 24, 2009

Stephen L. Salin, AICP
Vice President, Rail Planning
Dallas Area Rapid Transit
P.O. Box 660163
Dallas, TX 75266-0163

Re: *Project review under Section 106 of the National Historic Preservation Act of 1966, as amended: Dallas Area Rapid Transit (DART) Monroe Shops 30% Design Submittal Under the South Oak Cliff Corridor Memorandum of Agreement (FTA/106)*

Dear Mr. Salin:

Thank you for your correspondence of January 30, 2009 describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Adam Alsobrook, has completed its review of the information provided. We are in receipt of your letter and attachments that document the rehabilitation work at Monroe Shops. This information was provided according to Stipulation 3b set forth in the September 1993 South Oak Cliff Corridor Light Rail Transit Project Memorandum of Agreement (MOA) between the Texas State Historic Preservation Officer (SHPO) and the Federal Transit Administration (FTA).

The proposed rehabilitation of Monroe Shops is to be performed under two contracts. The first contract addresses the building shell, and the second contract introduces the interior and exterior modifications necessary for the building's new use as the DART Police headquarters. Before the proposed work is to begin, lead paint removal work will be performed. This lead paint removal has been reviewed and approved by the SHPO under a separate Section 106 coordination under Stipulation 3b of the 1993 MOA.

In regard to the building shell, several areas of work are proposed. Missing bricks will be replaced from a supply of original bricks onsite. Samples of replacement brick matching the original in size, color, and strength will be submitted to the SHPO if the supply of original bricks is insufficient. Use of replacement brick will be limited to areas that will not be exposed after construction or in non-public areas of the building. Samples of mortar for limited repointing will be submitted to the SHPO for review during the construction phase. The existing non-historic roofing system will be replaced with a membrane system with a high albedo for LEED purposes. An integrally colored concrete coping and flashing is proposed to be installed to approximate the appearance of the original coping and to further protect the walls from moisture intrusion. Non-historic downspouts, headers, and boots will be replaced with historically appropriate units.

Furthermore, all the existing non-historic deteriorated windows and storefront glazing installed in the 1990s renovation will be removed. The replacement painted steel window units, frame details, glazing type, glazing color, and glazing tint will be submitted to the SHPO for review and approval. Replacement storefront units, glazing type, glazing color, and glazing tint will also be submitted to the SHPO for review and approval. Also, existing non-historic exterior entry doors are proposed to be replaced with historically compatible door units that are consistent with the security requirements of the police headquarters. Overhead doors not to be used will be replaced with historically appropriate fixed materials. Exterior work will also include the installation of new canopies, exterior lighting, and site security features to be approved by the SHPO.

Work to the interior of the building will include the removal on non-historic gypsum board walls installed in an earlier renovation, though some of these walls may remain in place depending on the final design plan. Existing historic signs have been retained and protected and will be restored. Masonry repairs on the interior shall be accomplished in a manner similar to the repairs to brick masonry on the exterior of the building. After the rehabilitation work is accomplished on the interior, new construction will finish out the spaces for the use of the DART Transit Police.

Based on the documentation provided, the proposal appears to meet the *Secretary of the Interior's Standards for Rehabilitation* and therefore adequately satisfies Stipulation 3b set forth in the September 1993 MOA. We look forward to the design submittal at the next review stage, and to discussing the continued efforts of DART to rehabilitate the Monroe Shops for use by the DART Transit Police.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Adam Alsobrook at 512/463-6183.**

Sincerely,

Adam Alsobrook, Project Reviewer
For: F. Lawerence Oaks, State Historic Preservation Officer

cc: Melinda (Lindy) Thomas, Chair, Dallas County Historical Commission
FLO/aa

TEXAS HISTORICAL COMMISSION
real places telling real stories

June 15, 2009

Stephen L. Salin, AICP
Vice President, Rail Planning
Dallas Area Rapid Transit
P.O. Box 660163
Dallas, TX 75266-0163

Re: *Project review under Section 106 of the National Historic Preservation Act of 1966, as amended: Dallas Area Rapid Transit (DART) Monroe Shops 100% Design Submittal Under the South Oak Cliff Corridor Memorandum of Agreement (FTA/106)*

Dear Mr. Salin:

Thank you for your correspondence of May 18, 2009 describing the above referenced project. This letter serves as comment on the proposed undertaking from the Deputy State Historic Preservation Officer, the Chief Deputy Executive Director of the Texas Historical Commission.

The review staff, led by Adam Alsobrook, has completed its review of the information provided. We are in receipt of your letter and attachments that document the rehabilitation work at Monroe Shops. This information was provided according to Stipulation 3b set forth in the September 1993 South Oak Cliff Corridor Light Rail Transit Project Memorandum of Agreement (MOA) between the Texas State Historic Preservation Officer (SHPO) and the Federal Transit Administration (FTA).

Based on the documentation provided in this submittal and at the previous 30% and 65% design submittal stages, the proposal for the rehabilitation of Monroe Shops to serve as the DART Police headquarters appears to meet the *Secretary of the Interior's Standards for Rehabilitation* and therefore adequately satisfies Stipulation 3b set forth in the September 1993 MOA. The project may proceed.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Adam Alsobrook at 512/463-6183.**

Sincerely,

Adam Alsobrook, Project Reviewer
For: Mark Wolfe, Deputy State Historic Preservation Officer

cc: Michael Lowenberg, Chair, Dallas County Historical Commission
MW/aa

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September 22, 2009

Nicky DeFreece Emery
Senior Architectural Historian and Conservator
URS Group, Inc.
1950 North Stemmons Freeway, Suite 6000
Dallas, TX 75207

Re: *Project review under Section 106 of the National Historic Preservation Act of 1966, as amended: Dallas Area Rapid Transit (DART) Monroe Shops, Proposed Window Glass, Under the South Oak Cliff Corridor Memorandum of Agreement (FTA/106)*

Dear Ms. Emery:

Thank you for your correspondence of September 11, 2009 describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Adam Alsobrook, has completed its review of the information provided. We are in receipt of the proposed window glass sample for the replacement windows at Monroe Shops. This information was provided according to Stipulation 3b set forth in the September 1993 South Oak Cliff Corridor Light Rail Transit Project Memorandum of Agreement (MOA) between the Texas State Historic Preservation Officer (SHPO) and the Federal Transit Administration (FTA).

The glass sample submitted for Monroe Shops has excellent clarity with no visible film or tint, and has a neutral color that upon examination closely approximates the exterior appearance of historic glass. Your office has also stated that the proposed window glass satisfies the security requirements for the DART police headquarters while at the same time being cost effective. The proposed window glass sample appears to meet the *Secretary of the Interior's Standards for Rehabilitation* and therefore adequately satisfies Stipulation 3b set forth in the September 1993 MOA. Thank you for submitting this information for review and for inclusion in our files on this project.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Adam Alsobrook at 512/463-6183.**

Sincerely,

Adam Alsobrook, Project Reviewer
For: Mark Wolfe, State Historic Preservation Officer

cc: Michael Lowenberg, Chair, Dallas County Historical Commission
MW/aa

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TEXAS HISTORICAL COMMISSION

real places telling real stories

February 16, 2010

Stephen L. Salin, AICP
Vice President, Rail Planning
Dallas Area Rapid Transit
P.O. Box 660163
Dallas, TX 75266-0163

Re: *Project review under Section 106 of the National Historic Preservation Act of 1966, as amended: Dallas Area Rapid Transit (DART) Monroe Shops, Revised Window Detail Submittal under the South Oak Cliff Corridor Memorandum of Agreement (FTA/106)*

Dear Mr. Salin:

Thank you for your correspondence of February 10, 2010 describing the above referenced project. This letter serves as comment on the proposed undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission.

The review staff, led by Adam Alsobrook, has completed its review of the information provided. We are in receipt of your fax message and attachments that document the window replacement work at Monroe Shops. This information was provided according to Stipulation 3b set forth in the September 1993 South Oak Cliff Corridor Light Rail Transit Project Memorandum of Agreement (MOA) between the Texas State Historic Preservation Officer (SHPO) and the Federal Transit Administration (FTA).

The revised details as proposed appear to meet the *Secretary of the Interior's Standards for Rehabilitation* and are therefore appropriate alterations to the window details as previously reviewed and approved by our office. The work may proceed as proposed. Thank you for providing this information for review, and we look forward to our continued working relationship regarding the rehabilitation of Monroe Shops.

Thank you for your cooperation in this federal review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Adam Alsobrook at 512/463-6183.**

Sincerely,

Adam Alsobrook, Project Reviewer
For: Mark Wolfe, State Historic Preservation Officer

cc: Michael Lowenberg, Chair, Dallas County Historical Commission
MW/aa

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APPENDIX B
LOCATIONS OF CHARACTER-DEFINING ELEMENTS

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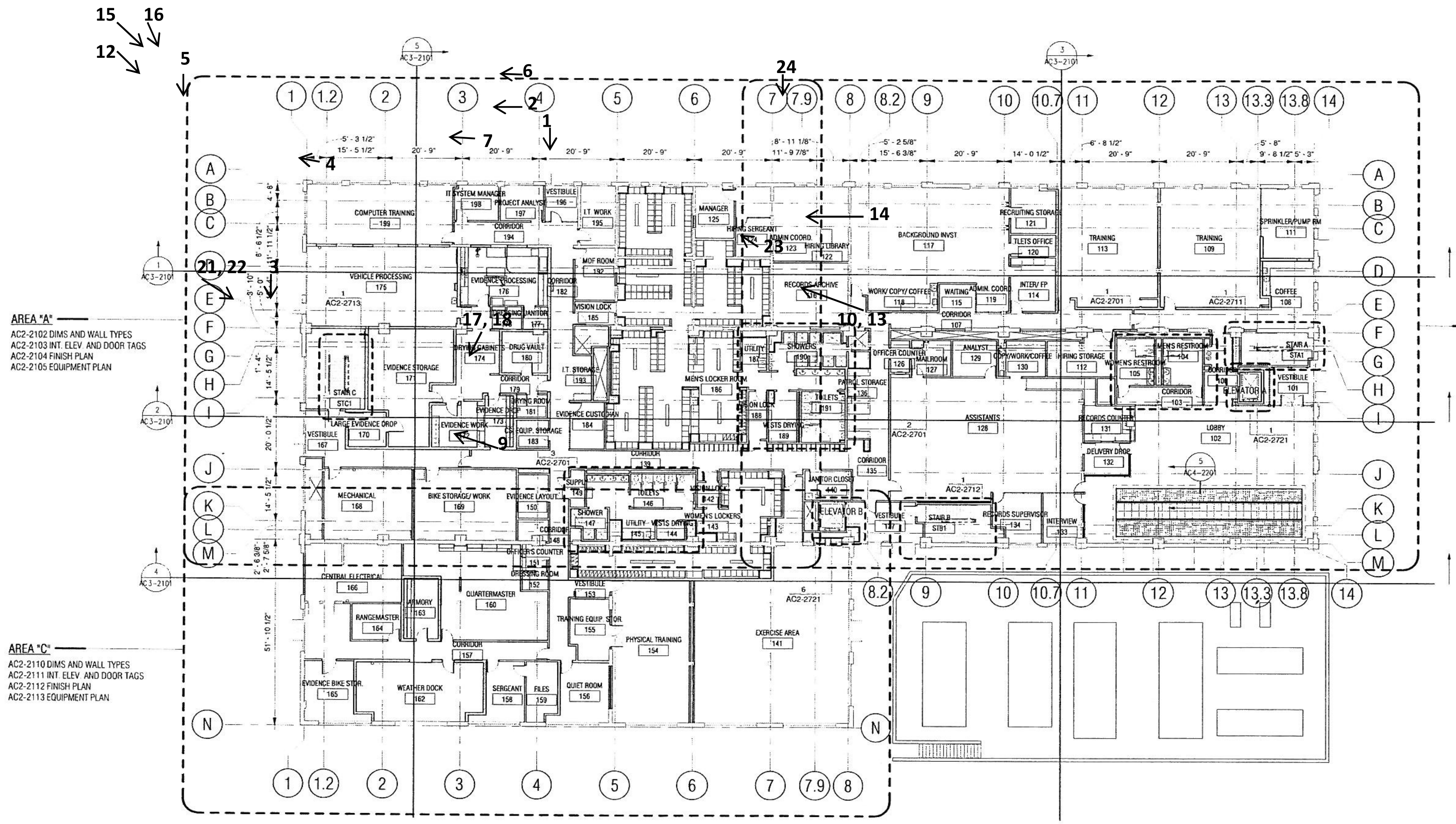
DWG No. AC2-2101



1. Historic Sign
2. Historic Sign
3. Historic Sign
4. Historic Sign
5. Fire Doors
6. Fire Doors
7. Historic Masonry/Brick
8. Historic Photograph
9. New Steel Windows
10. New Steel Windows
11. New Interior Wood Windows
12. Historic Openings
13. Historic Openings
14. Historic Openings
15. Parapet Cap
16. Parapet Cap
17. Historic Columns
18. Historic Columns
19. Historic Photograph
20. Historic Photograph
21. Crane Rail Support Beam
22. Crane Rail Support Beam
23. Historic trusses
24. Historic Plaster

1 INTERIOR FLOOR PLAN - LEVEL 1

SCALE: 1/16" = 1'-0"

NOT AN APPROVED DRAWING
100% DESIGN SUBMITTAL

CONTRACT SHEET No 43 OF 325

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

IN-PROGRESS

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BRINKLEY SARGENT ARCHITECTS
5000 QUORUM, SUITE 600
DALLAS, TEXAS 75245
TEL 972.960.9970
FAX 972.960.9751

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWMAN, Inc.

DART PROJECT

DART

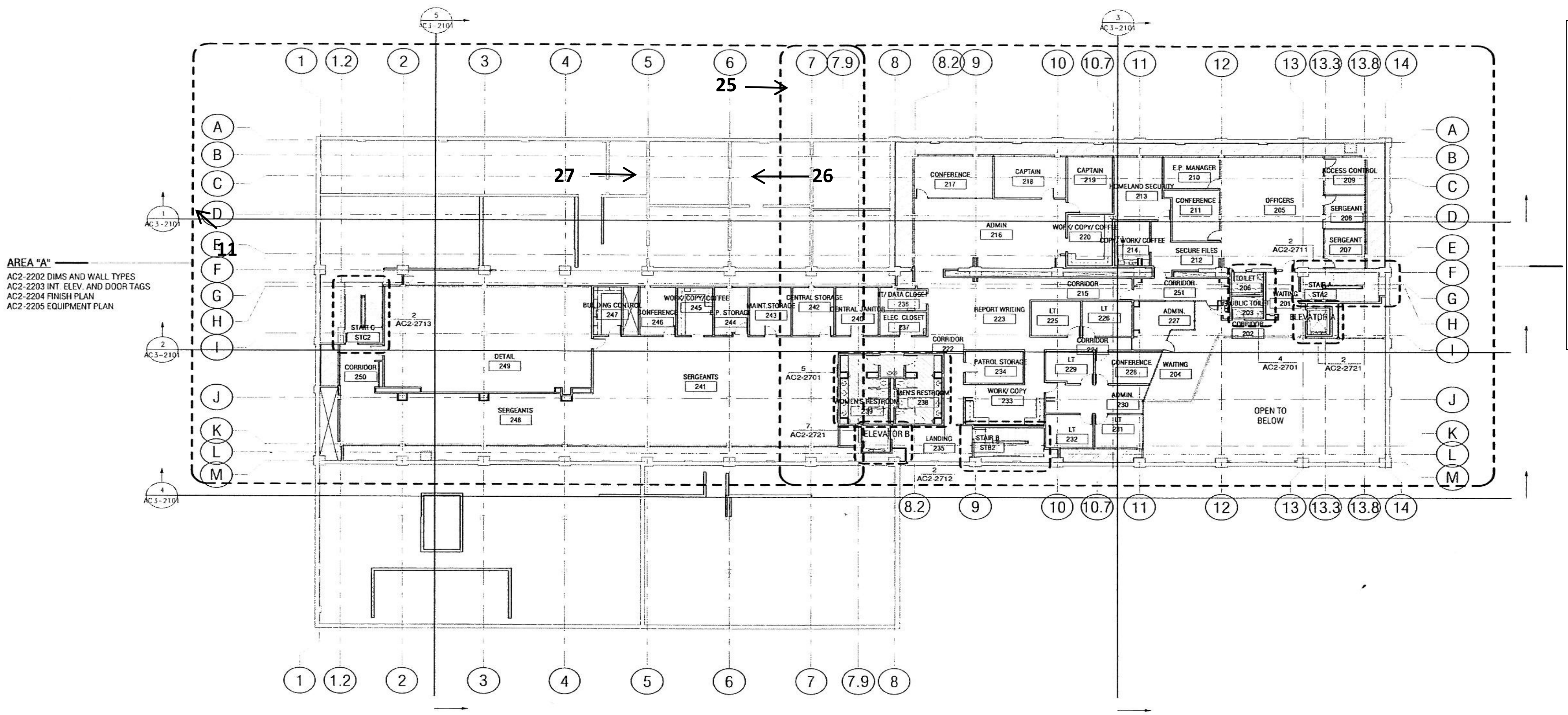
SCALE	1/16"=1'-0"
DRAWN	S. EVERETT
DESIGNED	S. EVERETT
CHECKED	G. READ
IN CHARGE	D. POWYSZYNSKI
DATE	14 AUG 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 2

INTERIOR FLOOR PLAN - LEVEL 1

CONTRACT	DWG No.	REV
	AC2-2101	0



1 INTERIOR FLOOR PLAN - LEVEL 2
SCALE 1/16" = 1'-0"

11. New Interior Wood Windows

25. Historic Plaster

26. Historic Brick Wall

27. Historic Brick Wall

AREA OF BUILT UP SLAB, REF. DETAIL 6/AC2-2701

NOT AN APPROVED DRAWING
100% DESIGN SUBMITTAL

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

IN-PROGRESS

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ON 14 AUG 09
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BRINKLEY SARGENT ARCHITECTS
5000 QUORUM, SUITE 600
DALLAS, TEXAS 75245
TEL 972.960.9970
FAX 972.960.9751

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWMAN, Inc.

DART PROJECT

SCALE	1/16"=1'-0"
DRAWN	S. EVERETT
DESIGNED	S. EVERETT
CHECKED	G. READ
IN CHARGE	D. POWYSZYNSKI
DATE	14 AUG 09

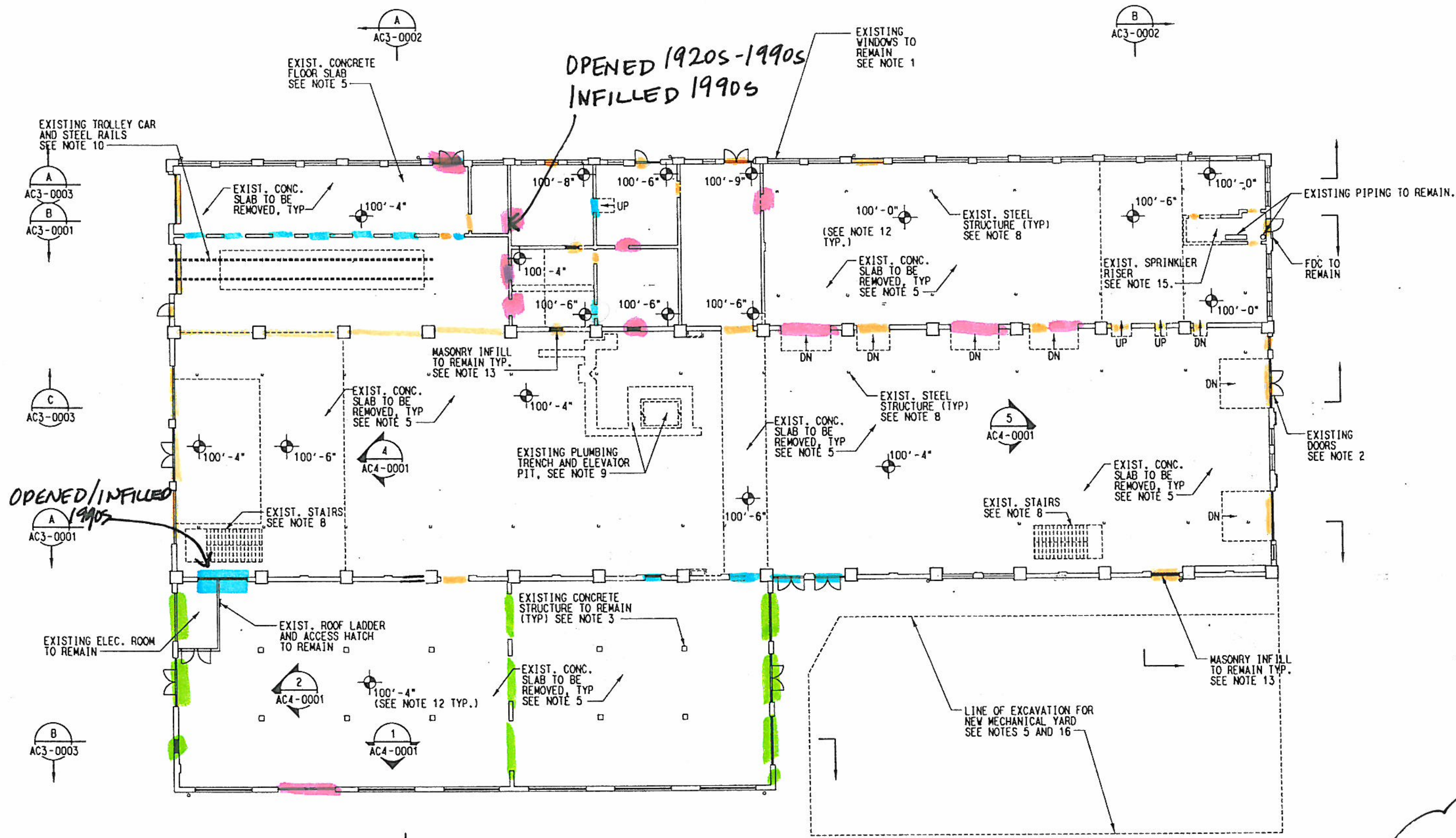
CONTRACT SHEET No. 56 OF 325

DART POLICE - MONROE SHOPS
CONTRACT NO. 2

INTERIOR FLOOR PLAN - LEVEL 2

CONTRACT | DWG No. AC2-2201 | REV 0

DWG No. AC2-2201



SHELL BUILDING-
DEMOLITION FLOOR PLAN
LEVEL ONE
SCALE: 1/16"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. EXISTING WINDOWS AND STOREFRONTS TO REMAIN, PROTECT.
2. EXISTING DOORS TO REMAIN, PROTECT.
3. NOT USED.
4. NOT USED.
5. DEMOLISH ENTIRE INTERIOR EXISTING CONCRETE SLAB UNLESS NOTED OTHERWISE. EXCAVATE TO DEPTH OF CONCRETE OR TO ELEV. OF 99'-4" WHICHEVER IS GREATER. PRESERVE STRUCTURAL INTEGRITY OF EXISTING EXTERIOR AND INTERIOR MASONRY WALLS. NOTIFY AUTHORITY OF ANY RAILS, STEEL, OR EQUIPMENT DISCOVERED IN OR UNDER EXISTING CONCRETE SLAB. AUTHORITY TO REVIEW AND APPROVE SALVAGE.
6. NOT USED.
7. NOT USED.
8. REMOVE EXISTING STAIRS AND STEEL STRUCTURE RELATED TO EXISTING SECOND FLOOR.
9. REMOVE STEEL COLUMNS AND PIT LADDER AT EXISTING ELEVATOR PIT. DEMOLISH CONCRETE PIT AND FOOTINGS. EXISTING PLUMBING STUB-UPS TO BE REMOVED.
10. TROLLEY TO BE RELOCATED, NIC. STEEL RAILS TO BE REMOVED.
11. NOT USED.
12. TOP OF SLAB ELEVATIONS ARE PROVIDED FOR REFERENCE ONLY AND TO INDICATE VARYING THICKNESSES OF THE EXISTING SLAB. ALL SPOT ELEVATIONS ARE IN RELATION TO THE ORIGINAL SLAB ON GRADE (DESIGNATION: ELEV. = 100'-0")
13. ALL EXISTING MASONRY INFILLS TO REMAIN UNLESS NOTED OTHERWISE.
14. NOT USED.
15. EXISTING WALLS TO BE DISSASSEMBLED. REMOVE MORTAR FROM BRICKS AND PREPARE TO BE RE-USED. BRICKS ARE TO BE USED TO REBUILD SPRINKLER ROOM WALLS IN FUTURE CONTRACT.
16. REFER TO STRUCTURAL AND SPECS FOR EXCAVATION DETAILS, NOTES AND EXTENTS.
17. ~~FOR REMOVAL OF BRICK TO CREATE NEW OPENINGS REFER TO~~ SHEET AC3-0004, AC3-0005, AC3-0006 AND AC3-0007.
18. EXISTING INTERIOR AND EXTERIOR WALLS TO REMAIN, PROTECT AND PRESERVE.

CHRONOLOGY OF OPENINGS

1914
1920s
1920s-1990s
1990s

1 OF 9

SNDE 5/28/2009

NOT AN APPROVED DRAWING
100% DESIGN SUBMITTAL

CONTRACT SHEET No. ~~18~~ 16 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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AGUIRRE RODEN
12700 PARK CENTRAL DR, FLOOR 15
DALLAS, TEXAS 75251
TEL 972-788-1508
FAX 972-788-1583

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

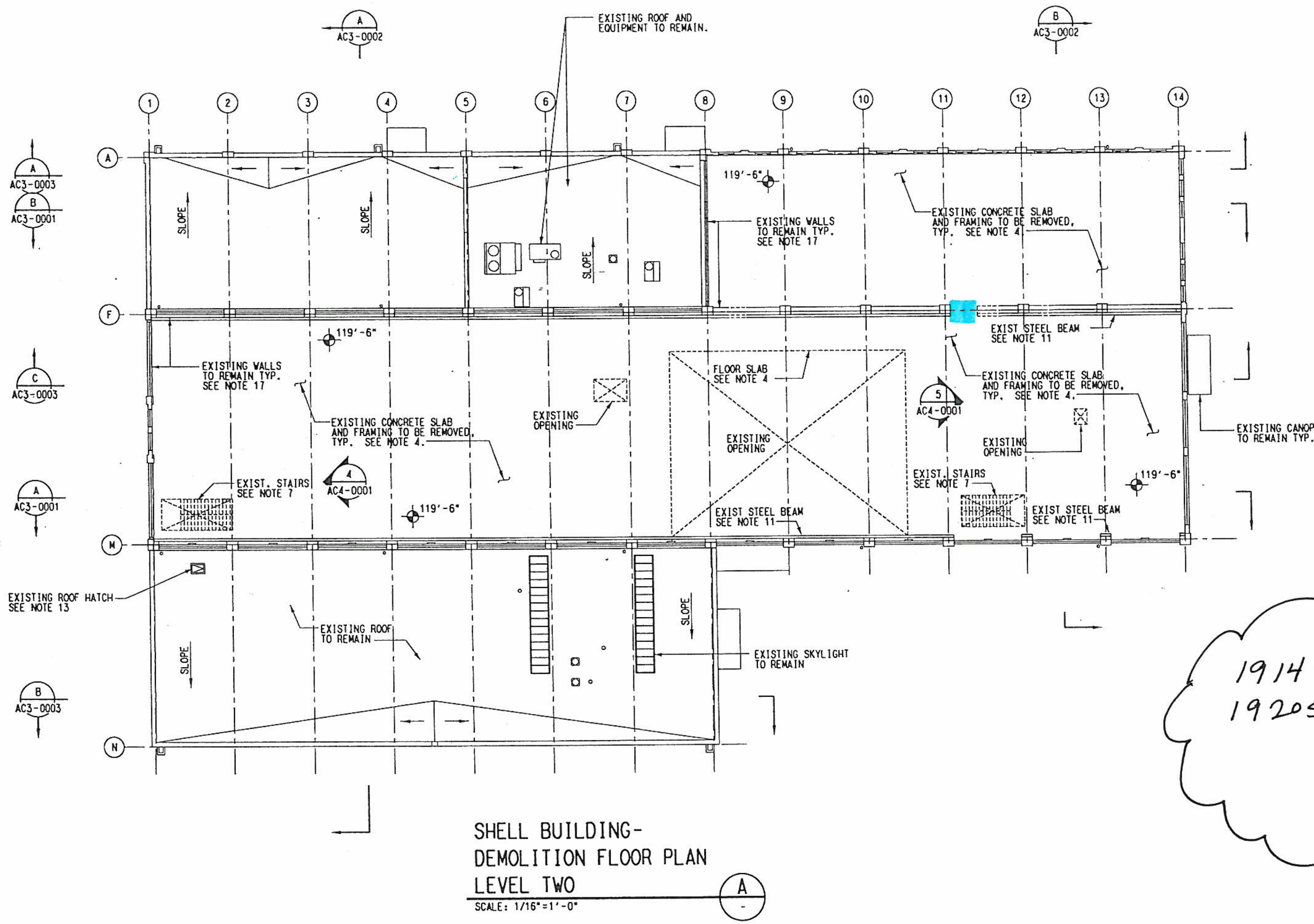
DART PROJECT

SCALE	1/16"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEVIS
IN CHARGE	D. POWSZYNSKI
DATE	15 MAY 09

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING-
DEMOLITION FLOOR PLAN
LEVEL 1

CONTRACT | DWG No. AC2-0001 | REV 0

DWG No. AC2-0002



SHELL BUILDING-
DEMOLITION FLOOR PLAN
LEVEL TWO

A

SCALE: 1/16"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. NOT USED.
2. NOT USED.
3. NOT USED.
4. DEMOLISH EXISTING UPPER LEVEL CONCRETE SLAB AND ASSOCIATED STEEL FRAMING. PROTECT EXISTING MASONRY WHERE FLOOR SLAB ABUTS. NOTIFY AUTHORITY REGARDING ANY ADVERSE CONDITIONS. AUTHORITY TO REVIEW AND APPROVE SALVAGE.
5. NOT USED.
6. NOT USED.
7. REMOVE EXISTING STAIRS AND STEEL STRUCTURE RELATED TO EXISTING SECOND FLOOR.
8. NOT USED.
9. NOT USED.
10. NOT USED.
11. PROTECT AND PRESERVE EXISTING STEEL CRANE RAIL BEAM ALONG COLUMN LINES 'F' AND 'M'.
12. NOT USED.
13. EXISTING ROOF ACCESS HATCH TO REMAIN.
14. NOT USED.
15. NOT USED.
16. NOT USED.
17. EXISTING INTERIOR AND EXTERIOR WALLS TO REMAIN, PROTECT AND PRESERVE.
18. FOR REMOVEL OF BRICK TO CREATE NEW OPENINGS REFER TO: AC3-0004, AC3-0005, AC3-0006 AND AC3-0007.

CHRONOLOGY OF OPENINGS

1914

1920s

1920s - 1990s

1990s

2 of 9
SNDE 5/29/2009

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CONTRACT SHEET No. 1917 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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TRACK 3

AGUIRRE, Inc.
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LOCKWOOD ANDREWS & NEWNAM, Inc.

FIRM REG: 10596

DART PROJECT

DART

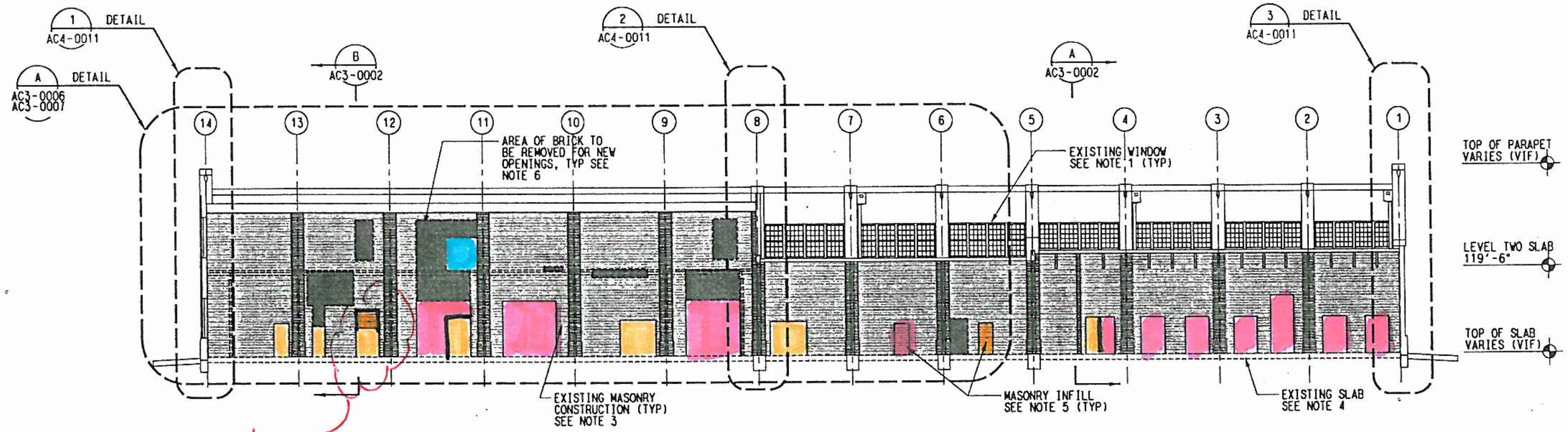
SCALE	1/16"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POWYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING-
DEMOLITION FLOOR PLAN
LEVEL 2

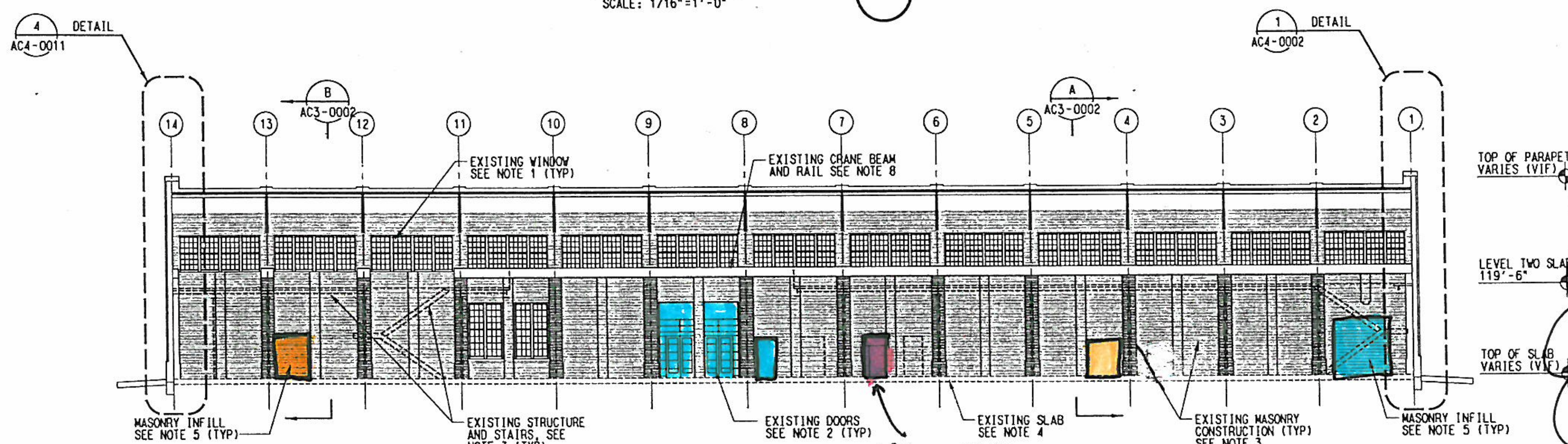
CONTRACT	DWG No.	REV
	AC2-0002	0

DWG No. AC3-0001



DOOR HEIGHT TO BE VERIFIED

DEMOLITION
BUILDING SECTION (B)
SCALE: 1/16"=1'-0"



1920s-1990s

DEMOLITION
BUILDING SECTION (A)
SCALE: 1/16"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. ALL EXISTING WINDOWS TO REMAIN UNLESS NOTED OTHERWISE.
2. ALL EXISTING EXTERIOR DOORS, STOREFRONTS AND FRAMES TO REMAIN UNLESS NOTED OTHERWISE.
3. ALL EXISTING MASONRY CONSTRUCTION TO REMAIN UNLESS NOTED OTHERWISE, PROTECT AND PRESERVE.
4. DEMOLISH ENTIRE INTERIOR CONCRETE SLAB UNLESS NOTED OTHERWISE. EXCAVATE TO DEPTH OF CONCRETE OR TO ELEV. OF 99'-4" WHICHEVER IS GREATER. PRESERVE STRUCTURAL INTEGRITY OF EXISTING EXTERIOR AND INTERIOR MASONRY WALLS. NOTIFY AUTHORITY OF ANY RAILS, STEEL, OR EQUIPMENT DISCOVERED IN OR UNDER EXISTING CONCRETE SLAB. AUTHORITY TO REVIEW AND APPROVE SALVAGE.
5. ALL EXISTING MASONRY INFILLS TO REMAIN UNLESS NOTED OTHERWISE.
6. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING, SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICK TO BE REUSED.
7. REMOVE EXISTING STAIRS AND STEEL STRUCTURE RELATED TO EXISTING SECOND FLOOR.
8. EXISTING CRANE BEAM AND RAIL TO REMAIN, PROTECT AND PRESERVE.

LEGEND:

SHADING FOR REMOVEL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS

1914
1920s
1920s-1990s
1990s
3 of 9
SNDE 5/28/2009

27 71

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CONTRACT SHEET No. 25 OF 70

REV	AMEND	DR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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TRACK 3

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CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.

FIRM REG: 10596

DART PROJECT

DART

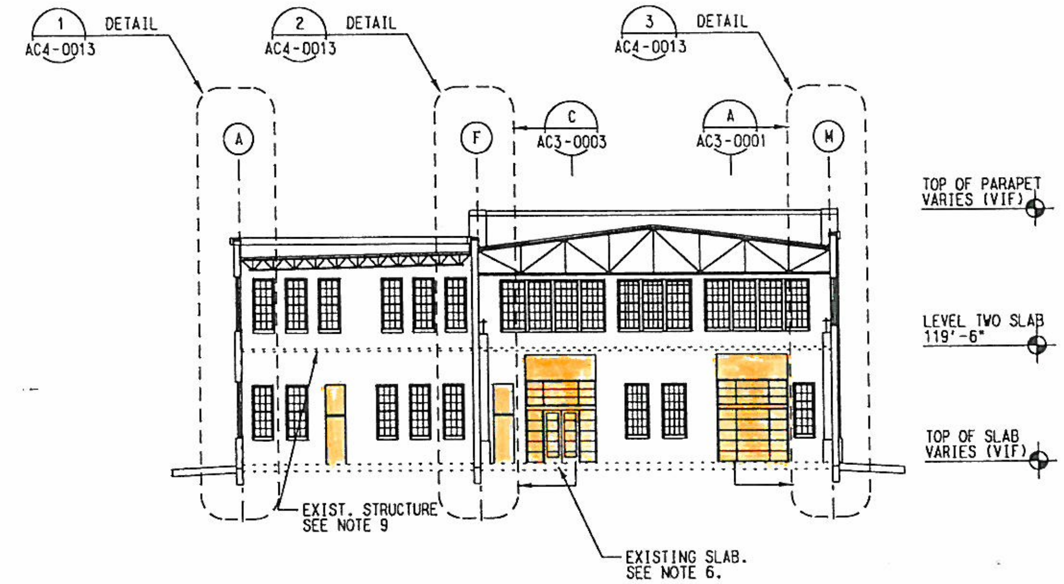
SCALE	1/16"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POWYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
DEMOLITION BUILDING SECTIONS
SHEET 1 OF 7

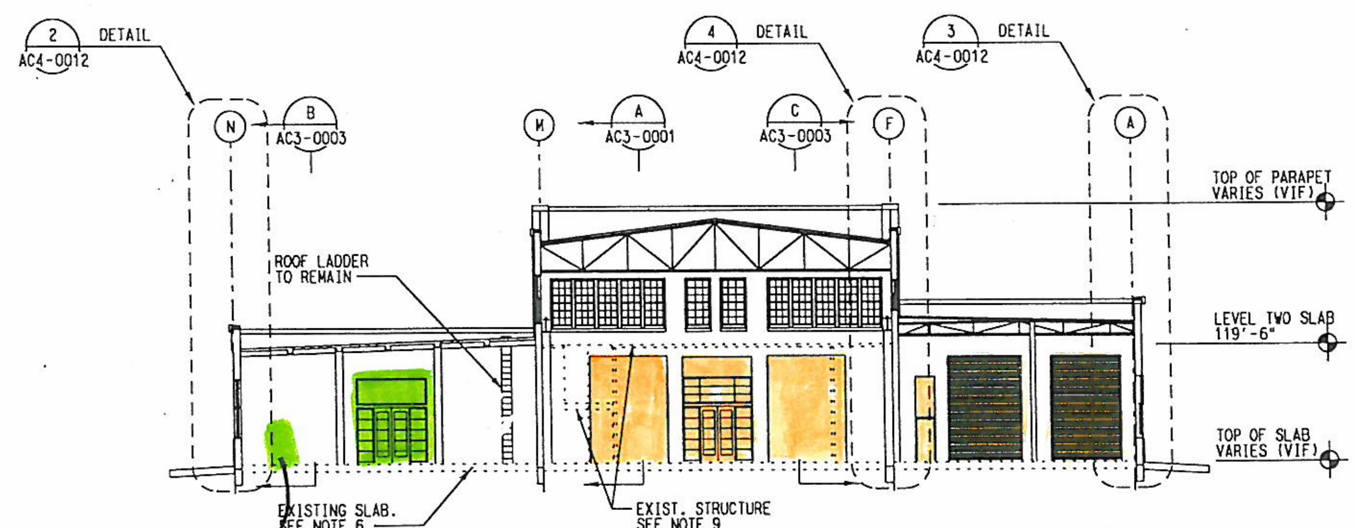
CONTRACT	DWG No.	REV
	AC3-0001	0

DWG No. AC3-0002



DEMOLITION BUILDING SECTION (B)

SCALE: 1/16"=1'-0"



Existing Masonry Infill To Remain

DEMOLITION BUILDING SECTION (A)

SCALE: 1/16"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. NOT USED.
2. NOT USED.
3. NOT USED.
4. NOT USED.
5. NOT USED.
6. DEMOLISH ENTIRE CONCRETE SLAB UNLESS NOTED OTHERWISE. EXCAVATE TO DEPTH OF CONCRETE OR TO ELEV. OF 99'-4" WHICHEVER IS GREATER. PRESERVE STRUCTURAL INTEGRITY OF EXISTING EXTERIOR AND INTERIOR MASONRY WALLS. NOTIFY AUTHORITY OF ANY RAILS, STEEL, OR EQUIPMENT DISCOVERED IN OR UNDER EXISTING CONRETE SLAB. AUTHORITY TO REVIEW AND APPROVE SALVAGE.
7. NOT USED.
8. NOT USED.
9. REMOVE EXISTING STAIRS AND STEEL STRUCTURE RELATED TO EXISTING SECOND FLOOR.

Chronology of Openings
1914
1920s
1920s-1990s
1990s
4 of 9
SNDE 5/28/2009

28 71

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CONTRACT SHEET No. 26 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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FAX 972-788-1583

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT

DART

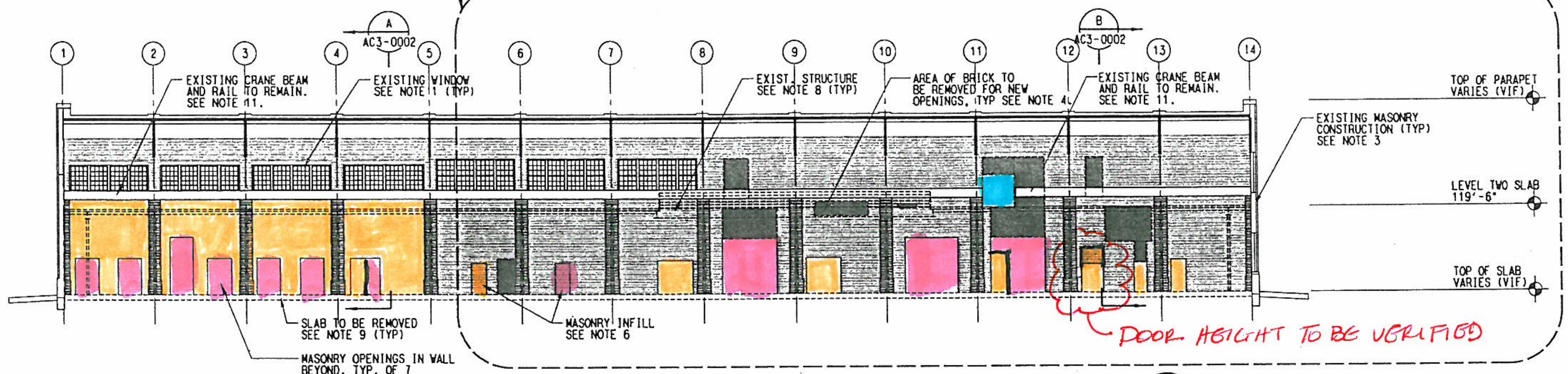
SCALE	1/16"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POWYSZYNSKI
DATE	15 MAY 09

CAES

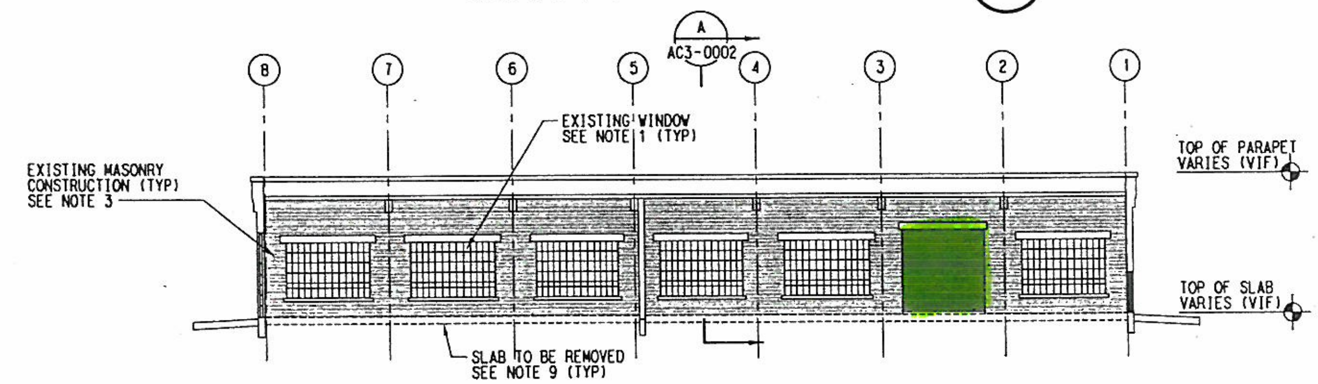
DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
DEMOLITION BUILDING SECTIONS
SHEET 2 OF 7

CONTRACT	DWG No.	REV
	AC3-0002	0

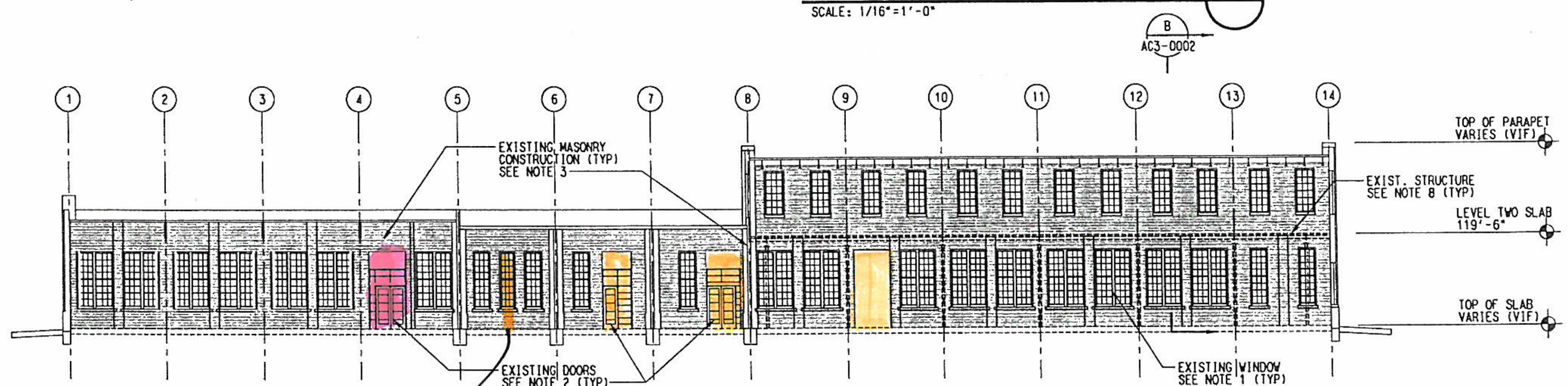
DWG No. AC3-0003



DEMOLITION BUILDING SECTION C
SCALE: 1/16"=1'-0"



DEMOLITION BUILDING SECTION B
SCALE: 1/16"=1'-0"



Former Door, Changed to WINDOW 1990s

DEMOLITION BUILDING SECTION A
SCALE: 1/16"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. ALL EXISTING WINDOWS TO REMAIN UNLESS NOTED OTHERWISE.
2. ALL EXISTING EXTERIOR DOORS, STOREFRONTS AND FRAMES, TO REMAIN UNLESS NOTED OTHERWISE.
3. ALL EXISTING MASONRY CONSTRUCTION TO REMAIN UNLESS NOTED OTHERWISE.
4. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING. SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICKS TO BE REUSED.
5. CONTRACTOR TO VERIFY SLAB ELEVATIONS, SLOPES, GRADE, AND OTHER EXISTING CONDITIONS PRIOR TO CONSTRUCTION.
6. ALL EXISTING MASONRY INFILLS TO REMAIN UNLESS NOTED OTHERWISE.
7. NOT USED
8. REMOVE EXISTING STAIRS AND STEEL STRUCTURE RELATED TO EXISTING SECOND FLOOR.
9. DEMOLISH ENTIRE INTERIOR CONCRETE SLAB UNLESS NOTED OTHERWISE. EXCAVATE TO DEPTH OF CONRETE OR TO ELEV. OF 99'-4" WHICHEVER IS GREATER. PRESERVE STRUCTURAL INTEGRITY OF EXISTING EXTERIOR AND INTERIOR MASONRY WALLS. NOTIFY AUTHORITY OF ANY RAILS, STEEL, OR EQUIPMENT DISCOVERED IN OR UNDER EXISTING CONCRETE SLAB. AUTHORITY TO REVIEW AND APPROVE SALVAGE.
10. NOT USED.
11. EXISTING CRANE BEAM AND RAIL TO REMAIN. PROTECT AND PRESERVE.

LEGEND:

SHADING FOR REMOVAL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS

1914
1920s
1920s-1990s
1990s

5 of 9

SNPE 5/28/2009

29 71

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CONTRACT SHEET No. 27 of 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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TEL 972-788-1508
FAX 972-788-1563

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT

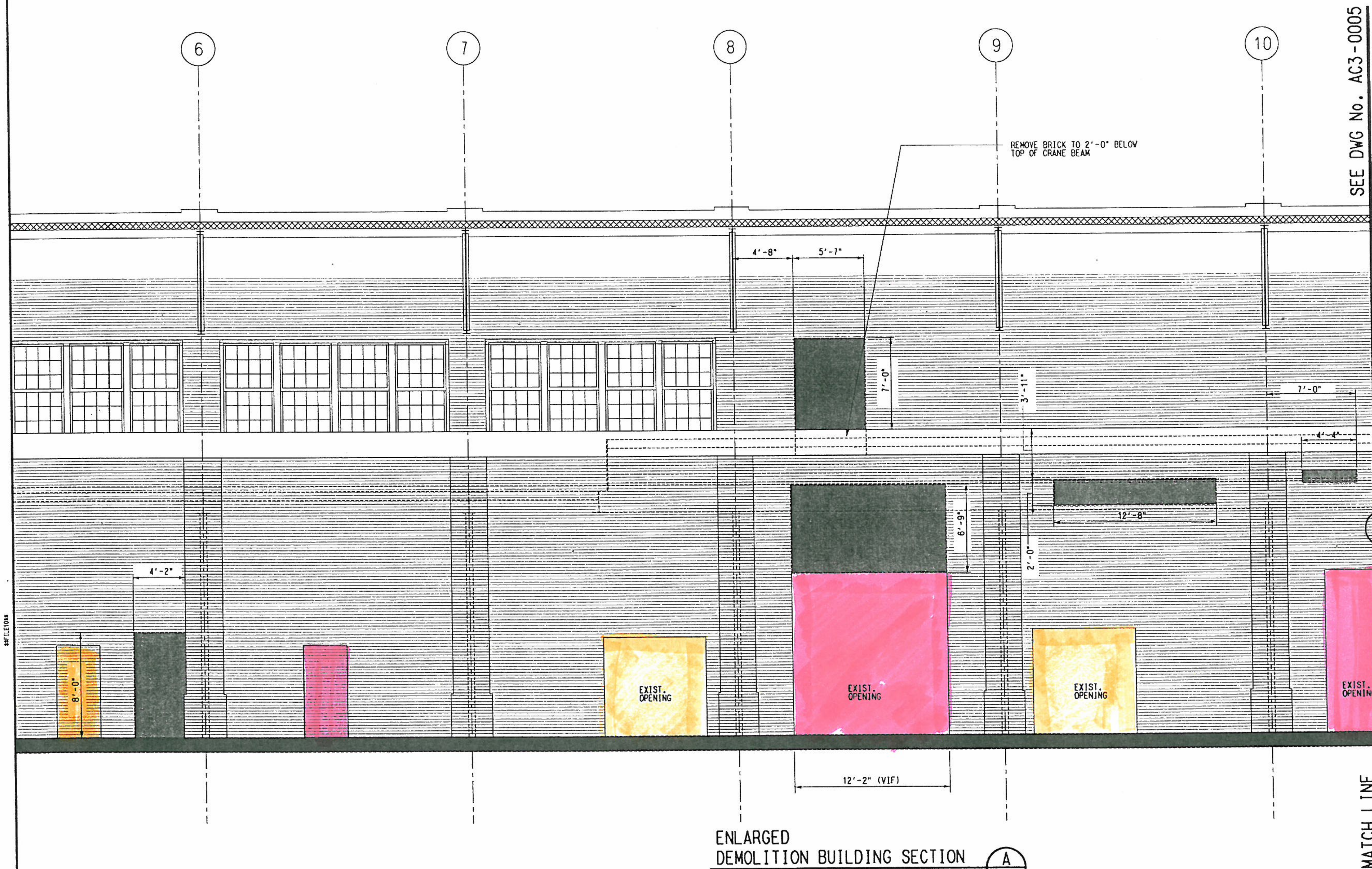
DART

SCALE	1/16"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEVIS
IN CHARGE	D. POVYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
DEMOLITION BUILDING SECTIONS
SHEET 3 OF 7

CONTRACT	DWG No.	REV
	AC3-0003	0



ENLARGED
DEMOLITION BUILDING SECTION A
SCALE: 1/4"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. REFER TO STRUCTURAL SHEET SC1-3401 DRAWINGS AND NOTES PRIOR TO ANY DEMOLITION. STEEL LINTELS AND JAMBS ARE TO BE INSTALLED PRIOR TO CUTTING AND REMOVING ANY MASONRY.
2. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING. SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICK TO BE REUSED.
3. REFER TO AC3-0001 AND AC3-0003 FOR TYPICAL NOTES. THIS SHEET IS FOR REMOVAL OF BRICK FOR NEW OPENINGS.
4. STEEL CHANNELS TO BE SHOP PRIMED AND TOUCH UP IN FIELD. FINISH COAT NIC.

LEGEND:

SHADING FOR REMOVEL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS
1914
1920s
1920s-1990s
1990s
6 of 9 SNDE 5/28/2009

30 71

NOT AN APPROVED DRAWING
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CONTRACT SHEET No. 28 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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FAX 972-788-1583

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APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT
DART

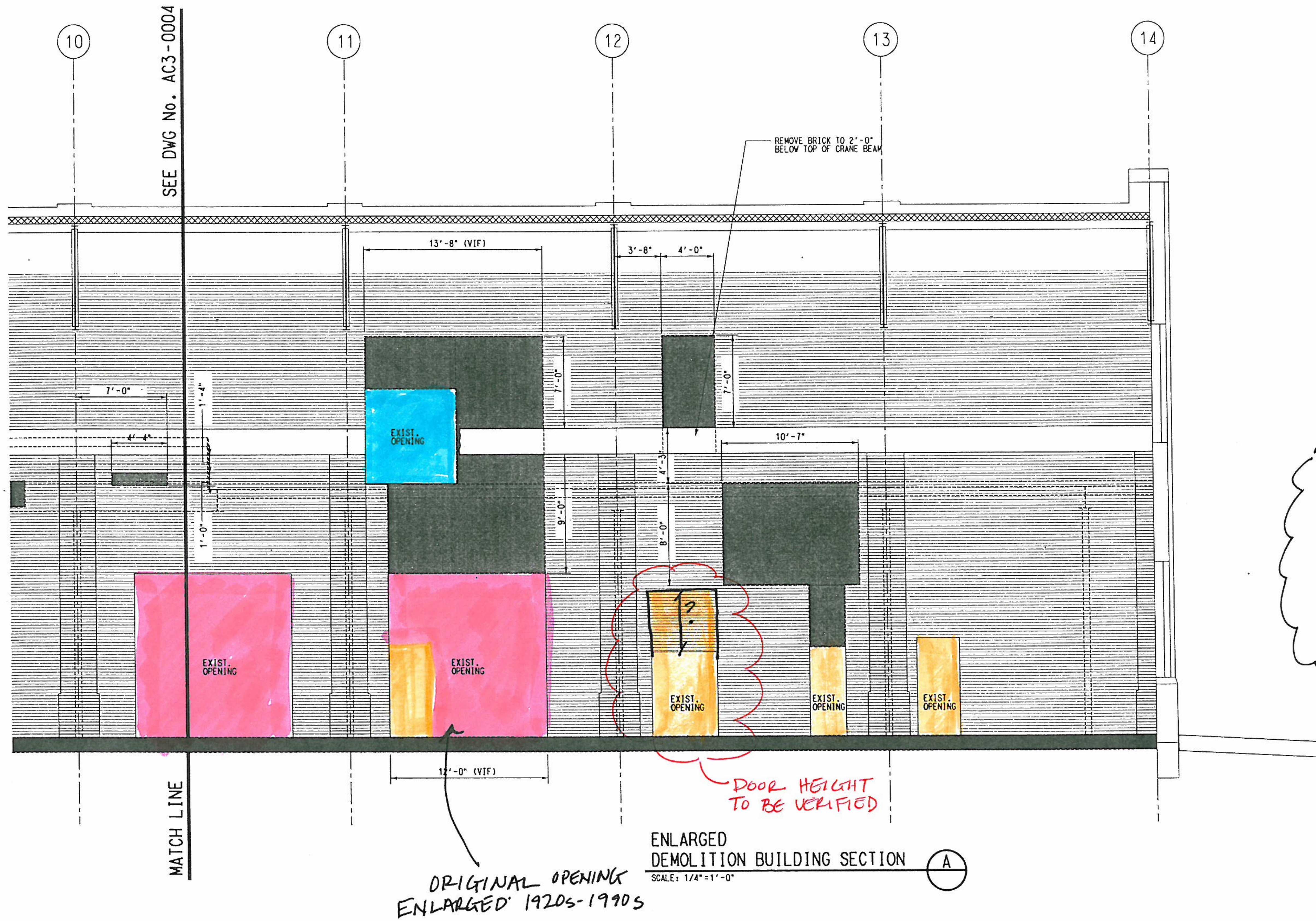
SCALE	1/4"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POWYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
ENLARGED
DEMOLITION BUILDING SECTIONS
SHEET 4 OF 7

CONTRACT | DWG No. AC3-0004 | REV 0

DWG No. AC3-0005



ENLARGED DEMOLITION BUILDING SECTION (A)

SCALE: 1/4"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. REFER TO STRUCTURAL SHEET SC1-3401 DRAWINGS AND NOTES PRIOR TO ANY DEMOLITION. STEEL LINTELS AND JAMBS ARE TO BE INSTALLED PRIOR TO CUTTING AND REMOVING ANY MASONRY.
2. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING. SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICK TO BE REUSED.
3. REFER TO AC3-0001 AND AC3-0003 FOR TYPICAL NOTES. THIS SHEET IS FOR REMOVAL OF BRICK FOR NEW OPENINGS.
4. STEEL CHANNELS TO BE SHOP PRIMED AND TOUCH UP IN FIELD. FINISH COAT NIC.

LEGEND:

SHADING FOR REMOVEL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS
1914
1920s
1920s-1990s
1990s

7 of 9
SNDE 5/28/2009

31 71

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CONTRACT SHEET No. 29 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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TRACK 3
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LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT
DART

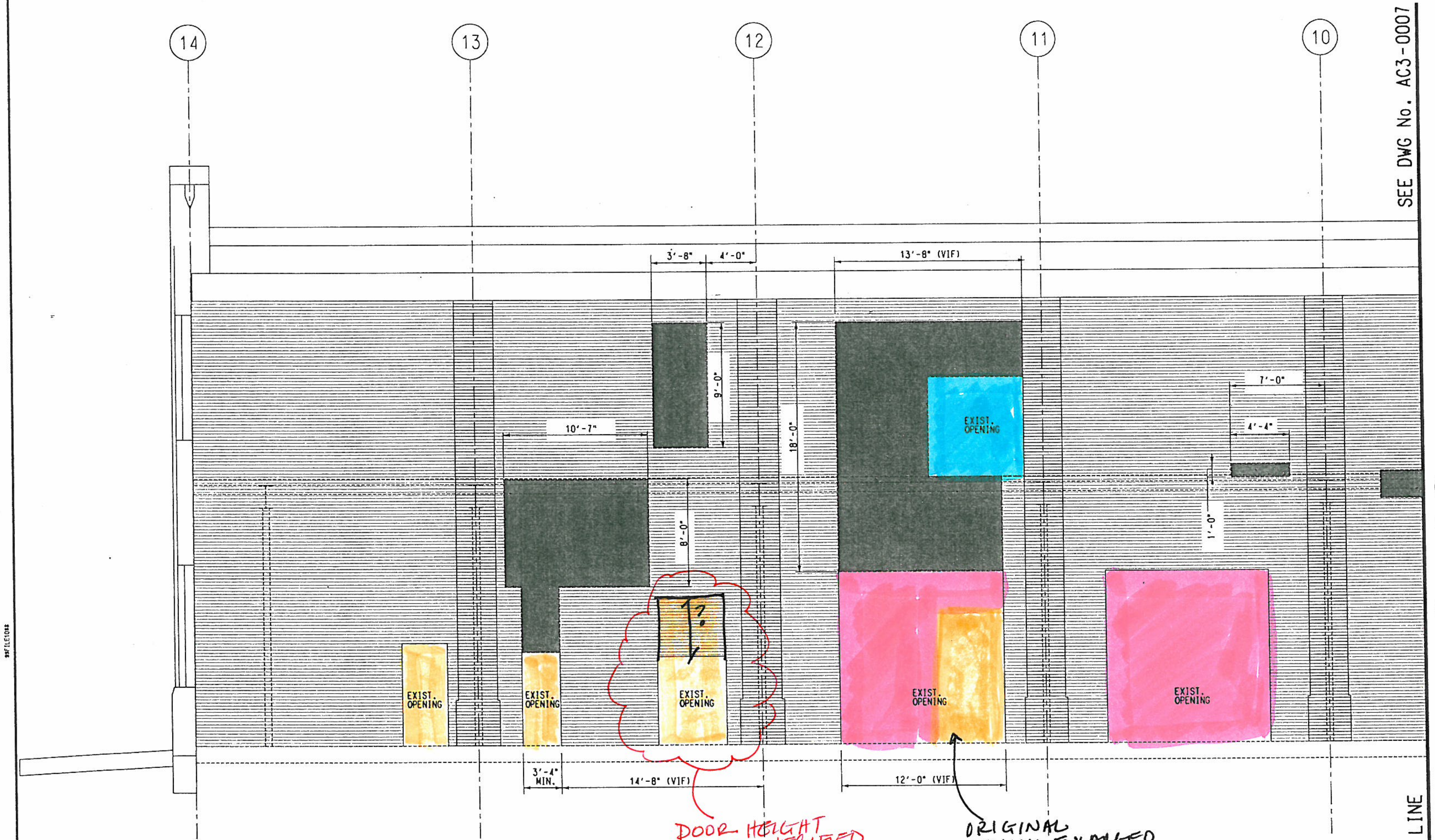
SCALE	1/4"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POWYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
ENLARGED
DEMOLITION BUILDING SECTIONS
SHEET 5 OF 7

CONTRACT | DWG No. AC3-0005 | REV 0

DWG No. AC3-0006



ENLARGED
DEMOLITION BUILDING SECTION (A)
SCALE: 1/4"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. REFER TO STRUCTURAL SHEET SC1-3401 DRAWINGS AND NOTES PRIOR TO ANY DEMOLITION. STEEL LINTELS AND JAMBS ARE TO BE INSTALLED PRIOR TO CUTTING AND REMOVING ANY MASONRY.
2. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING. SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICK TO BE REUSED.
3. REFER TO AC3-0001 AND AC3-0003 FOR TYPICAL NOTES. THIS SHEET IS FOR REMOVAL OF BRICK FOR NEW OPENINGS.
4. STEEL CHANNELS TO BE SHOP PRIMED AND TOUCH UP IN FIELD. FINISH COAT NIC.

LEGEND:

SHADING FOR REMOVEL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS
1914
1920s
1920s-1990s
1990s
8 of 9
SNDE 5/28/2009

32 71

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CONTRACT SHEET No. 30 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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TRACK 3
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LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT
DART

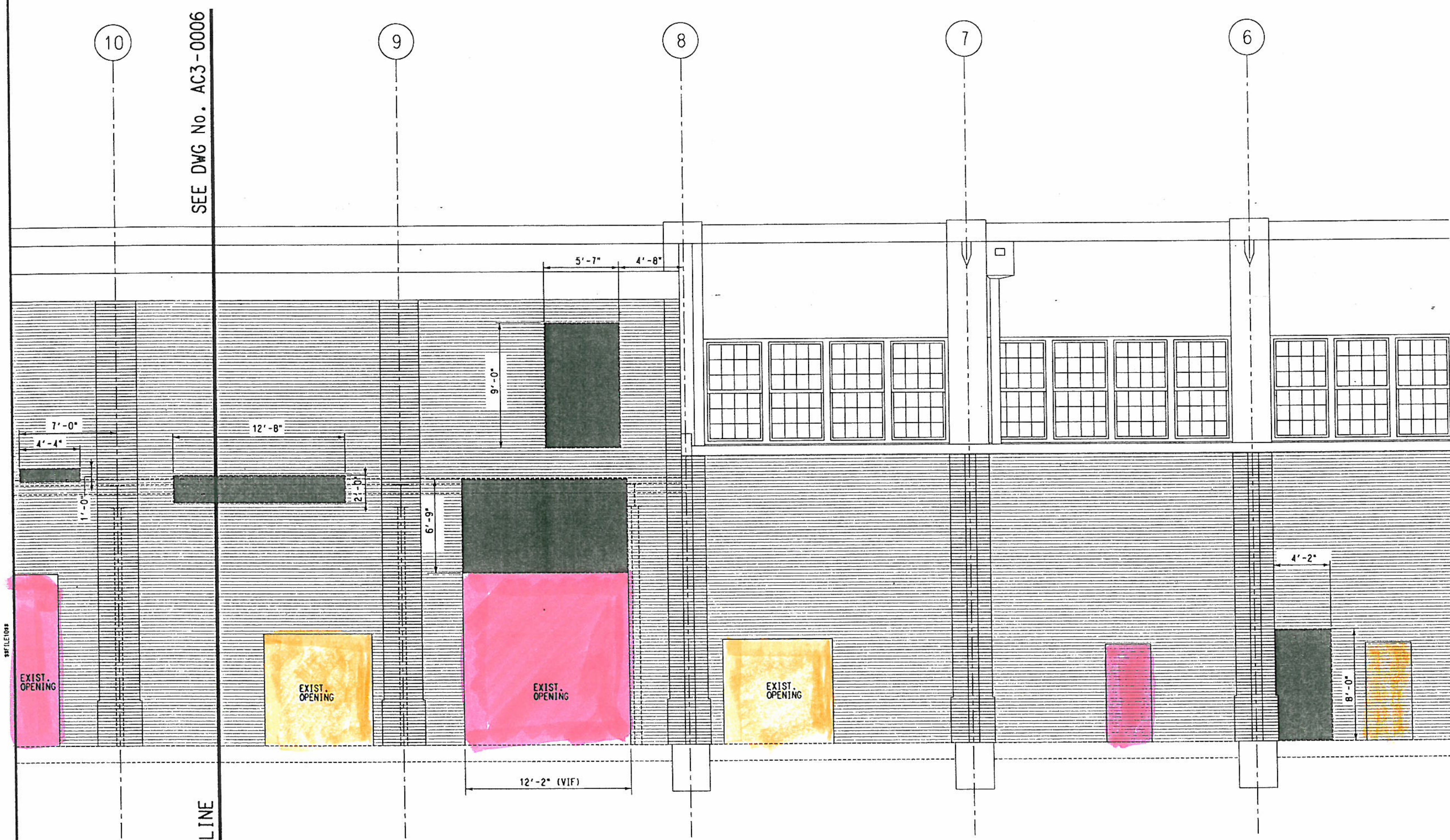
SCALE	1/4"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POVYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
ENLARGED
DEMOLITION BUILDING SECTIONS
SHEET 6 OF 7

CONTRACT | DWG No. AC3-0006 | REV 0

DWG No. AC3-0007



ENLARGED
DEMOLITION BUILDING SECTION (A)
SCALE: 1/4"=1'-0"

SCALE (IN FEET) 0 8' 16' 32'

NOTES:

1. REFER TO STRUCTURAL SHEET SC1-3401 DRAWINGS AND NOTES PRIOR TO ANY DEMOLITION. STEEL LINTELS AND JAMBS ARE TO BE INSTALLED PRIOR TO CUTTING AND REMOVING ANY MASONRY.
2. REMOVE EXISTING BRICK AS SHOWN ON DRAWING WITH SHADING. SALVAGE BRICKS; REMOVE MORTAR AND STORE FOR BRICK TO BE REUSED.
3. REFER TO AC3-0001 AND AC3-0003 FOR TYPICAL NOTES. THIS SHEET IS FOR REMOVAL OF BRICK FOR NEW OPENINGS.
4. STEEL CHANNELS TO BE SHOP PRIMED AND TOUCH UP IN FIELD. FINISH COAT NIC.

LEGEND:

SHADING FOR REMOVEL OF BRICK FOR NEW OPENING

CHRONOLOGY OF OPENINGS
1914
1920s
1920s - 1990s
1990s
9 of 9
SNOE 5/28/2009

33 71

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CONTRACT SHEET No. 31 OF 70

REV	AMEND	CR	DATE	DESCRIPTION	BY	ENG	CHK	APP

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DALLAS, TEXAS 75251
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FAX 972-788-1583

TRACK 3
AGUIRRE, Inc.
APM & ASSOCIATES, Inc.
CP&Y, Inc.
LOCKWOOD ANDREWS & NEWNAM, Inc.
FIRM REG: 10596

DART PROJECT

DART

SCALE	1/4"=1'-0"
DRAWN	E. TRAVIS
DESIGNED	E. TRAVIS
CHECKED	B. LEWIS
IN CHARGE	D. POVYSZYNSKI
DATE	15 MAY 09

CAES

DART POLICE - MONROE SHOPS
CONTRACT NO. 1
SHELL BUILDING
ENLARGED
DEMOLITION BUILDING SECTIONS
SHEET 7 OF 7

CONTRACT | DWG No. AC3-0007 | REV 0

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APPENDIX C
MAINTENANCE CHECKLISTS

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Daily Cleaning Checklist

Signs:

Do:

Dust lightly with a dry, lint free cloth, taking care to avoid dislodging paint.

Clean soiling with small amounts of plain water on a soft cloth taking care to not dislodge paint, rust, or loose metal. Dry immediately.

Do Not:

Do not use any cleaning products, solvents, or polishers.

Fire Doors and Hardware:

Do:

Dust lightly with a dry, lint free cloth, taking care to avoid dislodging paint.

Do Not:

Do not use any cleaning products, solvents, or polishers on the doors or hardware.

Brick Walls

Do Not:

Do not bump or hit the brick wall while vacuuming, mopping or polishing the floor.

Do not get any chemical cleaning products or solvents on the brick wall. If chemicals or solvents are splashed on to the wall, clean immediately with water and dry the brick.

Do not use abrasive cleaning methods, such as wire bristle brushes, on the brick.

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Lista Diaria de Limpieza

Letreros:

Que Hacer:

Sacudir ligeramente con un trapo seco que sea libre de hilas, teniendo cuidado para evitar desalojar la pintura.

Limpiar las manchas con pequeñas cantidades de agua pura con un trapo de tela suave teniendo cuidado para evitar que la pintura se desaloje, se oxide, o que el metal se desprenda. Secar inmediatamente.

Qué No Hacer:

No utilice ningún producto de limpieza, solvente o pulidor.

Puertas de Emergencia y Cerrajería:

Que Hacer:

Sacudir ligeramente con un trapo seco que sea libre de hilas, teniendo cuidado para evitar desalojar la pintura.

Qué No Hacer:

No utilice ningún producto de limpieza, solvente o pulidor en las puertas o en la cerradura.

Pared de Ladrillos:

Qué No Hacer:

No choque ni golpee la pared al utilizar la aspiradora, al limpiar o encerando el piso.

No ponga ninguna sustancia química de limpieza ni solventes en la pared de ladrillos.

Si alguna sustancia química o solvente es salpicada en a la pared, limpie inmediatamente con agua y seque el ladrillo.

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Six-Month Maintenance Checklist: Monroe Shops

Date Inspected:

Inspector(s):

Approved by Chief Architect:

Signs

Historic Signs should be cleaned with a dry lint free cloth. In case of severe soiling, plain water may be used and the sign dried immediately. The historic signs should not be cleaned with any kind of chemical solvents or cleaners. Photograph any deterioration or issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
rust				
metal condition				
paint				
dirt				
other				

Photographs (Key to Floorplans):

Interior Plaster

It is recommended that the plaster be left as is. It should be dusted as needed with a soft feather duster or similar. Nails, hooks and the like should not be drilled or hammered into the plaster. Historic attachments and

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracking				
dirt				
deterioration				
staining/mildew				
moisture				
other				

Photographs (Key to Floorplans):

Historic Wood and Metal Fire Doors

For general cleaning, light dusting with a lint-free cotton cloth is sufficient. Care should be taken during this light cleaning to not remove any of the paint that is remaining on the doors. The historic doors and hardware

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
dirt				
rust				
display mechanism				
metal condition				
paint				
hardware				
other				

Photographs (Key to Floorplans):

Historic Roof Trusses

Any conditions that may impact the structural integrity of the trusses should be addressed immediately. This may include weather events such as tornados or heavy snowfall, roof leaks (water/moisture on the trusses) and

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural condition				
cracking				
dirt				
rust				
metal condition/ deterioration				
paint condition				
other				

Photographs (Key to Floorplans):

Historic Crane Support Beams and Rails

A vacuum or broom can be used to remove loose dirt and dust. It should not be painted or sealed. The crane rail may not be cut, drilled through, or otherwise altered or removed from the building. Photograph peeling paint, rust, deteriorationor issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural condition				
cracking				
dirt				
rust				
metal condition/ deterioration				
other				

Photographs (Key to Floorplans):

Interurban Trolley Car

The trolley car should be examined and cleaned twice a year. The interior and exterior should be inspected and cleaned as noted in the Maintenance Manual.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
exterior body of car				
exterior paint				
undercarriage				
glass				
doors/stairs				
interior metal				
other				

Photographs (Key to Floorplans):

Exterior and Interior Masonry Cracks

Indicate on sheet the movement of the crack monitor or the movement of the crack as measured by crack guage.This should be done after crack widths have been measured by the crack width guage. Note distance between spigots, whether movement is horizontal and/or vertical, date of reading, and weather conditions. Indicate crack opening by " +" and closing by " -". If using crack monitor, also note readings on Crack Monitor Progress Sheet included . Measurements should be tracked over time and progressive cracks should be reported. Methods to address active cracks will be determined in conjunction with DART Facilities Manangement and DART Rail Planning, and will be coordinated with the Texas State Historic Preservation Office where warranted.

Crack Location	Measurement and Increase or Decrease from Previous Measurement	Recommendations	Date of Repair	Repair Methods
Location #1				
Location #2				
Location #3				
Location #4				
Location #5				
Location #6				
Location #7				
Location #8				

Weather Conditions (Note Temperature and Humidity):

Photographs (Key to Floorplans):

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Yearly Maintenance Checklist: Monroe Shops

Date Inspected:

Inspector(s):

Approved by Chief Architect:

Building/Site Drainage

Water should drain away from the building and area around the foundation should not have standing water. Photograph any drainage/water issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
fill adjacent to building				
clean out down spouts/leader boxes				
repair/adjust/align down spouts/leader boxes				
sprinkler heads facing away from building				
associated drainage deficiencies				
other				

Photographs (Key to Floorplans):

Foundation

The foundation should be checked for cracks and spalling. Standing water should be kept away from the foundation. Photograph any cracks or foundation issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural cracks				
stress cracks				
spalling/material loss				
pits/holes				
penetrations				
moisture/dampness/mildew				
other				

Photographs (Key to Floorplans):

Exterior and Interior Brick Walls and Masonry

Make sure that water is not penetrating the brick or mortar at any point. The brick, especially around window and door frames, the roof and parapet and foundation should be monitored for cracks and/or holes where moisture can get in. If masonry is repointed or repaired, the mortar should be of the same color and composition as is in the joint being repaired. The concrete window sills and headers should be monitored for cracks. These should be repaired with concrete that is the same color and texture as the existing concrete. Exterior landscaping sprinkler systems should be aimed away from the masonry and building to prevent the intrusion of water that can cause cracking, spalling and other maintenance issues. The gutters and Leader boxes should be kept in good condition and kept clean of debris. Photograph any brick cracks, damage or issues. Photograph any missing or damaged mortar.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracking (also see crack monitor checklist)				
spalling				
joint deterioration				
staining/mildew				
structural deterioration				
coating deterioration				
moisture				
other				

Photographs (Key to Floorplans):

Exterior and Interior Masonry Cracks

Indicate on sheet the movement of the crack monitor or the movement of the crack as measured by crack guage.This should be done after crack widths have been measured by the crack width guage. Note distance between spigots, whether movement is horizontal and/or vertical, date of reading, and weather conditions. Indicate crack opening by " +" and closing by " -". If using crack monitor, also note readings on Crack Monitor Progress Sheet included . Measurements should be tracked over time and progressive cracks should be reported. Methods to address active cracks will be determined in conjunction with DART Facilities Manangement and DART Rail Planning, and will be coordinated with the Texas State Historic Preservation Office where warranted.

Crack Location	Measurement and Increase or Decrease from Previous Measurement	Recommendations	Date of Repair	Repair Methods
Location #1				
Location #2				
Location #3				
Location #4				
Location #5				
Location #6				
Location #7				
Location #8				

Weather Conditions (Note Temperature and Humidity):

Photographs (Key to Floorplans):

Exterior Doors

The seal, weather stipping and caulk around exterior doors should be kept in good repair so as to prevent damage to the doors as well as any surrounding historic materials. Hardware and hinges should be kept in good repair. Manufacturer's recommendations for the maintenance and repair of all new doors should be followed. Photograph any issues with doors.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
deteriorated door material				
loose hinges/hardware				
hardware inoperable				
doors misaligned				
moisture/swelling				
inadequate/deteriorated weather stripping				
broken/cracked glazing				
other				

Photographs (Key to Floorplans):

Windows

The windows and caulk around them should be monitored. It is important that the caulk remains intact and that there is a tight seal between the window and the brick. This will ensure that moisture does not penetrate into the brick or wood blocking behind the metal window frames. Manufacturer's recommendations for the maintenance and repair of all new windows should be followed. Photograph any issues with windows.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracked/broken/missing glass				
deteriorated metal surrounds/panel				
deteriorated wood sill/frame				
missing/inoperable hardware				
deteriorated glazing compound/caulk				
deteriorated/missing joint sealant				
other				

Photographs (Key to Floorplans):

Exterior/Interior Window Trim

Monitor exterior concrete window sills and headers. If there are cracks, repair with same color and texture as the existing concrete. Monitor interior wood trim conditions.Photograph any issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracks in window sills/headers				
spalling				
staining/mildew				
rotted/deteriorated wood				
loose/bowed/detached wood				
other				

Photographs (Key to Floorplans):

Historic Openings

Alterations of historic door and window openings may impact the historic integrity of the building and create access issues. No additional openings may be infilled and no new openings can be created unless the Texas Historical Commission is consulted. Also, it is recommended that the areas around the openings be monitored. These openings should be inspected for cracks, holes and water penetration. Any penetrations should be repaired to maintain the building in a weather-tight condition. Photograph any alterations to openings or cracks, holes or water penetration.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracks				
holes/penetrations				
missing brick				
missing deteriorated caulk				
missing metal/wood surrounds				
other				

Photographs (Key to Floorplans):

Historic Concrete Columns in Gym

The columns should be maintained and inspected. Any roof leaks that might affect the columns should be dealt with immediately. Any signs of erosion, chipping or spalling should be addressed as soon as possible. Minor cracks or damage should be repaired with concrete of the same color and texture as the original. Large cracks should be examined by a structural engineer. Photograph any cracks or damage.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural condition				
cracking				
dirt				
spalling/deterioration				
other				

Photographs (Key to Floorplans):

Signs

Historic Signs should be cleaned with a dry lint free cloth. In case of severe soiling, plain water may be used and the sign dried immediately. The historic signs should not be cleaned with any kind of chemical solvents or cleaners. Photograph any deterioration or issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
rust				
metal condition				
paint				
dirt				
other				

Photographs (Key to Floorplans):

Interior Plaster

It is recommended that the plaster be left as is. It should be dusted as needed with a soft feather duster or similar. Nails, hooks and the like should not be drilled or hammered into the plaster. Historic attachments and hardware in the plaster should remain. Plaster should not be painted, sealed, or stained. The cracks should not be repaired and the plaster should not be replaced. Care should be taken to not remove any of the plaster. Photograph any deterioration, crumbling or damage.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracking				
dirt				
deterioration				
staining/mildew				
moisture				
other				

Photographs (Key to Floorplans):

Historic Wood and Metal Fire Doors

For general cleaning, light dusting with a lint-free cotton cloth is sufficient. Care should be taken during this light cleaning to not remove any of the paint that is remaining on the doors. The historic doors and hardware should not be cleaned with any kind of chemical solvents or cleaners. Photograph any issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
dirt				
rust				
display mechanism				
metal condition				
paint				
hardware				
other				

Photographs (Key to Floorplans):

Historic Roof Trusses

Any conditions that may impact the structural integrity of the trusses should be addressed immediately. This may include weather events such as tornados or heavy snowfall, roof leaks (water/moisture on the trusses) and excessive rust at main members. In the future, if the trusses need to be re-painted, they should be inspected for rust, sanded only where needed and painted. The color of the trusses is their historic color, and should remain the same color and gloss. Photograph peeling paint, rust, deterioration or issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural condition				
cracking				
dirt				
rust				
metal condition/ deterioration				
paint condition				
other				

Photographs (Key to Floorplans):

Historic Crane Support Beams and Rails

A vacuum or broom can be used to remove loose dirt and dust. It should not be painted or sealed. The crane rail may not be cut, drilled through, or otherwise altered or removed from the building. Photograph peeling paint, rust, deteriorationor issues.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
structural condition				
cracking				
dirt				
rust				
metal condition/ deterioration				
other				

Photographs (Key to Floorplans):

Sealants

Sealants including joint sealants and caulking, moisture barriers and expansion joint sealants should be carefully monitored. Deterioration or cracking can cause moisture to leak into the building causing severe maintainance issues and damage to historic and new materials. Manufacturer's and contractor's recommendations for the maintenance and repair of all sealants should be followed. Photograph any damage or deterioration to sealants or surrounding materials.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
material deterioration				
material loss				
sealant failure				
missing damaged caulk				
inappropriate material				
other				

Photographs (Key to Floorplans):

Roof

It is extremely important that the roof and parapet cap are maintained so that moisture does not leak into the building or the brick and cause damage. The roof should be inspected and the new parapet cap and mortar should be monitored for any cracks or damage. The flashing beneath the cap should also be monitored. The flashing at the base of the parapet wall and any other flashing around roof penetrations should be monitored closely to ensure that there are no leaks which could damage the historic masonry. Manufacturer's and contractor's recommendations for the maintenance and repair of all roofing materials should be followed. Photgraph any penetrations, cracks or damage.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracking				
penetrations/holes				
flashing				
structural deterioration				
coating deterioration				
roof drains-clear				
standing water				
other				

Photographs (Key to Floorplans):

Parapet Cap

It is extremely important that the roof and parapet cap are maintained so that moisture does not leak into the building or the brick and cause damage. The roof should be inspected and the new parapet cap and mortar should be monitored for any cracks or damage. The flashing beneath the cap should also be monitored. The flashing at the base of the parapet wall and any other flashing around roof penetrations should be monitored closely to ensure that there are no leaks which could damage the historic masonry. Manufacturer's and contractor's recommendations for the maintenance and repair of all parapet cap materials should be followed.Photograph any deterioration, penetrations or cracks.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
cracking				
structural deterioration				
spalling				
joint deterioration				
staining/mildew				
flashing				
other				

Photographs (Key to Floorplans):

Interurban Trolley Car

The trolley car should be examined and cleaned twice a year. The interior and exterior should be inspected and cleaned as noted in the Maintenance Manual.

Conditions	Comments	Recommendations	Date of Repair	Repair Methods
exterior body of car				
exterior paint				
undercarriage				
glass				
doors/stairs				
interior metal				
other				

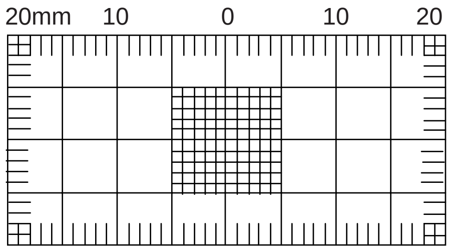
Photographs (Key to Floorplans):

PRG, Inc.
(800) 774-7891

CRACK MONITOR PROGRESS SHEET

Project: ______________________________

Location of Monitor: ______________________________



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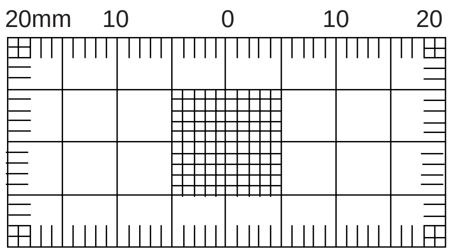

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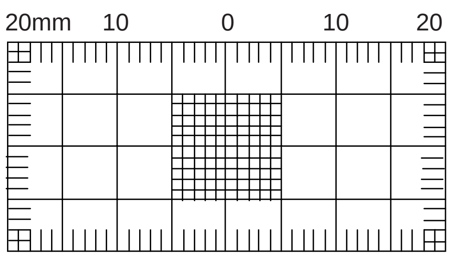

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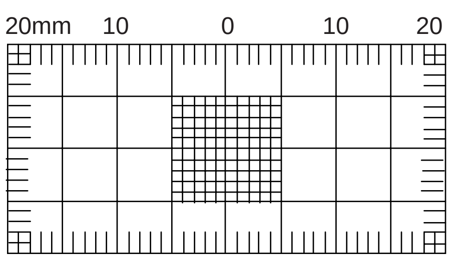

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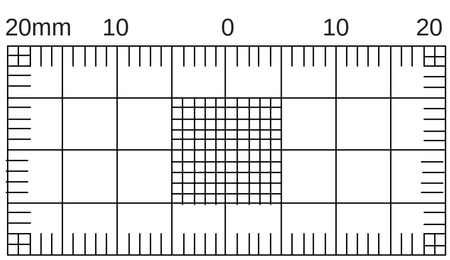

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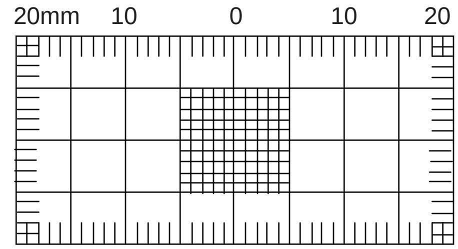

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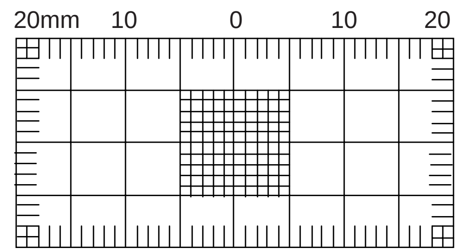

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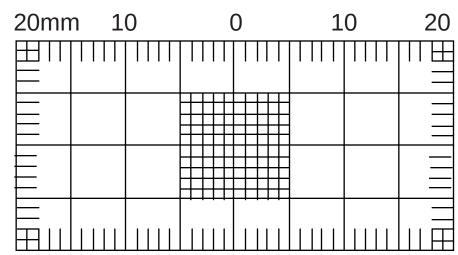

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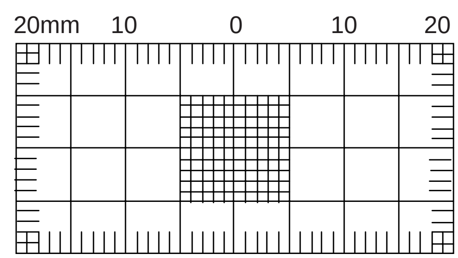

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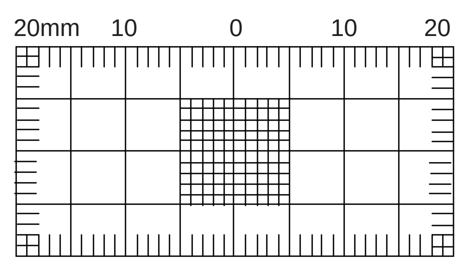

Date of Reading:

Coeff. of Thermal Expansion 3.80 X 10 -5 in/in/degree F (6.84 X 10 -5mm/mm/degree C)

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APPENDIX D
SECRETARY OF INTERIOR STANDARDS AND PRESERVATION BRIEFS

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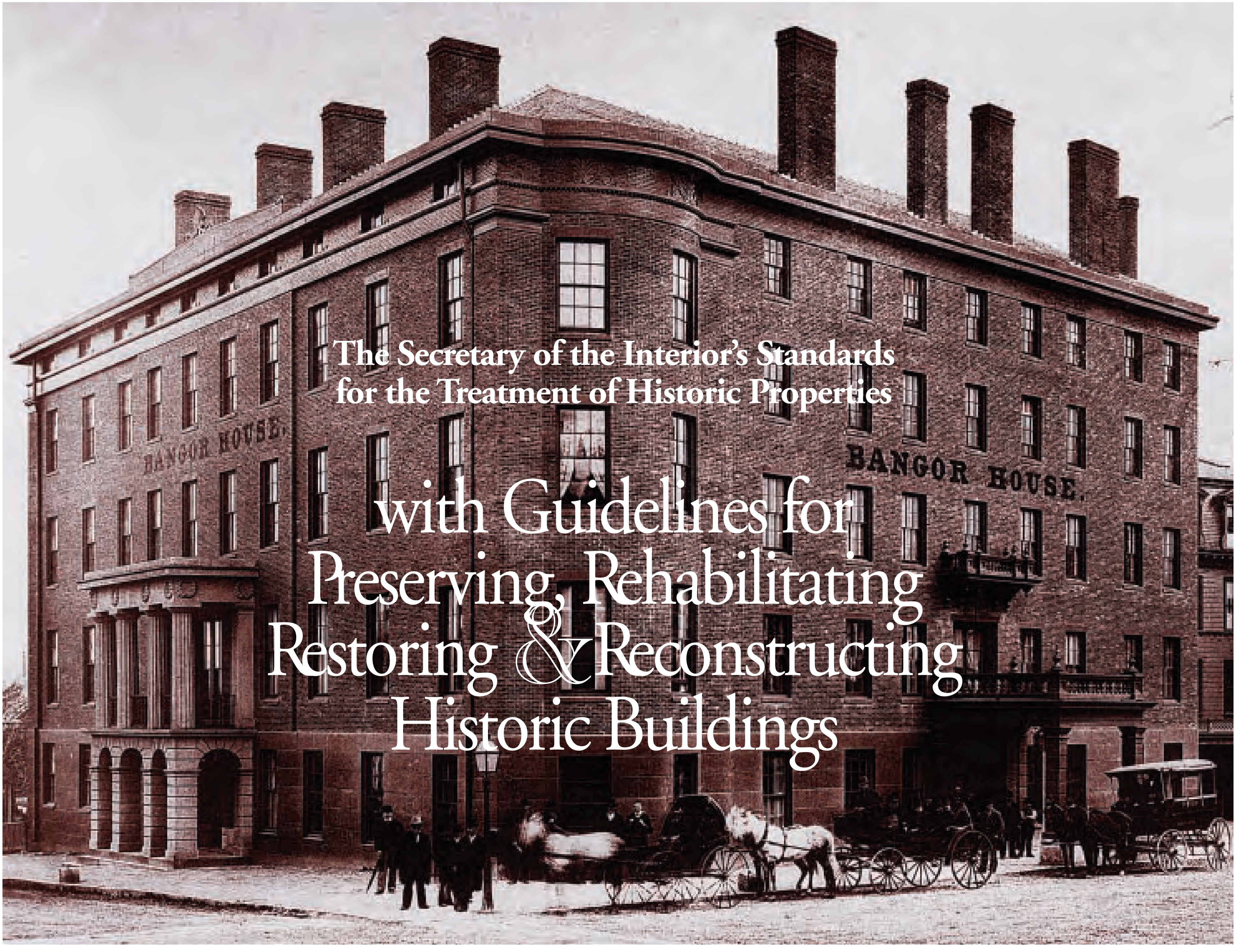

The Secretary of the Interior's Standards for the Treatment of Historic Properties

with Guidelines for Preserving, Rehabilitating Restoring & Reconstructing Historic Buildings

The Secretary of the Interior is responsible for establishing professional standards and providing advice on the preservation and protection of all cultural resources listed in or eligible for listing in the National Register of Historic Places. **The Secretary of the Interior's Standards for the Treatment of Historic Properties,** apply to all proposed development grant-in-aid projects assisted through the National Historic Preservation Fund, and are intended to be applied to a wide variety of resource types, including buildings, sites, structures, objects, and districts. They address four treatments: Preservation, Rehabilitation, Restoration, and Reconstruction. The treatment Standards, developed in 1992, were codified as 36 CFR Part 68 in the July 12, 1995 *Federal Register* (Vol. 60, No. 133). They replace the 1978 and 1983 versions of 36 CFR 68 entitled, "The Secretary of the Interior's Standards for Historic Preservation Projects." The Guidelines in this book also replace the Guidelines that were published in 1979 to accompany the earlier Standards.

Please note that **The Secretary of the Interior's Standards for the Treatment of Historic Properties** are only regulatory for projects receiving federal grant-in-aid funds; otherwise, the Standards and Guidelines are intended only as general guidance for work on any historic building.

Finally, another regulation, 36 CFR Part 67, focuses on "certified historic structures" as defined by the IRS Code of 1986. The "Standards for Rehabilitation" cited in 36 CFR 67 should always be used when property owners are seeking certification for Federal tax benefits.

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The Secretary of the Interior's Standards for the Treatment of Historic Properties

with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings

Kay D. Weeks and Anne E. Grimmer

U.S. Department of the Interior
National Park Service
Cultural Resource Stewardship and Partnerships
Heritage Preservation Services
Washington, D.C.
1995

Contents

Photo Credits

Front and Back Covers

Bangor House, Bangor, Maine, circa 1880. Historic photo (front) and drawing (back): Courtesy, Maine State Historic Preservation Office.

Historical Overview (Materials and Features)

Building Exterior: Masonry. Jack E. Boucher, HABS.

Building Exterior: Wood. Jack E. Boucher, HABS.

Building Exterior: Architectural Metals. Cervin Robinson, HABS.

Building Exterior: Roofs. Jack E. Boucher, HABS.

Building Exterior: Windows. Jack E. Boucher, HABS.

Building Exterior: Entrances and Porches. Jack E. Boucher, HABS.

Building Exterior: Storefronts. Jack E. Boucher, HABS.

Building Interior: Structural Systems. Cervin Robinson, HABS.

Building Interior: Spaces, Features and Finishes. Brooks Photographers, HABS Collection.

Building Interior: Mechanical Systems. National Park Service Files.

Building Site. Jack E. Boucher, HABS.

Setting (District/Neighborhood). Charles Ashton.

Energy Conservation. Laura A. Muckenfuss.

New Additions to Historic Buildings. Rodney Gary.

Accessibility Considerations. Department of Cultural Resources, Raleigh, North Carolina.

Health and Safety Considerations. National Park Service Files.

Chapter Heads

Preservation
Hale House, Los Angeles, California. Photos: Before: National Park Service files; After: Bruce Boehner.

Rehabilitation
Storefront, Painted Post, New York, after rehabilitation. Photo: Kellogg Studio.

Restoration
Camron-Stanford House, Oakland, California. Photos: Before: National Park Service files; After: Courtesy, James B. Spaulding.

Reconstruction
George Washington Memorial House at Washington Birthplace National Monument, Westmoreland County, Virginia. Photo: Richard Frear.

Text

It should be noted that those photographs used to illustrate the guidelines text that are not individually credited in the captions are from National Park Service files.

Acknowledgements

The Standards for the Treatment of Historic Properties, published in 1992, were reviewed by a broad cross-section of government entities and private sector organizations. *The Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings* were developed in cooperation with the National Conference of State Historic Preservation Officers and reviewed by individual State Historic Preservation Offices nationwide. We wish to thank Stan Graves and Claire Adams, in particular, for their thoughtful evaluation of the new material. Dahlia Hernandez provided administrative support throughout the project.

Finally, this book is dedicated to H. Ward Jandl, whose long-term commitment to historic preservation helped define the profession as we know it today.

The Secretary of the Interior's Standards for the Treatment of Historic Properties may be applied to one historic resource type or a variety of historic resource types; for example, a project may include a complex of buildings such as a house, garage, and barn; the site, with a designed landscape, natural features, and archeological components; structures such as a system of roadways and paths or a bridge; and objects such as fountains and statuary.

Historic Resource Types & Examples

Building: houses, barns, stables, sheds, garages, courthouses, city halls, social halls, commercial buildings, libraries, factories, mills, train depots, hotels, theaters, stationary mobile homes, schools, stores, and churches.

Site: habitation sites, funerary sites, rock shelters, village sites, hunting and fishing sites, ceremonial sites, petroglyphs, rock carvings, ruins, gardens, grounds, battlefields, campsites, sites of treaty signings, trails, areas of land, shipwrecks, cemeteries, designed landscapes, and natural features, such as springs and rock formations, and land areas having cultural significance.

Zoar Historic District, Ohio. Aerial view. Photo: National Park Service.

Elmendorf, Lexington, Kentucky. Photo: Charles A. Birnbaum.

Structure: bridges, tunnels, gold dredges, firetowers, canals, turbines, dams, power plants, corn-cribs, silos, roadways, shot towers, windmills, grain elevators, kilns, mounds, cairns, palisade fortifications, earthworks, railroad grades, systems of roadways and paths, boats and ships, railroad locomotives and cars, telescopes, carousels, bandstands, gazebos, and aircraft.

Object: sculpture, monuments, boundary markers, statuary, and fountains.

District: college campuses, central business districts, residential areas, commercial areas, large forts, industrial complexes, civic centers, rural villages, canal systems, collections of habitation and limited activity sites, irrigation systems, large farms, ranches, estates, or plantations, transportation networks, and large landscaped parks.

(Sidebar adapted from National Register Property and Resource Types, p. 15, National Register Bulletin 16A, How to Complete the National Register Form, published by the National Register Branch, Interagency Resources Division, National Park Service, U.S. Department of the Interior, 1991.)

Introduction

Choosing an Appropriate Treatment for the Historic Building

The Standards are neither technical nor prescriptive, but are intended to promote responsible preservation practices that help protect our Nation's irreplaceable cultural resources. For example, they cannot, in and of themselves, be used to make essential decisions about which features of the historic building should be saved and which can be changed. But once a treatment is selected, the Standards provide philosophical consistency to the work.

Choosing the most appropriate treatment for a building requires careful decision-making about a building's historical significance, as well as taking into account a number of other considerations:

Relative importance in history. Is the building a nationally significant resource—a rare survivor or the work of a master architect or craftsman? Did an important event take place in it? National Historic Landmarks, designated for their "exceptional significance in American history," or many buildings individually listed in the National Register often warrant Preservation or Restoration. Buildings that contribute to the significance of a historic district but are not individually listed in the National Register more frequently undergo Rehabilitation for a compatible new use.

Physical condition. What is the existing condition—or degree of material integrity—of the building prior to work? Has the original form survived largely intact or has it been altered over time? Are the alterations an important part of the building's history? Preservation may be appropriate if distinctive materials, features, and spaces are essentially intact and convey the building's historical significance. If the building requires more extensive repair and replacement, or if alterations or additions are necessary for a new use, then Rehabilitation is probably the most appropriate treatment. These key questions play major roles in determining what treatment is selected.

Proposed use. An essential, practical question to ask is: Will the building be used as it was historically or will it be given a new use? Many historic buildings can be adapted for new uses without seriously damaging their historic character; special-use properties such as grain silos, forts, ice houses, or windmills may be extremely difficult to adapt to new uses without major intervention and a resulting loss of historic character and even integrity.

Mandated code requirements. Regardless of the treatment, code requirements will need to be taken into consideration. But if hastily or poorly designed, a series of code-required actions may jeopardize a building's materials as well as its historic character. Thus, if a building needs to be seismically upgraded, modifications to the historic appearance should be minimal. Abatement of lead paint and asbestos within historic buildings requires particular care if important historic finishes are not to be adversely affected. Finally, alterations and new construction needed to meet accessibility requirements under the Americans with Disabilities Act of 1990 should be designed to minimize material loss and visual change to a historic building.

Using the Standards and Guidelines for a Preservation, Rehabilitation, Restoration, or Reconstruction Project

The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings are intended to provide guidance to historic building owners and building managers, preservation consultants, architects, contractors, and project reviewers prior to treatment.

As noted, while the treatment Standards are designed to be applied to all historic resource types included in the National Register of Historic Places—buildings, sites, structures, districts, and objects—the Guidelines apply to *specific* resource types; in this case, buildings.

The Guidelines have been prepared to assist in applying the Standards to all project work; consequently, they are not meant to give case-specific advice or address exceptions or rare instances. Therefore, it is recommended that the advice of qualified historic preservation professionals be obtained early in the planning stage of the project. Such professionals may include architects, architectural historians, historians, historical engineers, archeologists, and others who have experience in working with historic buildings.

The Guidelines pertain to both exterior and interior work on historic buildings of all sizes, materials, and types. Those approaches to work treatments and techniques that are consistent with ***The Secretary of the Interior's Standards for the Treatment of Historic Properties*** are listed in the "**Recommended**" column on the left; those which are inconsistent with the Standards are listed in the "**Not Recommended**" column on the right.

One chapter of this book is devoted to each of the four treatments: Preservation, Rehabilitation, Restoration, and Reconstruction. Each chapter contains one set of Standards and accompanying Guidelines that are to be used throughout the course of a project. The Standards for the first treatment, *Preservation,* require retention of the greatest amount of historic fabric, along with the building's historic form, features, and detailing as they have evolved over time. The *Rehabilitation* Standards acknowledge the need to alter or add to a historic building to meet continuing or new uses while retaining the building's historic character. The *Restoration* Standards allow for the depiction of a building at a particular time in its history by preserving materials from the period of significance and removing materials from other periods. The *Reconstruction* Standards establish a limited framework for re-creating a vanished or non-surviving building with new materials, primarily for interpretive purposes.

The Guidelines are preceded by a brief historical overview of the primary historic building materials (masonry, wood, and architectural metals) and their diverse uses over time. Next, building features comprised of these materials are discussed, beginning with the exterior, then moving to the interior. Special requirements or work that must be done to meet accessibility requirements, health and safety code requirements, or retrofitting to improve energy efficiency are also addressed here. Although usually not part of the overall process of protecting historic buildings, this work must also be assessed for its potential impact on a historic building.

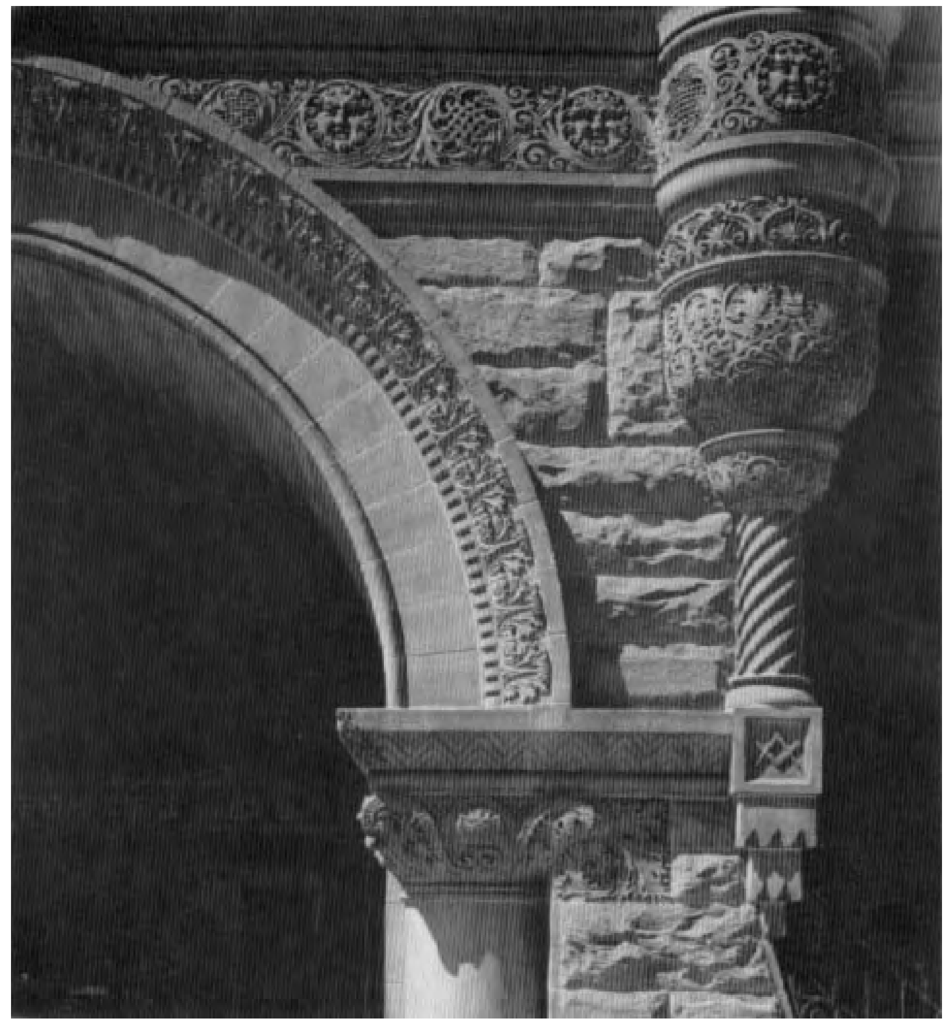
Historical Overview
Building Exterior *Materials*

Masonry

Stone is one of the more lasting of masonry building materials and has been used throughout the history of American building construction. The kinds of stone most commonly encountered on historic buildings in the U.S. include various types of sandstone, limestone, marble, granite, slate and fieldstone. *Brick* varied considerably in size and quality. Before 1870, brick clays were pressed into molds and were often unevenly fired. The quality of brick depended on the type of clay available and the brick-making techniques; by the 1870s—with the perfection of an extrusion process—bricks became more uniform and durable. *Terra cotta* is also a kiln-dried clay product popular from the late 19th century until the 1930s. The development of the steel-frame office buildings in the early 20th century contributed to the widespread use of architectural terra cotta. *Adobe*, which consists of sun-dried earthen bricks, was one of the earliest building materials used in the U.S., primarily in the Southwest where it is still popular.

Mortar is used to bond together masonry units. Historic mortar was generally quite soft, consisting primarily of lime and sand with other additives. By the latter part of the 19th century, portland cement was usually added resulting in a more rigid and nonabsorbing mortar. Like historic mortar, early *stucco* coatings were also heavily lime-based, increasing in hardness with the addition of portland cement in the late 19th century. *Concrete* has a long history, being variously made of tabby, volcanic ash and, later, of natural hydraulic cements, before the introduction of portland cement in the 1870s. Since then, concrete has also been used in its precast form.

While masonry is among the most durable of historic building materials, it is also very susceptible to damage by improper maintenance or repair techniques and harsh or abrasive cleaning methods.



Wood

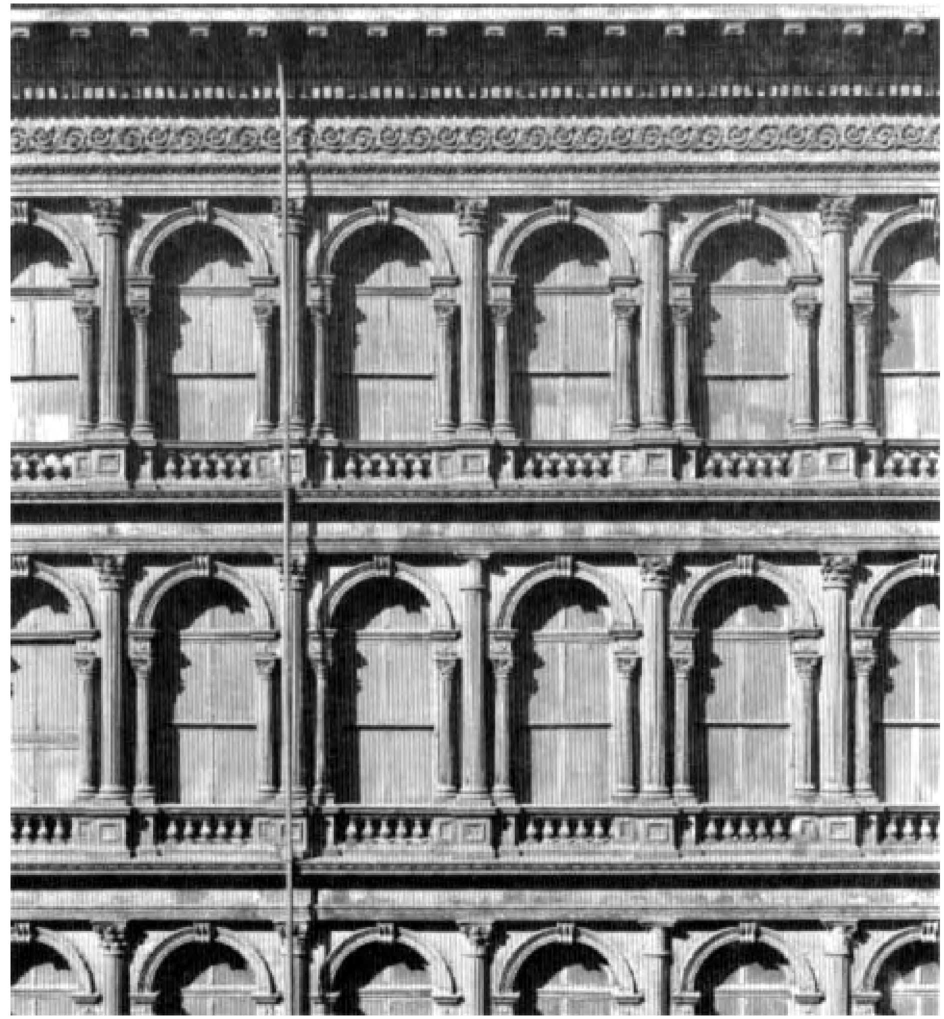
Wood has played a central role in American building during every period and in every style. Whether as structural members, exterior cladding, roofing, interior finishes, or decorative features, wood is frequently an essential component of historic buildings.

Because it can be easily shaped by sawing, sanding, planing, carving, and gouging, wood is used for architectural features such as clapboard, cornices, brackets, entablatures, shutters, columns and balustrades. These wooden features, both functional and decorative, are often important in defining the historic character of the building.

Architectural Metals

Architectural metal features—such as cast iron facades, porches, and steps; sheet metal cornices, siding, roofs, roof cresting and storefronts; and cast or rolled metal doors, window sash, entablatures, and hardware—are often highly decorative and may be important in defining the overall character of historic American buildings.

Metals commonly used in historic buildings include lead, tin, zinc, copper, bronze, brass, iron, steel, and to a lesser extent, nickel alloys, stainless steel and aluminum. Historic metal building components were often created by highly skilled, local artisans, and by the late 19th century, many of these components were prefabricated and readily available from catalogs in standardized sizes and designs.



Building Exterior *Features*

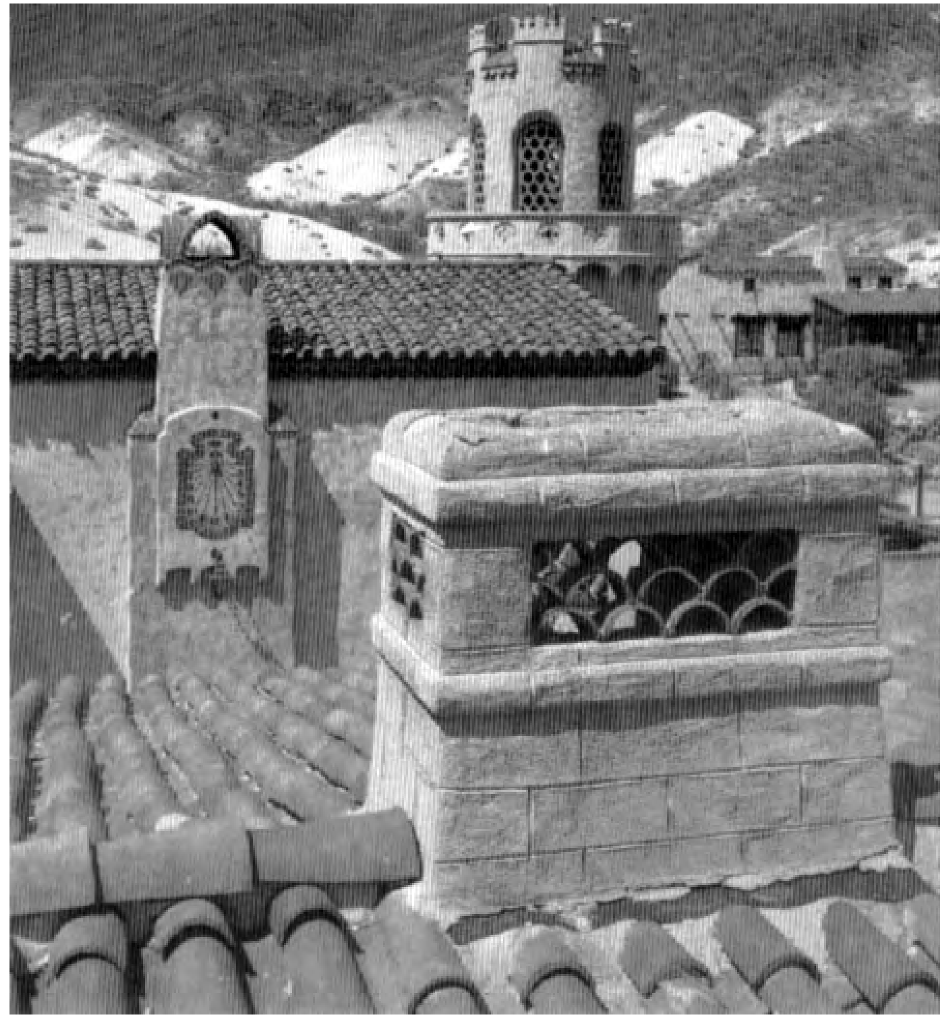
Roofs

The roof—with its shape; features such as cresting, dormers, cupolas, and chimneys; and the size, color, and patterning of the roofing material—is an important design element of many historic buildings. In addition, a weathertight roof is essential to the longterm preservation of the entire structure. Historic roofing reflects availability of materials, levels of construction technology, weather, and cost. Throughout the country in all periods of history, *wood shingles* have been used—their size, shape, and detailing differing according to regional craft practices.

European settlers used *clay tile* for roofing at least as early as the mid-17th century. In some cities, such as New York and Boston, clay tiles were popularly used as a precaution against fire. The Spanish influence in the use of clay tiles is found in the southern, southwestern and western states. In the mid-19th century, tile roofs were often replaced by *sheet-metal*, which is lighter and easier to maintain.

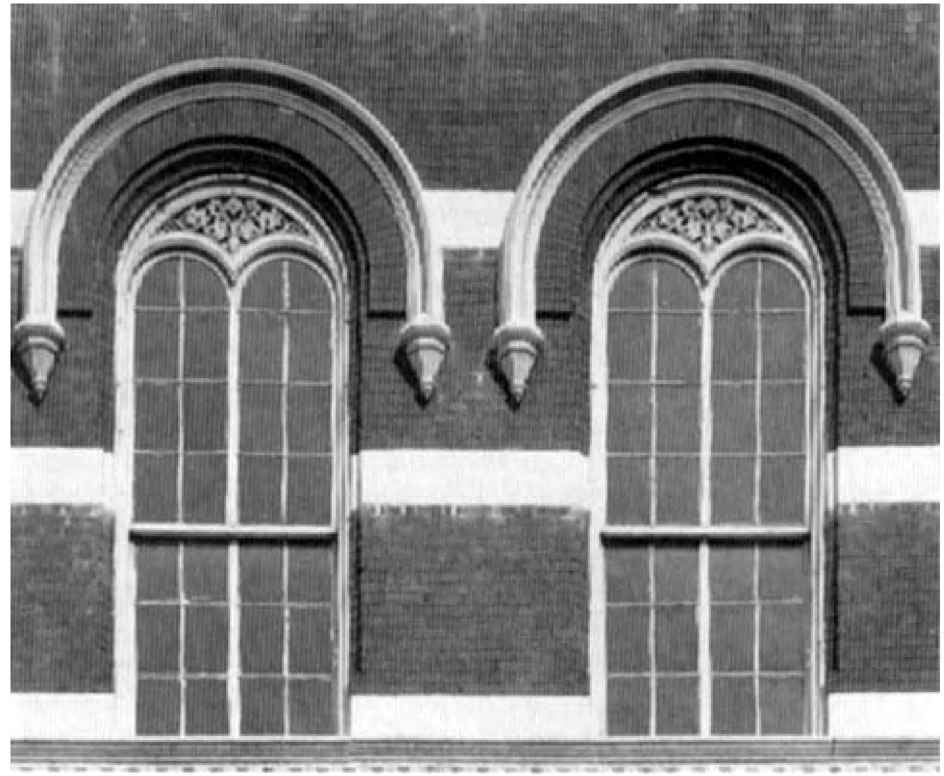
Evidence of the use of *slate* for roofing dates from the mid-17th century. Slate has remained popular for its durability, fireproof qualities, and its decorative applications. The use of metals for roofing and roof features dates from the 18th century, and includes the use of *sheet metal, corrugated metal, galvanized metal, tin-plate, copper, lead* and *zinc.*

New roofing materials developed in the early 20th century include built-up roll roofing, and concrete, asbestos, and asphalt shingles.



Windows

Technology and prevailing architectural styles have shaped the history of windows in the United States starting in the 17th century with wooden casement windows with tiny glass panes seated in lead cames. From the transitional single-hung sash in the early 1700s to the true double-hung sash later in the century, these early wooden windows were characterized by small panes, wide muntins, and decorative trim. As the sash thickness increased, muntins took on a thinner appearance as they narrowed in width but increased in thickness.

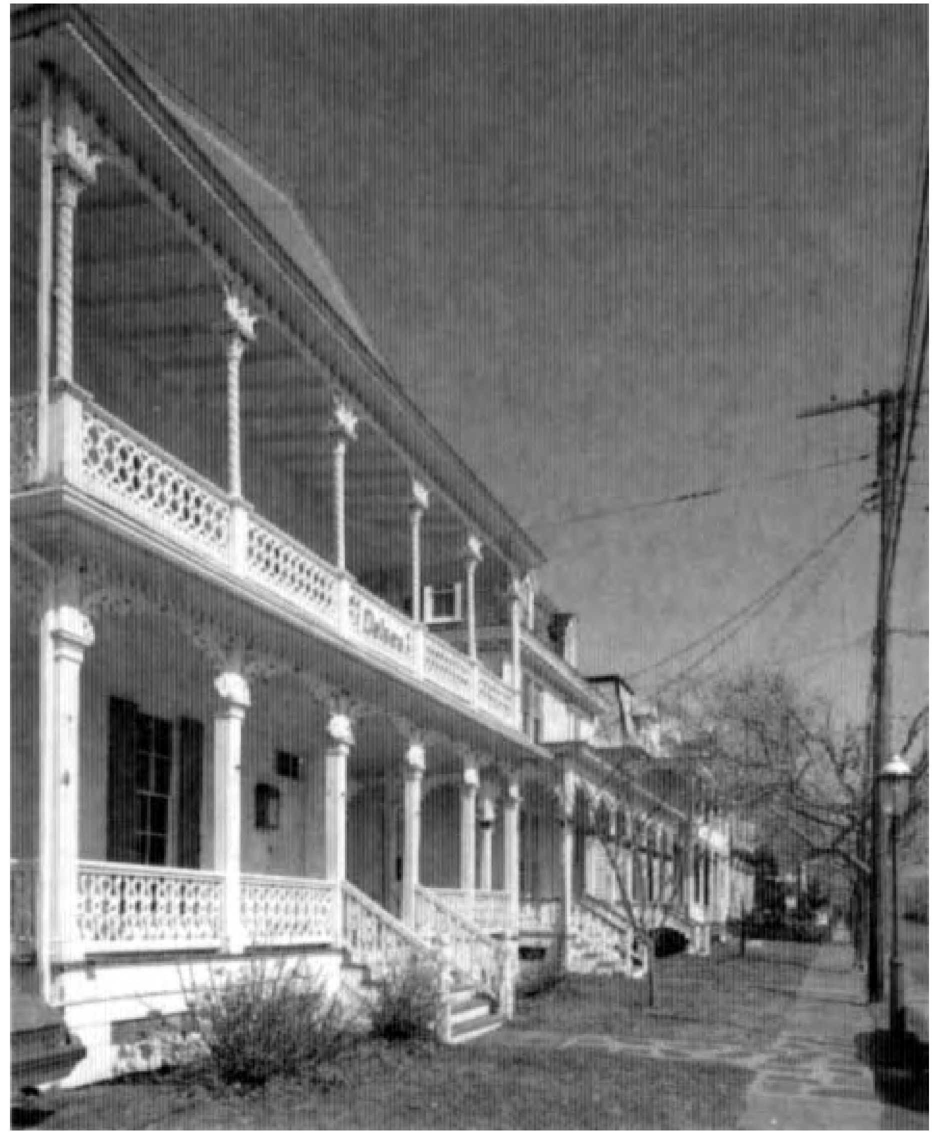


Changes in technology led to larger panes of glass so that by the mid-19th century, two-over-two lights were common; the manufacture of plate glass in the United States allowed for use of large sheets of glass in commercial and office buildings by the late 19th century. With mass-produced windows, mail order distribution, and changing architectural styles, it was possible to obtain a wide range of window designs and light patterns in sash. Early 20th century designs frequently utilized smaller lights in the upper sash and also casement windows. The desire for fireproof building construction in dense urban areas contributed to the growth of a thriving steel window industry along with a market for hollow metal and metal clad wooden windows.

As one of the few parts of a building serving as both an interior and exterior feature, windows are nearly always an important part of a historic building.

Entrances and Porches

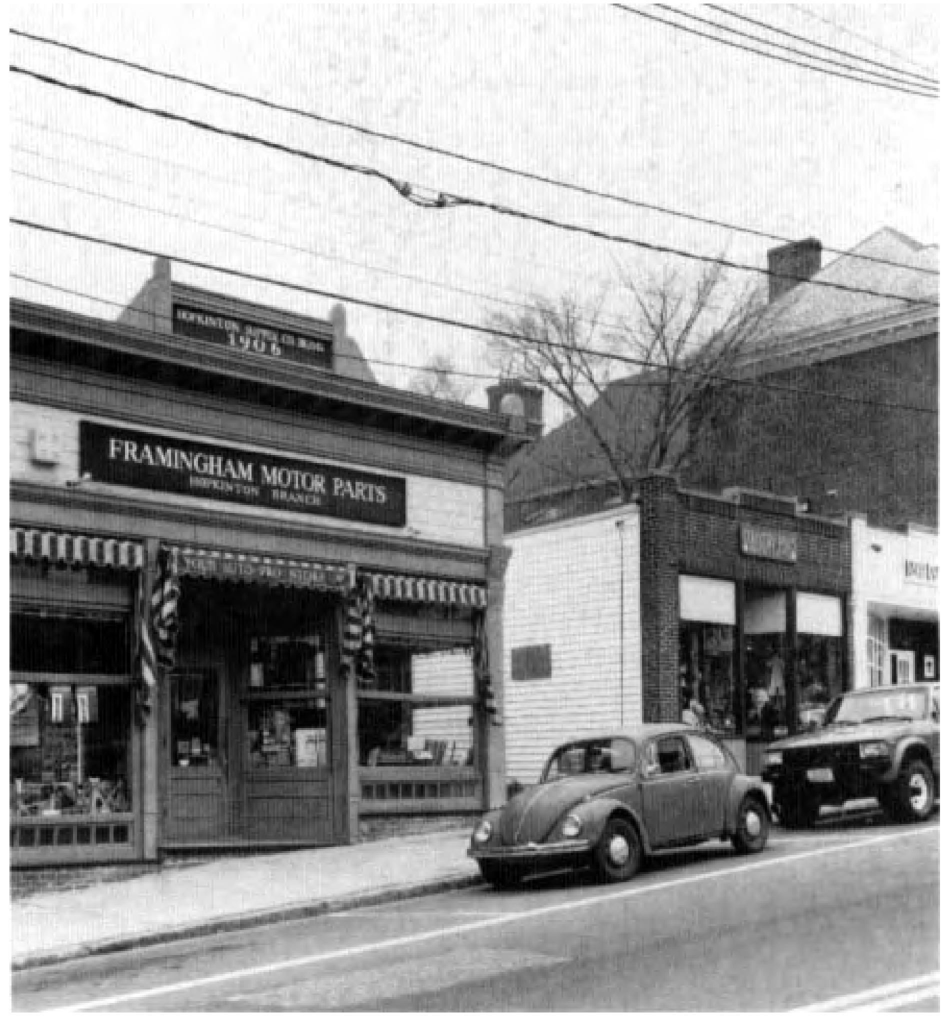
Entrances and porches are quite often the focus of historic buildings, particularly on primary elevations. Together with their functional and decorative features such as doors, steps, balustrades, pilasters, and entablatures, they can be extremely important in defining the overall character of a building. In many cases, porches were energy-saving devices, shading southern and western elevations. Usually entrances and porches were integral components of a historic building's design; for example, porches on Greek Revival houses, with Doric or Ionic columns and pediments, echoed the architectural elements and features of the larger building. Central one-bay porches or arcaded porches are evident in Italianate style buildings of the 1860s. Doors of Renaissance Revival style buildings frequently supported entablatures or pediments. Porches were particularly prominent features of Eastlake and Stick Style houses in which porch posts, railings, and balusters were characterized by a massive and robust quality, with members turned on a lathe. Porches of bungalows of the early 20th century were characterized by tapered porch posts, exposed post and beams, and low pitched roofs with wide overhangs. Art Deco commercial buildings were entered through stylized glass and stainless steel doors.



Storefronts

The earliest extant storefronts in the U.S., dating from the late 18th and early 19th centuries, had bay or oriel windows and provided limited display space. The 19th century witnessed the progressive enlargement of display windows as plate glass became available in increasingly larger units. The use of cast iron columns and lintels at ground floor level permitted structural members to be reduced in size. Recessed entrances provided shelter for sidewalk patrons and further enlarged display areas. In the 1920s and 1930s, aluminum, colored structural glass, stainless steel, glass block, neon, and other new materials were introduced to create Art Deco storefronts.

The storefront is usually the most prominent feature of a historic commercial building, playing a crucial role in a store's advertising and merchandising strategy. Although a storefront normally does not extend beyond the first story, the rest of the building is often related to it visually through a unity of form and detail. Window patterns on the upper floors, cornice elements, and other decorative features should be carefully retained, in addition to the storefront itself.

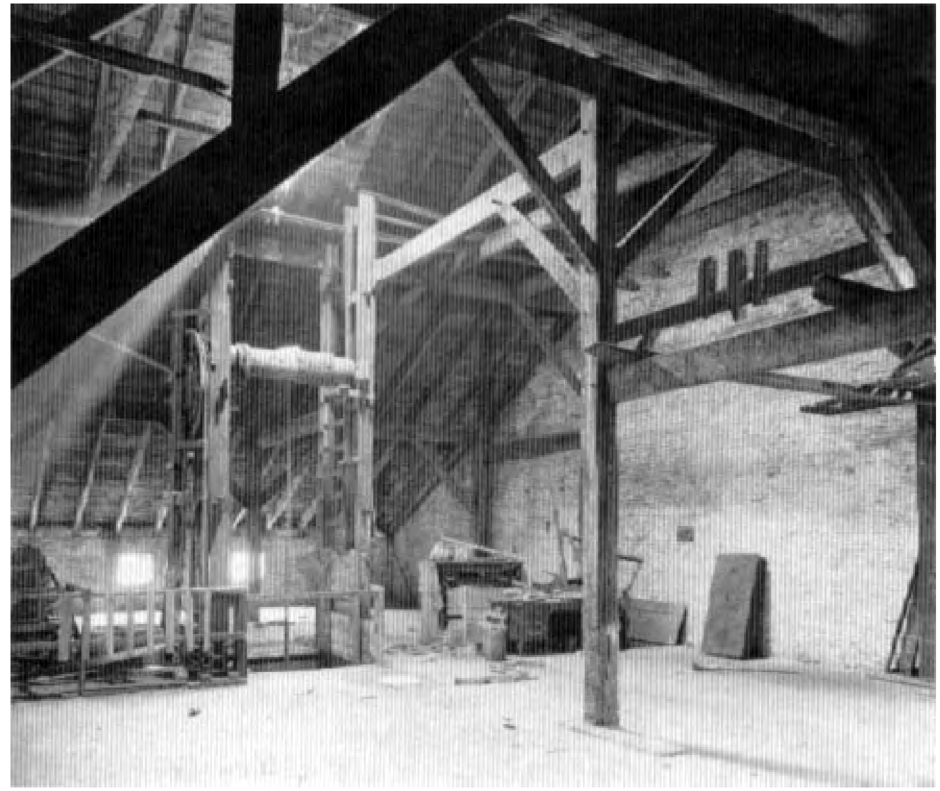


Building Interior

Structural Systems

The types of structural systems found in the United States include, but are not limited to the following: wooden frame construction (17th c.), balloon frame construction (19th c.), load-bearing masonry construction (18th c.), brick cavity wall construction (19th c.), heavy timber post and beam industrial construction (19th c.), fireproof iron construction (19th c.), heavy masonry and steel construction (19th c.), skeletal steel construction (19th c.), and concrete slab and post construction (20th c.).

If features of the structural system are exposed such as loadbearing brick walls, cast iron columns, roof trusses, posts and beams, vigas, or stone foundation walls, they may be important in defining the building's overall historic character. Unexposed structural features that are not character-defining or an entire structural system may nonetheless be significant in the history of building technology. The structural system should always be examined and evaluated early in the project planning stage to determine its physical condition, its ability to support any proposed changes in use, and its importance to the building's historic character or historical significance.



Spaces, Features, and Finishes

An interior floor plan, the arrangement and sequence of spaces, and built-in features and applied finishes are individually and collectively important in defining the historic character of the building. Interiors are comprised of a series of primary and secondary spaces. This is applicable to all buildings, from courthouses to cathedrals, to cottages and office buildings. Primary spaces, including entrance halls, parlors, or living rooms, assembly rooms and lobbies, are defined not only by their function, but also by their features, finishes, size and proportion.

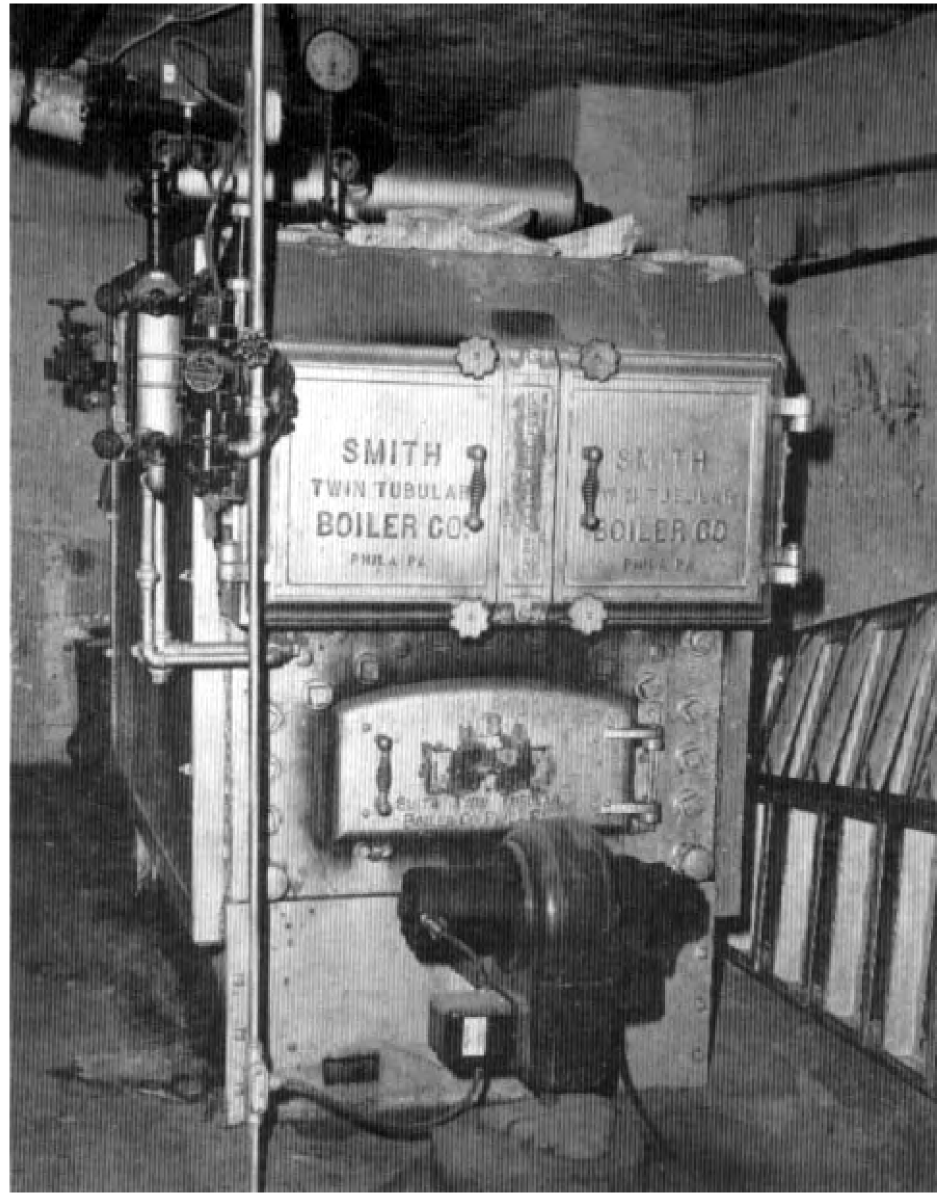
Secondary spaces are often more functional than decorative, and may include kitchens, bathrooms, mail rooms, utility spaces, secondary hallways, firestairs and office cubicles in a commercial or office space. Extensive changes can often be made in these less important areas without having a detrimental effect on the overall historic character.

Mechanical Systems

Mechanical, lighting and plumbing systems improved significantly with the coming of the Industrial Revolution. The 19th century interest in hygiene, personal comfort, and the reduction of the spread of disease were met with the development of central heating, piped water, piped gas, and network of underground cast iron sewers. Vitreous tiles in kitchens, baths and hospitals could be cleaned easily and regularly. The mass production of cast iron radiators made central heating affordable to many; some radiators were elaborate and included special warming chambers for plates or linens. Ornamental grilles and registers provided decorative covers for functional heaters in public spaces. By the turn of the 20th century, it was common to have all these modern amenities as an integral part of the building.

The greatest impacts of the 20th century on mechanical systems were the use of electricity for interior lighting, forced air ventilation, elevators for tall buildings, exterior lighting and electric heat. The new age of technology brought an increasingly high level of design and decorative art to many of the functional elements of mechanical, electrical and plumbing systems.

The visible decorative features of historic mechanical systems such as grilles, lighting fixtures, and ornamental switchplates may contribute to the overall historic character of the building. Their identification needs to take place, together with an evaluation of their physical condition, early in project planning. On the other hand, mechanical systems need to work efficiently so many older systems, such as compressors and their ductwork, and wiring and pipes often need to be upgraded or entirely replaced in order to meet modern requirements.



Building Site

The building site consists of a historic building or buildings, structures, and associated landscape features within a designed or legally defined parcel of land. A site may be significant in its own right, or because of its association with the historic building or buildings. The relationship between buildings and landscape features on a site should be an integral part of planning for every work project.

Setting (District/Neighborhood)

The setting is the larger area or environment in which a historic property is located. It may be an urban, suburban, or rural neighborhood or a natural landscape in which buildings have been constructed. The relationship of buildings to each other, setbacks, fence patterns, views, driveways and walkways, and street trees together create the character of a district or neighborhood.

Special Requirements

Work that must be done to meet accessibility requirements, health and safety requirements or retrofitting to improve energy efficiency is usually not part of the overall process of protecting historic buildings; rather, this work is assessed for its potential impact on the historic building.

Energy Efficiency

Some features of a historic building or site such as cupolas, shutters, transoms, skylights, sun rooms, porches, and plantings can play an energy-conserving role. Therefore, prior to retrofitting historic buildings to make them more energy efficient, the first step should always be to identify and evaluate existing historic features to assess their inherent energy-conserving potential. If it is determined that retrofitting measures are appropriate, then such work needs to be carried out with particular care to ensure that the building's historic character is retained.

Accessibility Considerations

It is often necessary to make modifications to a historic building so that it will be in compliance with current accessibility code requirements. Accessibility to certain historic structures is required by three specific federal laws: the Architectural Barriers Act of 1968, Section 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990. Federal rules, regulations, and standards have been developed which provide guidance on how to accomplish access to historic areas for people with disabilities. Work must be carefully planned and undertaken so that it does not result in the loss of character-defining spaces, features, and finishes. The goal is to provide the highest level of access with the lowest level of impact.

Health and Safety Considerations

In undertaking work on historic buildings, it is necessary to consider the impact that meeting current health and safety codes (public health, occupational health, life safety, fire safety, electrical, seismic, structural, and building codes) will have on character-defining spaces, features, and finishes. Special coordination with the responsible code officials at the state, county, or municipal level may be required. Securing required building permits and occupancy licenses is best accomplished early in work project planning. It is often necessary to look beyond the "letter" of code requirements to their underlying purpose; most modern codes allow for alterative approaches and reasonable variance to achieve compliance.

Some historic building materials (insulation, lead paint, etc.) contain toxic substances that are potentially hazardous to building occupants. Following careful investigation and analysis, some form of abatement may be required. All workers involved in the encapsulation, repair, or removal of known toxic materials should be adequately trained and should wear proper personal protective gear. Finally, preventive and routine maintenance for historic structures known to contain such materials should also be developed to include proper warnings and precautions.

Standards for Preservation & Guidelines for Preserving Historic Buildings

Preservation *is defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.*

Standards for Preservation

1. A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

2. The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

Guidelines for Preserving Historic Buildings

Introduction

In **Preservation**, the options for replacement are less extensive than in the treatment, Rehabilitation. This is because it is assumed at the outset that building materials and character-defining features are essentially intact, i.e, that more historic fabric has survived, unchanged over time. The expressed goal of the **Standards for Preservation and Guidelines for Preserving Historic Buildings** is retention of the building's existing form, features and detailing. This may be as simple as basic maintenance of existing materials and features or may involve preparing a historic structure report, undertaking laboratory testing such as paint and mortar analysis, and hiring conservators to perform sensitive work such as reconstituting interior finishes. Protection, maintenance, and repair are emphasized while replacement is minimized.

Identify, Retain, and Preserve Historic Materials and Features

The guidance for the treatment **Preservation** begins with recommendations to identify the form and detailing of those architectural materials and features that are important in defining the building's historic character and which must be retained in order to preserve that character. Therefore, guidance on ***identifying, retaining, and preserving*** character-defining features is always given first. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems; and the building's site and setting.

Stabilize Deteriorated Historic Materials and Features as a Preliminary Measure

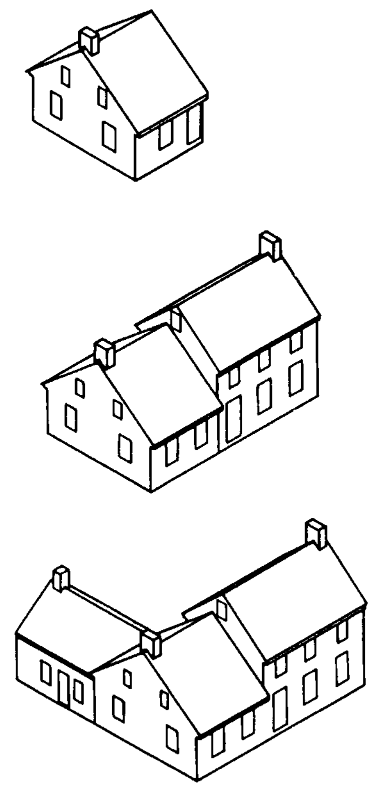
Deteriorated portions of a historic building may need to be protected thorough preliminary stabilization measures until additional work can be undertaken. ***Stabilizing*** may include structural reinforcement, weatherization, or correcting unsafe conditions. Temporary stabilization should always be carried out in such a manner that it detracts as little as possible from the historic building's appearance. Although it may not be necessary in every preservation project, stabilization is nonetheless an integral part of the treatment **Preservation;** it is equally applicable, if circumstances warrant, for the other treatments.

Protect and Maintain Historic Materials and Features

After identifying those materials and features that are important and must be retained in the process of **Preservation** work, then ***protecting and maintaining*** them are addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic materials through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair (Stabilize, Consolidate, and Conserve) Historic Materials and Features

Next, when the physical condition of character-defining materials and features requires additional work, ***repairing*** by ***stabilizing, consolidating, and***



This three-part drawing shows the evolution of a farm house over time. Such change is part of the history of the place and is respected within the treatment, Preservation. Drawing: Center for Historic Architecture and Engineering, University of Delaware (adapted from Preservation Brief 35: Understanding Old Buildings).

conserving is recommended. **Preservation** strives to retain existing materials and features while employing as little new material as possible. Consequently, guidance for repairing a historic material, such as masonry, again begins with the least degree of intervention possible such as strengthening fragile materials through consolidation, when appropriate, and repointing with mortar of an appropriate strength. Repairing masonry as well as wood and architectural metal features may also include patching, splicing, or otherwise reinforcing them using recognized preservation methods. Similarly, within the treatment **Preservation**, portions of a historic structural system could be reinforced using contemporary materials such as steel rods. All work should be physically and visually compatible, identifiable upon close inspection and documented for future research.

Limited Replacement In Kind of Extensively Deteriorated Portions of Historic Features

If repair by stabilization, consolidation, and conservation proves inadequate, the next level of intervention involves the ***limited replacement in kind*** of extensively deteriorated or missing *parts* of features when there are surviving prototypes (for example, brackets, dentils, steps, plaster, or portions of slate or tile roofing). The replacement material needs to match the old both physically and visually, i.e., wood with wood, etc. Thus, with the exception of hidden structural reinforcement and new mechanical system components, substitute materials are not appropriate in the treatment **Preservation**. Again, it is important that all new material be identified and properly documented for future research.

If prominent features are missing, such as an interior staircase, exterior cornice, or a roof dormer, then a Rehabilitation or Restoration treatment may be more appropriate.

Energy Efficiency/Accessibility Considerations/Health and Safety Code Considerations

These sections of the **Preservation** guidance address work done to meet accessibility requirements and health and safety code requirements; or limited retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of preservation projects, it is usually not part of the overall process of protecting, stabilizing, conserving, or repairing character-defining features; rather, such work is assessed for its potential negative impact on the building's character. For this reason, particular care must be taken not to obscure, damage, or destroy character-defining materials or features in the process of undertaking work to meet code and energy requirements.

Preservation as a Treatment. *When the property's distinctive materials, features, and spaces are essentially intact and thus convey the historic significance without extensive repair or replacement; when depiction at a particular period of time is not appropriate; and when a continuing or new use does not require additions or extensive alterations, Preservation may be considered as a treatment. Prior to undertaking work, a documentation plan for Preservation should be developed.*

Building Exterior

Masonry: Brick, stone, terra cotta, concrete, adobe, stucco, and mortar

Recommended	*Not Recommended*
Identifying, retaining, and preserving masonry features that are important in defining the overall historic character of the building such as walls, brackets, railings, cornices, window architraves, door pediments, steps, and columns; and details such as tooling and bonding patterns, coatings, and color.	Altering masonry features which are important in defining the overall historic character of the building so that, as a result, the character is diminished.
	Replacing historic masonry features instead of repairing or replacing only the deteriorated masonry.
	Applying paint or other coatings such as stucco to masonry that has been historically unpainted or uncoated.
	Removing paint from historically painted masonry.
	Changing the type of paint or coating or its color.
Stabilizing deteriorated or damaged masonry as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize deteriorated or damaged masonry until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining masonry by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved decorative features.	Failing to evaluate and treat the various causes of mortar joint deterioration such as leaking roofs or gutters, differential settlement of the building, capillary action, or extreme weather exposure.
Cleaning masonry only when necessary to halt deterioration or remove heavy soiling.	Cleaning masonry surfaces when they are not heavily soiled, thus needlessly introducing chemicals or moisture into historic materials.
Carrying out masonry surface cleaning tests after it has been determined that such cleaning is appropriate. Tests should be observed over a sufficient period of time so that both the immediate and the long range effects are known to enable selection of the gentlest method possible.	Cleaning masonry surfaces without testing or without sufficient time for the testing results to be of value.

Recommended	*Not Recommended*
Cleaning masonry surfaces with the gentlest method possible, such as low pressure water and detergents, using natural bristle brushes.	Sandblasting brick or stone surfaces using dry or wet grit or other abrasives. These methods of cleaning permanently erode the surface of the material and accelerate deterioration.
	Using a cleaning method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures.
	Cleaning with chemical products that will damage masonry, such as using acid on limestone or marble, or leaving chemicals on masonry surfaces.
	Applying high pressure water cleaning methods that will damage historic masonry and the mortar joints.
Inspecting painted masonry surfaces to determine whether repainting is necessary.	Removing paint that is firmly adhering to, and thus protecting, masonry surfaces.
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., hand-scraping) prior to repainting.	Using methods of removing paint which are destructive to masonry, such as sandblasting, application of caustic solutions, or high pressure waterblasting.
Applying compatible paint coating systems following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry.
Repainting with colors that are historically appropriate to the building and district.	Using new paint colors that are inappropriate to the historic building and district.
Evaluating the existing condition of the masonry to determine whether more than protection and maintenance are required, that is, if repairs to masonry features will be necessary.	Failing to undertake adequate measures to assure the protection of masonry features.
Repairing, stabilizing, and conserving fragile masonry by using well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.	Removing masonry that could be stabilized, repaired and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile materials.

Adequate protection and maintenance of a historic building is an ongoing commitment. Here, two workers are priming and repainting exterior stone and wood trim. If surface treatments are neglected, more extensive repair and replacement will be required. Each loss further undermines a building's historic integrity.

Recommended	*Not Recommended*
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls, or damaged plasterwork.	Removing nondeteriorated mortar from sound joints, then repointing the entire building to achieve a uniform appearance.
Removing deteriorated mortar by carefully hand-raking the joints to avoid damaging the masonry.	Using electric saws and hammers rather than hand tools to remove deteriorated mortar from joints prior to repointing.
Duplicating old mortar in strength, composition, color, and texture.	Repointing with mortar of high portland cement content (unless it is the content of the historic mortar). This can often create a bond that is stronger than the historic material and can cause damage as a result of the differing coefficient of expansion and the differing porosity of the material and the mortar.
	Repointing with a synthetic caulking compound.
	Using a "scrub" coating technique to repoint instead of traditional repointing methods.
Duplicating old mortar joints in width and in joint profile.	Changing the width or joint profile when repointing.

Recommended	*Not Recommended*
Repairing stucco by removing the damaged material and patching with new stucco that duplicates the old in strength, composition, color, and texture.	Removing sound stucco; or repairing with new stucco that is stronger than the historic material or does not convey the same visual appearance.
Using mud plaster as a surface coating over unfired, unstabilized adobe because the mud plaster will bond to the adobe.	Applying cement stucco to unfired, unstabilized adobe. Because the cement stucco will not bond properly, moisture can become entrapped between materials, resulting in accelerated deterioration of the adobe.
Cutting damaged concrete back to remove the source of deterioration (often corrosion on metal reinforcement bars). The new patch must be applied carefully so it will bond satisfactorily with, and match, the historic concrete.	Patching concrete without removing the source of deterioration.
Repairing masonry features by patching, piecing-in, or otherwise reinforcing the masonry using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing masonry that could be repaired, using improper repair techniques, or failing to document the new work.
Applying new or non-historic surface treatments such as water-repellent coatings to masonry only after repointing and only if masonry repairs have failed to arrest water penetration problems.	Applying waterproof, water repellent, or non-historic coatings such as stucco to masonry as a substitute for repointing and masonry repairs. Coatings are frequently unnecessary, expensive, and may change the appearance of historic masonry as well as accelerate its deterioration.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation***, and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of masonry features when there are surviving prototypes such as terra-cotta brackets or stone balusters. The new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire masonry feature such as a column or stairway when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic masonry feature; or failing to properly document the new work.

Building Exterior

Wood: Clapboard, weatherboard, shingles, and other wooden siding and decorative elements

Recommended	*Not Recommended*
Identifying, retaining, and preserving wood features that are important in defining the overall historic character of the building such as siding, cornices, brackets, window architraves, and doorway pediments; and their paints, finishes, and colors.	Altering wood features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic wood features instead of repairing or replacing only the deteriorated wood. Changing the type of paint or finish and its color.
Stabilizing deteriorated or damaged wood as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize deteriorated or damaged wood until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining wood features by providing proper drainage so that water is not allowed to stand on flat, horizontal surfaces or accumulate in decorative features.	Failing to identify, evaluate, and treat the causes of wood deterioration, including faulty flashing, leaking gutters, cracks and holes in siding, deteriorated caulking in joints and seams, plant material growing too close to wood surfaces, or insect or fungus infestation.
Applying chemical preservatives to wood features such as beam ends or outriggers that are exposed to decay hazards and are traditionally unpainted.	Using chemical preservatives such as creosote which, unless they were used historically, can change the appearance of wood features.
Retaining coatings such as paint that help protect the wood from moisture and ultraviolet light. Paint removal should be considered only where there is paint surface deterioration and as part of an overall maintenance program which involves repainting or applying other appropriate protective coatings.	Stripping paint or other coatings to reveal bare wood, thus exposing historically coated surfaces to the effects of accelerated weathering.
Inspecting painted wood surfaces to determine whether repainting is necessary or if cleaning is all that is required.	Removing paint that is firmly adhering to, and thus, protecting wood surfaces.
Removing damaged or deteriorated paint to the next sound layer using the gentlest method possible (handscraping and handsanding), then repainting.	Using destructive paint removal methods such as propane or butane torches, sandblasting or waterblasting. These methods can irreversibly damage historic woodwork.

Recommended	*Not Recommended*
Using with care electric hot-air guns on decorative wood features and electric heat plates on flat wood surfaces when paint is so deteriorated that total removal is necessary prior to repainting.	Using thermal devices improperly so that the historic woodwork is scorched.
Using chemical strippers primarily to supplement other methods such as handscraping, handsanding and the above-recommended thermal devices. Detachable wooden elements such as shutters, doors, and columns may—with the proper safeguards—be chemically dip-stripped.	Failing to neutralize the wood thoroughly after using chemicals so that new paint does not adhere. Allowing detachable wood features to soak too long in a caustic solution so that the wood grain is raised and the surface roughened.
Applying compatible paint coating systems following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting exterior woodwork.

Maximizing retention of historic materials and features is the primary goal of Preservation as demonstrated here in these "before" and "after" photographs. Aside from some minor repairs and limited replacement of deteriorated material, work on this house consisted primarily of repainting the wood exterior. Photos: Historic Charleston Foundation.

Recommended	*Not Recommended*
Repainting with colors that are appropriate to the historic building and district.	Using new colors that are inappropriate to the historic building or district.
Evaluating the existing condition of the wood to determine whether more than protection and maintenance are required, that is, if repairs to wood features will be necessary.	Failing to undertake adequate measures to assure the protection of wood features.
Repairing, stabilizing, and conserving fragile wood using well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.	Removing wood that could be stabilized and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile historic materials.
Repairing wood features by patching, piecing-in, or otherwise reinforcing the wood using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing wood that could be repaired, using improper repair techniques, or failing to document the new work.

The following work is highlighted to indicate that it represents the greatest degree of intervention that is generally recommended within the treatment **Preservation***, and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of wood features when there are surviving prototypes such as brackets, molding, or sections of siding. New work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire wood feature such as a column or stairway when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic wood feature; or failing to properly document the new work.

Building Exterior

Architectural Metals: Cast iron, steel, pressed tin, copper, aluminum, and zinc

Recommended	*Not Recommended*
Identifying, retaining, and preserving architectural metal features such as columns, capitals, window hoods, or stairways that are important in defining the overall historic character of the building; and their finishes and colors. Identification is also critical to differentiate between metals prior to work. Each metal has unique properties and thus requires different treatments.	Altering architectural metal features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic metal features instead of repairing or replacing only the deteriorated metal. Changing the type of finish or its historic color or accent scheme.
Stabilizing deteriorated or damaged architectural metals as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize deteriorated or damaged architectural metals until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining architectural metals from corrosion by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved, decorative features.	Failing to identify, evaluate, and treat the causes of corrosion, such as moisture from leaking roofs or gutters. Placing incompatible metals together without providing a reliable separation material. Such incompatibility can result in galvanic corrosion of the less noble metal, e.g., copper will corrode cast iron, steel, tin, and aluminum.
Cleaning architectural metals, when appropriate, to remove corrosion prior to repainting or applying other appropriate protective coatings.	Exposing metals which were intended to be protected from the environment. Applying paint or other coatings to metals such as copper, bronze, or stainless steel that were meant to be exposed.
Identifying the particular type of metal prior to any cleaning procedure and then testing to assure that the gentlest cleaning method possible is selected or determining that cleaning is inappropriate for the particular metal.	Using cleaning methods which alter or damage the historic color, texture, and finish of the metal; or cleaning when it is inappropriate for the metal. Removing the patina of historic metal. The patina may be a protective coating on some metals, such as bronze or copper, as well as a significant historic finish.

Recommended	*Not Recommended*
Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with appropriate chemical methods because their finishes can be easily abraded by blasting methods.	Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with grit blasting which will abrade the surface of the metal.
Using the gentlest cleaning methods for cast iron, wrought iron, and steel—hard metals—in order to remove paint buildup and corrosion. If handscraping and wire brushing have proven ineffective, low pressure grit blasting may be used as long as it does not abrade or damage the surface.	Failing to employ gentler methods prior to abrasively cleaning cast iron, wrought iron or steel; or using high pressure grit blasting.
Applying appropriate paint or other coating systems after cleaning in order to decrease the corrosion rate of metals or alloys.	Failing to re-apply protective coating systems to metals or alloys that require them after cleaning so that accelerated corrosion occurs.
Repainting with colors that are appropriate to the historic building or district.	Using new colors that are inappropriate to the historic building or district.
Applying an appropriate protective coating such as lacquer to an architectural metal feature such as a bronze door which is subject to heavy pedestrian use.	Failing to assess pedestrian use or new access patterns so that architectural metal features are subject to damage by use or inappropriate maintenance such as salting adjacent sidewalks.
Evaluating the existing condition of the architectural metals to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of architectural metal features.

Recommended

Repairing, stabilizing, and conserving fragile architectural metals using well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.

Repairing architectural metal features by patching, piecing-in, or otherwise reinforcing the metal using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Removing architectural metals that could be stabilized and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile historic materials.

Removing architectural metals that could be repaired, using improper repair techniques, or failing to document the new work.

Two examples of "limited replacement in kind" point out an appropriate scope of work within the treatment, Preservation. (a) One metal modillion that has sustained damage from a faulty gutter will need to be replaced; and (b) targeted repairs to deteriorated wood cornice elements (fascia board and modillions) meant that most of the historic materials were retained in the work.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation***, and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of architectural metal features when there are surviving prototypes such as porch balusters, column capitals or bases, or porch cresting. The new work should match the old in material, design, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire architectural metal feature such as a column or balustrade when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic metal feature; or failing to properly document the new work.

Building Exterior

Roofs

Recommended

Identifying, retaining, and preserving roofs—and their functional and decorative features—that are important in defining the overall historic character of the building. This includes the roof's shape, such as hipped, gambrel, and mansard; decorative features such as cupolas, cresting, chimneys, and weathervanes; and roofing material such as slate, wood, clay tile, and metal, as well as its size, color, and patterning.

Stabilizing deteriorated or damaged roofs as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.

Not Recommended

Altering the roof and roofing materials which are important in defining the overall historic character of the building so that, as a result, the character is diminished.

Replacing historic roofing material instead of repairing or replacing only the deteriorated material.

Changing the type or color of roofing materials.

Failing to stabilize a deteriorated or damaged roof until additional work is undertaken, thus allowing further damage to occur to the historic building.

It is particularly important to preserve materials that contribute to a building's historic character, such as this highly visible slate roof. In the event that repair and limited replacement are necessary, all new slate would need to match the old exactly. Photo: Jeffrey S. Levine.

Recommended	*Not Recommended*
Protecting and maintaining a roof by cleaning the gutters and downspouts and replacing deteriorated flashing. Roof sheathing should also be checked for proper venting to prevent moisture condensation and water penetration; and to insure that materials are free from insect infestation.	Failing to clean and maintain gutters and downspouts properly so that water and debris collect and cause damage to roof fasteners, sheathing, and the underlying structure.
Providing adequate anchorage for roofing material to guard against wind damage and moisture penetration.	Allowing roof fasteners, such as nails and clips to corrode so that roofing material is subject to accelerated deterioration.
Protecting a leaking roof with plywood and building paper until it can be properly repaired.	Permitting a leaking roof to remain unprotected so that accelerated deterioration of historic building materials—masonry, wood, plaster, paint and structural members—occurs.
Repairing a roof by reinforcing the historic materials which comprise roof features using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing materials that could be repaired, using improper repair techniques, or failing to document the new work. Failing to reuse intact slate or tile when only the roofing substrate needs replacement.

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Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of roof features or roof coverings when there are surviving prototypes such as cupola louvers, dentils, dormer roofing; or slates, tiles, or wood shingles on a main roof. the new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire roof feature such as a cupola or dormer when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic roof feature; or failing to properly document the new work.

Building Exterior

Windows

Recommended

Identifying, retaining, and preserving windows—and their functional and decorative features—that are important in defining the overall historic character of the building. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.

Not Recommended

Altering windows or window features which are important in defining the historic character of the building so that, as a result, the character is diminished.

Changing the historic appearance of windows by replacing materials, finishes, or colors which noticeably change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.

Obscuring historic window trim with metal or other material.

Preserving a building's historic windows generally involves scraping, sanding, and re-painting. While some repair work will most likely be undertaken within the scope of work on this institutional building, replacement of the window units is usually not an appropriate Preservation treatment. Photo: Chuck Fisher.

Recommended	*Not Recommended*
Conducting an indepth survey of the condition of existing windows early in preservation planning so that repair and upgrading methods and possible replacement options can be fully explored.	Replacing windows solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.
Stabilizing deteriorated or damaged windows as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged window until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining the wood and architectural metals which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.
Making windows weathertight by re-caulking and replacing or installing weatherstripping. These actions also improve thermal efficiency.	Retrofitting or replacing windows rather than maintaining the sash, frame, and glazing.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.	Failing to undertake adequate measures to assure the protection of historic windows.
Repairing window frames and sash by patching, piecing-in, consolidating or otherwise reinforcing them using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Failing to protect the historic glazing when repairing windows. Removing material that could be repaired, using improper repair techniques, or failing to document the new work. Failing to reuse serviceable window hardware such as brass sash lifts and sash locks.

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Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of windows when there are surviving prototypes such as frames, sash, sills, glazing, and hoodmolds. The new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire window when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic window; or failing to properly document the new work.

Building Exterior

Entrances and Porches

Recommended	*Not Recommended*
Identifying, retaining, and preserving entrances and porches—and their functional and decorative features—that are important in defining the overall historic character of the building such as doors, fanlights, sidelights, pilasters, entablatures, columns, balustrades, and stairs.	Altering entrances and porches which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic entrance and porch features instead of repairing or replacing only the deteriorated material.
Stabilizing deteriorated or damaged entrances and porches as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged entrance or porch until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining the masonry, wood, and architectural metals that comprise entrances and porches through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of entrances and porches results.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, repairs to entrance and porch features will be necessary.	Failing to undertake adequate measures to assure the protection of historic entrances and porches.
Repairing entrances and porches by reinforcing the historic materials using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing material that could be repaired, using improper repair techniques, or failing to document the new work.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation,** *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Limited Replacement in Kind

Recommended	*Not Recommended*
Replacing in kind extensively deteriorated or missing parts of repeated entrance and porch features when there are surviving prototypes such as balustrades, cornices, entablatures, columns, sidelights, and stairs. The new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire entrance or porch feature when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic entrance or porch feature; or failing to properly document the new work.

Building Exterior

Storefronts

Recommended

Identifying, retaining, and preserving storefronts—and their functional and decorative features—that are important in defining the overall historic character of the building such as display windows, signs, doors, transoms, kick plates, corner posts, and entablatures.

Stabilizing deteriorated or damaged storefronts as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.

Not Recommended

Altering storefronts—and their features—which are important in defining the overall historic character of the building so that, as a result, the character is diminished.

Replacing historic storefront features instead of repairing or replacing only the deteriorated material.

Failing to stabilize a deteriorated or damaged storefront until additional work is undertaken, thus allowing further damage to occur to the historic building.

The original form and features of this 1920s storefront have been retained through Preservation. Photo: David W. Look, AIA.

Recommended	Not Recommended
Protecting and maintaining masonry, wood, and architectural metals which comprise storefronts through appropriate treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of storefront features results.
Protecting storefronts against arson and vandalism before work begins by boarding up windows and doors and installing alarm systems that are keyed into local protection agencies.	Permitting entry into the building through unsecured or broken windows and doors so that interior features and finishes are damaged by exposure to weather or vandalism. Stripping storefronts of historic material such as wood, cast iron, terra cotta, carrara glass, and brick.
Evaluating the existing condition of storefront materials to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the preservation of the historic storefront.
Repairing storefronts by reinforcing the historic materials using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing material that could be repaired, using improper repair techniques, or failing to document the new work.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation,** *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	Not Recommended
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of storefronts where there are surviving prototypes such as transoms, kick plates, pilasters, or signs. The new work should match the old in materials, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire storefront when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the historic storefront feature; or failing to properly document the new work.

Building Interior

Structural Systems

Recommended

Identifying, retaining, and preserving structural systems—and individual features of systems—that are important in defining the overall historic character of the building, such as post and beam systems, trusses, summer beams, vigas, cast iron columns, above-grade stone foundation walls, or loadbearing brick or stone walls.

Stabilizing deteriorated or damaged structural systems as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.

Protecting and maintaining the structural system by cleaning the roof gutters and downspouts; replacing roof flashing; keeping masonry, wood, and architectural metals in a sound condition; and ensuring that structural members are free from insect infestation.

Examining and evaluating the existing condition of the structural system and its individual features using non-destructive techniques such as X-ray photography.

Not Recommended

Altering visible features of historic structural systems which are important in defining the overall historic character of the building so that, as a result, the character is diminished.

Overloading the existing structural system; or installing equipment or mechanical systems which could damage the structure.

Replacing a loadbearing masonry wall that could be augmented and retained.

Leaving known structural problems untreated such as deflection of beams, cracking and bowing of walls, or racking of structural members.

Utilizing treatments or products that accelerate the deterioration of structural material such as introducing urea-formaldehyde foam insulation into frame walls.

Failing to stabilize a deteriorated or damaged structural system until additional work is undertaken, thus allowing further damage to occur to the historic building.

Failing to provide proper building maintenance so that deterioration of the structural system results. Causes of deterioration include subsurface ground movement, vegetation growing too close to foundation walls, improper grading, fungal rot, and poor interior ventilation that results in condensation.

Utilizing destructive probing techniques that will damage or destroy structural material.

Recommended	*Not Recommended*
Repairing the structural system by augmenting or upgrading individual parts or features using recognized preservation methods. For example, weakened structural members such as floor framing can be paired with a new member, braced, or otherwise supplemented and reinforced.	Upgrading the building structurally in a manner that diminishes the historic character of the exterior, such as installing strapping channels or removing a decorative cornice; or damages interior features or spaces. Replacing a structural member or other feature of the structural system when it could be augmented and retained.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation** *and should be only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind those visible portions or features of the structural system that are either extensively deteriorated or missing when there are surviving prototypes such as cast iron columns and sections of loadbearing walls. The new work should match the old in materials, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire visible feature of the structural system when limited replacement of deteriorated and missing portions is appropriate. Using material for a portion of an exposed structural feature that does not match the historic feature; or failing to properly document the new work.
Considering the use of substitute material for unexposed structural replacements, such as roof rafters or trusses. Substitute material should, at a minimum, have equal loadbearing capabilities, and be unobtrusively dated to guide future research and treatment.	Using substitute material that does not equal the loadbearing capabilities of the historic material or design or is otherwise physically or chemically incompatible.

Building Interior

Spaces, Features, and Finishes

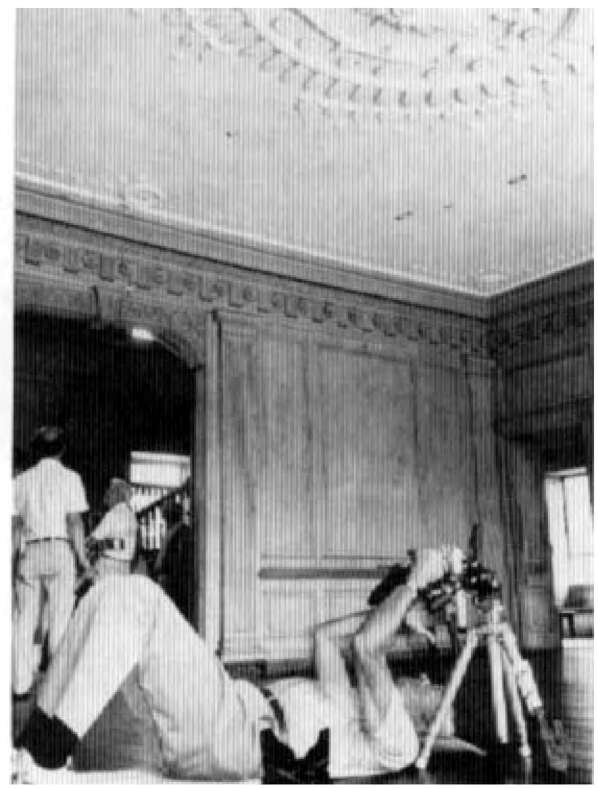
Recommended

Interior Spaces

Identifying, retaining, and preserving a floor plan or interior spaces that are important in defining the overall historic character of the building. This includes the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves such as lobbies, reception halls, entrance halls, double parlors, theaters, auditoriums, and important industrial or commercial spaces.

Not Recommended

Altering a floor plan or interior spaces—including individual rooms—which are important in defining the overall historic character of the building so that, as a result, the character is diminished.



Careful documentation of a building's physical condition is the critical first step in determining an appropriate level of intervention. (a) This may include relating the historical research to existing materials and features; or (b) documenting a particular problem such as this cracked ceiling. Photo (a): Jean E. Travers; Photo (b): Lee H. Nelson, FAIA.

Recommended	*Not Recommended*
Interior Features and Finishes	
Identifying, retaining, and preserving interior features and finishes that are important in defining the overall historic character of the building, including columns, cornices, baseboards, fireplaces and mantels, panelling, light fixtures, hardware, and flooring; and wallpaper, plaster, paint, and finishes such as stencilling, marbling, and graining; and other decorative materials that accent interior features and provide color, texture, and patterning to walls, floors, and ceilings.	Altering features and finishes which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic interior features and finishes instead of repairing or replacing only the deteriorated masonry. Installing new decorative material that obscures or damages character-defining interior features or finishes. Removing historic finishes, such as paint and plaster, or historic wall coverings, such as wallpaper. Applying paint, plaster, or other finishes to surfaces that have been historically unfinished. Stripping paint to bare wood rather than repairing or reapplying grained or marbled finishes to features such as doors and paneling. Changing the type of finish or its color, such as painting a previously varnished wood feature.
Stabilizing deteriorated or damaged interior features and finishes as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged interior feature or finish until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining masonry, wood, and architectural metals that comprise interior features through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of interior features results.

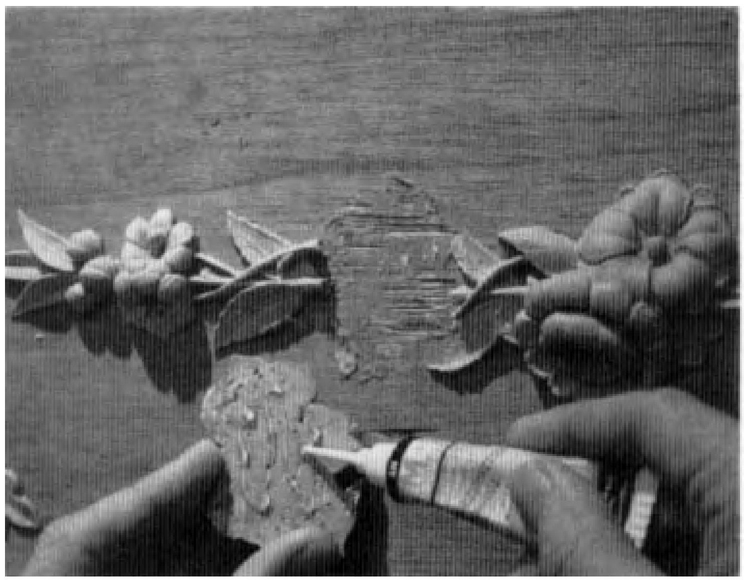
Recommended	*Not Recommended*
Protecting interior features and finishes against arson and vandalism before project work begins, boarding-up windows, and installing fire alarm systems that are keyed to local protection agencies.	Permitting entry into historic buildings through unsecured or broken windows and doors so that the interior features and finishes are damaged by exposure to weather or vandalism. Stripping interiors of features such as woodwork, doors, windows, light fixtures, copper piping, radiators; or of decorative materials.
Protecting interior features such as a staircase, mantel, or decorative finishes and wall coverings against damage during project work by covering them with heavy canvas or plastic sheets.	Failing to provide proper protection of interior features and finishes during work so that they are gouged, scratched, dented, or otherwise damaged.
Installing protective coverings in areas of heavy pedestrian traffic to protect historic features such as wall coverings, parquet flooring and panelling.	Failing to take new use patterns into consideration so that interior features and finishes are damaged.
Removing damaged or deteriorated paints and finishes to the next sound layer using the gentlest method possible, then repainting or refinishing using compatible paint or other coating systems.	Using destructive methods such as propane or butane torches or sandblasting to remove paint or other coatings. These methods can irreversibly damage the historic materials that comprise interior features.
Repainting with colors that are appropriate to the historic building.	Using new paint colors that are inappropriate to the historic building.
Limiting abrasive cleaning methods to certain industrial warehouse buildings where the interior masonry or plaster features do not have distinguishing design, detailing, tooling, or finishes; and where wood features are not finished, molded, beaded, or worked by hand. Abrasive cleaning should only be considered after other, gentler methods have been proven ineffective.	Changing the texture and patina of character-defining features through sandblasting or use of abrasive methods to remove paint, discoloration or plaster. This includes both exposed wood (including structural members) and masonry.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, if repairs to interior features and finishes will be necessary.	Failing to undertake adequate measures to assure the protection of interior features and finishes.

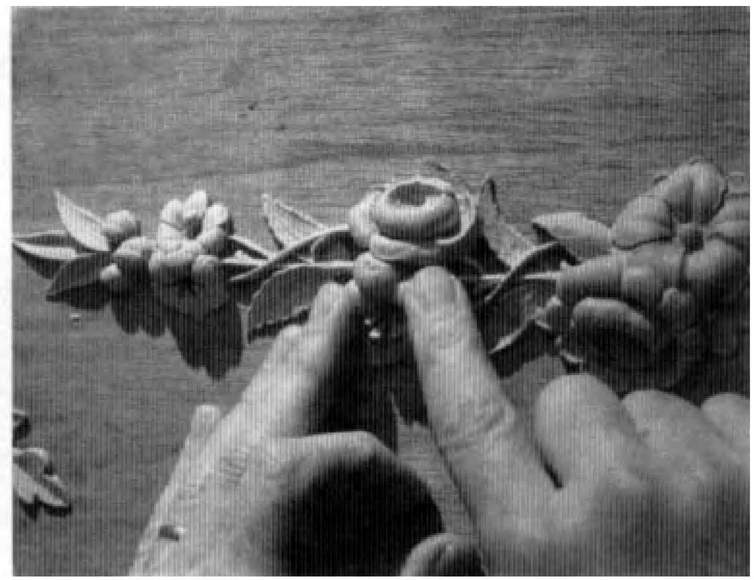
Recommended

Repairing historic interior features and finishes by reinforcing the materials using recognized preservation methods. The new work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.

Not Recommended

Removing materials that could be repaired, using improper techniques, or failing to document the new work.





In Preservation, an appropriate level of intervention is established prior to work in order to maximize retention of historic materials.
(a) A conservator is applying adhesive to 19th century composition ornament that has delaminated from its wood substrate.
(b) The compo fragment is carefully held in place until the quick-setting adhesive takes hold. Photos: Jonathan Thornton.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation,** *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of repeated interior features when there are surviving prototypes such as stairs, balustrades, wood panelling, columns; or decorative wall coverings or ornamental tin or plaster ceilings. New work should match the old in material, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire interior feature when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the interior feature; or failing to properly document the new work.

Building Interior

Mechanical Systems: Heating, Air Conditioning, Electrical, and Plumbing

Recommended	*Not Recommended*
Identifying, retaining, and preserving visible features of early mechanical systems that are important in defining the overall historic character of the building, such as radiators, vents, fans, grilles, plumbing fixtures, switchplates, and lights.	Removing or altering visible features of mechanical systems that are important in defining the overall historic character of the building so that, as a result, the character is diminished.
Stabilizing deteriorated or damaged mechanical systems as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged mechanical system until additional work is undertaken, thus allowing further damage to occur to the historic building.
Protecting and maintaining mechanical, plumbing, and electrical systems and their features through cyclical cleaning and other appropriate measures.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of mechanical systems and their visible features results.
Preventing accelerated deterioration of mechanical systems by providing adequate ventilation of attics, crawlspaces, and cellars so that moisture problems are avoided.	Enclosing mechanical systems in areas that are not adequately ventilated so that deterioration of the systems results.
Improving the energy efficiency of existing mechanical systems to help reduce the need for elaborate new equipment.	Installing unnecessary climate control systems which can add excessive moisture to the building. This additional moisture can either condense inside, damaging interior surfaces, or pass through interior walls to the exterior, potentially damaging adjacent materials as it migrates.
Repairing mechanical systems by augmenting or upgrading system parts, such as installing new pipes and ducts; rewiring; or adding new compressors or boilers.	Replacing a mechanical system or its functional parts when it could be upgraded and retained.
Replacing in kind those visible features of mechanical systems that are either extensively deteriorated or are prototypes such as ceiling fans, switchplates, radiators, grilles, or plumbing fixtures.	Installing a visible replacement feature that does not convey the same visual appearance.

The following should be considered in a **Preservation** *project when the installation of new mechanical equipment or system is required to make the building functional.*

Recommended	*Not Recommended*
Installing a new mechanical system if required, so that it causes the least alteration possible to the building.	Installing a new mechanical system so that character-defining structural or interior features are radically changed, damaged, or destroyed.
Providing adequate structural support for new mechanical equipment.	Failing to consider the weight and design of new mechanical equipment so that, as a result, historic structural members or finished surfaces are weakened or cracked.
Installing the vertical runs of ducts, pipes, and cables in closets, service rooms, and wall cavities.	Installing vertical runs of ducts, pipes, and cables in places where they will obscure character-defining features.
	Concealing mechanical equipment in walls or ceilings in a manner that requires excessive removal of historic building material.
Installing air conditioning in such a manner that historic features are not damaged or obscured and excessive moisture is not generated that will accelerate deterioration of historic materials.	Cutting through features such as masonry walls in order to install air conditioning units.

Building Site

Recommended	*Not Recommended*
Identifying, retaining, and preserving buildings and their features as well as features of the site that are important in defining its overall historic character. Site features may include circulation systems such as walks, paths, roads, or parking; vegetation such as trees, shrubs, fields, or herbaceous plant material; landforms such as terracing, berms or grading; furnishings such as lights, fences, or benches; decorative elements such as sculpture, statuary or monuments; water features including fountains, streams, pools, or lakes; and subsurface archeological features which are important in defining the history of the site.	Altering buildings and their features or site features which are important in defining the overall historic character of the property so that, as a result, the character is diminished.
Retaining the historic relationship between buildings and the landscape.	Removing or relocating buildings or landscape features, thus destroying the historic relationship between buildings and the landscape.
Stabilizing deteriorated or damaged building and site features as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged building or site feature until additional work is undertaken, thus allowing further damage to occur to the building site.

Drayton Hall, near Charleston, South Carolina, is an excellent example of an evolved 18th century plantation. Of particular note in this photograph are the landscape features added in the late 19th century—a reflecting pond and rose mound. With an overall Preservation treatment plan, these later features have been retained and protected. If a Restoration treatment had been selected, later features of the landscape as well as changes to the house would have been removed. Photo: Courtesy, National Trust for Historic Preservation.

Recommended	*Not Recommended*
Protecting and maintaining buildings and sites by providing proper drainage to assure that water does not erode foundation walls; drain toward the building; or damage or erode the landscape.	Failing to maintain adequate site drainage so that buildings and site features are damaged or destroyed; or alternatively, changing the site grading so that water no longer drains properly.
Minimizing disturbance of terrain around buildings or elsewhere on the site, thus reducing the possibility of destroying or damaging important landscape features or archeological resources.	Introducing heavy machinery into areas where it may disturb or damage important landscape features or archeological resources.
Surveying and documenting areas where the terrain will be altered to determine the potential impact to important landscape features or archeological resources.	Failing to survey the building site prior to beginning work which results in damage to, or destruction of, important landscape features or archeological resources.
Protecting, e.g., preserving in place, important archeological resources.	Leaving known archeological material unprotected so that it is damaged during preservation work.
Planning and carrying out any necessary investigation using professional archeologists and modern archeological methods when preservation in place is not feasible.	Permitting unqualified personnel to perform data recovery on archeological resources so that improper methodology results in the loss of important archeological material.
Preserving important landscape features, including ongoing maintenance of historic plant material.	Allowing important landscape features to be lost or damaged due to a lack of maintenance.
Protecting building and landscape features against arson and vandalism before preservation work begins, i.e., erecting protective fencing and installing alarm systems that are keyed into local protection agencies.	Permitting the property to remain unprotected so that the building and landscape features or archeological resources are damaged or destroyed.
	Removing or destroying features from the buildings or site such as wood siding, iron fencing, masonry balustrades, or plant material.
Providing continued protection of historic building materials and plant features through appropriate cleaning, rust removal, limited paint removal, and re-application of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of building and site feature results.

Recommended	*Not Recommended*
Evaluating the existing condition of materials and features to determine whether more than protection and maintenance are required, that is, if repairs to building and site features will be necessary.	Failing to undertake adequate measures to assure the protection of building and site features.
Repairing features of the building and site by reinforcing historic materials using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing materials that could be repaired, using improper repair techniques, or failing to document the new work.

The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment **Preservation,** *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	*Not Recommended*
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of the building or site where there are surviving prototypes such as part of a fountain, or portions of a walkway. New work should match the old in materials, design, color, and texture; and be unobtrusively dated to guide future research and treatment.	Replacing an entire feature of the building or site when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the building site feature; or failing to properly document the new work.

Setting (District/Neighborhood)

Recommended	*Not Recommended*
Identifying retaining, and preserving building and landscape features which are important in defining the historic character of the setting. Such features can include roads and streets, furnishings such as lights or benches, vegetation, gardens and yards, adjacent open space such as fields, parks, commons or woodlands, and important views or visual relationships.	Altering those features of the setting which are important in defining the historic character.
Retaining the historic relationship between buildings and landscape features of the setting. For example, preserving the relationship between a town common and its adjacent historic houses, municipal buildings, historic roads, and landscape features.	Altering the relationship between the buildings and landscape features within the setting by widening existing streets, changing landscape materials, or constructing inappropriately located new streets or parking. Removing or relocating historic buildings or landscape features, thus destroying their historic relationship within the setting.
Stabilizing deteriorated or damaged building and landscape features of the setting as a preliminary measure, when necessary, prior to undertaking appropriate preservation work.	Failing to stabilize a deteriorated or damaged building or landscape feature of the setting until additional work is undertaken, thus allowing further damage to the setting to occur.
Protecting and maintaining historic building materials and plant features through appropriate cleaning, rust removal, limited paint removal, and reapplication of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis which results in the deterioration of building and landscape features.
Protecting building and landscape features against arson and vandalism before preservation work begins by erecting protective fencing and installing alarm systems that are keyed into local preservation agencies.	Permitting the building and setting to remain unprotected so that interior or exterior features are damaged. Stripping or removing features from buildings or the setting such as wood siding, iron fencing, terra cotta balusters, or plant material.
Evaluating the existing condition of the building and landscape features to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of building and landscape features.

Recommended	Not Recommended
Repairing features of the building and landscape using recognized preservation methods. The new work should be unobtrusively dated to guide future research and treatment.	Removing material that could be repaired, using improper repair techniques, or failing to document the new work.

The following work is highlighted because it represents the greatest degree of intervention generally recommended within the treatment **Preservation**, *and should only be considered after protection, stabilization, and repair concerns have been addressed.*

Recommended	Not Recommended
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing parts of building and landscape features where there are surviving prototypes such as porch balustrades or paving materials.	Replacing an entire feature of the building or landscape when limited replacement of deteriorated and missing parts is appropriate. Using replacement material that does not match the building or landscape feature; or failing to properly document the new work.

The goal of Preservation is to retain the historic form, materials, and features of the building and its site as they have changed—or evolved—over time. This bank barn was built in the 1820s, then enlarged in 1898 and again in 1914. Today, it continues its role as a working farm structure as a result of sensitive preservation work. This included foundation re-grading; a new gutter system; structural strengthening; and replacement of a severely deteriorated metal roof. Photo: Jack E. Boucher, HABS.

Although the work in the following sections is quite often an important aspect of preservation projects, it is usually not part of the overall process of preserving character-defining features (maintenance, repair, and limited replacement); rather, such work is assessed for its potential negative impact on the building's historic character. For this reason, particular care must be taken not to obscure, alter, or damage character-defining features in the process of preservation work.

Energy Efficiency

Recommended	*Not Recommended*
Masonry/Wood/Architectural Metals	
Installing thermal insulation in attics and in unheated cellars and crawlspaces to increase the efficiency of the existing mechanical systems.	Applying thermal insulation with a high moisture content in wall cavities which may damage historic fabric.
Installing insulating material on the inside of masonry walls to increase energy efficiency where there is no character-defining interior molding around the windows or other interior architectural detailing.	Installing wall insulation without considering its effect on interior molding or other architectural detailing.
Windows	
Utilizing the inherent energy conserving features of a building by maintaining windows and louvered blinds in good operable condition for natural ventilation.	Removing historic shading devices rather than keeping them in an operable condition.
Improving thermal efficiency with weatherstripping, storm windows, caulking, interior shades, and if historically appropriate, blinds and awnings.	Replacing historic multi-paned sash with new thermal sash utilizing false muntins.
Installing interior storm windows with air-tight gaskets, ventilating holes, and/or removable clips to insure proper maintenance and to avoid condensation damage to historic windows.	Installing interior storm windows that allow moisture to accumulate and damage the window.
Installing exterior storm windows which do not damage or obscure the windows and frames.	Installing new exterior storm windows which are inappropriate in size or color.
	Replacing windows or transoms with fixed thermal glazing or permitting windows and transoms to remain inoperable rather than utilizing them for their energy conserving potential.

Recommended	*Not Recommended*
Entrances and Porches	
Maintaining porches and double vestibule entrances so that they can retain heat or block the sun and provide natural ventilation.	Changing the historic appearance of the building by enclosing porches.
Interior Features	
Retaining historic interior shutters and transoms for their inherent energy conserving features.	Removing historic interior features which play an energy conserving role.
Mechanical Systems	
Improving energy efficiency of existing mechanical systems by installing insulation in attics and basements.	Replacing existing mechanical systems that could be repaired for continued use.
Building Site	
Retaining plant materials, trees, and landscape features which perform passive solar energy functions such as sun shading and wind breaks.	Removing plant materials, trees, and landscape features that perform passive solar energy functions.
Setting (District/Neighborhood)	
Maintaining those existing landscape features which moderate the effects of the climate on the setting such as deciduous trees, evergreen wind-blocks, and lakes or ponds.	Stripping the setting of landscape features and landforms so that the effects of wind, rain, and sun result in accelerated deterioration of the historic building.

Accessibility Considerations

Recommended

Identifying the historic building's character-defining spaces, features, and finishes so that accessibility code-required work will not result in their damage or loss.

Complying with barrier-free access requirements, in such a manner that character-defining spaces, features, and finishes are preserved.

Working with local disability groups, access specialists, and historic preservation specialists to determine the most appropriate solution to access problems.

Providing barrier-free access that promotes independence for the disabled person to the highest degree practicable, while preserving significant historic features.

Finding solutions to meet accessibility requirements that minimize the impact on the historic building and its site, such as compatible ramps, paths, and lifts.

Not Recommended

Undertaking code-required alterations before identifying those spaces, features, or finishes which are character-defining and must therefore be preserved.

Altering, damaging, or destroying character-defining features in attempting to comply with accessibility requirements.

Making changes to buildings without first seeking expert advice from access specialists and historic preservationists to determine solutions.

Making access modifications that do not provide a reasonable balance between independent, safe access and preservation of historic features.

Making modifications for accessibility without considering the impact on the historic building and its site.

Health and Safety Considerations

Recommended	*Not Recommended*
Identifying the historic building's character-defining spaces, features, and finishes so that code-required work will not result in their damage or loss.	Undertaking code-required alterations to a building or site before identifying those spaces, features, or finishes which are character-defining and must therefore be preserved.
Complying with health and safety codes, including seismic code requirements, in such a manner that character-defining spaces, features, and finishes are preserved.	Altering, damaging, or destroying character-defining spaces, features, and finishes while making modifications to a building or site to comply with safety codes.
Removing toxic building materials only after thorough testing has been conducted and only after less invasive abatement methods have been shown to be inadequate.	Destroying historic interior features and finishes without careful testing and without considering less invasive abatement methods.
Providing workers with appropriate personal protective equipment for hazards found in the worksite.	Removing unhealthful building materials without regard to personal and environmental safety.
Working with local code officials to investigate systems, methods, or devices of equivalent or superior effectiveness and safety to those prescribed by code so that unnecessary alterations can be avoided.	Making changes to historic buildings without first exploring equivalent health and safety systems, methods, or devices that may be less damaging to historic spaces, features, and finishes.
Upgrading historic stairways and elevators to meet health and safety codes in a manner that assures their preservation, i.e., so that they are not damaged or obscured.	Damaging or obscuring historic stairways and elevators or altering adjacent spaces in the process of doing work to meet code requirements.
Installing sensitively designed fire suppression systems, such as sprinkler systems that result in retention of historic features and finishes.	Covering character-defining wood features with fire-resistant sheathing which results in altering their visual appearance.
Applying fire-retardant coatings, such as intumescent paints, which expand during fire to add thermal protection to steel.	Using fire-retardant coatings if they damage or obscure character-defining features.
Adding a new stairway or elevator to meet health and safety codes in a manner that preserves adjacent character-defining features and spaces.	Radically changing, damaging, or destroying character-defining spaces, features, or finishes when adding a new code-required stairway or elevator.

Standards for Rehabilitation & Guidelines for Rehabilitating Historic Buildings

Rehabilitation *is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.*

Standards for Rehabilitation

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.

4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.

7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction will be undertaken in a such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Guidelines for Rehabilitating Historic Buildings

Introduction

In **Rehabilitation**, historic building materials and character-defining features are protected and maintained as they are in the treatment Preservation; however, an assumption is made prior to work that existing historic fabric has become damaged or deteriorated over time and, as a result, more repair and replacement will be required. Thus, latitude is given in the **Standards for Rehabilitation and Guidelines for Rehabilitation** to replace extensively deteriorated, damaged, or missing features using either traditional or substitute materials. Of the four treatments, only Rehabilitation includes an opportunity to make possible an efficient contemporary use through alterations and additions.

Identify, Retain, and Preserve Historic Materials and Features

Like Preservation, guidance for the treatment **Rehabilitation** begins with recommendations to identify the form and detailing of those architectural materials and features that are important in defining the building's historic character and which must be retained in order to preserve that character. Therefore, guidance on ***identifying, retaining, and preserving*** character-defining features is always given first. The character of a historic building may be defined by the form and detailing of exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems.

Protect and Maintain Historic Materials and Features

After identifying those materials and features that are important and must be retained in the process of **Rehabilitation** work, then ***protecting and maintaining*** them are addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic material through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair Historic Materials and Features

Next, when the physical condition of character-defining materials and features warrants additional work ***repairing*** is recommended. **Rehabilitation** guidance for the repair of historic materials such as masonry, wood, and architectural metals again begins with the least degree of intervention possible such as patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading them according to recognized preservation methods. Repairing also includes the limited replacement in kind—or with

Note: The Guidelines for Rehabilitating Historic Buildings in this chapter have already appeared in *The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings*, published in 1992.

Originally built as single-family, semi-detached duplexes, these houses were rehabilitated for a new use as rental apartments. While some alteration to non-significant interior features and spaces was necessary in each one, the exteriors were essentially preserved. Photos: Mistick, Inc.

compatible substitute material—of extensively deteriorated or missing parts of features when there are surviving prototypes (for example, brackets, dentils, steps, plaster, or portions of slate or tile roofing). Although using the same kind of material is always the preferred option, substitute material is acceptable if the form and design as well as the substitute material itself convey the visual appearance of the remaining parts of the feature and finish.

Replace Deteriorated Historic Materials and Features

Following repair in the hierarchy, **Rehabilitation** guidance is provided for ***replacing*** an entire character-defining feature with new material because the level of deterioration or damage of materials precludes repair (for example, an exterior cornice; an interior staircase; or a complete porch or storefront). If the essential form and detailing are still evident so that the physical evidence can be used to re-establish the feature as an integral part of the rehabilitation, then its replacement is appropriate. Like the guidance for repair, the preferred option is always replacement of the entire feature in kind, that is, with the same material. Because this approach may not always be technically or economically feasible, provisions are made to consider the use of a compatible substitute material.

It should be noted that, while the National Park Service guidelines recommend the replacement of an entire character-defining feature that is extensively deteriorated, they never recommend removal and replacement with new material of a feature that—although damaged or deteriorated—could reasonably be repaired and thus preserved.

Design for the Replacement of Missing Historic Features

When an entire interior or exterior feature is missing (for example, an entrance, or cast iron facade; or a principal staircase), it no longer plays a role in physically defining the historic character of the building unless it can be accurately recovered in form and detailing through the process of carefully documenting the historical appearance. Although accepting the loss is one possibility, where an important architectural feature is missing, its replacement is always recommended in the **Rehabilitation** guidelines as the *first* or preferred, course of action. Thus, if adequate historical, pictorial, and physical documentation exists so that the feature may be accurately reproduced, and if it is desirable to re-establish the feature as part of the building's historical appearance, then designing and constructing a new feature based on such information is appropriate. However, a *second* acceptable option for the replacement feature is a new design that is compatible with the remaining character-defining features of the historic building. The new design should always take into account the size, scale, and material of the historic building itself and, most importantly, should be clearly differentiated so that a false historical appearance is not created.

Alterations/Additions for the New Use

Some exterior and interior alterations to a historic building are generally needed to assure its continued use, but it is most important that such alterations do not radically change, obscure, or destroy character-defining spaces, materials, features, or finishes. Alterations may include providing additional parking space on an existing historic building site; cutting new entrances or windows on secondary elevations; inserting an additional floor; installing an entirely new mechanical system; or creating an atrium or light well. Alteration may also include the selective removal of buildings or other features of the environment or building site that are intrusive and therefore detract from the overall historic character.

The construction of an exterior addition on a historic building may seem to be essential for the new use, but it is emphasized in the **Rehabilitation** guidelines that such new additions should be avoided, if possible, and considered *only* after it is determined that those needs cannot be met by altering secondary, i.e., non character-defining interior spaces. If, after a thorough evaluation of interior solutions, an exterior addition is still judged to be the only viable alterative, it should be designed and constructed to be clearly differentiated from the historic building and so that the character-defining features are not radically changed, obscured, damaged, or destroyed.

Additions and alterations to historic buildings are referenced within specific sections of the **Rehabilitation** guidelines such as Site, Roofs, Structural Systems, etc., but are addressed in detail in *New Additions to Historic Buildings*, found at the end of this chapter.

Energy Efficiency/Accessibility Considerations/Health and Safety Code Considerations

These sections of the guidance address work done to meet accessibility requirements and health and safety code requirements; or retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of **Rehabilitation** projects, it is usually not a part of the overall process of protecting or repairing character-defining features; rather, such work is assessed for its potential negative impact on the building's historic character. For this reason, particular care must be taken not to radically change, obscure, damage, or destroy character-defining materials or features in the process of meeting code and energy requirements.

Rehabilitation as a Treatment *When repair and replacement of deteriorated features are necessary; when alterations or additions to the property are planned for a new or continued use; and when its depiction at a particular time is not appropriate, Rehabilitation may be considered as a treatment. Prior to undertaking work, a documentation plan for Rehabilitation should be developed.*

Building Exterior

Masonry: Brick, stone, terra cotta, concrete, adobe, stucco and mortar

Recommended	*Not Recommended*
Identifying, retaining, and preserving masonry features that are important in defining the overall historic character of the building such as walls, brackets, railings, cornices, window architraves, door pediments, steps, and columns; and details such as tooling and bonding patterns, coatings, and color.	Removing or radically changing masonry features which are important in defining the overall historic character of the building so that, as a result, the character is diminished.
	Replacing or rebuilding a major portion of exterior masonry walls that could be repaired so that, as a result, the building is no longer historic and is essentially new construction.
	Applying paint or other coatings such as stucco to masonry that has been historically unpainted or uncoated to create a new appearance.
	Removing paint from historically painted masonry.
	Radically changing the type of paint or coating or its color.
Protecting and maintaining masonry by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved decorative features.	Failing to evaluate and treat the various causes of mortar joint deterioration such as leaking roofs or gutters, differential settlement of the building, capillary action, or extreme weather exposure.
Cleaning masonry only when necessary to halt deterioration or remove heavy soiling.	Cleaning masonry surfaces when they are not heavily soiled to create a new appearance, thus needlessly introducing chemicals or moisture into historic materials.
Carrying out masonry surface cleaning tests after it has been determined that such cleaning is appropriate. Tests should be observed over a sufficient period of time so that both the immediate and the long range effects are known to enable selection of the gentlest method possible.	Cleaning masonry surfaces without testing or without sufficient time for the testing results to be of value.

Recommended	*Not Recommended*
Cleaning masonry surfaces with the gentlest method possible, such as low pressure water and detergents, using natural bristle brushes.	Sandblasting brick or stone surfaces using dry or wet grit or other abrasives. These methods of cleaning permanently erode the surface of the material and accelerate deterioration.
	Using a cleaning method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures.
	Cleaning with chemical products that will damage masonry, such as using acid on limestone or marble, or leaving chemicals on masonry surfaces.
	Applying high pressure water cleaning methods that will damage historic masonry and the mortar joints.
Inspecting painted masonry surfaces to determine whether repainting is necessary.	Removing paint that is firmly adhering to, and thus protecting, masonry surfaces.
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., hand-scraping) prior to repainting.	Using methods of removing paint which are destructive to masonry, such as sandblasting, application of caustic solutions, or high pressure waterblasting.
Applying compatible paint coating systems following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry.
Repainting with colors that are historically appropriate to the building and district.	Using new paint colors that are inappropriate to the historic building and district.
Evaluating the overall condition of the masonry to determine whether more than protection and maintenance are required, that is, if repairs to masonry features will be necessary.	Failing to undertake adequate measures to assure the protection of masonry features.
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls, or damaged plasterwork.	Removing nondeteriorated mortar from sound joints, then repointing the entire building to achieve a uniform appearance.
Removing deteriorated mortar by carefully hand-raking the joints to avoid damaging the masonry.	Using electric saws and hammers rather than hand tools to remove deteriorated mortar from joints prior to repointing.

Recommended	*Not Recommended*
Duplicating old mortar in strength, composition, color, and texture.	Repointing with mortar of high portland cement content (unless it is the content of the historic mortar). This can often create a bond that is stronger than the historic material and can cause damage as a result of the differing coefficient of expansion and the differing porosity of the material and the mortar.
	Repointing with a synthetic caulking compound.
	Using a "scrub" coating technique to repoint instead of traditional repointing methods.
Duplicating old mortar joints in width and in joint profile.	Changing the width or joint profile when repointing.
Repairing stucco by removing the damaged material and patching with new stucco that duplicates the old in strength, composition, color, and texture.	Removing sound stucco; or repairing with new stucco that is stronger than the historic material or does not convey the same visual appearance.
Using mud plaster as a surface coating over unfired, unstabilized adobe because the mud plaster will bond to the adobe.	Applying cement stucco to unfired, unstabilized adobe. Because the cement stucco will not bond properly, moisture can become entrapped between materials, resulting in accelerated deterioration of the adobe.
Cutting damaged concrete back to remove the source of deterioration (often corrosion on metal reinforcement bars). The new patch must be applied carefully so it will bond satisfactorily with, and match, the historic concrete.	Patching concrete without removing the source of deterioration.
Repairing masonry features by patching, piecing-in, or consolidating the masonry using recognized preservation methods. Repair may also include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of masonry features when there are surviving prototypes such as terra-cotta brackets or stone balusters.	Replacing an entire masonry feature such as a cornice or balustrade when repair of the masonry and limited replacement of deteriorated or missing parts are appropriate.
	Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the masonry feature or that is physically or chemically incompatible.

Recommended	*Not Recommended*
Applying new or non-historic surface treatments such as water-repellent coatings to masonry only after repointing and only if masonry repairs have failed to arrest water penetration problems.	Applying waterproof, water repellent, or non-historic coatings such as stucco to masonry as a substitute for repointing and masonry repairs. Coatings are frequently unnecessary, expensive, and may change the appearance of historic masonry as well as accelerate its deterioration.
Replacing in kind an entire masonry feature that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples can include large sections of a wall, a cornice, balustrade, column, or stairway. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.	Removing a masonry feature that is unrepairable and not replacing it; or replacing it with a new feature that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing a new masonry feature such as steps or a door pediment when the historic feature is completely missing. It may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating a false historical appearance because the replaced masonry feature is based on insufficient historical, pictorial, and physical documentation. Introducing a new masonry feature that is incompatible in size, scale, material and color.

Building Exterior

Wood: Clapboard, weatherboard, shingles, and other wooden siding and decorative elements

Recommended	*Not Recommended*
Identifying, retaining, and preserving wood features that are important in defining the overall historic character of the building such as siding, cornices, brackets, window architraves, and doorway pediments; and their paints, finishes, and colors.	Removing or radically changing wood features which are important in defining the overall historic character of the building so that, as a result, the character is diminished.
	Removing a major portion of the historic wood from a facade instead of repairing or replacing only the deteriorated wood, then reconstructing the facade with new material in order to achieve a uniform or "improved" appearance.
	Radically changing the type of finish or its color or accent scheme so that the historic character of the exterior is diminished.
	Stripping historically painted surfaces to bare wood, then applying clear finishes or stains in order to create a "natural look."
	Stripping paint or varnish to bare wood rather than repairing or reapplying a special finish, i.e., a grained finish to an exterior wood feature such as a front door.
Protecting and maintaining wood features by providing proper drainage so that water is not allowed to stand on flat, horizontal surfaces or accumulate in decorative features.	Failing to identify, evaluate, and treat the causes of wood deterioration, including faulty flashing, leaking gutters, cracks and holes in siding, deteriorated caulking in joints and seams, plant material growing too close to wood surfaces, or insect or fungus infestation.
Applying chemical preservatives to wood features such as beam ends or outriggers that are exposed to decay hazards and are traditionally unpainted.	Using chemical preservatives such as creosote which, unless they were used historically, can change the appearance of wood features.
Retaining coatings such as paint that help protect the wood from moisture and ultraviolet light. Paint removal should be considered only where there is paint surface deterioration and as part of an overall maintenance program which involves repainting or applying other appropriate protective coatings.	Stripping paint or other coatings to reveal bare wood, thus exposing historically coated surfaces to the effects of accelerated weathering.

Recommended

Inspecting painted wood surfaces to determine whether repainting is necessary or if cleaning is all that is required.

Removing damaged or deteriorated paint to the next sound layer using the gentlest method possible (handscraping and handsanding), then repainting.

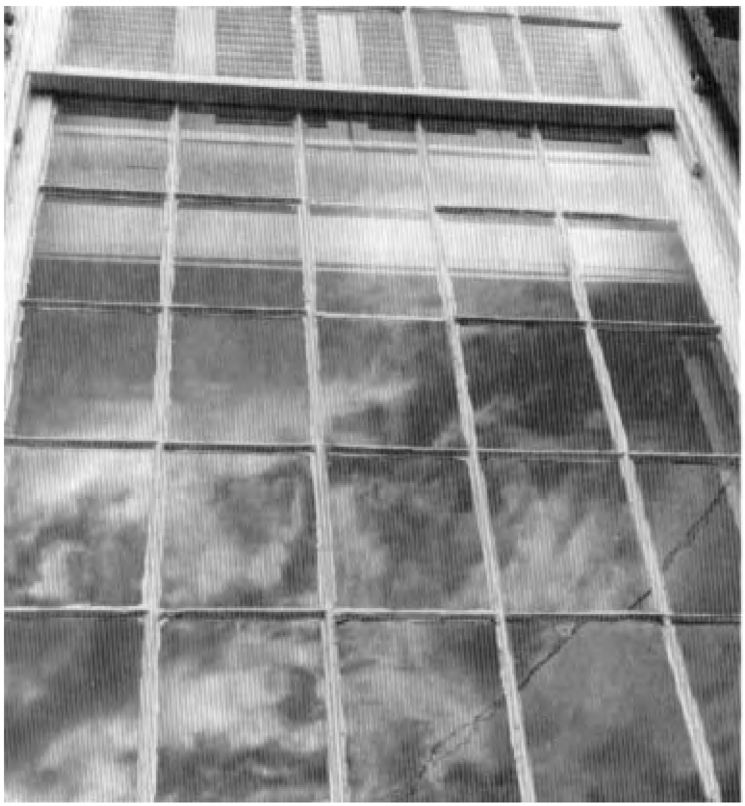
Using with care electric hot-air guns on decorative wood features and electric heat plates on flat wood surfaces when paint is so deteriorated that total removal is necessary prior to repainting.

Not Recommended

Removing paint that is firmly adhering to, and thus, protecting wood surfaces.

Using destructive paint removal methods such as propane or butane torches, sandblasting or waterblasting. These methods can irreversibly damage historic woodwork.

Using thermal devices improperly so that the historic woodwork is scorched.



According to the Standards for Rehabilitation, existing historic materials should be protected, maintained and repaired. In an exemplary project, the windows and shutters of this historic residence were carefully preserved.

Recommended

Using chemical strippers primarily to supplement other methods such as handscraping, handsanding and the above-recommended thermal devices. Detachable wooden elements such as shutters, doors, and columns may—with the proper safeguards—be chemically dip-stripped.

Applying compatible paint coating systems following proper surface preparation.

Repainting with colors that are appropriate to the historic building and district.

Evaluating the overall condition of the wood to determine whether more than protection and maintenance are required, that is, if repairs to wood features will be necessary.

Repairing wood features by patching, piecing-in, consolidating, or otherwise reinforcing the wood using recognized preservation methods. Repair may also include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of features where there are surviving prototypes such as brackets, molding, or sections of siding.

Replacing in kind an entire wood feature that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples of wood features include a cornice, entablature or balustrade. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.

Not Recommended

Failing to neutralize the wood thoroughly after using chemicals so that new paint does not adhere.

Allowing detachable wood features to soak too long in a caustic solution so that the wood grain is raised and the surface roughened.

Failing to follow manufacturers' product and application instructions when repainting exterior woodwork.

Using new colors that are inappropriate to the historic building or district.

Failing to undertake adequate measures to assure the protection of wood features.

Replacing an entire wood feature such as a cornice or wall when repair of the wood and limited replacement of deteriorated or missing parts are appropriate.

Using substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the wood feature or that is physically or chemically incompatible.

Removing an entire wood feature that is unrepairable and not replacing it; or replacing it with a new feature that does not convey the same visual appearance.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing a new wood feature such as a cornice or doorway when the historic feature is completely missing. It may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating a false historical appearance because the replaced wood feature is based on insufficient historical, pictorial, and physical documentation. Introducing a new wood feature that is incompatible in size, scale, material and color.

Building Exterior

Architectural Metals: Cast iron, steel, pressed tin, copper, aluminum, and zinc

Recommended	*Not Recommended*
Identifying, retaining, and preserving architectural metal features such as columns, capitals, window hoods, or stairways that are important in defining the overall historic character of the building; and their finishes and colors. Identification is also critical to differentiate between metals prior to work. Each metal has unique properties and thus requires different treatments.	Removing or radically changing architectural metal features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Removing a major portion of the historic architectural metal from a facade instead of repairing or replacing only the deteriorated metal, then reconstructing the facade with new material in order to create a uniform, or "improved" appearance. Radically changing the type of finish or its historic color or accent scheme.
Protecting and maintaining architectural metals from corrosion by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved, decorative features.	Failing to identify, evaluate, and treat the causes of corrosion, such as moisture from leaking roofs or gutters. Placing incompatible metals together without providing a reliable separation material. Such incompatibility can result in galvanic corrosion of the less noble metal, e.g., copper will corrode cast iron, steel, tin, and aluminum.
Cleaning architectural metals, when appropriate, to remove corrosion prior to repainting or applying other appropriate protective coatings.	Exposing metals which were intended to be protected from the environment. Applying paint or other coatings to metals such as copper, bronze, or stainless steel that were meant to be exposed.
Identifying the particular type of metal prior to any cleaning procedure and then testing to assure that the gentlest cleaning method possible is selected or determining that cleaning is inappropriate for the particular metal.	Using cleaning methods which alter or damage the historic color, texture, and finish of the metal; or cleaning when it is inappropriate for the metal. Removing the patina of historic metal. The patina may be a protective coating on some metals, such as bronze or copper, as well as a significant historic finish.

Recommended	*Not Recommended*
Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with appropriate chemical methods because their finishes can be easily abraded by blasting methods.	Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with grit blasting which will abrade the surface of the metal.
Using the gentlest cleaning methods for cast iron, wrought iron, and steel—hard metals—in order to remove paint buildup and corrosion. If handscraping and wire brushing have proven ineffective, low pressure grit blasting may be used as long as it does not abrade or damage the surface.	Failing to employ gentler methods prior to abrasively cleaning cast iron, wrought iron or steel; or using high pressure grit blasting.
Applying appropriate paint or other coating systems after cleaning in order to decrease the corrosion rate of metals or alloys.	Failing to re-apply protective coating systems to metals or alloys that require them after cleaning so that accelerated corrosion occurs.
Repainting with colors that are appropriate to the historic building or district.	Using new colors that are inappropriate to the historic building or district.
Applying an appropriate protective coating such as lacquer to an architectural metal feature such as a bronze door which is subject to heavy pedestrian use.	Failing to assess pedestrian use or new access patterns so that architectural metal features are subject to damage by use or inappropriate maintenance such as salting adjacent sidewalks.
Evaluating the overall condition of the architectural metals to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of architectural metal features.
Repairing architectural metal features by patching, splicing, or otherwise reinforcing the metal following recognized preservation methods. Repairs may also include the limited replacement in kind—or with a compatible substitute material—of those extensively deteriorated or missing parts of features when there are surviving prototypes such as porch balusters, column capitals or bases; or porch cresting.	Replacing an entire architectural metal feature such as a column or a balustrade when repair of the metal and limited replacement of deteriorated or missing parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the architectural metal feature or that is physically or chemically incompatible.

Recommended	*Not Recommended*
Replacing in kind an entire architectural metal feature that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples could include cast iron porch steps or steel sash windows. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.	Removing an architectural metal feature that is unrepairable and not replacing it; or replacing it with a new architectural metal feature that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing a new architectural metal feature such as a metal cornice or cast iron capital when the historic feature is completely missing. It may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating a false historical appearance because the replaced architectural metal feature is based on insufficient historical, pictorial, and physical documentation. Introducing a new architectural metal feature that is incompatible in size, scale, material, and color.

Building Exterior

Roofs

Recommended	*Not Recommended*
Identifying, retaining, and preserving roofs—and their functional and decorative features—that are important in defining the overall historic character of the building. This includes the roof's shape, such as hipped, gambrel, and mansard; decorative features such as cupolas, cresting chimneys, and weathervanes; and roofing material such as slate, wood, clay tile, and metal, as well as its size, color, and patterning.	Radically changing, damaging, or destroying roofs which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Removing a major portion of the roof or roofing material that is repairable, then reconstructing it with new material in order to create a uniform, or "improved" appearance. Changing the configuration of a roof by adding new features such as dormer windows, vents, or skylights so that the historic character is diminished. Stripping the roof of sound historic material such as slate, clay tile, wood, and architectural metal. Applying paint or other coatings to roofing material which has been historically uncoated.
Protecting and maintaining a roof by cleaning the gutters and downspouts and replacing deteriorated flashing. Roof sheathing should also be checked for proper venting to prevent moisture condensation and water penetration; and to ensure that materials are free from insect infestation.	Failing to clean and maintain gutters and downspouts properly so that water and debris collect and cause damage to roof fasteners, sheathing, and the underlying structure.
Providing adequate anchorage for roofing material to guard against wind damage and moisture penetration.	Allowing roof fasteners, such as nails and clips to corrode so that roofing material is subject to accelerated deterioration.
Protecting a leaking roof with plywood and building paper until it can be properly repaired.	Permitting a leaking roof to remain unprotected so that accelerated deterioration of historic building materials—masonry, wood, plaster, paint and structural members—occurs.

Recommended

Repairing a roof by reinforcing the historic materials which comprise roof features. Repairs will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of features when there are surviving prototypes such as cupola louvers, dentils, dormer roofing; or slates, tiles, or wood shingles on a main roof.

Replacing in kind an entire feature of the roof that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples can include a large section of roofing, or a dormer or chimney. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.

Not Recommended

Replacing an entire roof feature such as a cupola or dormer when repair of the historic materials and limited replacement of deteriorated or missing parts are appropriate.

Failing to reuse intact slate or tile when only the roofing substrate needs replacement.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the roof or that is physically or chemically incompatible.

Removing a feature of the roof that is unrepairable, such as a chimney or dormer, and not replacing it; or replacing it with a new feature that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and constructing a new feature when the historic feature is completely missing, such as chimney or cupola. It may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating a false historical appearance because the replaced feature is based on insufficient historical, pictorial, and physical documentation. Introducing a new roof feature that is incompatible in size, scale, material and color.
Alterations/Additions for the New Use	
Installing mechanical and service equipment on the roof such as air conditioning, transformers, or solar collectors when required for the new use so that they are inconspicuous from the public right-of-way and do not damage or obscure character-defining features.	Installing mechanical or service equipment so that it damages or obscures character-defining features; or is conspicuous from the public right-of-way.
Designing additions to roofs such as residential, office, or storage spaces; elevator housing; decks and terraces; or dormers or skylights when required by the new use so that they are inconspicuous from the public right-of-way and do not damage or obscure character-defining features.	Radically changing a character-defining roof shape or damaging or destroying character-defining roofing material as a result of incompatible design or improper installation techniques.

Building Exterior

Windows

Recommended	Not Recommended
Identifying, retaining, and preserving windows—and their functional and decorative features—that are important in defining the overall historic character of the building. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.	Removing or radically changing windows which are important in defining the historic character of the building so that, as a result, the character is diminished.
	Changing the number, location, size or glazing pattern of windows, through cutting new openings, blocking-in windows, and installing replacement sash that do not fit the historic window opening.
	Changing the historic appearance of windows through the use of inappropriate designs, materials, finishes, or colors which noticeably change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.
	Obscuring historic window trim with metal or other material.
Conducting an indepth survey of the condition of existing windows early in rehabilitation planning so that repair and upgrading methods and possible replacement options can be fully explored.	Stripping windows of historic material such as wood, cast iron, and bronze.
	Replacing windows solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.
Protecting and maintaining the wood and architectural metals which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.
Making windows weathertight by re-caulking and replacing or installing weatherstripping. These actions also improve thermal efficiency.	Retrofitting or replacing windows rather than maintaining the sash, frame, and glazing.

Recommended	*Not Recommended*
Evaluating the overall condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.	Failing to undertake adequate measures to assure the protection of historic windows.
Repairing window frames and sash by patching, splicing, consolidating or otherwise reinforcing. Such repair may also include replacement in kind—or with compatible substitute material—of those parts that are either extensively deteriorated or are missing when there are surviving prototypes such as architraves, hoodmolds, sash, sills, and interior or exterior shutters and blinds.	Replacing an entire window when repair of materials and limited replacement of deteriorated or missing parts are appropriate. Failing to reuse serviceable window hardware such as brass sash lifts and sash locks. Using substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the window or that is physically or chemically incompatible.
Replacing in kind an entire window that is too deteriorated to repair using the same sash and pane configuration and other design details. If using the same kind of material is not technically or economically feasible when replacing windows deteriorated beyond repair, then a compatible substitute material may be considered.	Removing a character-defining window that is unrepairable and blocking it in; or replacing it with a new window that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing new windows when the historic windows (frames, sash and glazing) are completely missing. The replacement windows may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the window openings and the historic character of the building.	Creating a false historical appearance because the replaced window is based on insufficient historical, pictorial, and physical documentation. Introducing a new design that is incompatible with the historic character of the building.
Alterations/Additions for the New Use	
Designing and installing additional windows on rear or other non-character-defining elevations if required by the new use. New window openings may also be cut into exposed party walls. Such design should be compatible with the overall design of the building, but not duplicate the fenestration pattern and detailing of a character-defining elevation.	Installing new windows, including frames, sash, and muntin configuration that are incompatible with the building's historic appearance or obscure, damage, or destroy character-defining features.
Providing a setback in the design of dropped ceilings when they are required for the new use to allow for the full height of the window openings.	Inserting new floors or furred-down ceilings which cut across the glazed areas of windows so that the exterior form and appearance of the windows are changed.

a

b

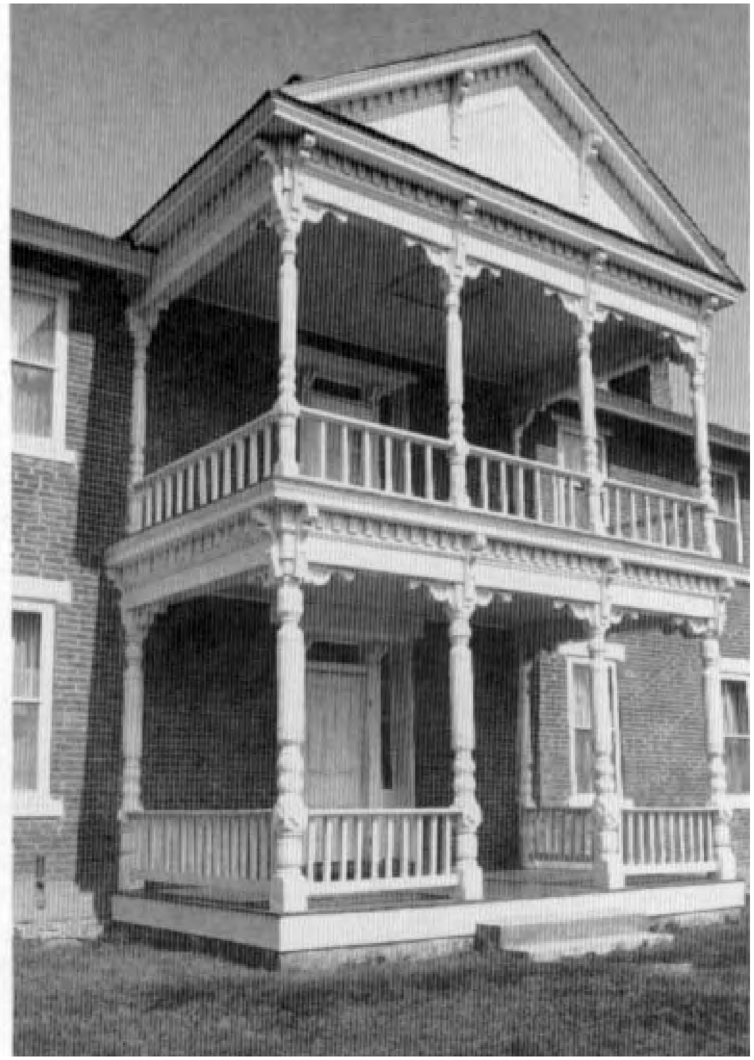
c

(a) An armory complex was rehabilitated for rental housing. (b) This view of the rear elevation shows the paired, nine-over-nine wood sash windows and high sills that characterized the building. (c) After inappropriate rehabilitation work, the same rear elevation is shown with new skylights added to the roof, prefabricated panels filling the former brick areas, and new wood decks and privacy fences. Because the work changed the historic character, the project did not meet the Standards.

Building Exterior

Entrances and Porches

Recommended	*Not Recommended*
Identifying, retaining, and preserving entrances and porches—and their functional and decorative features—that are important in defining the overall historic character of the building such as doors, fanlights, sidelights, pilaster, entablatures, columns, balustrades, and stairs.	Removing or radically changing entrances and porches which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Stripping entrances and porches of historic material such as wood, cast iron, terra cotta tile, and brick. Removing an entrance or porch because the building has been re-oriented to accommodate a new use. Cutting new entrances on a primary elevation. Altering utilitarian or service entrances so they appear to be formal entrances by adding panelled doors, fanlights, and sidelights.
Protecting and maintaining the masonry, wood, and architectural metals that comprise entrances and porches through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of entrances and porches results.
Evaluating the overall condition of materials to determine whether more than protection and maintenance are required, that is, repairs to entrance and porch features will be necessary.	Failing to undertake adequate measures to assure the protection of historic entrances and porches.
Repairing entrances and porches by reinforcing the historic materials. Repair will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of repeated features where there are surviving prototypes such as balustrades, cornices, entablatures, columns, sidelights, and stairs.	Replacing an entire entrance or porch when the repair of materials and limited replacement of parts are appropriate. Using a substitute material for the replacement parts that does not convey the visual appearance of the surviving parts of the entrance and porch or that is physically or chemically incompatible.



In Rehabilitation, deteriorated features should be repaired, whenever possible, and replaced when the severity of the damage makes it necessary. Here, a two-story porch is seen prior to treatment (left). The floor boards are rotted out and the columns are in a state of collapse, supported only by crude, temporary shafts. Other components are in varying stages of decay. Appropriate work on the historic porch (right) included repairs to the porch rails; and total replacement of the extensively deteriorated columns and floor boards. Some dismantling of the porch was necessary.

Recommended	*Not Recommended*
Replacing in kind an entire entrance or porch that is too deteriorated to repair—if the form and detailing are still evident—using the physical evidence as a model to reproduce the feature. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.	Removing an entrance or porch that is unrepairable and not replacing it; or replacing it with a new entrance or porch that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and constructing a new entrance or porch when the historic entrance or porch is completely missing. It may be a restoration based on historical, pictorial, and physical documentation; or be a new design that is compatible with the historic character building.	Creating a false historical appearance because the replaced entrance or porch is based on insufficient historical, pictorial, and physical documentation. Introducing a new entrance or porch that is incompatible in size, scale, material, and color.
Alterations/Additions for the New Use	
Designing enclosures for historic porches on secondary elevations when required by the new use in a manner that preserves the historic character of the building. This can include using large sheets of glass and recessing the enclosure wall behind existing scrollwork, posts, and balustrades.	Enclosing porches in a manner that results in a diminution or loss of historic character by using materials such as wood, stucco, or masonry.
Designing and installing additional entrances or porches on secondary elevations when required for the new use in a manner that preserves the historic character of the buildings, i.e., limiting such alteration to non-character-defining elevations.	Installing secondary service entrances and porches that are incompatible in size and scale with the historic building or obscure, damage, or destroy character-defining features.

Building Exterior

Storefronts

Recommended	*Not Recommended*
Identifying, retaining, and preserving storefronts—and their functional and decorative features—that are important in defining the overall historic character of the building such as display windows, signs, doors, transoms, kick plates, corner posts, and entablatures. The removal of inappropriate, nonhistoric cladding, false mansard roofs, and other later alterations can help reveal the historic character of a storefront.	Removing or radically changing storefronts—and their features—which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Changing the storefront so that it appears residential rather than commercial in character. Removing historic material from the storefront to create a recessed arcade. Introducing coach lanterns, mansard designs, wood shakes, nonoperable shutters, and small-paned windows if they cannot be documented historically. Changing the location of a storefront's main entrance.
Protecting and maintaining masonry, wood, and architectural metals which comprise storefronts through appropriate treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of storefront features results.
Protecting storefronts against arson and vandalism before work begins by boarding up windows and installing alarm systems that are keyed into local protection agencies.	Permitting entry into the building through unsecured or broken windows and doors so that interior features and finishes are damaged by exposure to weather or vandalism. Stripping storefronts of historic material such as wood, cast iron, terra cotta, carrara glass, and brick.
Evaluating the existing condition of storefront materials to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the preservation of the historic storefront.

Recommended	*Not Recommended*
Repairing storefronts by reinforcing the historic materials. Repairs will also generally include the limited replacement in kind—or with compatible substitute materials—of those extensively deteriorated or missing parts of storefronts where there are surviving prototypes such as transoms, kick plates, pilasters, or signs.	Replacing an entire storefront when repair of materials and limited replacement of its parts are appropriate. Using substitute material for the replacement parts that does not convey the same visual appearance as the surviving parts of the storefront or that is physically or chemically incompatible.
Replacing in kind an entire storefront that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model. If using the same material is not technically or economically feasible, then compatible substitute materials may be considered.	Removing a storefront that is unrepairable and not replacing it; or replacing it with a new storefront that does not convey the same visual appearance.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and constructing a new storefront when the historic storefront is completely missing. It may be an accurate restoration using historical, pictorial, and physical documentation; or be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating a false historical appearance because the replaced storefront is based on insufficient historical, pictorial, and physical documentation. Introducing a new design that is incompatible in size, scale, material, and color. Using inappropriately scaled signs and logos or other types of signs that obscure, damage, or destroy remaining character-defining features of the historic building.

a

b

c

In the treatment, Rehabilitation, one option for replacing missing historic features is to use pictorial documentation and/or physical evidence to re-create the historic feature. (a) In this example, the ornamental cornice of an 1866 limestone building was missing; and the ground level storefront had been extensively altered. (b) and (c) Based on the availability of photographic and other documentation, the owners were able to accurately restore the cornice and storefront to their historic configuration. A substitute material, fiberglass, was used to fabricate the missing pressed metal cornice, an acceptable alternative in this project. All work met the Standards.

Building Interior

Structural Systems

Recommended

Identifying, retaining, and preserving structural systems—and individual features of systems—that are important in defining the overall historic character of the building, such as post and beam systems, trusses, summer beams, vigas, cast iron columns, above-grade stone foundation walls, or loadbearing brick or stone walls.

Protecting and maintaining the structural system by cleaning the roof gutters and downspouts; replacing roof flashing; keeping masonry, wood, and architectural metals in a sound condition; and ensuring that structural members are free from insect infestation.

Examining and evaluating the physical condition of the structural system and its individual features using non-destructive techniques such as X-ray photography.

Not Recommended

Removing, covering, or radically changing visible features of structural systems which are important in defining the overall historic character of the building so that, as a result, the character is diminished.

Putting a new use into the building which could overload the existing structural system; or installing equipment or mechanical systems which could damage the structure.

Demolishing a loadbearing masonry wall that could be augmented and retained, and replacing it with a new wall (i.e., brick or stone), using the historic masonry only as an exterior veneer.

Leaving known structural problems untreated such as deflection of beams, cracking and bowing of walls, or racking of structural members.

Utilizing treatments or products that accelerate the deterioration of structural material such as introducing urea-formaldehyde foam insulation into frame walls.

Failing to provide proper building maintenance so that deterioration of the structural system results. Causes of deterioration include subsurface ground movement, vegetation growing too close to foundation walls, improper grading, fungal rot, and poor interior ventilation that results in condensation.

Utilizing destructive probing techniques that will damage or destroy structural material.

Recommended	*Not Recommended*
Repairing the structural system by augmenting or upgrading individual parts or features. For example, weakened structural members such as floor framing can be paired with a new member, braced, or otherwise supplemented and reinforced.	Upgrading the building structurally in a manner that diminishes the historic character of the exterior, such as installing strapping channels or removing a decorative cornice; or damages interior features or spaces. Replacing a structural member or other feature of the structural system when it could be augmented and retained.
Replacing in kind—or with substitute material—those portions or features of the structural system that are either extensively deteriorated or are missing when there are surviving prototypes such as cast iron columns, roof rafters or trusses, or sections of loadbearing walls. Substitute material should convey the same form, design, and overall visual appearance as the historic feature; and, at a minimum, be equal to its loadbearing capabilities.	Installing a visible replacement feature that does not convey the same visual appearance, e.g., replacing an exposed wood summer beam with a steel beam. Using substitute material that does not equal the loadbearing capabilities of the historic material and design or is otherwise physically or chemically incompatible.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

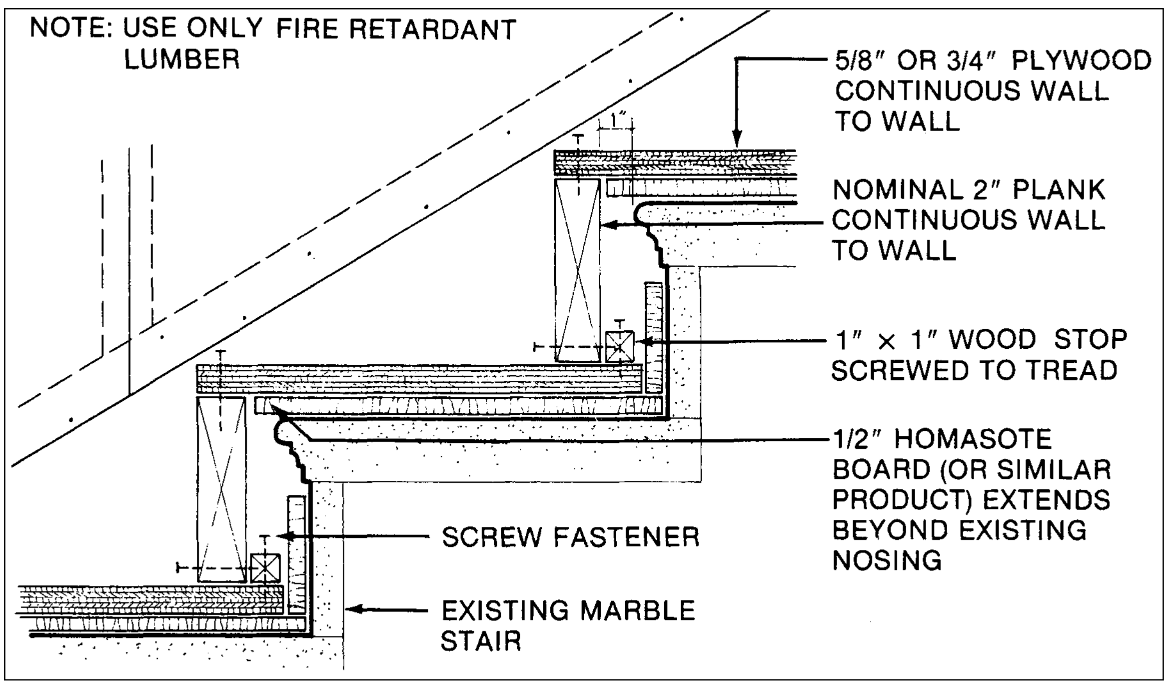
Recommended	*Not Recommended*
Alterations/Additions for the New Use	
Limiting any new excavations adjacent to historic foundations to avoid undermining the structural stability of the building or adjacent historic buildings. Studies should be done to ascertain potential damage to archeological resources.	Carrying out excavations or regrading adjacent to or within a historic building which could cause the historic foundation to settle, shift, or fail; could have a similar effect on adjacent historic buildings; or could destroy significant archeological resources.
Correcting structural deficiencies in preparation for the new use in a manner that preserves the structural system and individual character-defining features.	Radically changing interior spaces or damaging or destroying features or finishes that are character-defining while trying to correct structural deficiencies in preparation for the new use.
Designing and installing new mechanical or electrical systems when required for the new use which minimize the number of cutouts or holes in structural members.	Installing new mechanical and electrical systems or equipment in a manner which results in numerous cuts, splices, or alterations to the structural members.
Adding a new floor when required for the new use if such an alteration does not damage or destroy the structural system or obscure, damage, or destroy character-defining spaces, features, or finishes.	Inserting a new floor when such a radical change damages a structural system or obscures or destroys interior spaces, features, or finishes.
	Inserting new floors or furred-down ceilings which cut across the glazed areas of windows so that the exterior form and appearance of the windows are radically changed.
Creating an atrium or a light well to provide natural light when required for the new use in a manner that assures the preservation of the structural system as well as character-defining interior spaces, features, and finishes.	Damaging the structural system or individual features; or radically changing, damaging, or destroying character-defining interior spaces, features, or finishes in order to create an atrium or a light well.

Building Interior

Spaces, Features, and Finishes

Recommended	*Not Recommended*
Interior Spaces	
Identifying, retaining, and preserving a floor plan or interior spaces that are important in defining the overall historic character of the building. This includes the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves such as lobbies, reception halls, entrance halls, double parlors, theaters, auditoriums, and important industrial or commercial spaces.	Radically changing a floor plan or interior spaces—including individual rooms—which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Altering the floor plan by demolishing principal walls and partitions to create a new appearance. Altering or destroying interior spaces by inserting floors, cutting through floors, lowering ceilings, or adding or removing walls. Relocating an interior feature such as a staircase so that the historic relationship between features and spaces is altered.
Interior Features and Finishes	
Identifying, retaining, and preserving interior features and finishes that are important in defining the overall historic character of the building, including columns, cornices, baseboards, fireplaces and mantels, panelling, light fixtures, hardware, and flooring; and wallpaper, plaster, paint, and finishes such as stencilling, marbling, and graining; and other decorative materials that accent interior features and provide color, texture, and patterning to walls, floors, and ceilings.	Removing or radically changing features and finishes which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Installing new decorative material that obscures or damages character-defining interior features or finishes. Removing paint, plaster, or other finishes from historically finished surfaces to create a new appearance (e.g., removing plaster to expose masonry surfaces such as brick walls or a chimney piece). Applying paint, plaster, or other finishes to surfaces that have been historically unfinished to create a new appearance. Stripping paint to bare wood rather than repairing or reapplying grained or marbled finishes to features such as doors and panelling. Radically changing the type of finish or its color, such as painting a previously varnished wood feature.

Recommended	*Not Recommended*
Protecting and maintaining masonry, wood, and architectural metals which comprise interior features through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of interior features results.
Protecting interior features and finishes against arson and vandalism before project work begins, erecting protective fencing, boarding-up windows, and installing fire alarm systems that are keyed to local protection agencies.	Permitting entry into historic buildings through unsecured or broken windows and doors so that the interior features and finishes are damaged by exposure to weather or vandalism. Stripping interiors of features such as woodwork, doors, windows, light fixtures, copper piping, radiators; or of decorative materials.
Protecting interior features such as a staircase, mantel, or decorative finishes and wall coverings against damage during project work by covering them with heavy canvas or plastic sheets.	Failing to provide proper protection of interior features and finishes during work so that they are gouged, scratched, dented, or otherwise damaged.



Historic features that characterize a building should always be protected from damage during rehabilitation work. The drawing shows how a resilient, temporary stair covering was applied over the existing marble staircase. Drawing: National Park Service staff, based on material originally prepared by Emery Roth and Sons, P.C.

Recommended	*Not Recommended*
Installing protective coverings in areas of heavy pedestrian traffic to protect historic features such as wall coverings, parquet flooring and panelling.	Failing to take new use patterns into consideration so that interior features and finishes are damaged.
Removing damaged or deteriorated paints and finishes to the next sound layer using the gentlest method possible, then repainting or refinishing using compatible paint or other coating systems.	Using destructive methods such as propane or butane torches or sandblasting to remove paint or other coatings. These methods can irreversibly damage the historic materials that comprise interior features.
Repainting with colors that are appropriate to the historic building.	Using new paint colors that are inappropriate to the historic building.
Limiting abrasive cleaning methods to certain industrial warehouse buildings where the interior masonry or plaster features do not have distinguishing design, detailing, tooling, or finishes; and where wood features are not finished, molded, beaded, or worked by hand. Abrasive cleaning should only be considered after other, gentler methods have been proven ineffective.	Changing the texture and patina of character-defining features through sandblasting or use of abrasive methods to remove paint, discoloration or plaster. This includes both exposed wood (including structural members) and masonry.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, if repairs to interior features and finishes will be necessary.	Failing to undertake adequate measures to assure the protection of interior features and finishes.
Repairing interior features and finishes by reinforcing the historic materials. Repair will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of repeated features when there are surviving prototypes such as stairs, balustrades, wood panelling, columns; or decorative wall coverings or ornamental tin or plaster ceilings.	Replacing an entire interior feature such as a staircase, panelled wall, parquet floor, or cornice; or finish such as a decorative wall covering or ceiling when repair of materials and limited replacement of such parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts or portions of the interior feature or finish or that is physically or chemically incompatible.

Recommended

Replacing in kind an entire interior feature or finish that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model for reproduction. Examples could include wainscoting, a tin ceiling, or interior stairs. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.

Not Recommended

Removing a character-defining feature or finish that is unrepairable and not replacing it; or replacing it with a new feature or finish that does not convey the same visual appearance.

a

b

Rehabilitating historic dwelling units often includes some level of lead-paint hazard abatement. Whenever lead-base paint begins to peel, chip, craze, or otherwise comes loose (a), it should be removed in a manner that protects the worker as well as the immediate environment. In this example (b), the deteriorating lead-paint was removed throughout the apartment building and a compatible primer and finish paint applied. Photos: Sharon C. Park, AIA.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and installing a new interior feature or finish if the historic feature or finish is completely missing. This could include missing partitions, stairs, elevators, lighting fixtures, and wall coverings; or even entire rooms if all historic spaces, features, and finishes are missing or have been destroyed by inappropriate "renovations." The design may be a restoration based on historical, pictorial, and physical documentation; or be a new design that is compatible with the historic character of the building, district, or neighborhood.	Creating a false historical appearance because the replaced feature is based on insufficient physical, historical, and pictorial documentation or on information derived from another building. Introducing a new interior feature or finish that is incompatible with the scale, design, materials, color, and texture of the surviving interior features and finishes.
Alterations/Additions for the New Use	
Accommodating service functions such as bathrooms, mechanical equipment, and office machines required by the building's new use in secondary spaces such as first floor service areas or on upper floors.	Dividing rooms, lowering ceilings, and damaging or obscuring character-defining features such as fireplaces, niches, stairways or alcoves, so that a new use can be accommodated in the building.
Reusing decorative material or features that have had to be removed during the rehabilitation work including wall and baseboard trim, door molding, panelled doors, and simple wainscoting; and relocating such material or features in areas appropriate to their historic placement.	Discarding historic material when it can be reused within the rehabilitation project or relocating it in historically inappropriate areas.
Installing permanent partitions in secondary spaces; removable partitions that do not destroy the sense of space should be installed when the new use requires the subdivision of character-defining interior space.	Installing permanent partitions that damage or obscure character-defining spaces, features, or finishes.
Enclosing an interior stairway where required by code so that its character is retained. In many cases, glazed fire-rated walls may be used.	Enclosing an interior stairway with fire-rated construction so that the stairwell space or any character-defining features are destroyed.

Recommended	*Not Recommended*
Placing new code-required stairways or elevators in secondary and service areas of the historic building.	Radically changing, damaging, or destroying character-defining spaces, features, or finishes when adding new code-required stairways and elevators.
Creating an atrium or a light well to provide natural light when required for the new use in a manner that preserves character-defining interior spaces, features, and finishes as well as the structural system.	Destroying character-defining interior spaces, features, or finishes; or damaging the structural system in order to create an atrium or light well.
Adding a new floor if required for the new use in a manner that preserves character-defining structural features, and interior spaces, features, and finishes.	Inserting a new floor within a building that alters or destroys the fenestration; radically changes a character-defining interior space; or obscures, damages, or destroys decorative detailing.

Building Interior

Mechanical Systems: Heating, Air Conditioning, Electrical, and Plumbing

Recommended	*Not Recommended*
Identifying, retaining, and preserving visible features of early mechanical systems that are important in defining the overall historic character of the building, such as radiators, vents, fans, grilles, plumbing fixtures, switchplates, and lights.	Removing or radically changing features of mechanical systems that are important in defining the overall historic character of the building so that, as a result, the character is diminished.
Protecting and maintaining mechanical, plumbing, and electrical systems and their features through cyclical cleaning and other appropriate measures.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of mechanical systems and their visible features results.
Preventing accelerated deterioration of mechanical systems by providing adequate ventilation of attics, crawlspaces, and cellars so that moisture problems are avoided.	Enclosing mechanical systems in areas that are not adequately ventilated so that deterioration of the systems results.
Improving the energy efficiency of existing mechanical systems to help reduce the need for elaborate new equipment. Consideration should be given to installing storm windows, insulating attic crawl space, or adding awnings, if appropriate.	Installing unnecessary air conditioning or climate control systems which can add excessive moisture to the building. This additional moisture can either condense inside, damaging interior surfaces, or pass through interior walls to the exterior, potentially damaging adjacent materials as it migrates.
Repairing mechanical systems by augmenting or upgrading system parts, such as installing new pipes and ducts; rewiring; or adding new compressors or boilers.	Replacing a mechanical system or its functional parts when it could be upgraded and retained.
Replacing in kind—or with compatible substitute material—those visible features of mechanical systems that are either extensively deteriorated or are prototypes such as ceiling fans, switchplates, radiators, grilles, or plumbing fixtures.	Installing a visible replacement feature that does not convey the same visual appearance.

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Recommended	*Not Recommended*
Alterations/Additions for the New Use	
Installing a completely new mechanical system if required for the new use so that it causes the least alteration possible to the building's floor plan, the exterior elevations, and the least damage to the historic building material.	Installing a new mechanical system so that character-defining structural or interior features are radically changed, damaged, or destroyed.
Providing adequate structural support for new mechanical equipment.	Failing to consider the weight and design of new mechanical equipment so that, as a result, historic structural members or finished surfaces are weakened or cracked.
Installing the vertical runs of ducts, pipes, and cables in closets, service rooms, and wall cavities.	Installing vertical runs of ducts, pipes, and cables in places where they will obscure character-defining features.
	Concealing mechanical equipment in walls or ceilings in a manner that requires the removal of historic building material.
	Installing a "dropped" acoustical ceiling to hide mechanical equipment when this destroys the proportions of character-defining interior spaces.
Installing air conditioning units if required by the new use in such a manner that historic features are not damaged or obscured and excessive moisture is not generated that will accelerate deterioration of historic materials.	Cutting through features such as masonry walls in order to install air conditioning units.
Installing heating/air conditioning units in the window frames in such a manner that the sash and frames are protected. Window installations should be considered only when all other viable heating/cooling systems would result in significant damage to historic materials.	Radically changing the appearance of the historic building or damaging or destroying windows by installing heating/air conditioning units in historic window frames.

Building Site

Recommended	*Not Recommended*
Identifying, retaining, and preserving buildings and their features as well as features of the site that are important in defining its overall historic character. Site features may include circulation systems such as walks, paths, roads, or parking; vegetation such as trees, shrubs, fields, or herbaceous plant material; landforms such as terracing, berms or grading; furnishings such as lights, fences, or benches; decorative elements such as sculpture, statuary or monuments; water features including fountains, streams, pools, or lakes; and subsurface archeological features which are important in defining the history of the site.	Removing or radically changing buildings and their features or site features which are important in defining the overall historic character of the property so that, as a result, the character is diminished.
Retaining the historic relationship between buildings and the landscape.	Removing or relocating buildings or landscape features, thus destroying the historic relationship between buildings and the landscape.
	Removing or relocating historic buildings on a site or in a complex of related historic structures—such as a mill complex or farm—thus diminishing the historic character of the site or complex.
	Moving buildings onto the site, thus creating a false historical appearance.
	Radically changing the grade level of the site. For example, changing the grade adjacent to a building to permit development of a formerly below-grade area that would drastically change the historic relationship of the building to its site.
Protecting and maintaining buildings and the site by providing proper drainage to assure that water does not erode foundation walls; drain toward the building; or damage or erode the landscape.	Failing to maintain adequate site drainage so that buildings and site features are damaged or destroyed; or alternatively, changing the site grading so that water no longer drains properly.
Minimizing disturbance of terrain around buildings or elsewhere on the site, thus reducing the possibility of destroying or damaging important landscape features or archeological resources.	Introducing heavy machinery into areas where it may disturb or damage important landscape features or archeological resources.

Recommended	*Not Recommended*
Surveying and documenting areas where the terrain will be altered to determine the potential impact to important landscape features or archeological resources.	Failing to survey the building site prior to the beginning of rehabilitation work which results in damage to, or destruction of, important landscape features or archeological resources.
Protecting, e.g., preserving in place important archeological resources.	Leaving known archeological material unprotected so that it is damaged during rehabilitation work.
Planning and carrying out any necessary investigation using professional archeologists and modern archeological methods when preservation in place is not feasible.	Permitting unqualified personnel to perform data recovery on archeological resources so that improper methodology results in the loss of important archeological material.
Preserving important landscape features, including ongoing maintenance of historic plant material.	Allowing important landscape features to be lost or damaged due to a lack of maintenance.
Protecting the building and landscape features against arson and vandalism before rehabilitation work begins, i.e., erecting protective fencing and installing alarm systems that are keyed into local protection agencies.	Permitting the property to remain unprotected so that the building and landscape features or archeological resources are damaged or destroyed.
	Removing or destroying features from the building or site such as wood siding, iron fencing, masonry balustrades, or plant material.
Providing continued protection of historic building materials and plant features through appropriate cleaning, rust removal, limited paint removal, and re-application of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of building and site features results.
Evaluating the overall condition of the materials and features of the property to determine whether more than protection and maintenance are required, that is, if repairs to building and site features will be necessary.	Failing to undertake adequate measures to assure the protection of building and site features.

Recommended	*Not Recommended*
Repairing features of the building and site by reinforcing historic materials.	Replacing an entire feature of the building or site such as a fence, walkway, or driveway when repair of materials and limited compatible replacement of deteriorated or missing parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the building or site feature or that is physically or chemically incompatible.
Replacing in kind an entire feature of the building or site that is too deteriorated to repair if the overall form and detailing are still evident. Physical evidence from the deteriorated feature should be used as a model to guide the new work. This could include an entrance or porch, walkway, or fountain. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.	Removing a feature of the building or site that is unrepairable and not replacing it; or replacing it with a new feature that does not convey the same visual appearance.
Replacing deteriorated or damaged landscape features in kind.	Adding conjectural landscape features to the site such as period reproduction lamps, fences, fountains, or vegetation that are historically inappropriate, thus creating a false sense of historic development.

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Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and constructing a new feature of a building or site when the historic feature is completely missing, such as an outbuilding, terrace, or driveway. It may be based on historical, pictorial, and physical documentation; or be a new design that is compatible with the historic character of the building and site.	Creating a false historical appearance because the replaced feature is based on insufficient historical, pictorial, and physical documentation. Introducing a new building or site feature that is out of scale or of an otherwise inappropriate design. Introducing a new landscape feature, including plant material, that is visually incompatible with the site, or that alters or destroys the historic site patterns or vistas.
Alterations/Additions for the New Use	
Designing new onsite parking, loading docks, or ramps when required by the new use so that they are as unobtrusive as possible and assure the preservation of the historic relationship between the building or buildings and the landscape.	Locating any new construction on the building site in a location which contains important landscape features or open space, for example removing a lawn and walkway and installing a parking lot.
Designing new exterior additions to historic buildings or adjacent new construction which is compatible with the historic character of the site and which preserves the historic relationship between the building or buildings and the landscape.	Placing parking facilities directly adjacent to historic buildings where automobiles may cause damage to the buildings or landscape features, or be intrusive to the building site. Introducing new construction onto the building site which is visually incompatible in terms of size, scale, design, materials, color, and texture; which destroys historic relationships on the site; or which damages or destroys important landscape features.
Removing non-significant buildings, additions, or site features which detract from the historic character of the site.	Removing a historic building in a complex of buildings; or removing a building feature, or a landscape feature which is important in defining the historic character of the site.

Setting (District/Neighborhood)

Recommended	*Not Recommended*
Identifying retaining, and preserving building and landscape features which are important in defining the historic character of the setting. Such features can include roads and streets, furnishings such as lights or benches, vegetation, gardens and yards, adjacent open space such as fields, parks, commons or woodlands, and important views or visual relationships.	Removing or radically changing those features of the setting which are important in defining the historic character.
Retaining the historic relationship between buildings and landscape features of the setting. For example, preserving the relationship between a town common and its adjacent historic houses, municipal buildings, historic roads, and landscape features.	Destroying the relationship between the buildings and landscape features within the setting by widening existing streets, changing landscape materials or constructing inappropriately located new streets or parking. Removing or relocating historic buildings or landscape features, thus destroying their historic relationship within the setting.
Protecting and maintaining historic building materials and plant features through appropriate cleaning, rust removal, limited paint removal, and reapplication of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis which results in the deterioration of building and landscape features.
Protecting building and landscape features such as lighting or trees, against arson and vandalism before rehabilitation work begins by erecting protective fencing and installing alarm systems that are keyed into local protection agencies.	Permitting the building and setting to remain unprotected so that interior or exterior features are damaged. Stripping or removing features from buildings or the setting such as wood siding, iron fencing, terra cotta balusters, or plant material.
Evaluating the overall condition of the building and landscape features to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of building and landscape features.

Recommended

Repairing features of the building and landscape by reinforcing the historic materials. Repair will also generally include the replacement in kind—or with a compatible substitute material—of those extensively deteriorated or missing parts of features when there are surviving prototypes such as porch balustrades or paving materials.

Replacing in kind an entire feature of the building or landscape that is too deteriorated to repair— when the overall form and detailing are still evident —using the physical evidence as a model to guide the new work. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered.

Not Recommended

Replacing an entire feature of the building or landscape when repair of materials and limited replacement of deteriorated or missing parts are appropriate.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the building or landscape, or that is physically, chemically, or ecologically incompatible.

Removing a feature of the building or landscape that is unrepairable and not replacing it; or replacing it with a new feature that does not convey the same visual appearance.

The following work is highlighted to indicate that it represents the particularly complex technical or design aspects of **Rehabilitation** *projects and should only be considered after the preservation concerns listed above have been addressed.*

Recommended	*Not Recommended*
Design for the Replacement of Missing Historic Features	
Designing and constructing a new feature of the building or landscape when the historic feature is completely missing, such as row house steps, a porch, a streetlight, or terrace. It may be a restoration based on documentary or physical evidence; or be a new design that is compatible with the historic character of the setting.	Creating a false historical appearance because the replaced feature is based on insufficient documentary or physical evidence. Introducing a new building or landscape feature that is out of scale or otherwise inappropriate to the setting's historic character, e.g., replacing picket fencing with chain link fencing.
Alterations/Additions for the New Use	
Designing required new parking so that it is as unobtrusive as possible, thus minimizing the effect on the historic character of the setting. "Shared" parking should also be planned so that several businesses can utilize one parking area as opposed to introducing random, multiple lots.	Placing parking facilities directly adjacent to historic buildings which result in damage to historic landscape features, such as the removal of plant material, relocation of paths and walkways, or blocking of alleys.
Designing and constructing new additions to historic buildings when required by the new use. New work should be compatible with the historic character of the setting in terms of size, scale design, material, color, and texture.	Introducing new construction into historic districts that is visually incompatible or that destroys historic relationships within the setting.
Removing nonsignificant buildings, additions or landscape features which detract from the historic character of the setting.	Removing a historic building, building feature, or landscape feature that is important in defining the historic character of the setting.

a

b

c

If a rear elevation of a historic building is distinctive and highly visible in the neighborhood, altering it may not meet the Standards. (a and b) This 3-story brick rowhouse featured a second story gallery and brick kitchen wing characteristic of other residences in the district which backed onto a connecting roadway. (c) In the rehabilitation, the wing and gallery were demolished and a large addition constructed that severely impacted the building's historic form and character.

Although the work in these sections is quite often an important aspect of rehabilitation projects, it is usually not part of the overall process of preserving character-defining features (maintenance, repair, replacement); rather, such work is assessed for its potential negative impact on the building's historic character. For this reason, particular care must be taken not to obscure, radically change, damage, or destroy character-defining features in the process of rehabilitation work.

Energy Efficiency

Recommended	*Not Recommended*
Masonry/Wood/Architectural Metals	
Installing thermal insulation in attics and in unheated cellars and crawlspaces to increase the efficiency of the existing mechanical systems.	Applying thermal insulation with a high moisture content in wall cavities which may damage historic fabric.
Installing insulating material on the inside of masonry walls to increase energy efficiency where there is no character-defining interior molding around the windows or other interior architectural detailing.	Installing wall insulation without considering its effect on interior molding or other architectural detailing.
Windows	
Utilizing the inherent energy conserving features of a building by maintaining windows and louvered blinds in good operable condition for natural ventilation.	Removing historic shading devices rather than keeping them in an operable condition.
Improving thermal efficiency with weatherstripping, storm windows, caulking, interior shades, and if historically appropriate, blinds and awnings.	Replacing historic multi-paned sash with new thermal sash utilizing false muntins.
Installing interior storm windows with air-tight gaskets, ventilating holes, and/or removable clips to ensure proper maintenance and to avoid condensation damage to historic windows.	Installing interior storm windows that allow moisture to accumulate and damage the window.
Installing exterior storm windows which do not damage or obscure the windows and frames.	Installing new exterior storm windows which are inappropriate in size or color.
	Replacing windows or transoms with fixed thermal glazing or permitting windows and transoms to remain inoperable rather than utilizing them for their energy conserving potential.

Recommended	*Not Recommended*
Entrances and Porches	
Maintaining porches and double vestibule entrances so that they can retain heat or block the sun and provide natural ventilation.	Changing the historic appearance of the building by enclosing porches.
Interior Features	
Retaining historic interior shutters and transoms for their inherent energy conserving features.	Removing historic interior features which play an energy conserving role.
Mechanical Systems	
Improving energy efficiency of existing mechanical systems by installing insulation in attics and basements.	Replacing existing mechanical systems that could be repaired for continued use.
Building Site	
Retaining plant materials, trees, and landscape features which perform passive solar energy functions such as sun shading and wind breaks.	Removing plant materials, trees, and landscape features that perform passive solar energy functions.
Setting (District/Neighborhood)	
Maintaining those existing landscape features which moderate the effects of the climate on the setting such as deciduous trees, evergreen wind-blocks, and lakes or ponds.	Stripping the setting of landscape features and landforms so that effects of the wind, rain, and sun result in accelerated deterioration of the historic building.
New Additions to Historic Buildings	
Placing a new addition that may be necessary to increase energy efficiency on non-character-defining elevations.	Designing a new addition which obscures, damages, or destroys character-defining features.

New Additions to Historic Buildings

Recommended

Placing functions and services required for the new use in non-character-defining interior spaces rather than constructing a new addition.

Constructing a new addition so that there is the least possible loss of historic materials and so that character-defining features are not obscured, damaged, or destroyed.

Designing a new addition in a manner that makes clear what is historic and what is new.

Not Recommended

Expanding the size of the historic building by constructing a new addition when the new use could be met by altering non-character-defining interior spaces.

Attaching a new addition so that the character-defining features of the historic building are obscured, damaged, or destroyed.

Duplicating the exact form, material, style, and detailing of the historic building in a new addition so that the new work appears to be part of the historic building.

Imitating a historic style or period of architecture in a new addition.

Rehabilitation, like Preservation, acknowledges a building's change over time; the retention and repair of existing historic materials and features is thus always recommended. However, unlike Preservation, the dual goal of Rehabilitation is to—respectfully—add to or alter a building in order to meet new use requirements. This downtown Chicago library was expanded in 1981 when additional space was required with light and humidity control for the rare book collection. The compatible 10-story wing was linked to the historic block on side and rear elevations. Its simple design is compatible with the historic form, features, and detailing; old and new are clearly differentiated. Photo: Dave Clifton.

Recommended	*Not Recommended*
Considering the design for an attached exterior addition in terms of its relationship to the historic building as well as the historic district or neighborhood. Design for the new work may be contemporary or may reference design motifs from the historic building. In either case, it should always be clearly differentiated from the historic building and be compatible in terms of mass, materials, relationship of solids to voids, and color.	Designing and constructing new additions that result in the diminution or loss of the historic character of the resource, including its design, materials, workmanship, location, or setting.
Placing a new addition on a non-character-defining elevation and limiting the size and scale in relationship to the historic building.	Designing a new addition that obscures, damages, or destroys character-defining features of the historic building.
Designing a rooftop addition when required for the new use, that is set back from the wall plane and as inconspicuous as possible when viewed from the street.	Constructing a rooftop addition so that the historic appearance of the building is radically changed.

Accessibility Considerations

Recommended

Identifying the historic building's character-defining spaces, features, and finishes so that accessibility code-required work will not result in their damage or loss.

Complying with barrier-free access requirements, in such a manner that character-defining spaces, features, and finishes are preserved.

Working with local disability groups, access specialists, and historic preservation specialists to determine the most appropriate solution to access problems.

Providing barrier-free access that promotes independence for the disabled person to the highest degree practicable, while preserving significant historic features.

Designing new or additional means of access that are compatible with the historic building and its setting.

Not Recommended

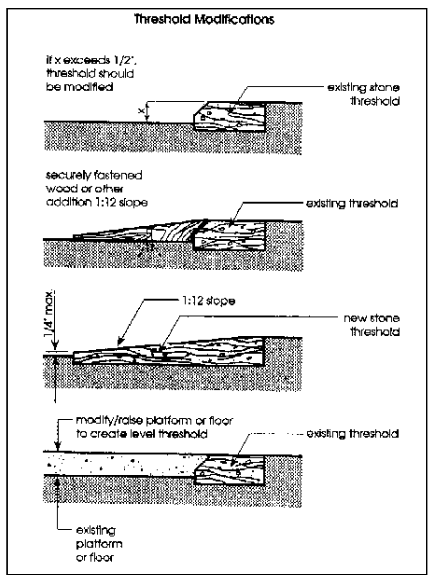
Undertaking code-required alterations before identifying those spaces, features, or finishes which are character-defining and must therefore be preserved.

Altering, damaging, or destroying character-defining features in attempting to comply with accessibility requirements.

Making changes to buildings without first seeking expert advice from access specialists and historic preservationists, to determine solutions.

Making access modifications that do not provide a reasonable balance between independent, safe access and preservation of historic features.

Designing new or additional means of access without considering the impact on the historic building and its setting.



Making a building accessible to the public is a requirement under the Americans with Disabilities Act of 1990, whatever the treatment. Full, partial, or alternative approaches to accessibility depends upon the historical significance of a building and the ability to make changes. In these examples, thresholds that exceed allowable heights were modified several ways to increase accessibility. without jeopardizing the historic character. Drawing: Uniform Federal Accessibility Standard (UFAS) Retrofit Manual.

Health and Safety Considerations

Recommended	*Not Recommended*
Identifying the historic building's character-defining spaces, features, and finishes so that code-required work will not result in their damage or loss.	Undertaking code-required alterations to a building or site before identifying those spaces, features, or finishes which are character-defining and must therefore be preserved.
Complying with health and safety codes, including seismic code requirements, in such a manner that character-defining spaces, features, and finishes are preserved.	Altering, damaging, or destroying character-defining spaces, features, and finishes while making modifications to a building or site to comply with safety codes.
Removing toxic building materials only after thorough testing has been conducted and only after less invasive abatement methods have been shown to be inadequate.	Destroying historic interior features and finishes without careful testing and without considering less invasive abatement methods.
Providing workers with appropriate personal protective equipment for hazards found in the worksite.	Removing unhealthful building materials without regard to personal and environmental safety.
Working with local code officials to investigate systems, methods, or devices of equivalent or superior effectiveness and safety to those prescribed by code so that unnecessary alterations can be avoided.	Making changes to historic buildings without first exploring equivalent health and safety systems, methods, or devices that may be less damaging to historic spaces, features, and finishes.
Upgrading historic stairways and elevators to meet health and safety codes in a manner that assures their preservation, i.e., so that they are not damaged or obscured.	Damaging or obscuring historic stairways and elevators or altering adjacent spaces in the process of doing work to meet code requirements.
Installing sensitively designed fire suppression systems, such as sprinkler systems that result in retention of historic features and finishes.	Covering character-defining wood features with fire-resistant sheathing which results in altering their visual appearance.
Applying fire-retardant coatings, such as intumescent paints, which expand during fire to add thermal protection to steel.	Using fire-retardant coatings if they damage or obscure character-defining features.
Adding a new stairway or elevator to meet health and safety codes in a manner that preserves adjacent character-defining features and spaces.	Radically changing, damaging, or destroying character-defining spaces, features, or finishes when adding a new code-required stairway or elevator.
Placing a code-required stairway or elevator that cannot be accommodated within the historic building in a new exterior addition. Such an addition should be on an inconspicuous elevation.	Constructing a new addition to accommodate code-required stairs and elevators on character-defining elevations highly visible from the street; or where it obscures, damages, or destroys character-defining features.

Standards for Restoration & Guidelines for Restoring Historic Buildings

Restoration *is defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.*

Standards for Restoration

1. A property will be used as it was historically or be given a new use which reflects the property's restoration period.

2. Materials and features from the restoration period will be retained and preserved. The removal of materials or alteration of features, spaces, and spatial relationships that characterize the period will not be undertaken.

3. Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate and conserve materials and features from the restoration period will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

4. Materials, features, spaces, and finishes that characterize other historical periods will be documented prior to their alteration or removal.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize the restoration period will be preserved.

6. Deteriorated features from the restoration period will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials.

7. Replacement of missing features from the restoration period will be substantiated by documentary and physical evidence. A false sense of history will not be created by adding conjectural features, features from other properties, or by combining features that never existed together historically.

8. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

9. Archeological resources affected by a project will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

10. Designs that were never executed historically will not be constructed.

Guidelines for Restoring Historic Buildings

Introduction

Rather than maintaining and preserving a building as it has evolved over time, the expressed goal of the **Standards for Restoration and Guidelines for Restoring Historic Buildings** is to make the building appear as it did at a particular—and most significant—time in its history. First, those materials and features from the "restoration period" are identified, based on thorough historical research. Next, features from the restoration period are maintained, protected, repaired (i.e., stabilized, consolidated, and conserved), and replaced, if necessary. As opposed to other treatments, the scope of work in **Restoration** can include removal of features from other periods; missing features from the restoration period may be replaced, based on documentary and physical evidence, using traditional materials or compatible substitute materials. The final guidance emphasizes that only those designs that can be documented as having been built should be re-created in a restoration project.

Identify, Retain, and Preserve Materials and Features from the Restoration Period

The guidance for the treatment **Restoration** begins with recommendations to identify the form and detailing of those existing architectural materials and features that are significant to the restoration period as established by historical research and documentation. Thus, guidance on ***identifying, retaining, and preserving*** features from the restoration period is always given first. The historic building's appearance may be defined by the form and detailing of its exterior materials, such as masonry, wood, and metal; exterior features, such as roofs, porches, and windows; interior materials, such as plaster and paint; and interior features, such as moldings and stairways, room configuration and spatial relationships, as well as structural and mechanical systems; and the building's site and setting.

Protect and Maintain Materials and Features from the Restoration Period

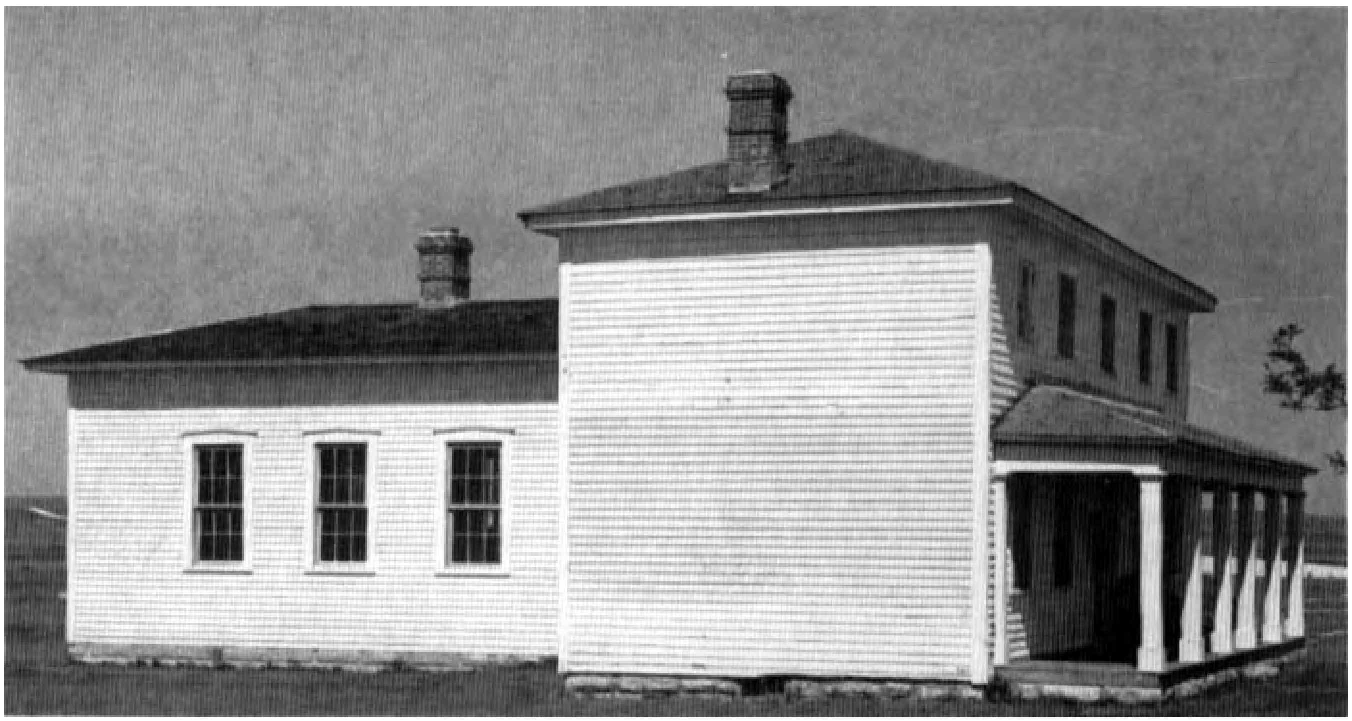
After identifying those existing materials and features from the restoration period that must be retained in the process of **Restoration** work, then ***protecting and maintaining*** them is addressed. Protection generally involves the least degree of intervention and is preparatory to other work. For example, protection includes the maintenance of historic material through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, alarm systems and other temporary protective measures. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

Repair (Stabilize, Consolidate, and Conserve) Materials and Features from the Restoration Period

Next, when the physical condition of restoration period features requires additional work, ***repairing*** by ***stabilizing, consolidating, and conserving*** is recommended. **Restoration** guidance focuses upon the preservation of those materials and features that are significant to the period. Consequently, guidance for repairing a historic material, such as masonry, again begins with the least degree of intervention possible, such as strengthening fragile materials through consolidation, when appropriate, and repointing with mortar of an appropriate strength. Repairing masonry as well as wood and architectural metals includes patching, splicing, or otherwise reinforcing them using recognized preservation methods. Similarly, portions of a historic structural system could be reinforced using contemporary material such as steel rods. In **Restoration**, repair may also include the limited replacement in kind—or with compatible substitute material—of extensively deteriorated or missing parts of existing features when there are surviving prototypes to use as a model. Examples could include terra-cotta brackets, wood balusters, or cast iron fencing.

Replace Extensively Deteriorated Features from the Restoration Period

In **Restoration**, ***replacing*** an entire feature from the restoration period (i.e., a cornice, balustrade, column, or stairway) that is too deteriorated to repair may be appropriate. Together with documentary evidence, the form and detailing of the historic feature should be used as a model for the replacement. Using the same kind of material is preferred; however, compatible substitute material may be considered. All new work should be unobtrusively dated to guide future research and treatment.



In a project at Fort Hays, Kansas, the wood frame officers' quarters were restored to the late 1860s—their period of significance. This included replacing a missing kitchen ell, chimneys, porch columns, and cornice, and closing a later window opening in the main block. The building and others in the museum complex is used to interpret frontier history.

If documentary and physical evidence are not available to provide an accurate re-creation of missing features, the treatment Rehabilitation might be a better overall approach to project work.

Remove Existing Features from Other Historic Periods

Most buildings represent continuing occupancies and change over time, but in **Restoration**, the goal is to depict the building as it appeared at the most significant time in its history. Thus, work is included to remove or alter existing historic features that do not represent the restoration period. This could include features such as windows, entrances and doors, roof dormers, or landscape features. Prior to altering or removing materials, features, spaces, and finishes that characterize other historical periods, they should be documented to guide future research and treatment.

Re-Create Missing Features from the Restoration Period

Most **Restoration** projects involve re-creating features that were significant to the building at a particular time, but are now missing. Examples could include a stone balustrade, a porch, or cast iron storefront. Each missing feature should be substantiated by documentary and physical evidence. Without sufficient documentation for these "re-creations," an accurate depiction cannot be achieved. Combining features that never existed together historically can also create a false sense of history. Using traditional materials to depict lost features is always the preferred approach; however, using compatible substitute material is an acceptable alternative in **Restoration** because, as emphasized, the goal of this treatment is to replicate the "appearance" of the historic building at a particular time, not to retain and preserve all historic materials as they have evolved over time.

If documentary and physical evidence are not available to provide an accurate re-creation of missing features, the treatment Rehabilitation might be a better overall approach to project work.

Energy Efficiency/Accessibility Considerations/ Health and Safety Code Considerations

These sections of the **Restoration** guidance address work done to meet accessibility requirements and health and safety code requirements; or limited retrofitting measures to improve energy efficiency. Although this work is quite often an important aspect of restoration projects, it is usually not part of the overall process of protecting, stabilizing, conserving, or repairing features from the restoration period; rather, such work is assessed for its potential negative impact on the building's historic appearance. For this reason, particular care must be taken not to obscure, damage, or destroy historic materials or features from the restoration period in the process of undertaking work to meet code and energy requirements.

Restoration as a Treatment. *When the property's design, architectural, or historical significance during a particular period of time outweighs the potential loss of extant materials, features, spaces, and finishes that characterize other historical periods; when there is substantial physical and documentary evidence for the work; and when contemporary alterations and additions are not planned, Restoration may be considered as a treatment. Prior to undertaking work, a particular period of time, i.e., the restoration period, should be selected and justified, and a documentation plan for Restoration developed.*

Building Exterior

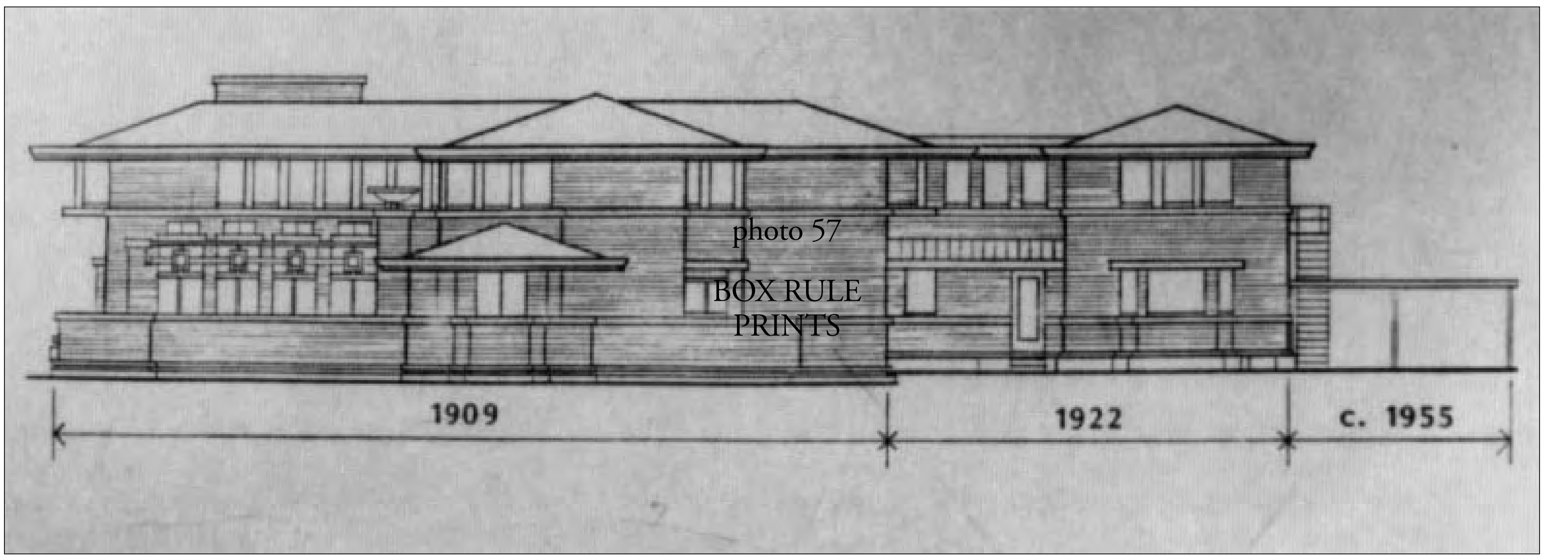
Masonry: Brick, stone, terra cotta, concrete, adobe, stucco and mortar

Recommended	*Not Recommended*
Identifying, retaining, and preserving masonry features from the restoration period such as walls, brackets, railings, cornices, window architraves, door pediments, steps, and columns; and details such as tooling and bonding patterns, coatings, and color.	Altering masonry features from the restoration period. Failing to properly document masonry features from the restoration period which may result in their loss. Applying paint or other coatings such as stucco to masonry or removing paint or stucco from masonry if such treatments cannot be documented to the restoration period. Changing the type or color of the paint or coating unless the work can be substantiated by historical documentation.
Protecting and maintaining masonry from the restoration period by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved decorative features.	Failing to evaluate and treat the various causes of mortar joint deterioration such as leaking roofs or gutters, differential settlement of the building, capillary action, or extreme weather exposure.
Cleaning masonry only when necessary to halt deterioration or remove heavy soiling.	Cleaning masonry surfaces when they are not heavily soiled, thus needlessly introducing chemicals or moisture into historic materials.
Carrying out masonry surface cleaning tests after it has been determined that such cleaning is appropriate. Tests should be observed over a sufficient period of time so that both the immediate and the long range effects are known to enable selection of the gentlest method possible.	Cleaning masonry surfaces without testing or without sufficient time for the testing results to be of value.

Recommended	*Not Recommended*
Cleaning masonry surfaces with the gentlest method possible, such as low pressure water and detergents, using natural bristle brushes.	Sandblasting brick or stone surfaces using dry or wet grit or other abrasives. These methods of cleaning permanently erode the surface of the material and accelerate deterioration.
	Using a cleaning method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures.
	Cleaning with chemical products that will damage masonry, such as using acid on limestone or marble, or leaving chemicals on masonry surfaces.
	Applying high pressure water cleaning methods that will damage historic masonry and the mortar joints.
Inspecting painted masonry surfaces to determine whether repainting is necessary.	Removing paint that is firmly adhering to, and thus protecting, masonry surfaces.
Removing damaged or deteriorated paint only to the next sound layer using the gentlest method possible (e.g., handscraping) prior to repainting.	Using methods of removing paint which are destructive to masonry, such as sandblasting, application of caustic solutions, or high pressure waterblasting.
Applying compatible paint coating systems following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting masonry.
Repainting with colors that are documented to the restoration period of the building.	Using new paint colors that are not documented to the restoration period of the building.
Evaluating the existing condition of the masonry to determine whether more than protection and maintenance are required, that is, if repairs to masonry features from the restoration period will be necessary.	Failing to undertake adequate measures to assure the protection of masonry features from the restoration period.
Repairing, stabilizing and conserving fragile masonry from the restoration period by well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.	Removing masonry from the restoration period that could be stabilized, repaired and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile historic materials.

Recommended	*Not Recommended*
Repairing masonry walls and other masonry features by repointing the mortar joints where there is evidence of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls, or damaged plasterwork.	Removing nondeteriorated mortar from sound joints, then repointing the entire building to achieve a uniform appearance.
Removing deteriorated mortar by carefully hand-raking the joints to avoid damaging the masonry.	Using electric saws and hammers rather than hand tools to remove deteriorated mortar from joints prior to repointing.
Duplicating and, if necessary, reproducing period mortar in strength, composition, color, and texture.	Repointing with mortar of high portland cement content (unless it is the content of the historic mortar). This can often create a bond that is stronger than the historic material and can cause damage as a result of the differing coefficient of expansion and the differing porosity of the material and the mortar.
	Repointing with a synthetic caulking compound.
	Using a "scrub" coating technique to repoint instead of traditional repointing methods.
Duplicating and, if necessary, reproducing period mortar joints in width and in joint profile.	Changing the width or joint profile when repointing.
Repairing stucco by removing the damaged material and patching with new stucco that duplicates stucco of the restoration period in strength, composition, color, and texture.	Removing sound stucco; or repairing with new stucco that is stronger than the historic material or does not convey the same visual appearance.
Using mud plaster as a surface coating over unfired, unstabilized adobe because the mud plaster will bond to the adobe.	Applying cement stucco to unfired, unstabilized adobe. Because the cement stucco will not bond properly, moisture can become entrapped between materials, resulting in accelerated deterioration of the adobe.
Cutting damaged concrete back to remove the source of deterioration (often corrosion on metal reinforcement bars). The new patch must be applied carefully so it will bond satisfactorily with, and match, the historic concrete.	Patching concrete without removing the source of deterioration.

Recommended	*Not Recommended*
Repairing masonry features from the restoration period by patching, piecing-in, or otherwise reinforcing the masonry using recognized preservation methods. Repair may also include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of masonry features from the restoration period when there are surviving prototypes such as terra-cotta brackets or stone balusters. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire masonry feature from the restoration period such as a cornice or balustrade when repair of the masonry and limited replacement of deteriorated or missing parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the masonry feature or that is physically or chemically incompatible.
Applying new or non-historic surface treatments such as water-repellent coatings to masonry only after repointing and only if masonry repairs have failed to arrest water penetration problems.	Applying waterproof, water repellent, or non-historic coatings such as stucco to masonry as a substitute for repointing and masonry repairs. Coatings are frequently unnecessary, expensive, and may change the appearance of historic masonry as well as accelerate its deterioration.



The Meyer May House in Grand Rapids, Michigan, was designed by Frank Lloyd Wright and built in 1909. In 1922, May added to the house for an expanding family. After the May occupancy, the house was altered for use as apartments, with a carport added in 1955. In the 1980s restoration, the Wright's original design was deemed more significant than May's later changes, and, as a result, the additions were removed and the house returned to its 1909 appearance. Drawing: Martha L. Werenfels, AIA.

Recommended	*Not Recommended*
Replacing in kind an entire masonry feature from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples can include large sections of a wall, a cornice, balustrade, column, or stairway. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a masonry feature from the restoration period that is unrepairable and not replacing it.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic masonry features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing masonry features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering masonry features from other historic periods such as a later doorway, porch, or steps.	Failing to remove a masonry feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document masonry features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing masonry feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a terra-cotta bracket or stone balustrade.	Constructing a masonry feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Wood: Clapboard, weatherboard, shingles, and other wooden siding and decorative elements

Recommended	*Not Recommended*
Identifying, retaining, and preserving wood features from the restoration period such as siding, cornices, brackets, window architraves, and doorway pediments; and their paints, finishes, and color.	Altering wood features from the restoration period. Failing to properly document wood features from the restoration period which may result in their loss. Applying paint or other coatings to wood or removing paint from wood if such treatments cannot be documented to the restoration period. Changing the type or color of the paint or coating unless the work can be substantiated by historical documentation.
Protecting and maintaining wood features from the restoration period by providing proper drainage so that water is not allowed to stand on flat, horizontal surfaces or accumulate in decorative features.	Failing to identify, evaluate, and treat the causes of wood deterioration, including faulty flashing, leaking gutters, cracks and holes in siding, deteriorated caulking in joints and seams, plant material growing too close to wood surfaces, or insect or fungus infestation.
Applying chemical preservatives to wood features such as beam ends or outriggers that are exposed to decay hazards and are traditionally unpainted.	Using chemical preservatives such as creosote which, unless they were used historically, can change the appearance of wood features.
Retaining coatings such as paint that help protect the wood from moisture and ultraviolet light. Paint removal should be considered only where there is paint surface deterioration and as part of an overall maintenance program which involves repainting or applying other appropriate protective coatings.	Stripping paint or other coatings to reveal bare wood, thus exposing historically coated surfaces to the effects of accelerated weathering.
Inspecting painted wood surfaces to determine whether repainting is necessary or if cleaning is all that is required.	Removing paint that is firmly adhering to, and thus, protecting wood surfaces.
Removing damaged or deteriorated paint to the next sound layer using the gentlest method possible (handscraping and handsanding), then repainting.	Using destructive paint removal methods such as propane or butane torches, sandblasting or waterblasting. These methods can irreversibly damage historic woodwork.

Ongoing work at this house focuses on the maintenance and repair of exterior wood features from the restoration period. After scraping and sanding, the wood was painted in colors documented to the Restoration period. Photo: ©Mary Randlett, 1992.

Recommended	*Not Recommended*
Using with care electric hot-air guns on decorative wood features and electric heat plates on flat wood surfaces when paint is so deteriorated that total removal is necessary prior to repainting.	Using thermal devices improperly so that the historic woodwork is scorched.
Using chemical strippers primarily to supplement other methods such as handscraping, handsanding and the above-recommended thermal devices. Detachable wooden elements such as shutters, doors, and columns may—with the proper safeguards—be chemically dip-stripped.	Failing to neutralize the wood thoroughly after using chemicals so that new paint does not adhere. Allowing detachable wood features to soak too long in a caustic solution so that the wood grain is raised and the surface roughened.

Recommended	*Not Recommended*
Applying compatible paint coating systems following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting exterior woodwork.
Repainting with colors that are documented to the restoration period of the building.	Using new colors that are not documented to the restoration period of the building.
Evaluating the existing condition of the wood to determine whether more than protection and maintenance are required, that is, if repairs to wood features from the restoration period will be necessary.	Failing to undertake adequate measures to assure the protection of wood features from the restoration period.
Repairing, stabilizing, and conserving fragile wood from the restoration period using well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.	Removing wood from the restoration period that could be stabilized and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile historic materials.
Repairing wood features from the restoration period by patching, piecing-in, or otherwise reinforcing the wood using recognized preservation methods. Repair may also include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of features from the restoration period where there are surviving prototypes such as brackets, molding, or sections of siding. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire wood feature from the restoration period such as a cornice or wall when repair of the wood and limited replacement of deteriorated or missing parts are appropriate. Using substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the wood feature or that is physically or chemically incompatible.
Replacing in kind an entire wood feature from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples of wood features include a cornice, entablature or balustrade. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a wood feature from the restoration period that is unrepairable and not replacing it.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic wood features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing wood features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering wood features from other historic periods such as a later doorway, porch, or steps.	Failing to remove a wood feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document wood features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing wood feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a roof dormer or porch.	Constructing a wood feature that was part of the original design for the building, but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Architectual Metals: Cast iron, steel pressed tin, copper, aluminum, and zinc

Recommended	*Not Recommended*
Identifying, retaining, and preserving architectural metal features from the restoration period such as columns, capitals, window hoods, or stairways; and their finishes and colors. Identification is also critical to differentiate between metals prior to work. Each metal has unique properties and thus requires different treatments.	Altering architectural metal features from the restoration period. Failing to properly document architectural metal features from the restoration period which may result in their loss. Changing the type of finish, historic color, or accent scheme unless the work can be substantiated by historical documentation.
Protecting and maintaining restoration period architectural metals from corrosion by providing proper drainage so that water does not stand on flat, horizontal surfaces or accumulate in curved, decorative features.	Failing to identify, evaluate, and treat the causes of corrosion, such as moisture from leaking roofs or gutters.
Cleaning architectural metals, when appropriate, to remove corrosion prior to repainting or applying other appropriate protective coatings.	Exposing metals which were intended to be protected from the environment. Applying paint or other coatings to metals such as copper, bronze, or stainless steel that were meant to be exposed.
Identifying the particular type of metal prior to any cleaning procedure and then testing to assure that the gentlest cleaning method possible is selected or determining that cleaning is inappropriate for the particular metal.	Using cleaning methods which alter or damage the historic color, texture, and finish of the metal; or cleaning when it is inappropriate for the metal. Removing the patina of historic metal. The patina may be a protective coating on some metals, such as bronze or copper, as well as a significant historic finish.
Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with appropriate chemical methods because their finishes can be easily abraded by blasting methods.	Cleaning soft metals such as lead, tin, copper, terneplate, and zinc with grit blasting which will abrade the surface of the metal.

Recommended

Using the gentlest cleaning methods for cast iron, wrought iron, and steel—hard metals—in order to remove paint buildup and corrosion. If handscraping and wire brushing have proven ineffective, low pressure grit blasting may be used as long as it does not abrade or damage the surface.

Applying appropriate paint or other coating systems after cleaning in order to decrease the corrosion rate of metals or alloys.

Repainting with colors that are documented to the restoration period of the building.

Applying an appropriate protective coating such as lacquer to an architectural metal feature such as a bronze door which is subject to heavy pedestrian use.

Evaluating the existing condition of the architectural metals to determine whether more than protection and maintenance are required, that is, if repairs to metal features from the restoration period will be necessary.

Repairing, stabilizing, and conserving fragile architectural metal from the restoration period using well-tested consolidants, when appropriate. Repairs should be physically and visually compatible and identifiable upon close inspection for future research.

Repairing architectural metal features from the restoration period by patching, splicing, or otherwise reinforcing the metal using recognized preservation methods. Repairs may also include the limited replacement in kind—or with a compatible substitute material—of those extensively deteriorated or missing parts of features from the restoration period when there are surviving prototypes such as porch balusters, column capitals or bases; or porch cresting. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Failing to employ gentler methods prior to abrasively cleaning cast iron, wrought iron or steel; or using high pressure grit blasting.

Failing to re-apply protective coating systems to metals or alloys that require them after cleaning so that accelerated corrosion occurs.

Using new colors that are not documented to the restoration period of the building.

Failing to assess pedestrian use or new access patterns so that architectural metal features are subject to damage by use or inappropriate maintenance such as salting adjacent sidewalks.

Failing to undertake adequate measures to assure the protection of architectural metal features from the restoration period.

Removing architectural metal from the restoration period that could be stabilized and conserved; or using untested consolidants and untrained personnel, thus causing further damage to fragile historic materials.

Replacing an entire architectural metal feature from the restoration period such as a column or a balustrade when repair of the metal and limited replacement of deteriorated or missing parts are appropriate.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the architectural metal feature or that is physically or chemically incompatible.

The Standards for Restoration call for the repair of existing features from the restoration period as well as the re-creation of missing features from the period. In some instances, when missing features are replaced, substitute materials may be considered if they convey the appearance of the historic materials. In this example at Philadelphia's Independence Hall, the clock was re-built in 1972-73 using cast stone and wood with fiberglass and polyester bronze ornamentation. Photo: Lee H. Nelson, FAIA.

Recommended

Replacing in kind an entire architectural metal feature from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples could include cast iron porch steps or roof cresting. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Removing an architectural metal feature from the restoration period that is unrepairable and not replacing it.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic architectural metal features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing architectural metal features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering architectural metal features from other historic periods such as a later cast iron porch railing or aluminum windows.	Failing to remove an architectural metal feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document architectural metal features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing architectural metal feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a cast iron storefront or porch.	Constructing an architectural metal feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Roofs

Recommended	*Not Recommended*
Identifying, retaining, and preserving roofs and roof features from the restoration period. This includes the roof's shape, such as hipped, gambrel, and mansard; decorative features such as cupolas, cresting, chimneys, and weathervanes; and roofing material such as slate, wood, clay tile, and metal, as well as size, color, and patterning.	Altering roofs and roof features from the restoration period. Failing to properly document roof features from the restoration period which may result in their loss. Changing the type or color of roofing materials unless the work can be substantiated by historical documentation.
Protecting and maintaining a restoration period roof by cleaning the gutters and downspouts and replacing deteriorated flashing. Roof sheathing should also be checked for proper venting to prevent moisture condensation and water penetration; and to insure that materials are free from insect infestation.	Failing to clean and maintain gutters and downspouts properly so that water and debris collect and cause damage to roof fasteners, sheathing, and the underlying structure.
Providing adequate anchorage for roofing material to guard against wind damage and moisture penetration.	Allowing roof fasteners, such as nails and clips, to corrode so that roofing material is subject to accelerated deterioration.
Protecting a leaking roof with plywood and building paper until it can be properly repaired.	Permitting a leaking roof to remain unprotected so that accelerated deterioration of historic building materials—masonry, wood, plaster, paint and structural members—occurs.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, if repairs to roofs and roof features will be necessary.	Failing to undertake adequate measures to assure the protection of roofs and roof features from the restoration period.
Repairing a roof from the restoration period by reinforcing the materials which comprise roof features. Repairs will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of features when there are surviving prototypes such as cupola louvers, dentils, dormer roofing; or slates, tiles, or wood shingles. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire roof feature from the restoration period such as a cupola or dormer when the repair of materials and limited replacement of deteriorated or missing parts are appropriate. Failing to reuse intact slate or tile when only the roofing substrate needs replacement. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the roof or that is physically or chemically incompatible.

Recommended	*Not Recommended*
Replacing in kind an entire roof feature from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model to reproduce the feature. Examples can include a large section of roofing, or a dormer or chimney. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a roof feature from the restoration period that is unrepairable, and not replacing it; or failing to document the new work.

The following **Restoration** *work involves the removal or alteration of existing historic roofs and roof features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing roof features from the restoration period using all new materials in order to create an accurate historic appearance.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering roofs or roof features from other historic periods such as a later dormer or asphalt roofing.	Failing to remove a roof feature from another period, thus confusing the depiction and of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document roofing materials and roof features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating missing roofing material or a roof feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a dormer or cupola.	Constructing a roof feature that was part of the original design for the building, but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Windows

Recommended

Identifying, retaining, and preserving windows—and their functional and decorative features—from the restoration period. Such features can include frames, sash, muntins, glazing, sills, heads, hoodmolds, panelled or decorated jambs and moldings, and interior and exterior shutters and blinds.

Conducting an indepth survey of the condition of existing windows from the restoration period early in the planning process so that repair and upgrading methods and possible replacement options can be fully explored.

Protecting and maintaining the wood and architectural metals from the restoration period which comprise the window frame, sash, muntins, and surrounds through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.

Making windows weathertight by re-caulking, and replacing or installing weatherstripping. These actions also improve thermal efficiency.

Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, i.e. if repairs to windows and window features will be required.

Not Recommended

Altering windows or window features from the restoration period.

Failing to properly document window features from the restoration period which may result in their loss.

Applying paint or other coatings to window features or removing them if such treatments cannot be documented to the restoration period.

Changing the type or color of protective surface coatings on window features unless the work can be substantiated by historical documentation.

Stripping windows of sound material such as wood, cast iron, and bronze.

Replacing windows from the restoration period solely because of peeling paint, broken glass, stuck sash, and high air infiltration. These conditions, in themselves, are no indication that windows are beyond repair.

Failing to provide adequate protection of materials on a cyclical basis so that deterioration of the window results.

Retrofitting or replacing windows from the restoration period rather than maintaining the sash, frame, and glazing.

Failing to undertake adequate measures to assure the protection of window materials from the restoration period.

Recommended

Repairing window frames and sash from the restoration period by patching, splicing, consolidating or otherwise reinforcing. Such repair may also include replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts when there are surviving prototypes such as architraves, hoodmolds, sash, sills, and interior or exterior shutters and blinds. The new work should be unobtrusively dated to guide future research and treatment.

Replacing in kind a window feature from the restoration period that is too deteriorated to repair using the same sash and pane configuration and other design details. If using the same kind of material is not technically or economically feasible when replacing windows deteriorated beyond repair, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Replacing an entire window from the restoration period when repair of materials and limited replacement of deteriorated or missing parts are appropriate.

Failing to reuse serviceable window hardware such as brass sash lifts and sash locks.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the window or that is physically or chemically incompatible.

Removing a window feature from the restoration period that is unrepairable and not replacing it; or failing to document the new work.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic windows and window features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing window features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering windows or window features from other historic periods, such as later single-pane glazing or inappropriate shutters.	Failing to remove a window feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document window features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing window or window feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a hoodmold or shutter.	Constructing a window feature that was part of the original design for the building, but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Entrances and Porches

Recommended	*Not Recommended*
Identifying, retaining, and preserving entrances and porches from the restoration period—and their functional and decorative features—such as doors, fanlights, sidelights, pilasters, entablatures, columns, balustrades, and stairs.	Altering entrances and porch features from the restoration period. Failing to properly document entrance and porch features from the restoration period which may result in their loss Applying paint or other coatings to entrance and porch features or removing them if such treatments cannot be documented to the restoration period. Changing the type or color of protective surface coatings on entrance and porch features unless the work can be substantiated by historical documentation. Stripping entrances and porches of sound material such as wood, iron, cast iron, terra cotta, tile and brick.
Protecting and maintaining the masonry, wood, and architectural metals that comprise restoration period entrances and porches through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and re-application of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of entrances and porches results.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, if repairs to entrance and porch features will be necessary.	Failing to undertake adequate measures to assure the protection of historic entrances and porches from the restoration period.

Recommended

Repairing entrances and porches from the restoration period by reinforcing the historic materials. Repairs will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of repeated features where there are surviving prototypes such as balustrades, cornices, entablatures, columns, sidelights, and stairs. The new work should be unobtrusively dated to guide future research and treatment.

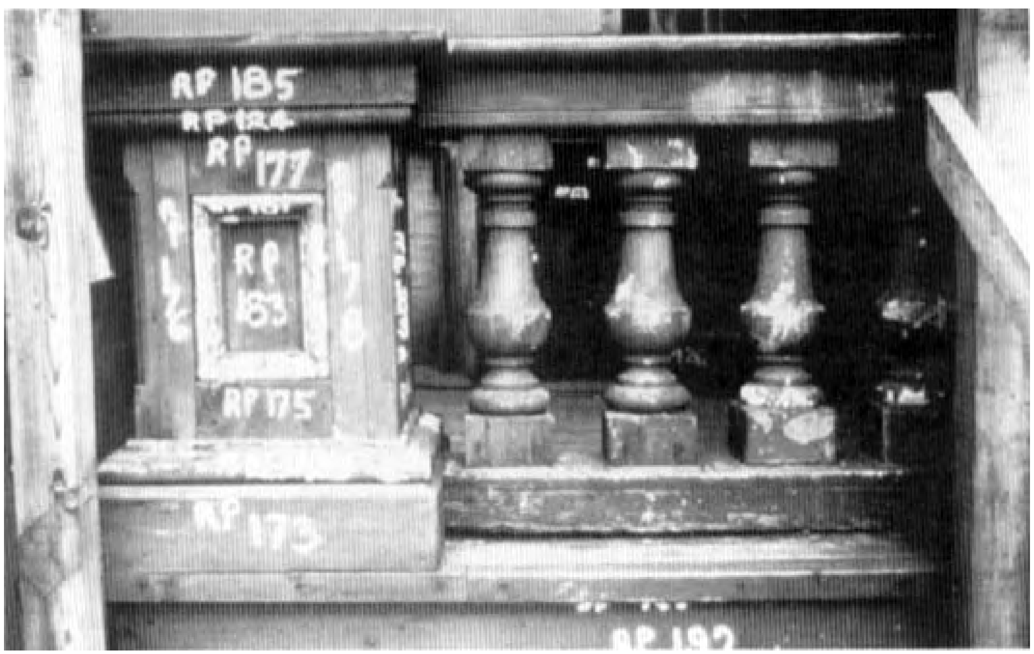
Replacing in kind an entire entrance or porch from the restoration period that is too deteriorated to repair—if the form and detailing are still evident—using the physical evidence as a model to reproduce the feature. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Replacing an entire entrance or porch feature from the restoration period when the repair of materials and limited replacement of parts are appropriate.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the entrance and porch or that is physically or chemically incompatible.

Removing an entrance or porch feature from the restoration period that is unrepairable and not replacing it; or failing to document the new work.



Portions of the small porch on an Italianate mansion were carefully numbered prior to Restoration. Some original elements were restored in place, while others had to be removed for repair, then reinstalled. Any element too deteriorated to save was replaced with a new one replicated to match the original design. Photo: Morgan W. Phillips.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic entrance and porch features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing entrance and porch features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering entrances and porches and their features from other historic periods such as a later porch railing or balustrade.	Failing to remove an entrance or porch feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document entrance or porch features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing entrance or porch or its features that existed during the restoration period based on physical or documentary evidence; for example, duplicating a fanlight or porch column.	Constructing an entrance or porch feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Exterior

Storefronts

Recommended	*Not Recommended*
Identifying, retaining, and preserving storefronts from the restoration period—and their functional and decorative features—such as display windows, signs, doors, transoms, kick plates, corner posts, and entablatures.	Altering storefronts—and their features—from the restoration period. Failing to properly document storefront features from the restoration period which may result in their loss. Applying paint or other coatings to storefront features or removing them if such treatments cannot be documented to the restoration period. Changing the type or color of protective surface coatings on storefront features unless the work can be substantiated by historical documentation.
Protecting and maintaining masonry, wood, and architectural metals which comprise restoration period storefronts through appropriate treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of storefront features results.
Protecting storefronts against arson and vandalism before restoration work begins by boarding up windows and installing alarm systems that are keyed into local protection agencies.	Permitting entry into the building through unsecured or broken windows and doors so that interior features and finishes are damaged by exposure to weather or vandalism. Stripping storefronts of historic material from the restoration period such as wood, cast iron, terra cotta, carrara glass, and brick.
Evaluating the existing condition of storefront materials to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of storefront materials from the restoration period.

Recommended	*Not Recommended*
Repairing storefronts from the restoration period by reinforcing the historic materials. Repairs will also generally include the limited replacement in kind—or with compatible substitute materials—of those extensively deteriorated or missing parts of storefronts where there are surviving prototypes such as transoms, kick plates, pilasters, or signs. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire storefront feature from the restoration period when repair of materials and limited replacement of its parts are appropriate. Using substitute material for the replacement part that does not convey the same visual appearance as the surviving parts of the storefront or that is physically or chemically incompatible.
Replacing in kind a storefront from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model. If using the same material is not technically or economically feasible, then compatible substitute materials may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a storefront feature from the restoration period that is unrepairable, and not replacing it; or failing to document the new work.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic storefront features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing storefront features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering storefronts and their features from other historic periods such as inappropriate cladding or signage.	Failing to remove a storefront feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document storefront features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing storefront or storefront feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a display window or transom.	Constructing a storefront feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Interior

Structural Systems

Recommended	*Not Recommended*
Identifying, retaining, and preserving structural systems from the restoration period—and individual features of systems—such as post and beam systems, trusses, summer beams, vigas, cast iron columns, above-grade stone foundation walls, or loadbearing brick or stone walls.	Altering visible features of structural systems from the restoration period. Failing to properly document structural systems from the restoration period which may result in their loss. Overloading the existing structural system; or installing equipment or mechanical systems which could damage the structure. Replacing a loadbearing masonry wall that could be augmented and retained. Leaving known structural problems untreated such as deflection of beams, cracking and bowing of walls, or racking of structural members.
Protecting and maintaining the structural system by cleaning the roof gutters and downspouts; replacing roof flashing; keeping masonry, wood, and architectural metals in a sound condition; and ensuring that structural members are free from insect infestation.	Failing to provide proper building maintenance so that deterioration of the structural system results. Causes of deterioration include subsurface ground movement, vegetation growing too close to foundation walls, improper grading, fungal rot, and poor interior ventilation that results in condensation.
Examining and evaluating the physical condition of the structural system and its individual features using non-destructive techniques such as X-ray photography.	Utilizing destructive probing techniques that will damage or destroy structural material.
Repairing the structural system by augmenting or upgrading individual parts or features in a manner that is consistent with the restoration period. For example, weakened structural members such as floor framing can be paired with a new member, braced, or otherwise supplemented and reinforced. The new work should be unobtrusively dated to guide future research and treatment.	Upgrading the building structurally in a manner that diminishes the historic character of the exterior, such as installing strapping channels or removing a decorative cornice; or that damages interior features or spaces. Replacing a structural member or other feature of the structural system when it could be augmented and retained.

Recommended	Not Recommended
Replacing in kind—or with substitute material—those portions or features of the structural system that are either extensively deteriorated or are missing when there are surviving prototypes such as cast iron columns, roof rafters or trusses, or sections of loadbearing walls. Substitute material should convey the same form, design, and overall visual appearance as the historic feature; and, at a minimum, be equal to its loadbearing capabilities. The new work should be unobtrusively dated to guide future research and treatment.	Installing a visible replacement feature that does not convey the same visual appearance, e.g., replacing an exposed wood summer beam with a steel beam; or failing to document the new work. Using substitute material that does not equal the loadbearing capabilities of the historic material and design or is otherwise physically or chemically incompatible.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic structural systems and features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing structural system features from the restoration period using all new materials.*

Recommended	Not Recommended
Removing Existing Features from Other Historic Periods	
Removing or altering visually intrusive structural features from other historic periods such as a non-matching column or exposed ceiling beams.	Failing to remove or alter a visually intrusive structural feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document structural features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing structural feature that existed during the restoration period based on physical or documentary evidence; for example, duplicating a viga or cast iron column.	Constructing a structural feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Interior

Spaces, Features, and Finishes

Recommended	*Not Recommended*
Interior Spaces	
Identifying, retaining, and preserving a floor plan or interior spaces from the restoration period. This includes the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves, such as lobbies, reception halls, entrance halls, double parlors, theaters, auditoriums, and important industrial or commercial spaces.	Altering a floor plan or interior spaces—including individual rooms—from the restoration period.
Interior Features and Finishes	
Identifying, retaining, and preserving interior features and finishes from the restoration period. These include columns, cornices, baseboards, fireplaces and mantels, panelling, light fixtures, hardware, and flooring; and wallpaper, plaster, paint, and finishes such as stencilling, marbling, and graining; and other decorative materials that accent interior features and provide color, texture, and patterning to walls, floors, and ceilings.	Altering features or finishes from the restoration period. Failing to properly document spaces, features, and finishes from the restoration period which may result in their loss. Applying paint, plaster, or other finishes to surfaces unless the work can be substantiated historical documentation. Stripping paint to bare wood rather than repairing or reapplying grained or marbled finishes from the restoration period to features such as doors and panelling. Changing the type of finish or its color, such as painting a previously varnished wood feature, unless the work can be substantiated by historical documentation.
Protecting and maintaining masonry, wood, and architectural metals that comprise restoration period interior features through appropriate surface treatments such as cleaning, rust removal, limited paint removal, and reapplication of protective coating systems.	Failing to provide adequate protection to materials on a cyclical basis so that deterioration of interior features results.

Recommended	*Not Recommended*
Protecting interior spaces, features and finishes against arson and vandalism before project work begins, erecting protective fencing, boarding-up windows, and installing fire alarm systems that are keyed to local protection agencies.	Permitting entry into historic buildings through unsecured or broken windows and doors so that the interior features and finishes are damaged by exposure to weather or vandalism. Stripping interiors of restoration period features such as woodwork, doors, windows, light fixtures, copper piping, radiators; or of decorative materials.
Protecting interior features such as a staircase, mantel, or decorative finishes and wall coverings against damage during project work by covering them with heavy canvas or plastic sheets.	Failing to provide proper protection of interior features and finishes during work so that they are gouged, scratched, dented, or otherwise damaged.
Installing protective coverings in areas of heavy pedestrian traffic to protect historic features such as wall coverings, parquet flooring and panelling.	Failing to take new use patterns into consideration so that interior features and finishes are damaged.
Removing damaged or deteriorated paints and finishes to the next sound layer using the gentlest method possible, then repainting or refinishing using compatible paint or other coating systems based on historical documentation.	Using destructive methods such as propane or butane torches or sandblasting to remove paint or other coatings. These methods can irreversibly damage the historic materials that comprise interior features.
Repainting with colors that are documented to the building's restoration period.	Using new paint colors that are inappropriate to the building's restoration period.
Limiting abrasive cleaning methods to certain industrial warehouse buildings where the interior masonry or plaster features do not have distinguishing design, detailing, tooling, or finishes; and where wood features are not finished, molded, beaded, or worked by hand. Abrasive cleaning should only be considered after other, gentler methods have been proven ineffective.	Changing the texture and patina of features from the restoration period through sandblasting or use of abrasive methods to remove paint, discoloration or plaster. This includes both exposed wood (including structural members) and masonry.
Evaluating the existing condition of materials to determine whether more than protection and maintenance are required, that is, if repairs to interior features and finishes will be necessary.	Failing to undertake adequate measures to assure the protection of interior features and finishes.

Recommended

Repairing interior features and finishes from the restoration period by reinforcing the historic materials. Repair will also generally include the limited replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of repeated features when there are surviving prototypes such as stairs, balustrades, wood panelling, columns; or decorative wall coverings or ornamental tin or plaster ceilings. The new work should be unobtrusively dated to guide future research and treatment.

Replacing in kind an entire interior feature or finish from the restoration period that is too deteriorated to repair—if the overall form and detailing are still evident—using the physical evidence as a model for reproduction. Examples could include wainscoting, a tin ceiling, or interior stairs. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.

Not Recommended

Replacing an interior feature from the restoration period such as a staircase, panelled wall, parquet floor, or cornice; or finish such as a decorative wall covering or ceiling when repair of materials and limited replacement of such parts are appropriate.

Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts or portions of the interior feature or finish or that is physically or chemically incompatible.

Removing a feature or finish from the restoration period that is unrepairable and not replacing it; or failing to document the new work.

A complete paint investigation often needs to be conducted during Restoration. Paint samples are carefully collected onsite. In the laboratory, an ultra violet light is used to identify pigment and binding media. Paint samples are then photographed. Physical evidence documented through laboratory research provides a sound basis for an accurate restoration of painted finishes, such as the complex stencilling pictured here. Photo left: Courtesy, Alexis Elza; Photo right: Courtesy, Andrea Gilmore.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic interior spaces, features, and finishes that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing interior spaces, features, and finishes from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering interior spaces, features and finishes from other historic periods such as a later suspended ceiling or wood panelling.	Failing to remove or alter an interior space, feature, or finish from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document interior spaces, features, and finishes from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating an interior space, or a missing feature or finish from the restoration period based on physical or documentary evidence; for example, duplicating a marbleized mantel or a staircase.	Constructing an interior space, feature, or finish that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

The missing plaster cornice was restored as part of an overall project to return a residence to its original appearance. The traditional method of producing a cornice is unchanged today. Photo: Old-House Journal.

Building Interior

Mechanical Systems: Heating, Air Conditioning, Electrical, and Plumbing

Recommended	*Not Recommended*
Identifying, retaining, and preserving visible features of mechanical systems from the restoration period such as radiators, vents, fans, grilles, plumbing fixtures, switchplates, and lights.	Altering visible decorative features of mechanical systems from the restoration period. Failing to properly document mechanical systems and their visible decorative features from the restoration period which may result in their loss.
Protecting and maintaining mechanical, plumbing, and electrical systems and their features from the restoration period through cyclical cleaning and other appropriate measures.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of mechanical systems and their visible features results.
Preventing accelerated deterioration of mechanical systems by providing adequate ventilation of attics, crawlspaces, and cellars so that moisture problems are avoided.	Enclosing mechanical systems in areas that are not adequately ventilated so that deterioration of the systems results.
Improving the energy efficiency of existing mechanical systems to help reduce the need for elaborate new equipment.	Installing unnecessary air conditioning or climate control systems which can add excessive moisture to the building. This additional moisture can either condense inside, damaging interior surfaces, or pass through interior walls to the exterior, potentially damaging adjacent materials as it migrates.
Repairing mechanical systems from the restoration period by augmenting or upgrading system parts, such as installing new pipes and ducts; rewiring; or adding new compressors or boilers.	Replacing a mechanical system from the restoration period or its functional parts when it could be upgraded and retained.
Replacing in kind—or with compatible substitute material—those visible features of restoration period mechanical systems that are either extensively deteriorated or are prototypes such as ceiling fans, switchplates, radiators, grilles, or plumbing fixtures.	Installing a visible replacement feature that does not convey the same visual appearance.
Installing a new mechanical system, if required, in a way that results in the least alteration possible to the building.	Installing a new mechanical system so that structural or interior features from the restoration period are altered.

Recommended	*Not Recommended*
Providing adequate structural support for new mechanical equipment.	Failing to consider the weight and design of new mechanical equipment so that, as a result, historic structural members or finished surfaces are weakened or cracked.
Installing the vertical runs of ducts, pipes, and cables in closets, service rooms, and wall cavities.	Installing vertical runs of ducts, pipes, and cables in places where they will obscure features from the restoration period.
Installing air conditioning units in such a manner that features are not damaged or obscured and excessive moisture is not generated that will accelerate deterioration of historic materials.	Concealing mechanical equipment in walls or ceilings in a manner that requires the removal of building material from the restoration period.
	Cutting through features such as masonry walls in order to install air conditioning units.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic mechanical systems and features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing mechanical systems and features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering mechanical systems and features from other historic periods such as a later elevator or plumbing fixture.	Failing to remove a mechanical system or feature from another period, thus confusing the depiction of the building's significance.
Documenting materials and features dating from other periods prior to their alteration or removal. If possible, selected examples of these features or materials should be stored to facilitate future research.	Failing to document mechanical systems and features from other historic periods that are removed from the building so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing feature of the mechanical system that existed during the restoration period based on physical or documentary evidence; for example, duplicating a heating vent or gaslight fixture.	Constructing a mechanical system or feature that was part of the original design for the building but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Building Site

Recommended

Identifying, retaining, and preserving restoration period buildings and their features as well as features of the site. Site features may include circulation systems such as walks, paths, roads, or parking; vegetation such as trees, shrubs, fields, or herbaceous plant material; landforms such as terracing, berms or grading; furnishings such as lights, fences, or benches; decorative elements such as sculpture, statuary or monuments; water features including fountains, streams, pools, or lakes; and subsurface archeological features which are important in defining the restoration period.

Not Recommended

Altering buildings and their features or site features from the restoration period.

Failing to properly document building and site features from the restoration period which may result in their loss.

This ca. 1900 photograph (left) would be invaluable to guide restoration of the deteriorated house (right) to its documented earlier appearance, complete with decorative trim, shutters, polychromed exterior, and fencing. Photos: Courtesy, North Carolina Department of Archives and History.

Recommended	*Not Recommended*
Re-establishing the relationship between buildings and the landscape that existed during the restoration period.	Retaining non-restoration period buildings or landscape features.
Protecting and maintaining buildings and the site by providing proper drainage to assure that water does not erode foundation walls; drain toward the building; or damage or erode the landscape.	Failing to maintain adequate site drainage so that buildings and site features are damaged or destroyed; or alternatively, changing the site grading so that water no longer drains properly.
Minimizing disturbance of terrain around buildings or elsewhere on the site, thus reducing the possibility of destroying or damaging important landscape features or archeological resources.	Introducing heavy machinery into areas where it may disturb or damage important landscape features or archeological resources.
Surveying and documenting areas where the terrain will be altered during restoration work to determine the potential impact to landscape features or archeological resources.	Failing to survey the building site prior to beginning restoration work which results in damage to, or destruction of, landscape features or archeological resources.
Protecting, e.g., preserving in place, important archeological resources.	Leaving known archeological material unprotected so that it is damaged during restoration work.
Planning and carrying out any necessary investigation using professional archeologists and modern archeological methods when preservation in place is not feasible.	Permitting unqualified personnel to perform data recovery on archeological resources so that improper methodology results in the loss of important archeological material.
Preserving important landscape features from the restoration period, including ongoing maintenance of historic plant material.	Allowing restoration period landscape features to be lost or damaged due to a lack of maintenance.
Protecting building and landscape features against arson and vandalism before restoration work begins, i.e., erecting protective fencing and installing alarm systems that are keyed into local protection agencies.	Permitting the property to remain unprotected so that the building and landscape features or archeological resources are damaged or destroyed.
	Removing restoration period features from the building or site such as wood siding, iron fencing, masonry balustrades, or plant material.

Recommended	*Not Recommended*
Providing continued protection of building materials and plant features from the restoration period through appropriate cleaning, rust removal, limited paint removal, and re-application of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis so that deterioration of building and site features results.
Evaluating the existing condition of materials and features to determine whether more than protection and maintenance are required, that is, if repairs to building and site features will be necessary.	Failing to undertake adequate measures to assure the protection of building and site features.
Repairing restoration period features of the building and site by reinforcing historic materials. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire restoration period feature of the building or site such as a fence, walkway, or driveway when repair of materials and limited compatible replacement of deteriorated or missing parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the building or site feature or that is physically or chemically incompatible.
Replacing in kind an entire restoration period feature of the building or site that is too deteriorated to repair if the overall form and detailing are still evident. Physical evidence from the deteriorated feature should be used as a model to guide the new work. This could include an entrance or porch, walkway, or fountain. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a restoration period feature of the building or site that is unrepairable and not replacing it; or failing to document the new work.
Replacing deteriorated or damaged landscape features of the restoration period in kind or with compatible substitute material. The replacement feature should be based on physical evidence and convey the same appearance.	Adding conjectural landscape features to the site such as period reproduction lamps, fences, fountains, or vegetation that are historically inappropriate, thus creating an inaccurate depiction of the restoration period.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing historic building site features that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing building site features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering features of the building or site from other historic periods such as a later outbuilding, paved road, or overgrown tree.	Failing to remove a feature of the building or site from another period, thus creating an inaccurate historic appearance.
Documenting features of the building or site from other periods prior to their alteration or removal.	Failing to document features of the building or site from other historic periods that are removed during restoration so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing feature of the building or site that existed during the restoration period based on physical or documentary evidence; for example, duplicating a terrace, gazebo, or fencing.	Constructing a feature of the building or site that was part of the original design, but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

Setting (District/Neighborhood)

Recommended	*Not Recommended*
Identifying retaining, and preserving restoration period building and landscape features of the setting. Such features can include roads and streets, furnishings such as lights or benches, vegetation, gardens and yards, adjacent open space such as fields, parks, commons or woodlands, and important views or visual relationships.	Altering features of the setting that can be documented to the restoration period. Failing to properly document restoration period building and landscape features, which may result in their loss.
Re-establishing the relationship between buildings and landscape features of the setting that existed during the restoration period.	Retaining non-restoration period buildings or landscape features.
Protecting and maintaining building materials and plant features from the restoration period through appropriate cleaning, rust removal, limited paint removal, and reapplication of protective coating systems; and pruning and vegetation management.	Failing to provide adequate protection of materials on a cyclical basis which results in the deterioration of building and landscape features.
Protecting buildings and landscape features against arson and vandalism before restoration work begins by erecting protective fencing and installing alarm systems that are keyed into local protection agencies.	Permitting the building and setting to remain unprotected so that interior or exterior features are damaged. Stripping or removing features from buildings or the setting such as wood siding, iron fencing, terra cotta balusters, or plant material.
Evaluating the existing condition of the building and landscape features to determine whether more than protection and maintenance are required, that is, if repairs to features will be necessary.	Failing to undertake adequate measures to assure the protection of building and landscape features.
Repairing restoration period features of the building and landscape by reinforcing the historic materials. Repair will generally include the replacement in kind—or with compatible substitute material—of those extensively deteriorated or missing parts of features where there are surviving prototypes such as porch balustrades or paving materials. The new work should be unobtrusively dated to guide future research and treatment.	Replacing an entire restoration period feature of the building or landscape setting when repair of materials and limited replacement of deteriorated or missing parts are appropriate. Using a substitute material for the replacement part that does not convey the visual appearance of the surviving parts of the building or landscape, or that is physically, chemically, or ecologically incompatible.

Recommended	*Not Recommended*
Replacing in kind an entire restoration period feature of the building or landscape that is too deteriorated to repair—when the overall form and detailing are still evident—using the physical evidence as a model to guide the new work. If using the same kind of material is not technically or economically feasible, then a compatible substitute material may be considered. The new work should be unobtrusively dated to guide future research and treatment.	Removing a restoration period feature of the building or landscape that is unrepairable and not replacing it; or failing to document the new work.

The following **Restoration** *work is highlighted to indicate that it involves the removal or alteration of existing features of the historic setting that would be retained in Preservation and Rehabilitation treatments; and the replacement of missing features from the restoration period using all new materials.*

Recommended	*Not Recommended*
Removing Existing Features from Other Historic Periods	
Removing or altering features of the building or landscape from other historic periods, such as a later road, sidewalk, or fence.	Failing to remove a feature of the building or landscape from another period, thus creating an inaccurate historic appearance.
Documenting features of the building or landscape dating from other periods prior to their alteration or removal.	Failing to document features of the building or landscape from other historic periods that are removed from the setting so that a valuable portion of the historic record is lost.
Re-creating Missing Features from the Restoration Period	
Re-creating a missing feature of the building or landscape in the setting that existed during the restoration period based on physical or documentary evidence; for example, duplicating a path or park bench.	Constructing a feature of the building or landscape that was part of the original design for the setting but was never actually built; or constructing a feature which was thought to have existed during the restoration period, but for which there is insufficient documentation.

The Bronson-Mulholland House in Palatka, Florida, ca. 1845, is shown (a) before and (b) after the treatment, Restoration. Over the years the east (far right) side of the veranda had been filled in as a sixth bay. During the restoration, this later infill was removed and the east veranda, together with its flooring, stairs, and foundation, restored. Photo: City of Palatka, Community Development Department.

Although the work in the following sections is quite often an important aspect of restoration projects, it is usually not part of the overall process of preserving features from the restoration period (protection, stabilization, conservation, repair, and replacement); rather, such work is assessed for its potential negative impact on the building's historic appearance. For this reason, particular care must be taken not to obscure, alter, or damage features from the restoration period in the process of undertaking work to meet code and ener-

Energy Efficiency

Recommended	*Not Recommended*
Masonry/Wood/Architectural Metals	
Installing thermal insulation in attics and in unheated cellars and crawlspaces to increase the efficiency of the existing mechanical systems.	Applying thermal insulation with a high moisture content in wall cavities which may damage historic fabric.
Installing insulating material on the inside of masonry walls to increase energy efficiency where there is no interior molding around the windows or other interior architectural detailing from the restoration period.	Installing wall insulation without considering its effect on interior or other architectural detailing.
Windows	
Utilizing the inherent energy conserving features of a building by maintaining windows and louvered blinds from the restoration period in good operable condition for natural ventilation.	Using shading devices that are inappropriate to the restoration period.
Improving thermal efficiency with weatherstripping, storm windows, caulking, interior shades, and if historically appropriate, blinds and awnings.	Replacing multi-paned sash from the restoration period with new thermal sash utilizing false muntins.
Installing interior storm windows with air-tight gaskets, ventilating holes, and/or removable clips to ensure proper maintenance and to avoid condensation damage to historic windows.	Installing interior storm windows that allow moisture to accumulate and damage the window.
Installing exterior storm windows which do not damage or obscure the windows and frames.	Installing new exterior storm windows which are inappropriate in size or color.
	Replacing windows or transoms from the restoration period with fixed thermal glazing or permitting windows and transoms to remain inoperable rather than utilizing them for their energy conserving potential.

Recommended	*Not Recommended*
Entrances and Porches	
Maintaining porches and double vestibule entrances from the restoration period so that they can retain heat or block the sun and provide natural ventilation.	Changing porches significant to the restoration period by enclosing them.
Interior Features	
Retaining interior shutters and transoms from the restoration period for their inherent energy conserving features.	Removing interior features from the restoration period that play a secondary energy conserving role.
Mechanical Systems	
Improving energy efficiency of existing mechanical systems by installing insulation in attics and basements.	Replacing existing mechanical systems that could be repaired for continued use.
Building Site	
Retaining plant materials, trees, and landscape features which perform passive solar energy functions, such as sun shading and wind breaks, if appropriate to the restoration period.	Removing plant materials, trees, and landscape features from the restoration period that perform passive solar energy functions.
Setting (District/Neighborhood)	
Maintaining those existing landscape features which moderate the effects of the climate on the setting such as deciduous trees, evergreen wind-blocks, and lakes or ponds, if appropriate to the restoration period.	Stripping the setting of landscape features and landforms from the restoration period so that effects of the wind, rain, and sun result in accelerated deterioration of the historic building.

Accessibility Considerations

Recommended

Identifying spaces, features, and finishes from the restoration period so that accessibility code-required work will not result in their damage or loss.

Complying with barrier-free access requirements in such a manner that spaces, features, and finishes from the restoration period are preserved.

Working with local disability groups, access specialists, and historic preservation specialists to determine the most appropriate solution to access problems.

Providing barrier-free access that promotes independence for to the highest degree practicable, while preserving significant historic features.

Finding solutions to meet accessibility requirements that minimize the impact on the historic building and its site, such as compatible ramps, paths, and lifts.

Not Recommended

Undertaking code-required alterations before identifying those spaces, features, or finishes from the restoration period which must be preserved.

Altering, damaging, or destroying features from the restoration period in attempting to comply with accessibility requirements.

Making changes to buildings without first seeking expert advice from access specialists and historic preservationists to determine solutions.

Making access modifications that do not provide a reasonable balance between independent, safe access and preservation of historic features.

Making modifications for accessibility without considering the impact on the historic building and its site.

Health and Safety Considerations

Recommended	*Not Recommended*
Identifying spaces, features, and finishes from the restoration period so that code-required work will not result in their damage or loss.	Undertaking code-required alterations to a building or site before identifying those spaces, features, or finishes from the restoration period which must be preserved.
Complying with health and safety codes, including seismic code requirements, in such a manner that spaces, features, and finishes from the restoration period are preserved.	Altering, damaging, or destroying spaces, features, and finishes while making modifications to a building or site to comply with safety codes.
Removing toxic building materials only after thorough testing has been conducted and only after less invasive abatement methods have been shown to be inadequate.	Destroying interior features and finishes from the restoration period without careful testing and without considering less invasive abatement methods.
Providing workers with appropriate personal protective equipment for hazards found at the worksite.	Removing unhealthful building materials without regard to personal and environmental safety.
Working with local code officials to investigate systems, methods, or devices of equivalent or superior effectiveness and safety to those prescribed by code so that unnecessary alterations can be avoided.	Making changes to historic buildings without first exploring equivalent health and safety systems, methods, or devices that may be less damaging to spaces, features, and finishes from the restoration period.
Upgrading historic stairways and elevators from the restoration period to meet health and safety codes in a manner that assures their preservation, i.e., so that they are not damaged or obscured.	Damaging or obscuring stairways and elevators or altering adjacent spaces from the restoration period in the process of doing work to meet code requirements.
Installing sensitively designed fire suppression systems, such as sprinkler systems, that result in retention of features and finishes from the restoration period.	Covering wood features from the restoration period with fire-resistant sheathing which results in altering their visual appearance.
Applying fire-retardant coatings, such as intumescent paints, which expand during fire to add thermal protection to steel.	Using fire-retardant coatings if they damage or obscure features from the restoration period.
Adding a new stairway or elevator to meet health and safety codes in a manner that preserves adjacent features and spaces from the restoration period.	Altering the appearance of spaces, features, or finishes from the restoration period when adding a new code-required stairway or elevator.

Standards for Reconstruction & Guidelines for Reconstructing Historic Buildings

Reconstruction *is defined as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.*

Standards for Reconstruction

1. Reconstruction will be used to depict vanished or non-surviving portions of a property when documentary and physical evidence is available to permit accurate reconstruction with minimal conjecture, and such reconstruction is essential to the public understanding of the property.

2. Reconstruction of a landscape, building, structure, or object in its historic location will be preceded by a thorough archeological investigation to identify and evaluate those features and artifacts which are essential to an accurate reconstruction. If such resources must be disturbed, mitigation measures will be undertaken.

3. Reconstruction will include measures to preserve any remaining historic materials, features, and spatial relationships.

4. Reconstruction will be based on the accurate duplication of historic features and elements substantiated by documentary or physical evidence rather than on conjectural designs or the availability of different features from other historic properties. A reconstructed property will re-create the appearance of the non-surviving historic property in materials, design, color, and texture.

5. A reconstruction will be clearly identified as a contemporary re-creation.

6. Designs that were never executed historically will not be constructed.

Guidelines for Reconstructing Historic Buildings

Introduction

Whereas the treatment Restoration provides guidance on restoring—or re-creating—building features, the **Standards for Reconstruction and Guidelines for Reconstructing Historic Buildings** address those aspects of treatment necessary to re-create an entire non-surviving building with new material. Much like restoration, the goal is to make the building appear as it did at a particular—and most significant—time in its history. The difference is, in **Reconstruction**, there is far less extant historic material prior to treatment and, in some cases, nothing visible. Because of the potential for historical error in the absence of sound physical evidence, this treatment can be justified only rarely and, thus, is the least frequently undertaken. Documentation requirements prior to and following work are very stringent. Measures should be taken to preserve extant historic surface and subsurface material. Finally, the reconstructed building must be clearly identified as a contemporary re-creation.

In the 1930s reconstruction of the 18th century Governor's Palace at Colonial Williamsburg, Virginia, the archeological remains of the brick foundation were carefully preserved in situ, and serve as a base for the reconstructed walls. Photo: The Colonial Williamsburg Foundation.

Research and Document Historical Significance

Guidance for the treatment **Reconstruction** begins with ***researching and documenting*** the building's historical significance to ascertain that its re-creation is essential to the public understanding of the property. Often, another extant historic building on the site or in a setting can adequately explain the property, together with other interpretive aids. Justifying a reconstruction requires detailed physical and documentary evidence to minimize or eliminate conjecture and ensure that the reconstruction is as accurate as possible. Only one period of significance is generally identified; a building, as it evolved, is rarely re-created. During this important fact-finding stage, if research does not provide adequate documentation for an accurate reconstruction, other interpretive methods should be considered, such as an explanatory marker.

Investigate Archeological Resources

Investigating archeological resources is the next area of guidance in the treatment **Reconstruction**. The goal of physical research is to identify features of the building and site which are essential to an accurate re-creation and must be reconstructed, while leaving those archeological resources that are not essential, undisturbed. Information that is not relevant to the project should be preserved in place for future research. The archeological findings, together with archival documentation, are then used to replicate the plan of the building, together with the relationship and size of rooms, corridors, and other spaces, and spatial relationships.

Identify, Protect and Preserve Extant Historic Features

Closely aligned with archeological research, recommendations are given for ***identifying, protecting, and preserving*** extant features of the historic building. It is never appropriate to base a **Reconstruction** upon conjectural designs or the availability of different features from other buildings. Thus, any remaining historic materials and features, such as remnants of a foundation or chimney and site features such as a walkway or path, should be retained, when practicable, and incorporated into the reconstruction. The historic as well as new material should be carefully documented to guide future research and treatment.

Reconstruct Non-Surviving Building and Site

After the research and documentation phases, guidance is given for **Reconstruction** work itself. Exterior and interior features are addressed in general, always emphasizing the need for an accurate *depiction*, i.e., careful duplication of the appearance of historic interior paints, and finishes such as stencilling, marbling, and graining. In the absence of extant historic materials, the objective in reconstruction is to re-create the appearance of the historic building for interpretive purposes. Thus, while the use of traditional materials and finishes is always preferred, in some instances, substitute materials may be used if they are able to convey the same visual appearance.

Where non-visible features of the building are concerned—such as interior structural systems or mechanical systems—it is expected that contemporary materials and technology will be employed.

Re-creating the building site should be an integral aspect of project work. The initial archeological inventory of subsurface and aboveground remains is used as documentation to reconstruct landscape features such as walks and roads, fences, benches, and fountains.

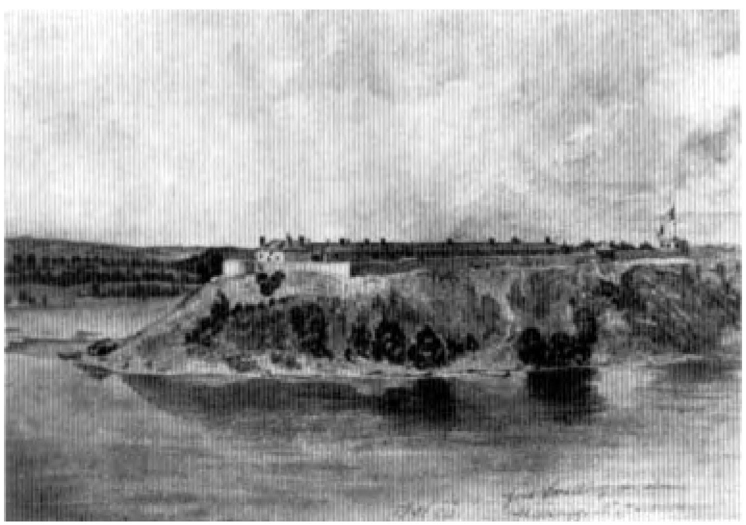
Energy Efficiency/Accessibility/Health and Safety Code Considerations

Code requirements must also be met in Reconstruction projects. For code purposes, a reconstructed building may be considered as essentially new construction. Guidance for these sections is thus abbreviated, and focuses on achieving design solutions that do not destroy extant historic features and materials or obscure reconstructed features.

Reconstruction as a Treatment. *When a contemporary depiction is required to understand and interpret a property's historic value (including the re-creation of missing components in a historic district or site); when no other property with the same associative value has survived; and when sufficient historical documentation exists to ensure an accurate reproduction, Reconstruction may be considered as a treatment. Prior to undertaking work, a documentation plan for Reconstruction should be developed.*

Reconstruction should generally be based on an extensive archeological investigation, as was done here to re-create a non-surviving commissary building at Fort Snelling.

Recommended	*Not Recommended*
Researching and documenting the property's historical significance, focusing on the availability of documentary and physical evidence needed to justify reconstruction of the non-surviving building.	Undertaking a reconstruction based on insufficient research, so that, as a result, an historically inaccurate building is created.
	Reconstructing a building unnecessarily when an existing building adequately reflects or explains the history of the property, the historical event, or has the same associative value.
	Executing a design for the building that was never constructed historically.
Investigating archeological resources to identify and evaluate those features and artifacts which are essential to the design and plan of the building.	Failing to identify and evaluate archeological information prior to reconstruction, or destroying extant historical information not relevant to the reconstruction but which should be preserved in place.



Jean Baptiste Wengler's watercolor rendering of Fort Snelling, Minnesota, in 1857, is aesthetically pleasing, but the overall view does not constitute adequate documentary evidence for a Reconstruction. Oral histories are also unreliable sources of documentation for treatment.

Recommended

Minimizing disturbance of terrain to reduce the possibility of destroying archeological resources.

Identifying, retaining, and preserving extant historic features of the building and site, such as remnants of a foundation, chimney, or walkway.

Not Recommended

Introducing heavy machinery or equipment into areas where it may disturb archeological resources.

Beginning reconstruction work without first conducting a detailed site investigation to physically substantiate the documentary evidence.

Basing a reconstruction on conjectural designs or the availability of different features from other historic buildings.

(a) and (b). Two photos illustrate the use of contemporary construction materials and techniques within the treatment, Reconstruction. Because Reconstruction is employed to portray a significant earlier time, usually for interpretive purposes, substitute materials may be appropriate if they are able to convey the historic appearance.

Recommended	*Not Recommended*
Building Exterior	
Reconstructing a non-surviving building to depict the documented historic appearance. Although traditional building materials such as masonry, wood, and architectural metals are preferable, substitute materials may be used as long as they re-create the historical appearance.	Reconstructing features that cannot be documented historically or for which inadequate documentation exists. Using substitute materials that do not convey the appearance of the historic building.
Re-creating the documented design of exterior features such as the roof shape and coverings; architectural detailing; windows; entrances and porches; steps and doors; and their historic spatial relationships and proportions.	Omitting a documented exterior feature; or re-building a feature, but altering its historic design. Using inappropriate designs or materials that do not convey the historic appearance, such as aluminum storm and screen window combinations.
Reproducing the appearance of historic paint colors and finishes based on physical and documentary evidence.	Using paint colors that cannot be documented through research and investigation to be appropriate to the building or using other undocumented finishes.
Using signs to identify the building as a contemporary re-creation.	Failing to explain that the building is a reconstruction, thus confusing the public understanding.
Building Interior	
Re-creating the appearance of *visible* features of the historical structural system, such as post and beam systems, trusses, summer beams, vigas, cast iron columns, above-grade stone foundations, or loadbearing brick or stone walls. Substitute materials may be used for unexposed structural features if they were not important to the historic significance of the building.	Changing the documented appearance of visible features of the structural system.
Re-creating a historic floor plan or interior spaces, including the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves.	Altering the documented historic floor plan or relocating an important interior feature such as a staircase so that the historic relationship between the feature and space is inaccurately depicted.

Recommended	*Not Recommended*
Duplicating the documented historic appearance of the building's interior features and finishes, including columns, cornices, baseboards, fireplaces and mantels, panelling, light fixtures, hardware, and flooring; and wallpaper, plaster, paint and finishes such as stencilling, marbling and graining; and other decorative materials that accented interior features and provided color, texture, and patterning to walls, floors and ceilings.	Altering the documented appearance of interior features and finishes so that, as a result, an inaccurate depiction of the historic building is created. For example, moving a feature from one area of a room to another; or changing the type or color of the finish.
Installing modern mechanical systems in the least obtrusive way possible, while meeting user need.	Altering the historic plan or the re-created appearance unnecessarily when installing modern mechanical systems.
Installing the vertical runs of ducts, pipes, and cables in closets, service rooms, and wall cavities.	Installing vertical runs in ducts, pipes, and cables in places where they will intrude upon the historic depiction of the building.
Installing exterior electrical and telephone cables underground, or in the least obtrusive way possible.	Attaching exterior electrical and telephone cables to the principal elevations of the reconstructed building, unless their existence and visibility can be documented.

The spacious grounds at Middleton Place, near Charleston, South Carolina, constitute the first landscaped garden in America. The molded terraces, originally constructed in the 18th century, were largely reconstructed in the early 20th century based on extant remains and other documentary evidence. Photo: Middleton Place.

Building Site

Recommended

Basing decisions for reconstructing building site features on the availability of documentary and physical evidence.

Inventorying the building site to determine the existence of aboveground remains and subsurface archeological materials, then using this evidence as corroborating documentation for the reconstruction of related site features. These may include walks, paths, roads, and parking; trees, shrubs, fields or herbaceous plant material; terracing, berms, or grading; lights, fences, or benches; sculpture, statuary, or monuments; fountains, streams, pools, or lakes.

Re-establishing the historic relationship between the building or buildings and historic site features, whenever possible.

Not Recommended

Reconstructing building site features without first conducting a detailed investigation to physically substantiate the documentary evidence.

Giving the building's site a false appearance by basing the reconstruction or conjectural designs or the availability of features from other nearby sites.

Changing the historic spatial relationship between the building and historic site features, or reconstructing some site features, but not others, thus creating a false appearance.

Recommended

Setting (District or Neighborhood)

Basing decisions for reconstructing features of the building's setting on the availability of documentary and physical evidence.

Inventorying the setting to determine the existence of above-ground remains and subsurface archeological materials, using this evidence as corroborating documentation for the reconstruction of missing features of the setting. Such features could include roads and streets; furnishings such as lights or benches; vegetation, gardens and yards; adjacent open space such as fields, parks, commons or woodlands; and important views or visual relationships.

Re-establishing the historic spatial relationship between buildings and landscape features of the setting.

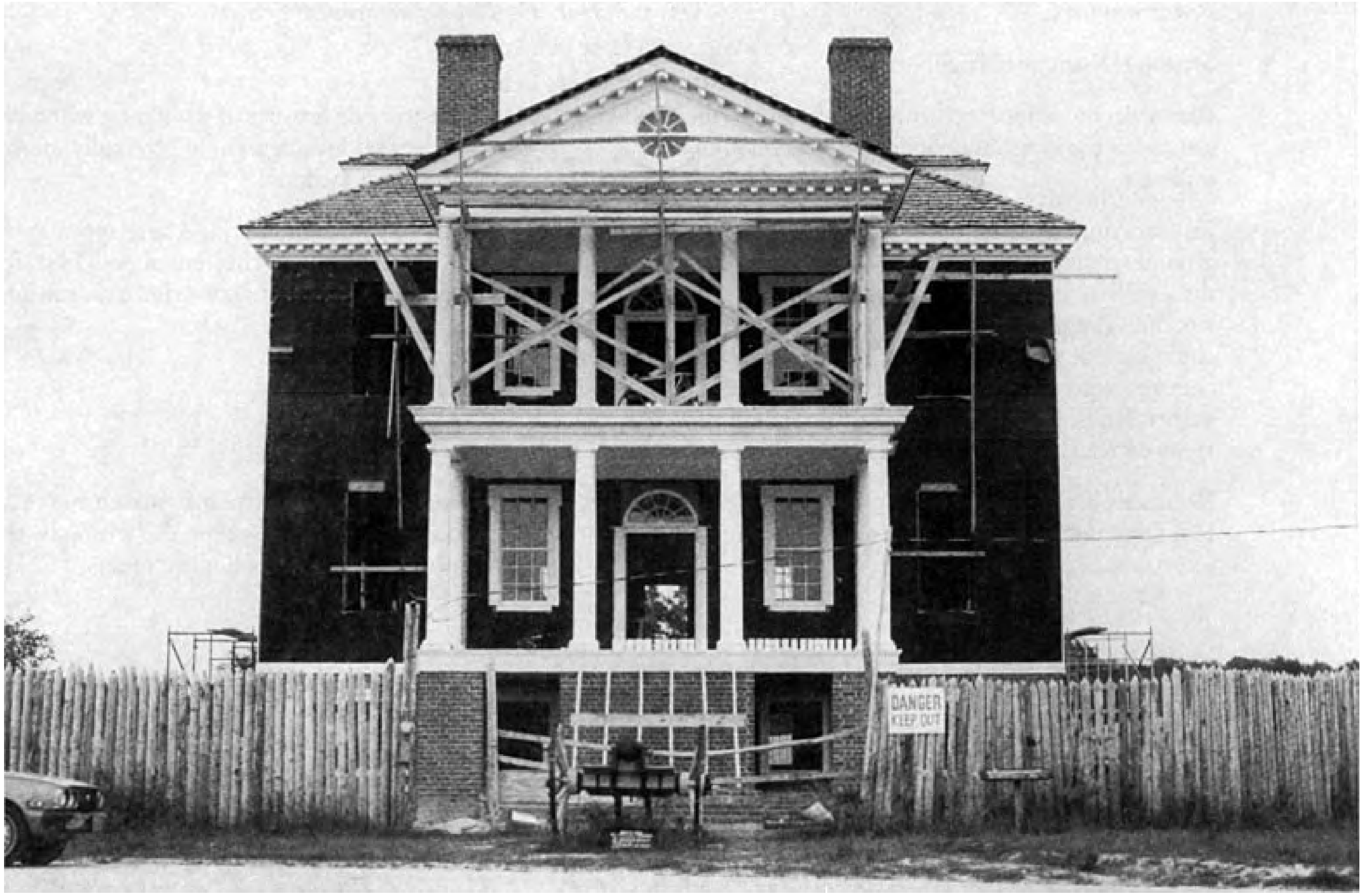
Not Recommended

Reconstructing features of the setting without first conducting a detailed investigation to physically substantiate the documentary evidence.

Giving the building's setting a false appearance by basing the reconstruction on conjectural designs or the availability of features from other nearby districts or neighborhoods.

Confusing the historic spatial relationship between buildings and landscape features within the setting by reconstructing some missing elements, but not others.

(a) and (b). Two views of the Officers' Quarters at Fort Snelling (ca. 1885 to 1900) not only provide information on the materials and form of the historic block, they document the wooden walkways and other landscape features such as stairs, railings, and tree placement. Historical and pictorial evidence would need to be combined with specific physical evidence in order to make the case for Reconstruction as a treatment.



The 1778 Kershaw House, which served as British Headquarters during the Revolutionary War, was burned by Union troops in 1865. In the early 1970s, the house was reconstructed as part of Camden Battlefield, Camden, South Carolina. Built expressly for interpretive purposes, it serves as an illustrative reminder of a past event of national significance. The Standards for Reconstruction call for any re-created building to be clearly identified as a contemporary depiction. This is most often done by means of an exterior sign or plaque, or through an explanatory brochure or exhibit. A guide may inform visitors as well. Photo: Richard Frear.

Whereas preservation, rehabilitation, and restoration treatments usually necessitate retrofitting to meet code and energy requirements, in this treatment it is assumed that the reconstructed building will be essentially ***new*** *construction. Thus, only minimal guidance is provided in the following section, although the work must still be assessed for its potential negative impact on the reconstructed*

Recommended	*Not Recommended*
Energy Efficiency	
Installing thermal insulation, where appropriate, as part of the reconstruction.	Installing thermal insulation with a high moisture content.
Utilizing the inherent energy conserving features of windows and blinds, porches and double vestibule entrances in a reconstruction project.	Using windows and shading devices that are inappropriate to the reconstruction. Installing new thermal sash with false muntins instead of using sash that is appropriate to the reconstruction.
Utilizing plant materials, trees, and landscape features, especially those which perform passive solar energy functions such as sun shading and wind breaks, when appropriate to the reconstruction.	Removing plant materials and landscape features which perform passive energy functions if they are appropriate to the reconstruction.
Accessibility Considerations	
Taking accessibility requirements into consideration early in the planning stage so that barrier-free access can be provided in a way that is compatible with the reconstruction.	Obscuring or damaging the appearance of the reconstructed building in the process of providing barrier-free access.
Health and Safety Considerations	
Considering health and safety code requirements, such as the installation of fire suppression systems, early in the planning stage of the project so that the work is compatible with the reconstruction.	Meeting health and safety requirements without considering their visual impact on the reconstruction.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION &

ILLUSTRATED GUIDELINES ON **SUSTAINABILITY** FOR REHABILITATING HISTORIC BUILDINGS

U.S. Department of the Interior
National Park Service
Technical Preservation Services

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION &

ILLUSTRATED GUIDELINES ON SUSTAINABILITY FOR REHABILITATING HISTORIC BUILDINGS

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U.S. Department of the Interior
National Park Service
Technical Preservation Services
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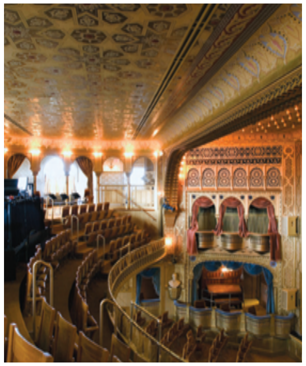
Contents

Acknowledgements

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings was produced by Anne E. Grimmer and Kay D. Weeks, first published in 1992 and reprinted in 1997. The *Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*, which are presented in the same format, replace the chapter on "Energy Conservation" in the 1992 publication. They have been developed with the guidance and support of numerous public agencies, professional organizations and individuals.

All photographs and drawings included here not individually credited have been selected from National Park Service files.



Foreword

The *Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings* replaces the chapter on "Energy Conservation" in the *Illustrated Guidelines for Rehabilitating Historic Buildings* published in 1992. (This same guidance is presented in the chapter entitled "Energy Retrofitting" in the unillustrated *Guidelines for Rehabilitating Historic Buildings.*) The illustrated version of the *Guidelines for Rehabilitating Historic Buildings* was designed to further enhance overall understanding and interpretation of basic preservation principles. *The Illustrated Guidelines on Sustainability* begin with an overview focusing on the fact that historic buildings are themselves often inherently sustainable and that this should be used to advantage in any proposal to upgrade them. These guidelines offer specific guidance on how to make historic buildings more sustainable in a manner that will preserve their historic character and that will meet *The Secretary of the Interior's Standards for Rehabilitation.* The written guidance is illustrated with examples of appropriate or "recommended" treatments and some that are "not recommended" or could negatively impact the building's historic character. The National Park Service Branch of Technical Preservation Services has developed these illustrated guidelines in accordance with its directive to provide information concerning professional methods and techniques to ensure the preservation and rehabilitation of the historic properties that are an important part of the nation's heritage.

THE SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION

1

[1] Stained glass skylight provides natural light in a historic train station.

Introduction to the Standards

The Secretary of the Interior is responsible for establishing standards for all programs under Departmental authority and for advising federal agencies on the preservation of historic properties listed in or eligible for listing in the National Register of Historic Places. In partial fulfillment of this responsibility *The Secretary of the Interior's Standards for the Treatment of Historic Properties* have been developed to guide work undertaken on historic properties; there are separate standards for preservation, rehabilitation, restoration and reconstruction. *The Standards for Rehabilitation* (codified in 36 CFR 67) comprise that section of the overall treatment standards and address the most prevalent treatment. "Rehabilitation" is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values."

Initially developed by the Secretary of the Interior to determine the appropriateness of proposed project work on registered properties supported by the Historic Preservation Fund grant-in-aid program, the Standards have been widely used over the years—particularly to determine if a rehabilitation project qualifies as a Certified Rehabilitation for Federal Historic Preservation Tax Incentives. In addition, the Standards have guided federal agencies in carrying out their responsibilities for properties in federal ownership or control; and state and local officials in reviewing both federal and non-federal rehabilitation proposals. They have also been adopted by historic district and planning commissions across the country.

The intent of the Standards is to assist in the long-term preservation of historic materials and features. The Standards pertain to historic buildings of all materials, construction types, sizes and occupancy and include the exterior and the interior of the buildings. They also encompass the building's site and environment, including landscape features, as well as attached, adjacent or related new construction. To be certified for federal tax purposes, a rehabilitation project must be determined by the Secretary of the Interior to be consistent with the historic character of the structure(s) and, where applicable, the district in which it is located.

2

3

[2-3] Clerestory windows provide natural light in a historic industrial building: Before and after rehabilitation.

4

[4] Covered walkways and horizontal sun screens are distinctive and sustainable features in some mid-century modern office buildings.

As stated in the definition, the treatment "rehabilitation" assumes that at least some repair or alteration of the historic building will be needed in order to provide for an efficient contemporary use; however, these repairs and alterations must not damage or destroy materials, features or finishes that are important in defining the building's historic character. For example, certain treatments—if improperly applied—may cause or accelerate physical deterioration of the historic building. This can include using improper repointing or exterior masonry cleaning techniques, or introducing insulation that may damage historic fabric. Any of these treatments will likely result in a project that does not meet the Standards. Similarly, exterior additions that duplicate the form, material and detailing of the historic structure to the extent that they compromise its historic character also will fail to meet the Standards.

The Secretary of the Interior's Standards for Rehabilitation

The Standards (Department of the Interior regulations 36 CFR 67) pertain to all historic properties listed in or eligible for listing in the National Register of Historic Places.

1) A property shall be used for its intended historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2) The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3) Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4) Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5) Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property shall be preserved.

6) Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

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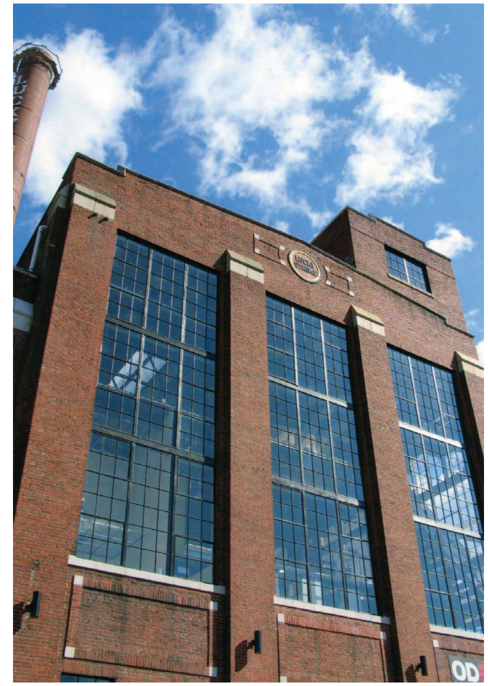

6

[5-6] Large windows and a roof monitor provide natural illumination in a historic industrial building.

7

[7-9] Porches and canvas awnings provide shade and keep interiors cool in historic residential and commercial buildings.

8

9

7) Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8) Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9) New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10) New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

11

[11] A vestibule helps retain interior conditioned air in the living space in this historic row house.

10

[10] Wood shutters provide natural light when open and keep interiors cool when closed in historic residential buildings.

12

13

14

[12-14] Roof monitors provide natural light in historic industrial buildings

GUIDELINES FOR REHABILITATING HISTORIC BUILDINGS

Introduction to the Guidelines

The *Guidelines for Rehabilitating Historic Buildings* were initially developed in 1977 to help property owners, developers and federal managers apply *The Secretary of the Interior's Standards for Rehabilitation* during the project planning stage by providing general design and technical recommendations. Unlike the Standards, the Guidelines are not codified as program requirements.

The Guidelines are general and intended to provide guidance to help in interpreting and applying the Standards to all rehabilitation projects. They are not meant to give case-specific advice. For instance, they cannot tell owners or developers which features in a historic building are important in defining the historic character and must be retained. This case-by-case determination is best accomplished by seeking assistance from qualified historic preservation professionals in the very early stages of project planning.

Like the Standards, the Guidelines pertain to historic buildings of all materials, construction types, sizes and occupancy; and apply to exterior and interior work, as well as new additions and the building's site and environment. The Guidelines are presented in a "Recommended" vs. "Not Recommended" format. Those approaches, treatments and techniques that are consistent with *The Secretary of the Interior's Standards for Rehabilitation* are listed in the "Recommended" column on the left; those approaches, treatments and techniques which could adversely affect a building's historic character are listed in the "Not Recommended" column on the right. To provide clear and consistent guidance for property owners, developers and federal agency managers, the "Recommended" courses of action are listed in order of historic preservation concerns so that a rehabilitation project may be successfully planned and completed—one that, first, assures the preservation of a building's important or "character-defining" architectural materials, features and spaces and, second, makes possible an efficient contemporary use. The guidance that follows begins with the most basic and least invasive approaches that will help the project achieve the desired goal, before considering work that may involve more change and potentially greater impact on the historic character of the building.

Sustainability

Before implementing any energy conservation measures to enhance the sustainability of a historic building, the existing energy-efficient characteristics of the building should be assessed. Buildings are more than their individual components. The design, materials, type of construction, size, shape, site orientation, surrounding landscape and climate all play a role in how buildings perform. Historic building construction methods and materials often maximized natural sources of heating, lighting and ventilation to respond to local climatic conditions. The key to a successful rehabilitation project is to identify and understand any lost original and existing energy-efficient aspects of the historic building, as well as to identify and understand its character-defining features to ensure they are preserved. The most sustainable building may be one that already exists. Thus, good preservation practice is often synonymous with sustainability. There are numerous treatments--traditional as well as new technological innovations--that may be used to upgrade a historic building to help it operate even more efficiently. Increasingly stricter energy standards and code requirements may dictate that at least some of these treatments be implemented as part of a rehabilitation project of any size or type of building. Whether a historic building is rehabilitated for a new or a continuing use, it is important to utilize the building's inherently-sustainable qualities as they were intended. It is equally important that they function effectively together with any new measures undertaken to further improve energy efficiency.

15

[15] Glass skylight illuminates historic shopping arcade.

16

17

18

[16-18] Inherently sustainable features of historic buildings: Shutters and a deep porch keep the interior cool in a historic house in a warm climate (top); a skylight provides natural light to the interior of this mid-20th century house (center); partially glazed partitions and doors allow natural light into the corridor of a historic office building (bottom).

PLANNING

RECOMMENDED	NOT RECOMMENDED
Forming an integrated sustainability team when working on a large project that includes a preservation professional to ensure that the character and integrity of the historic building is maintained during any upgrades.	Omitting preservation expertise from a sustainability project team.
Analyzing the condition of inherently-sustainable features of the historic building, such as shutters, storm windows, awnings, porches, vents, roof monitors, skylights, light wells, transoms and naturally-lit corridors, and including them in energy audits and energy modeling, before planning upgrades.	Ignoring inherently-sustainable features of the existing historic building when creating energy models and planning upgrades.
Identifying ways to reduce energy use, such as installing fixtures and appliances that conserve resources, including energy-efficient lighting or energy-efficient lamps in existing light fixtures, low-flow plumbing fixtures, sensors and timers that control water flow, lighting and temperature, before undertaking more invasive treatments that may negatively impact the historic building.	
Prioritizing sustainable improvements, beginning with minimally invasive treatments that are least likely to damage historic building material.	Beginning work with substantive or irreversible treatments without first considering and implementing less invasive measures.

MAINTENANCE

RECOMMENDED	NOT RECOMMENDED
Maintaining historic buildings regularly to preserve historic fabric and maximize operational efficiency.	Delaying maintenance treatments which may result in the loss of historic building fabric or decrease the performance of existing systems or features.
Retaining and repairing durable historic building materials	Removing durable historic building materials and replacing them with materials perceived as more sustainable; for instance, removing historic heart pine flooring and replacing it with new bamboo flooring.
Using environmentally-friendly cleaning products that are compatible with historic finishes.	Using cleaning products potentially harmful to both historic finishes and the environment.
Using sustainable products and treatments, such as low VOC paints and adhesives and lead-safe paint removal methods, as much as possible, when rehabilitating a historic building.	

21

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Not Recommended: [21-22] The peeling paint on an exterior window sill and on the interior of a window indicates that these features have not received regular maintenance. The broken casement window hardware also needs to be repaired to make the window operable.

19

20

Recommended: [19] Caulking the gap between the aluminum storm window and wood window frame helps maximize thermal efficiency in this historic residence.

[20] Using sustainable cleaning products preserves both the environment and the historic building.

23

24

Recommended: [23-25] Historic exterior storm windows have been well maintained and continue to perform as intended.

WINDOWS

RECOMMENDED	NOT RECOMMENDED
Maintaining windows on a regular basis to ensure that they function properly and are completely operable.	Neglecting to maintain historic windows and allowing them to deteriorate beyond repair with the result that they must be replaced.
Retaining and repairing historic windows when deteriorated.	Removing repairable historic windows and replacing them with new windows for perceived improvement in energy performance.
Weather stripping and caulking historic windows, when appropriate, to make them weather tight.	
Installing interior or exterior storm windows or panels that are compatible with existing historic windows.	Replacing repairable historic windows with new insulated windows.

25

26

Recommended: [26] The new metal interior storm window was carefully matched to the exterior window as part of the rehabilitation of this historic armory building.

Not Recommended: [27] A broken sash cord can be repaired easily and does not justify replacement of the window.

27

WINDOWS

RECOMMENDED	NOT RECOMMENDED
Installing compatible and energy-efficient replacement windows that match the appearance, size, design, proportion and profile of the existing historic windows and that are also durable, repairable and recyclable, when existing windows are too deteriorated to repair.	Installing incompatible or inefficient replacement window units that are not durable, recyclable or repairable when existing windows are deteriorated beyond repair or missing.
Replacing missing windows with new, energy-efficient windows that are appropriate to the style of historic building and that are also durable, repairable and recyclable.	
Retrofitting historic windows with high-performance glazing or clear film, when possible, and only if the historic character can be maintained.	

31

32

Not Recommended: [31-32] Ill-fitting exterior aluminum storm windows viewed from both inside and outside are clearly not energy efficient.

Not Recommended: [30] Not only have incompatible windows that do not fit the size and shape of the historic window openings been installed, but the original openings have also been shortened to install through-the-wall HVAC units.

28

29

Recommended: [28-29] These exterior storm windows match the pane configuration of the historic interior windows in a residence and in a multi-story hotel building.

30

33

34

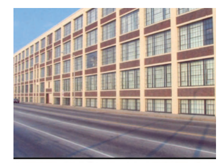
35

Recommended: [33-35] Original metal windows were appropriately repaired as part of the rehabilitation of this historic industrial building.

WINDOWS

RECOMMENDED	NOT RECOMMENDED
Retrofitting historic steel windows and curtain-wall systems to improve thermal performance without compromising their character.	
Installing clear, low-emissivity (low-e) glass or film without noticeable color in historically-clear windows to reduce solar heat gain.	Retrofitting historically-clear windows with tinted glass or reflective coatings that will negatively impact the historic character of the building.
Installing film in a slightly lighter shade of the same color tint when replacing glazing panels on historically-dark-tinted windows to improve daylighting.	Introducing clear glazing or a significantly lighter colored film or tint than the original to improve daylighting when replacing historically dark-tinted windows.

36



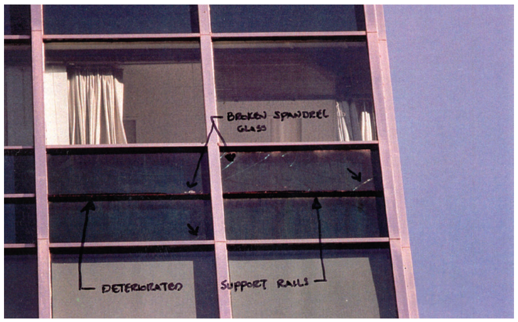
37

38

Recommended: [36-38] Original metal windows were retained and made operable during the rehabilitation of this historic mill complex. Installing patio slider doors as interior storm windows was a creative and successful solution to improve the energy efficiency of the existing windows.

WINDOWS

RECOMMENDED	NOT RECOMMENDED
Maintaining existing, reinstalling or installing new, historically-appropriate shutters and awnings.	Removing historic shutters and awnings or installing inappropriate ones.
Repairing or reopening historically-operable interior transoms, when possible, to improve air flow and cross ventilation.	Covering or removing existing transoms.



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40

Recommended: [39-40] The original windows, which were deteriorated beyond repair, featured a dark tint. They were replaced with a slightly lighter-tinted glazing to improve daylighting in this mid-century modern office building.

41

Recommended: [41] Traditional canvas awnings should be retained when they exist on historic buildings.

42

Recommended: [42] Transoms and screen doors are distinctive and practical features that provided cross ventilation in this historic hotel.

43

Recommended: [43] The wall and door glazing ensures that the corridor receives natural daylight and the operable transom helps air to circulate in this historic office building.

WEATHERIZATION AND INSULATION

RECOMMENDED	NOT RECOMMENDED
Using a variety of analytical tools, such as a comprehensive energy audit, blower door tests, infrared thermography, energy modeling or daylight modeling, to gain an understanding of the building's performance and potential before implementing any weatherization or retrofit treatments.	Implementing energy-retrofit measures without first diagnosing the building's performance and energy needs.
Developing a weatherization plan based on the results of the energy analysis of the building's performance and potential.	
Eliminating infiltration first, beginning with the least invasive and most cost-effective weatherization measures, such as caulking and weather stripping, before undertaking more invasive weatherization measures.	Undertaking treatments that result in loss of historic fabric, for example, installing wall insulation that requires removing plaster, before carrying out simple and less damaging weatherization measures.
Understanding the inherent thermal properties of the historic building materials and the actual insulating needs for the specific climate and building type before adding or changing insulation.	
Insulating unfinished spaces, such as attics, basements and crawl spaces, first.	Insulating a finished space, which requires removing historic plaster and trim, before insulating unfinished spaces.

44

Recommended: [44-45] A blower door test is a useful tool to help identify air infiltration in a historic building before undertaking weatherization or retrofit treatments. *Top Photo: Robert J. Cagnetta, Heritage Restoration, Inc.*


45

46

Recommended: [46] A hand-held infrared scanner reveals areas that are not well insulated and that allow heat transfer through the walls of a building.


47


48

Recommended: [47-48] Insulation should be installed first in unfinished areas such as attics, crawl spaces and basements of residential buildings.

WEATHERIZATION AND INSULATION

RECOMMENDED	NOT RECOMMENDED
Using the appropriate type of insulation in unfinished spaces and ensuring the space is adequately ventilated.	Using wet-spray or other spray-in insulation that is not reversible or may damage historic materials.
	Adding insulation in cavities that are susceptible to water infiltration.
Ensuring that air infiltration is reduced before adding wall insulation.	Insulating walls without first reducing air infiltration.
Installing appropriate wall insulation, only if necessary, after lower impact treatments have been carried out.	Installing wall insulation that is not reversible and that may cause damage to historic building materials.
	Installing insulation on the exterior of a historic building, which results in the loss of historic materials and may alter the proportion and relationship of the wall to the historic windows and trim.
Removing interior plaster only in limited quantities and when absolutely necessary to install appropriate insulation.	Removing all interior plaster to install appropriate insulation.
Replacing interior plaster—removed to install insulation—with plaster or gypsum board to retain the historic character of the interior, and in a manner that retains the historic proportion and relationship of the wall to the historic windows and trim.	Replacing interior plaster—removed to install insulation—with gypsum board that is too thick and that alters the historic proportion and relationship of the wall to the historic windows and trim.
Reinstalling historic trim that was removed to install insulation.	Replicating trim rather than retaining and reinstalling historic trim that is repairable.

52

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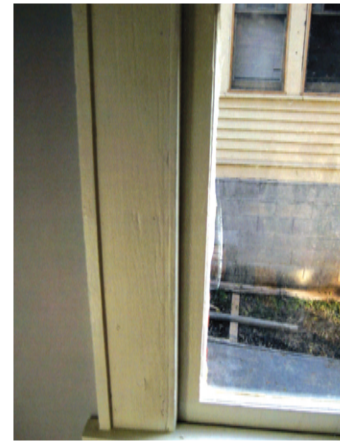
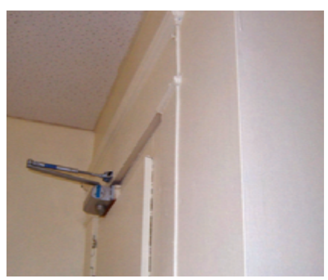


Recommended: [52-53] The original proportion and relationship of the wall to the windows and trim, which is important in defining the character of these historic interior spaces, has been retained here.

54


Recommended: [54] This rigid insulation has been correctly installed in the wall cavity so that when the gypsum board is hung the original proportion and relationship of the wall to the trim will be retained. *Photo: Robert J. Cagnetta, Heritage Restoration, Inc.*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51

Not Recommended: [49] The original proportion and relationship of the wall to the door trim has been all but lost because the gypsum board installed was too thick.

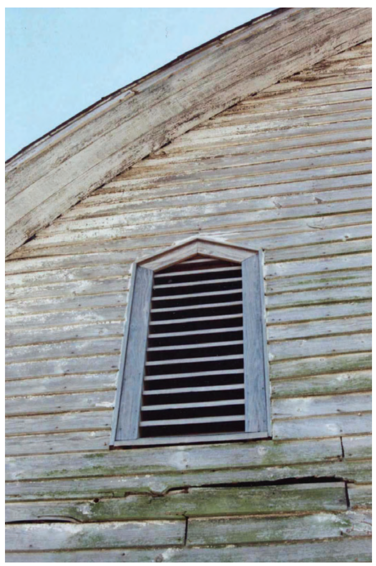
[50-51] When wall insulation was installed here the walls were furred out, which created deep, historically inappropriate window recesses. The repairable historic trim was also not reinstalled.

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) AND AIR CIRCULATION

RECOMMENDED	NOT RECOMMENDED
Retaining and maintaining functional and efficient HVAC systems.	Replacing existing HVAC systems without testing their efficiency first.
Upgrading existing HVAC systems to increase efficiency and performance within normal replacement cycles.	Replacing HVAC systems prematurely when existing systems are operating efficiently.
Installing an energy-efficient system that takes into account whole building performance and retains the historic character of the building and site when a new HVAC system is necessary.	Installing an inefficient HVAC system or installing a new system based on pre-retrofit building performance when a smaller system may be more appropriate.


55

Recommended: [55-57] Wood vents in the gable ends of a historic house and a barn and cast-iron oval vents in a masonry foundation traditionally helped air circulate.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HEATING, VENTILATING AND AIR CONDITIONING (HVAC) AND AIR CIRCULATION

RECOMMENDED	NOT RECOMMENDED
Supplementing the efficiency of HVAC systems with less energy-intensive measures, such as programmable thermostats, attic and ceiling fans, louvers and vents, where appropriate.	
Retaining or installing high efficiency, ductless air conditioners when appropriate, which may be a more sensitive approach than installing a new, ducted, central air-conditioning system that may damage historic building material.	Installing through-the-wall air conditioners, which damages historic material and negatively impacts the building's historic character.
	Installing a central HVAC system in a manner that damages historic building material.

60

Recommended: [60] Original radiators that are still functional and efficient were retained in the rehabilitation of this historic house.

58

Recommended: [58] Ceiling fans enhance the efficiency of HVAC systems in historic buildings.

59

Recommended: [59] Installing a programmable thermostat can help existing systems to operate more efficiently.

61

Not Recommended: [61] The cuts made in the brick and the decorative stone trim to install through-the-wall air conditioners have not only destroyed building material, but have also negatively impacted the character of this historic apartment building.

62

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) AND AIR CIRCULATION

RECOMMENDED	NOT RECOMMENDED
Installing new mechanical ductwork sensitively or using a mini-duct system, so that ducts are not visible from the exterior and do not adversely impact the historic character of the interior space.	Installing new mechanical ductwork that is visible from the exterior or adversely impacts the historic character of the interior space.
Leaving interior ductwork exposed where appropriate, such as in industrial spaces, or when concealing the ductwork would destroy historic fabric.	Leaving interior ductwork exposed in highly-finished spaces where it would negatively impact the historic character of the space.
Leaving interior ductwork exposed and painting it, when concealing it would negatively impact historic fabric, such as a historic pressed metal ceiling.	Leaving exposed ductwork unpainted in finished interior spaces, such as those with a pressed metal ceiling.
Placing HVAC equipment where it will operate effectively and efficiently and be minimally visible and will not negatively impact the historic character of the building or its site.	Placing HVAC equipment in highly-visible locations on the roof or on the site where it will negatively impact the historic character of the building or its site.

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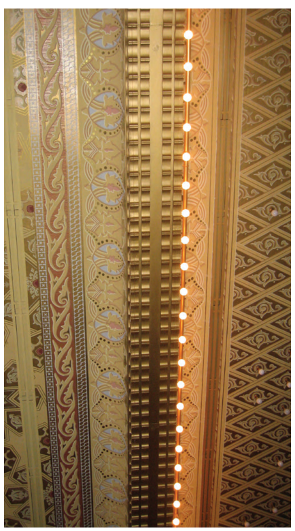

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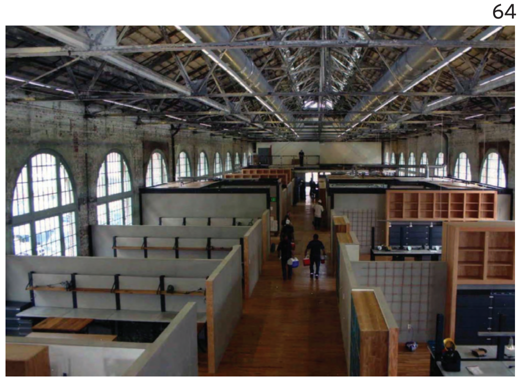

65

66

Recommended: [62-63] Carefully installed new mechanical ductwork is barely visible in the elaborately decorated ceiling of this historic theater.
[64] The ductwork has been left unpainted which is compatible with this historic industrial interior.
[65] To avoid damaging the metal ceiling, the ductwork was left exposed and it was painted to minimize its impact, thus preserving the historic character of this former bank.

Not Recommended: [66] Interior ductwork has been inappropriately left exposed and unpainted here in this traditionally-finished school entrance hall.

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) AND AIR CIRCULATION

RECOMMENDED	NOT RECOMMENDED
Commissioning or examining the performance of the HVAC system and continuing to examine it regularly to ensure that it is operating efficiently.	Installing a new HVAC system without commissioning or testing its efficiency after installation.
Investigating whether a geothermal heat pump will enhance the heating and cooling efficiency of the building before installing one.	Installing a geothermal heat pump without evidence that it will improve the heating and cooling efficiency of the building.
	Installing a geothermal system where there is a significant landscape or where there are archeological resources that could be damaged.

70


71

Recommended: [70-71] A geothermal system was installed on the property of this historic mansion, but only after an archeological investigation was conducted of the grounds.


67


68


69

Recommended:[67] A professional energy auditor analyzes the performance of an existing furnace to ensure it is operating efficiently.

[68-69] A geothermal system, evidenced by a panel in the sidewalk, was installed on the site of this historic firehouse during rehabilitation.

SOLAR TECHNNOLOGY

RECOMMENDED	NOT RECOMMENDED
Considering on-site, solar technology only after implementing all appropriate treatments to improve energy efficiency of the building, which often have greater life-cycle cost benefit than on-site renewable energy.	Installing on-site, solar technology without first implementing all appropriate treatments to the building to improve its energy efficiency.
Analyzing whether solar technology can be used successfully and will benefit a historic building without compromising its character or the character of the site or the surrounding historic district.	Installing a solar device without first analyzing its potential benefit or whether it will negatively impact the character of the historic building or site or the surrounding historic district.
Installing a solar device in a compatible location on the site or on a non-historic building or addition where it will have minimal impact on the historic building and its site.	Placing a solar device in a highly-visible location where it will negatively impact the historic building and its site.
Installing a solar device on the historic building only after other locations have been investigated and determined infeasible.	Installing a solar device on the historic building without first considering other locations.

72

73

Recommended: [72-73] Solar panels were installed appropriately on the rear portion of the roof on this historic row house that are not visible from the primary elevation.

74

Recommended: [74] Free-standing solar panels have been installed here that are visible but appropriately located at the rear of the property and compatible with the character of this industrial site.

75

Not Recommended: [75] Solar roof panels have been installed at the rear, but because the house is situated on a corner, they are highly visible and negatively impact the character of the historic property.

SOLAR TECHNNOLOGY

RECOMMENDED	NOT RECOMMENDED
Installing a low-profile solar device on the historic building so that it is not visible or only minimally visible from the public right of way: for example, on a flat roof and set back to take advantage of a parapet or other roof feature to screen solar panels from view; or on a secondary slope of a roof, out of view from the public right of way.	Installing a solar device in a prominent location on the building where it will negatively impact its historic character.
Installing a solar device on the historic building in a manner that does not damage historic roofing material or negatively impact the building's historic character and is reversible.	Installing a solar device on the historic building in a manner that damages historic roofing material or replaces it with an incompatible material and is not reversible.
	Removing historic roof features to install solar panels.
	Altering a historic, character-defining roof slope to install solar panels.
	Installing solar devices that are not reversible.
Installing solar roof panels horizontally -- flat or parallel to the roof—to reduce visibility.	Placing solar roof panels vertically where they are highly visible and will negatively impact the historic character of the building.

76

77

79

Not Recommended: [79] Although installing solar panels behind a rear parking lot might be a suitable location in many cases, here the panels negatively impact the historic property on which they are located.

Recommended: [76-77] Solar panels, which also serve as awnings, were installed in secondary locations on the side and rear of this historic post office and cannot be seen from the front of the building. [78] Solar panels placed horizontally on the roof of this historic building are not visible from below.

78

WIND POWER—WIND TURBINES AND WINDMILLS

RECOMMENDED	NOT RECOMMENDED
Considering on-site, wind-power technology only after implementing all appropriate treatments to the building to improve energy efficiency, which often have greater life-cycle cost benefit than on-site renewable energy.	Installing on-site, wind-power technology, without first implementing all appropriate treatments to the building to improve energy efficiency.
Analyzing whether wind-power technology can be used successfully and will benefit a historic building without compromising its character or the character of the site or the surrounding historic district.	Installing wind-powered equipment without first analyzing its potential benefit or whether it will negatively impact the character of the historic building or the site or the surrounding historic district.
Installing wind-powered equipment in an appropriate location on the site or on a non-historic building or addition where it will not negatively impact the historic character of the building, the site or the surrounding historic district.	Placing wind-powered equipment on the site where it is highly visible when it is not compatible with the historic character of the site.

80

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Recommended: [80] It is often best to install wind-powered equipment in off-site, rural locations to avoid negatively impacting a historic building and its site.

[81] This wind turbine is located in a large parking lot next to a historic manufacturing complex and it is compatible with the character of the industrial site.

[82] This 2011 Kansas postage stamp features a traditional windmill and modern wind turbines to illustrate the importance of wind power in the growth of the state.

WIND POWER—WIND TURBINES AND WINDMILLS

RECOMMENDED	NOT RECOMMENDED
Installing wind-powered equipment on the historic building without damaging the roof or walls or otherwise negatively impacting the building's historic character.	Installing wind-powered equipment on the historic building in a manner that damages the roof, compromises its structure or negatively impacts the building's historic character.
	Removing historic roof features to install wind-powered equipment, such as wind turbines.
	Installing wind-powered equipment on the historic building that is not reversible.
	Installing wind-powered equipment on the primary façade of a historic building or where it is highly visible.
Investigating off-site, renewable energy options when installing on-site wind-power equipment would negatively impact the historic character of the building or site.	

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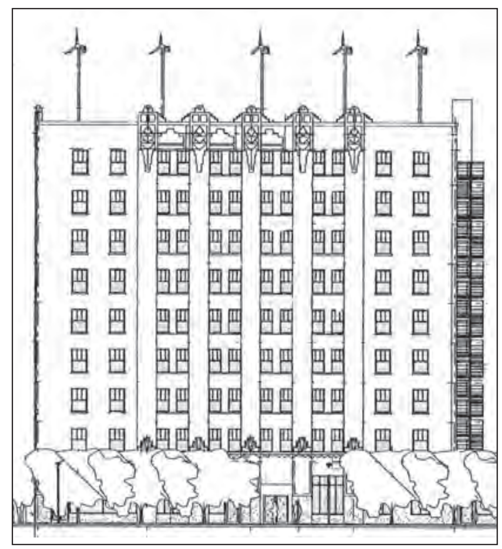


Not Recommended:
[83-84] This historic hotel is a prominent and highly visible local landmark, and the wind turbines proposed to be added on the roof would negatively impact its historic character.

ROOFS—COOL ROOFS AND GREEN ROOFS

RECOMMENDED	NOT RECOMMENDED
Retaining and repairing durable, character-defining historic roofing materials in good condition.	Replacing durable, character-defining historic roofing materials in good condition with a roofing material perceived as more sustainable.
Analyzing whether a cool roof or a green roof is appropriate for the historic building.	
Installing a cool roof or a green roof on a flat-roofed historic building where it will not be visible from the public right of way and will not negatively impact the building's historic character.	Installing a cool roof or a green roof without considering whether it will be highly visible from the public right of way and will negatively impact the building's historic character.
Selecting appropriate roofing materials and colors when putting a new cool roof on the historic building.	Installing a cool roof that is incompatible in material or color with the historic building.
Ensuring that the historic building can structurally accommodate the added weight of a green roof and sensitively improving the structural capacity, if necessary.	Adding a green roof that would be too heavy and would damage the historic building or supplementing the structural capacity of the historic building in an insensitive manner.

85

86

Recommended: [85-86] A cool or green roof is best installed on a flat roof where it cannot be seen from the public right of way and will not negatively impact the character of the historic building.

87

Not Recommended: [87] Historic roofing materials in good condition should be retained rather than replaced with another material perceived as more sustainable, such as, in this case, solar roofing shingles.

88

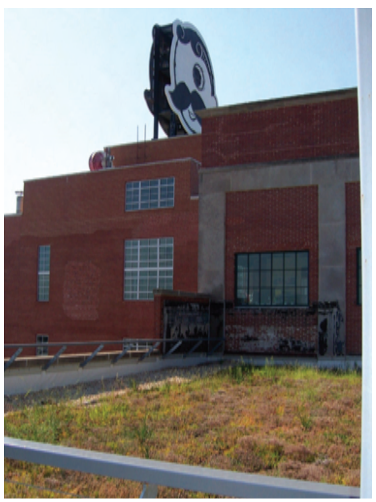
Not Recommended: [88] This new, cool white metal roof is not an appropriate material or color for this historic mid-20th century house.

ROOFS—COOL ROOFS AND GREEN ROOFS

RECOMMENDED	NOT RECOMMENDED
Ensuring that the roof is water tight and that roof drains, gutters and downspouts function properly before installing a green roof.	Installing a green roof without ensuring that the roof covering is water tight and that drainage systems function properly.
Including a moisture-monitoring system when installing a green roof to protect the historic building from added moisture and accidental leakage.	
Selecting sustainable native plants that are drought resistant and will not require excessive watering of a green roof.	
Selecting appropriately-scaled vegetation for a green roof that will not grow so tall that it will be visible and detract from the building's historic character.	Selecting vegetation for a green roof that will be visible above the roof or parapet.

93


Not Recommended: [93] The vegetation on these green roofs has grown too tall and negatively impacts the character of these historic commercial buildings.

89


90-91

92


Recommended: [89-92] Low-scale and sustainable native plants are appropriate for these roof gardens on historic buildings.

94

95

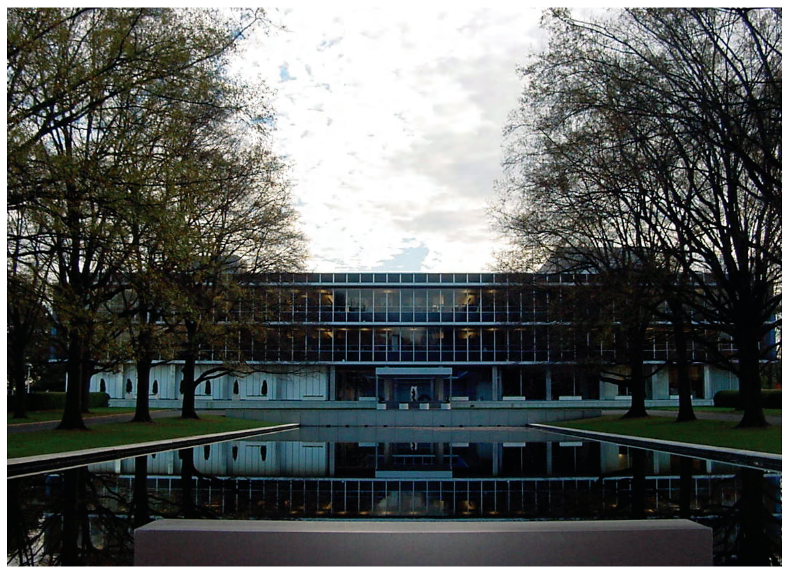
Recommended: [94-95] Permeable pavers were used at this historic residential property for a driveway and parking (above) and a hard-packed, construction aggregate provides environmentally-friendly paths for visitors at this historic site (below).

[96] Mature trees and a water feature contribute to the sustainability of this mid-twentieth century property.

SITE FEATURES AND WATER EFFICIENCY

RECOMMENDED	NOT RECOMMENDED
Respecting an important cultural landscape and significant character-defining site features when considering adding new sustainable features to the site.	Installing new sustainable site features without considering their potentially negative impact on an important cultural landscape and character-defining site features.
Using to advantage existing storm-water-management features, such as gutters, downspouts and cisterns, as well as site topography and vegetation that contribute to the sustainability of the historic property.	Ignoring existing features that contribute to the sustainability of the historic property.
Adding natural, sustainable features to the site, such as shade trees, if appropriate, to reduce cooling loads for the historic building.	Removing existing natural features, such as shade trees, that contribute to the building's sustainability.
	Planting trees where they may grow to encroach upon or damage the historic building.
Using permeable paving where appropriate on a historic building site to manage storm water.	

96



97

Not Recommended: [97] This tree, which was planted too close to the building, has caused the masonry wall to retain moisture that damaged the mortar and required that the brick be repointed in this area.

SITE FEATURES AND WATER EFFICIENCY

RECOMMENDED	NOT RECOMMENDED
Avoiding paving up to the building foundation to reduce heat island effect, building temperature, damage to the foundation and storm-water runoff.	Paving up to the building foundation with impermeable materials.
Landscaping with native plants, if appropriate, to enhance the sustainability of the historic site.	Introducing non-native plant species to the historic site that are not sustainable.
Adding features, such as bioswales, rain gardens, rain barrels, large collection tanks and cisterns, if compatible, to the historic building site to enhance storm-water management and on-site water reuse.	

98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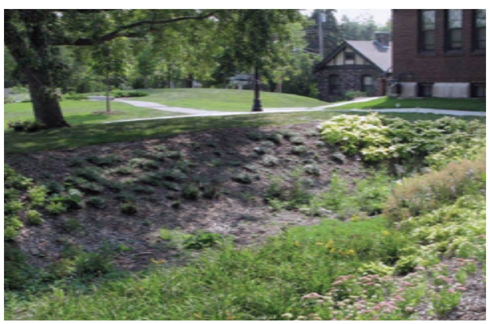
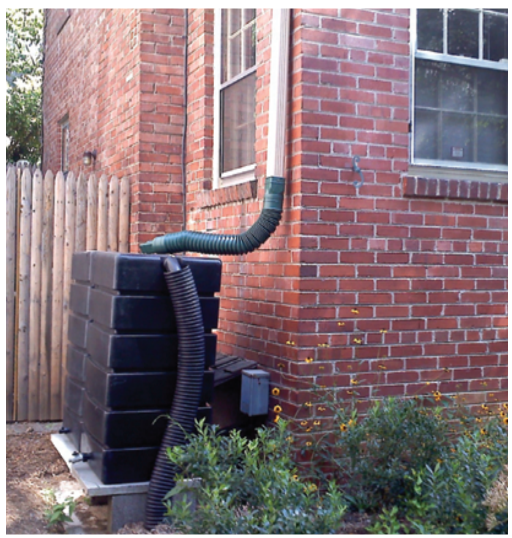


Recommended: [98-100] Rain gardens and rain-water collection tanks are features that may be added to a historic property to improve storm-water management and increase on-site water use.


100

101


Not Recommended: [101] Splash back from the impermeable concrete paving next to the foundation is damaging these stones.

102

103

Recommended: [102-103]
Small, covered atriums that are compatible with the character of these historic warehouses have been inserted to light the interior.

DAYLIGHTING

RECOMMENDED	NOT RECOMMENDED
Retaining features that provide natural light to corridors, such as partial glass partitions, glazed doors and transoms, commonly found in historic office buildings.	Removing or covering features that provide natural light to corridors, such as partial glass partitions, glazed doors and transoms, commonly found in historic office buildings.
Reopening historic windows that have been blocked in to add natural light and ventilation.	Blocking in historic window openings to accommodate new building uses.
Adding skylights or dormers on secondary roof elevations where they are not visible or are only minimally visible so that they do not negatively impact the building's historic character.	Adding skylights or dormers on primary or highly-visible roof elevations where they will negatively impact the building's historic character.
Adding a small light well or light tubes, where necessary and appropriate, to allow more daylight into the historic building.	
Inserting a small atrium, only when necessary, to allow more daylight into the building in a manner that is compatible with the historic character of the building.	Cutting a very large atrium into the historic building that is not compatible with the building's historic character.
	Creating an open, uncovered atrium or courtyard in the historic building that appears to be an outdoor space, rather than an interior space.

Not Recommended: [104-106]
Skylights added on a primary roof elevation negatively impact the character of these historic houses.

104

105

106

DAYLIGHTING

RECOMMENDED	NOT RECOMMENDED
Installing light-control devices on the historic building where appropriate to the building type, such as light shelves in industrial or mid-century modern buildings, awnings on some commercial and residential buildings and shutters on residential buildings that had them historically.	Installing light-control devices that are incompatible with the type or style of the historic building.
Installing automated daylighting controls on interior lighting systems that ensure adequate indoor lighting and allow for energy-saving use of daylighting.	
Adding new window openings on secondary and less visible facades, where appropriate, to allow more natural light into the historic building.	Adding new window openings on primary elevations that will negatively impact the character of the historic building.

107

Recommended: [107] Traditional canopies compatible with the industrial character of this former factory building were installed when it was converted for residential use.

[108-109] The original, partially-glazed doors and office partitions, as well as skylights, that let natural light into the corridors were retained as part of the rehabilitation of this early-20th century building.

108

109

110

111

Recommended: [110] A clerestory window lights the interior corridor of this historic mill building.

[111] A limited number of new window openings may be added to non-character-defining, secondary facades to allow natural light into formerly windowless spaces.

U.S. Department of the Interior
National Park Service
Technical Preservation Services

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PRESERVATION BRIEF#1
ASSESSING CLEANING AND WATER-REPELLENT TREATMENTS FOR HISTORIC MASONRY BUILDINGS

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1 Preservation Briefs

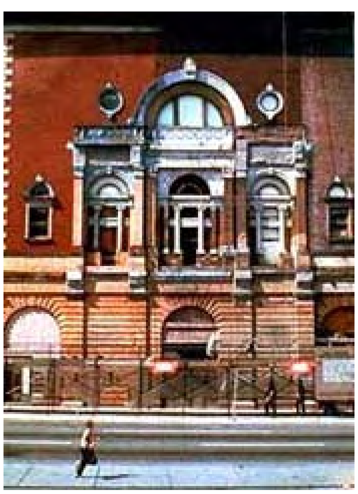
Technical Preservation Services
National Park Service
U.S. Department of the Interior

Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings

Robert C. Mack, FAIA
Anne Grimmer

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Inappropriate cleaning and coating treatments are a major cause of damage to historic masonry buildings. While either or both treatments may be appropriate in some cases, they can be very destructive to historic masonry if they are not selected carefully. Historic masonry, as considered here, includes stone, brick, architectural terra cotta, cast stone, concrete and concrete block. It is frequently cleaned because cleaning is equated with improvement. Cleaning may sometimes be followed by the application of a water-repellent coating. However, unless these procedures are carried out under the guidance and supervision of an architectural conservator, they may result in irrevocable damage to the historic resource.



Ninety years of accumulated dirt and pollutants are being removed from this historic theater using an appropriate chemical cleaner, applied in

The purpose of this Brief is to provide information on the variety of cleaning methods and materials that are available for use on the *exterior* of historic masonry buildings, and to provide guidance in selecting the most appropriate method or combination of methods. The difference between water-repellent coatings and waterproof coatings is explained, and the purpose of each, the suitability of their application to historic masonry buildings, and the possible consequences of their inappropriate use are discussed.

The Brief is intended to help develop sensitivity to the qualities of historic masonry that makes it so special, and to assist historic building owners and property managers in working cooperatively with architects, architectural conservators, and contractors. Although specifically intended for historic buildings, the information is applicable to all masonry buildings. This publication updates and expands *Preservation Briefs 1: The Cleaning and Waterproof Coating of Masonry Buildings.* The Brief is not

stages. Photo: Richard Wagner, AIA.

meant to be a cleaning manual or a guide for preparing specifications. Rather, it provides general information to raise awareness of the many factors involved in selecting cleaning and water-repellent treatments for historic masonry buildings.

Preparing for a Cleaning Project

Reasons for cleaning. First, it is important to determine whether it is appropriate to clean the masonry. The objective of cleaning a historic masonry building must be considered carefully before arriving at a decision to clean. There are several major reasons for cleaning a historic masonry building: **improve the appearance of the building** by removing unattractive dirt or soiling materials, or non-historic paint from the masonry; **retard deterioration** by removing soiling materials that may be damaging the masonry; or **provide a clean surface** to accurately match repointing mortars or patching compounds, or to conduct a condition survey of the masonry.

Identify what is to be removed. The general nature and source of dirt or soiling material on a building must be identified to remove it in the gentlest means possible--that is, in the most effective, yet least harmful, manner. Soot and smoke, for example, require a different cleaning agent to remove than oil stains or metallic stains. Other common cleaning problems include biological growth such as mold or mildew, and organic matter such as the tendrils left on masonry after removal of ivy.

Consider the historic appearance of the building. If the proposed cleaning is to remove paint, it is important in each case to learn whether or not unpainted masonry is historically appropriate. And, it is necessary to consider why the building was painted. Was it to cover bad repointing or unmatched repairs? Was the building painted to protect soft brick or to conceal deteriorating stone? Or, was painted masonry simply a fashionable treatment in a particular historic period? Many buildings were painted at the time of construction or shortly thereafter; retention of the paint, therefore, may be more appropriate historically than removing it. And, if the building appears to have been painted for a long time, it is also important to think about whether the paint is part of the character of the historic building and if it has acquired significance over time.

Consider the practicalities of cleaning or paint removal. Some gypsum or sulfate crusts may have become integral with the stone and, if cleaning could result in removing some of the stone surface, it may be preferable not to clean. Even where unpainted masonry is appropriate, the retention of the paint may be more practical than removal in terms of long range preservation of the masonry. In some cases, however, removal of the paint may be desirable. For example, the old paint layers may have built up to such an extent that removal is necessary to ensure a sound surface to which the new paint will adhere.

Study the masonry. Although not always necessary, in some instances it can be beneficial to have the coating or paint type, color, and layering on the masonry researched before attempting its removal. Analysis of the nature of the soiling or of the paint to be removed from the masonry, as well as guidance on the appropriate cleaning method, may be provided by professional consultants, including architectural conservators, conservation scientists, and preservation architects. The State Historic Preservation Office (SHPO), local historic district commissions, architectural review boards, and preservation-oriented websites may also be able to supply useful information on masonry cleaning techniques.

Understanding the Building Materials

The decorative trim on this brick builing is architectural terra-cotta intended to simulate the limestone foundation. Photo: NPS files.

The construction of the building must be considered when developing a cleaning program because inappropriate cleaning can have a deleterious effect on the masonry as well as on other building materials. The masonry material or materials must be correctly identified. It is sometimes difficult to distinguish one type of stone from another; for example, certain sandstones can be easily confused with limestones. Or, what appears to be natural stone may not be stone at all, but cast stone or concrete. Historically, cast stone and architectural terra cotta were frequently used in combination with natural stone, especially for trim elements or on upper stories of a building where, from a distance, these substitute materials looked like real stone. Other features on historic buildings that appear to be stone, such as decorative cornices, entablatures and window hoods, may not even be masonry, but metal.

Identify prior treatments. Previous treatments of the building and its surroundings should be researched and building maintenance records should be obtained, if available. Sometimes if streaked or spotty areas do not seem to get cleaner following an initial cleaning, closer inspection and analysis may be warranted. The discoloration may turn out not to be dirt but the remnant of a water-repellent coating applied long ago which has darkened the surface of the masonry over time. Successful removal may require testing several cleaning agents to find something that will dissolve and remove the coating. Complete removal may not always be possible. Repairs may have been stained to match a dirty building, and cleaning may make these differences apparent. De-icing salts used near the building that have dissolved can migrate into the masonry. Cleaning may draw the salts to the surface, where they will appear as efflorescence (a powdery, white substance), which may require a second treatment to be removed. Allowances for dealing with such unknown factors, any of which can be a potential problem, should be included when investigating cleaning methods and materials. Just as more than one kind of masonry on a historic building may necessitate multiple cleaning approaches, unknown conditions that are encountered may also require additional cleaning treatments.

Any cleaning method should be tested before using it on historic masonry. Photo: NPS files.

Choose the appropriate cleaner. The importance of testing cleaning methods and materials cannot be over emphasized. Applying the wrong cleaning agents to historic masonry can have disastrous results. Acidic cleaners can be extremely damaging to acid-sensitive stones, such as marble and limestone, resulting in etching and dissolution of these stones. Other kinds of masonry can also be damaged by incompatible cleaning agents, or even by cleaning agents that are usually compatible. There are also numerous kinds of sandstone, each with a considerably different geological composition. While an acid-based cleaner may be safely used on some sandstones, others are acid-sensitive and can be severely etched or dissolved by an acid cleaner. Some sandstones contain water-soluble minerals and can be eroded by water cleaning. And, even if the stone type is correctly identified, stones, as well as some bricks, may contain unexpected impurities, such as iron particles, that may react negatively with a particular cleaning agent and result in staining. Thorough understanding of the physical and chemical properties of the masonry will help avoid the inadvertent selection of damaging cleaning agents.

Other building materials also may be affected by the cleaning process. Some chemicals, for example, may have a corrosive effect on paint or glass. The portions of building elements most vulnerable to deterioration may not be visible, such as embedded ends of iron window bars. Other totally unseen items, such as iron cramps or ties which hold the masonry to the structural frame, also may be subject to corrosion from the use of chemicals or even from plain water. The only way to prevent problems in these cases is to study the building construction in detail and evaluate proposed cleaning methods with this information in mind. However, due to the very likely possibility of encountering unknown factors, any cleaning project involving historic masonry should be viewed as unique to that particular building.

Cleaning Methods and Materials

Masonry cleaning methods generally are divided into three major groups: water, chemical, and abrasive. *Water methods* soften the dirt or soiling material and rinse the deposits from the masonry surface. *Chemical cleaners* react with dirt, soiling material or paint to effect their removal, after which the cleaning effluent is rinsed off the masonry surface with water. *Abrasive methods* include blasting with grit, and the use of grinders and sanding discs, all of which mechanically remove the dirt, soiling material or paint (and, usually, some of the masonry surface). Abrasive cleaning is also often followed with a water rinse. *Laser cleaning*, although not discussed here in detail, is another technique that is used sometimes by conservators to clean small areas of historic masonry. It can be quite effective for cleaning limited areas, but it is expensive and generally not practical for most historic masonry cleaning projects.

Although it may seem contrary to common sense, masonry cleaning projects should be carried out starting at the bottom and proceeding to the top of the building always keeping all surfaces wet below the area being cleaned. The rationale for this approach is based on the principle that dirty water or cleaning effluent dripping from cleaning in progress above will leave streaks on a dirty surface but will not streak a clean surface as long as it is kept wet and rinsed frequently.

Water Cleaning

Water cleaning methods are generally the *gentlest means possible*, and they can be used safely to remove dirt from all types of historic masonry.* There are essentially four kinds of water-based methods: soaking; pressure water washing; water washing supplemented with non-ionic detergent; and steam, or hot-pressurized water cleaning. Once water cleaning has been completed, it is often necessary to follow up with a water rinse to wash off the loosened soiling material from the masonry.

* Water cleaning methods may not be appropriate to use on some badly deteriorated masonry because water may exacerbate the deterioration, or on gypsum or alabaster, which are very soluble in water.

Soaking. Prolonged spraying or misting with water is particularly effective for cleaning limestone and marble. It is also a good method for removing heavy accumulations of soot, sulfate crusts or gypsum crusts that tend to form in protected areas of a building not regularly washed by rain. Water is distributed to lengths of punctured hose or pipe with non-ferrous fittings hung from moveable scaffolding or a swing stage that continuously mists the surface of the masonry with a very fine spray. A timed on-off spray is another approach to using this cleaning technique. After one area has been cleaned, the apparatus is moved on to another. Soaking is often used in combination with water washing and is also followed by a final water rinse. Soaking is a very slow method--it may take several days or a week--but it is a very gentle method to use on historic masonry.

Water Washing. Washing with low-pressure or medium-pressure water is probably one of the most commonly used methods for removing dirt or other pollutant soiling from historic masonry buildings. Starting with a very low pressure (100 psi or below), even using a garden hose, and progressing as needed to slightly higher pressure--generally no higher than 300-400 psi--is always the recommended way to begin. Scrubbing with natural bristle or synthetic bristle brushes--never metal which can abrade the surface and leave metal particles that can stain the masonry--can help in cleaning areas of the masonry that are especially dirty.

Low-to-medium-pressure steam (hot-pressurized water washing) is a gentle method of softening heavy soiling deposits and cleaning historic marble. Photo: NPS files.

Water Washing with Detergents. Non-ionic detergents--which are not the same as soaps--are synthetic organic compounds that are especially effective in removing oily soil. (Examples of some of the numerous proprietary non-ionic detergents include Igepal by GAF, Tergitol by Union Carbide and Triton by Rohm & Haas.) Thus, the addition of a non-ionic detergent, or surfactant, to a low- or medium-pressure water wash can be a useful aid in the cleaning process. (A non-ionic detergent, unlike most household detergents, does not leave a solid, visible residue on the masonry.) Adding a non-ionic detergent and scrubbing with a natural bristle or synthetic bristle brush can facilitate cleaning textured or intricately carved masonry. This should be followed with a final water rinse.

Steam/Hot-Pressurized Water Cleaning. Steam cleaning is actually low-pressure hot water washing because the steam condenses almost immediately upon leaving the hose. This is a gentle and effective method for cleaning stone and particularly for acid-sensitive stones. Steam can be especially useful in removing built-up soiling deposits and dried-up plant materials, such as ivy disks and tendrils. It can also be an efficient means of cleaning carved stone details and, because it does not generate a lot of liquid water, it can sometimes be appropriate to use for cleaning interior masonry.

Potential hazards of water cleaning. Despite the fact that water-based methods are generally the most gentle, even they can be damaging to historic masonry. Before beginning a water cleaning project, it is important to make sure that all mortar joints are sound and that the building is watertight. Otherwise water can seep through the walls to the interior, resulting in rusting metal anchors and stained and ruined plaster.

Some water supplies may contain traces of iron and copper which may cause masonry to discolor. Adding a chelating or complexing agent to the water, such as EDTA (ethylene diamine tetra-acetic acid), which inactivates other metallic ions, as well as softens minerals and water hardness, will help prevent staining on light-colored masonry.

Any cleaning method involving water should never be done in cold weather or if there is any likelihood of frost or freezing because water within the masonry can freeze, causing spalling and cracking. Since a masonry wall may take over a week to dry after cleaning, no water cleaning should be permitted for several days prior to the first average frost date, or even earlier if local forecasts predict cold weather.

Most important of all, it is imperative to be aware that using water at too high a pressure, a practice common to "power washing" and "water blasting", is very abrasive and can easily etch marble and other soft stones, as well as some types of brick. In addition, the distance of the nozzle from the masonry surface and the type of nozzle, as well as gallons per minute (gpm), are also important variables in a water cleaning process that can have a significant impact on the outcome of the project. This is why it is imperative that the cleaning be closely monitored to ensure that the cleaning operators do not raise the pressure or bring the nozzle too close to the masonry in an effort to "speed up" the process. The appearance of grains of stone or sand in the cleaning effluent on the ground is an indication that the water pressure may be too high.

Chemical Cleaning

Chemical cleaners, generally in the form of proprietary products, are another material frequently used to clean historic masonry. They can remove dirt, as well as paint and other coatings, metallic and plant stains, and graffiti. Chemical cleaners used to remove dirt and soiling include **acids, alkalies** and **organic compounds.** Acidic cleaners, of course, should not be used on masonry that is acid sensitive. Paint removers are **alkaline**, based on **organic solvents** or other chemicals.

Chemical Cleaners to Remove Dirt

Both alkaline and acidic cleaning treatments include the use of water. Both cleaners are also likely to contain surfactants (wetting agents), that facilitate the chemical reaction that removes the dirt. Generally, the masonry is wet first for both types of cleaners, then the chemical cleaner is sprayed on at very low pressure or brushed onto the surface. The cleaner is left to dwell on the masonry for an amount of time recommended by the product manufacturer or, preferably, determined by testing, and rinsed off with a low- or moderate-pressure cold, or sometimes hot, water wash.

More than one application of the cleaner may be necessary, and it is always a good practice to test the product manufacturer’s recommendations concerning dilution rates and dwell times. Because each cleaning situation is unique, dilution rates and dwell times can vary considerably. The masonry surface may be scrubbed lightly with natural or synthetic bristle brushes prior to rinsing. After rinsing, pH strips should be applied to the surface to ensure that the masonry has been neutralized completely.

Acidic Cleaners. Acid-based cleaning products may be used on **non-acid sensitive masonry**, which generally includes: granite, most sandstones, slate, unglazed brick and unglazed architectural terra cotta, cast stone and concrete. Most commercial acidic cleaners are composed primarily of hydrofluoric acid, and often include some phosphoric acid to prevent rust-like stains from developing on the masonry after the cleaning. Acid cleaners are applied to the pre-wet masonry which should be kept wet while the acid is allowed to "work", and then removed with a water wash.

Alkaline Cleaners. Alkaline cleaners should be used on **acid-sensitive** masonry, including: limestone, polished and unpolished marble, calcareous sandstone, glazed brick and glazed architectural terra cotta, and polished granite. (Alkaline cleaners may also be used sometimes on masonry materials that are not acid sensitive--after testing, of course--but they may not be as effective as they are on acid-sensitive masonry.) Alkaline cleaning products consist primarily of two ingredients: a non-ionic detergent or surfactant; and an alkali, such as potassium hydroxide or ammonium hydroxide. Like acidic cleaners, alkaline products are usually applied to pre-wet masonry, allowed to dwell, and then rinsed off with water. (Longer dwell times may be necessary with alkaline cleaners than with acidic cleaners.) Two additional steps are required to remove alkaline cleaners after the initial rinse. First the masonry is given a slightly acidic wash--often with acetic acid--to neutralize it, and then it is rinsed again with water.

Chemical Cleaners to Remove Paint and Other Coatings, Stains and Graffiti

Removing paint and some other coatings, stains and graffiti can best be accomplished with alkaline paint removers, organic solvent paint removers, or other cleaning compounds. The removal of layers of paint from a masonry surface usually involves applying the remover either by brush, roller or spraying, followed by a thorough water wash. As with any chemical cleaning, the manufacturer's recommendations regarding application procedures should always be tested before beginning work.

Alkaline Paint Removers. These are usually of much the same composition as other alkaline cleaners, containing potassium or ammonium hydroxide, or trisodium phosphate. They are used to remove oil, latex and acrylic paints, and are effective for removing multiple layers of paint. Alkaline cleaners may also remove some acrylic water-repellent coatings. As with other alkaline cleaners, both an acidic neutralizing wash and a final water rinse are generally required following the use of alkaline paint removers.

Organic Solvent Paint Removers. The formulation of organic solvent paint removers varies and may include a combination of solvents, including methylene chloride, methanol, acetone, xylene and toluene.

Other Paint Removers and Cleaners. Other cleaning compounds that can be used to remove paint and some painted graffiti from historic masonry include paint removers based on N-methyl-2-pyrrolidone (NMP), or on petroleum-based compounds. Removing stains, whether they are industrial (smoke, soot, grease or tar), metallic (iron or copper), or biological (plant and fungal) in origin, depends on carefully matching the type of remover to the type of stain. Successful removal of stains from historic masonry often requires the application of a number of different removers before the right one is found. The removal of layers of paint from a masonry surface is usually accomplished by applying the remover either by brush, roller or spraying, followed by a thorough water wash.

Potential hazards of chemical cleaning. Since most chemical cleaning methods involve water, they have many of the potential problems of plain water cleaning. Like water methods, they should not be used in cold weather because of the possibility of freezing. Chemical cleaning should never be undertaken in temperatures below 40 degrees F (4 degrees C), and generally not below 50 degrees F. In addition, many chemical cleaners simply do not work in cold temperatures. Both acidic and alkaline cleaners can be dangerous to cleaning operators, and clearly, there are environmental concerns associated with the use of chemical cleaners.

If not carefully chosen, chemical cleaners can react adversely with many types of masonry. Obviously, acidic cleaners should not be used on acid-sensitive materials; however, it is not always clear exactly what the composition is of any stone or other masonry material. For, this reason, testing the cleaner on an inconspicuous spot on the building is always necessary. While certain acid-based cleaners may be appropriate if used as directed on a particular type of masonry, if left too long or if not adequately rinsed from the masonry they can have a negative effect. For example, hydrofluoric acid can etch masonry leaving a hazy residue (whitish deposits of silica or calcium fluoride salts) on the surface. While this efflorescence may usually be removed by a second cleaning--although it is likely to be expensive and time-consuming--**hydrofluoric acid** can also leave calcium fluoride salts or a colloidal silica deposit on masonry which may be impossible to remove. Other acids, particularly **hydrochloric (muriatic) acid**, which is very powerful, should not be used on historic masonry, because it can dissolve lime-based mortar, damage brick and some stones, and leave chloride deposits on the masonry.

Alkaline cleaners can stain sandstones that contain a ferrous compound. Before using an alkaline cleaner on sandstone it is always important to test it, since it may be difficult to know whether a particular sandstone may contain a ferrous compound. Some alkaline cleaners, such as **sodium hydroxide (caustic soda or lye)** and **ammonium bifluoride**, can also damage or leave disfiguring brownish-yellow stains and, in most cases, should not be used on historic masonry. Although alkaline cleaners will not etch a masonry surface as acids can, they are caustic and can burn the surface. In addition, alkaline cleaners can deposit potentially damaging salts in the masonry which can be difficult to rinse thoroughly.

Poulticing to Remove Stains and Graffiti

Graffiti and stains, which have penetrated into the masonry, often are best removed by using a poultice. A poultice consists of an absorbent material or clay powder (such as kaolin or fuller's earth, or even shredded paper or paper towels), mixed with a liquid (a solvent or other remover) to form a paste which is applied to the stain. The poultice is kept moist and left on the stain as long as necessary for it to draw the stain out of the masonry. As it dries, the paste absorbs the staining material so that it is not redeposited on the masonry surface.


The iron stain on this granite post may be removed by applying a commercial rust-removal product in a poultice. Photo: NPS files

Some commercial cleaning products and paint removers are specially formulated as a paste or gel that will cling to a vertical surface and remain moist for a longer period of time in order to prolong the action of the chemical on the stain. Pre-mixed poultices are also available as a paste or in powder form needing only the addition of the appropriate liquid. The masonry must be pre-wet before applying an alkaline cleaning agent, but not when using a solvent. Once the stain has been removed, the masonry must be rinsed thoroughly.

Abrasive and Mechanical Cleaning

Generally, abrasive cleaning methods are not appropriate for use on historic masonry buildings. Abrasive cleaning methods are just that--abrasive. Grit blasters, grinders, and sanding discs all operate by abrading the dirt or paint off the surface of the masonry, rather than reacting with the dirt and the masonry which is how water and chemical methods work. Since the abrasives do not differentiate between the dirt and the masonry, they can also remove the outer surface of the masonry at the same time, and result in permanently damaging the masonry. Brick, architectural terra cotta, soft stone, detailed carvings, and polished surfaces, are especially susceptible to physical and aesthetic damage by abrasive methods. Brick and architectural terra cotta are fired products which have a smooth, glazed surface which can be removed by abrasive blasting or grinding. Abrasively-cleaned masonry is damaged aesthetically as well as physically, and it has a rough surface which tends to hold dirt and the roughness will make future cleaning more difficult. Abrasive cleaning processes can also increase the likelihood of subsurface cracking of the masonry. Abrasion of carved details causes a rounding of sharp corners and other loss of delicate features, while abrasion of polished surfaces removes the polished finish of stone.

Mortar joints, especially those with lime mortar, also can be eroded by abrasive or mechanical cleaning. In some cases, the damage may be visual, such as loss of joint detail or increased joint shadows. As mortar joints constitute a significant portion of the masonry surface (up to 20 per cent in a brick wall), this can result in the loss of a considerable amount of the historic fabric. Erosion of the mortar joints may also permit increased water penetration, which will likely necessitate repointing.

Sandblasting has permanently damaged this brick wall. Photo: NPS files

Abrasive Blasting. Blasting with abrasive grit or another abrasive material is the most frequently used abrasive method. Sandblasting is most commonly associated with abrasive cleaning. Finely ground silica or glass powder, glass beads, ground garnet, powdered walnut and other ground nut shells, grain hulls, aluminum oxide, plastic particles and even tiny pieces of sponge, are just a few of the other materials that have also been used for abrasive cleaning. Although abrasive blasting is not an appropriate method of cleaning historic masonry, it can be safely used to clean some materials. Finely-powdered walnut shells are commonly used for cleaning monumental bronze sculpture, and skilled conservators clean delicate museum objects and finely detailed, carved stone features with very small, micro-abrasive units using aluminum oxide.

A number of current approaches to abrasive blasting rely on materials that are not usually thought of as abrasive, and not as commonly associated with traditional abrasive grit cleaning. Some patented abrasive cleaning processes--one dry, one wet--use finely-ground glass powder intended to "erase" or remove dirt and surface soiling only, but not paint or stains. Cleaning with baking soda (sodium bicarbonate) is another patented process. Baking soda blasting is being used in some communities as a means of quick graffiti removal. However, it should not be used on historic masonry which it can easily abrade and can permanently "etch" the graffiti into the stone; it can also leave potentially damaging salts in the stone which cannot be removed. Most of these abrasive grits may be used either dry or wet, although dry grit tends to be used more frequently.

Ice particles, or pelletized dry ice (carbon dioxide or CO_2), are another medium used as an abrasive cleaner. This is also too abrasive to be used on most historic masonry, but it may have practical application for removing mastics or asphaltic coatings from some substrates.

Some of these processes are promoted as being more environmentally safe and not damaging to historic masonry buildings. However, it must be remembered that they are abrasive and that they "clean" by removing a small portion of the masonry surface, even though it may be only a minuscule portion. The fact that they are essentially abrasive treatments must always be taken into consideration when planning a masonry cleaning project. In general, abrasive methods should not be used to clean historic masonry buildings. In some, very limited instances, highly-controlled, gentle abrasive cleaning may be appropriate on selected, hard-to-clean areas of a historic masonry building if carried out under the watchful supervision of a professional conservator. But, abrasive cleaning should never be used on an entire building.

Grinders and Sanding Disks. Grinding the masonry surface with mechanical grinders and sanding disks is another means of abrasive cleaning that should not be used on historic masonry. Like abrasive blasting, grinders and disks do not really clean masonry but instead grind away and abrasively remove and, thus, damage the masonry surface itself rather than remove just the soiling material.

Planning a Cleaning Project

Once the masonry and soiling material or paint have been identified, and the condition of the masonry has been evaluated, planning for the cleaning project can begin.

Testing cleaning methods. In order to determine the *gentlest means possible*, several cleaning methods or materials may have to be tested prior to selecting the best one to use on the building. Testing should always begin with the gentlest and least invasive method proceeding gradually, if necessary, to more complicated methods, or a combination of methods. All too often simple methods, such as a low-pressure water wash, are not even considered, yet they frequently are effective, safe, and not expensive. Water of slightly higher pressure or with a non-ionic detergent additive also may be effective. It is worth repeating that these methods should always be tested prior to considering harsher methods; they are safer for the building and the environment, often safer for the applicator, and relatively inexpensive.

The level of cleanliness desired also should be determined prior to selection of a cleaning method. Obviously, the intent of cleaning is to remove most of the dirt, soiling material, stains, paint or other coating. A "brand new" appearance, however, may be inappropriate for an older building, and may require an overly harsh cleaning method to be achieved. When undertaking a cleaning project, it is important to be aware that some stains simply may not be removable. It may be wise, therefore, to agree upon a slightly lower level of cleanliness that will serve as the standard for the cleaning project. The precise amount of residual dirt considered acceptable may depend on the type of masonry, the type of soiling and difficulty of total removal, and local environmental conditions.

Cleaning tests should be carried out in an area of sufficient size to give a true indication of their effectiveness. It is preferable to conduct the test in an inconspicuous location on the building so that it will not be obvious if the test is not successful. A test area may be quite small to begin, sometimes as small as six square inches, and gradually may be increased in size as the most appropriate methods and cleaning agents are determined. Eventually the test area may be expanded to a square yard or more, and it should include several masonry units and mortar joints. It should be remembered that a single building may have several types of masonry and that even similar materials may have different surface finishes. Each material and different finish should be tested separately. Cleaning tests should be evaluated only after the masonry has dried completely. *The results of the tests may indicate that several methods of cleaning should be used on a single building.*

When feasible, test areas should be allowed to weather for an extended period of time prior to final evaluation. A waiting period of a full year would be ideal in order to expose the test patch to a full range of seasons. If this is not possible, the test patch should weather for at least a month or two. For any building which is considered historically important, the delay is insignificant compared to the potential damage and disfigurement which may result from using an incompletely tested method. *The successfully cleaned test patch should be protected as it will serve as a standard against which the entire cleaning project will be measured.*

Environmental considerations. The potential effect of any method proposed for cleaning historic masonry should be evaluated carefully. Chemical cleaners and paint removers may damage trees, shrubs, grass, and plants. A plan must be provided for environmentally safe removal and disposal of the cleaning materials and the rinsing effluent before beginning the cleaning project. Authorities from the local regulatory agency--usually under the jurisdiction of the federal or state Environmental Protection Agency (EPA)--should be consulted prior to beginning a cleaning project, especially if it involves anything more than plain water washing. This advance planning will ensure that the cleaning effluent or run-off, which is the combination of the cleaning agent and the substance removed from the masonry, is handled and disposed of in an environmentally sound and legal manner. Some alkaline and acidic cleaners can be neutralized so that they can be safely discharged into storm sewers. However, most solvent-based cleaners cannot be neutralized and are categorized as pollutants, and must be disposed of by a licensed transport, storage and disposal facility. Thus, it is always advisable to consult with the appropriate agencies before starting to clean to ensure that the project progresses smoothly and is not interrupted by a stop-work order because a required permit was not obtained in advance.

Vinyl guttering or polyethylene-lined troughs placed around the perimeter of the base of the building can serve to catch chemical cleaning waste as it is rinsed off the building. This will reduce the amount of chemicals entering and polluting the soil, and also will keep the cleaning waste contained until it can be removed safely. Some patented cleaning systems have developed special equipment to facilitate the containment and later disposal of cleaning waste.

Concern over the release of volatile organic compounds (VOCs) into the air has resulted in the manufacture of new, more environmentally responsible cleaners and paint removers, while some materials traditionally used in cleaning may no longer be available for these same reasons. Other health and safety concerns have created additional cleaning challenges, such as lead paint removal, which is likely to require special removal and disposal techniques.

The lower floors of this historic brick and architectural terra-cotta building have been covered during chemical cleaning to protect pedestrians and vehicular traffic from potentially harmful overspray. Photo: NPS files.

Cleaning can also cause damage to non-masonry materials on a building, including glass, metal and wood. Thus, it is usually necessary to cover windows and doors, and other features that may be vulnerable to chemical cleaners. They should be covered with plastic or polyethylene, or a masking agent that is applied as a liquid which dries to form a thin protective film on glass, and is easily peeled off after the cleaning is finished. Wind drift, for example, can also damage other property by carrying cleaning chemicals onto nearby automobiles, resulting in etching of the glass or spotting of the paint finish. Similarly, airborne dust can enter surrounding buildings, and excess water can collect in nearby yards and basements.

Safety considerations. Possible health dangers of each method selected for the cleaning project must be considered before selecting a cleaning method to avoid harm to the cleaning applicators, and the necessary precautions must be taken. The precautions listed in Material Safety Data Sheets (MSDS) that are provided with chemical products should always be followed. Protective clothing, respirators, hearing and face shields, and gloves must be provided to workers to be worn at all times. Acidic and alkaline chemical cleaners in both liquid and vapor forms can also cause serious injury to passers-by. It may be necessary to schedule cleaning at night or weekends if the building is located in a busy urban area to reduce the potential danger of chemical overspray to pedestrians. Cleaning during non-business hours will allow HVAC systems to be turned off and vents to be covered to prevent dangerous chemical fumes from entering the building which will also ensure the safety of the building's occupants. Abrasive and mechanical methods produce dust which can pose a serious health hazard, particularly if the abrasive or the masonry contains silica.

Water-Repellent Coatings and Waterproof Coatings

To begin with, it is important to understand that waterproof coatings and water-repellent coatings are not the same. Although these terms are frequently interchanged and commonly confused with one another, they are completely different materials. **Water-**

repellent coatings--often referred to incorrectly as "sealers", but which do not or should not "seal"--are intended to keep liquid water from penetrating the surface but to allow water vapor to enter and leave, or pass through, the surface of the masonry. Water-repellent coatings are generally transparent, or clear, although once applied some may darken or discolor certain types of masonry while others may give it a glossy or shiny appearance. **Waterproof coatings** seal the surface from liquid water and from water vapor. They are usually opaque, or pigmented, and include bituminous coatings and some elastomeric paints and coatings.

Water-Repellent Coatings

Water-repellent coatings are formulated to be vapor permeable, or "breathable". They do not seal the surface completely to water vapor so it can enter the masonry wall as well as leave the wall. While the first water-repellent coatings to be developed were primarily acrylic or silicone resins in organic solvents, now most water-repellent coatings are water-based and formulated from modified siloxanes, silanes and other alkoxysilanes, or metallic stearates. While some of these products are shipped from the factory ready to use, other water-borne water repellents must be diluted at the job site. Unlike earlier water-repellent coatings which tended to form a "film" on the masonry surface, modern water-repellent coatings actually penetrate into the masonry substrate slightly and, generally, are almost invisible if properly applied to the masonry. They are also more vapor permeable than the old coatings, yet they still reduce the vapor permeability of the masonry. Once inside the wall, water vapor can condense at cold spots producing liquid water which, unlike water vapor, cannot escape through a water-repellent coating. The liquid water within the wall, whether from condensation, leaking gutters, or other sources, can cause considerable damage.

This clear coating has failed and is pulling off pieces of the stone as it peels. Photo: NPS files

Water-repellent coatings are not consolidants. Although modern water-repellents may penetrate slightly beneath the masonry surface, instead of just "sitting" on top of it, they do not perform the same function as a consolidant which is to "consolidate" and replace lost binder to strengthen deteriorating masonry. Even after many years of laboratory study and testing, few consolidants have proven very effective. The composition of fired products such as brick and architectural terra cotta, as well as many types of building stone, does not lend itself to consolidation.

Some modern water-repellent coatings which contain a binder intended to replace the natural binders in stone that have been lost through weathering and natural erosion are described in product literature as both a water repellent and a consolidant The fact that the newer water-repellent coatings penetrate beneath the masonry surface instead of just forming a layer on top of the surface may indeed convey at least some consolidating properties to certain stones. However, a water-repellent coating cannot be considered a consolidant. In some instances, a water-repellent or "preservative" coating, if applied to already damaged or spalling stone, may form a surface crust which, if it fails, may exacerbate the deterioration by pulling off even more of the stone.

Is a Water-Repellent Treatment Necessary?

Water-repellent coatings are frequently applied to historic masonry buildings for the wrong reason. They also are often applied without an understanding of what they are and what they are intended to do. And these coatings can be very difficult, if not impossible, to remove from the masonry if they fail or become discolored. Most importantly, the application of water-repellent coatings to historic masonry is usually unnecessary.

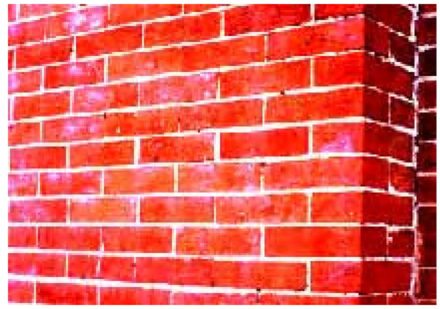
Most historic masonry buildings, unless they are painted, have survived for decades without a water-repellent coating and, thus, probably do not need one now. Water penetration to the interior of a masonry building is seldom due to porous masonry, but results from poor or deferred maintenance. Leaking roofs, clogged or deteriorated gutters and downspouts, missing mortar, or cracks and open joints around door and window openings are almost always the cause of moisture-related problems in a historic masonry building. **If historic masonry buildings are kept watertight and in good repair, water-repellent coatings should not be necessary.**

Rising damp (capillary moisture pulled up from the ground), or condensation can also be a source of excess moisture in masonry buildings. A water-repellent coating will not solve this problem either and, in fact, may be likely to exacerbate it. Furthermore, a water-repellent coating should never be applied to a damp wall. Moisture in the wall would reduce the ability of a coating to adhere to the masonry and to penetrate below the surface. But, if it did adhere, it would hold the moisture inside the masonry because, although a water-repellent coating is permeable to water vapor, liquid water cannot pass through it. In the case of rising damp, a coating may force the moisture to go even higher in the wall because it can slow down evaporation, and thereby retain the moisture in the wall.

Excessive moisture in masonry walls may carry waterborne soluble salts from the masonry units themselves or from the mortar through the walls. If the water is permitted to come to the surface, the salts may appear on the masonry surface as efflorescence (a whitish powder) upon evaporation. However, the salts can be potentially dangerous if they remain in the masonry and crystallize beneath the surface as subflorescence. Subflorescence eventually may cause the surface of the masonry to spall, particularly if a water-repellent coating has been applied which tends to reduce the flow of moisture out from the subsurface of the masonry. Although many of the newer water-repellent products are more breathable than their predecessors, they can be especially damaging if applied to masonry that contains salts, because they limit the flow of moisture through masonry.

When a Water-Repellent Coating May be Appropriate

There are some instances when a water-repellent coating may be considered appropriate to use on a historic masonry building. Soft, incompletely fired brick from the 18th-and early-19th centuries may have become so porous that paint or some type of coating is needed to protect it from further deterioration or dissolution. When a masonry building has been neglected for a long period of time, necessary repairs may be required in order to make it watertight. If, following a reasonable period of time after the building has been made watertight and has dried out completely, moisture appears actually to be penetrating through the repointed and repaired masonry walls, then the application of a water-repellent coating may be considered *in selected areas only.* This decision should be made in consultation with an architectural conservator. And, if such a treatment is undertaken, it should not be applied to the entire exterior of the building.



Anti-graffiti or barrier coatings are another type of clear coating--although barrier coatings can also be pigmented--that may be applied to exterior masonry, but they are not formulated primarily as water repellents. The purpose of these coatings is to make it harder for graffiti to stick to a masonry surface and, thus, easier to clean. But, like water-repellent coatings, in most cases the application of anti-graffiti coatings is generally not recommended for historic masonry buildings. These coatings are often quite shiny which can greatly alter the appearance of a historic masonry surface, and they are not always effective. Generally, other ways of discouraging graffiti, such as improved lighting, can be more effective than a coating. However, the application of anti-graffiti coatings may be appropriate in some instances on vulnerable areas of historic masonry buildings which are frequent targets of graffiti that are located in out-of-the-way places where constant surveillance is not possible.

Improper cleaning methods may have been responsible for the formation of efflorescence on this brick. Photo: NPS files.

Some water-repellent coatings are recommended by product manufacturers as a means of keeping dirt and pollutants or biological growth from collecting on the surface of masonry buildings and, thus, reducing the need for frequent cleaning. While this at times may be true, in some cases a coating may actually retain dirt more than uncoated masonry. Generally, the application of a water-repellent coating is not recommended on a historic masonry building as a means of preventing biological growth. Some water-repellent coatings may actually encourage biological growth on a masonry wall. Biological growth on masonry buildings has traditionally been kept at bay through regularly-scheduled cleaning as part of a maintenance plan. Simple cleaning of the masonry with low-pressure water using a natural- or synthetic-bristled scrub brush can be very effective if done on a regular basis. Commercial products are also available which can be sprayed on masonry to remove biological growth.

In most instances, a water-repellent coating is not necessary if a building is watertight. The application of a water-repellent coating is not a recommended treatment for historic masonry buildings unless there is a specific problem which it may help solve. If the problem occurs on only part of the building, it is best to treat only that area rather than an entire building. Extreme exposures such as parapets, for example, or portions of the building subject to driving rain can be treated more effectively and less expensively than the entire building. Water-repellent coatings are not permanent and must be reapplied periodically although, if they are truly invisible, it can be difficult to know when they are no longer providing the intended protection.

Testing a water-repellent coating by applying it in one small area may not be helpful in determining its suitability for the building because a limited test area does not allow an adequate evaluation of a treatment. Since water may enter and leave through the surrounding untreated areas, there is no way to tell if the coated test area is "breathable." But trying a coating in a small area may help to determine whether the coating is visible on the surface or if it will otherwise change the appearance of the masonry.

Waterproof Coatings

In theory, waterproof coatings usually do not cause problems as long as they exclude all water from the masonry. If water does enter the wall from the ground or from the inside of a building, the coating can intensify the damage because the water will not be able to escape. During cold weather this water in the wall can freeze causing serious mechanical disruption, such as spalling.

In addition, the water eventually will get out by the path of least resistance. If this path is toward the interior, damage to interior finishes can result; if it is toward the exterior, it can lead to damage to the masonry caused by built-up water pressure.

In most instances, waterproof coatings should not be applied to historic masonry. The possible exception to this might be the application of a waterproof coating to below-grade exterior foundation walls as a last resort to stop water infiltration on interior basement walls. **Generally, however, waterproof coatings, which include *elastomeric paints*, should almost never be applied above grade to**

historic masonry buildings.

Summary

A well-planned cleaning project is an essential step in preserving, rehabilitating or restoring a historic masonry building. Proper cleaning methods and coating treatments, when determined necessary for the preservation of the masonry, can enhance the aesthetic character as well as the structural stability of a historic building. Removing years of accumulated dirt, pollutant crusts, stains, graffiti or paint, if done with appropriate caution, can extend the life and longevity of the historic resource. Cleaning that is carelessly or insensitively prescribed or carried out by inexperienced workers can have the opposite of the intended effect. It may scar the masonry permanently, and may actually result in hastening deterioration by introducing harmful residual chemicals and salts into the masonry or causing surface loss. Using the wrong cleaning method or using the right method incorrectly, applying the wrong kind of coating or applying a coating that is not needed can result in serious damage, both physically and aesthetically, to a historic masonry building. Cleaning a historic masonry building should always be done using the gentlest means possible that will clean, but not damage the building. It should always be taken into consideration before applying a water-repellent coating or a waterproof coating to a historic masonry building whether it is really necessary and whether it is in the best interest of preserving the building.

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Acknowledgements

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The original version of *Preservation Brief 1: The Cleaning and Waterproof Coating of Masonry Buildings was written* by Robert C. Mack, AIA. It inaugurated the Preservation Briefs series when it was published in 1975.

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Washington, DC   November, 2000

Home page logo: Approriate cleaning of historic masonry. Photo: NPS files.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments to a broad public.

PRESERVATION BRIEF#2
REPOINTING MORTAR JOINTS IN HISTORIC MASONRY BUILDINGS

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URS

MEMO

Date: February 21, 2012
Re: Monroe Shops Masonry Repairs

This memo serves to present masonry repair mortars in the event repairs should be undertaken for Monroe Shops in Dallas, Texas under Dallas Area Rapid Transit's (DART) MOA for the South Oak Cliff Corridor (Stipulation 3b).

DART had the historic brick and mortar analyzed by HVJ Associates and Wiss, Janney, Elstner, Inc. (HVJ Associates. *Dallas Area Rapid Transit-Monroe Shops Police Headquarters Existing Masonry Investigation*. March 8, 2010. Prepared for Track 3.). Three samples of bricks were tested for compressive strength; samples were taken from an interior wall of the first building phase, an exterior wall of the first building phase (now an interior wall adjacent to the second building phase), and an interior wall of the second building phase. Three samples of mortar were analyzed; mortar samples were taken from the interior of the first building phase, the interior of the second building phase, and the exterior wall. Brick analysis was performed by HVJ Associates of Dallas, Texas. Analysis of the historic brick resulted in compressive strength ranging from 4980 to 5350 psi when tested per ASTM C-67-09. These results exceed ASTM C-216, requiring specifications for facing brick in the Dallas area (moderate weathering) to reach average compressive strength of 2500 psi for five samples, and no less than 2200 psi for any individual sample.

Mortar analysis was performed by Wiss, Janney, Elstner, Inc. of Austin, Texas. Petrography (ASTM C856), chemical analysis (ASTM C1324), sieve analysis (ASTM C136), and L*a*b* color testing of each mortar sample were performed. Tests resulted in a recommendation that the tuck pointing mortars used at Monroe Shops should have good durability, but similar mechanical strength as the original mortars. For the first building phase (the west and central bays) modern Type N mortar of ASTM C270 was recommended, containing natural sand fine aggregate, Portland cement, and hydrated lime with a sand-to-binder volumetric ratio of 1:3 and a cement-to-lime volumetric ratio of 1:1. For the second building phase (the eastern bay), Type S mortar was recommended. For both replacement mortars, common natural river sand for masonry use from the greater Dallas-Fort Worth area was recommended, with a gradation consistent with the requirement of ASTM C144, and a composition of the sand similar to that of existing mortar for a better color match. Common gray Portland cement should be avoided, and tan to buff colored Portland cement was recommended.

Upon review of the results presented by HVJ Associates and Wiss, Janney, Elstner, Inc., a mock-up using Light Buff 10X and Light Buff 10H Quikrete mortar was prepared in a well-lit area of the interior of the building. Upon review of the results of the mock-up, DART and the Texas State Historic Preservation Office approved the use of **Light Buff 10X Quikrete Type S mortar** for the whole building, as this mortar strength is more consistent with the 4980 to 5350 psi of the brick at Monroe Shops. Joint profiles of the new mortar are struck to match the original joint profiles. Future repairs should be undertaken using **Light Buff 10X Quikrete Type S mortar** and in accordance with the Monroe Shops repair Contract Documents and the applicable Secretary of the Interior Preservation Briefs, included herein.

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Mason Mix

Product No. 1136

DIVISION **4**

Masonry Mortaring
04 05 13

PRODUCT DESCRIPTION

QUIKRETE® Mason Mix is a contractor grade mortar mix designed for laying brick, concrete masonry units and stone.

PRODUCT USE

QUIKRETE® Mason Mix is a contractor grade mortar mix designed for laying brick, concrete masonry units and stone. QUIKRETE® Mason Mix is a pre-blended, sanded product. The standard formulation meets ASTM C 270 and C 1714 as Type S mortar. Other types are available by special request.

COLORS

QUIKRETE® Mason Mix is available in gray and additional colors by special order. Color can also be added to the product as it is mixed by adding QUIKRETE® Stucco and Mortar Color (#1319) to the mixing water. Twenty standard colors are available.

SIZES

- QUIKRETE® Mason Mix -
    - 60 lb (27.2 kg) bags
    - 80 lb (36.3 kg) bags

YIELD

- Each 80 lb (36.3 kg) bag of QUIKRETE® Mason Mix will lay up to 37 standard bricks or 13 standard (8” x 8” x 16” [200 mm x 200 mm x 400 mm]) blocks.

TECHNICAL DATA

APPLICABLE STANDARDS

ASTM International

- ASTM C 270 Specification for Mortar for Unit Masonry
- ASTM C 387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
- ASTM C 1714 Specification for Preblended Dry Mortar Mix for Unit Masonry

PHYSICAL/CHEMICAL PROPERTIES

QUIKRETE® Mason Mix meets or exceeds the property requirements of ASTM C 270, ASTM C 387 and ASTM C 1714 for the type selected. Refer to Appendix XI of ASTM C270 for guidance in selecting the proper mortar type. See Table 1.

INSTALLATION

SURFACE PREPARATION

Surfaces to receive Mason Mix should be clean and free of dirt, loose debris, grease, oil, etc., for the best possible bond.

MIXING

- For each 80 lb (36.3 kg) bag, add 9 pt (4.3 L) of fresh water to mixer
- Turn the mixer on and begin adding bags of Mason Mix
- If the material becomes too difficult to mix, add additional water until a workable mix of trowelable consistency is obtained

Note - Final water content should be 9 - 14 pt (4.3 - 6.6 L) for each 80 lb (36.3 kg) bag and 7 - 10 pt (3.3 - 4.7 L) for each 60 lb (27.2 kg) bag.

INSTALLATION

- Apply a full bed of mortar onto the base, approximately 1/2" - 3/4" (12.7 - 19.1 mm) thick
- Push downward into the mortar bed and sideways against the previously laid block with a slight twisting motion
- Tool the mortar joints when they become thumbprint hard. This will make the mortar joint watertight and provide a neat appearance

Table 1

Hydraulic Cement- Lime Mortars or Cement Mortars			
Type	Minimum Compressive Strength, psi (MPa)	Water Retention Minimum %	Air content Maximum %
M	2500 (17.2)	75	12
S	1800 (12.4)	75	12
N	750 (5.2)	75	14[1]
O	350 (2.4)	75	14[1]
Masonry Cement Mortars			
Type	Minimum Compressive Strength, psi (MPa)	Water Retention Minimum %	Air content Maximum %
M	2500 (17.2)	75	18
S	1800 (12.4)	75	18
N	750 (5.2)	75	20[2]
O	350 (2.4)	75	20[2]

[1] When structural reinforcement is included, the maximum air content shall be 12%

[2] When structural reinforcement is included, the maximum air content shall be 18%

CURING

Curing of masonry mortars is required only if conditions are very hot, dry or windy. In such cases, a gentle mist of water applied to the surface will prevent premature drying and improve the strength of the mortar.

PRECAUTIONS

Variations in mix water amount, mix time, curing conditions and finishing will cause color variations.

WARRANTY

The QUIKRETE® Companies warrant this product to be of merchantable quality when used or applied in accordance with the instructions herein. The product is not warranted as suitable for any purpose or use other than the general purpose for which it is intended. Liability under this warranty is limited to the replacement of its product (as purchased) found to be defective, or at the shipping companies' option, to refund the purchase price. In the event of a claim under this warranty, notice must be given to The QUIKRETE® Companies in writing. This limited warranty is issued and accepted in lieu of all other express warranties and expressly excludes liability for consequential damages.

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2 Preservation Briefs

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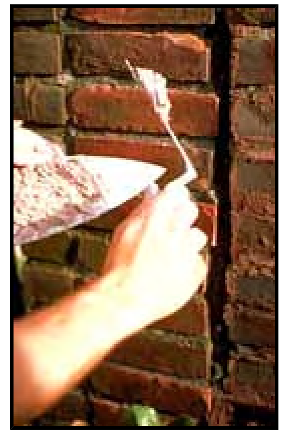


Repointing Mortar Joints in Historic Masonry Buildings

Robert C. Mack, FAIA, and John P. Speweik

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Masonry--brick, stone, terra-cotta, and concrete block--is found on nearly every historic building. Structures with all-masonry exteriors come to mind immediately, but most other buildings at least have masonry foundations or chimneys. Although generally considered "permanent," masonry is subject to deterioration, especially at the mortar joints. Repointing, also known simply as "pointing"or--somewhat inaccurately--"tuck pointing"*, is the process of removing deteriorated mortar from the joints of a masonry wall and replacing it with new mortar. Properly done, repointing restores the visual and physical integrity of the masonry. Improperly done, repointing not only detracts from the appearance of the building, but may also cause physical damage to the masonry units themselves.

The purpose of this Brief is to provide general guidance on appropriate materials and methods for repointing historic masonry buildings and it is intended to benefit building owners, architects, and contractors. The Brief should serve as a guide to prepare specifications for repointing historic masonry buildings. It should also help develop sensitivity to the particular needs of historic masonry, and to assist historic building owners in working cooperatively with architects, architectural conservators and historic preservation consultants, and contractors. Although specifically intended for historic buildings, the guidance is appropriate for other masonry buildings as well. This publication updates *Preservation Briefs 2: Repointing Mortar Joints in Historic Brick*

Buildings to include all types of historic unit masonry. The scope of the earlier Brief has also been expanded to acknowledge that the many buildings constructed in the first half of the 20th century are now historic and eligible for listing in the National Register of Historic Places, and that they may have been originally constructed with portland cement mortar.

**Tuckpointing technically describes a primarily decorative application of a raised mortar joint or lime putty joint on top of flush mortar joints.*

Historical Background

Mortar consisting primarily of lime and sand has been used as an integral part of masonry structures for thousands of years. Up until about the mid-19th century, lime or quicklime (sometimes called lump lime) was delivered to construction sites, where it had to be slaked, or combined with water. Mixing with water caused it to boil and resulted in a wet lime putty that was left to mature in a pit or wooden box for several weeks, up to a year. Traditional mortar was made from lime putty, or slaked lime, combined with local sand, generally in a ratio of 1 part lime putty to 3 parts sand by volume. Often other ingredients, such as crushed marine shells (another source of lime), brick dust, clay, natural cements, pigments, and even animal hair were also added to mortar, but the basic formulation for lime putty and sand mortar remained unchanged for centuries until the advent of portland cement or its forerunner, Roman cement, a natural, hydraulic cement.

Portland cement was patented in Great Britain in 1824. It was named after the stone from Portland in Dorset which it resembled when hard. This is a fast-curing, hydraulic cement which hardens under water. Portland cement was first manufactured in the United States in 1872, although it was imported before this date. But it was not in common use throughout the country until the early 20th century. Up until the turn of the century portland cement was considered primarily an additive, or "minor ingredient" to help accelerate mortar set time. By the 1930s, however, most masons used a mix of equal parts portland cement and lime putty. Thus, the mortar found in masonry structures built between 1873 and 1930 can range from pure lime and sand mixes to a wide variety of lime, portland cement, and sand combinations.

In the 1930s more new mortar products intended to hasten and simplify masons' work were introduced in the U.S. These included **masonry cement**, a premixed, bagged mortar which is a combination of portland cement and ground limestone, and **hydrated lime**, machine-slaked lime that eliminated the necessity of slaking quicklime into putty at the site.

Identifying the Problem Before Repointing

The decision to repoint is most often related to some obvious sign of deterioration, such as disintegrating mortar, cracks in mortar joints, loose bricks or stones, damp walls, or damaged plasterwork. It is, however, erroneous to assume that repointing alone will solve deficiencies that result from other problems. The root cause of the deterioration--leaking roofs or gutters, differential settlement of the building, capillary action causing rising damp, or extreme weather exposure--should always be dealt with prior to beginning work. Without appropriate repairs to eliminate the source of the problem, mortar deterioration will continue and any repointing will have been a waste of time and money.

Masons practice using lime putty mortar to repair historic marble. Photo: NPS files.

Use of Consultants. Because there are so many possible causes for deterioration in historic buildings, it may be desirable to retain a consultant, such as a historic architect or architectural conservator, to analyze the building. In addition to determining the most appropriate solutions to the problems, a consultant can prepare specifications which reflect the particular requirements of each job and can provide oversight of the work in progress. Referrals to preservation consultants frequently can be obtained from State Historic Preservation Offices, the American Institute for Conservation of Historic and Artistic Works (AIC), the Association for Preservation Technology (APT), and local chapters of the American Institute of Architects (AIA).

Finding an Appropriate Mortar Match

Preliminary research is necessary to ensure that the proposed repointing work is both physically and visually appropriate to the building. Analysis of unweathered portions of the historic mortar to which the new mortar will be matched can suggest appropriate mixes for the repointing mortar so that it will not damage the building because it is excessively strong or vapor impermeable. Examination and analysis of the masonry units--brick, stone or terra cotta--and the techniques used in the original construction will assist in maintaining the building's historic appearance. A simple, non- technical, evaluation of the masonry units and mortar can provide information concerning the relative strength and permeability of each--critical factors in selecting the repointing mortar--while a visual analysis of the historic mortar can provide the information necessary for developing the new mortar mix and application techniques.

This late 19th century granite has recently been repointed with the joint profile and mortar color carefully matched to the original. Photo: NPS files.

Although not crucial to a successful repointing project, for projects involving properties of special historic significance, a mortar analysis by a qualified laboratory can be useful by providing information on the original ingredients. However, there are limitations with such an analysis, and replacement mortar specifications should not be based solely on laboratory analysis. Analysis requires interpretation, and there are important factors which affect the condition and performance of the mortar that cannot be established through laboratory analysis. These may include: the original water content, rate of curing, weather conditions during original construction, the method of mixing and placing the mortar, and the cleanliness and condition of the sand. *The most useful information that can come out of laboratory analysis is the identification of sand by gradation and color.* This allows the color and the texture of the mortar to be matched with some accuracy because sand is the largest ingredient by volume.

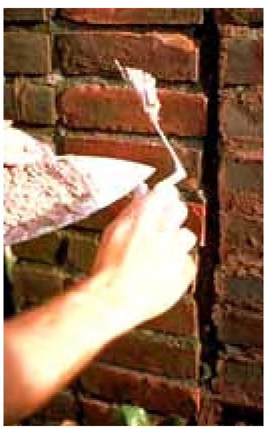
In creating a repointing mortar that is compatible with the masonry units, the objective is to achieve one that matches the historic mortar as closely as possible, so that the new material can coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity. The exact physical and chemical properties of the historic mortar are not of major significance as long as the new mortar conforms to the following criteria:

- The new mortar must match the historic mortar in **color, texture and tooling.** (If a laboratory analysis is undertaken, it may be possible to match the binder components and their proportions with the historic mortar, if those materials are available.)

- The **sand must match the sand** in the historic mortar. (The color and texture of the new mortar will usually fall into place if the sand is matched successfully.)

- The new mortar must have **greater vapor permeability** and be **softer** (measured in compressive strength) than the masonry units.

- The new mortar must be **as vapor permeable** and **as soft or softer** (measured in compressive strength) than the historic mortar. (Softness or hardness is not necessarily an indication of permeability; old, hard lime mortars can still retain high permeability.)



This mortar is the proper consistency for repointing historic brick. Photo: John P. Speweik.

Mortar Analysis

Methods for analyzing mortars can be divided into two broad categories: **wet chemical** and **instrumental.** Many laboratories that analyze historic mortars use a simple **wet-chemical** method called acid digestion, whereby a sample of the mortar is crushed and then mixed with a dilute acid. The acid dissolves all the carbonate-containing minerals not only in the binder, but also in the aggregate (such as oyster shells, coral sands, or other carbonate-based materials), as well as any other acid-soluble materials. The sand and fine-grained acid-insoluble material is left behind. There are several variations on the simple acid digestion test. One involves collecting the carbon dioxide gas given off as the carbonate is digested by the acid; based on the gas volume the carbnate content of the mortar can be accurately determined (Jedrzejewska, 1960). Simple acid digestion methods are rapid, inexpensive, and easy to perform, but the information they provide about the original composition of a mortar is limited to the color and texture of the sand. The gas collection method provides more information about the binder than a simple acid digestion test.

Instrumental analysis methods that have been used to evaluate mortars include polarized light or thin-section microscopy, scanning electron microscopy, atomic absorption spectroscopy, X-ray diffraction, and differential thermal analysis. All instrumental methods require not only expensive, specialized equipment, but also highly-trained experienced analysts. However, instrumental methods can provide much more information about a mortar. Thin-section microscopy is probably the most commonly used instrumental method. Examination of thin slices of a mortar in transmitted light is often used to supplement acid digestion methods, particularly to look for carbonate-based aggregate. For example, the new ASTM test method, ASTM C 1324-96 "Test Method for Examination and Analysis of Hardened Mortars" which was designed specifically for the analysis of modern lime-cement and masonry cement mortars, combines a complex series of wet chemical analyses with thin-section microscopy.

The drawback of most mortar analysis methods is that mortar samples of known composition have not been analyzed in order to evaluate the method. Historic mortars were not prepared to narrowly defined specifications from materials of uniform quality; they contain a wide array of locally derived materials combined at the discretion of the mason. While a particular method might be able to accurately determine the original proportions of a lime-cement-sand mortar prepared from modern materials, the usefulness of that method for evaluating historic mortars is questionable unless it has been tested against mortars prepared from materials more commonly used in the past. **Lorraine Schnabel.**

Properties of Mortar

Mortars for repointing should be softer or more permeable than the masonry units and no harder or more impermeable than the historic mortar to prevent damage to the masonry units. It is a common error to assume that hardness or high strength is a measure of appropriateness, particularly for lime-based historic mortars. Stresses within a wall caused by expansion, contraction, moisture migration, or settlement must be accommodated in some manner; in a masonry wall, these stresses should be relieved by the mortar rather than by the masonry units. A mortar that is stronger in compressive strength than the masonry units will not "give," thus causing stresses to be relieved through the masonry units--resulting in permanent damage to the masonry, such as cracking and spalling, that cannot be repaired easily.

While stresses can also break the bond between the mortar and the masonry units, permitting water to penetrate the resulting hairline cracks, this is easier to correct in the joint through repointing than if the break occurs in the masonry units.


This early 19th century building is being repointed with lime mortar. Photo: Travis McDonald.

Permeability, or rate of vapor transmission, is also critical. High lime mortars are more permeable than denser cement mortars. Historically, mortar acted as a bedding material--not unlike an expansion joint--rather than a "glue" for the masonry units, and moisture was able to migrate through the mortar joints rather than the masonry units. When moisture evaporates from the masonry it deposits any soluble salts either on the surface as *efflorescence* or below the surface as *subflorescence.* While salts deposited on the surface of masonry units are usually relatively harmless, salt crystallization within a masonry unit creates pressure that can cause parts ofthe outer surface to spall off or delaminate. If the mortar does not permitmoisture or moisture vapor to migrate out of the wall and evaporate, theresult will be damage to the masonry units.

Components of Mortar

Sand. Sand is the largest component of mortar and the material that gives mortar its distinctive color, texture and cohesiveness. Sand must be free of impurities, such as salts or clay. The three key characteristics of sand are: particle shape, gradation and void ratios.

When viewed under a magnifying glass or low-power microscope, particles of sand generally have either rounded edges, such as found in beach and river sand, or sharp, angular edges, found in crushed or manufactured sand. For repointing mortar, rounded or natural sand is preferred for two reasons. It is usually similar to the sand in the historic mortar and provides a better visual match. It also has better working qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the remaining historic mortar and the surface of the adjacent masonry units. Although manufactured sand is frequently more readily available, it is usually possible to locate a supply of rounded sand.

The gradation of the sand (particle size distribution) plays a very important role in the durability and cohesive properties of a mortar. Mortar must have a certain percentage of large to small particle sizes in order to deliver the optimum performance. Acceptable guidelines on particle size distribution may be found in ASTM C 144 (American Society for Testing and Materials). However, in actuality, since neither historic nor modern sands are always in compliance with ASTM C 144, matching the same particle appearance and gradation usually requires sieving the sand.

A scoop of sand contains many small voids between the individual grains. A mortar that performs well fills all these small voids with binder (cement/lime combination or mix) in a balanced manner. Well-graded sand generally has a 30 per cent void ratio by volume. Thus, 30 per cent binder by volume generally should be used, unless the historic mortar had a different binder: aggregate ratio. This represents the 1:3 binder to sand ratios often seen in mortar specifications.

For repointing, sand generally should conform to ASTM C 144 to assure proper gradation and freedom from impurities; some variation may be necessary to match the original size and gradation. Sand color and texture also should match the original as closely as possible to provide the proper color match without other additives.

Lime. Mortar formulations prior to the late-19th century used lime as the primary binding material. Lime is derived from heating limestone at high temperatures which burns off the carbon dioxide, and turns the limestone into quicklime. There are three types of limestone--calcium, magnesium, and dolomitic--differentiated by the different levels of magnesium carbonate they contain which impart specific qualities to mortar. Historically, calcium lime was used for mortar rather than the dolomitic lime (calcium magnesium carbonate) most often used today. But it is also important to keep in mind the fact that the historic limes, and other components of mortar, varied a great deal because they were natural, as opposed to modern lime which is manufactured and, therefore, standardized. Because some of the kinds of lime, as well as other components of mortar, that were used historically are no longer readily available, even when a conscious effort is made to replicate a "historic" mix, this may not be achievable due to the differences between modern and historic materials.

Lime, itself, when mixed with water into a paste is very plastic and creamy. It will remain workable and soft indefinitely, if stored in a

Caulking was inappropriately used here in place of mortar on the top of the wall. As a result, it has not been durable. Photo: NPS files.

sealed container. Lime (calcium hydroxide) hardens by carbonation absorbing carbon dioxide primarily from the air, converting itself to calcium carbonate. Once a lime and sand mortar is mixed and placed in a wall, it begins the process of carbonation. If lime mortar is left to dry too rapidly, carbonation of the mortar will be reduced, resulting in poor adhesion and poor durability. In addition, lime mortar is slightly water soluble and thus is able to re-seal any hairline cracks that may develop during the life of the mortar. Lime mortar is soft, porous, and changes little in volume during temperature fluctuations thus making it a good choice for historic buildings. *Because of these qualities, high calcium lime mortar may be considered for many repointing projects, not just those involving historic buildings.*

For repointing, lime should conform to ASTM C 207, Type S, or Type SA, Hydrated Lime for Masonry Purposes. This machine-slaked lime is designed to assure high plasticity and water retention. The use of quicklime which must be slaked and soaked by hand may have advantages over hydrated lime in some restoration projects if time and money allow.

Lime putty. Lime putty is slaked lime that has a putty or paste-like consistency. It should conform to ASTM C 5. Mortar can be mixed using lime putty according to ASTM C 270 property or proportion specification.

Portland cement. More recent, 20th-century mortar has used portland cement as a primary binding material. A straight portland cement and sand mortar is extremely hard, resists the movement of water, shrinks upon setting, and undergoes relatively large thermal movements. When mixed with water, portland cement forms a harsh, stiff paste that is quite unworkable, becoming hard very quickly. (Unlike lime, portland cement will harden regardless of weather conditions and does not require wetting and drying cycles.) Some portland cement assists the workability and plasticity of the mortar without adversely affecting the finished project; it also provides early strength to the mortar and speeds setting. Thus, it may be appropriate to add some portland cement to an essentially lime-based mortar even when repointing relatively soft 18th or 19th century brick under some circumstances when a slightly harder mortar is required. The more portland cement that is added to a mortar formulation the harder it becomes--and the faster the initial set.

For repointing, portland cement should conform to ASTM C 150. White, non- staining portland cement may provide a better color match for some historic mortars than the more commonly available grey portland cement. But, it should not be assumed, however, that white portland cement is always appropriate for all historic buildings, since the original mortar may have been mixed with grey cement. The cement should not have more than 0.60 per cent alkali to help avoid efflorescence.

Masonry cement. Masonry cement is a preblended mortar mix commonly found at hardware and home repair stores. It is designed to produce mortars with a compressive strength of 750 psi or higher when mixed with sand and water at the job site. It may contain hydrated lime, but it always contains a large amount of portland cement, as well as ground limestone and other workability agents, including air-entraining agents.

Because masonry cements are not required to contain hydrated lime, and generally do not contain lime, they produce high strength mortars that can damage historic masonry. *For this reason, they generally are not recommended for use on historic masonry buildings.*

Lime mortar (pre-blended). Hydrated lime mortars, and pre-blended lime putty mortars with or without a matched sand are commercially available. Custom mortars are also available with color. In most instances, pre-blended lime mortars containing sand may not provide an exact match; however, if the project calls for total repointing, a pre-blended lime mortar may be worth considering as long as the mortar is compatible in strength with the masonry. If the project involves only selected, "spot" repointing, then it may be better to carry out a mortar analysis which can provide a custom pre-blended lime mortar with a matching sand. In either case, if a preblended lime mortar is to be used, it should contain Type S or SA hydrated lime conforming to ASTM C 207.

Water. Water should be potable--clean and free from acids, alkalis, or other dissolved organic materials.

Other Components

Historic components. In addition to the color of the sand, the texture of the mortar is of critical importance in duplicating historic mortar. Most mortars dating from the mid-19th century on--with some exceptions--have a fairly homogeneous texture and color. Some earlier mortars are not as uniformly textured and may contain lumps of partially burned lime or "dirty lime", shell (which often provided a source of lime, particularly in coastal areas), natural cements, pieces of clay, lampblack or other pigments, or even animal hair. The visual characteristics of these mortars can be duplicated through the use of similar materials in the repointing mortar.

Replicating such unique or individual mortars will require writing new specifications for each project. If possible, suggested sources for special materials should be included. For example, crushed oyster shells can be obtained in a variety of sizes from poultry supply dealers.

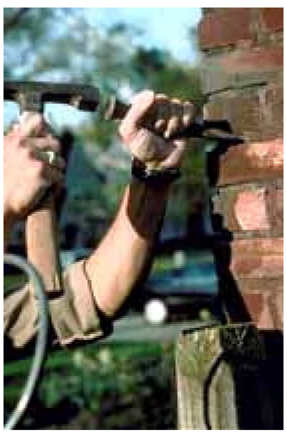
Pigments. Some historic mortars, particularly in the late 19th century, were tinted to match or contrast with the brick or stone. Red pigments, sometimes in the form of brick dust, as well as brown, and black pigments were commonly used. Modern pigments are available which can be added to the mortar at the job site, but they should not exceed 10 per cent by weight of the portland cement in the mix, and carbon black should be limited to 2 per cent. Only synthetic mineral oxides, which are alkali-proof and sun-fast, should be used to prevent bleaching and fading.

Modern components. Admixtures are used to create specific characteristics in mortar, and whether they should be used will depend upon the individual project. *Air entraining agents*, for example, help the mortar to resist freeze-thaw damage in northern climates. *Accelerators* are used to reduce mortar freezing prior to setting while *retarders* help to extend the mortar life in hot climates. Selection of admixtures should be made by the architect or architectural conservator as part of the specifications, not something routinely added by the masons.

Generally, modern chemical additives are unnecessary and may, in fact, have detrimental effects in historic masonry projects. The use of antifreeze compounds is not recommended. They are not very effective with high lime mortars and may introduce salts, which may cause efflorescence later. A better practice is to warm the sand and water, and to protect the completed work from freezing. No definitive study has determined whether air-entraining additives should be used to resist frost action and enhance plasticity, but in areas of extreme exposure requiring high-strength mortars with lower permeability, air-entrainment of 10-16 percent may be desirable (see formula for "severe weather exposure" in **Mortar Type and Mix**). Bonding agents are not a substitute for proper joint preparation, and they should generally be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces. In addition, a bonding agent is difficult to remove if smeared on a masonry surface.

Mortar Type and Mix

Mortars for repointing projects, especially those involving historic buildings, typically are custom mixed in order to ensure the proper physical and visual qualities. These materials can be combined in varying proportions to create a mortar with the desired performance and durability. The actual specification of a particular mortar type should take into consideration all of the factors affecting the life of the building including: current site conditions, present condition of the masonry, function of the new mortar, degree of weather exposure, and skill of the mason. Thus, no two repointing projects are exactly the same. Modern materials specified for use in repointing mortar should conform to specifications of the American Society for Testing and Materials (ASTM) or comparable federal specifications, and the resulting mortar should conform to ASTM C 270, Mortar for Unit Masonry.



Here, a hammer and chisel are being correctly used to prepare a joint for repointing. Photo: John P. Speweik.

Specifying the proportions for the repointing mortar for a specific job is not as difficult as it might seem. Five mortar types, each with a corresponding recommended mix, have been established by ASTM to distinguish high strength mortar from soft flexible mortars. The ASTM designated them in decreasing order of approximate general strength as Type M (2,500 psi), Type S (1,800 psi), Type N (750 psi), Type O (350 psi) and Type K (75 psi). (The letters identifying the types are from the words MASON WORK using every other letter.) Type K has the highest lime content of the mixes that contain portland cement, although it is seldom used today, except for some historic preservation projects. The designation "L" in the accompanying chart identifies a straight lime and sand mix. Specifying the appropriate ASTM mortar by proportion of ingredients, will ensure the desired physical properties. Unless specified otherwise, measurements or proportions for mortar mixes are always given in the following order: cement-lime-sand. Thus, a Type K mix, for example, would be referred to as 1-3-10, or 1 part cement to 3 parts lime to 10 parts sand. Other requirements to create the desired visual qualities should be included in the specifications.

The strength of a mortar can vary. If mixed with higher amounts of portland cement, a harder mortar is obtained. The more lime that is added, the softer and more plastic the mortar becomes, increasing its workability. A mortar strong in compressive strength might be desirable for a hard stone (such as granite) pier holding up a bridge deck, whereas a softer, more permeable lime mortar would be preferable for a historic wall of soft brick. Masonry deterioration caused by salt deposition results when the mortar is less permeable than the masonry unit. A strong mortar is still more permeable than hard, dense stone. However, in a wall constructed of soft bricks where the masonry unit itself has a relatively high permeability or vapor transmission rate, a soft, high lime mortar is necessary to retain sufficient permeability.

Budgeting and Scheduling

Repointing is both expensive and time consuming due to the extent of handwork and special materials required. It is preferable to repoint only those areas that require work rather than an entire wall, as is often specified. But, if 25 to 50 per cent or more of a wall needs to be repointed, repointing the entire wall may be more cost effective than spot repointing. Total repointing may also be more sensible when access is difficult, requiring the erection of expensive scaffolding (unless the majority of the mortar is sound and unlikely to require replacement in the foreseeable future). Each project requires judgement based on a variety of factors. Recognizing this at the outset will help to prevent many jobs from becoming prohibitively expensive.

When repairing this stone wall, the mason matched the raised profile of the original tuckpointing. Photo: NPS files.

In scheduling, seasonal aspects need to be considered first. Generally speaking, wall temperatures between 40 and 95 degrees F (8 and 38 degrees C) will prevent freezing or excessive evaporation of the water in the mortar. Ideally, repointing should be done in shade, away from strong sunlight in order to slow the drying process, especially during hot weather. If necessary, shade can be provided for large-scale projects with appropriate modifications to scaffolding.

The relationship of repointing to other work proposed on the building must also be recognized. For example, if paint removal or cleaning is anticipated, and if the mortar joints are basically sound and need only selective repointing, it is generally better to postpone repointing until after completion of these activities. However, if the mortar has eroded badly, allowing moisture to penetrate deeply into the wall, repointing should be accomplished before cleaning. Related work, such as structural or roof repairs, should be scheduled so that they do not interfere with repointing and so that all work can take maximum advantage of erected scaffolding.

Building managers also must recognize the difficulties that a repointing project can create. The process is time consuming, and scaffolding may need to remain in place for an extended period of time. The joint preparation process can be quite noisy and can generate large quantities of dust which must be controlled, especially at air intakes to protect human health, and also where it might damage operating machinery. Entrances may be blocked from time to time making access difficult for both building tenants and visitors. Clearly, building managers will need to coordinate the repointing work with other events at the site.

Contractor Selection

The ideal way to select a contractor is to ask knowledgeable owners of recently repointed historic buildings for recommendations. Qualified contractors then can provide lists of

A mechanical grinder improperly used to cut out the horizontal joint and incompatible repointing have seriously damaged the 19th century brick. Photo: NPS files.

other repointing projects for inspection. More commonly, however, the contractor for a repointing project is selected through a competitive bidding process over which the client or consultant has only limited control. In this situation it is important to ensure that the specifications stipulate that masons must have a minimum of five years' experience with repointing historic masonry buildings to be eligible to bid on the project. Contracts are awarded to the lowest responsible bidder, and bidders who have performed poorly on other projects usually can be eliminated from consideration on this basis, even if they have the lowest prices.

The contract documents should call for unit prices as well as a base bid. Unit pricing forces the contractor to determine in advance what the cost addition or reduction will be for work which varies from the scope of the base bid. If, for example, the contractor has fifty linear feet less of stone repointing than indicated on the contract documents but thirty linear feet more of brick repointing, it will be easy to determine the final price for the work. Note that each type of work--brick repointing, stone repointing, or similar items--will have its own unit price. The unit price also should reflect quantities; one linear foot of pointing in five different spots will be more expensive than five contiguous linear feet.

Execution of the Work

Test Panels. These panels are prepared by the contractor using the same techniques that will be used on the remainder of the project. Several panel locations--preferably not on the front or other highly visible location of the building--may be necessary to include all types of masonry, joint styles, mortar colors, and other problems likely to be encountered on the job. If cleaning tests, for example, are also to be undertaken, they should be carried out in the same location. Usually a 3 foot by 3 foot area is sufficient for brickwork, while a somewhat larger area may be required for stonework. These panels establish an acceptable standard of work and serve as a benchmark for evaluating and accepting subsequent work on the building.

Unskilled repointing has negatively impacted the character of this late-19th century building. Photo: NPS files.

Joint Preparation. Old mortar should be removed to a minimum depth of 2 to 2-1/2 times the width of the joint to ensure an adequate bond and to prevent mortar "popouts." For most brick joints, this will require removal of the mortar to a depth of approximately ½ to 1 inch; for stone masonry with wide joints, mortar may need to be removed to a depth of several inches. Any loose or disintegrated mortar beyond this minimum depth also should be removed.

Although some damage may be inevitable, careful joint preparation can help limit damage to masonry units. The traditional manner of removing old mortar is through the use of hand chisels and mash hammers. Though labor-intensive, in most instances this method poses the least threat for damage to historic masonry units and produces the best final product.

The most common method of removing mortar, however, is through the use of power saws or grinders. The use of power tools by unskilled masons can be disastrous for historic masonry, particularly soft brick. Using power saws on walls with thin joints, such as most brick walls, almost always will result in damage to the masonry units by breaking the edges and by overcutting on the head, or vertical joints.

However, small pneumatically-powered chisels generally can be used safely and effectively to remove mortar on historic buildings as long as the masons maintain appropriate control over the equipment. Under certain circumstances, thin diamond-bladed grinders may be used to cut out *horizontal* joints only on hard portland cement mortar common to most early-20th century masonry buildings. Usually, automatic tools most successfully remove old mortar without damaging the masonry units when they are used in combination with hand tools in preparation for repointing. Where horizontal joints are uniform and fairly wide, it may be possible to use a power masonry saw to assist the removal of mortar, such as by cutting along the middle of the joint; final mortar removal from the sides of the joints still should be done with a hand chisel and hammer. Caulking cutters with diamond blades can sometimes be used successfully to cut out joints without damaging the masonry. Caulking cutters are slow; they do not rotate, but vibrate at very high speeds, thus minimizing the possibility of damage to masonry units. Although mechanical tools may be safely used in limited circumstances to cut out horizontal joints in preparation for repointing, they should never be used on vertical joints because of the danger of slipping and cutting into the brick above or below the vertical joint. Using power tools to remove mortar without damaging the surrounding masonry units also necessitates highly skilled masons experienced in working on historic masonry buildings. Contractors should demonstrate proficiency with power tools before their use is approved.

Using any of these power tools may also be more acceptable on hard stone, such as quartzite or granite, than on terra cotta with its glass-like glaze, or on soft brick or stone. The test panel should determine the acceptability of power tools. If power tools are to be permitted, the contractor should establish a quality control program to account for worker fatigue and similar variables.

Mortar should be removed cleanly from the masonry units, leaving square corners at the back of the cut. Before filling, the joints should be rinsed with a jet of water to remove all loose particles and dust. At the time of filling, the joints should be damp, but with no standing water present. For masonry walls--limestone, sandstone and common brick--that are extremely absorbent, it is recommended that a continual mist of water be applied for a few hours before repointing begins.

Mortar Preparation. Mortar components should be measured and mixed carefully to assure the uniformity of visual and physical characteristics. Dry ingredients are measured by volume and thoroughly mixed before the addition of any water. Sand must be added in a damp, loose condition to avoid over sanding. Repointing mortar is typically pre-hydrated by adding water so it will just hold together, thus allowing it to stand for a period of time before the final water is added. Half the water should be added, followed by mixing for approximately 5 minutes. The remaining water should then be added in small portions until a mortar of the desired consistency is reached. The total volume of water necessary may vary from batch to batch, depending on weather conditions. It is important to keep the water to a minimum for two reasons: first, a drier mortar is cleaner to work with, and it can be compacted tightly into the joints; second, with no excess water to evaporate, the mortar cures without shrinkage cracks. Mortar should be used within approximately 30 minutes of final mixing, and "retempering," or adding more water, should not be permitted.

Using Lime Putty to Make Mortar. Mortar made with lime putty and sand, sometimes referred to as roughage or course stuff, should be measured by volume, and may require slightly different proportions from those used with hydrated lime. No additional water is usually needed to achieve a workable consistency because enough water is already contained in the putty. Sand is proportioned first, followed by the lime putty, then mixed for five minutes or until all the sand is thoroughly coated with the lime putty. But mixing, in the familiar sense of turning over with a hoe, sometimes may not be sufficient if the best possible performance is to be obtained from a lime putty mortar. Although the old practice of chopping, beating and ramming the mortar has largely been forgotten, recent field work has confirmed that lime putty and sand rammed and beaten with a wooden mallet or ax handle, interspersed by chopping with a hoe, can significantly improve workability and performance. The intensity of this action increases the overall lime/sand contact and removes any surplus water by compacting the other ingredients. It may also be advantageous for larger projects to use a mortar pan mill for mixing. Mortar pan mills which have a long tradition in Europe produce a superior lime putty mortar not attainable with today's modern paddle and drum type mixers.

For larger repointing projects the lime putty and sand can be mixed together ahead of time and stored indefinitely, on or off site, which eliminates the need for piles of sand on the job site. This mixture, which resembles damp brown sugar, must be protected from the air in sealed containers with a wet piece of burlap over the top or sealed in a large plastic bag to prevent evaporation and premature carbonation. The lime putty and sand mixture can be recombined into a workable plastic state months later with no additional water.

If portland cement is specified in a lime putty and sand mortar--Type O (1:2:9) or Type K (1:3:11)--the portland cement should first be mixed into a slurry paste before adding it to the lime putty and sand. Not only will this ensure that the portland cement is evenly distributed throughout the mixture, but if dry portland cement is added to wet ingredients it tends to "ball up," jeopardizing dispersion. (Usually water must be added to the lime putty and sand anyway once the portland cement is introduced.) Any color pigments should be added at this stage and mixed for a full five minutes. The mortar should be used within 30 minutes to 1½ hours and it should not be retempered. Once portland cement has been added the mortar can no longer be stored.

Filling the Joint. Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately 1/4 inch of mortar, packing it well into the back corners. This application may extend along the wall for several feet. As soon as the mortar has reached thumb-print hardness, another 1/4 inch layer of mortar--approximately the same thickness--may be applied. Several layers will be needed to fill the joint flush with the outer surface of the masonry. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process and layering thus minimizes overall shrinkage.

When the final layer of mortar is thumb-print hard, the joint should be tooled to match the historic joint. Proper timing of the tooling is important for uniform color and appearance. If tooled when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the masonry units will not be achieved.

If the old bricks or stones have worn, rounded edges, it is best to recess the final mortar slightly from the face of the masonry. This treatment will help avoid a joint which is visually wider than the actual joint; it also will avoid creation of a large, thin featheredge which is easily damaged, thus admitting water. After tooling, excess mortar can be removed from the edge of the joint by brushing with a natural bristle or nylon brush. Metal bristle brushes should never be used on historic masonry.

Curing Conditions. The preliminary hardening of high-lime content mortars--those mortars that contain more lime by volume than portland cement, i.e., Type O (1:2:9), Type K (1:3:11), and straight lime/sand, Type "L" (0:1:3)--takes place fairly rapidly as water in the mix is lost to the porous surface of the masonry and through evaporation. A high lime mortar (especially Type "L") left to dry out too rapidly can result in chalking, poor adhesion, and poor durability. Periodic wetting of the repointed area after the mortar joints are thumb-print hard and have been finish tooled may significantly accelerate the carbonation process. When feasible, misting using a hand sprayer with a fine nozzle can be simple to do for a day or two after repointing. Local conditions will dictate the frequency of wetting, but initially it may be as often as every hour and gradually reduced to every three or four hours. Walls should be covered with burlap for the first three days after repointing. (Plastic may be used, but it should be tented out and not placed directly against the wall.) This helps keep the walls damp and protects them from direct sunlight. Once carbonation of the lime has begun, it will continue for many years and the lime will gain strength as it reverts back to calcium carbonate within the wall.

This 18th century pediment and surrounding wall exhibit distinctively different mortar joints. Photo: NPS files.

***Aging* the Mortar.** Even with the best efforts at matching the existing mortar color, texture, and materials, there will usually be a visible difference between the old and new work, partly because the new mortar has been matched to the unweathered portions of the historic mortar. Another reason for a slight mismatch may be that the sand is more exposed in old mortar due to the slight erosion of the lime or cement. Although spot repointing is generally preferable and some color difference should be acceptable, if the difference between old and new mortar is too extreme, it may be advisable in some instances to repoint an entire area of a wall, or an entire feature such as a bay, to minimize the difference between the old and the new mortar. If the mortars have been properly matched, usually the best way to deal with surface color differences is to let the mortars age naturally. Other treatments to overcome these differences, including cleaning the non-repointed areas or staining the new mortar, should be carefully tested prior to implementation.

Staining the new mortar to achieve a better color match is generally not recommended, but it may be appropriate in some instances. Although staining may provide an initial match, the old and new mortars may weather at different rates, leading to visual differences after a few seasons. In addition, the mixtures used to stain the mortar may be harmful to the masonry; for example, they may introduce salts into the masonry which can lead to efflorescence.

Cleaning the Repointed Masonry. If repointing work is carefully executed, there will be little need for cleaning other than to remove the small amount of mortar from the edge of the joint following tooling. This can be done with a stiff natural bristle or nylon brush after the mortar has dried, but before it is initially set (1-2 hours). Mortar that has hardened can usually be removed with a wooden paddle or, if necessary, a chisel.

Further cleaning is best accomplished with plain water and natural bristle or nylon brushes. If chemicals must be used, they should be selected with extreme caution. Improper cleaning can lead to deterioration of the masonry units, deterioration of the mortar, mortar smear, and efflorescence. New mortar joints are especially susceptible to damage because they do not become fully cured for several months. Chemical cleaners, particularly acids, should never be used on dry masonry. The masonry should always be completely soaked once with water before chemicals are applied. After cleaning, the walls should be flushed again with plain water to remove all traces of the chemicals.

Several precautions should be taken if a freshly repointed masonry wall is to be cleaned. First, the mortar should be fully hardened before cleaning. Thirty days is usually sufficient, depending on weather and exposure; as mentioned previously, the mortar will continue to cure even after it has hardened. Test panels should be prepared to evaluate the effects of different cleaning methods. Generally, on newly repointed masonry walls, only very low pressure (100 psi) water washing supplemented by stiff natural bristle or nylon brushes should be used, except on glazed or polished surfaces, where only soft cloths should be used.**

New construction "bloom" or efflorescence occasionally appears within the first few months of repointing and usually disappears through the normal process of weathering. If the efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with stiff natural or nylon bristle brushes followed by wet brushing. Hydrochloric (muriatic) acid, is generally ineffective, and it should not be used to remove efflorescence. It may liberate additional salts, which, in turn, can lead to more efflorescence.

Surface Grouting is sometimes suggested as an alternative to repointing brick buildings, in particular. This process involves the application of a thin coat of cement-based grout to the mortar joints and the mortar/brick interface. To be effective, the grout must extend slightly onto the face of the masonry units, thus widening the joint visually. The change in the joint appearance can alter the historic character of the structure to an unacceptable degree. In addition, although masking of the bricks is intended to keep the grout off the remainder of the face of the bricks, some level of residue, called "veiling," will inevitably remain. Surface grouting cannot substitute for the more extensive work of repointing, and it is not a recommended treatment for historic masonry.

***Additional information on masonry cleaning is presented in Preservation Briefs 1: Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings, Robert C. Mack, FAIA, and Anne Grimmer, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 2000; and Keeping it Clean: Removing Exterior Dirt, Paint, Stains & Graffiti from Historic Masonry Buildings, Anne E. Grimmer, Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Department of the Interior, 1988.*

Visually Examining the Mortar and the Masonry Units

A simple *in situ* comparison will help determine the hardness and condition of the mortar and the masonry units. Begin by scraping the mortar with a screwdriver, and gradually tapping harder with a cold chisel and mason's hammer. Masonry units can be tested in the same way beginning, even more gently, by scraping with a fingernail. This relative analysis which is derived from the 10-point hardness scale used to describe minerals, provides a good starting point for selection of an appropriate mortar. It is described more fully in "The Russack System for Brick & Mortar Description" referenced in **Selected Reading** at the end of this Brief.

Mortar samples should be chosen carefully, and picked from a variety of locations on the building to find unweathered mortar, if possible. Portions of the building may have been repointed in the past while other areas may be subject to conditions causing unusual deterioration. There may be several colors of mortar dating from different construction periods or sand used from different sources during the initial construction. Any of these situations can give false readings to the visual or physical characteristics required for the new mortar. Variations should be noted which may require developing more than one mix.

1) Remove with a chisel and hammer three or four unweathered samples of the mortar to be matched from several locations on the building. (Set the largest sample aside--this will be used later for comparison with the repointing mortar). Removing a full representation of samples will allow selection of a "mean" or average mortar sample.

2) Mash the remaining samples with a wooden mallet, or hammer if necessary, until they are separated into their constituent parts. There should be a good handful of the material.

3) Examine the powdered portion--the lime and/or cement matrix of the mortar. Most particularly, note the color. There is a tendency to think of historic mortars as having white binders, but grey portland cement was available by the last quarter of the 19th century, and traditional limes were also sometimes grey. Thus, in some instances, the natural color of the historic binder may be grey, rather than white. The mortar may also have been tinted to create a colored mortar, and this color should be identified at this point.

4) Carefully blow away the powdery material (the lime and/or cement matrix which bound the mortar together).

5) With a low power (10 power) magnifying glass, examine the remaining sand and other materials such as lumps of lime or shell.

6) Note and record the wide range of color as well as the varying sizes of the individual grains of sand, impurities, or other materials.

Other Factors to Consider

Color. Regardless of the color of the binder or colored additives, the sand is the primary material that gives mortar its color. A surprising variety of colors of sand may be found in a single sample of historic mortar, and the different sizes of the grains of sand or other materials, such as incompletely ground lime or cement, play an important role in the texture of the repointing mortar. Therefore, when specifying sand for repointing mortar, it may be necessary to obtain sand from several sources and to combine or screen them in order to approximate the range of sand colors and grain sizes in the historic mortar sample.

Pointing Style. Close examination of the historic masonry wall and the techniques used in the original construction will assist in maintaining the visual qualities of the building. Pointing styles and the methods of producing them should be examined. It is important to look at both the horizontal and the vertical joints to determine the order in which they were tooled and whether they were the same style. Some late-19th and early-20th century buildings, for example, have horizontal joints that were raked back while the vertical joints were finished flush and stained to match the bricks, thus creating the illusion of horizontal bands. Pointing styles may also differ from one facade to another; front walls often received greater attention to mortar detailing than side and rear walls.

Tuckpointing is not true repointing but the application of a raised joint or lime putty joint on top of flush mortar joints. **Penciling** is a purely decorative, painted surface treatment over a mortar joint, often in a contrasting color.

Masonry Units. The masonry units should also be examined so that any replacement units will match the historic masonry. Within a wall there may be a wide range of colors, textures, and sizes, particularly with hand-made brick or rough-cut, locally-quarried stone. Replacement units should blend in with the full range of masonry units rather than a single brick or stone.

Matching Color and Texture of the Repointing Mortar

New mortar should match the unweathered interior portions of the historic mortar. The simplest way to check the match is to make a small sample of the proposed mix and allow it to cure at a temperature of approximately 70 degrees F for about a week, or it can be baked in an oven to speed up the curing; this sample is then broken open and the surface is compared with the surface of the largest "saved" sample of historic mortar.

If a proper color match cannot be achieved through the use of natural sand or colored aggregates like crushed marble or brick dust, it may be necessary to use a modern mortar pigment.

During the early stages of the project, it should be determined how closely the new mortar should match the historic mortar. Will "quite close" be sufficient, or is "exactly" expected? The specifications should state this clearly so that the contractor has a reasonable idea how much time and expense will be required to develop an acceptable match.

The same judgment will be necessary in matching replacement terra cotta, stone or brick. If there is a known source for replacements, this should be included in the specifications. If a source cannot be determined prior to the bidding process, the specifications should include an estimated price for the replacement materials with the final price based on the actual cost to the contractor.

Mortar Types (Measured by volume)			
Designation	Cement	Hydrated Lime or Lime Putty	Sand
M	1	1/4	3 - 3 3/4
S	1	1/2	4 - 4 1/2
N	1	1	5 - 6
O	1	2	8 - 9
K	1	3	10 - 12
"L"	0	1	2 1/4 - 3

Suggested Mortar Types for Different Exposures			
	Exposure		
Masonry Material	Sheltered	Moderate	Severe
Very durable:	O	N	S

granite, hard-cored brick, etc.			
Moderately durable: limestone, durable stone, molded brick	K	O	N
Minimally durable: soft hand-made brick	"L"	K	O

Summary

For the Owner/Administrator. The owner or administrator of a historic building should remember that repointing is likely to be a lengthy and expensive process. First, there must be adequate time for evaluation of the building and investigation into the cause of problems. Then, there will be time needed for preparation of the contract documents. The work itself is precise, time-consuming and noisy, and scaffolding may cover the face of the building for some time. Therefore, the owner must carefully plan the work to avoid problems. Schedules for both repointing and other activities will thus require careful coordination to avoid unanticipated conflicts. The owner must avoid the tendency to rush the work or cut corners if the historic building is to retain its visual integrity and the job is to be durable.

For the Architect/Consultant. Because the primary role of the consultant is to ensure the life of the building, a knowledge of historic construction techniques and the special problems found in older buildings is essential. The consultant must assist the owner in planning for logistical problems relating to research and construction. It is the consultant's responsibility to determine the cause of the mortar deterioration and ensure that it is corrected before the masonry is repointed. The consultant must also be prepared to spend more time in project inspections than is customary in modern construction.

For the Masons. Successful repointing depends on the masons themselves. Experienced masons understand the special requirements for work on historic buildings and the added time and expense they require. The entire masonry crew must be willing and able to perform the work in conformance with the specifications, even when the specifications may not be in conformance with standard practice. At the same time, the masons should not hesitate to question the specifications if it appears that the work specified would damage the building.

Conclusion

A good repointing job is meant to last, at least 30 years, and preferably 50- 100 years. Shortcuts and poor craftsmanship result not only in diminishing the historic character of a building, but also in a job that looks bad, and will require future repointing sooner than if the work had been done correctly. The mortar joint in a historic masonry building has often been called a wall's "first line of defense." Good repointing practices guarantee the long life of the mortar joint, the wall, and the historic structure. Although careful maintenance will help preserve the freshly repointed mortar joints, it is important to remember that mortar joints are intended to be sacrificial and will probably require repointing some time in the future. Nevertheless, if the historic mortar joints proved durable for many years, then careful repointing should have an equally long life, ultimately contributing to the preservation of the entire building.

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Useful Addresses

Brick Institute of America
11490 Commerce Park Drive
Reston, VA 22091

National Lime Association
200 N. Glebe Road, Suite 800
Arlington, VA 22203

Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077

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Home page logo: Soft mortar for repointing. Photo: John P. Speweik.

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PRESERVATION BRIEF#3
CONSERVING ENERGY IN HISTORIC BUILDINGS

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3 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

>Conserving Energy in Historic Buildings

Baird M. Smith, AIA

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

With the dwindling supply of energy resources and new efficiency demands placed on the existing building stock, many owners of historic buildings and their architects are assessing the ability of these buildings to conserve energy with an eye to improving thermal performance. This brief has been developed to assist those persons attempting energy conservation measures and weatherization improvements such as adding insulation and storm windows or caulking of exterior building joints. In historic buildings, many measures can result in the inappropriate alteration of important architectural features, or, perhaps even worse, cause serious damage to the historic building materials through unwanted chemical reactions or moisture caused deterioration. This brief recommends measures that will achieve the greatest energy savings with the least alteration to the historic buildings, while using materials that do not cause damage and that represent sound economic investments.

Inherent Energy Saving Characteristics of Historic Buildings

Many historic buildings have energy saving physical features and devices that contribute to good thermal performance. Studies by the Energy Research and Development Administration (see bibliography) show that the buildings with the poorest energy efficiency are actually those built between 1940 and 1975.

Older buildings were found to use less energy for heating and cooling and hence probably require fewer weatherization improvements. They use less energy because they were built with a well-developed sense of physical comfort and because they maximized the natural sources of heating, lighting and ventilation. The historic building owner should understand these inherent energy-saving qualities.

Shutters can be used to minimize the problem of summer heat gain by shading the windows. Photo: NPS files.

The most obvious (and almost universal) inherent energy saving characteristic was the use of operable windows to provide natural ventilation and light. In addition, historic commercial and public buildings often include interior light/ventilation courts, rooftop ventilators, clerestories or skylights. These features provide energy efficient fresh air and light, assuring that energy consuming mechanical devices may be needed only to supplement the natural energy sources. Any time the mechanical heating and air conditioning equipment can be turned off and the windows opened, energy will be saved.

Early builders and architects dealt with the poor thermal properties of windows in two ways. First, the number of windows in a building was kept to only those necessary to provide adequate light and ventilation. This differs from the approach in many modern buildings where the percentage of windows in a wall can be nearly 100%. Historic buildings where the ratio of glass to wall is often less than 20%, are better energy conservers than most new buildings. Secondly, to minimize the heat gain or loss from windows, historic buildings often include interior or exterior shutters, interior venetian blinds, curtains and drapes, or exterior awnings. Thus, a historic window could remain an energy efficient component of a building.

This 19th c. building in Massachusetts employed several energy-conserving features in its historic design, including shade trees, roof overhangs, awnings and shutters. Photo: HABS collection, NPS.

There are other physical characteristics that enable historic buildings to be energy efficient. For instance, in the warmer climates of the United States, buildings were often built to minimize the heat gain from the summer sun. This was accomplished by introducing exterior balconies, porches, wide roof overhangs, awnings and shade trees. In addition, many of these buildings were designed with the living spaces on the second floor to catch breezes and to escape the radiant heat from the earth's surface. Also, exterior walls were often painted light colors to reflect the hot summer sun, resulting in cooler interior living spaces.

Winter heat loss from buildings in the northern climates was reduced by using heavy masonry walls, minimizing the number and size of windows, and often using dark paint colors for the exterior walls. The heavy masonry walls used so typically in the late 19th century and early 20th century, exhibit characteristics that improve their thermal performance beyond that formerly recognized. It has been determined that walls of large mass and weight (thick brick or stone) have the advantage of high thermal inertia, also known as the "M factor." This inertia modifies the thermal resistance (R factor) (1) of the wall by lengthening the time scale of heat transmission. For instance, a wall with high thermal inertia, subjected to solar radiation for an hour, will absorb the heat at its outside surface, but transfer it to the interior over a period as long as 6 hours. Conversely, a wall having the same R factor, but low thermal inertia, will transfer the heat in perhaps 2 hours.

High thermal inertia is the reason many older public and commercial buildings, without modern air conditioning, still feel cool on the inside throughout the summer. The heat from the midday sun does not penetrate the buildings until late afternoon and evening, when it is unoccupied.

Heavy masonry walls and few windows serve to maximize warmth inside. Photo: HABS collection, NPS.

Although these characteristics may not typify all historic buildings, the point is that historic buildings often have thermal properties that need little improvement. One must understand the inherent energy saving qualities of a building, and assure, by reopening the windows for instance, that the building functions as it was intended.

To reduce heating and cooling expenditures there are two broad courses of action that may be taken. First, begin passive measures to assure that a building and its existing components function as efficiently as possible without the necessity of making alterations or adding new materials. The second course of action is preservation retrofitting, which includes altering the building by making appropriate weatherization measures to improve thermal performance. Undertaking the passive measures and the preservation retrofitting recommended here could result in a 50% decrease in energy expenditures in historic buildings.

Passive Measures

The first passive measures to utilize are operational controls; that is, controlling how and when a building is used. These controls incorporate programmatic planning and scheduling efforts by the owner to minimize usage of energy-consuming equipment. A building should survey and quantify all aspects of energy usage, by evaluating the monies expended for electricity, gas, and fuel oil for a year and by surveying how and when each room is used. This will identify ways of conserving energy by initiating operational controls such as:

- lowering the thermostat in the winter, raising it in the summer
- controlling the temperature in those rooms actually used
- reducing the level of illumination and number of lights (maximize natural light)
- using operable windows, shutters, awnings and vents as originally intended to control interior environment (maximize fresh air)
- having mechanical equipment serviced regularly to ensure maximum efficiency
- cleaning radiators and forced air registers to ensure proper operation

The passive measures outlined above can save as much as 30% of the energy used in a building. They should be the first undertakings to save energy in any existing building and are particularly appropriate for historic buildings because they do not necessitate building alterations or the introduction of new materials that may cause damage. Passive measures make energy sense, common sense, and preservation sense!

Preservation Retrofitting

In addition to passive measures, building owners may undertake certain retrofitting measures that will not jeopardize the historic character of the building and can be accomplished at a reasonable cost. Preservation retrofitting improves the thermal performance of the building, resulting in another 20%30% reduction in energy.

When considering retrofitting measures, historic building owners should keep in mind that there are no permanent solutions. One can only meet the standards being applied today with today's materials and techniques. In the future, it is likely that the standards and the technologies will change and a whole new retrofitting plan may be necessary. Thus, owners of historic buildings should limit retrofitting measures to those that achieve reasonable energy savings, at reasonable costs, with the least intrusion or impact on the character of the building. Overzealous retrofitting, which introduces the risk of damage to historic building materials, should not be undertaken.

The preservation retrofitting measures presented here, were developed to address the three most common problems in historic structures caused by some retrofitting actions. The first problem concerns retrofitting actions that necessitated inappropriate building alterations, such as the wholesale removal of historic windows, or the addition of insulating aluminum siding, or installing dropped ceilings in significant interior spaces. To avoid such alterations, refer to the Secretary of the Interior's "Standards for Historic Preservation Projects" which provide the philosophical and practical basis for all preservation retrofitting measures (see last page).

The second problem area is to assure that retrofitting measures do not create moisturerelated deterioration problems. One must recognize that large quantities of moisture are present on the interior of buildings.

In northern climates, the moisture may be a problem during the winter when it condenses on cold surfaces such as windows. As the moisture passes through the walls and roof it may condense within these materials, creating the potential for deterioration. The problem is avoided if a vapor barrier is added facing in.

In southern climates, insulation and vapor barriers are handled quite differently because moisture problems occur in the summer when the moist outside air is migrating to the interior of the building. In these cases, the insulation is installed with the vapor barrier facing out (opposite the treatment of northern climates). Expert advice should be sought to avoid moisture-related problems to insulation and building materials in southern climates.

The third problem area involves the avoidance of those materials that are chemically or physically incompatible with existing materials, or that are improperly installed. A serious problem exists with certain cellulose insulations that use ammonium or aluminum sulfate as a fire retardant, rather than boric acid which causes no problems. The sulfates react with moisture in the air forming sulfuric acid which can cause damage to most metals (including plumbing and wiring), building stones, brick and wood. In one instance, a metal building insulated with cellulose of this type collapsed when the sulfuric acid weakened the structural connections! To avoid problems such as these, refer to the recommendations provided here, and consult with local officials, such as a building inspector, the better business bureau, or a consumer protection agency.

Before a building owner or architect can plan retrofitting measures, some of the existing physical conditions of the building should be investigated. The basic building components (attic, roof, walls and basement) should be checked to determine the methods of construction used and the presence of insulation. Check the insulation for full coverage and whether there is a vapor barrier. This inspection will aid in determining the need for additional insulation, what type of insulation to use (batt, blownin, or poured), and where to install it. In addition, sources of air infiltration should be checked at doors, windows, or where floor and ceiling systems meet the walls. Last, it is important to check the condition of the exterior wall materials, such as painted wooden siding or brick, and the condition of the roof, to determine the weather tightness of the building. A building owner must assure that rain and snow are kept out of the building before expending money for weatherization improvements.

Retrofitting Measures

The following listing includes the most common retrofitting measures; some measures are highly recommended for a preservation retrofitting plan, but, as will be explained, others are less beneficial or even harmful to the historic building:

- Air Infiltration
- Attic Insulation
- Storm Windows
- Basement and Crawl Space Insulation
- Duct and Pipe Insulation
- Awnings and Shading Devices
- Doors and Storm Doors
- Vestibules
- Replacement Windows
- Wall Insulation--Wood Frame
- Wall Insulation--Masonry Cavity Walls
- Wall Insulation--Installed on the Inside
- Wall Insulation--Installed on the Outside
- Waterproof Coatings for Masonry

The recommended measures to preservation retrofitting begin with those at the top of the list. The first ones are the simplest, least expensive, and offer the highest potential for saving energy. The remaining measures are not recommended for general use either because of potential technical and preservation problems, or because of the costs outweighing the anticipated energy savings. Specific solutions must be determined based on the facts and circumstances of the particular problem; therefore, advice from professionals experienced in historic preservation, such as, architects, engineers and mechanical contractors should be solicited.

Air Infiltration: Substantial heat loss occurs because cold outside air infiltrates the building through loose windows, doors, and cracks in the outside shell of the building. Adding weatherstripping to doors and windows, and caulking of open cracks and joints will substantially reduce this infiltration. Care should be taken not to reduce infiltration to the point where the building is completely sealed and moisture migration is prevented. Without some infiltration, condensation problems could occur throughout the building. Avoid caulking and weatherstripping materials that, when applied, introduce inappropriate colors or otherwise visually impair the architectural character of the building. Reducing air infiltration should be the first priority of a preservation retrofitting plan. The cost is low, little skill is required, and the benefits are substantial.

Attic Insulation: Heat rising through the attic and roof is a major source of heat loss, and reducing this heat loss should be one of the highest priorities in preservation retrofitting. Adding insulation in accessible attic spaces is very effective in saving energy and is generally accomplished at a reasonable cost, requiring little skill to install. The most common attic insulations include blankets of fiberglass and mineral wool, blownin cellulose (treated with boric acid only), blowing wool, vermiculite, and blown fiberglass. If the attic is unheated (not used for habitation), then the insulation is placed between the floor joists with the vapor barrier facing down. If flooring is present, or if the attic is heated, the insulation is generally placed between the roof rafters with the vapor barrier facing in. All should be installed according to the manufacturer's recommendations. A weatherization manual entitled, "In the Bank . . . or Up the Chimney" (see the bibliography) provides detailed descriptions about a variety of installation methods used for attic insulation. The manual also recommends the amount of attic insulation used in various parts of the country. If the attic has some insulation, add more (but without a vapor barrier) to reach the total depth recommended.

Problems occur if the attic space is not properly ventilated. This lack of ventilation will cause the insulation to become saturated and lose its thermal effectiveness. The attic is adequately ventilated when the net area of ventilation (free area of a louver or vent) equals approximately 1/300 of the attic floor area. With adequate attic ventilation, the addition of attic insulation should be one of the highest priorities of a preservation retrofitting plan.

Storm doors have been added on the inside of this historic building as an energy-conserving device. Photo: NPS files.

If the attic floor is inaccessible, or if it is impossible to add insulation along the roof rafters, consider attaching insulation to the ceilings of the rooms immediately below the attic. Some insulations are manufactured specifically for these cases and include a durable surface which becomes the new ceiling. This option should not be considered if it causes irreparable damage to historic or architectural spaces or features; however, in other cases, it could be a recommended measure of a preservation retrofitting plan.

Storm Windows: Windows are a primary source of heat loss because they are both a poor thermal barrier (R factor of only 0.89) and often a source of air infiltration. Adding storm windows greatly improves these poor characteristics. If a building has existing storm windows (either wood or metal framed), they should be retained. Assure they are tight fitting and in good working condition. If they are not in place, it is a recommended measure of a preservation retrofitting plan to add new metal framed windows on the exterior. This will result in a window assembly (historic window plus storm window) with an R factor of 1.79 which outperforms a double paned window assembly (with an air space up to 1/2") that only has an R factor of 1.72. When installing the storm windows, be careful not to damage the historic window frame. If the metal frames visually impair the appearance of the building, it may be necessary to paint them to match the color of the historic frame.

Triple-track metal storm windows are recommended because they are readily available, in numerous sizes, and at a reasonable cost. If a preassembled storm window is not available for a particular window size, and a custommade storm window is required, the cost can be very high. In this case, compare the cost of manufacture and installation with the expected cost savings resulting from the increased thermal efficiency. Generally, custom-made storm windows, of either wood or metal frames, are not cost effective, and would not be recommended in a preservation retrofitting plan.

Interior storm window installations can be as thermally effective as exterior storm windows; however, there is high potential for damage to the historic window and sill from condensation. With storm windows on the interior, the outer sash (in this case the historic sash) will be cold in the winter, and hence moisture may condense there. This condensation often collects on the flat surface of the sash or window sill causing paint to blister and the wood to begin to deteriorate. Rigid plastic sheets are used as interior storm windows by attaching them directly to the historic sash. They are not quite as effective as the storm windows described previously because of the possibility of air infiltration around the historic sash. If the rigid plastic sheets are used, assure that they are installed with minimum damage to the historic sash, removed periodically to allow the historic sash to dry, and that the historic frame and sash are completely caulked and weatherstripped.

Tinted glazing has jeopardized the character of this historic office building and is, thus, not a recommended approach. Photo: Mike Jackson.

In most cases, interior storm windows of either metal frames or of plastic sheets are not recommended for preservation retrofitting because of the potential for damage to the historic window. If interior storm windows are in place, the potential for moisture deterioration can be lessened by opening (or removing, depending on the type) the storm windows during the mild months allowing the historic window to dry thoroughly.

Basement and Crawl Space Insulation: Substantial heat is lost through cold basements and crawl spaces. Adding insulation in these locations is an effective preservation retrofitting measure and should be a high priority action. It is complicated, however, because of the excessive moisture that is often present. One must be aware of this and assure that insulation is properly installed for the specific location. For instance, in crawl spaces and certain unheated basements, the insulation is generally placed between the first floor joists (the ceiling of the basement) with the **vapor barrier facing up**. Do not staple the insulation in place, because the staples often rust away. Use special anchors developed for insulation in moist areas such as these.

In heated basements, or where the basement contains the heating plant (furnace), or where there are exposed water and sewer pipes, insulation should be installed against foundation walls. Begin the insulation within the first floor joists, and proceed down the wall to a point at least 3 feet below the exterior ground level if possible, with the **vapor barrier facing in.** Use either batt or rigid insulation.

Installing insulation in the basement or crawl space should be a high priority of a preservation retrofitting plan, as long as adequate provision is made to ventilate the unheated space, perhaps even by installing an exhaust fan.

Duct and Pipe Insulation: Wrapping insulation around heating and cooling ducts and hot water pipes, is a recommended preservation retrofitting measure. Use insulation which is intended for this use and install it according to manufacturer's recommendations. Note that air conditioning ducts will be cold in the summer, and hence moisture will condense there. Use insulation with the **vapor barrier facing out**, away from the duct. These measures are inexpensive and have little potential for damage to the historic building.

Awnings and Shading Devices: In the past, awnings and trees were used extensively to provide shade to keep buildings cooler in the summer. If awnings or trees are in place, keep them in good condition, and take advantage of their energy-saving contribution. Building owners may consider adding awnings or trees if the summer cooling load is substantial. If awnings are added, assure that they are installed without damaging the building or visually impairing its architectural character. If trees are added, select deciduous trees that provide shade in the summer but, after dropping their leaves, would allow the sun to warm the building in the winter. When planting trees, assure that they are no closer than 10 feet to the building to avoid damage to the foundations. Adding either awnings or shade trees may be expensive, but in hot climates, the benefits can justify the costs.

Awnings reduce heat gain in the summer and, when they are raised in the winter, radiant heat from the sun provides free supplementary heat. Photo: NPS files.

Doors and Storm Doors: Most historic wooden doors, if they are solid wood or paneled, have fairly good thermal properties and should not be replaced, especially if they are important architectural features. Assure that the frames and doors have proper maintenance, regular painting, and that caulking and weatherstripping is applied as necessary.

A storm door would improve the thermal performance of the historic door; however, recent studies indicate that installing a storm door is not normally cost effective in residential settings. The costs are high compared to the anticipated savings. Therefore, storm doors should only be added to buildings in cold climates, and added in such a way to minimize the visual impact on the building's appearance. The storm door design should be compatible with the architectural character of the building and may be painted to match the colors of the historic door.

Vestibules: Vestibules create a secondary air space at a doorway to reduce air infiltration occurring while the primary door is open. If a vestibule is in place, retain it. If not, adding a vestibule, either on the exterior or interior, should be carefully considered to determine the possible visual impact on the character of the building. The energy savings would be comparatively small compared to construction costs. Adding a vestibule should be considered in very cold climates, or where door use is very high, but in either case, the additional question of visual intrusion must be resolved before it is added. For most cases with historic buildings, adding a vestibule is not recommended.

Replacement Windows: Unfortunately, a common weatherization measure, especially in larger buildings, has been the replacement of historic windows with modern double paned windows. The intention was to improve the thermal performance of the existing windows and to reduce longterm maintenance costs. The evidence is clear that adding exterior storm windows is a viable alternative to replacing the historic windows and it is the recommended approach in preservation retrofitting. However, if the historic windows are severely deteriorated and their repair would be impractical, or economically infeasible, then replacement windows may be warranted. The new windows, of either wood or metal, should closely match the historic windows in size, number of panes, muntin shape, frame, color and reflective qualities of the glass.

Wall Insulation--Wood Frame: The addition of wall insulation in a wood frame building is generally not recommended as a preservation retrofitting measure because the costs are high, and the potential for damage to historic building materials is even higher. Also, wall insulation is not particularly effective for small frame buildings (one story) because the heat loss from the uninsulated walls is a relatively small percentage of the total, and part of that can be attributed to infiltration. If, however, the historic building is two or more stories, and is located in a cold climate, wall insulation may be considered if extreme care (as explained later) is exercised with its installation.

The installation of wall insulation in historic frame buildings can result in serious technical and preservation problems. As discussed before, insulation must be kept dry to function properly, and requires a vapor barrier and some provision for air movement. Introducing insulation in wall cavities, without a vapor barrier and some ventilation can be disastrous. The insulation would become saturated, losing its thermal properties, and in fact, actually increasing the heat loss through the wall. Additionally, the moisture (in vapor form) may condense into water droplets and begin serious deterioration of adjacent building materials such as sills, window frames, framing and bracing. The situation is greatly complicated, because correcting such problems could necessitate the complete (and costly) dismantling of the exterior or interior wall surfaces. It should be clear that adding wall insulation has the potential for causing serious damage to historic building materials.

If adding wall insulation to frame buildings is determined to be absolutely necessary, the first approach should be to consider the careful removal of the exterior siding so that it may later be reinstalled. Then introduce batt insulation with the **vapor barrier facing in** into the now accessible wall cavity. The first step in this approach is an investigation to determine if the siding can be removed without causing serious damage.

If it is feasible, introducing insulation in this fashion provides the best possible solution to insulating a wall, and provides an excellent opportunity to view most of the structural system for possible hidden structural problems or insect infestations. A building owner should not consider this approach if it would result in substantial damage to or loss of historic wooden siding. Most siding, however, would probably withstand this method if reasonable care is exercised.

The second possible approach for wall insulation involves injecting or blowing insulation into the wall cavity. The common insulations are the loose fill types that can be blown into the cavity, the poured types, or the injected types such as foam. Obviously a vapor barrier cannot be simultaneously blown into the space. However, an equivalent vapor barrier can be created by assuring that the interior wall surfaces are covered with an impermeable paint layer. Two layers of oil base paint or one layer of impermeable latex paint constitute an acceptable vapor barrier. Naturally, for this to work, the paint layer must cover all interior surfaces adjacent to the newly installed wall insulation. Special attention should be given to rooms that are major sources of interior moisture--the laundry room, the bathrooms and the kitchen.

In addition to providing a vapor barrier, make provisions for some air to circulate in the wall cavity to help ventilate the insulation and the wall materials. This can be accomplished in several ways. One method is to install small screened vents (about 2 inches in diameter) at the base of each stud cavity. If this option is taken, the vents should be as inconspicuous as possible. A second venting method can be used where the exterior siding is horizontally lapped. Assure that each piece of siding is separated from the other, allowing some air to pass between them. Successive exterior paint layers often seal the joint between each piece of siding. Break the paint seal (carefully insert a chisel and twist) between the sections of exterior siding to provide the necessary ventilation for the insulation and wall materials.

With provisions for a vapor barrier (interior paint layer) and wall ventilation (exterior vents) satisfied, the appropriate type of wall insulation may then be selected. There are three recommended types to consider: blown cellulose (with boric acid as the fire retardant), vermiculite, or perlite. Cellulose is the preferred wall insulation because of its higher R factor and its capability to flow well into the various spaces within a wall cavity.

There are two insulation types that are not recommended for wall insulation: ***ureaformaldehyde foams, and cellulose*** which uses aluminum or ammonium sulfate instead of boric acid as a fire retardant. The cellulose treated with the sulfates reacts with moisture in the air and forms sulfuric acid which corrodes many metals and causes building stones to slowly disintegrate. This insulation is not appropriate for use in historic buildings.

Although ureaformaldehyde foams appear to have potential as retrofit materials (they flow into any wall cavity space and have a high R factor) their use is not recommended for preservation retrofitting until some serious problems are corrected. The major problem is that the injected material carries large quantities of moisture into the wall system. As the foam cures, this moisture must be absorbed into the adjacent materials. This process has caused interior and exterior paint to blister, and caused water to actually puddle at the base of a wall, creating the likelihood of serious deterioration to the historic building materials. There are other problems that affect both historic buildings and other existing buildings. Foams are a twopart chemical installed by franchised contractors. To obtain the exact proportion of the two parts, the foam must be mixed and installed under controlled conditions of temperature and humidity. There are cases where the controls were not followed and the foam either cured improperly, not attaining the desired R factor, or the foam continued to emit a formaldehyde smell. In addition, the advertised maximum shrinkage after curing (3%) has been tested and found to be twice as high. Until this material is further developed and the risks eliminated, it is clearly not an appropriate material for preservation retrofitting.

Wall Insulation--Masonry Cavity Walls: Some owners of historic buildings with masonry cavity wall construction have attempted to introduce insulation into the cavity. This is not good practice because it ignores the fact that masonry cavity walls normally have acceptable thermal performance, needing no improvement. Additionally, introducing insulation into the cavity will most likely result in condensation problems and alter the intended function of the cavity. The air cavity acts as a vapor barrier in that moist air passing through the inner wythe of masonry meets the cold face of the outer wythe and condenses. Water droplets form and fall to the bottom of the wall cavity where they are channeled to the outside through weep holes. The air cavity also improves the thermal performance of the wall because it slows the transfer of heat or cold between the two wythes, causing the two wall masses to function independently with a thermal cushion between them.

Adding insulation to this cavity alters the vapor barrier and thermal cushion functions of the air space and will likely clog the weep holes, causing the moisture to puddle at the base of the wall. Also, the addition of insulation creates a situation where the moisture dew point (where moisture condenses) moves from the inner face of the outer wythe, into the outer wythe itself. Thus, during a freeze, this condensation will freeze, causing spalling and severe deterioration. The evidence is clear that introducing insulation, of any type, into a masonry cavity wall is not recommended in a preservation retrofitting plan.

Wall Insulation--Installed on the Inside: Insulation could be added to a wall whether it be wooden or masonry, by attaching the insulation to furring strips mounted on the interior wall faces. Both rigid insulation, usually 1 or 2 inches thick, and batt insulation, generally 3-1/2 inches thick, can be added in this fashion, with the vapor barrier facing in. Extra caution must be exercised if rigid plastic foam insulation is used because it can give off dense smoke and rapidly spreading flame when burned. Therefore, it must be installed with a fireproof covering, usually 1/2-inch gypsum wallboard. Insulation should not be installed on the inside if it necessitates relocation or destruction of important architectural decoration, such as cornices, chair rails, or window trims, or causes the destruction of historic plaster or other wall finishes. Insulation installed in this fashion would be expensive and could only be a recommended preservation retrofitting measure if it is a large building, located in a cold climate, and if the interior spaces and features have little or no architectural significance.

Wall Insulation--Installed on the Outside: There is a growing use of aluminum or vinyl siding installed directly over historic wooden sidings, supposedly to reduce longterm maintenance and to improve the thermal performance of the wall. From a preservation viewpoint, this is a poor practice for several reasons. New siding covers from view existing or potential deterioration problems or insect infestations. Additionally, installation often results in damage or alteration to existing decorative features such as beaded weatherboarding, window and door trim, corner boards, cornices, or roof trim. The cost of installing the artificial sidings compared with the modest increase, if any, in the thermal performance of the wall does not add up to an effective energy-saving measure. The use of artificial siding is not recommended in a preservation retrofitting plan.

Good preservation practice would assure regular maintenance of the existing siding through periodic painting and caulking. Where deterioration is present, individual pieces of siding should be removed and replaced with matching new ones. Refer to the earlier sections of this brief for recommended retrofitting measures to improve the thermal performance of wood frame walls.

Waterproof Coatings for Masonry: Some owners of historic buildings use waterproof coatings on masonry believing it would improve the thermal performance of the wall by keeping it dry (dry masonry would have a better R factor than when wet). Application of waterproof coatings is not recommended because the coatings actually trap moisture within the masonry, and can cause spalling and severe deterioration during a freezing cycle.

In cases where exterior brick is painted, consider continued periodic painting and maintenance, since paints are an excellent preservation treatment for brick. When repainting, a building owner might consider choosing a light paint color in warm climates, or a dark color in co!d climates, to gain some advantage over the summer heat gain or winter heat loss, whichever the case may be. These colors should match those used historically on the building or should match colors available historically.

Mechanical Equipment

A detailed treatise of recommended or not recommended heating or air conditioning equipment, or of alternative energy sources such as solar energy or wind power, is beyond the scope of this brief. The best advice concerning mechanical equipment in historic buildings is to assure that the existing equipment works as efficiently as possible. If the best professional advice recommends replacement of existing equipment, a building owner should keep the following considerations in mind. First, as technology advances in the coming years, the equipment installed now will be outdated rapidly relative to the life of the historic building. Therefore, it may be best to wait and watch, until new technologies (such as solar energy) become more feasible, efficient, and inexpensive. Secondly, do not install new equipment and ductwork in such a way that its installation, or possible later removal, will cause irreversible damage to significant historic building materials. The concept of complete invisibility, which necessitates hiding piping and ductwork within wall and floor systems, may not always be appropriate for historic buildings because of the damage that often results. Every effort should be made to select a mechanical system that will require the least intrusion into the historic fabric of the building and that can be updated or altered without major intervention into the wall and floor systems. These points should be considered when weighing the decision to replace a less than efficient exiting system with a costly new system, which may cause substantial damage to the historic building materials and in turn may prove inefficient in the future.

Summary

The primary focus of this brief has been to describe ways to achieve the maximum energy savings in historic buildings without jeopardizing the architectural, cultural and historical qualities for which the properties have been recognized. This can be accomplished through undertaking the passive measures and the "recommended" preservation retrofitting. Secondly, this brief has emphasized the benefits of undertaking the retrofitting measures in phases so that the actual energy savings anticipated from each retrofitting measure can be realized. Thus, the "not recommended" retrofitting measures, with potential for damage or alteration of historic building materials, would not have to be undertaken, because the maximum feasible savings would have already been accomplished.

Lastly, and perhaps most important, we must recognize that the technologies of retrofitting and weatherization are relatively new. Unfortunately, most current research and product development is directed toward new construction. It is hoped that reports such as this, and the realization that fully 30% of all construction in the United States now involves work on existing buildings, will stimulate the development of new products that can be used with little hesitation in historic buildings. Until that time, owners of historic buildings can undertake the preservation retrofitting measures recommended here and greatly reduce the energy used for heating and cooling, without destroying those historic and architectural qualities that make the building worthy of preservation.

NOTE

(1) R factor is the measure of the ability of insulation to decrease heat flow. The higher the factor, the better the thermal performance of the material.

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Home page logo: *Copper Grasshopper Weather Vane* by Shem Drowne, 1742, Faneuil Hall, Dock Square, Boston, Massachusetts. Photo: Courtesy, Index of American Design, Mass-Me-230, National Gallery of Art.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF#4
ROOFING FOR HISTORIC BUILDINGS

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>Roofing for Historic Buildings

Sarah M. Sweetser

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Significance of the Roof

A weather-tight roof is basic in the preservation of a structure, regardless of its age, size, or design. In the system that allows a building to work as a shelter, the roof sheds the rain, shades from the sun, and buffers the weather.

During some periods in the history of architecture, the roof imparts much of the architectural character. It defines the style and contributes to the building's aesthetics. The hipped roofs of Georgian architecture, the turrets of Queen Anne, the Mansard roofs, and the graceful slopes of the Shingle Style and Bungalow designs are examples of the use of roofing as a major design feature.

But no matter how decorative the patterning or how compelling the form, the roof is a highly vulnerable element of a shelter that will inevitably fail. A poor roof will permit the accelerated deterioration of historic building materials-- masonry, wood, plaster, paint-- and will cause general disintegration of the basic structure. Furthermore, there is an urgency involved in repairing a leaky roof since such repair costs will quickly become prohibitive. Although such action is desirable as soon as a failure is discovered, temporary patching methods should be carefully chosen to prevent inadvertent damage to sound or historic roofing materials and related features. Before any repair work is performed, the historic value of the materials used on the roof should be understood. Then a complete internal and external inspection of the roof should be planned to determine all the causes of failure and to identify the alternatives for repair or replacement of the roofing.

Historic Roofing Materials in America

Clay Tile: European settlers used clay tile for roofing as early as the mid-17th century; many pantiles (S-curved tiles), as well as flat roofing tiles, were used in Jamestown, Virginia. In some cities such as New York and Boston, clay was popularly used as a precaution against such fires as those that engulfed London in 1666 and scorched Boston in 1679.

Repairs on this pantile roof were made with new tiles held in place with metal hangers. Photo: NPS files.

Tiles roofs found in the mid-18th century Moravian settlements in Pennsylvania closely resembled those found in Germany. Typically, the tiles were 1415" long, 67" wide with a curved butt. A lug on the back allowed the tiles to hang on the lathing without nails or pegs. The tile surface was usually scored with finger marks to promote drainage. In the Southwest, the tile roofs of the Spanish missionaries (mission tiles) were first manufactured (ca. 1780) at the Mission San Antonio de Padua in California. These semicircular tiles were made by molding clay over sections of logs, and they were generally 22" long and tapered in width.

The plain or flat rectangular tiles most commonly used from the 17th through the beginning of the 19th century measured about 10" by 6" by 1/2," and had two holes at one end for a nail or peg fastener. Sometimes mortar was applied between the courses to secure the tiles in a heavy wind.

In the mid-19th century, tile roofs were often replaced by sheet-metal roofs, which were lighter and easier to install and maintain. However, by the turn of the century, the Romanesque Revival and Mission style buildings created a new demand and popularity for this picturesque roofing material.

Slate: Another practice settlers brought to the New World was slate roofing. Evidence of roofing slates have been found also among the ruins of mid-17th century Jamestown. But because of the cost and the time required to obtain the material, which was mostly imported from Wales, the use of slate was initially limited. Even in Philadelphia (the second largest city in the English-speaking world at the time of the Revolution) slates were so rare that "The Slate Roof House" distinctly referred to William Penn's home built late in the 1600s. Sources of native slate were known to exist along the eastern seaboard from Maine to Virginia, but difficulties in inland transportation limited its availability to the cities, and contributed to its expense. Welsh slate continued to be imported until the development of canals and railroads in the mid-19th century made American slate more accessible and economical.

Slate was popular for its durability, fireproof qualities, and aesthetic potential. Because slate was available in different colors (red, green, purple, and blue-gray), it was an effective material for decorative patterns on many 19th century roofs (Gothic and Mansard styles). Slate continued to be used well into the 20th century, notably on many Tudor revival style buildings of the 1920s.

Shingles: Wood shingles were popular throughout the country in all periods of building history. The size and shape of the shingles as well as the detailing of the shingle roof differed according to regional craft practices. People within particular regions developed preferences for the local species of wood that most suited their purposes. In New England and the Delaware Valley, white pine was frequently used: in the South, cypress and oak; in the far west, red cedar or redwood. Sometimes a protective coating was applied to increase the durability of the shingle such as a mixture of brick dust and fish oil, or a paint made of red iron oxide and linseed oil.

Replacement of particular historic details is important to the individual historic character of a roof, such as this rounded butt wood shingle roof. In the restoration, the drainage around a dormer was improved by the addition of carefully concealed modern metal flashing. Photo: NPS files.

Commonly in urban areas, wooden roofs were replaced with more fire resistant materials, but in rural areas this was not a major concern. On many Victorian country houses, the practice of wood shingling survived the technological advances of metal roofing in the 19th century, and near the turn of the century enjoyed a full revival in its namesake, the Shingle Style. Colonial revival and the Bungalow styles in the 20th century assured wood shingles a place as one of the most fashionable, domestic roofing materials.

Galvanized sheet-metal shingles imitating the appearance of pantiles remained popular from the second half of the 19th century into the 20th century. Photo: NPS files.

Metal: Metal roofing in America is principally a 19th-century phenomenon. Before then the only metals commonly used were lead and copper. For example, a lead roof covered "Rosewell," one of the grandest mansions in 18th century Virginia. But more often, lead was used for protective flashing. Lead, as well as copper, covered roof surfaces where wood, tile, or slate shingles were inappropriate because of the roof's pitch or shape.

Copper with standing seams covered some of the more notable early American roofs including that of Christ Church (1727-1744) in Philadelphia. Flat-seamed copper was used on many domes and cupolas. The copper sheets were imported from England until the end of the 18th century when facilities for rolling sheet metal were developed in America.

Sheet iron was first known to have been manufactured here by the Revolutionary War financier, Robert Morris, who had a rolling mill near Trenton, New Jersey. At his mill Morris produced the roof of his own Philadelphia mansion, which he started in 1794. The architect Benjamin H. Latrobe used sheet iron to replace the roof on Princeton's "Nassau Hall," which had been gutted by fire in 1802.

The method for corrugating iron was originally patented in England in 1829. Corrugating stiffened the sheets, and allowed greater span over a lighter framework, as well as reduced installation time and labor. In 1834 the American architect William Strickland proposed corrugated iron to cover his design for the market place in Philadelphia.

Galvanizing with zinc to protect the base metal from rust was developed in France in 1837. By the 1850s the material was used on post offices and customhouses, as well as on train sheds and factories. In 1857 one of the first metal roofs in the South was installed on the U.S. Mint in New Orleans. The Mint was thereby " fireproofed" with a 20-gauge galvanized, corrugated iron roof on iron trusses.

Tin-plate iron, commonly called "tin roofing," was used extensively in Canada in the 18th century, but it was not as common in the United States until later. Thomas Jefferson was an early advocate of tin roofing, and he installed a standing-seam tin roof on "Monticello" (ca. 1770-1802). The Arch Street Meetinghouse (1804) in Philadelphia had tin shingles laid in a herringbone pattern on a "piazza" roof.

Tin shingles, commonly embossed to imitate wod or tile, or with a decorative design, were popular as an inexpensive, textured roofing material. Photo: NPS files.

However, once rolling mills were established in this country, the low cost, light weight, and low maintenance of tin plate made it the most common roofing material. Embossed tin shingles, whose surfaces created interesting patterns, were popular throughout the country in the late 19th century. Tin roofs were kept well-painted, usually red; or, as the architect A. J. Davis suggested, in a color to imitate the green patina of copper.

Terne plate differed from tin plate in that the iron was dipped in an alloy of lead and tin, giving it a duller finish. Historic, as well as modern, documentation often confuses the two, so much that it is difficult to determine how often actual "terne" was used.

Zinc came into use in the 1820s, at the same time tin plate was becoming popular. Although a less expensive substitute for lead, its advantages were controversial, and it was never widely used in this country.

Other Materials: Asphalt shingles and roll roofing were used in the 1890s. Many roofs of asbestos, aluminum, stainless steel, galvanized steel, and lead-coated copper may soon have historic values as well. Awareness of these and other traditions of roofing materials and their detailing will contribute to more sensitive preservation treatments.

Locating the Problem

Failures of Surface Materials

When trouble occurs, it is important to contact a professional, either an architect, a reputable roofing contractor, or a craftsman familiar with the inherent characteristics of the particular historic roofing system involved. These professionals may be able to advise on immediate patching procedures and help plan more permanent repairs. A thorough examination of the roof should start with an appraisal of the existing condition and quality of the roofing material itself. Particular attention should be given to any southern slope because year-round exposure to direct sun may cause it to break down first.

Wood: Some historic roofing materials have limited life expectancies because of normal organic decay and "wear." For example, the flat surfaces of wood shingles erode from exposure to rain and ultraviolet rays. Some species are more hardy than others, and heartwood, for example, is stronger and more durable than sapwood.

Ideally, shingles are split with the grain perpendicular to the surface. This is because if shingles are sawn across the grain, moisture may enter the grain and cause the wood to deteriorate. Prolonged moisture on or in the wood allows moss or fungi to grow, which will further hold the moisture and cause rot.

Metal: Of the inorganic roofing materials used on historic buildings, the most common are perhaps the sheet metals: lead, copper, zinc, tin plate, terne plate, and galvanized iron. In varying degrees each of these sheet metals are likely to deteriorate from chemical action by pitting or streaking. This can be caused by airborne pollutants; acid rainwater; acids from lichen or moss; alkalis found in lime mortars or portland cement, which might be on adjoining features and washes down on the roof surface; or tannic acids from adjacent wood sheathings or shingles made of red cedar or oak.

Temporary stabilization or "mothballing" with materials, such as plywood and building paper, can protect the roof of a project until it can be properly repaired or replaced. Photo: NPS files.

Corrosion from "galvanic action" occurs when dissimilar metals, such as copper and iron, are used in direct contact. Corrosion may also occur even though the metals are physically separated; one of the metals will react chemically against the other in the presence of an electrolyte such as rainwater. In roofing, this situation might occur when either a copper roof is decorated with iron cresting, or when steel nails are used in copper sheets. In some instances the corrosion can be prevented by inserting a plastic insulator between the dissimilar materials. Ideally, the fasteners should be a metal sympathetic to those involved.

Iron rusts unless it is well-painted or plated. Historically this problem was avoided by use of tin plating or galvanizing. But this method is durable only as long as the coating remains intact. Once the plating is worn or damaged, the exposed iron will rust. Therefore, any iron-based roofing material needs to be undercoated, and its surface needs to be kept well-painted to prevent corrosion.

One cause of sheet metal deterioration is fatigue. Depending upon the size and the gauge of the metal sheets, wear and metal failure can occur at the joints or at any protrusions in the sheathing as a result from the metal's alternating movement to thermal changes. Lead will tear because of "creep," or the gravitational stress that causes the material to move down the roof slope.

Slate: Perhaps the most durable roofing materials are slate and tile. Seemingly indestructible, both vary in quality. Some slates are hard and tough without being brittle. Soft slates are more subject to erosion and to attack by airborne and rainwater chemicals, which cause the slates to wear at nail holes, to delaminate, or to break. In winter, slate is very susceptible to breakage by ice, or ice dams.

Tile: Tiles will weather well, but tend to crack or break if hit, as by tree branches, or if they are walked on improperly. Like slates, tiles cannot support much weight. Low quality tiles that have been insufficiently fired during manufacture, will craze and spall under the effects of freeze and thaw cycles on their porous surfaces.

Failures of Support Systems

Once the condition of the roofing material has been determined, the related features and support systems should be examined on the exterior and on the interior of the roof. The gutters and downspouts need periodic cleaning and maintenance since a variety of debris fill them, causing water to back up and seep under roofing units. Water will eventually cause fasteners, sheathing, and roofing structure to deteriorate. During winter, the daily freeze-thaw cycles can cause ice floes to develop under the roof surface. The pressure from these ice floes will dislodge the roofing material, especially slates, shingles, or tiles. Moreover, the buildup of ice dams above the gutters can trap enough moisture to rot the sheathing or the structural members.

Many large public buildings have built-in gutters set within the perimeter of the roof. The downspouts for these gutters may run within the walls of the building, or drainage may be through the roof surface or through a parapet to exterior downspouts. These systems can be effective if properly maintained; however, if the roof slope is inadequate for good runoff, or if the traps are allowed to clog, rainwater will form pools on the roof surface. Interior downspouts can collect debris and thus back up, perhaps leaking water into the surrounding walls. Exterior downspouts may fill with water, which in cold weather may freeze and crack the pipes. Conduits from the built-in gutter to the exterior downspout may also leak water into the surrounding roof structure or walls.

Failure of the flashing system is usually a major cause of roof deterioration. Flashing should be carefully inspected for failure caused by either poor workmanship, thermal stress, or metal deterioration (both of flashing material itself and of the fasteners). With many roofing materials, the replacement of flashing on an existing roof is a major operation, which may require taking up large sections of the roof surface. Therefore, the installation of top quality flashing material on a new or replaced roof should be a primary consideration. ***Remember, some roofing and flashing materials are not compatible.***

Because of the roof's visibility, the slate detailing around the dormers is important to the character of this structure. Photo: NPS files.

Roof fasteners and clips should also be made of a material compatible with all other materials used, or coated to prevent rust. For example, the tannic acid in oak will corrode iron nails. Some roofs such as slate and sheet metals may fail if nailed too rigidly.

If the roof structure appears sound and nothing indicates recent movement, the area to be examined most closely is the roof substrate--the sheathing or the battens. The danger spots would be near the roof plates, under any exterior patches, at the intersections of the roof planes, or at vertical surfaces such as dormers. Water penetration, indicating a breach in the roofing surface or flashing, should be readily apparent, usually as a damp spot or stain. Probing with a small pen knife may reveal any rot which may indicate previously undetected damage to the roofing membrane. Insect infestation evident by small exit holes and frass (a sawdustlike debris) should also be noted. Condensation on the underside of the roofing is undesirable and indicates improper ventilation. Moisture will have an adverse effect on any roofing material; a good roof stays dry inside and out.

Repair or Replace

Understanding potential weaknesses of roofing material also requires knowledge of repair difficulties. Individual slates can be replaced normally without major disruption to the rest of the roof, but replacing flashing on a slate roof can require substantial removal of surrounding slates. If it is the substrate or a support material that has deteriorated, many surface materials such as slate or tile can be reused if handled care fully during the repair. Such problems should be evaluated at the outset of any project to determine if the roof can be effectively patched, or if it should be completely replaced.

Will the repairs be effective? Maintenance costs tend to multiply once trouble starts. As the cost of labor escalates, repeated repairs could soon equal the cost of a new roof.

The more durable the surface is initially, the easier it will be to maintain. Some roofing materials such as slate are expensive to install, but if top quality slate and flashing are used, it will last 40-60 years with minimal maintenance. Although the installation cost of the roof will be high, low maintenance needs will make the lifetime cost of the roof less expensive.

Historical Research

In a restoration project, research of documents and physical investigation of the building usually will establish the roof's history. Documentary research should include any original plans or building specifications, early insurance surveys, newspaper descriptions, or the personal papers and files of people who owned or were involved in the history of the building. Old photographs of the building might provide evidence of missing details.

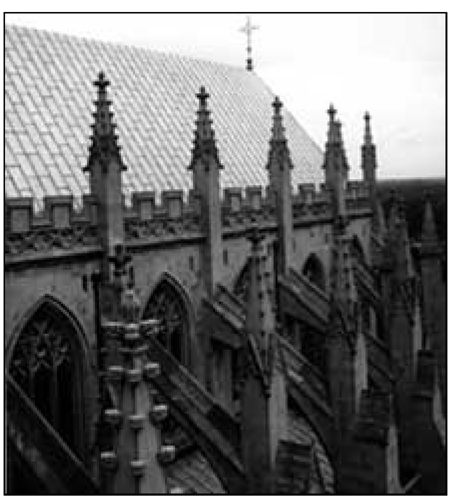
Along with a thorough understanding of any written history of the building, a physical investigation of the roofing and its structure may reveal information about the roof's construction history. Starting with an overall impression of the structure, are there any changes in the roof slope, its configuration, or roofing materials? Perhaps there are obvious patches or changes in patterning of exterior brickwork where a gable roof was changed to a gambrel, or where a whole upper story was added. Perhaps there are obvious stylistic changes in the roof line, dormers, or ornamentation. These observations could help one understand any important alteration, and could help establish the direction of further investigation.

Because most roofs are physically out of the range of careful scrutiny, the "principle of least effort" has probably limited the extent and quality of previous patching or replacing, and usually considerable evidence of an earlier roof surface remains. Sometimes the older roof will be found as an underlayment of the current exposed roof. Original roofing may still be intact in awkward places under later features on a roof. Often if there is any unfinished attic space, remnants of roofing may have been dropped and left when the roof was being built or repaired. If the configuration of the roof has been changed, some of the original material might still be in place under the existing roof. Sometimes whole sections of the roof and roof framing will have been left intact under the higher roof. The profile and/or flashing of the earlier roof may be apparent on the interior of the walls at the level of the alteration. If the sheathing or lathing appears to have survived changes in the roofing surface, they may contain evidence of the roofing systems. These may appear either as dirt marks, which provide "shadows" of a roofing material, or as nails broken or driven down into the wood,.rather than pulled out during previous alterations or repairs. Wooden headers in the roof framing may indicate that earlier chimneys or skylights have been removed. Any metal ornamentation that might have existed may be indicated by anchors or unusual markings along the ridge or at other edges of the roof. This primary evidence is essential for a full understanding of the roof's history.

Caution should be taken in dating early "fabric" on the evidence of a single item, as recycling of materials is not a mid-20th century innovation. Carpenters have been reusing materials, sheathing, and framing members in the interest of economy for centuries. Therefore, any analysis of the materials found, such as nails or sawmarks on the wood, requires an accurate knowledge of the history of local building practices before any final conclusion can be accurately reached. It is helpful to establish a sequence of construction history for the roof and roofing materials; any historic fabric or pertinent evidence in the roof should be photographed, measured, and recorded for future reference.

During the repair work, useful evidence might unexpectedly appear. It is essential that records be kept of any type of work on a historic building, before, during, and after the project. Photographs are generally the easiest and fastest method, and should include overall views and details at the gutters, flashing, dormers, chimneys, valleys, ridges, and eaves. All photographs should be immediately labeled to insure accurate identification at a later date. Any patterning or design on the roofing deserves particular attention. For example, slate roofs are often decorative and have subtle changes in size, color, and texture, such as a gradually decreasing coursing length from the eave to the peak. If not carefully noted before a project begins, there may be problems in replacing the surface. The standard reference for this phase of the work is *Recording Historic Buildings*, compiled by Harley J. McKee for the Historic American Buildings Survey, National Park Service, Washington, D.C., 1970.

Replacing the Historic Roofing Material



Good design and quality materials for the roof surface, fastenings, and

Professional advice will be needed to assess the various aspects of replacing a historic roof. With some exceptions, most historic roofing materials are available today. If not, an architect or preservation group who has previously worked with the same type material may be able to recommend suppliers. Special roofing materials, such as tile or embossed metal shingles, can be produced by manufacturers of related products that are commonly used elsewhere, either on the exterior or interior of a structure. With some creative thinking and research, the historic materials usually can be found.

Craft Practices: Determining the craft practices used in the installation of a historic roof is another major concern in roof restoration. Early builders took great pride in their work, and experience has shown

flashing minimize failures. Photo: NPS files.

that the " rustic" or irregular designs commercially labeled "Early American" are a 20th-century invention. For example, historically, wood shingles underwent several distinct operations in their manufacture including splitting by hand, and smoothing the surface with a draw knife. In modern nomenclature, the same item would be a "tapersplit" shingle which has been dressed. Unfortunately, the rustic appearance of today's commercially available "handsplit" and re-sawn shingle bears no resemblance to the handmade roofing materials used on early American buildings.

Early craftsmen worked with a great deal of common sense; they understood their materials. For example they knew that wood shingles should be relatively narrow; shingles much wider than about 6" would split when walked on, or they may curl or crack from varying temperature and moisture. It is important to understand these aspects of craftsmanship, remembering that people wanted their roofs to be weather-tight and to last a long time. The recent use of "mother goose" shingles on historic structures is a gross underestimation of the early craftsman's skills.

Supervision: Finding a modern craftsman to reproduce historic details may take some effort. It may even involve some special instruction to raise his understanding of certain historic craft practices. At the same time, it may be pointless (and expensive) to follow historic craft practices in any construction that will not be visible on the finished product. But if the roofing details are readily visible, their appearance should be based on architectural evidence or on historic prototypes. For instance, the spacing of the seams on a standing-seam metal roof will affect the building's overall scale and should therefore match the original dimensions of the seams.

Many older roofing practices are no longer performed because of modern improvements. Research and review of specific detailing in the roof with the contractor before beginning the project is highly recommended. For example, one early craft practice was to finish the ridge of a wood shingle roof with a roof "comb"--that is, the top course of one slope of the roof was extended uniformly beyond the peak to shield the ridge, and to provide some weather protection for the raw horizontal edges of the shingles on the other slope. If the "comb" is known to have been the correct detail, it should be used. Though this method leaves the top course vulnerable to the weather, a disguised strip of flashing will strengthen this weak point.

Detail drawings or a sample mockup will help ensure that the contractor or craftsman understands the scope and special requirements of the project. It should never be assumed that the modern carpenter, slater, sheet metal worker, or roofer will know all the historic details. Supervision is as important as any other stage of the process.

Alternative Materials

The use of the historic roofing material on a structure may be restricted by building codes or by the availability of the materials, in which case an appropriate alternative will have to be found.

Some municipal building codes allow variances for roofing materials in historic districts. In other instances, individual variances may be obtained. Most modern heating and cooking is fueled by gas, electricity, or oil--none of which emit the hot embers that historically have been the cause of roof fires. Where wood burning fireplaces or stoves are used, spark arrestor screens at the top of the chimneys help to prevent flaming material from escaping, thus reducing the number of fires that start at the roof. In most states, insurance rates have been equalized to reflect revised considerations for the risks involved with various roofing materials.

In a rehabilitation project, there may be valid reasons for replacing the roof with a material other than the original. The historic roofing may no longer be available, or the cost of obtaining specially fabricated materials may be prohibitive. But the decision to use an alternative material should be weighed carefully against the primary concern to keep the historic character of the building. If the roof is flat and is not visible from any elevation of the building, and if there are advantages to substituting a modern built-up composition roof for what might have been a flat metal roof, then it may make better economic and construction sense to use a modern roofing method. But if the roof is readily visible, the alternative material should match as closely as possible the scale, texture, and coloration of the historic roofing material.

Asphalt shingles or ceramic tiles are common substitute materials intended to duplicate the appearance of wood shingles, slates, or tiles. Fire-retardant, treated wood shingles are currently available. The treated wood tends, however, to be brittle, and may require extra care (and expense) to install. In some instances, shingles laid with an interlay of fire-retardant building paper may be an acceptable alternative.

Lead-coated copper, terne-coated steel, and aluminum/ zinc-coated steel can successfully replace tin, terne plate, zinc, or lead. Copper-coated steel is a less expensive (and less durable) substitute for sheet copper.

The search for alternative roofing materials is not new. As early as the 18th century, fear of fire caused many wood shingle or board roofs to be replaced by sheet metal or clay tile. Some historic roofs were failures from the start, based on overambitious and naive use of materials as they were first developed. Research on a structure may reveal that an inadequately designed or a highly combustible roof was replaced early in its history, and therefore restoration of a later roof material would have a valid precedent. In some cities, the substitution of sheet metal on early row houses occurred as soon as the rolled material became available.

Cost and ease of maintenance may dictate the substitution of a material wholly different in appearance from the original. The practical problems (wind, weather, and roof pitch) should be weighed against the historical consideration of scale, texture, and color. Sometimes the effect of the alternative material will be minimal. But on roofs with a high degree of visibility and patterning or texture, the substitution may seriously alter the architectural character of the building.

Temporary Stabilization

It may be necessary to carry out an immediate and temporary stabilization to prevent further deterioration until research can determine how the roof should be restored or rehabilitated, or until funding can be provided to do a proper job. A simple covering of exterior plywood or roll roofing might provide adequate protection, but any temporary covering should be applied with caution. One should be careful not to overload the roof structure, or to damage or destroy historic evidence or fabric that might be incorporated into a new roof at a later date. In this sense, repairs with caulking or bituminous patching compounds should be recognized as potentially harmful, since they are difficult to remove, and at their best, are very temporary.

Precautions

The architect or contractor should warn the owner of any precautions to be taken against the specific hazards in installing the roofing material. Soldering of sheet metals, for instance, can be a fire hazard, either from the open flame or from overheating and undetected smoldering of the wooden substrate materials.

Thought should be given to the design and placement of any modern roof appurtenances such as plumbing stacks, air vents, or TV antennas. Consideration should begin with the placement of modern plumbing on the interior of the building, otherwise a series of vent stacks may pierce the roof membrane at various spots creating maintenance problems as well as aesthetic ones. Air handling units placed in the attic space will require vents which, in turn, require sensitive design. Incorporating these in unused chimneys has been very successful in the past.

Whenever gutters and downspouts are needed that were not on the building historically, the additions should be made as unobtrusively as possible, perhaps by painting them out with a color compatible with the nearby wall or trim.

Maintenance

Special problems inherent in the design of an elaborate historic roof can be controlled through regular maintenance. The shape and detailing are essential elements of the building's historic character, and should not be modified, despite the use of alternative surface materials. Photo: NPS files.

Although a new roof can be an object of beauty, it will not be protective for long without proper maintenance. At least twice a year, the roof should be inspected against a checklist. All changes should be recorded and reported. Guidelines should be established for any foot traffic that may be required for the maintenance of the roof. Many roofing materials should not be walked on at all. For some--slate, asbestos, and clay tile--a self-supporting ladder might be hung over the ridge of the roof, or planks might be spanned across the roof surface. Such items should be specifically designed and kept in a storage space accessible to the roof. If exterior work ever requires hanging scaffolding, use caution to insure that the anchors do not penetrate, break, or wear the roofing surface, gutters, or flashing.

Any roofing system should be recognized as a membrane that is designed to be self-sustaining, but that can be easily damaged by intrusions such as pedestrian traffic or fallen tree branches. Certain items should be checked at specific times. For example, gutters tend to accumulate leaves and debris during the spring and fall and after heavy rain. Hidden gutter screening both at downspouts and over the full length of the gutter could help keep them clean. The surface material would require checking after a storm as well. Periodic checking of the underside of the roof from the attic after a storm or winter freezing may give early warning of any leaks. Generally, damage from water or ice is less likely on a roof that has good flashing on the outside and is well ventilated and insulated on the inside. Specific instructions for the maintenance of the different roof materials should be available from the architect or contractor.

Summary

The essential ingredients for replacing and maintaining a historic roof are:

- **Understanding the historic character** of the building and being sympathetic to it.

- **Careful examination and recording** of the existing roof and any evidence of earlier roofs.

- **Consideration of the historic craftsmanship** and detailing and implementing them in the renewal wherever visible.

- **Supervision of the roofers** or maintenance personnel to assure preservation of historic fabric and proper understanding of the scope and detailing of the project.

- **Consideration of alternative materials** where the original cannot be used.

- **Cyclical maintenance** program to assure that the staff understands how to take care of the roof and of the particular trouble spots to safeguard.

With these points in mind, it will be possible to preserve the architectural character and maintain the physical integrity of the roofing on a historic building.

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Acknowledgements

This Preservation Brief was written by Sarah M Sweetser, Architectural Historian, Technical Preservation Services Division. Much of the technical information was based upon an unpublished report prepared under contract for this office by John G. and Diana S. Waite. Some of the historical information was from Charles E. Peterson, FAIA, "American Notes," Journal of the Society of Architectural Historians. The illustrations for this brief not specifically credited are from the files of the Technical Preservation Services Division.

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Home page logo: Decorative roofing feature. Photo: HABS Collection, NPS.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF#6
DANGERS OF ABRASIVE CLEANING TO HISTORIC BUILDINGS

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6 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

Dangers of Abrasive Cleaning to Historic Buildings

Anne E. Grimmer

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

"Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible." ***The Secretary of the Interior's Standards for Rehabilitation.***

Abrasive cleaning methods are responsible for causing a great deal of damage to historic building materials. To prevent indiscriminate use of these potentially harmful techniques, this brief has been prepared to explain abrasive cleaning methods, how they can be physically and aesthetically destructive to historic building materials, and why they generally are not acceptable preservation treatments for historic structures. There are alternative, less harsh means of cleaning and removing paint and stains from historic buildings. However, careful testing should precede general cleaning to assure that the method selected will not have an adverse effect on the building materials. A historic building is irreplaceable, and should be cleaned using only the "gentlest means possible" to best preserve it.

What is Abrasive Cleaning?

Abrasive cleaning methods include all techniques that physically abrade the building surface to remove soils, discolorations or coatings. Such techniques involve the use of certain *materials* which impact or abrade the surface under pressure, or abrasive *tools and equipment.* Sand, because it is readily available, is probably the most commonly used type of grit material. However, any of the following materials may be substituted for sand, and all can be classified as abrasive substances: ground slag or volcanic ash, crushed (pulverized)

Abrasive cleaning can cause permanent damage to historic fabric, such as this brick wall. Photo: NPS files.

walnut or almond shells, rice husks, ground corncobs, ground coconut shells, crushed eggshells, silica flour, synthetic particles, glass beads and micro-balloons. Even *water* under pressure can be an abrasive substance. Tools and equipment that are abrasive to historic building materials include wire brushes, rotary wheels, power sanding disks and belt sanders.

The use of water in combination with grit may also be classified as an abrasive cleaning method. Depending on the manner in which it is applied, water *may* soften the impact of the grit, but water that is too highly pressurized can be very abrasive. There are basically two different methods which can be referred to as "wet grit," and it is important to differentiate between the two. One technique involves the addition of a stream of water to a regular sandblasting nozzle. This is done primarily to cut down dust, and has very little, if any, effect on reducing the aggressiveness, or cutting action of the grit particles. With the second technique, a very small amount of grit is added to a pressurized water stream. This method may be controlled by regulating the amount of grit fed into the water stream, as well as the pressure of the water.

Why Are Abrasive Cleaning Methods Used?

Usually, an abrasive cleaning method is selected as an expeditious means of quickly removing years of dirt accumulation, unsightly stains, or deteriorating building fabric or finishes, such as stucco or paint.

The fact that sandblasting is one of the best known and most readily available building cleaning treatments is probably the major reason for its frequent use.

Brick molding next to the window has been severely abraded by sandblasting to remove paint. Photo: NPS files.

Many mid-19th century brick buildings were painted immediately or soon after completion to protect poor quality brick or to imitate another material, such as stone. Sometimes brick buildings were painted in an effort to produce what was considered a more harmonious relationship between a building and its natural surroundings. By the 1870s, brick buildings were often left unpainted as mechanization in the brick industry brought a cheaper pressed brick and fashion decreed a sudden preference for dark colors. However, it was still customary to paint brick of poorer quality for the additional protection the paint afforded.

It is a common 20th century misconception that all historic masonry buildings were initially unpainted. If the intent of a modern restoration is to return a building to its original appearance, removal of the paint not only may be historically inaccurate, but also harmful. Many older buildings were painted or stuccoed at some point to correct recurring maintenance problems caused by faulty construction techniques, to hide alterations, or in an attempt to solve moisture problems. If this is the case, removal of paint or stucco may cause these problems to reoccur.

Another reason for paint removal, particularly in rehabilitation projects, is to give the building a "new image" in response to contemporary design trends and to attract investors or tenants. Thus, it is necessary to consider the purpose of the intended cleaning. While it is clearly important to remove unsightly stains, heavy encrustations of dirt, peeling paint or other surface coatings, it may not be equally desirable to remove paint from a building which originally was painted. Many historic buildings which show only a slight amount of soil or discoloration are much better left as they are.

A thin layer of soil is more often protective of the building fabric than it is harmful, and seldom detracts from the building's architectural and/or historic character. Too thorough cleaning of a historic building may not only sacrifice some of the building's character, but also, misguided cleaning efforts can cause a great deal of damage to historic building fabric. Unless there are stains, graffiti or dirt and pollution deposits which are destroying the building fabric, it is generally preferable to do as little cleaning as possible, or to repaint where necessary. It is important to remember that a historic building does not have to look as if it were newly constructed to be an attractive or successful restoration or rehabilitation project.

Problems of Abrasive Cleaning

On the left, grit blasting has obliterated the vertical tooling marks from granite, a very dense stone. Photo: NPS files.

The crux of the problem is that abrasive cleaning is just that--abrasive. An abrasively cleaned historic structure may be physically as well as aesthetically damaged. Abrasive methods "clean" by eroding dirt or paint, but at the same time they also tend to erode the surface of the building material. In this way, abrasive cleaning is destructive and causes irreversible harm to the historic building fabric. If the fabric is brick, abrasive methods remove the hard, outer protective surface, and therefore make the brick more susceptible to rapid weathering and deterioration.

Grit blasting may also increase the water permeability of a brick wall. The impact of the grit particles tends to erode the bond between the mortar and the brick, leaving cracks or enlarging existing cracks where water can enter. Some types of stone develop a protective patina or "quarry crust" parallel to the worked surface (created by the movement of moisture towards the outer edge), which also may be damaged by abrasive cleaning. The rate at which the material subsequently weathers depends on the quality of the inner surface that is exposed.

Abrasive cleaning can destroy, or substantially diminish, decorative detailing on buildings such as a molded brickwork or architectural terra-cotta, ornamental carving on wood or stone, and evidence of historic craft techniques, such as tool marks and other surface textures.

In addition, perfectly sound and/or "tooled" mortar joints can be worn away by abrasive techniques. This not only results in the loss of historic craft detailing but also requires repointing, a step involving considerable time, skill and expense, and which might not have been necessary had a gentler method been chosen. Erosion and pitting of the building material by abrasive cleaning creates a greater surface area on which dirt and pollutants collect. In this sense, the building fabric "attracts" more dirt, and will require more frequent cleaning in the future.

In addition to causing physical and aesthetic harm to the historic fabric, there are several adverse environmental effects of dry abrasive cleaning methods. Because of the friction caused by the abrasive medium hitting the building fabric, these techniques usually create a considerable amount of dust, which is unhealthy, particularly to the operators of the abrasive equipment. It further pollutes the environment around the job site, and deposits dust on neighboring buildings, parked vehicles and nearby trees and shrubbery. Some adjacent materials not intended for abrasive treatment such as wood or glass, may also be damaged because the equipment may be difficult to regulate.

Wet grit methods, while eliminating dust, deposit a messy slurry on the ground or other objects surrounding the base of the building. In colder climates where there is the threat of frost, any wet cleaning process applied to historic masonry structures must be done in warm weather, allowing ample time for the wall to dry out thoroughly before cold weather sets in. Water which remains and freezes in cracks and openings of the masonry surface eventually may lead to spalling. High-pressure wet cleaning may force an inordinate amount of water into the walls, affecting interior materials such as plaster or joist ends, as well as metal building components within the walls.

Variable Factors

The greatest problem in developing practical guidelines for cleaning any historic building is the large number of variable and unpredictable factors involved. Because these variables make each cleaning project unique, it is difficult to establish specific standards at this time. This is particularly true of abrasive cleaning methods because their inherent potential for causing damage is multiplied by the following factors:

- the type and condition of the material being cleaned
- the size and sharpness of the grit particles or the mechanical equipment
- the pressure with which the abrasive grit or equipment is applied to the building surface
- the skill and care of the operator, and
- the constancy of the pressure on all surfaces during the cleaning process.

Pressure: The damaging effects of most of the variable factors involved in abrasive cleaning are self evident. However, the matter of pressure requires further explanation. In cleaning specifications, pressure is generally abbreviated as "psi" (pounds per square inch), which technically refers to the "tip" pressure, or the amount of pressure at the nozzle of the blasting apparatus. Sometimes "psig," or pressure at the gauge (which may be many feet away, at the other end of the hose), is used in place of "psi." These terms are often incorrectly used interchangeably.

Despite the apparent care taken by most architects and building cleaning contractors to prepare specifications for pressure cleaning which will not cause harm to the delicate fabric of a historic building, it is very difficult to ensure that the same amount of pressure is applied to all parts of the building. For example, if the operator of the pressure equipment stands on the ground while cleaning a two-story structure, the amount of force reaching the first story will be greater than that hitting the second story, even if the operator stands on scaffolding or in a cherry picker, because of the "line drop" in the distance from the pressure source to the nozzle. Although technically it may be possible to prepare cleaning specifications with tight controls that would eliminate all but a small margin of error, it may not be easy to find professional cleaning firms willing to work under such restrictive conditions. The fact is that many professional building cleaning firms do not really understand the extreme delicacy of historic building fabric, and how it differs from modern construction materials. Consequently, they may accept building cleaning projects for which they have no experience.

Bronze statuary may be cleaned gently using crushed walnut shells. Photo: NPS files.

The amount of pressure used in any kind of cleaning treatment which involves pressure, whether it is dry or wet grit, chemicals or just plain water, is crucial to the outcome of the cleaning project. Unfortunately, no standards have been established for determining the correct pressure for cleaning each of the many historic building materials which would not cause harm. The considerable discrepancy between the way the building cleaning industry and architectural conservators define "high" and "low" pressure cleaning plays a significant role in the difficulty of creating standards.

Nonhistoric/Industrial: A representative of the building cleaning industry might consider "high" pressure water cleaning to be anything over 5,000 psi, or even as high as 10,000 to 15,000 psi! Water under this much pressure may be necessary to clean industrial structures or machinery, but would destroy most historic building materials. Industrial chemical cleaning commonly utilizes pressures between 1,000 and 2,500 psi.

Historic: By contrast, conscientious dry or wet abrasive cleaning of a historic structure would be conducted within the range of 20 to 100 psi at a range of 3 to 12 inches. Cleaning at this low pressure requires the use of a very fine 00 or 0 mesh grit forced through a nozzle with a 1/4-inch opening. A similar, even more delicate method being adopted by architectural conservators uses a micro-abrasive grit on small, hard-to-clean areas of carved, cut or molded ornament on a building facade. Originally developed by museum conservators for cleaning sculpture, this technique may employ glass beads, micro-balloons, or another type of micro-abrasive gently powered at approximately 40 psi by a very small, almost pencil-like pressure instrument. Although a slightly larger pressure instrument may be used on historic buildings, this technique still has limited practical applicability on a large scale building cleaning project because of the cost and the relatively few technicians competent to handle the task. In general, architectural conservators have determined that only through very controlled conditions can most historic building material be abrasively cleaned of soil or paint without measurable damage to the surface or profile of the substrate.

Yet some professional cleaning companies which specialize in cleaning historic masonry buildings use chemicals and water at a pressure of approximately 1,500 psi, while other cleaning firms recommend lower pressures ranging from 200 to 800 psi for a similar project. An architectural conservator might decide, after testing, that some historic structures could be cleaned properly using a moderate pressure (200-600 psi), or even a high pressure (600-1800 psi) water rinse. However, cleaning historic buildings under such high pressure should be considered an exception rather than the rule, and would require *very careful* testing and supervision to assure that the historic surface materials could withstand the pressure without gouging, pitting or loosening.

These differences in the amount of pressure used by commercial or industrial building cleaners and architectural conservators point to one of the main problems in using abrasive means to clean historic buildings: misunderstanding of the potentially fragile nature of historic building materials. There is no one cleaning formula or pressure suitable for all situations. Decisions regarding the proper cleaning process for historic structures can be made only after careful analysis of the building fabric, and testing.

How Building Materials React to Abrasive Cleaning Methods

Brick and Architectural Terra-cotta: Abrasive blasting does not affect all building materials to the same degree. Such techniques quite logically cause greater damage to softer and more porous materials, such as brick or architectural terra-cotta. When these materials are cleaned abrasively, the hard, outer layer (closest to the heat of the kiln) is eroded, leaving the soft, inner core exposed and susceptible to accelerated weathering. Glazed architectural terra-cotta and ceramic veneer have a baked on glaze which is also easily damaged by abrasive cleaning. Glazed architectural terra-cotta was designed for easy maintenance, and generally can be cleaned using detergent and water; but chemicals or steam may be needed to remove more persistent stains. Large areas of brick or architectural terra-cotta which have been painted are best left painted, or repainted if necessary.

Plaster and Stucco: Plaster and stucco are types of masonry finish materials that are softer than brick or terra-cotta; if treated abrasively these materials will simply disintegrate. Indeed, when plaster or stucco is treated abrasively it is usually with the intention of removing the plaster or stucco from whatever base material or substrate it is covering. Obviously, such abrasive techniques should not be applied to clean sound plaster or stuccoed walls, or decorative plaster wall surfaces.

Building Stones: Building stones are cut from the three main categories of natural rock: dense, igneous rock such as granite; sandy, sedimentary rock such as limestone or sandstone; and crystalline, metamorphic rock such as marble. As opposed to kiln-dried masonry materials such as brick and architectural terra-cotta, building stones are generally homogeneous in character at the time of a building's construction. However, as the stone is exposed to weathering and environmental pollutants, the surface may become friable, or may develop a protective skin or patina. These outer surfaces are very susceptible to damage by abrasive or improper chemical cleaning.

Very high-pressure water has scarred this granite. Photo: NPS files.

Building stones are frequently cut into ashlar blocks or "dressed" with tool marks that give the building surface a specific texture and contribute to its historic character as much as ornately carved decorative stonework. Such detailing is easily damaged by abrasive cleaning techniques; the pattern of tooling or cutting is erased, and the crisp lines of moldings or carving are worn or pitted.

Occasionally, it may be possible to clean small areas of rough-cut granite, limestone or sandstone having a heavy dirt encrustation by using the "wet grit" method, whereby a small amount of abrasive material is injected into a controlled, pressurized water stream. However, this technique requires very careful supervision in order to prevent damage to the stone. Polished or honed marble or granite should never be treated abrasively, as the abrasion would remove the finish in much the way glass would be etched or "frosted" by such a process. It is generally preferable to underclean, as too strong a cleaning procedure will erode the stone, exposing a new and increased surface area to collect atmospheric moisture and dirt. Removing paint, stains or graffiti from most types of stone may be accomplished by a chemical treatment carefully selected to best handle the removal of the particular type of paint or stain without damaging the stone. (See section on the "Gentlest Means Possible.")

Wood: Most types of wood used for buildings are soft, fibrous and porous, and are particularly susceptible to damage by abrasive cleaning. Because the summer wood between the lines of the grain is softer than the grain itself, it will be worn away by abrasive blasting or power tools, leaving an uneven surface with the grain raised and often frayed or "fuzzy." Once this has occurred, it is almost impossible to achieve a smooth surface again except by extensive hand sanding, which is expensive and will quickly negate any costs saved earlier by sandblasting. Such harsh cleaning treatment also obliterates historic tool marks, fine carving and detailing, which precludes its use on any interior or exterior woodwork which has been hand planed, milled or carved.

Metals: Like stone, metals are another group of building materials which vary considerably in hardness and durability. Softer metals which are used architecturally, such as tin, zinc, lead, copper or aluminum, generally should not be cleaned abrasively as the process deforms and destroys the original surface texture and appearance, as well as the acquired patina.

Decorative pressed metal interior or exterior features should not be cleaned abrasively. Photo: NPS files.

Much applied architectural metal work used on historic buildings--tin, zinc, lead and copper--is often quite thin and soft, and therefore susceptible to denting and pitting. Galvanized sheet metal is especially vulnerable, as abrasive treatment would wear away the protective galvanized layer.

In the late 19th and early 20th centuries, these metals were often cut, pressed or otherwise shaped from sheets of metal into a wide variety of practical uses such as roofs, gutters and flashing, and facade ornamentation such as cornices, friezes, dormers, panels, cupolas, oriel windows, etc. The architecture of the 1920s and 1930s made use of metals such as chrome, nickel alloys, aluminum and stainless steel in decorative exterior panels, window frames, and doorways. Harsh abrasive blasting would destroy the original surface finish of most of these metals, and would increase the possibility of corrosion.

However, conservation specialists are now employing a sensitive technique of glass bead peening to clean some of the harder metals, in particular large bronze outdoor sculpture. Very fine (75125 micron) glass beads are used at a low pressure of 60 to 80 psi. Because these glass beads are completely spherical, there are no sharp edges to cut the surface of the metal. After cleaning, these statues undergo a lengthy process of polishing. Coatings are applied which protect the surface from corrosion, but they must be renewed every 3 to 5 years. A similarly delicate cleaning technique employing glass beads has been used in Europe to clean historic masonry structures without causing damage. But at this time the process has not been tested sufficiently in the United States to recommend it as a building conservation measure.

Sometimes a very fine smooth sand is used at a low pressure to clean or remove paint and corrosion from copper flashing and other metal building components. Restoration architects recently found that a mixture of crushed walnut shells and copper slag at a pressure of approximately 200 psi was the only way to remove corrosion successfully from a mid-19th century terne-coated iron roof. Metal cleaned in this manner must be painted immediately to prevent rapid recurrence of corrosion. It is thought that these methods "work harden" the surface by compressing the outer layer, and actually may be good for the surface of the metal. But the extremely complex nature and the time required by such processes make it very expensive and impractical for large-scale use at this time.

Cast and wrought iron architectural elements may be gently sandblasted or abrasively cleaned using a wire brush to remove layers of paint, rust and

Cast iron may be abrasively cleaned, but must be painted immediately to prevent rust. Photo: NPS files.

corrosion. Sandblasting was, in fact, developed originally as an efficient maintenance procedure for engineering and industrial structures and heavy machinery--iron and steel bridges, machine tool frames, engine frames, and railroad rolling stock--in order to clean and prepare them for repainting. Because iron is hard, its surface, which is naturally somewhat uneven, will not be noticeably damaged by controlled abrasion. Such treatment will, however, result in a small amount of pitting. But this slight abrasion creates a good surface for paint, since the iron must he repainted immediately to prevent corrosion. Any abrasive cleaning of metal building components will also remove the caulking from joints and around other openings. Such areas must be recaulked quickly to prevent moisture from entering and rusting the metal, or causing deterioration of other building fabric inside the structure.

When is Abrasive Cleaning Permissible?

Industrial interiors that are not finely milled may be abrasively cleaned, in some instances. Photo: NPS files.

For the most part, abrasive cleaning is destructive to historic building materials. A limited number of special cases have been explained when it may be appropriate, if supervised by a skilled conservator, to use a delicate abrasive technique on some historic building materials. The type of "wet grit" cleaning which involves a small amount of grit injected into a stream of low pressure water may be used on small areas of stone masonry (i.e., rough cut limestone, sandstone or unpolished granite), where milder cleaning methods have not been totally successful in removing harmful deposits of dirt and pollutants. Such areas may include stone window sills, the tops of cornices or column capitals, or other detailed areas of the facade.

This is still an abrasive technique, and without proper caution in handling, it can be *just as harmful to the building surface as any other abrasive cleaning method*. Thus, the decision to use this type of "wet grit" process should be made only after consultation with an experienced building conservator. Remember that *it is very time consuming and expensive to use any abrasive technique on a historic building in such a manner that it does not cause harm to the often fragile and friable building materials*.

At this time, and only under certain circumstances, abrasive cleaning methods may he used in the rehabilitation of interior spaces of warehouse or industrial buildings for contemporary uses.

Interior spaces of factories or warehouse structures in which the masonry or plaster surfaces do not have significant design, detailing, tooling or finish, and in which wooden architectural features are not finished, molded, beaded or worked by hand, may be cleaned abrasively in order to remove layers of paint and industrial discolorations such as smoke, soot, etc. It is expected after such treatment that brick surfaces will be rough and pitted, and wood will be somewhat frayed or "fuzzy" with raised wood grain. These nonsignificant surfaces will be damaged and have a roughened texture, but because they are interior elements, they will not be subject to further deterioration caused by weathering.

Historic Interiors That Should Not Be Cleaned Abrasively


Decorative wood exterior or interior features should not be cleaned abrasively. Photo: NPS files.

Those instances (generally industrial and some commercial properties), when it may be acceptable to use an abrasive treatment on the interior of historic structures have been described. But for the majority of historic buildings, the Secretary of the Interior's *Guidelines for Rehabilitation* do not recommend "changing the texture of exposed wooden architectural features (including structural members) and masonry surfaces through sandblasting or use of other abrasive techniques to remove paint, discolorations and plaster

Thus, it is not acceptable to clean abrasively interiors of historic residential and commercial properties which have *finished* interior spaces featuring milled woodwork such as doors, window and door moldings, wainscoting, stair balustrades and mantelpieces. Even the most modest historic house interior, although it may not feature elaborate detailing, contains plaster and woodwork that is architecturally significant to the original design and function of the house. Abrasive cleaning of such an interior would be destructive to the historic integrity of the building.

Abrasive cleaning is also impractical. Rough surfaces of abrasively cleaned wooden elements are hard to keep clean. It is also difficult to seal, paint or maintain these surfaces which can be splintery and a problem to the building's occupants. The force of abrasive blasting may cause grit particles to lodge in cracks of wooden elements, which will be a nuisance as the grit is loosened by vibrations and gradually sifts out. Removal of plaster will reduce the thermal and insulating value of the walls. Interior brick is usually softer than exterior brick, and generally of a poorer quality. Removing surface plaster from such brick by abrasive means often exposes gaping mortar joints and mismatched or repaired brickwork which was never intended to show. The resulting bare brick wall may require repointing, often difficult to match. It also may be necessary to apply a transparent surface coating (or sealer) in order to prevent the mortar and brick from "dusting." However. a sealer may not only change the color of the brick, but may also compound any existing moisture problems by restricting the normal evaporation of water vapor from the masonry surface.

"Gentlest Means Possible"

There are alternative means of removing dirt, stains and paint from historic building surfaces that can be recommended as more efficient and less destructive than abrasive techniques. The "gentlest means possible" of removing dirt from a building surface can be achieved by using a low-pressure water wash, scrubbing areas of more persistent grime with a natural bristle (never metal) brush. Steam cleaning can also be used effectively to clean some historic building fabric. Low-pressure water or steam will soften the dirt and cause the deposits to rise to the surface, where they can be washed away.

A third cleaning technique which may be recommended to remove dirt, as well as stains, graffiti or paint, involves the use of commercially available chemical cleaners or paint removers, which, when applied to masonry, loosen or dissolve the dirt or stains. These cleaning agents may be used in combination with water or steam, followed by a clear water wash to remove the residue of dirt and the chemical cleaners from the masonry. A natural bristle brush may also facilitate this type of chemically assisted cleaning, particularly in areas of heavy dirt deposits or stains, and a wooden scraper can be useful in removing thick encrustations of soot. A limewash or absorbent talc, whiting or clay poultice with a solvent can be used effectively to draw out salts or stains from the surface of the selected areas of a building facade. It is almost impossible to remove paint from masonry surfaces without causing some damage to the masonry, and it is best to leave the surfaces as they are or repaint them if necessary.

Some physicists are experimenting with the use of pulsed laser beams and xenon flash lamps for cleaning historic masonry surfaces. At this time it is a slow, expensive cleaning method, but its initial success indicates that it may have an increasingly important role in the future.

There are many chemical paint removers which, when applied to painted wood, soften and dissolve the paint so that it can be scraped off by hand. Peeling paint can be removed from wood by hand scraping and sanding. Particularly thick layers of paint may be softened with a heat gun or heat plate, providing appropriate precautions are taken, and the paint film scraped off by hand. Too much heat applied to the same spot can burn the wood, and the fumes caused by burning paint are dangerous to inhale, and can he explosive. Furthermore, the hot air from heat guns can start fires in the building cavity. Thus, adequate ventilation is important when using a heat gun or heat plate, as well as when using a chemical stripper. A torch or open flame should never he used.

Preparations for Cleaning: It cannot be overemphasized that all of these cleaning methods must be approached with caution. When using any of these procedures which involve water or other liquid cleaning agents on masonry, it is imperative that all openings be tightly covered, and all cracks or joints be well pointed in order to avoid the danger of water penetrating the building's facade, a circumstance which might result in serious moisture related problems such as efflorescence and/or subflorescence. Any time water is used on masonry as a cleaning agent, either in its pure state or in combination with chemical cleaners, it is very important that the work be done in warm weather when there is no danger of frost for several months. Otherwise water which has penetrated the masonry may freeze, eventually causing the surface of the building to crack and spall, which may create another conservation problem more serious to the health of the building than dirt.

Each kind of masonry has a unique composition and reacts differently with various chemical cleaning substances. Water and/or chemicals may interact with minerals in stone and cause new types of stains to leach out to the surface immediately, or more gradually in a delayed reaction. What may be a safe and effective cleaner for certain stain on one type of stone, may leave unattractive discolorations on another stone, or totally dissolve a third type.

Testing: Cleaning historic building materials, particularly masonry, is a technically complex subject, and thus, should never be done without expert consultation and testing. No cleaning project should be undertaken without first applying the intended cleaning agent to a representative test patch area in an inconspicuous location on the building surface. The test patch or patches should be allowed to weather for a period of time, preferably through a complete seasonal cycle, in order to determine that the cleaned area will not he adversely affected by wet or freezing weather or any by-products of the cleaning process.

Mitigating the Effects of Abrasive Cleaning

There are certain restoration measures which can be adopted to help preserve a historic building exterior which has been damaged by abrasive methods. Wood that has been sandblasted will exhibit a frayed or "fuzzed" surface, or a harder wood will have an exaggerated raised grain. The only way to remove this rough surface or to smooth the grain is by laborious sanding. Sandblasted wood, unless it has been extensively sanded, serves as a dustcatcher, will weather faster, and will present a continuing and ever worsening maintenance problem. Such wood, after sanding, should be painted or given a clear surface coating to protect the wood, and allow for somewhat easier maintenance.

There are few successful preservative treatments that may be applied to grit-blasted exterior masonry. Harder, denser stone may have suffered only a loss of crisp edges or tool marks, or other indications of craft technique. If the stone has a compact and uniform composition, it should continue to weather with little additional deterioration. But some types of sandstone, marble and limestone will weather at an accelerated rate once their protective "quarry crust" or patina has been removed.

Softer types of masonry, particularly brick and architectural terra-cotta, are the most likely to require some remedial treatment if they have been abrasively cleaned. Old brick, being essentially a soft, baked clay product, is greatly susceptible to increased deterioration when its hard, outer skin is removed through abrasive techniques. This problem can be minimized by painting the brick. An alternative is to treat it with a clear sealer or surface coating but this will give the masonry a glossy, or shiny look. It is usually preferable to paint the brick rather than to apply a transparent sealer since sealers reduce the transpiration of moisture, allowing salts to crystallize as subflorescence that eventually spalls the brick. If a brick surface has been so extensively damaged by abrasive cleaning and weathering that spalling has already begun, it may be necessary to cover the walls with stucco, if it will adhere.

Of course, the application of paint, a clear surface coating (sealer), or stucco to deteriorating masonry means that the historical appearance will be sacrificed in an attempt to conserve the historic building materials. However, the original color and texture will have been changed already by the abrasive treatment. At this point it is more important to try to preserve the brick, and there is little choice but to protect it from "dusting" or spalling too rapidly. As a last resort, in the case of severely spalling brick, there may be no option but to replace the brick--a difficult, expensive (particularly if custom-made reproduction brick is used), and lengthy process. As described earlier, sandblasted interior brick work, while not subject to change of weather, may require the application of a transparent surface coating or painting as a maintenance procedure to contain loose mortar and brick dust. (See ***Preservation Briefs: No. 1*** for a more thorough discussion of coatings.)

Metals, other than cast or wrought iron, that have been pitted and dented by harsh abrasive blasting usually cannot be smoothed out. Although fillers may be satisfactory for smoothing a painted surface, exposed metal that has been damaged usually will have to be replaced.

Summary

Sandblasting or other abrasive methods of cleaning or paint removal are by their nature destructive to historic building materials and should not be used on historic buildings except in a few well-monitored instances. There are exceptions when certain types of abrasive cleaning may be permissible, but only if conducted by a trained conservator, and if cleaning is necessary for the preservation of the historic structure.

There is no one formula that will be suitable for cleaning all historic building surfaces. Although there are many commercial cleaning products and methods available, it is impossible to state definitively which of these will be the most effective without causing harm to the building fabric. It is often difficult to identify ingredients or their proportions contained in cleaning products; consequently it is hard to predict how a product will react to the building materials to be cleaned. Similar uncertainties affect the outcome of other cleaning methods as they are applied to historic building materials. Further advances in understanding the complex nature of the many variables of the cleaning techniques may someday provide a better and simpler solution to the problems. But until that time, the process of cleaning historic buildings must be approached with caution through trial and error.

It is important to remember that historic building materials are neither indestructible, nor are they renewable. They must be treated in a responsible manner, which may mean little or no cleaning at all if they are to be preserved for future generations to enjoy. If it is in the best interest of the building to clean it, then it should be done "using the gentlest means possible."

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Home page logo: Undamaged historic brick (above). Sandblasted brick (below). Photo: Courtesy, Illinois Historic Preservation Agency.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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15 PRESERVATION BRIEFS

Preservation of Historic Concrete

Paul Gaudette and Deborah Slaton

National Park Service
U.S. Department of the Interior

Heritage Preservation Services

Introduction to Historic Concrete

Concrete is an extraordinarily versatile building material used for utilitarian, ornamental, and monumental structures since ancient times. Composed of a mixture of sand, gravel, crushed stone, or other coarse material, bound together with lime or cement, concrete undergoes a chemical reaction and hardens when water is added. Inserting reinforcement adds tensile strength to structural concrete elements. The use of reinforcement contributes significantly to the range and size of building and structure types that can be constructed with concrete.

While early twentieth century proponents of modern concrete often considered it to be permanent, it is, like all materials, subject to deterioration. This Brief provides an overview of the history of concrete and its popularization in the United States, surveys the principal causes and modes of concrete deterioration, and outlines approaches to repair and protection that are appropriate to historic concrete. In the context of this Brief, historic concrete is considered to be concrete used in construction of structures of historical, architectural, or engineering interest, whether those structures are old or relatively new.

Brief History of Use and Manufacture

The ancient Romans found that a mixture of lime putty and pozzolana, a fine volcanic ash, would harden under water. The resulting hydraulic cement became a major feature of Roman building practice, and was used in many buildings and engineering projects such as bridges and aqueducts. Concrete technology was kept alive during the Middle Ages in Spain and Africa. The Spanish introduced a form of concrete to the New World in the first decades of the sixteenth century, referred to as "tapia" or "tabby." This material, a mixture of lime, sand, and shell or stone aggregate mixed with water, was placed between wooden forms, tamped, and allowed to dry in successive layers. Tabby was later used by the English settlers in the coastal southeastern United States.

The early history of concrete was fragmented, with developments in materials and construction techniques occurring on different continents and in various countries. In the United States, concrete was slow in achieving widespread acceptance in building construction and did not begin to gain popularity until the late nineteenth century. It was more readily accepted for use in transportation and infrastructure systems.

The Erie Canal in New York is an example of the early use of concrete in transportation in the United States. The natural hydraulic cement used in the canal construction was processed from a deposit of limestone found in 1818 near Chittenango, southeast of Syracuse. The use of concrete in residential construction was

Figure 1. The Sebastopol House in Seguin, Texas, is an 1856 Greek Revival-style house constructed of lime concrete. Lime concrete or "limecrete" was a popular construction material, as it could be made inexpensively from local materials. By 1900, the town had approximately ninety limecrete structures, twenty of which remain. Photo: Texas Parks and Wildlife Department.

Figure 2. Chatterton House was the home of the post trader at Fort Fred Steel in Wyoming, one of several forts established in the 1860s to protect the Union Pacific Railroad. The walls of the post trader's house were built using stone aggregate and lime, without cement. The use of this material presents special preservation challenges.

publicized in the second edition of Orson S. Fowler's *A Home for All* (1853) which described the advantages of "gravel wall" construction to a wide audience. The town of Seguin, Texas, thirty-five miles east of San Antonio, already had a number of concrete buildings by the 1850s and came to be called "The Mother of Concrete Cities," with approximately ninety concrete buildings made from local "lime water" and gravel (Fig. 1).

Impressed by the economic advantages of poured gravel wall or "lime-grout" construction, the Quartermaster General's Office of the War Department embarked on a campaign to improve the quality of building for frontier military posts. As a result, lime-grout structures were constructed at several western posts soon after the Civil War, including Fort Fred Steele and Fort Laramie, both in Wyoming (Fig. 2). By the 1880s, sufficient experience had been gained with unreinforced concrete to permit construction of much larger buildings. A notable example from this period is the Ponce de Leon Hotel in St. Augustine, Florida.

Extensive construction in concrete also occurred through the system of coastal fortifications commissioned by the federal government in the 1890s for the Atlantic, Pacific, and Gulf coasts. Unlike most concrete construction to that time, the special requirements of coastal fortifications called for concrete walls as much as 20 feet thick, often at sites that were difficult to access. Major structures in the coastal defenses of the 1890s were built of mass concrete with no internal reinforcing, a practice that was replaced by the use of reinforcing bars in fortifications constructed after about 1905.

The use of reinforced concrete in the United States dates from 1860, when S.T. Fowler obtained a patent for a reinforced concrete wall. In the early 1870s, William E. Ward built his own house in Port Chester, New York, using concrete reinforced with iron rods for all structural elements. Despite these developments, such construction remained a novelty until after 1880, when innovations introduced by Ernest L. Ransome made the use of reinforced concrete more practicable. Ransome made many contributions to the development of concrete construction technology, including the use of twisted reinforcing bars to improve bond between the concrete and the steel, which he patented in 1884. Two years later, Ransome introduced the rotary kiln to United States cement production. The new kiln had greater capacity and burned more thoroughly and uniformly, allowing development of a less expensive, more uniform, and more reliable manufactured cement. Improvements in concrete production initiated by Ransom led to a much greater acceptance of concrete after 1900.

The Lincoln Highway Association, incorporated in 1913, promoted the use of concrete in construction of a coast-to-coast roadway system. The goal of the Lincoln Highway Association and highway advocate Henry B. Joy was to educate the country in the need for good roads made of concrete, with an improved Lincoln

Figure 3. The Lincoln Highway Association promoted construction of a high quality continuous hard surface roadway across the country. The Boys Scouts of America installed concrete road markers along the Lincoln Highway in 1928.

Figure 4. The highly ornamental concrete panels on the exterior facade of the Baha'i House of Worship in Wilmette, Illinois, illustrate the work of fabricator John J. Earley, known as "the man who made concrete beautiful."

Figure 5. Following World War II, architects and engineers took advantage of improvements in concrete production, quality control, and advances in precast concrete to design structures such as the Police Headquarters building in Philadelphia, Pennsylvania, constructed in 1961. Photo: Courtesy of the Philadelphia Police Department.

Highway as an example. Concrete "seedling miles" were constructed in remote areas to emphasize the superiority of concrete over unimproved dirt. The Association believed that as people learned about concrete, they would press the government to construct good roads throughout their states. Americans' enthusiasm for good roads led to the involvement of the federal government in road-building and the creation of numbered U.S. routes in the 1920s (Fig. 3).

During the early twentieth century, Ernest Ransome in Beverly, Massachusetts, Albert Kahn in Detroit, and Richard E. Schmidt in Chicago, promoted concrete for use in "Factory Style" utilitarian buildings with an exposed concrete frame infilled with expanses of glass. Thomas Edison's cast-in-place reinforced concrete homes in Union Township, New Jersey (1908), proclaimed a similarly functional emphasis in residential construction. From the 1920s onward, concrete began to be used with spectacular design results: examples include John J. Earley's Meridian Hill Park in Washington, D.C.; Louis Bourgeois' exuberant, graceful Baha'i Temple in Wilmette, Illinois (1920–1953), for which Earley fabricated the concrete (Fig. 4); and Frank Lloyd Wright's Fallingwater near Bear Run, Pennsylvania (1934). Continuing improvements in quality control and development of innovative fabrication processes, such as the Shockbeton method for precast concrete, provided increasing opportunities for architects and engineers. Wright's Guggenheim Museum in New York City (1959); Geddes Brecher Qualls & Cunningham's Police Headquarters building in Philadelphia, Pennsylvania (1961); and Eero Saarinen's soaring terminal building at Dulles International Airport outside Washington, D.C., and the TWA terminal at Kennedy Airport in New York (1962), exemplify the masterful use of concrete achieved in the modern era (Fig. 5).

Figure 6. The Bailey Magnet School in Jackson, Mississippi, was designed as the Jackson Junior High School by the firm of N.W. Overstreet & Town in 1936. The streamlined building exemplifies the applicability of concrete to creating a modern architectural aesthetic. Photo: Bill Burris, Burris/Wagnon Architects, P.A.

Figure 7. Detailed bas reliefs as well as sculptures, such as this lion at the Bailey Magnet School, could be used as ornamentation on concrete buildings. Sculptural concrete elements were typically cast in molds.

Throughout the twentieth century, a wide range of architectural and engineering structures were built using concrete as a practical and cost-effective choice—and concrete also became valued for its aesthetic qualities. Cast in place and precast concrete were readily adapted to the Streamlined Moderne style, as exemplified by the Bailey Magnet School in Jackson, Mississippi, designed as the Jackson Junior High School by N.W. Overstreet & Town in 1936 (Figs. 6 and 7). The school is one of many concrete buildings designed and constructed under the auspices of the Public Works Administration. Recreational structures and landscape features also utilized the structural range and unique character of exposed concrete to advantage, as seen in Chicago's Lincoln Park Chess Pavilion, designed by Morris Webster in 1956 (Fig. 8), and the Ira C. Keller Fountain in Portland Oregon, designed by Lawrence Halprin in 1969 (Fig. 9). Concrete was also popular for building interiors, with ornamental features and exposed structural elements recognized as part of the design aesthetic (See Figs. 10 and 11 in sidebar).

Historic Interiors

The expanded use of concrete provided new opportunities to create dramatic spaces and ornate architectural detail on the interiors of buildings, at a significant cost savings over traditional construction practices. The architectural design of the Berkeley City Club in Berkeley, California, expressed Moorish and Gothic elements in concrete on the interior of the building (Fig. 10). Used as a woman's social club, the building was designed by noted California architect Julia Morgan and constructed in 1929. The vaulted ceilings, columns, and ornamental capitals of the lobby and the ornamental arches and beamed ceiling of the "plunge" are all constructed of concrete.

Figure 10. The Berkeley City Club has significant interior spaces and features of concrete construction, including the lobby and pool. Photos: Una Gilmartin (left) and Brian Kehoe (right), Wiss, Janney, Elstner Associates, Inc.

The historic character of a building's interior can also be conveyed in a more utilitarian manner in terms of concrete features and finishes (Fig. 11). The exposed concrete structure—columns, capitals, and drop panels—is an integral part of the character of this old commercial building in Minneapolis. In concrete warehouse and factory buildings of the early twentieth century, exposed concrete columns and formboard finish concrete slab ceilings are common features as seen in this warehouse, now converted for use as a parking garage and shops.

Figure 11. Whether in a circa 1925 office (left) or in a parking garage and retail facility (right), exposed concrete structures help characterize these building interiors. Photo: Minnesota Historical Society (left).

Concrete Characteristics

Concrete is composed of fine (sand) and coarse (crushed stone or gravel) aggregates and paste made of portland cement and water. The predominant material in terms of bulk is the aggregate. Portland cement is the binder most commonly used in modern concrete. It is commercially manufactured by blending limestone or chalk with clays that contain alumina, silica, lime, iron oxide and magnesia, and heating the compounds together to high temperatures. The hydration process that occurs between the portland cement and water results in formation of an alkali paste that surrounds and binds the aggregate together as a solid mass.

The quality of the concrete is dependent on the ratio of water to the binder; binder content; sound, durable, and well-graded aggregates; compaction during placement; and proper curing. The amount of water used in the mix affects the concrete permeability and strength. The use of excess water beyond that required in the hydration process results in more permeable concrete, which is more susceptible to weathering and deterioration. Admixtures are commonly added to concrete to adjust concrete properties such as setting or hardening time, requirements for water, workability, and other characteristics. For example, the advent of air entraining agents in the 1930s provided enhanced durability for concrete.

During the twentieth century, there was a steady rise in the strength of ordinary concrete as chemical processes became better understood and quality control measures improved. In addition, the need to protect embedded reinforcement against corrosion was acknowledged. Requirements for concrete cover over reinforcing steel, increased cement content, decreased water-cement ratio, and air entrainment all contributed to greater concrete strength and improved durability.

Mechanisms and Modes of Deterioration

Causes of Deterioration

Concrete deterioration occurs primarily because of corrosion of the embedded steel, degradation of the concrete itself, use of improper techniques or materials in construction, or structural problems. The causes of concrete deterioration must be understood in order to select an appropriate repair and protection system.

While reinforcing steel has played a pivotal role in expanding the applications of concrete in twentieth century architecture, corrosion of this steel has also caused deterioration in many historic structures. Reinforcing steel embedded in the concrete is normally surrounded by a passivating oxide layer that, when present, protects the steel from corrosion and aids in bonding the steel and concrete. When the concrete's normal alkaline environment (above a pH of 10) is compromised and the steel is exposed to water, water vapor, or high relative humidity, corrosion of the steel reinforcing takes place. A reduction in alkalinity results from carbonation, a process that occurs when the carbon dioxide in the atmosphere reacts with calcium hydroxide and moisture in the concrete. Carbonation starts at the concrete's exposed surface but may extend to the reinforcing steel over time. When carbonation reaches the metal reinforcement, the concrete no longer protects the steel from corrosion.

Figure 8. The Chess Pavilion in Chicago's Lincoln Park was designed by architect Morris Webster and constructed in 1956. The pavilion is a distinctive landscape feature, with its reinforced concrete cantilevered slab that provides cover for chess players.

Figure 9. The Ira C. Keller Fountain in Portland, Oregon, was designed by Lawrence Halprin and constructed in 1969. The fountain is constructed primarily of concrete pillars with formboard textures and surrounding elements, patterned with geometric lines, which facilitate the path of water. Photo: Anita Washko, Wiss, Janney, Elstner Associates, Inc.

Corrosion of embedded reinforcing steel may be initiated and accelerated if calcium chloride was added to the concrete as a set accelerator during original construction to promote more rapid curing. It may also take place if the concrete is later exposed to deicing salts, as may occur during the winter in northern climates. Seawater or other marine environments can also provide large amounts of chloride, either from inadequately washed original aggregate or from exposure of the concrete to seawater.

Corrosion-related damage to reinforced concrete is the result of rust, a product of the corrosion process of steel, which expands and thus requires more space in the concrete than the steel did at the time of installation. This change in volume of the steel results in expansive forces, which cause cracking and spalling of the adjacent concrete (Fig. 12). Other signs of corrosion of embedded steel include delamination of the concrete (planar separations parallel to the surface) and rust staining (often a precursor to spalling) on the concrete near the steel.

Lack of proper maintenance of building elements such as roofs and drainage systems can contribute to water-related deterioration of the adjacent concrete, particularly when concrete is saturated with water and then exposed to freezing temperatures. As water within the concrete freezes, it expands and exerts forces on the adjacent concrete. Repeated freezing and thawing can result in the concrete cracking and delaminating. Such damage appears as surface degradation, including severe scaling and micro-cracking that extends into the concrete. The condition is most often observed near the surface of the concrete but can also eventually occur deep within the concrete. This type of deterioration is usually most severe at joints, architectural details, and other areas with more surface exposure to weather. In the second half of the twentieth century, concrete has utilized entrained air (the incorporation of microscopic air bubbles) to provide enhanced protection against damage due to cyclic freezing of saturated concrete.

The use of certain aggregates can also result in deterioration of the concrete. Alkali-aggregate reactions—in some cases alkali-silica reaction (ASR)—occur when alkalis normally present in cement react with certain aggregates, leading to the development of an expansive crystalline gel. When this gel is exposed to moisture, it expands and causes cracking of the aggregate and concrete matrix. Deleterious aggregates are typically found only in certain areas of the country and can be detected through analysis by an experienced petrographer. Low-alkali cements as well as fly ash are used today in new construction to prevent such reactions where this problem may occur.

Problems Specifically Encountered with Historic Concrete

Materials and workmanship used in the construction of historic concrete structures, particularly those built before the First World War, sometimes present potential sources of problems. For example, where the aggregate consisted of cinder from burned coal or crushed brick,

Figure 12. The concrete lighthouse at the Kilauea Point Light Station, Kilauea, Kauai, Hawaii, was constructed circa 1913. The concrete, which was a good quality, high strength mix for its day, is in good condition after almost one hundred years in service. Deterioration in the form of spalling related to corrosion of embedded reinforcing steel has occurred primarily in areas of higher ornamentation such as projecting bands and brackets (see close-up photo).

the concrete tends to be weak and porous because these aggregates absorb water. Some of these aggregates can be extremely susceptible to deterioration when exposed to moisture and cyclic freezing and thawing. Concrete was sometimes compromised by inclusion of seawater or beach sand that was not thoroughly washed with fresh water, a condition more common with coastal fortifications built prior to 1900. The sodium chloride present in seawater and beach sand accelerates the rate of corrosion of the reinforced concrete.

Another problem encountered with historic concrete is related to poor consolidation of the concrete during its placement in forms, or in molds in the case of precasting. This problem is especially prevalent in highly ornamental units. Early twentieth century concrete was often tamped or rodded into place, similar to techniques used in forming cast stone. Poorly consolidated concrete often contains voids ("bugholes" or "honeycombs"), which can reduce the protective concrete cover over the embedded reinforcing bars, entrap water, and, if sufficiently large and strategically numerous, reduce localized concrete strength. Vibration technology has improved over time and flowability agents are also used today to address this problem.

A common type of deterioration observed in concrete is the effect of weathering from exposure to wind, rain, snow, and salt water or spray. Weathering appears as erosion of the cement paste, a condition more prevalent in northern regions where precipitation can be highly acidic. This results in the exposure of the aggregate particles on the exposed concrete surface. Variations may occur in the aggregate exposure due to differential erosion or dissolution of exposed cement paste. Erosion can also be caused by the mechanical action of water channeled over concrete, such as by the lack of drip grooves in belt courses and sills, and by inadequate drainage. In addition, high-pressure water when used for cleaning can also erode the concrete surface.

In concrete structures built prior to the First World War, concrete was often placed into forms in relatively short vertical lifts due to limitations in lifting and pouring techniques available at the time. Joints between different concrete placements (often termed cold joints or lift lines) may sometimes be considered an important part of the character of a concrete element (Fig. 13). However, wide joints may permit water to infiltrate the concrete, resulting in more rapid paste erosion or freeze-thaw deterioration of adjacent concrete in cold climates.

In the early twentieth century, concrete was sometimes placed in several layers parallel to the exterior surface. A base concrete was first created with formwork and then a more cement rich mortar layer was applied to the exposed vertical face of the

Figure 13. Fort Casey on Admiralty Head, Fort Casey, Washington, was constructed in 1898. The lift lines from placement of concrete are clearly visible on the exterior walls and characterize the finished appearance.

base concrete. The higher cement content in the facing concrete provided a more water-resistant outer layer and finished surface. The application of a cement-rich top layer, referred to in some early concrete publications as "waterproofing," was also used on top surfaces of concrete walls, or as the top layer in sidewalks. With this type of concrete construction, deterioration can occur over time as a result of debonding between layers, and can proceed very rapidly once the protective cement-rich layer begins to break down.

It is common for historic concrete to have a highly variable appearance, including color and finish texture. Different levels of aggregate exposure due to paste erosion are often found in exposed aggregate concrete. This variability in the appearance of historic concrete increases the level of difficulty in assessing and repairing weathered concrete.

Signs of Distress and Deterioration

Characteristic signs of failure in concrete include cracking, spalling, staining, and deflection. Cracking occurs in most concrete but will vary in depth, width, direction, pattern, and location, and can be either active or dormant (inactive). Active cracks can widen, deepen, or migrate through the concrete, while dormant cracks remain relatively unchanged in size. Some dormant cracks, such as those caused by early age shrinkage of the concrete during curing, are not a structural concern but when left unrepaired, can provide convenient channels for moisture penetration and subsequent damage. Random surface cracks, also called map cracks due to their resemblance to lines on a map, are usually related to early-age shrinkage but may also indicate other types of deterioration such as alkali-silica reaction.

Structural cracks can be caused by temporary or continued overloads, uneven foundation settling, seismic forces, or original design inadequacies. Structural cracks are active if excessive loads are applied to a structure, if the overload is continuing, or if settlement is ongoing. These cracks are dormant if the temporary overloads have been removed or if differential settlement has stabilized. Thermally-induced cracks result from stresses produced by the expansion and contraction of the concrete during temperature changes. These cracks frequently occur at the ends or re-entrant corners of older concrete structures that were built without expansion joints to relieve such stress.

Spalling (the loss of surface material) is often associated with freezing and thawing as well as cracking and delamination of the concrete cover over embedded reinforcing steel. Spalling occurs when reinforcing bars corrode and the corrosion by-products expand, creating high stresses on the adjacent concrete, which cracks and is displaced. Spalling can also occur when water absorbed by the concrete freezes and thaws (Fig. 14). In addition, surface spalling or scaling may result from the improper finishing, forming, or other surface

Figures 14. Layers of architectural concrete that have debonded (spalled) from the surface were removed from a historic water tank during the investigation performed to assess existing conditions. Photos: Anita Washko, Wiss, Janney, Elstner Associates, Inc.

phenomena when water-rich cement paste (laitance) rises to the surface. The resulting weak material is vulnerable to spalling of thin layers, or scaling. In some cases, spalling of the concrete can diminish the load-carrying capacity of the structure.

Deflection is the bending or sagging of structural beams, joists, or slabs, and can be an indication of deficiencies in the strength and structural soundness of concrete. This condition can be produced by overloading, corrosion of embedded reinforcing, or inadequate design or construction, such as use of low-strength concrete or undersized reinforcing bars.

Staining of the concrete surface can be related to soiling from atmospheric pollutants or other contaminants, dirt accumulation, and the presence of organic growth. However, stains can also indicate more serious underlying problems, such as corrosion of embedded reinforcing steel, improper previous surface treatments, alkali-aggregate reaction, or efflorescence, the deposition of soluble salts on the surface of the concrete as a result of water migration (Fig. 15).

Planning for Concrete Preservation

The significance of a historic concrete building or structure—including whether it is important for its architectural or engineering design, for its materials and construction techniques, or both—guides decision making about repair and, if needed, replacement methods. Determining the causes of deterioration is also central to the development of a conservation and repair plan. With historic concrete buildings, one of the more difficult challenges is allowing for sufficient time during the planning phase to analyze the concrete, develop mixes, and provide time for adequate aging of mock-ups for matching to the original concrete.

An understanding of the original construction techniques (cement characteristics, mix design, original intent of assembly, type of placement, precast versus cast in place, etc.) and previous repair work performed on the concrete is important in determining causes of existing deterioration and the susceptibility of the structure to potential other types of deterioration. For example, concrete placed in short lifts (individual concrete placements) or constructed in precast segments will have numerous joints that can provide entry points for water infiltration. Inappropriate prior repairs, such as installation of patches using an incompatible material, can affect the future performance of the concrete. Such prior repairs may require corrective work.

As with other preservation projects, three primary approaches are usually considered for historic concrete structures: ***maintenance***, ***repair***, or ***replacement***. Maintenance and repair best achieve the preservation goal of minimal intervention and the greatest retention of existing historic fabric. However, where elements of the building are severely deteriorated or where inherent problems with the material lead to ongoing failures, replacement may be necessary.

During planning, information is gathered through research, visual survey, inspection openings, and laboratory studies. The material should then be reviewed by professionals experienced in concrete deterioration to help evaluate the nature and causes of the concrete problems, to assess both the short-term and long-term effects of the deterioration, and to formulate proper repair approaches.

Condition Assessment

A condition assessment of a concrete building or structure should begin with a review of all available documents related to original construction and prior repairs. While plans and specifications for older concrete buildings are not always available, they can be an invaluable resource and every attempt should be made to find them. They may provide information on the composition of the concrete mix or on the type and location of reinforcing bars. If available, documents related to past repairs should also be reviewed to

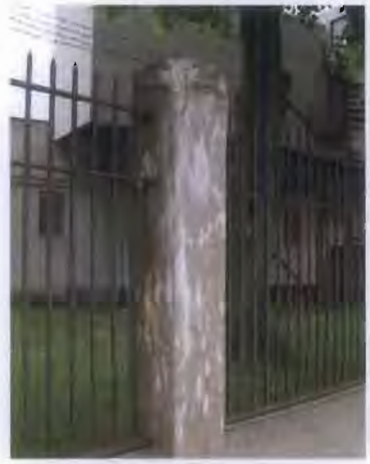

Figure 15. Evidence of moisture movement through concrete is apparent in the form of mineral deposits on the concrete surface. Cyclic freezing and thawing of entrapped moisture, and corrosion of embedded reinforcement, have also contributed to deterioration of the concrete column on this fence at Crocker Field in Fitchburg, Massachusetts, designed by the Olmsted Brothers.

understand how the repairs were made and to help evaluate their anticipated performance and service life. Archival photographs can also provide a valuable source of information about original construction.

A visual condition survey will help identify and evaluate the extent, types, and patterns of distress and deterioration. The American Concrete Institute offers several useful guides on how to perform a visual condition survey of concrete. Generally, the condition assessment begins with an overall visual survey, followed by a close-up investigation of representative areas to obtain more detailed information about modes of deterioration.

A number of nondestructive testing methods can be used in the field to evaluate concealed conditions. Basic techniques include sounding with a hand-held hammer (or for horizontal surfaces, a chain) to help identify areas of delamination. More sophisticated techniques include impact-echo testing (Fig. 16), ground penetrating radar, pulse velocity, and other methods that characterize concrete thickness and locate voids or delaminations. Magnetic detection instruments are used to locate embedded reinforcing steel and can be calibrated to identify the size and depth of reinforcement. Corrosion measurements can be taken using copper-copper sulfate half-cell tests or linear polarization techniques to determine the probability or rate of active corrosion of the reinforcing steel.

To further evaluate the condition of the concrete, samples may be removed for laboratory study to determine material components and composition, and causes of deterioration. Samples need to be representative of existing conditions but should be taken from unobtrusive locations. Laboratory studies of the concrete may include petrographic evaluation following ASTM C856, *Practice for Petrographic Examination of Hardened Concrete*. Petrographic examination, consisting of microscopical studies performed by a geologist specializing in the evaluation of construction materials, is performed to determine air content, water-cement ratio, cement content, and general aggregate characteristics. Laboratory studies can also include chemical analyses to determine chloride content, sulfate content, and alkali levels of the concrete; identification of deleterious aggregates; and determination of depth of carbonation. Compressive strength studies can be conducted to evaluate the strength of the existing concrete and provide information for repair work. The laboratory studies provide a general identification of the original concrete's components and aggregates, and evidence of damage due to various mechanisms including cyclic freezing and thawing, alkali-aggregate reactivity, or sulfate attack. Information gathered through laboratory studies can also be used to help develop a mix design for the repair concrete.

Cleaning

As with other historic structures, concrete structures are cleaned for several reasons: to improve the appearance of the concrete, as a cyclical maintenance measure, or in preparation for repairs. Consideration should first be given to whether the historic concrete structure needs to be cleaned at all. If cleaning is required, then the gentlest system that will be effective should be selected.

Three primary methods are used for cleaning concrete: water methods, abrasive surface treatments, and chemical surface treatments. Low-pressure water (less than 200 psi) or steam cleaning can effectively remove surface soiling from sound concrete; however, care is required on fragile or deteriorated surfaces. In addition, water and steam methods are typically not effective in removing staining or severe soiling. Power washing with high-pressure water is sometimes used to clean or remove coatings from sound, high-strength concrete, but high-pressure water washing is generally damaging to and not appropriate for concrete on historic structures.

When used with proper controls and at very low pressures (typically 35 to 75 psi), microabrasive surface treatments using very fine particulates, such as dolomitic limestone powder, can sometimes clean effectively. However, microabrasive cleaning may alter the texture and surface reflectivity of concrete. Some concrete can be damaged even by fine particulates applied at very low pressures.

Figure 16. Impact echo testing is performed on a concrete structural slab to help determine depth of deterioration. In this method, a short pulse of energy is introduced into the structure and a transducer mounted on the impacted surface of the structure receives the reflected input waves or echoes. These waves are analyzed to help identify flaws and deterioration within the concrete.

Chemical surface treatments can clean effectively but may also alter the appearance of the concrete by bleaching the concrete, removing the paste, etching the aggregate, or otherwise altering the surface. Detergent cleaners or mild, diluted acid cleaners may be appropriate for removal of staining or severe soiling. Cleaning products that contain strong acids such as hydrochloric (muriatic) or hydrofluoric acid, which will damage concrete and are harmful to persons, animals, site features, and the environment, should not be used.

For any cleaning process, trial samples should be performed prior to full-scale implementation. The intent of the cleaning program should not be to return the structure to a like new appearance. Concrete can age gracefully, and as long as soiling is not severe or deleterious, many structures can still be appreciated without extensive cleaning.

Methods of Maintenance and Repair

The maintenance of historic concrete often is thought of in terms of appropriate cleaning to remove unattractive dirt or soiling materials. However, the implementation of an overall maintenance plan for a historic structure is the most effective way to help protect historic concrete. For examples, the lack of maintenance to roofs and drainage systems can promote water related damage to adjacent concrete features. The repeated use of deicing salts in winter climates can pit the surface of old concrete and also may promote decay in embedded steel reinforcements. Inadequate protection of concrete walls adjacent to driveways and parking areas can result in the need for repair work later on.

The maintenance of historic concrete involves the regular inspection of concrete to establish baseline conditions and identify needed repairs. Inspection tasks involve monitoring protection systems, including sealant joints, expansion joints, and protective coatings; reviewing existing conditions for development of distress such as cracking and delaminations; documenting conditions observed; and developing and implementing a cyclical repair program.

Sealants are an important part of maintenance of historic concrete structures. Elastomeric sealants, which have replaced traditional oil-resin based caulks for many applications, are used to seal cracks and joints to keep out moisture and reduce air infiltration. Sealants are commonly used at windows and door perimeters, at interfaces between concrete and other materials, and at attachments to or through walls or roofs, such as with lamps, signs, or exterior plumbing fixtures.

Figure 17. (a) The 63rd Street Beach House was constructed on the shoreline of Chicago in 1919. The highly exposed aggregate concrete of the exterior walls of the beach house was used for many buildings in the Chicago parks as an alternative to more expensive stone construction. Photo: Leslie Schwartz Photography. (b) Concrete deterioration included cracking, spalling, and delamination caused by corrosion of embedded reinforcing steel and concrete damage due to cyclic freezing and thawing. (c) Various sizes and types of aggregates were reviewed for matching to the original concrete materials. (d) Mock-ups of the concrete repair mix were prepared for comparison to the original concrete. Considerations included aggregate type and size, cement color, proportions, aggregate exposure, and surface finish. (e) The craftsman finished the surface to replicate the original appearance in a mock-up on the structure. Here, he used a nylon bristle brush to remove loose paste and expose the aggregate, creating a variable surface to match the adjacent original concrete.

Where used for crack repairs on historic facades, the finished appearance of the sealant application must be considered, as it may be visually intrusive. In some cases, sand can be broadcast onto the surface of the sealant to help conceal the repair.

Urethane and polyurethane sealants are often used to seal joints and cracks in concrete structures, paving, and walkways; these sealants provide a service life of up to ten years. High-performance silicone sealants also are often used with concrete, as they provide a range of movement capabilities and a service life of twenty years or more. Some silicone sealants may stain adjacent materials, which may be a problem with more porous concrete, and may also tend to accumulate dust and dirt. The effectiveness of sealants for sealing joints and cracks depends on numerous factors including proper surface preparation and application. Sealants should be examined as part of routine maintenance inspections, as these materials deteriorate faster than their substrates and must be replaced periodically as a part of cyclical maintenance.

Repair of historic concrete may be required to address deterioration because the original design and construction did not provide for long-term durability, or to facilitate a change in use of the structure. Examples include increasing concrete cover to protect reinforcing steel and reducing water infiltration into the structure by repair of joints. Any such improvements must be thoroughly evaluated for compatibility with the original design and appearance. Care is required in all aspects of historic concrete repair, including surface preparation; installation of formwork; development of the concrete mix design; and concrete placement, consolidation, and curing.

An appropriate repair program addresses existing distress and reduces the rate of future deterioration, which in many cases involves moisture-related issues. The repair program should incorporate materials and methods that are sympathetic to the existing materials in character and appearance, and which provide good long-term performance. In addition, repair materials should age and weather similarly to the original materials. In order to best achieve these goals, concrete repair projects should be divided into three phases: development of trial repair procedures, trial repairs and evaluation, and production repair work.

For any concrete repair project, the process of investigation, laboratory analysis, trial samples, mock-ups, and full-scale repairs allows ongoing refinement of the repair work as well as implementation of quality-control measures. The trial repair process provides an opportunity for the owner, architect, engineer, and contractor to evaluate the concrete mix design and the installation and finishing techniques for the repairs from both technical and aesthetic standpoints. The final repair materials and procedures should match the original concrete in appearance while meeting the established criteria for durability. Information gathered through trial repairs and mock-ups is invaluable in refining the construction documents prior to the start of the overall repair project (Fig. 17).

Surface Preparation

In undertaking surface preparation for historic concrete repair, care must be taken to limit removal of existing material while still providing an appropriate substrate for repairs. This is particularly important where ornamentation and fine details are involved. Preparation for localized repairs usually begins with removal of the loose concrete to determine the general extent of the repair, followed by saw-cutting the perimeter of the repair area. The repair area should extend beyond the area of concrete deterioration to a sufficient extent to provide a sound substrate. When repairing concrete with an exposed aggregate or other special surface texture, a sawcut edge may be too visually evident. To hide the repair edge, techniques such as lightly hand-chipping the edge of the patch may be used to conceal the joint between the original concrete and the new repair material. The depth to which the concrete needs to be removed may be difficult to determine without invasive probing in the repair area. Removal of concrete should typically extend beyond the level of the reinforcing steel, if present, so that the patch encapsulates the reinforcing steel, which provides mechanical attachment for the repair.

If the concrete was originally of lower strength and quality, the assessment of present soundness is more difficult. Deteriorated and unsound concrete is typically removed using pneumatic chipping hammers. Removal of concrete in historic structures is better controlled by using smaller chipping hammers or hand tools. The area of the concrete to be repaired and the exposed reinforcing steel are then cleaned, usually by careful sandblast and air blast procedures applied only within the repair area. Adjacent original concrete surfaces should be protected during this work. In some cases, project constraints such as dust control may limit the ability to thoroughly clean the concrete and steel. For example, it may be necessary to use needle scaling (a small pneumatic impact device) and wire brushing instead of sandblasting.

Supplemental steel may be needed when existing reinforcing steel is severely deteriorated, or if reinforcing steel is not present in repair areas. Exposed existing reinforcing and other embedded steel elements can be cleaned, primed, and painted with a corrosion-inhibiting coating. The patching material should be reinforced and mechanically attached to the existing concrete. Reinforcement materials used in repairs most often include mild steel, epoxy-coated steel, or stainless steel, depending on existing conditions.

Formwork and Molds

Special formwork is needed to recreate ornamental concrete features—which may be complex, in high relief, or architecturally detailed—and to provide special surface finishes such as wood form board textures. Construction of the formwork itself requires particular skill and craftsmanship. Reusable forms can be used for concrete ornamentation that is repeated across a building facade, or precast concrete elements may be used to replace missing or unrepairable architectural features. Formwork for ornamental concrete is often created using a four-step process: a casting of the original concrete is taken; a plaster replica of the unit is prepared; a mold or form is made from the plaster replica; and a new concrete unit is cast. Custom formwork and molds are often the work of specialty companies, such as precasters and cast stone fabricators.

The process of forming architectural features or special surface textures is particularly challenging if early age stripping (removal of formwork early in the concrete curing process) is needed to perform surface treatment on the concrete. Timing for formwork removal is related to strength gain, which in turn is partly dependent on temperature and weather conditions. Early age removal of formwork in highly detailed concrete can lead to damage of the new concrete that has not yet gained sufficient strength through curing.

Selection of Repair Materials and Mix Design

Selection and design of proper repair materials is a critical component of the repair project. This process requires evaluation of the performance, characteristics, and limitations of the repair materials, and may involve laboratory testing of proposed materials and trial repairs. The materials should be selected to address the specific type of repair required and to be compatible with special characteristics of the original concrete. Some modern repair materials are designed to have a high compressive strength and to be impermeable. Even though inherently durable, these newer materials may not be appropriate for use in repairing a low strength historic concrete.

The concrete's durability, or resistance to deterioration, and the materials and methods selected for repair depend on its composition, design, and quality of workmanship. In most cases, a mix design for durable replacement concrete should use materials similar to those of the original concrete mix. Prepackaged materials are often not appropriate for repair of historic concrete. The concrete patching material can be air entrained or polymer-modified if subject to exterior exposure, and should incorporate an appropriate selection of aggregate and cement type, and proper water content and water

Figure 18. (a) Exposed aggregate precast concrete is sounded with a hammer to detect areas of deterioration. Corrosion of the exposed reinforcing steel bar has led to spalling of the adjacent concrete. (b) Samples of aggregate considered for use in repair concrete are compared to the original concrete materials in terms of size, color, texture, and reflectance. (c) Various sample panels are made using the selected concrete repair mix design for comparison to the original concrete on the building, and the mix design is adjusted based on review of the samples. (d) After removal of the spall, the concrete surface is prepared for installation of a formed patch. (e) Prior to placement of the concrete, a retarding agent is brush-applied to the inside face of the formwork to slow curing at the surface. After the concrete is partially cured, the forms are removed and the surface of the concrete is rubbed to remove some of the paste and expose the aggregate to match the original concrete.

to cement ratio. Some admixtures, including polymer modifiers, may change the appearance of the concrete mix. Design of the concrete patching material should address characteristics required for durability, workability, strength gain, compressive strength, and other performance attributes. During installation of the repair, skilled workmanship is required to ensure proper mixing procedures, placement, consolidation, and curing.

Matching and Repair Techniques for Historic Concrete

Repair measures should be selected that retain as much of the original material as possible, while providing for removal of an adequate amount of deteriorated concrete to provide a sound substrate for a durable repair. The installed repair must visually match the existing concrete as closely as possible and should be similar in other aspects such as compressive strength, permeability, and other characteristics important in the mix design of the concrete (Fig. 18).

Understanding the original construction techniques often provides opportunities in the design of repairs. For example, joints between the new and old concrete can be hidden in changes in surface profile and cold joints. The required patching mix for the concrete to be used in the repair will likely need to be specially designed to replicate the appearance of the adjacent historic concrete. A high level of craftsmanship is required for finishing of historic concrete, in particular to create the sometimes inconsistent finish and variation in the original concrete in contrast to the more even appearance required for most non-historic repairs.

To match the various characteristics of the original concrete, trial mixes should be developed. These mixes need to take into account the types and colors of aggregates and paste present in the original concrete. Different mixes may be needed because of variations in the appearance and composition of the historic concrete. The trials should utilize different forming and finishing techniques to achieve the best possible match to the original concrete. Initial trials should first take place on site but off the structure. The mix designs providing the best match are then installed as trial repairs on the structure, and assessed after they have cured.

Achieving compatibility between repair work and original concrete may be difficult, especially given the variability often present in historic concrete materials and finishes. Formed rather than trowel-applied patch repairs are recommended for durability, as forming permits better ranges of mix ingredients (such as coarse aggregates) and improved consolidation as compared to trowel-applied repairs. Parge coatings usually are not recommended as they do not provide as durable repair as formed concrete. However, in some cases parge coatings may be appropriate to match an original parged surface treatment. Proper placement and finishing of the repair are important to obtain a match with the original concrete. To minimize problems associated with rapid curing of concrete, such as surface cracking, it is important to use proper curing methods and to allow for sufficient time.

Hairline cracks that show no sign of increasing in size may often be left unrepaired. The width of the crack and the amount of movement usually limits the selection of crack repair techniques that are available. Although it is difficult to determine whether cracks are moving or non-moving, and therefore most cracks should be assumed to be moving, it is possible to repair non-moving cracks by installation of a cementitious repair mortar matching the adjacent concrete. It is generally desirable not to widen cracks prior to the mortar application. Repair mortar containing sand in the mix may be used for wider cracks; unsanded repair mortar may be used for narrower cracks.

When it is desirable to re-establish the structural integrity of a concrete structure involving dormant cracks, epoxy injection repair has proven to be an effective procedure. Such a repair is made by first sealing the crack on both sides of a wall or structural member with epoxy, polyester, wax, tape, or cement slurry, and then injecting epoxy through small holes or ports drilled in the concrete. Once the epoxy in the crack has hardened, the surface sealing material may be removed; however, this type of repair is usually quite apparent. Although it may be possible to inject epoxy without leaving noticeable residue, this process is difficult and, in general, the use of epoxy repairs in visible areas of concrete on historic structures is not recommended.

Active structural cracks (which move as loads are added or removed) and thermal cracks (which move as temperatures fluctuate) must be repaired in a manner that will accommodate the anticipated movement. In some more extreme cases, expansion joints may have to be introduced before crack repairs are undertaken. Active cracks may be filled with sealants that will adhere to the sides of the cracks and will compress or expand during crack movement. The design, detailing, and execution of sealant repairs require considerable attention, or they will detract from the appearance of the historic building. The routing and cleaning of a crack, and installation of an elastomeric sealant to prevent water penetration, is used to address cracks where movement is anticipated. However, unless located in a concealed area of the concrete, this technique is often not acceptable for historic structures because the repair will be visually intrusive (Fig. 19). Other approaches, such as installation of a cementitious crack repair, may need to be considered even though this type of repair may be less effective or have a shorter service life than a sealant repair.

Replacement

If specific components of historic concrete structures are beyond repair, replacement components can be cast to match historic ones. Replacement of original concrete should be carefully considered and viewed as a method of last resort. In some cases, such as for repeated ornamental units, it may be more cost-effective to fabricate precast concrete units to replace missing elements. The forms created for precast or cast-in-place units can then be used again during future repair projects.

Careful mix formulation, placement, and finishing are required to ensure that replacement concrete units will match the historic concrete. There is often a tendency to make replacement concrete more consistent in appearance than the original concrete. The consistency can be in stark contrast with the variability of the original concrete

Figure 19. A high-speed grinder ia used to widen a crack in preparation for installation of a sealant. This process is called "routing." After the crack is prepared, the sealant is installed to prevent moisture infiltration through the crack. Although sealant repairs can provide a durable, watertight repair for moving cracks, they tend to be very visible.

due to original construction techniques, architectural design, or differential exposure to weather. Trial repairs and mock-ups are used to evaluate the proposed replacement concrete work and to refine construction techniques (Fig 20).

Protection Systems

Coatings and Penetrating Sealers. Protection systems such as a penetrating sealers or film forming coating are often used with non-historic structures to protect the concrete and increase the length of the service life of concrete repairs. However, film-forming coatings are often inappropriate for use on a historic structure, unless the structure was coated historically. Film-forming coatings will often change the color and appearance of a surface, and higher build coatings can also mask architectural finishes and ornamental details. For example, the application of a coating on concrete having a formboard finish may hide the wood texture of the surface. Pigmented film-forming coatings are also typically not appropriate for use over exposed aggregate concrete, where the uncoated exposed surface contributes significantly to the historic character of

Figure 20. (a) The Jefferson Davis Memorial in Fairview, Kentucky, constructed from 1917–1924, is 351 feet tall and constructed of unreinforced concrete. The walls of the memorial are 8 feet thick at the base and 2 feet thick at the top of the wall. Access to the monument for investigation was provided by rappelling techniques, while ground supported and suspended scaffolding was used to access the exterior during repairs. (b) The concrete was severely deteriorated at isolated locations, with spalling and damage from cyclic freezing and thawing of entrapped water. In addition, previous repairs were at the end of their service life and removal of deteriorated concrete and failed previous repairs was required. Light duty chipping hammers were used to avoid damage to adjacent material when removing deteriorated concrete to the level of sound concrete. (c) Field samples were performed to match the color, finish, and texture of the original concrete. A challenge in matching of historic concrete is achieving variability of appearance. (d) The completed surface after repairs exhibits intentional variability of the concrete surface to match the appearance of the original concrete. Some formwork imperfections that would normally be removed by finishing were intentionally left in place, to replicate the highly variable finish of the original concrete. (e) The Jefferson Davis Memorial after completion of repairs in 2004. Photo e: Joseph Lenzi, Senler, Campbell & Associates, Inc.

concrete. In cases where the color of a substrate needs to be changed, such as to modify the appearance of existing repairs, an alternative to pigmented film-forming coatings is the use of pigmented stains.

Many proprietary clear, penetrating sealers are currently available to protect concrete substrates. These products render fine cracks and pores within the concrete hydrophobic; however, they do not bridge or fill cracks. Clear sealers may change the appearance of the concrete in that treated areas become more visible after rain in contrast to the more absorptive areas of original concrete. Once applied, penetrating sealers cannot be effectively removed and are therefore considered irreversible. They should not be used on historic concrete without thorough prior consideration. However, clear penetrating sealers provide an important means of protection for historic concrete that is not of good quality and can help to avoid more extensive future repairs or replacement. Thus they are sometimes appropriate for use on historic concrete. Once applied, these sealers will require periodic re-application.

Waterproofing membranes are systems used to protect concrete surfaces such as roofs, terraces, plazas, or balconies, as well as surfaces below grade. Systems range from coal tar pitch membranes used on older buildings, to asphalt or urethane-based systems. On historic buildings, membrane systems are typically used only on surfaces that were originally protected by a similar system and surfaces that are not visible from grade. Waterproofing membranes may be covered by roofing, paving, or other architectural finishes.

Laboratory and field testing is recommended prior to application of a protection system or treatment on any concrete structure; testing is even more critical for historic structures because many such treatments are not reversible. As with other repairs, trial samples are important to evaluate the effectiveness of the treatment and to determine whether it will harm the concrete or affect its appearance.

Cathodic Protection. Corrosion is an electrochemical process in which electrons flow between cathodic (positively charged) and anodic (negatively charged) areas on a metal surface; corrosion occurs at the anodes. Cathodic protection is a technique used to control the corrosion of metal by making the whole metal surface the cathode of an electrochemical cell. This technique is used to protect metal structures from corrosion and is also sometimes used to protect steel reinforcement embedded in concrete. For reinforced concrete, cathodic protection is typically accomplished by connecting an auxiliary anode to the reinforcing so that the entire reinforcing bar becomes a cathode. In sacrificial anode (passive) systems, current flows naturally by galvanic action between the less noble anode (such as zinc) and the cathode. In impressed-current (active) systems, current is impressed between an inert anode (such as titanium) and the cathode. Cathodic protection is intended to reduce the rate of corrosion of embedded steel in concrete, which in turn reduces overall deterioration. Protecting embedded steel from corrosion helps to prevent concrete cracking and spalling.

Impressed-current cathodic protection is the most effective means of mitigating steel corrosion and has been used in practical structural applications since the 1970s. However, impressed-current cathodic protection systems are typically the most costly to install and require substantial ongoing monitoring, adjustment, and maintenance to ensure a proper voltage output (protection current) over time. Sacrificial anode cathodic protection dates back to the 1800s, when the hulls of ships were protected using this technology. Today many industries utilize the concept of sacrificial anode cathodic protection for the protection of steel exposed to corrosive environments. It is less costly than an impressed-current system, but is somewhat less effective and requires reapplication of the anode when it becomes depleted.

Re-alkalization. Another technique currently available to protect concrete is realkalization, which is a process to restore the alkalinity of carbonated concrete. The treatment involves soaking the concrete with an alkaline solution, in some cases forcing it into the concrete to the level of the reinforcing steel by passage of direct current. These actions increase the alkalinity of the concrete around the reinforcement, thus restoring the protective alkaline environment for the reinforcement. Like impressed-current cathodic protection methods, it is costly. Other corrosion methods are also available but have a somewhat shorter history of use.

Careful evaluation of existing conditions, the causes and nature of distress, and environmental factors is essential before a protection method is selected and implemented. Not every protection system will be effective on each structure. In addition, the level of intrusion caused by the protection system must be carefully evaluated before it is used on a historic concrete structure.

Summary

In the United States, concrete has been a popular construction material since the late nineteenth century and recently has gained greater recognition as a historic material. Preservation of historic concrete requires a thorough understanding of the causes and types of deterioration, as well as of repair and replacement materials and methods. It is important that adequate time is allotted during the planning phase of a project to provide for trial repairs and mock-ups in order to evaluate the effectiveness and aesthetics of the repairs. Careful design is essential and, as with other preservation efforts, the skill of those performing the work is critical to the success of the repairs. The successful repair of many historic concrete structures in recent years demonstrates that the techniques and materials now available can extend the life of such structures and help ensure their preservation.

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PRESERVATION BRIEF#16
THE USE OF SUBSTITUTE MATERIALS ON HISTORIC BUILDING EXTERIORS

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16 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

The Use of Substitute Materials on Historic Building Exteriors

Sharon C. Park, AIA

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

The Secretary of the Interior's Standards for Rehabilitation require that "deteriorated architectural features be repaired rather than replaced, wherever possible. In the event that replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual properties." Substitute materials should be used only on a limited basis and only when they will match the appearance and general properties of the historic material and will not damage the historic resource.

Introduction

When deteriorated, damaged, or lost features of a historic building need repair or replacement, it is almost always best to use historic materials. In limited circumstances substitute materials that imitate historic materials may be used if the appearance and properties of the historic materials can be matched closely and no damage to the remaining historic fabric will result.

Great care must be taken if substitute materials are used on the exteriors of historic buildings. Ultraviolet light, moisture penetration behind joints, and stresses caused by changing temperatures can greatly impair the performance of substitute materials over time. Only after consideration of all options, in consultation with qualified professionals, experienced fabricators and contractors, and development of carefully written specifications should this work be undertaken.

The practice of using substitute materials in architecture is not new, yet it continues to pose practical problems and to raise philosophical questions. On the practical level the


In the reconstruction of the clock tower at Independence Hall, the substitute materials used were cast stone and wood with fiberglass and polyester bronze ornamentation. Photo: NPS files.

inappropriate choice or improper installation of substitute materials can cause a radical change in a building's appearance and can cause extensive physical damage over time. On the more philosophical level, the wholesale use of substitute materials can raise questions concerning the integrity of historic buildings largely comprised of new materials. In both cases the integrity of the historic resource can be destroyed.

Some preservationists advocate that substitute materials should be avoided in all but the most limited cases. The fact is, however, that substitute materials are being used more frequently than ever in preservation projects, and in many cases with positive results. They can be cost-effective, can permit the accurate visual duplication of historic materials, and last a reasonable time. Growing evidence indicates that with proper planning, careful specifications and supervision, substitute materials can be used successfully in the process of restoring the visual appearance of historic resources.

This Brief provides general guidance on the use of substitute materials on the exteriors of historic buildings. While substitute materials are frequently used on interiors, these applications are not subject to weathering and moisture penetration, and will not be discussed in this Brief. Given the general nature of this publication, specifications for substitute materials are not provided. The guidance provided should not be used in place of consultations with qualified professionals. This Brief includes a discussion of when to use substitute materials, cautions regarding their expected performance, and descriptions of several substitute materials, their advantages and disadvantages. This review of materials is by no means comprehensive, and attitudes and findings will change as technology develops.

Historical Use of Substitute Materials

The tradition of using cheaper and more common materials in imitation of more expensive and less available materials is a long one. George Washington, for example, used wood painted with sand-impregnated paint at Mount Vernon to imitate cut ashlar stone. This technique along with scoring stucco into block patterns was fairly common in colonial America to imitate stone.

Molded or cast masonry substitutes, such as dry-tamp cast stone and poured concrete, became popular in place of quarried stone during the 19th century. These masonry units were fabricated locally, avoiding expensive quarrying and shipping costs, and were versatile in representing either ornately carved blocks, plain wall stones or rough cut textured surfaces. The end result depended on the type of patterned or textured mold used and was particularly popular in conjunction with mail order houses. Later, panels of cementitious permastone or formstone and less expensive asphalt and sheet metal panels were used to imitate brick or stone.

Metal (cast, stamped, or brake-formed) was used for storefronts, canopies, railings, and other features, such as galvanized metal cornices substituting for wood or stone, stamped metal panels for Spanish clay roofing tiles, and cast-iron column capitals and even entire building fronts in imitation of building stone.

Substitute materials need to be located with care to avoid damage. The fiberglass column base has chipped, whereas the historic cast iron would have remained sound. Photo: NPS files.

Terra-cotta, a molded fired clay product, was itself a substitute material and was very popular in the late 19th and early 20th centuries. It simulated the appearance of intricately carved stonework, which was expensive and time-consuming to produce. Terra cotta could be glazed to imitate a variety of natural stones, from brownstones to limestones, or could be colored for a polychrome effect.

Nineteenth century technology made a variety of materials readily available that not only were able to imitate more expensive materials but were also cheaper to fabricate and easier to use. Throughout the century, imitative materials continued to evolve. For example, ornamental window hoods were originally made of wood or carved stone. In an effort to find a cheaper substitute for carved stone and to speed fabrication time, cast stone, an early form of concrete, or cast-iron hoods often replaced stone. Toward the end of the century, even less expensive sheet metal hoods, imitating stone, also came into widespread use. All of these materials, stone, cast stone, cast iron, and various pressed metals were in production at the same time and were selected on the basis on the basis of the availability of materials and local craftsmanship, as well as durability and cost. The criteria for selection today are not much different.

Many of the materials used historically to imitate other materials are still available. These are often referred to as the traditional materials: wood, cast stone, concrete, terra cotta and cast metals. In the last few decades, however, and partly as a result of the historic preservation movement, new families of synthetic materials, such as fiberglass, acrylic polymers, and epoxy resins, have been developed and are being used as substitute materials in construction. In some respects these newer products (often referred to as high tech materials) show great promise; in others, they are less satisfactory, since they are often difficult to integrate physically with the porous historic materials and may be too new to have established solid performance records.

When to Consider Using Substitute Materials in Preservation Projects

Because the overzealous use of substitute materials can greatly impair the historic character of a historic structure, all preservation options should be explored thoroughly before substitute materials are used. It is important to remember that the purpose of repairing damaged features and of replacing lost and irreparably damaged ones is both to match visually what was there and to cause no further deterioration. For these reasons it is not appropriate to cover up historic materials with synthetic materials that will alter the appearance, proportions and details of a historic building and that will conceal future deterioration.

Some materials have been used successfully for the repair of damaged features such as epoxies for wood infilling, cementitious patching for sandstone repairs, or plastic stone for masonry repairs. Repairs are preferable to replacement whether or not the repairs are in kind or with a synthetic substitute material.

In general, four circumstances warrant the consideration of substitute materials: 1) the unavailability of historic materials; 2) the unavailability of skilled craftsmen; 3) inherent flaws in the original materials; and 4) code-required changes (which in many cases can be extremely destructive of historic resources).

Cost may or may not be a determining factor in considering the use of substitute materials. Depending on the area of the country, the amount of material needed, and the projected life of less durable substitute materials, it may be cheaper in the long run to use the original material, even though it may be harder to find.

The core of a deteriorated wood outrigger was first drilled out. Photos (left and right): Courtesy, Harrison Goodall.

An inert material was injected into the hollow outrigger, permitting the outer wood to be retained and preserved.

Due to many early failures of substitute materials, some preservationist are looking abroad to find materials (especially stone) that match the historic materials in an effort to restore historic buildings accurately and to avoid many of the uncertainties that come with the use of substitute materials.

1. The unavailability of the historic material.

The most common reason for considering substitute materials is the difficulty in finding a good match for the historic material (particularly a problem for masonry materials where the color and texture are derived from the material itself). This may be due to the actual unavailability of the material or to protracted delivery dates. For example, the local quarry that supplied the sandstone for a building may no longer be in operation. All efforts should be made to locate another quarry that could supply a satisfactory match. If this approach fails, substitute materials such as dry-tamp cast stone or textured precast concrete may be a suitable substitute if care is taken to ensure that the detail, color and texture of the original stone are matched. In some cases, it may be possible to use a sand-impregnated paint on wood as a replacement section, achieved using readily available traditional materials, conventional tools and work skills. Simple solutions should not be overlooked.

2. The unavailability of historic craft techniques and lack of skilled artisans.
These two reasons complicate any preservation or rehabilitation project. This is particularly true for intricate ornamental work, such as carved wood, carved stone, wrought iron, cast iron, or molded terra cotta. However, a number of stone and wood cutters now employ sophisticated carving machines, some even computerized. It is also possible to cast substitute replacement pieces using aluminum, cast stone, fiberglass, polymer concretes, glass fiber reinforced concretes and terra cotta. Mold making and casting takes skill and craftsmen who can undertake this work are available. Efforts should always be made, prior to replacement, to seek out artisans who might be able to repair ornamental elements and thereby save the historic features in place.

3. Poor original building materials.

Some historic building materials were of inherently poor quality or their modern counterparts are inferior. In addition, some materials were naturally incompatible with other materials on the building, causing staining or galvanic corrosion. Examples of poor quality materials were the very soft sandstones which eroded quickly. An example of poor quality modern replacement material is the tin coated steel roofing which is much less durable than the historic tin or terne iron which is no longer available. In some cases, more durable natural stones or precast concrete might be available as substitutes for the soft stones and modern terne-coated stainless steel or lead-coated copper might produce a more durable yet visually compatible replacement roofing.

Cast aluminum has been used as a replacement material for cast iron. Photo: NPS files.

4. Code-related changes.

Sometimes referred to as life and safety codes, building codes often require changes to historic buildings. Many cities in earthquake zones, for example, have laws requiring that overhanging masonry parapets and cornices, or freestanding urns or finials be securely re-anchored to new structural frames or be removed completely. In some cases, it may be acceptable to replace these heavy historic elements with light replicas. In other cases, the extent of historic fabric removed may be so great as to diminish the integrity of the resource. This could affect the significance of the structure and jeopardize National Register status. In addition, removal of repairable historic materials could result in loss of Federal tax credits for rehabilitation. Department of the Interior regulations make clear that the Secretary of the Interior's Standards for Rehabilitation take precedence over other regulations and codes in determining whether a project is consistent with the historic character of the building undergoing rehabilitation.

Two secondary reasons for considering the use of substitute materials are their lighter weight and for some materials, a reduced need of maintenance. These reasons can become important if there is a need to keep dead loads to a minimum or if the feature being replaced is relatively inaccessible for routine maintenance.

Cautions and Concerns

In dealing with exterior features and materials, it must be remembered that moisture penetration, ultraviolet degradation, and differing thermal expansion and contraction rates of dissimilar materials make any repair or replacement problematic. To ensure that a repair or replacement will perform well over time, it is critical to understand fully the properties of both the original and the substitute materials, to install replacement materials correctly, to assess their impact on adjacent historic materials, and to have reasonable expectations of future performance.

Many high tech materials are too new to have been tested thoroughly. The differences in vapor permeability between some synthetic materials and the historic materials have in some cases caused unexpected further deterioration. It is therefore difficult to recommend substitute materials if the historic materials are still available. As previously mentioned, consideration should always be given first to using traditional materials and methods of repair or replacement before accepting unproven techniques, materials or applications.

Substitute materials must meet three basic criteria before being considered: they must be compatible with the historic materials in appearance; their physical properties must be similar to those of the historic materials, or be installed in a manner that tolerates differences; and they must meet certain basic performance expectations over an extended period of time.

A waterproof coating is an inappropraite substitute material to apply to adobe as it seals in moisture and may result in spalling. Photo: NPS files.

Matching the Appearance of the Historic Materials

In order to provide an appearance that is compatible with the historic material, the new material should match the details and craftsmanship of the original as well as the color, surface texture, surface reflectivity and finish of the original material. The closer an element is to the viewer, the more closely the material and craftsmanship must match the original.

Matching the color and surface texture of the historic material with a substitute material is normally difficult. To enhance the chances of a good match, it is advisable to clean a portion of the building where new materials are to be used. If pigments are to be added to the substitute material, a specialist should determine the formulation of the mix, the natural aggregates and the types of pigments to be used. As all exposed material is subject to ultraviolet degradation, if possible, samples of the new materials made during the early planning phases should be tested or allowed to weather over several seasons to test for color stability.

Fabricators should supply a sufficient number of samples to permit onsite comparison of color, texture, detailing, and other critical qualities. In situations where there are subtle variations in color and texture within the original materials, the substitute materials should be similarly varied so that they are not conspicuous by their uniformity.

Substitute materials, notably the masonry ones, may be more water-absorbent than the historic material. If this is visually distracting, it may be appropriate to apply a protective vapor-permeable coating on the substitute material. However, these clear coatings tend to alter the reflectivity of the material, must be reapplied periodically, and may trap salts and moisture, which can in turn produce spalling. For these reasons, they are not recommended for use on historic materials.

Matching the Physical Properties

While substitute materials can closely match the appearance of historic ones, their physical properties may differ greatly. The chemical composition of the material (i.e., presence of acids, alkalines, salts, or metals) should be evaluated to ensure that the replacement materials will be compatible with the historic resource. Special care must therefore be taken to integrate and to anchor the new materials properly. The thermal expansion and contraction coefficients of each adjacent material must be within tolerable limits. The function of joints must be understood and detailed either to eliminate moisture penetration or to allow vapor permeability. Materials that will cause galvanic corrosion or other chemical reactions must be isolated from one another.

To ensure proper attachment, surface preparation is critical. Deteriorated underlying material must be cleaned out. Noncorrosive anchoring devices or fasteners that are designed to carry the new material and to withstand wind, snow and other destructive elements should be used. Properly chosen fasteners allow attached materials to expand and contract at their own rates. Caulking, flexible sealants or expansion joints between the historic material and the substitute material can absorb slight differences of movement. Since physical failures often result from poor anchorage or improper installation techniques, a structural engineer should be a member of any team undertaking major repairs.

Some of the new high tech materials such as epoxies and polymers are much stronger than historic materials and generally impermeable to moisture. These differences can cause serious problems unless the new materials are modified to match the expansion and contraction properties of adjacent historic materials more closely, or unless the new materials are isolated from the historic ones altogether. When stronger or vapor impermeable new materials are used alongside historic ones, stresses from trapped moisture or differing expansion and contraction rates generally hasten deterioration of the weaker historic material. For this reason, a conservative approach to repair or replacement is recommended, one that uses more pliant materials rather than high-strength ones. Since it is almost impossible for substitute materials to match the properties of historic materials perfectly, the new system incorporating new and historic materials should be designed so that if material failures occur, they occur within the new material rather than the historic material.

Performance Expectations

While a substitute material may appear to be acceptable at the time of installation, both its appearance and its performance may deteriorate rapidly. Some materials are so new that industry standards are not available, thus making it difficult to specify quality control in fabrication, or to predict maintenance requirements and long term performance. Where possible, projects involving substitute materials in similar circumstances should be examined. Material specifications outlining stability of color and texture; compressive or tensile strengths if appropriate; the acceptable range of thermal coefficients, and the durability of coatings and finishes should be included in the contract documents. Without these written documents, the owner may be left with little recourse if failure occurs.


The historic cornice was successfully replaced with a fiberglass cornice. Photo: NPS files.

The tight controls necessary to ensure long-term performance extend beyond having written performance standards and selecting materials that have a successful track record. It is important to select qualified fabricators and installers who know what they are doing and who can follow up if repairs are necessary. Installers and contractors unfamiliar with specific substitute materials and how they function in your local environmental conditions should be avoided.

The surfaces of substitute materials may need special care once installed. For example, chemical residues or mold release agents should be removed completely prior to installation, since they attract pollutants and cause the replacement materials to appear dirtier than the adjacent historic materials. Furthermore, substitute materials may require more frequent cleaning, special cleaning products and protection from impact by hanging window-cleaning scaffolding. Finally, it is critical that the substitute materials be identified as part of the historical record of the building so that proper care and maintenance of all the building materials continue to ensure the life of the historic resource.

Choosing an Appropriate Substitute Material

Once all reasonable options for repair or replacement in kind have been exhausted, the choice among a wide variety of substitute materials currently on the market must be made. The charts at the end of this Brief describe a number of such materials, many of them in the family of modified concretes which are gaining greater use. The charts do not include wood, stamped metal, mineral fiber cement shingles and some other traditional imitative materials, since their properties and performance are better known. Nor do the charts include vinyls or molded urethanes which are sometimes used as cosmetic claddings or as substitutes for wooden millwork. Because millwork is still readily available, it should be replaced in kind.

The charts describe the properties and uses of several materials finding greater use in historic preservation projects, and outline advantages and disadvantages of each. It should not be read as an endorsement of any of these materials, but serves as a reminder that numerous materials must be studied carefully before selecting the appropriate treatment. Included are three predominantly masonry materials (cast stone, precast concrete, and glass fiber reinforced concrete); two predominantly resinous materials (epoxy and glass fiber reinforced polymers also known as fiberglass), and cast aluminum which has been used as a substitute for various metals and woods.

Pros and Cons of Various Substitute Materials

Cast Aluminum

Material: Cast aluminum is a molten aluminum alloy cast in permanent (metal) molds or onetime sand molds which must be adjusted for shrinkage during the curing process. Color is from paint applied to primed aluminum or from a factory finished coating. Small sections can be bolted together to achieve intricate or sculptural details. Unit castings are also available for items such as column plinth blocks.

Application: Cast aluminum can be a substitute for cast iron or other decorative elements. This would include grillwork, roof crestings, cornices, ornamental spandrels, storefront elements, columns, capitals, and column bases and plinth blocks. If not self-supporting, elements are generally screwed or bolted to a structural frame. As a result of galvanic corrosion problems with dissimilar metals, joint details are very important.

Advantages:

- light weight (1/2 of castiron)
- corrosion-resistant, noncombustible
- intricate castings possible
- easily assembled, good delivery time
- can be prepared for a variety of colors
- long life, durable, less brittle than cast iron

Disadvantages:

- lower structural strength than castiron
- difficult to prevent galvanic corrosion with other metals
- greater expansion and contraction than castiron; requires
- gaskets or caulked joints
- difficult to keep paint on aluminum

Checklist:

- Can existing be repaired or replaced inkind?
- How is cast aluminum to be with other metals attached?
- Have full-size details been developed for each piece to be cast?
- How are expansion joints detailed?
- Will there be a galvanic corrosion problem?
- Are fabricators/installers experienced?

Cast Stone (dry tamped)

Material: Cast stone is an almost-dry cement, lime and aggregate mixture which is dry-tamped into a mold to produce a dense stone-like unit. Confusion arises in the building industry as many refer to high quality precast concrete as cast stone. In fact, while it is a form of precast concrete, the drytamp fabrication method produces an outer surface resembling a stone surface. The inner core can be either drytamped or poured full of concrete. Reinforcing bars and anchorage devices can be installed during fabrication.

Application: Cast stone is often the most visually similar material as a replacement for unveined deteriorated stone, such as brownstone or sandstone, or terra cotta in imitation of stone. It is used both for surface wall stones and for ornamental features such as window and door surrounds, voussoirs, brackets and hoods. Rubberlike molds can be taken of good stones on site or made up at the factory from shop drawings.

Advantages:

- replicates stone texture with good molds (which can come from extant stone) and fabrication
- expansion/contraction similar to stone
- minimal shrinkage of material
- anchors and reinforcing bars can be built in
- material is firerated
- range of color available
- vapor permeable

Disadvantages:

- heavy units may require additional anchorage
- color can fade in sunlight
- may be more absorbent than natural stone
- replacement stones are obvious if too few models and molds are made

Checklist:

- Are the original or similar materials available?
- How are units to be installed and anchored?
- Have performance standards been developed to ensure color stability?
- Have large samples been delivered to site for color, finish and absorption testing?
- Has mortar been matched to adjacent historic mortar to achieve a good color/tooling match?
- Are fabricators/installers experienced?

Glass Fiber Reinforced Concretes (GFRC)

Material: Glass fiber reinforced concretes are lightweight concrete compounds modified with additives and reinforced with glass fibers. They are generally fabricated as thin shelled panels and applied to a separate structural frame or anchorage system. The GFRC is most commonly sprayed into forms although it can be poured. The glass must be alkaline resistant to avoid deteriorating effects caused by the cement mix. The color is derived from the natural aggregates and if necessary a small percentage of added pigments.

Application: Glass fiber reinforced concretes are used in place of features originally made of stone, terra cotta, metal or wood, such as cornices, projecting window and door trims, brackets, finials, or wall murals. As a molded product it can be produced in long sections of repetitive designs or as sculptural elements. Because of its low shrinkage, it can be produced from molds taken directly from the building. It is installed with a separate noncorrosive anchorage system. As a predominantly cementitious material, it is vapor permeable.

Advantages:

- lightweight, easily installed
- good molding ability, crisp detail possible
- weather resistant
- can be left uncoated or else painted
- little shrinkage during fabrication
- molds made directly from historic features
- cements generally breathable
- material is firerated

Disadvantages:

- non-loadbearing use only
- generally requires separate anchorage system
- large panels must be reinforced
- color additives may fade with sunlight
- joints must be properly detailed
- may have different absorption rate than adjacent historic material

Checklist:

- Are the original materials and craftsmanship still available?
- Have samples been inspected on the site to ensure detail/texture match?
- Has anchorage system been properly designed?
- Have performance standards been developed?
- Are fabricators/installers experienced?

Precast Concrete

Material: Precast concrete is a wet mix of cement and aggregate poured into molds to create masonry units. Molds can be made from existing good surfaces on the building. Color is generally integral to the mix as a natural coloration of the sand or aggregate, or as a small percentage of pigment. To avoid unsightly air bubbles that result from the natural curing process, great care must be taken in the initial and longterm vibration of the mix. Because of its weight it is generally used to reproduce individual units of masonry and not thin shell panels.

Application: Precast concrete is generally used in place of masonry materials such as stone or terra cotta. It is used both for flat wall surfaces and for textured or ornamental elements. This includes wall stones, window and door surrounds, stair treads, paving pieces, parapets, urns, balusters and other decorative elements. It differs from cast stone in that the surface is more dependent on the textured mold than the hand tamping method of fabrication.

Advantages:

- easily fabricated, takes shape well
- rubber molds can be made from building stones
- minimal shrinkage of material
- can be load bearing or anchorage can be cast in
- expansion/contraction similar to stone
- material is firerated
- range of color and aggregate available
- vapor permeable

Disadvantages:

- may be more moisture absorbent than stone although coatings may be applied
- color fades in sunlight
- small air bubbles may disfigure units
- replacement stones are conspicuous if too few models and molds are made

Checklist:

- Is the historic material still available?
- What are the structural/anchorage requirements?
- Have samples been matched for color/texture/absorption? Have shop drawings been made for each shape?
- Are there performance standards?
- Has mortar been matched to adjacent historic mortar to achieve good color/tooling match?
- Are fabricators/installers experienced?

Fiber Reinforced Polymers (FRP, Fiberglass)

Material: Fiberglass is the most well known of the FRP products generally produced as a thin rigid laminate shell formed by pouring a polyester or epoxy resin gelcoat into a mold. When tack-free, layers of chopped glass or glass fabric are added along with additional resins. Reinforcing rods and struts can be added if necessary; the gel coat can be pigmented or painted.

Application: Fiberglass, a non load-bearing material attached to a separate structural frame, is frequently used as a replacement where a lightweight element is needed or an inaccessible location makes frequent maintenance of historic materials difficult. Its good molding ability and versatility to represent stone, wood, metal and terra cotta make it an alternative to ornate or carved building elements such as column capitals, bases, spandrel panels, beltcourses, balustrades, window hoods or parapets. Its ability to reproduce bright colors is a great advantage.

Advantages:

- lightweight, long spans available with a separate structural frame
- high ratio of strength to weight

- good molding ability
- integral color with exposed high quality pigmented gel-coat or takes paint well
- easily installed, can be cut, patched, sanded
- non-corrosive, rot-resistant

Disadvantages:

- requires separate anchorage system
- combustible (fire retardants can be added); fragile to impact.
- high coefficient of expansion and contraction requires frequently placed expansion joints
- ultraviolet sensitive unless surface is coated or pigments are in gelcoat
- vapor impermeability may require ventilation detail

Checklist:

- Can original materials be saved/used?
- Have expansion joints been designed to avoid unsightly appearance?
- Are there standards for color stability/durability?
- Have shop drawings been made for each piece?
- Have samples been matched for color and texture?
- Are fabricators/installers experienced?
- Do codes restrict use of FRP?

Epoxies (Epoxy Concretes, Polymer Concretes)

Material: Epoxy is a resinous two-part thermosetting material used as a consolidant, an adhesive, a patching compound, and as a molding resin. It can repair damaged material or recreate lost features. The resins which are poured into molds are usually mixed with fillers such as sand, or glass spheres, to lighten the mix and modify their expansion/contraction properties. When mixed with aggregates, such as sand or stone chips, they are often called epoxy concrete or polymer concrete, which is a misnomer as there are no cementitious materials contained within the mix. Epoxies are vapor impermeable, which makes detailing of the new elements extremely important so as to avoid trapping moisture behind the replacement material. It can be used with wood, stone, terra cotta, and various metals.

Application: Epoxy is one of the most versatile of the new materials. It can be used to bind together broken fragments of terra cotta; to build up or infill missing sections of ornamental metal; or to cast missing elements of wooden ornaments. Small cast elements can be attached to existing materials or entire new features can be cast. The resins are poured into molds and due to the rapid setting of the material and the need to avoid cracking, the molded units are generally small or hollow inside. Multiple molds can be combined for larger elements. With special rods, the epoxies can be structurally reinforced. Examples of epoxy replacement pieces include: finials, sculptural details, small column capitals, and medallions.

Advantages:

- can be used for repair/replacement
- lightweight, easily installed
- good casting ability; molds can be taken from building material can be sanded and carved.
- color and ultraviolet screening can be added; takes paint well
- durable, rot and fungus resistant

Disadvantages:

- materials are flammable and generate heat as they cure and may be toxic when burned
- toxic materials require special protection for operator and adequate ventilation while curing
- material may be subject to ultraviolet deterioration unless coated or filters added rigidity of material
- often must be modified with fillers to match expansion coefficients
- vapor impermeable

Checklist:

- Are historic materials available for molds, or for splicing-in as a repair option?
- Has the epoxy resin been formulated within the expansion/contraction coefficients of adjacent materials?
- Have samples been matched for color/finish?
- Are fabricators/installers experienced?
- Is there a sound substrate of material to avoid deterioration behind new material?
- Are there performance standards?

Summary

Substitute materials--those products used to imitate historic materials--should be used only after all other options for repair and replacement in kind have been ruled out. Because there are so many unknowns regarding the longterm performance of substitute materials, their use should not be considered without a thorough investigation into the proposed materials, the fabricator, the installer, the availability of specifications, and the use of that material in a similar situation in a similar environment.

Substitute materials are normally used when the historic materials or craftsmanship are no longer available, if the original materials are of a poor quality or are causing damage to adjacent materials, or if there are specific code requirements that preclude the use of historic materials. Use of these materials should be limited, since replacement of historic materials on a large scale may jeopardize the integrity of a historic resource. Every means of repairing deteriorating historic materials or replacing them with identical materials should be examined before turning to substitute materials.

The importance of matching the appearance and physical properties of historic materials and, thus, of finding a successful longterm solution cannot be overstated. The successful solutions illustrated in this Brief were from historic preservation projects involving professional teams of architects, engineers, fabricators, and other specialists. Cost was not necessarily a factor, and all agreed that whenever possible, the historic materials should be used. When substitute materials were selected, the solutions were often expensive and were reached only after careful consideration of all options, and with the assistance of expert professionals.

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Home page logo: Cast alumnimum used as a replacement for cast iron. Photo: NPS files.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

PRESERVATION BRIEF#17
IDENTIFYING THE VISUAL ASPECTS OF HISTORIC BUILDINGS

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17 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

Architectural Character
Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character

Lee H. Nelson, FAIA

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

The Secretary of the Interior's Standards for the Treatment of Historic Properties embody two important goals: **1)** the preservation of historic materials and, **2)** the preservation of a building's distinguishing character. Every old building is unique, with its own identity and its own distinctive character. *Character* refers to all those visual aspects and physical features that comprise the appearance of every historic building. Character-defining elements include the overall shape of the building, its materials, craftsmanship, decorative details, interior spaces and features, as well as the various aspects of its site and environment.

The purpose of this Brief is to help the owner or the architect identify those features or elements that give the building its visual character and that should be taken into account in order to preserve them to the maximum extent possible.

There are different ways of understanding old buildings. They can be seen as examples of specific building types, which are usually related to a building's function, such as schools, courthouses or churches.

Buildings can be studied as examples of using specific materials such as concrete, wood, steel, or limestone. They can also be considered as examples of an historical period, which is often related to a specific architectural style, such as Gothic Revival farmhouses, one-story bungalows, or Art Deco apartment buildings.

There are many other facets of an historic building besides its functional type, its materials or construction or style that contribute to its historic qualities or significance. Some of these qualities are feelings conveyed by the sense of time and place or in buildings associated with events or people. A complete understanding of any property may require documentary research about its style, construction, function, its furnishings or contents; knowledge about the original builder, owners, and later occupants; and knowledge about the evolutionary history of the building. Even though buildings may be of historic, rather than architectural significance, it is their tangible elements that embody its significance for association with specific events or persons and it is those tangible elements both on the exterior and interior that should be preserved.

Therefore, the approach taken in this Brief is limited to **identifying those visual and tangible aspects of the historic building.** While this may aid in the planning process for carrying out any ongoing or new use or restoration of the building, this approach is not a substitute for developing an understanding about the significance of an historic building and the district in which it is located. If the various materials, features and spaces that give a building its visual character are not recognized and preserved, then essential aspects of its character may be damaged in the process of change.

A building's character can be irreversibly damaged or changed in many ways, for example, by inappropriate repointing of the brickwork, by removal of a distinctive side porch, by changes to the window sash, by changes to the setting around the building, by changes to the major room arrangements, by the introduction of an atrium, by painting previously unpainted woodwork, etc.

A Three-Step Process to Identify A Building's Visual Character

This Brief outlines a three-step approach that can be used by anyone to identify those materials, features and spaces that contribute to the visual character of a building. This approach involves first examining the building from afar to understand its overall setting and architectural context; then moving up very close to appreciate its materials and the craftsmanship and surface finishes evident in these materials; and then going into and through the building to perceive those spaces, rooms and details that comprise its interior visual character.

Step 1: Identify the Overall Visual Aspects

Identifying the overall visual character of a building is nothing more than looking at its distinguishing physical aspects without focusing on its details. The major contributors to a building's overall character are embodied in the general aspects of its setting; the shape of the building; its roof and roof features, such as chimneys or cupolas; the various projections on the building, such as porches or bay windows; the recesses or voids in a building, such as open galleries, arcades, or recessed balconies; the openings for windows and doorways; and finally the various exterior materials that contribute to the building's character.

Step One involves looking at the building from a distance to understand the character of its site and setting, and it involves walking around the building where that is possible. Some buildings will have one or more sides that are more important than the others because they are more highly visible. This does not mean that the rear of the building is of no value whatever but it simply means that it is less important to the overall character. On the other hand, the rear may have an interesting back porch or offer a private garden space or some other aspect that may contribute to the visual character. Such a general approach to looking at the building and site will provide a better understanding of its overall character without having to resort to an infinitely long checklist of its possible features and details. Regardless of whether a building is complicated or relatively plain, it is these broad categories that contribute to an understanding of the overall character rather than the specifics of architectural features such as moldings and their profiles.

Step 2: Identify the Visual Character at Close Range

Step Two involves looking at the building at close range or arm's length, where it is possible to see all the surface qualities of the materials, such as their color and texture, or surface evidence of craftsmanship or age. In some instances, the visual character is the result of the juxtaposition of materials that are contrastingly different in their color and texture. The surface qualities of the materials may be important because they impart the very sense of craftsmanship and age that distinguishes historic buildings from other buildings. Furthermore, many of these close up qualities can be easily damaged or obscured by work that affects those surfaces. Examples of this could include painting previously unpainted masonry, rotary disk sanding of smooth wood siding to remove paint, abrasive cleaning of tooled stonework, or repointing reddish mortar joints with gray portland cement.

There is an almost infinite variety of surface materials, textures and finishes that are part of a building's character which are fragile and easily lost.

Step 3: Identify the Visual Character of Interior Spaces, Features and Finishes

Perceiving the character of interior spaces can be somewhat more difficult than dealing with the exterior. In part, this is because so much of the exterior can be seen at one time and it is possible to grasp its essential character rather quickly. To understand the interior character, **Step Three** says it is necessary to move through the spaces *one at a time.* While it is not difficult to perceive the character of one individual room, it becomes more difficult to deal with spaces that are interconnected and interrelated. Sometimes, as in office buildings, it is the vestibules or lobbies or corridors that are important to the interior character of the building. With other groups of buildings the visual qualities of the interior are related to the plan of the building, as in a church with its axial plan creating a narrow tunnel-like space which obviously has a different character than an open space like a sports pavilion. Thus the shape of the space may be an essential part of its character.

With some buildings it is possible to perceive that there is a visual linkage in a sequence of spaces, as in a hotel, from the lobby to the grand staircase to the ballroom. Closing off the openings between those spaces would change the character from visually linked spaces to a series of closed spaces. For example, in a house that has a front and back parlor linked with an open archway, the two rooms are perceived together, and this visual relationship is part of the character of the building. To close off the open archway would change the character of such a residence.

The importance of interior features and finishes to the character of the building should not be overlooked. In relatively simple rooms, the primary visual aspects may be in features such as fireplace mantels, lighting fixtures or wooden floors. In some rooms, the absolute plainness is the character-defining aspect of the interior. So-called secondary spaces also may be important in their own way, from the standpoint of history or because of the family activities that occurred in those rooms. Such secondary spaces, while perhaps historically significant, are not usually perceived as important to the visual character of the building. Thus we do not take them into account in the visual understanding of the building.

Overall Visual Character: Shape

The **shape** of a building can be an important aspect of its overall visual character. The building illustrated here, for example, has a distinctive horizontal boxlike shape with the middle portion of the box projecting up an extra story.

This building has other visual aspects that help define its overall character, including the pattern of vertical bands of windows, the decorative horizontal bands which separate the base of the building from the upper floors, the dark brown color of the brick, the large arched entranceway, and the castle-like tower behind the building.

Overall Visual Character: Openings

The **opening** illustrated here dominates the visual character of this building because of its size, shape, location, materials, and craftsmanship. Because of its relation to the generous staircase, this opening places a strong emphasis on the principal entry to the building. Enclosing this arcade-like entry with glass, for example, would materially and visually change the character of the building.

Overall Visual Character: Roof and Related Features

This building has a number of character-defining aspects which include the windows and the decorative stonework, but certainly the roof and its related features are visually important to its overall visual character. The **roof** is not only highly visible, it has elaborate stone dormers, and it also has decorative metalwork and slatework. The red and black slates of differing sizes and shapes are laid in patterns that extend around the roof of this large and freestanding building. Any changes to this patterned slatework, or to the other roofing details would damage the visual character of the building.

Overall Visual Character: Roof and Related Features

On this building, the most important visual aspects of its character are the **roof and its related features** , such as the dormers and chimneys. The roof is important to the visual character because its steepness makes it highly visible, and its prominence is reinforced by the patterned tinwork, the six dormers and the two chimneys. Changes to the roof or its features, such as removal or alterations to the dormers, for example, would certainly change the character of this

building. This does not discount the importance of its other aspects, such as the porch, the windows, the brickwork, or its setting; but the roof is clearly crucial to understanding the overall visual character of this building as seen from a distance.

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A **projecting** porch or balcony can be very important to the overall visual character of almost any building and to the district in which it is located. Despite the size of this building (3-1/2 stories), and its distinctive roofline profile, and despite the importance of the very large window openings, the lacy wrap-around iron balcony is singularly important to the visual character of this building. It would seriously affect the character to remove the balcony, to enclose it, or to replace it with a balcony lacking the same degree of detail of the original material.

Overall Visual Character: Trim

If one were to analyze the overall shape or form of this building, it would be seen that it is a gable-roofed house with dormers and a wrap-around porch. It is similar to many other houses of the period. It is the wooden **trim** on the eaves and around the porch that gives this building its own identify and its special visual character.

Although such wooden trim is vulnerable to the elements, and must be kept painted to prevent deterioration; the loss of this trim would seriously damage the overall visual character of this building, and its loss would obliterate much of the closeup visual character so dependent upon craftsmanship for the moldings, carvings, and the see-through jigsaw work.

Overall Visual Character: Setting

Even architecturally modest buildings frequently will have a **setting** that contributes to their overall character. In this very urban district, setbacks are the exception, so that the small front yard is something of a luxury, and it is important to the overall character because of its design and materials, which include the iron fence along the sidewalk, the curved walk leading to the porch, and the various plantings. In a district where parking spaces are in great demand, such front yards are sometimes converted to off-street parking, but in this instance, that would essentially destroy its setting and would drastically change the visual character of this historic property.

Arm's Length Visual Character: Materials

At arm's length, the visual character is most often determined by the surface qualities of the **materials** and craftsmanship; and while these aspects are often inextricably related, the original choice of materials often plays the dominant role in establishing the close range character because of the color, texture, or shape of the materials.

In this instance, the variety and arrangement of the materials is important in defining the visual character, starting with the large pieces of broken stone which form the projecting base for the building walls, then changing to a wall of roughly rectangular stones which vary in size, color, and texture, all with accentuated, projecting beads of mortar, then there is a rather precise and narrow band of cut and dressed stones with minimal mortar joints, and finally, the main building walls are composed of bricks, rather uniform in color, with fairly generous mortar joints. It is the juxtaposition and variety of these materials (and of course, the craftsmanship) that is very important to the visual character. Changing the raised mortar joints, for example, would drastically alter the character at arm's length.

Arm's Length Visual Character: Craft Details

There are many instances where **craft details** dominate the arm's length visual character. As seen here, the craft details are especially noticeable because the stones are all of a uniform color, and they are all squared off, but their surfaces were worked with differing tools and techniques to create a great variety of textures, resulting in a tour-de-force of craft details. This texture is very important at close range. It was a deliberately contrived surface that is an important contributor to the visual character of this building.

Interior Visual Character: Individually Important Spaces

In assessing the interior visual character of any historic building, it is necessary to ask whether there are spaces that are important to the character of this particular building, whether the building is architecturally rich or modest, or even if it is a simple or utilitarian structure.

The character of the **individually important space**, which is illustrated here, is a combination of its size, the twin curving staircases, the massive columns and curving vaulted ceilings, in addition to

the quality of the materials in the floor and in the stairs. If the ceiling were to be lowered to provide space for heating ducts, or if the stairways were to be enclosed for code reasons, the shape and character of this space would be damaged, even if there was no permanent physical damage. Such changes can easily destroy the visual character of an individually important interior space. Thus, it is important that the visual aspects of a building's interior character be recognized before planning any changes or alterations.

Interior Visual Character: Related Spaces

Many buildings have interior spaces that are visually or physically related so that, as you move through them, they are perceived not as separate spaces, but as a sequence of **related spaces** that are important in defining the interior character of the building. The example which is illustrated here consists of two spaces that are visually linked to each other.
The top photo shows a vestibule which is of a generous size and unusual in its own right, but more important, it visually relates to the staircase off of it.

The stairway, bottom photo, is the second part of this sequence of related spaces, and it provides continuing access to the upper floors. These related spaces are very important in defining the interior character of this building. Almost any change to these spaces, such as installing doors between the vestibule and the hallway, or enclosing the stair would seriously impact their character and the way that character is perceived.

Interior Visual Character: Interior Features

Interior features are three-dimensional building elements or architectural details that are an integral part of the building as opposed to furniture. Interior features are often important in defining the character of an individual room or space. In some instances, an interior feature, like a large and ornamental open stairway may dominate the visual character of an entire building. In other instances, a modest iron stairway (like the one illustrated here) may be an important interior feature, and its preservation would be crucial to preserving the interior character of the building.

Such features can also include the obvious things like fireplace mantles, plaster ceiling medallions, or paneling, but they also extend to features like hardware, lighting fixtures, bank tellers cages, decorative elevator doors, etc.

Interior Visual Character: Surface Materials and Finishes

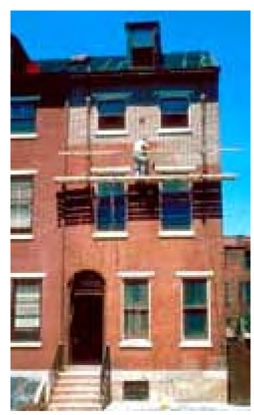
When identifying the visual character of historic interior spaces one should not overlook the importance of those materials and finishes that comprise the surfaces of walls, floors and ceilings. The surfaces may have evidence of either handcraft or machine made products that are important contributors to the visual character, including patterned or inlaid designs in the wood flooring, decorative painting practices such as stenciling, imitation marble or wood grain, wallpapering, tinwork, tile floors, etc.

The example illustrated here involves a combination of real marble at the base of the column, imitation marble patterns on the plaster surface of the column (a practice called scagliola), and a tile floor surface that uses small mosaic tiles arranged to form geometric designs in several different colors. While such decorative materials and finishes may be important in defining the interior visual character of this particular building, it should be remembered that in much more modest buildings, the plainness of **surface materials and finishes** may be an essential aspect of their historic character.

Interior: Exposed Structure

If features of the **structural system** are exposed, such as loadbearing brick walls, cast iron columns, roof trusses, posts and beams, vigas, or stone foundation walls, they may be important in defining the building's interior visual character.

Fragility of A Building's Visual Character



Some aspects of a building's visual character are **fragile and are easily lost.** This is true of brickwork, for example, which can be irreversibly damaged with inappropriate cleaning techniques or by insensitive repointing practices. At least two factors are important contributors to the visual character of brickwork, namely the brick itself and the craftsmanship. Between these, there are many more aspects worth noting, such as color range of bricks, size and shape variations, texture, bonding patterns, together with the many variable qualities of the mortar joints, such as color, width of joint and tooling.

These qualities could be easily damaged by painting the brick, by raking out the joint with power tools, or repointing with a joint that is too wide. As seen here during the process of repointing, the visual character of this front wall is being dramatically changed from a wall where the bricks predominate, to a wall that is visually dominated by the mortar joints.

Conclusion

Using this three-step approach, it is possible to conduct a walk through and identify all those elements and features that help define the visual character of the building. In most cases, there are a number of aspects about the exterior and interior that are important to the character of an historic building. The visual emphasis of this brief will make it possible to ascertain those things that should be preserved because their loss or alteration would diminish or destroy aspects of the historic character whether on the outside, or on the inside of the building.

The Architectural Character Checklist/Questionnaire

This checklist can be taken to the building and used to identify those aspects that give the building and setting its essential visual qualities and character. This checklist consists of a series of questions that are designed to help in identifying those things that contribute to a building's character. The use of this checklist involves the threestep process of looking for: 1) the overall visual aspects, 2) the visual character at close range, and 3) the visual character of interior spaces, features and finishes.

Because this is a process to identify architectural character, it does not address those intangible qualities that give a property or building or its contents its historic significance, instead this checklist is organized on the assumption that historic significance is embodied in those tangible aspects that include the building's setting, its form and fabric.

STEP ONE

1. Shape

What is there about the form or shape of the building that gives the building its identity? Is the shape distinctive in relation to the neighboring buildings? Is it simply a low, squat box, or is it a tall, narrow building with a corner tower? Is the shape highly consistent with its neighbors? Is the shape so complicated because of wings, or ells, or differences in height, that its complexity is important to its character? Conversely, is the shape so simple or plain that adding a feature like a porch would change that character? Does the shape convey its historic function as in smoke stacks or silos?

Notes on the Shape or Form of the Building:

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2. Roof and Roof Features

Does the roof shape or its steep (or shallow) slope contribute to the building's character? Does the fact that the roof is highly visible (or not visible at all) contribute to the architectural identity of the building? Are certain roof features important to the profile of the building against the sky or its background, such as cupolas, multiple chimneys, dormers, cresting, or weather vanes? Are the roofing materials or their colors or their patterns (such as patterned slates) more noticeable than the shape or slope of the roof?

Notes on the Roof and Roof Features:

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3. Openings

Is there a rhythm or pattern to the arrangement of windows or other openings in the walls; like the rhythm of windows in a factory building, or a threepart window in the front bay of a house; or is there a noticeable relationship between the width of the window openings and the wall space between the window openings? Are there distinctive openings, like a large arched entranceway, or decorative window lintels that accentuate the importance the window openings, or unusually shaped windows, or patterned window sash, like small panes of glass in the windows or doors, that are important to the character? Is the plainness of the window openings such that adding shutters or gingerbread trim would radically change its character? Is there a hierarchy of facades that make the front windows more important than the side windows? What about those walls where the absence of windows establishes its own character?

Notes on the Openings:

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4. Projections

Are there parts of the building that are characterdefining because they project from the walls of the building like porches, cornices, bay windows, or balconies? Are there turrets, or widely overhanging eaves, projecting pediments or chimneys?

Notes on the Projections:

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5. Trim and Secondary Features

Does the trim around the windows or doors contribute to the character of the building? Is there other trim on the walls or around the projections that, because of its decoration or color or patterning contributes to the character of the building? Are there secondary features such as shutters, decorative gables, railings, or exterior wall panels?

Notes on the Trim and Secondary Features:

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6. Materials

Do the materials or combination of materials contribute to the overall character of the building as seen from a distance because of their color or patterning, such as broken faced stone, scalloped wall shingling, rounded rock foundation walls, boards and battens, or textured stucco?

Notes on the Materials

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7. Setting

What are the aspects of the setting that are important to the visual character? For example, is the alignment of buildings along a city street and their relationship to the sidewalk the essential aspect of its setting? Or, conversely, is the essential character dependent upon the tree plantings and out buildings which surround the farmhouse? Is the front yard important to the setting of the modest house? Is the specific site important to the setting such as being on a hilltop, along a river, or, is the building placed on the site in such a way to enhance its setting? Is there a special relationship to the adjoining streets and other buildings? Is there a view? Is there fencing, planting, terracing, walkways or any other landscape aspects that contribute to the setting?

Notes on the Setting:

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STEP TWO

8. Materials at Close Range

Are there one or more materials that have an inherent texture that contributes to the close range character, such as stucco, exposed aggregate concrete, or brick textured with vertical grooves? Or materials with inherent colors such as smooth orange colored brick with dark spots of iron pyrites, or prominently veined stone, or green serpentine stone? Are there combinations of materials, used in juxtaposition, such as several different kinds of stone, combinations of stone and brick, dressed stones for window lintels used in conjunction with rough stones for the wall? Has the choice of materials or the combinations of materials contributed to the character?

Notes on the Materials at Close Range:

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9. Craft Details

Is there high quality brickwork with narrow mortar joints? Is there hand tooled or patterned stonework? Do the walls exhibit carefully struck vertical mortar joints and recessed horizontal joints? Is the wall shinglework laid up in patterns or does it retain evidence of the circular saw marks or can the grain of the wood be seen through the semitransparent stain? Are there hand split or handdressed clapboards, or machine smooth beveled siding, or wood rusticated to look like stone, or Art Deco zigzag designs executed in stucco?

Almost any evidence of craft details, whether handmade or machinemade, will contribute to the character of a building because it is a manifestation of the materials, of the times in which the work was done, and of the tools and processes that were used. It further reflects the effects of time, of maintenance (and/or neglect) that the building has received over the years. All of these aspects are a part of the surface qualities that are seen only at close range.

Notes on the Craft Details:

STEP THREE

10. Individual Spaces

Are there individual rooms or spaces that are important to this building because of their size, height, proportion, configuration, or function, like the center hallway in a house, or the bank lobby, or the school auditorium, or the ballroom in a hotel, or a courtroom in a county courthouse?

Notes on the Individual Spaces.

11. Related Spaces and Sequences of Spaces

Are there adjoining rooms that are visually and physically related with large doorways or open archways so that they are perceived as related rooms as opposed to separate rooms? Is there an important sequence of spaces that are related to each other, such as the sequence from the entry way to the lobby to the stairway and to the upper balcony as in a theatre; or the sequence in a residence from the entry vestibule to the hallway to the front parlor, and on through the sliding doors to the back parlor; or the sequence in an office building from the entry vestibule to the lobby to the bank of elevators?

Notes on the Related Spaces and Sequences of Spaces:

12. Interior Features

Are there interior features that help define the character of the building, such as fireplace mantels, stairways and balustrades, arched openings, interior shutters, inglenooks, cornices, ceiling medallions, light fixtures, balconies, doors, windows, hardware, wainscoting, panelling, trim, church pews, courtroom bars, teller cages, waiting room benches?

Notes on the Interior Features:

13. Surface Finishes and Materials

Are there surface finishes and materials that can affect the design, the color or the texture of the interior? Are there materials and finishes or craft practices that contribute to the interior character, such as wooden parquet floors, checkerboard marble floors, pressed metal ceilings, fine hardwoods, grained doors or marbleized surfaces, or polychrome painted surfaces, or stenciling, or wallpaper that is important to the historic character? Are there surface finishes and materials that, because of their plainness, are imparting the essential character of the interior such as hard or bright, shiny wall surfaces of plaster or glass or metal?

Notes on the Surface Finishes and Materials:

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14. Exposed Structure

Are there spaces where the exposed structural elements define the interior character such as the exposed posts, beams, and trusses in a church or train shed or factory? Are there rooms with decorative ceiling beams (nonstructural) in bungalows, or exposed vigas in adobe buildings?

Notes on the Exposed Structure:

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This concludes the three-step process of identifying the visual aspects of historic buildings and is intended as an aid in preserving their character and other distinguishing qualities. It is not intended as a means of understanding the significance of historical properties or districts, nor of the events or people associated with them. That can only be done through other kinds of research and investigation.

Acknowledgements

This Preservation Brief was originally developed as a slide talk/methodology in 1982 to discuss the use of the Secretary of the Interior's Standards for Rehabilitation in relation to preserving historic character; and it was amplified and modified in succeeding years to help guide preservation decision making, initially for maintenance personnel in the National Park Service.

Please note that many of the figures that were in the printed Brief had to be omitted here; however you can go to a special web site, The Walk-Through--Identifying the Visual Character of Historic Buildings, to study all of Lee Nelson's photos and text presented as a long distance learning program.

A number of people contributed to the evolution of the ideas presented here. Special thanks go to Emogene Bevitt and Gary Hume, primarily for the many and frequent discussions relating to this approach in its evolutionary stages; to Mark Fram, Ontario Heritage Foundation, Toronto, for suggesting several additions to the Checklist; and more recently, to my coworkers, both in Washington and in our regional offices, especially Ward Jandl, Sara Blumenthal, Charles Fisher, Sharon Park, AIA, Jean Travers, Camille Martone, Susan Dynes, Michael Auer, Anne Grimmer, Kay Weeks, Betsy Chittenden, Patrick Andrus, Carol Shull, Hugh Miller, FAIA, Jerry Rogers, Paul Alley, David Look, AIA, Margaret Pepin-Donat, Bonnie Halda, Keith Everett, Thomas Keohan, the Preservation Services Division, MidAtlantic Region, and several reviewers in state preservation offices, especially Ann Haaker, Illinois; and Stan Graves, AIA, Texas; for providing very critical and constructive review of the manuscript.

Washington, D.C. September, 1988

Home page logo: Close-up of stone wall, showing craftsmanship. Photo: NPS files.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF#18
REHABILITATING INTERIORS IN HISTORIC BUILDINGS; IDENTIFYING/PRESERVING CHARACTER-DEFINING ELEMENTS

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Benchmark
Environmental Consultants

July 2, 2009

Mr. Steve Griffin
Dallas Area Rapid Transit

RE: MONROE SHOPS PAINT AND PRIMER SPECIFICATIONS

Dear Mr. Griffin:

During the course of Task order's 29, 31 and 33 Benchmark Environmental Consultants (BEC) was on site to verify appropriate measures were taken to assure the manufacturer's recommendations were being followed during all preparation, priming, and painting activities at the Monroe Shops located at 2111 S. Corinth Street Road in Dallas, Texas. BEC verified that the appropriate colors approved by DART were being used.

PAINT AND PRIMER COLORS

PAINT: **Sherwin Williams Pro Industrial 0 VOC Acrylic**

- Green #6748
  - Applied to the trusses, bar joists and lintels
- Snowbound #7004
  - Applied to the corrugated metal deck, purlins and lintels

PRIMER: **Sherwin Williams Kem Kromik Universal Primer (alkyd resin)**

- White
  - Applied to the trusses, corrugated metal deck, purlins and exterior lintels
- Red
  - Applied to the interior lintels

We appreciate the opportunity to provide environmental services to you. If you need additional information or have questions, please contact us at (214) 363-5996. We look forward to working with you on this and future projects.

Respectfully,
Benchmark Environmental Consultants

Wayne Ulrick
Facilities Department Manager

Industrial & Marine Coatings

KEM KROMIK® UNIVERSAL METAL PRIMER

B50NZ6 BROWN **B50WZ1** OFF WHITE
B50AZ6 GRAY

PRODUCT INFORMATION

Revised 4/05

PRODUCT DESCRIPTION

KEM KROMIK UNIVERSAL METAL PRIMER is a rust inhibiting, low VOC, modified alkyd resin primer designed for use over iron and steel substrates. Can be used as a "universal" primer under high performance topcoats and is also suitable as a "barrier" coat over conventional coatings which would normally be attacked by strong solvents in high performance coatings.

- High film build
- Corrosion resistant

- Can be topcoated with epoxies and urethanes
- Apply down to 40°F

RECOMMENDED USES

For use over prepared steel.

- "Universal" primer
- Shopcoat primer
- "Barrier" coating
- Maintenance primer
- Interior / exterior metal primer
- Structural steel
- Equipment / machinery
- Marine vessels
- Hand rails
- Conforms to AWWA D102-03, OCS #1
- Suitable for use in USDA inspected facilities

PRODUCT CHARACTERISTICS

Finish: Flat

Color: Brown, Off White, Gray

Volume Solids: 53% ± 2%

Weight Solids: 73% ± 2%

VOC (EPA Method 24): <420 g/L, 3.5 lb/gal, Off White

Recommended Spreading Rate per coat:

Wet mils:	6.0 - 8.0
Dry mils:	3.0 - 4.0
Coverage:	212 - 283 sq ft/gal approximate

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 6.0 mils wet @ 50% RH:

	@ 40°F	**@ 77°F**	**@ 110°F**
To touch:	2 hours	30 minutes	15 minutes
Tack free:	2½ hours	1 hour	20 minutes
To recoat with itself and alkyds:	2½ hours	1 hour	45 minutes
To recoat with high performance/hot solvent topcoats:	36 hours	16 hours	16 hours
To cure:	7 days	7 days	7 days

Note: For maximum adhesion, acrylic topcoats require 48 - 72 hours drying of primer.

Drying time is temperature, humidity, and film thickness dependent.

Shelf Life: 36 months, unopened
Store indoors at 40°F to 100°F.

Flash Point: 80°F, PMCC

Reducer: Not recommended

Clean Up: Xylene, R2K4

PERFORMANCE CHARACTERISTICS

System Tested: (unless otherwise indicated)
Substrate: Steel
Surface Preparation: SSPC-SP6
1 ct. Kem Kromik Universal @ 3.0 mils dft

Abrasion Resistance:
Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
Result: 250 mg loss

Adhesion:
Method: ASTM D4541
Result: 260 psi

Direct Impact Resistance:
Method: ASTM D2794
Result: 70 in. lbs.

Dry Heat Resistance:
Method: ASTM D2485
Result: 200°F

Flexibility:
Method: ASTM D522, 180° bend, 1/4" mandrel
Result: Passes

Moisture Condensation Resistance:
Method: ASTM D4585, 100°F, 500 hours
Result: Good

Pencil Hardness:
Method: ASTM D3363
Result: H

Salt Fog Resistance:
Method: ASTM B117, 500 hours
Result: Good

Thermal Shock:
Method: ASTM D2246, 5 cycles
Result: Passes

Provides performance comparable to products formulated to federal specifications: TT-P-664D.

continued on back

Industrial
&
Marine
Coatings

KEM KROMIK®
UNIVERSAL METAL PRIMER

B50NZ6 Brown
B50WZ1 Off White
B50AZ6 Gray

PRODUCT INFORMATION

Recommended Systems

Steel, Alkyd Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Industrial Enamel HS @ 2.0 - 4.0 mils dft/ct
or WB Industrial Enamel @ 1.5 - 3.0 mils dft/ct
or Steel Spec Fast Dry Alkyd @ 3.0 - 5.0 mils dft/ct

Steel, Aluminum Finish:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Silver-Brite Aluminum @ 1.0 - 1.5 mils dft/ct

Steel, Acrylic Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. DTM Acrylic Coating @ 2.5 - 4.0 mils dft/ct
or Sher-Cryl HPA @ 2.5 - 4.0 mils dft/ct

Steel, Epoxy Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Tile-Clad HS Epoxy @ 2.5 - 4.0 mils dft/ct

Steel, Polyurethane Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Hi-Solids Polyurethane @ 3.0 - 4.0 mils dft/ct
or Polylon 1900 Polyurethane @ 2.0 - 3.0 mils dft/ct

Steel, Silicone Alkyd Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Steel Master 9500 @ 2.5 - 4.0 mils dft/ct

Steel, Water Based Epoxy Topcoat:
1 ct. Kem Kromik Universal Metal Primer @ 3.0 - 4.0 mils dft
1-2 cts. Water Based Catalyzed Epoxy @ 2.5 - 4.0 mils dft/ct
or Waterbased Tile Clad Epoxy @ 2.0 - 4.0 mils dft/ct

The systems listed above are representative of the product's use. Other systems may be appropriate.

Surface Preparation

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:
Iron & Steel: SSPC-SP2

Tinting

Do not tint.

Application Conditions

Temperature:	40°F minimum, 120°F maximum (air, surface, and material) At least 5°F above dew point
Relative humidity:	85% maximum

Refer to product Application Bulletin for detailed application information.

Ordering Information

Packaging:	1 and 5 gallon containers
Weight per gallon:	12.5 ± 0.35 lb, may vary with color

Safety Precautions

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

Disclaimer

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

Warranty

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid for the defective product as determined by Sherwin-Williams. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY SHERWIN-WILLIAMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

2.11A

KEM KROMIK®
UNIVERSAL METAL PRIMER

Industrial & Marine Coatings

B50NZ6	Brown	B50WZ1	Off White
		B50AZ6	Gray

APPLICATION BULLETIN

Revised 4/05

Surface Preparation

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel
Minimum surface preparation is Hand Tool Clean per SSPC-SP2. Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. For better performance, use Commercial Blast Cleaning per SSPC-SP6, blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2 mils). Prime any bare steel within 8 hours or before flash rusting occurs.

Previously Painted Surfaces
If in sound condition, clean the surface of all foreign material. Smooth, hard, or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test area, allowing paint to dry one week before testing adhesion. If adhesion is poor, or if this product attacks the previous finish, removal of the previous coating may be necessary. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface as above.

As a "Barrier" Coat:
It if is necessary to topcoat a previously painted surface with chemically resistant or strong solvent topcoats, Kem Kromik Universal Metal Primer can be used as a barrier coat to prevent lifting. Apply a coat of Kem Kromik Universal Metal Primer to a small area to test for adhesion or bleeding. If there is evidence of either poor adhesion or bleeding, clean surface to bare substrate and apply recommended system.

Application Conditions

Temperature:	40°F minimum, 120°F maximum (air, surface, and material) At least 5°F above dew point
Relative humidity:	85% maximum

Application Equipment

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compliant with existing VOC regulations and compatible with the existing environmental and application conditions.

Reducer .... Not recommended

Clean Up .... Xylene, R2K4

Airless Spray
Pressure .... 1800-3000 psi
Hose .... 1/4" ID
Tip .... .015" - .019"
Filter .... 60 mesh

Conventional Spray
Gun .... Binks 95
Fluid Nozzle 63C
Air Nozzle 63PB
Atomization Pressure ... 50 psi
Fluid Pressure .... 15-20 psi

Brush
Brush .... Natural Bristle

Roller
Cover .... 3/8" woven with phenolic core

If specific application equipment is not listed above, equivalent equipment may be substituted.

continued on back

Industrial & Marine Coatings

2.11A

KEM KROMIK®
UNIVERSAL METAL PRIMER

B50NZ6 Brown
B50WZ1 Off White
B50AZ6 Gray

APPLICATION BULLETIN

Application Procedures

Surface preparation must be completed as indicated.

Mixing Instructions: Mix paint thoroughly by boxing and stirring before use.

Apply paint at the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate per coat:

Wet mils:	6.0 - 8.0
Dry mils:	3.0 - 4.0
Coverage:	212 - 283 sq ft/gal approximate

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 6.0 mils wet @ 50% RH:

	@ 40°F	@ 77°F	@ 110°F
To touch:	2 hours	30 minutes	15 minutes
Tack free:	2½ hours	1 hour	20 minutes
To recoat with itself and alkyds:	2½ hours	1 hour	45 minutes
To recoat with high performance/hot solvent topcoats:	36 hours	16 hours	16 hours
To cure:	7 days	7 days	7 days

Note: For maximum adhesion, acrylic topcoats require 48 - 72 hours drying of primer.

Drying time is temperature, humidity, and film thickness dependent.

Application of coating above maximum or below minimum recommended spreading rate may adversely affect coating performance.

Performance Tips

Stripe coat all crevices, welds, and sharp angles to prevent early failure in these areas.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross spray at a right angle.

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.

No reduction of material is recommended as it can affect film build, appearance, and adhesion.

Intimate contact with the steel surface and primer is necessary for adequate rust inhibition and adhesion.

Refer to Product Information sheet for additional performance characteristics and properties.

Clean Up Instructions

Clean spills and spatters immediately with Xylene, R2K4. Clean tools immediately after use with Xylene, R2K4. Follow manufacturer's safety recommendations when using any solvent.

Safety Precautions

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

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MATERIAL SAFETY DATA SHEET

B50WZ1
30 00

DATE OF PREPARATION
Mar 26, 2009

SECTION 1 — PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NUMBER
B50WZ1
PRODUCT NAME
KEM KROMIK® Universal Metal Primer (VOC Comp.), Off White
MANUFACTURER'S NAME
THE SHERWIN-WILLIAMS COMPANY
101 Prospect Avenue N.W.
Cleveland, OH 44115

Telephone Numbers and Websites

Product Information	www.sherwin-williams.com
Regulatory Information	(216) 566-2902 www.paintdocs.com
Medical Emergency	(216) 566-2917
Transportation Emergency*	(800) 424-9300
**for Chemical Emergency ONLY (spill, leak, fire, exposure, or accident)*	

SECTION 2 — COMPOSITION/INFORMATION ON INGREDIENTS

% by Weight	CAS Number	Ingredient		Units	Vapor Pressure
3	**108-88-3**	**Toluene**			
		ACGIH TLV	20	PPM	22 mm
		OSHA PEL	100	PPM (Skin)	
		OSHA PEL	150	PPM (Skin) STEL	
2	**100-41-4**	**Ethylbenzene**			
		ACGIH TLV	100	PPM	7.1 mm
		ACGIH TLV	125	PPM STEL	
		OSHA PEL	100	PPM	
		OSHA PEL	125	PPM STEL	
11	**1330-20-7**	**Xylene**			
		ACGIH TLV	100	PPM	5.9 mm
		ACGIH TLV	150	PPM STEL	
		OSHA PEL	100	PPM	
		OSHA PEL	150	PPM STEL	
2	**64742-95-6**	**Light Aromatic Hydrocarbons**			
		ACGIH TLV		Not Available	3.8 mm
		OSHA PEL		Not Available	
4	**95-63-6**	**1,2,4-Trimethylbenzene**			
		ACGIH TLV	25	PPM	2.03 mm
		OSHA PEL	25	PPM	
0.2	**14808-60-7**	**Quartz**			
		ACGIH TLV	0.025	mg/m3 as Resp. Dust	
		OSHA PEL	0.1	mg/m3 as Resp. Dust	
5	**14807-96-6**	**Talc**			
		ACGIH TLV	2	mg/m3 as Resp. Dust	
		OSHA PEL	2	mg/m3 as Resp. Dust	
38	**471-34-1**	**Calcium Carbonate**			
		ACGIH TLV	10	mg/m3 as Dust	
		OSHA PEL	15	mg/m3 Total Dust	
		OSHA PEL	5	mg/m3 Respirable Fraction	
10	**13463-67-7**	**Titanium Dioxide**			
		ACGIH TLV	10	mg/m3 as Dust	
		OSHA PEL	10	mg/m3 Total Dust	
		OSHA PEL	5	mg/m3 Respirable Fraction	

SECTION 3 — HAZARDS IDENTIFICATION

ROUTES OF EXPOSURE

INHALATION of vapor or spray mist.
EYE or SKIN contact with the product, vapor or spray mist.

HMIS Codes	
Health	2*
Flammability	3
Reactivity	0

EFFECTS OF OVEREXPOSURE

EYES: Irritation.
SKIN: Prolonged or repeated exposure may cause irritation.
INHALATION: Irritation of the upper respiratory system.

May cause nervous system depression. Extreme overexposure may result in unconsciousness and possibly death.
Prolonged overexposure to solvent ingredients in Section 2 may cause adverse effects to the liver, urinary, cardiovascular and reproductive systems.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

Headache, dizziness, nausea, and loss of coordination are indications of excessive exposure to vapors or spray mists.
Redness and itching or burning sensation may indicate eye or excessive skin exposure.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

None generally recognized.

CANCER INFORMATION

For complete discussion of toxicology data refer to Section 11.

SECTION 4 — FIRST AID MEASURES

EYES: Flush eyes with large amounts of water for 15 minutes. Get medical attention.
SKIN: Wash affected area thoroughly with soap and water.
Remove contaminated clothing and launder before re-use.
INHALATION: If affected, remove from exposure. Restore breathing. Keep warm and quiet.
INGESTION: Do not induce vomiting. Get medical attention immediately.

SECTION 5 — FIRE FIGHTING MEASURES

FLASH POINT	LEL	UEL	FLAMMABILITY CLASSIFICATION
80 °F PMCC	0.7	7.0	RED LABEL -- Flammable, Flash below 100 °F (38 °C)

EXTINGUISHING MEDIA

Carbon Dioxide, Dry Chemical, Foam

UNUSUAL FIRE AND EXPLOSION HAZARDS

Closed containers may explode when exposed to extreme heat.
Application to hot surfaces requires special precautions.
During emergency conditions overexposure to decomposition products may cause a health hazard. Symptoms may not be immediately apparent. Obtain medical attention.

SPECIAL FIRE FIGHTING PROCEDURES

Full protective equipment including self-contained breathing apparatus should be used.
Water spray may be ineffective. If water is used, fog nozzles are preferable. Water may be used to cool closed containers to prevent pressure build-up and possible autoignition or explosion when exposed to extreme heat.

SECTION 6 — ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

- Remove all sources of ignition. Ventilate the area.
- Remove with inert absorbent.

SECTION 7 — HANDLING AND STORAGE

STORAGE CATEGORY

DOL Storage Class IC

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Contents are FLAMMABLE. Keep away from heat, sparks, and open flame.
During use and until all vapors are gone: Keep area ventilated - Do not smoke - Extinguish all flames, pilot lights, and heaters - Turn off stoves, electric tools and appliances, and any other sources of ignition.
Consult NFPA Code. Use approved Bonding and Grounding procedures.
Keep container closed when not in use. Transfer only to approved containers with complete and appropriate labeling. Do not take internally. Keep out of the reach of children.

SECTION 8 — EXPOSURE CONTROLS/PERSONAL PROTECTION

PRECAUTIONS TO BE TAKEN IN USE

Use only with adequate ventilation.
Avoid contact with skin and eyes. Avoid breathing vapor and spray mist.
Wash hands after using.

This coating may contain materials classified as nuisance particulates (listed "as Dust" in Section 2) which may be present at hazardous levels only during sanding or abrading of the dried film. If no specific dusts are listed in Section 2, the applicable limits for nuisance dusts are ACGIH TLV 10 mg/m3 (total dust), 3 mg/m3 (respirable fraction), OSHA PEL 15 mg/m3 (total dust), 5 mg/m3 (respirable fraction).

VENTILATION

Local exhaust preferable. General exhaust acceptable if the exposure to materials in Section 2 is maintained below applicable exposure limits. Refer to OSHA Standards 1910.94, 1910.107, 1910.108.

RESPIRATORY PROTECTION

If personal exposure cannot be controlled below applicable limits by ventilation, wear a properly fitted organic vapor/particulate respirator approved by NIOSH/MSHA for protection against materials in Section 2.

When sanding or abrading the dried film, wear a dust/mist respirator approved by NIOSH/MSHA for dust which may be generated from this product, underlying paint, or the abrasive.

PROTECTIVE GLOVES

Wear gloves which are recommended by glove supplier for protection against materials in Section 2.

EYE PROTECTION

Wear safety spectacles with unperforated sideshields.

OTHER PRECAUTIONS

Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

PRODUCT WEIGHT	12.88 lb/gal	1543 g/l
SPECIFIC GRAVITY	1.55	
BOILING POINT	222 - 360 °F	105 - 182 °C
MELTING POINT	Not Available	
VOLATILE VOLUME	45%	
EVAPORATION RATE	Slower than ether	
VAPOR DENSITY	Heavier than air	
SOLUBILITY IN WATER	N.A.	

VOLATILE ORGANIC COMPOUNDS (VOC Theoretical - As Packaged)

3.29lb/gal	394g/l	Less Water and Federally Exempt Solvents
3.29lb/gal	394g/l	Emitted VOC

SECTION 10 — STABILITY AND REACTIVITY

STABILITY — Stable

CONDITIONS TO AVOID

None known.

INCOMPATIBILITY

None known.

HAZARDOUS DECOMPOSITION PRODUCTS

By fire: Carbon Dioxide, Carbon Monoxide

HAZARDOUS POLYMERIZATION

Will not occur

SECTION 11 — TOXICOLOGICAL INFORMATION

CHRONIC HEALTH HAZARDS

Reports have associated repeated and prolonged overexposure to solvents with permanent brain and nervous system damage.

Ethylbenzene is classified by IARC as possibly carcinogenic to humans (2B) based on inadequate evidence in humans and sufficient evidence in laboratory animals. Lifetime inhalation exposure of rats and mice to high ethylbenzene concentrations resulted in increases in certain types of cancer, including kidney tumors in rats and lung and liver tumors in mice. These effects were not observed in animals exposed to lower concentrations. There is no evidence that ethylbenzene causes cancer in humans.

Crystalline Silica (Quartz, Cristobalite) is listed by IARC and NTP. Long term exposure to high levels of silica dust, which can occur only when sanding or abrading the dry film, may cause lung damage (silicosis) and possibly cancer.

IARC's Monograph No. 93 reports there is sufficient evidence of carcinogenicity in experimental rats exposed to titanium dioxide but inadequate evidence for carcinogenicity in humans and has assigned a Group 2B rating. In addition, the IARC summary concludes, "No significant exposure to titanium dioxide is thought to occur during the use of products in which titanium is bound to other materials, such as paint."

TOXICOLOGY DATA

CAS No.	Ingredient Name			
108-88-3	**Toluene**			
		LC50 RAT	4HR	4000 ppm
		LD50 RAT		5000 mg/kg
100-41-4	**Ethylbenzene**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		3500 mg/kg
1330-20-7	**Xylene**			
		LC50 RAT	4HR	5000 ppm
		LD50 RAT		4300 mg/kg
64742-95-6	**Light Aromatic Hydrocarbons**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available
95-63-6	**1,2,4-Trimethylbenzene**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available
14808-60-7	**Quartz**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available
14807-96-6	**Talc**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available
471-34-1	**Calcium Carbonate**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available
13463-67-7	**Titanium Dioxide**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available

SECTION 12 — ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION

No data available.

SECTION 13 — DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD

Waste from this product may be hazardous as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261.
Waste must be tested for ignitability to determine the applicable EPA hazardous waste numbers.
Incinerate in approved facility. Do not incinerate closed container. Dispose of in accordance with Federal, State/Provincial, and Local regulations regarding pollution.

SECTION 14 — TRANSPORT INFORMATION

US Ground (DOT)

1 Gallon and Less may be Classed as CONSUMER COMMODITY, ORM-D
Larger Containers are Regulated as:
UN1263, PAINT, 3, PG III, (ERG#128)

DOT (Dept of Transportation) Hazardous Substances & Reportable Quantities

Toluene 1000 lb RQ
Xylenes (isomers and mixture) 100 lb RQ

Bulk Containers may be Shipped as (check reportable quantities):

RQ, UN1263, PAINT, 3, PG III, (XYLENES (ISOMERS AND MIXTURE)), (ERG#128)

Canada (TDG)

UN1263, PAINT, CLASS 3, PG III, LIMITED QUANTITY, (ERG#128)

IMO

UN1263, PAINT, CLASS 3, PG III, (27 C c.c.), EmS F-E, S-E

SECTION 15 — REGULATORY INFORMATION

SARA 313 *(40 CFR 372.65C)* SUPPLIER NOTIFICATION

CAS No.	CHEMICAL/COMPOUND	% by WT	% Element
108-88-3	Toluene	3	
100-41-4	Ethylbenzene	2	
1330-20-7	Xylene	11	
95-63-6	1,2,4-Trimethylbenzene	4	
	Zinc Compound	3	1.6

CALIFORNIA PROPOSITION 65

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

TSCA CERTIFICATION

All chemicals in this product are listed, or are exempt from listing, on the TSCA Inventory.

SECTION 16 — OTHER INFORMATION

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

The above information pertains to this product as currently formulated, and is based on the information available at this time. Addition of reducers or other additives to this product may substantially alter the composition and hazards of the product. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information.

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113.03

PRO INDUSTRIAL™

0 VOC ACRYLIC

B66-600 Series	Gloss
B66-650 Series	Semi-Gloss
B66-660 Satin	Satin

CHARACTERISTICS

Pro Industrial 0 VOC Acrylic is an ambient cured, single component acrylic coating. It is designed for interior and exterior industrial and commercial applications

- Chemical resistant
- Superior color and gloss retention
- Outstanding early moisture resistance
- Flash rust/early rust resistant
- Suitable for use in USDA inspected facilities
- Low odor
- Fast dry
- HAPS free

Color: most colors

Recommended Spread Rate per ct:

Wet mils:	6.0 - 12.0
Dry mils:	2.5 - 4.0
Coverage:	140 - 225 sq ft/gal approximate

Note: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 7.0 mils wet 50% RH:

	@ 50°F	@ 77°F	@ 120°F
To touch:	1 hr	30 min	5 min
Tack free:	8 hrs	5 hrs	15 min
To recoat:	8 hrs	5 hrs	15 min
To cure:	30 days	30 days	30 days

Drying and recoat times are temperature, humidity, and film thickness dependent.

Finish: Gloss, Semi-Gloss and Satin

Flash Point: 499°F, Seta Flash

Tinting with BAC or EnviroToner:

Base	oz/gal	Strength
Extra White	0-4	100%
Deep Base	8-12	100%
Ultradeep Base	8-12	100%

B66W611

(may vary by color and gloss)

VOC (EPA Method #24):

Unreduced 0 g/L; trace

Volume Solids: 35 ± 2%

Weight Solids: 44 ± 2%

Weight per Gallon: 9.51 lb/gal ±2%

SPECIFICATIONS

Steel:
2 cts. Pro Industrial 0 VOC Acrylic

Steel*:
1 ct. Pro Industrial Pro-Cryl Universal Primer
or DTM Acrylic Primer/Finish
or Kem Bond HS
or Zinc Clad Primer
2 cts. Pro Industrial 0 VOC Acrylic

Aluminum:
2 cts. Pro Industrial 0 VOC Acrylic

Aluminum:
1 ct. DTM Wash Primer
2 cts. Pro Industrial 0 VOC Acrylic

Concrete Block:
1 ct. Heavy Duty Block Filler
2 cts. Pro Industrial 0 VOC Acrylic

Concrete/Masonry:
2 cts. Pro Industrial 0 VOC Acrylic

Drywall
1 ct. ProGreen 200 Int. Latex Primer
2 cts. Pro Industrial 0 VOC Acrylic

Galvanizing:
2 cts. Pro Industrial 0 VOC Acrylic

Prefinished Siding: (Baked-on finishes)
1 ct. DTM Bonding Prime
2 cts. Pro Industrial 0 VOC Acrylic

Wood, exterior:
1 ct. A-100 Exterior Wood Primer
2 cts. Pro Industrial 0 VOC Acrylic

Wood, interior:
1 ct. PrepRite Classic Latex Primer
2 cts. Pro Industrial 0 VOC Acrylic

* Application of coating to unprimed steel may cause pinpoint rusting. Safety Colors, Deep Base, and Ultradeep colors require a prime coat for maximum durability, adhesion, and corrosion protection.

System Tested: (unless otherwise indicated)
Substrate: Steel
Surface Preparation: SSPC-SP10
Finish: 2 cts. Pro Industrial 0 VOC Acrylic

As of 09/22/08, Complies with:			
OTC	Yes	LEED® CIv2.0	Yes
SCAQMD	Yes	LEED® NCv2.2	Yes
CARB	Yes	LEED® CSv2.0	Yes
MPI Spec #	No	LEED® H	No
NAHB	No		

Adhesion:
Method: ASTM D4541
Result: 1386 psi

Corrosion Weathering over Pro-Cryl Primer:
Method: ASTM D5894, 1500 hours, 5 cycles
Result: Rating 10, per ASTM D714 for blistering
Rating 9 per ASTM D1654 for corrosion

Direct Impact Resistance:
Method: ASTM D2794
Result: >160 in. lb

Dry Heat Resistance:
Method: ASTM D2485
Result: 250°F

Flexibility:
Method: ASTM D522, 180° bend, 1/8" mandrel
Result: Passes

Humidity Resistance with Pro-Cryl Primer:
Method: ASTM D4585, 1500 hours
Result: Rating 10 per ASTM D714 for blistering
Rating 10 per ASTM D1654 for corrosion

Pencil Hardness:
Method: ASTM D3363
Result: 2B

Salt Fog Resistance with Pro-Cryl Primer:
Method: ASTM B117, 1500 hours
Result: Rating 10 per ASTM D714 for blistering
Rating 9 per ASTM D1654 for corrosion

Thermal Cycling:
Method: ASTM D2246, 5 cycles
Result: Passes

continued on back

113.03
PRO INDUSTRIAL™
0 VOC ACRYLIC

B66-600 SERIES GLOSS
B66-650 SERIES SEMI-GLOSS
B66-660 SERIES SATIN

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Safety Colors, Deep Base, and Ultradeep colors require a prime coat for maximum durability, adhesion, and corrosion protection.
Do not use hydrocarbon solvents for cleaning.

Iron & Steel
Minimum surface preparation is Hand Tool Clean per SSPC-SP2. Remove all oil and grease from surface per SSPC-SP1. For better performance, use Commercial Blast Cleaning per SSPC-SP6. Primer recommended for best performance.

Aluminum
Remove all oil, grease, dirt, oxide and other foreign material per SSPC-SP1.

Galvanizing
The surface should be weathered for 6 months prior to painting. Remove all oil and grease per SSPC-SP1. Rusty galvanizing requires a minimum of Hand Tool Cleaning per SSPC-SP2. Prime area the same day as cleaned with Pro-Cryl.

Concrete and Masonry
For surface preparation, refer to SSPC-SP13/NACE 6 or ICRI 03732, CSP 1-3. Surfaces should be thoroughly cleaned and dry. Surface temperatures must be at least 55°F before filling. If required for a smoother finish, use Heavy Duty Block Filler, B42W46. Filler must be thoroughly dry before topcoating per manufacturer's recommendations.
Weathered masonry and soft or porous cement board must be brush blasted or power tool cleaned to remove loosely adhering contamination and to get to a hard, firm surface. Apply one coat Loxon Conditioner, following label recommendations.

SURFACE PREPARATION

Wood
Surface must be clean, dry and sound. Prime with recommended primer. No painting should be done immediately after a rain or during foggy weather. Knots and pitch streaks must be scraped, sanded and spot primed before full coat of primer is applied. All nail holes or small openings must be properly caulked.

Pre-Finished Siding:
Remove oil, grease, dirt, oxides, and other contaminants from the surface by cleaning per SSPC-SP1 or water blasting per NACE Standard RP-01-72. Always checks for compatibility of the previously painted surface with the new coating by applying a test patch of 2 - 3 square feet. Allow to dry thoroughly for 1 week before checking adhesion. DTM Bonding Primer is required.

Previously Painted Surfaces
If in sound condition, clean the surface of all foreign material. Smooth, hard or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test area, allowing paint to dry one week before testing adhesion. If adhesion is poor, additional abrasion of the surface and/or removal of the previous coating may be necessary. Retest surface for adhesion. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface as above.

CLEANUP INFORMATION

Clean spills and spatters immediately with soap and warm water. Clean hands and tools immediately after use with soap and warm water. After cleaning, flush spray equipment with Mineral Spirits to prevent rusting of the equipment. Follow manufacturer's safety recommendations when using Mineral Spirits.
NOTE: If coating is allowed to "set-up", Reducer #54, R7K54, may be required for cleaning. Follow manufacturer's safety recommendations when using Reducer #54.

APPLICATION

Refer to the MSDS sheet before use

Temperature: 50°F minimum
120°F maximum
(Air, surface, and material)
At least 5°F above dew point
Relative humidity: 85% maximum

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compatible with the existing environmental and application conditions.

Reducer/Clean Up Water

Airless Spray
Pressure .... 1500 psi
Hose .... 1/4" ID
Tip .... .017" - .021"
Filter .... 60 mesh
Reduction .... Not recommended

Conventional Spray
Gun .... Binks 95
Fluid Nozzle 66
Air Nozzle 63PB
Atomization Pressure .... 50 psi
Fluid Pressure .... 15-20 psi
Reduction .. As needed up to 12½%by volume

Brush
Brush .... Nylon / polyester
Reduction .... Not recommended

Roller
Cover .... 3/8" woven
Reduction .... Not recommended
If specific application equipment is listed above, equivalent equipment may be substituted.

MATERIAL SAFETY DATA SHEET

B66W651
06 00

DATE OF PREPARATION
May 23, 2009

SECTION 1 — PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NUMBER
B66W651
PRODUCT NAME
PRO INDUSTRIAL™ 0 VOC Acrylic Coating - Semi-Gloss, Extra White
MANUFACTURER'S NAME
THE SHERWIN-WILLIAMS COMPANY
101 Prospect Avenue N.W.
Cleveland, OH 44115

Telephone Numbers and Websites

Product Information	www.sherwin-williams.com
Regulatory Information	(216) 566-2902 www.paintdocs.com
Medical Emergency	(216) 566-2917
Transportation Emergency*	(800) 424-9300
**for Chemical Emergency ONLY (spill, leak, fire, exposure, or accident)*	

SECTION 2 — COMPOSITION/INFORMATION ON INGREDIENTS

% by Weight	CAS Number	Ingredient	Units	Vapor Pressure
13	**13463-67-7**	**Titanium Dioxide**		
		ACGIH TLV	10 mg/m3 as Dust	
		OSHA PEL	10 mg/m3 Total Dust	
		OSHA PEL	5 mg/m3 Respirable Fraction	

SECTION 3 — HAZARDS IDENTIFICATION

HMIS Codes

Health	2*
Flammability	0
Reactivity	0

ROUTES OF EXPOSURE
INHALATION of vapor or spray mist.
EYE or SKIN contact with the product, vapor or spray mist.
EFFECTS OF OVEREXPOSURE
EYES: Irritation.
SKIN: Prolonged or repeated exposure may cause irritation.
INHALATION: Irritation of the upper respiratory system.

SIGNS AND SYMPTOMS OF OVEREXPOSURE
Redness and itching or burning sensation may indicate eye or excessive skin exposure.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
None generally recognized.
CANCER INFORMATION
For complete discussion of toxicology data refer to Section 11.

SECTION 4 — FIRST AID MEASURES

EYES: Flush eyes with large amounts of water for 15 minutes. Get medical attention.
SKIN: Wash affected area thoroughly with soap and water.
INHALATION: If affected, remove from exposure. Restore breathing. Keep warm and quiet.
INGESTION: Do not induce vomiting. Get medical attention immediately.

SECTION 5 — FIRE FIGHTING MEASURES

FLASH POINT	LEL	UEL	FLAMMABILITY CLASSIFICATION
Not Applicable	N.A.	N.A.	Not Applicable

EXTINGUISHING MEDIA
Carbon Dioxide, Dry Chemical, Alcohol Foam

UNUSUAL FIRE AND EXPLOSION HAZARDS

Closed containers may explode (due to the build-up of pressure) when exposed to extreme heat.

During emergency conditions overexposure to decomposition products may cause a health hazard. Symptoms may not be immediately apparent. Obtain medical attention.

SPECIAL FIRE FIGHTING PROCEDURES

Full protective equipment including self-contained breathing apparatus should be used.

Water spray may be ineffective. If water is used, fog nozzles are preferable. Water may be used to cool closed containers to prevent pressure build-up and possible autoignition or explosion when exposed to extreme heat.

SECTION 6 — ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

- Remove all sources of ignition. Ventilate the area.
- Remove with inert absorbent.

SECTION 7 — HANDLING AND STORAGE

STORAGE CATEGORY

Not Applicable

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Keep container closed when not in use. Transfer only to approved containers with complete and appropriate labeling. Do not take internally. Keep out of the reach of children.

SECTION 8 — EXPOSURE CONTROLS/PERSONAL PROTECTION

PRECAUTIONS TO BE TAKEN IN USE

Use only with adequate ventilation.

Avoid contact with skin and eyes. Avoid breathing vapor and spray mist.

Wash hands after using.

This coating may contain materials classified as nuisance particulates (listed "as Dust" in Section 2) which may be present at hazardous levels only during sanding or abrading of the dried film. If no specific dusts are listed in Section 2, the applicable limits for nuisance dusts are ACGIH TLV 10 mg/m3 (total dust), 3 mg/m3 (respirable fraction), OSHA PEL 15 mg/m3 (total dust), 5 mg/m3 (respirable fraction).

VENTILATION

Local exhaust preferable. General exhaust acceptable if the exposure to materials in Section 2 is maintained below applicable exposure limits. Refer to OSHA Standards 1910.94, 1910.107, 1910.108.

RESPIRATORY PROTECTION

If personal exposure cannot be controlled below applicable limits by ventilation, wear a properly fitted organic vapor/particulate respirator approved by NIOSH/MSHA for protection against materials in Section 2.

When sanding or abrading the dried film, wear a dust/mist respirator approved by NIOSH/MSHA for dust which may be generated from this product, underlying paint, or the abrasive.

PROTECTIVE GLOVES

Required for long or repeated contact.

EYE PROTECTION

Wear safety spectacles with unperforated sideshields.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

PRODUCT WEIGHT	9.53 lb/gal	1141 g/l
SPECIFIC GRAVITY	1.15	
BOILING POINT	212 - 213 °F	100 - 100 °C
MELTING POINT	Not Available	
VOLATILE VOLUME	65%	
EVAPORATION RATE	Slower than ether	
VAPOR DENSITY	Heavier than air	
SOLUBILITY IN WATER	N.A.	
pH	9.0	

VOLATILE ORGANIC COMPOUNDS (VOC Theoretical - As Packaged)

0.00lb/gal	0g/l	Less Water and Federally Exempt Solvents
0.00lb/gal	0g/l	Emitted VOC

SECTION 10 — STABILITY AND REACTIVITY

STABILITY — Stable

CONDITIONS TO AVOID

None known.

INCOMPATIBILITY

None known.

HAZARDOUS DECOMPOSITION PRODUCTS
By fire: Carbon Dioxide, Carbon Monoxide
HAZARDOUS POLYMERIZATION
Will not occur

SECTION 11 — TOXICOLOGICAL INFORMATION

CHRONIC HEALTH HAZARDS
IARC's Monograph No. 93 reports there is sufficient evidence of carcinogenicity in experimental rats exposed to titanium dioxide but inadequate evidence for carcinogenicity in humans and has assigned a Group 2B rating. In addition, the IARC summary concludes, "No significant exposure to titanium dioxide is thought to occur during the use of products in which titanium is bound to other materials, such as paint."
TOXICOLOGY DATA

CAS No.	Ingredient Name			
13463-67-7	**Titanium Dioxide**			
		LC50 RAT	4HR	Not Available
		LD50 RAT		Not Available

SECTION 12 — ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION
No data available.

SECTION 13 — DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD
Waste from this product is not hazardous as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261.
Incinerate in approved facility. Do not incinerate closed container. Dispose of in accordance with Federal, State/Provincial, and Local regulations regarding pollution.

SECTION 14 — TRANSPORT INFORMATION

US Ground (DOT)
Not Regulated for Transportation.
Canada (TDG)
Not Regulated for Transportation.
IMO
Not Regulated for Transportation.

SECTION 15 — REGULATORY INFORMATION

SARA 313 *(40 CFR 372.65C)* SUPPLIER NOTIFICATION

CAS No.	CHEMICAL/COMPOUND	% by WT	% Element

No ingredients in this product are subject to SARA 313 (40 CFR 372.65C) Supplier Notification.
CALIFORNIA PROPOSITION 65
WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.
TSCA CERTIFICATION
All chemicals in this product are listed, or are exempt from listing, on the TSCA Inventory.

SECTION 16 — OTHER INFORMATION

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

The above information pertains to this product as currently formulated, and is based on the information available at this time. Addition of reducers or other additives to this product may substantially alter the composition and hazards of the product. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information.

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18 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

Rehabilitating Interiors in Historic Buildings
Identifying and Preserving Character-Defining Elements

H. Ward Jandl

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

A floor plan, the arrangement of spaces, and features and applied finishes may be individually or collectively important in defining the historic character of the building and the purpose for which it was constructed. Thus, their identification, retention, protection, and repair should be given prime consideration in every preservation project. Caution should be exercised in developing plans that would radically change character-defining spaces or that would obscure, damage or destroy interior features or finishes.

The interiors of mills and industrial buildings are frequently open, unadorned spaces with exposed structural elements. While these spaces can serve many new uses, the floor to ceiling height and exposed truss system are character-defining features that should be retained in rehabilitation. Photo: NPS files.

While the exterior of a building may be its most prominent visible aspect, or its "public face," its interior can be even more important in conveying the building's history and development over time. Rehabilitation within the context of the Secretary of the Interior's Standards for Rehabilitation calls for the preservation of exterior and interior portions or features of the building that are significant to its historic, architectural and cultural values.

Interior components worthy of preservation may include the building's plan (sequence of spaces and circulation patterns), the building's spaces (rooms and volumes), individual architectural features, and the various finishes and materials that make up the walls, floors, and ceilings. A theater auditorium or sequences of rooms such as double parlors or a lobby leading to a stairway that ascends to a mezzanine may comprise a building's most important spaces. Individual rooms may contain notable features such as plaster cornices, millwork, parquet wood floors, and hardware. Paints, wall coverings, and finishing techniques such as graining, may provide color, texture, and patterns which add to a building's unique character.

Virtually all rehabilitations of historic buildings involve some degree of interior alteration, even if the buildings are to be used for their original purpose. Interior rehabilitation proposals may range from preservation of existing features and spaces to total reconfigurations. In some cases, depending on the building, restoration may be warranted to preserve historic character adequately; in other cases, extensive alterations may be perfectly acceptable.


Not only are the features of this early 20th century interior worthy of preservation, the planned sequence of spaces impart a grandeur that is characteristic of high style residences of the period. Photo: Jack E. Boucher, HABS collection.

This Preservation Brief has been developed to assist building owners and architects in identifying and evaluating those elements of a building's interior that contribute to its historic character and in planning for the preservation of those elements in the process of rehabilitation. The guidance applies to all building types and styles, from 18th century churches to 20th century office buildings. The Brief does not attempt to provide specific advice on preservation techniques and treatments, given the vast range of buildings, but rather suggests general preservation approaches to guide construction work.

Identifying and Evaluating the Importance of Interior Elements Prior to Rehabilitation

Before determining what uses might be appropriate and before drawing up plans, a thorough professional assessment should be undertaken to identify those tangible architectural components that, prior to rehabilitation, convey the building's sense of time and place--that is, its "historic character." Such an assessment, accomplished by walking through and taking account of each element that makes up the interior, can help ensure that a truly compatible use for the building, one that requires minimal alteration to the building, is selected.

Researching The Building's History

A review of the building's history will reveal why and when the building achieved significance or how it contributes to the significance of the district. This information helps to evaluate whether a particular rehabilitation treatment will be appropriate to the building and whether it will preserve those tangible components of the building that convey its significance for association with specific events or persons along with its architectural importance. In this regard, National Register files may prove useful in explaining why and for what period of time the building is significant. In some cases research may show that later alterations are significant to the building; in other cases, the alterations may be without historical or architectural merit, and may be removed in the rehabilitation.

Identifying Interior Elements

Interiors of buildings can be seen as a series


Many institutional buildings possess distinctive spaces or floor plans that are important in conveying the significance of the property. This grand hall, which occupies the entire floor of the building, could not be subdivided without destroying the integrity of the space. Photo: NPS files.

of primary and secondary spaces. The goal of the assessment is to identify which elements contribute to the building's character and which do not. Sometimes it will be the sequence and flow of spaces, and not just the individual rooms themselves, that contribute to the building's character. This is particularly evident in buildings that have strong central axes or those that are consciously asymmetrical in design. In other cases, it may be the size or shape of the space that is distinctive.

The importance of some interiors may not be readily apparent based on a visual inspection; sometimes rooms that do not appear to be architecturally distinguished are associated with important persons and events that occurred within the building.

Primary spaces, are found in all buildings, both monumental and modest. Examples may include foyers, corridors, elevator lobbies, assembly rooms, stairhalls, and parlors. Often they are the places in the building that the public uses and sees; sometimes they are the most architecturally detailed spaces in the building, carefully proportioned and finished with costly materials. They may be functionally and architecturally related to the building's external appearance. In a simpler building, a primary space may be distinguishable only by its location, size, proportions, or use. Primary spaces are always important to the character of the building and should be preserved.


The interior of this 19th worker's house has not been properly maintained, but it may be as important historically as a richly ornamented interior. Its wide baseboards, flat window trim, and four-panel door should be carefully preserved in a rehabilitation project. Photo: NPS files.

Secondary spaces are generally more utilitarian in appearance and size than primary spaces. They may include areas and rooms that service the building, such as bathrooms, and kitchens. Examples of secondary spaces in a commercial or office structure may include storerooms, service corridors, and in some cases, the offices themselves. Secondary spaces tend to be of less importance to the building and may accept greater change in the course of work without compromising the building's historic character.

Spaces are often designed to interrelate both visually and functionally. The sequence of spaces, such as vestibule-hall-parlor or foyer-lobby-stair-auditorium or stairhall-corridor-classroom, can define and express the building's historic function and unique character. Important sequences of spaces should be identified and retained in the rehabilitation project.

Floor plans may also be distinctive and characteristic of a style of architecture or a region. Examples include Greek Revival and shotgun houses. Floor plans may also reflect social, educational, and medical theories of the period. Many 19th century psychiatric institutions, for example, had plans based on the ideas of Thomas Kirkbride, a Philadelphia doctor who authored a book on asylum design.

In addition to evaluating the relative importance of the various spaces, the assessment should identify architectural features and finishes that are part of the interior's history and character. Marble or wood wainscoting in corridors, elevator cabs, crown molding, baseboards, mantels, ceiling medallions, window and door trim, tile and parquet floors, and staircases are among those features that can be found in historic buildings. Architectural finishes of note may include grained woodwork, marbleized columns, and plastered walls. Those features that are characteristic of the building's style and period of construction should, again, be retained in the rehabilitation.

Features and finishes, even if machine-made and not exhibiting particularly fine craftsmanship, may be character defining; these would include pressed metal ceilings and millwork around windows and doors. The interior of a plain, simple detailed worker's house of the 19th century may be as important historically as a richly ornamented, high-style townhouse of the same period. Both resources, if equally intact, convey important information about the early inhabitants and deserve the same careful attention to detail in the preservation process.

The location and condition of the building's existing heating, plumbing, and electrical systems also need to be noted in the assessment. The visible features of historic systems--radiators, grilles, light fixtures, switchplates, bathtubs, etc.--can contribute to the overall character of the building, even if the systems themselves need upgrading.

Assessing Alterations and Deterioration

In assessing a building's interior, it is important to ascertain the extent of alteration and deterioration that may have taken place over the years; these factors help determine what degree of change is appropriate in the project. Close examination of existing fabric and original floorplans, where available, can reveal which alterations have been additive, such as new partitions inserted for functional or structural reasons and historic features covered up rather than destroyed. It can also reveal which have been subtractive, such as key walls removed and architectural features destroyed. If an interior has been modified by additive changes and if these changes have not acquired significance, it may be relatively easy to remove the alterations and return the interior to its historic appearance. If an interior has been greatly altered through subtractive changes, there may be more latitude in making further alterations in the process of rehabilitation because the integrity of the interior has been compromised. At the same time, if the interior had been exceptionally significant, and solid documentation on its historic condition is available, reconstruction of the missing features may be the preferred option.

This corridor has glazed walls, oak trim, and marble wainscotting, typical of those found in the late 19th and early 20th century office buildings. Corridors such as this, displaying simple detailing, should be a

It is always a recommended practice to photograph interior spaces and features thoroughly prior to rehabilitation. Measured floor plans showing the existing conditions are extremely useful. This documentation is invaluable in drawing up rehabilitation plans and specifications and in assessing the impact of changes to the property for historic preservation certification purposes.

Drawing Up Plans and Executing Work

If the historic building is to be rehabilitated, it is critical that the new use not require substantial alteration of distinctive spaces or removal of character-defining architectural features or finishes. If an interior loses the physical vestiges of its past as well as its historic function, the sense of time and place associated both with the building and the district in which it is located is lost.

The recommended approaches that follow address

priority in rehabilitation projects involving commercial buildings. Photo: NPS files.

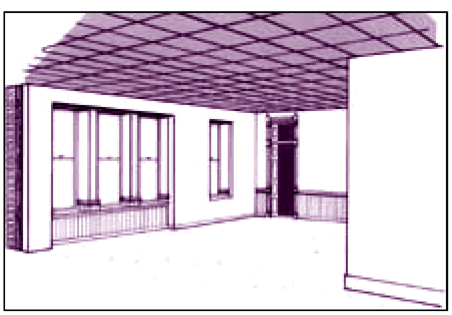
common problems associated with the rehabilitation of historic interiors and have been adapted from the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. Adherence to these suggestions can help ensure that character-defining interior elements are preserved in the process of rehabilitation. The checklist covers a range of situations and is not intended to be all-inclusive. Readers are strongly encouraged to review the full set of guidelines before undertaking any rehabilitation project.

Recommended Approaches for Rehabilitating Historic Interiors

1. Retain and preserve floor plans and interior spaces that are important in defining the overall historic character of the building. This includes the size, configuration, proportion, and relationship of rooms and corridors; the relationship of features to spaces; and the spaces themselves such as lobbies, reception halls, entrance halls, double parlors, theaters, auditoriums, and important industrial or commercial use spaces. Put service functions required by the building's new use, such as bathrooms, mechanical equipment, and office machines, in secondary spaces.

2. Avoid subdividing spaces that are characteristic of a building type or style or that are directly associated with specific persons or patterns of events. Space may be subdivided both vertically through the insertion of new partitions or horizontally through insertion of new floors or mezzanines. The insertion of new additional floors should be considered only when they will not damage or destroy the structural system or obscure, damage, or destroy character-defining spaces, features, or finishes. If rooms have already been subdivided through an earlier insensitive renovation, consider removing the partitions and restoring the room to its original proportions and size.

3. Avoid making new cuts in floors and ceilings where such cuts would change character-defining spaces and the historic configuration of such spaces. Inserting of a new atrium or a lightwell is appropriate only in very limited situations where the existing interiors are not historically or architecturally distinguished.



Furring out exterior walls to add insulation and suspending new ceilings to hide ductwork can change a room's proportions and cause interior features to appear fragmented. The interior character of this school classroom that was converted to apartment use has been destroyed. Drawing: Neal A. Vogel

4. Avoid installing dropped ceilings below ornamental ceilings or in rooms where high ceilings are part of the building's character. In addition to obscuring or destroying significant details, such treatments will also change the space's proportions. If dropped ceilings are installed in buildings that lack character-defining spaces, such as mills and factories, they should be well set back from the windows so they are not visible from the exterior.

5. Retain and preserve interior features and finishes that are important in defining the overall historic character of the building. This might include columns, doors, cornices, baseboards, fireplaces and mantels, paneling, light fixtures, elevator cabs, hardware, and flooring; and wallpaper, plaster, paint, and finishes such as stenciling, marbleizing, and graining; and other decorative materials that accent interior features and provide color, texture, and patterning to walls, floors, and ceilings.

6. Retain stairs in their historic configuration and to location. If a second means of egress is required, consider constructing new stairs in secondary spaces. The application of fire-retardant coatings, such as intumescent paints; the installation of fire suppression systems, such as sprinklers; and the construction of glass enclosures can in many cases permit retention of stairs and other character-defining features.

7. Retain and preserve visible features of early mechanical systems that are important in defining the overall historic character of the building, such as radiators, vents, fans, grilles, plumbing fixtures, switchplates, and lights. If new heating, air conditioning, lighting and plumbing systems are installed, they should be done in a way that does not destroy character-defining spaces, features and finishes. Ducts, pipes, and wiring should be installed as inconspicuously as possible: in secondary spaces, in the attic or basement if possible, or in closets.

8. Avoid "furring out" perimeter walls for insulation purposes. This requires unnecessary removal of window trim and can change a room's proportions. Consider alternative means of improving thermal performance, such as installing insulation in attics and basements and adding storm windows.

9. Avoid removing paint and plaster from traditionally finished surfaces, to expose masonry and wood. Conversely, avoid painting previously unpainted millwork. Repairing deteriorated plasterwork is encouraged. If the plaster is too deteriorated to save, and the walls and ceilings are not highly ornamented, gypsum board may be an acceptable replacement material. The use of paint colors appropriate to the period of the building's construction is encouraged.

Plaster has been removed from perimeter walls, leaving brick exposed. The plaster should have been retained and repaired, as necessary. Photo: NPS files.

10. Avoid using destructive methods--propane and butane torches or sandblasting--to remove paint or other coatings from historic features. Avoid harsh cleaning agents that can change the appearance of wood.

Meeting Building, Life Safety and Fire Codes

Buildings undergoing rehabilitation must comply with existing building, life safety and fire codes. The application of codes to specific projects varies from building to building, and town to town. Code requirements may make some reuse proposals impractical; in other cases, only minor changes may be needed to bring the project into compliance. In some situations, it may be possible to obtain a code variance to preserve distinctive interior features. (It should be noted that the Secretary's Standards for Rehabilitation take precedence over other regulations and codes in determining whether a rehabilitation project qualifies for Federal tax benefits.) A thorough understanding of the applicable regulations and close coordination with code officials, building inspectors, and fire marshals can prevent the alteration of significant historic interiors.

Sources of Assistance

Rehabilitation and restoration work should be undertaken by professionals who have an established reputation in the field.

Given the wide range of interior work items, from ornamental plaster repair to marble cleaning and the application of graining, it is possible that a number of specialists and subcontractors will need to be brought in to bring the project to completion. State Historic Preservation Officers and local preservation organizations may be a useful source of information in this regard. Good sources of information on appropriate preservation techniques for specific interior features and finishes include the Bulletin of the Association for Preservation Technology and The Old-House Journal; other useful publications are listed in the bibliography.

Protecting Interior Elements During Rehabilitation

Architectural features and finishes to be preserved in the process of rehabilitation should be clearly marked on plans and at the site. This step, along with careful supervision of the interior demolition work and protection against arson and vandalism, can prevent the unintended destruction of architectural elements that contribute to the building's historic character.

Protective coverings should be installed around architectural features and finishes to avoid damage in the course of construction work and to protect workers. Staircases and floors, in particular, are subjected to dirt and heavy wear, and the risk exists of incurring costly or irreparable damage. In most cases, the best, and least costly, preservation approach is to design and construct a protective system that enables stairs and floors to be used yet protects them from damage. Other architectural features such as mantels, doors, wainscoting, and decorative finishes may be protected by using heavy canvas or plastic sheets.

Summary

After rehabilitation, this severly deteriorated space was returned to its original elegance. Plaster was repaired and repainted; scagliola colums were restored to match marble; and missing decorative metalwork was re-installed in front of the windows. Photo: Carol M. Highsmith.

In many cases, the interior of a historic building is as important as its exterior. The careful identification and evaluation of interior architectural elements, after undertaking research on the building's history and use, is critically important before changes to the building are contemplated. Only after this evaluation should new uses be decided and plans be drawn up. The best rehabilitation is one that preserves and protects those rooms, sequences of spaces, features and finishes that define and shape the overall historic character of the building.

Selected Reading List

There are few books written exclusively on preserving historic interiors, and most of these tend to focus on residential interiors. Articles on the subject appear regularly in The Old-House Journal, the Bulletin of the Association for Preservation Technology, and Historic Preservation Magazine.

Ferro, Maximilian L., and Melissa L. Cook. *Electric Wiring and Lighting in Historic American Buildings.* New Bedford, Massachusetts: AFC/A Nortek Company, 1984.

Fisher, Charles E. "Temporary Protection of Historic Stairways During Rehabilitation Work." *Preservation Tech Note*. Washington, D.C.: Preservation Assistance Division, National Park Service, U.S. Department of the Interior, 1985.

Jennings, Jan, and Herbert Gottfried. *American Vernacular Interior Architecture 1870-1940.* New York: Van Nostrand Reinhold Company, 1988.

Johnson, Ed. *Old House Woodwork Restoration: How to Restore Doors, Windows, Walls, Stairs and Decorative Trim to Their Original Beauty.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1983.

Labine, Clem, and Carolyn Flaherty (editors). *The Old-House Journal Compendium.* Woodstock, New York: The Overlook Press, 1980.

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U.S. Department of Housing and Urban Development. *Rehabilitation Guidelines, volume 111*. Washington, D.C.: U.S. Department of Housing and Urban Development, 1980-84.

Winkler, Gail Caskey, and Roger W. Moss. *Victorian Interior Decoration: American Interiors 1830-1900*. New York: Henry Holt and Company, 1986.

Acknowledgements

This Preservation Brief is based on a discussion paper prepared by the author for a National Park Service regional workshop held in March, 1987, and on a paper written by Gary Hume, "Interior Spaces in Historic Buildings," October, 1987. Appreciation is extended to the staff of Technical Preservation Services Branch and to the staff of NPS regional offices who reviewed the manuscript and provided many useful suggestions.

Washington, D.C. October, 1988

Home page logo: Detail of carving on interior shutter. Hammond-Harwood House, Annapolis, Maryland. Photo: NPS files.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF#21
REPAIRING HISTORIC FLAT PLASTER WALLS AND CEILINGS

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21 Preservation Briefs
Technical Preservation Services
National Park Service
U.S. Department of the Interior

Repairing Historic Flat Plaster Walls and Ceilings

Mary Lee MacDonald

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Plaster in a historic building is like a family album. The handwriting of the artisans, the taste of the original occupants, and the evolving styles of decoration are embodied in the fabric of the building. From modest farmhouses to great buildings, regardless of the ethnic origins of the occupants, plaster has traditionally been used to finish interior walls.

A versatile material, plaster could be applied over brick, stone, half-timber, or frame construction. It provided a durable surface that was easy to clean and that could be applied to flat or curved walls and ceilings.

Plaster could be treated in any number of ways: it could receive stenciling, decorative painting, wallpaper, or whitewash. This variety and the adaptability of the material to nearly any building size, shape, or configuration meant that plaster was the wall surface chosen for nearly all buildings until the 1930s or 40s.

Plaster was used as the interior surface

Historic plaster may first appear so fraught with problems that its total removal seems the only alternative. But there are practical and historical reasons for saving it. First, three-coat plaster is unmatched in strength and durability. It resists fire and reduces sound transmission. Next, replacing plaster is expensive. A building owner needs to think carefully about the condition of the plaster that remains; plaster is often not as badly damaged as it first appears.

Of more concern to preservationists, however, original lime and gypsum plaster is part of the building's historic fabric--its smooth troweled or textured surfaces and subtle contours evoke the presence of America's earlier craftsmen.

coating of this elegant 1911 church located in Eugene, Oregon. Photo: NPS files.

Plaster can also serve as a plain surface for irreplaceable decorative finishes. For both reasons, plaster walls and ceilings contribute to the historic character of the interior and should be left in place and repaired if at all possible.

The approaches described in this Brief stress repairs using wet plaster, and traditional materials and techniques that will best assist the preservation of historic plaster walls and ceilings--and their appearance. Dry wall repairs are not included here, but have been written about extensively in other contexts. Finally, this Brief describes a replacement option when historic plaster cannot be repaired. Thus, a veneer plaster system is discussed rather than dry wall. Veneer systems include a coat or coats of wet plaster--although thinly applied--which can, to a greater extent, simulate traditional hand-troweled or textured finish coats. This system is generally better suited to historic preservation projects than dry wall.

To repair plaster, a building owner must often enlist the help of a plasterer. Plastering is a skilled craft, requiring years of training and special tools. While minor repairs can be undertaken by building owners, most repairs will require the assistance of a plasterer.

Historical Background

Plasterers in North America have relied on two materials to create their handiwork--lime and gypsum. Until the end of the 19th century, plasterers used lime plaster. Lime plaster was made from four ingredients: lime, aggregate, fiber, and water. The lime came from ground-and-heated limestone or oyster shells; the aggregate from sand; and the fiber from cattle or hog hair. Manufacturing changes at the end of the 19th century made it possible to use gypsum as a plastering material. Gypsum and lime plasters were used in combination for the base and finish coats during the early part of the 20th century; gypsum was eventually favored because it set more rapidly and, initially, had a harder finish.

The builders of this mid-18th century house installed the baseboard molding first, then applied a mud and horse hair plaster. Lime was used for the finish plaster. Photo: NPS files.

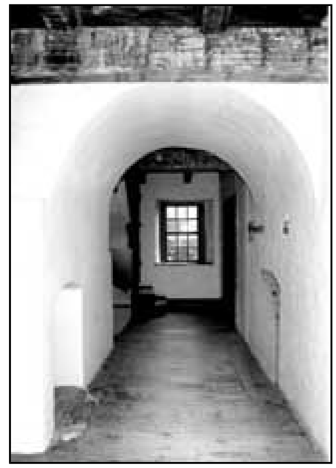
Not only did the basic plastering material change, but the method of application changed also. In early America, the windows, doors, and all other trim were installed before the plaster was applied to the wall. Generally the woodwork was prime-painted before plastering. Obtaining a plumb, level wall, while working against built-up moldings, must have been difficult. But sometime in the first half of the 19th century, builders began installing wooden plaster "grounds" around windows and doors and at the base of the wall. Installing these grounds so that they were level and plumb made the job much easier because the plasterer could work from a level, plumb, straight surface. Woodwork was then nailed to the "grounds" after the walls were plastered. Evidence of plaster behind trim is often an aid to dating historic houses, or to discerning their physical evolution.

Lime Plaster

When building a house, plasterers traditionally mixed bags of quick lime with water to "hydrate" or "slake" the lime. As the lime absorbed the water, heat was given off. When the heat diminished, and the lime and water were thoroughly mixed, the lime putty that resulted was used to make plaster.

When lime putty, sand, water, and animal hair were mixed, the mixture provided the plasterer with "coarse stuff." This mixture was applied in one or two layers to build up the wall thickness. But the best plaster was done with three coats. The first two coats made up the coarse stuff; they were the scratch coat and the brown coat. The finish plaster, called "setting stuff," contained a much higher proportion of lime putty, little aggregate, and no fiber, and gave the wall a smooth white surface finish.

Compared to the 3/8-inch-thick layers of the scratch and brown coats, the finish coat was a mere 1/8-inch thick. Additives were used for various finish qualities. For example, fine white sand was mixed in for a "float finish." This finish was popular in the early 1900s. (If the plasterer raked the sand with a broom, the plaster wall would retain swirl marks or stipples.) Or marble dust was added to create a hard-finish white coat which could be smoothed and polished with a steel trowel. Finally, a little plaster of Paris, or "gauged stuff," was often added to the finish plaster to accelerate the setting time.



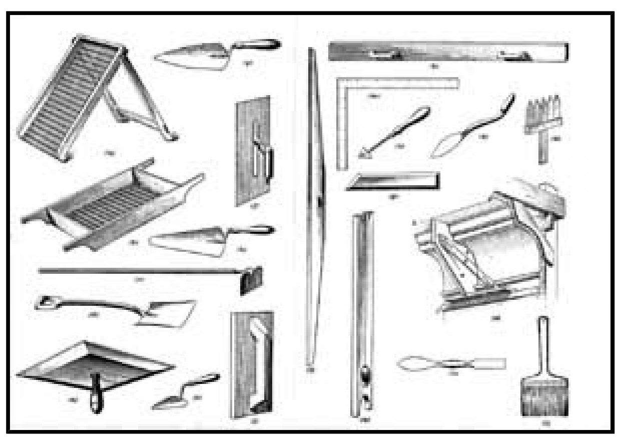
Schifferstadt, a simple house of German origin that dates to 1756, utilized plaster for both flat and curved walls. The building is located in Frederick, Maryland Photo: NPS files.

Although lime plaster was used in this country until the early 1900s, it had certain disadvantages. A plastered wall could take more than a year to dry; this delayed painting or papering. In addition, bagged quick lime had to be carefully protected from contact with air, or it became inert because it reacted with ambient moisture and carbon dioxide. Around 1900, gypsum began to be used as a plastering material.

Gypsum Plaster

Gypsum begins to cure as soon as it is mixed with water. It sets in minutes and completely dries in two to three weeks. Historically, gypsum made a more rigid plaster and did not require a fibrous binder. However it is difficult to tell the difference between lime and gypsum plaster once the plaster has cured.

Despite these desirable working characteristics, gypsum plaster was more vulnerable to water damage than lime. Lime plasters had often been applied directly to masonry walls (without lathing), forming a suction bond. They could survive occasional wind-driven moisture or water winking up from the ground. Gypsum plaster needed protection from water. Furring strips had to be used against masonry walls to create a dead air space. This prevented moisture transfer.



Many of these traditional plastering tools are still used today. Drawing: NPS files.

In rehabilitation and restoration projects, one should rely on the plasterer's judgment about whether to use lime or gypsum plaster. In general, gypsum plaster is the material plasterers use today. Different types of aggregate may be specified by the architect such as clean river sand, perlite, pumice, or vermiculite; however, if historic finishes and textures are being replicated, sand should be used as the base-coat aggregate. Today, if fiber is required in a base coat, a special gypsum is available which includes wood fibers. Lime putty, mixed with about 35% gypsum (gauging plaster) to help it harden, is still used as the finish coat.

Lath

Lath provided a means of holding the plaster in place. Wooden lath was nailed at right angles directly to the structural members of the buildings (the joists and studs), or it was fastened to nonstructural spaced strips known as furring strips. Three types of lath can be found on historic buildings.

Wood Lath. Wood lath is usually made up of narrow, thin strips of wood with spaces in between. The plasterer applies a slight pressure to push the wet plaster through the spaces. The plaster slumps down on the inside of the wall, forming plaster "keys." These keys hold the plaster in place.

Metal Lath. Metal lath, patented in England in 1797, began to be used in parts of the United States toward the end of the 19th century. The steel making up the metal lath contained many more spaces than wood lath had contained. These spaces increased the number of keys; metal lath was better able to hold plaster than wood lath had been.

Rock Lath. A third lath system commonly used was rock lath (also called plaster board or gypsum-board lath). In use as early as 1900, rock lath was made up of compressed gypsum covered by a paper facing. Some rock lath was textured or perforated to provide a key for wet plaster. A special paper with gypsum crystals in it provides the key for rock lath used today; when wet plaster is applied to the surface, a crystalline bond is achieved.

Rock lath was the most economical of the three lathing systems. Lathers or carpenters could prepare a room more quickly. By the late 1930s, rock lath was used almost exclusively in residential plastering.

Common Plaster Problems

When plaster dries, it is a relatively rigid material which should last almost indefinitely. However, there are conditions that cause plaster to crack, effloresce, separate, or become detached from its lath framewor. These include:

- Structural Problems
- Poor Workmanship
- Improper Curing
- Moisture

Structural Problems

Overloading. Stresses within a wall, or acting on the house as a whole, can create stress cracks. Appearing as diagonal lines in a wall, stress cracks usually start at a door or window frame, but they can appear anywhere in the wall, with seemingly random starting points .

Builders of now-historic houses had no codes to help them size the structural members of buildings. The weight of the roof, the second and third stories, the furniture, and the occupants could impose a heavy burden on beams, joists, and studs. Even when houses were built properly, later remodeling efforts may have cut in a doorway or window without adding a structural beam or "header" across the top of the opening. Occasionally, load-bearing members were simply too small to carry the loads above them. Deflection or wood "creep" (deflection that occurs over time) can create cracks in plaster.

Stress cracks in plaster over a kitchen door frame can be repaired using fiberglass mesh tape and joint compound. Photo: NPS files.

Overloading and structural movement (especially when combined with rotting lath, rusted nails, or poor quality plaster) can cause plaster to detach from the lath. The plaster loses its key. When the mechanical bond with the lath is broken, plaster becomes loose or bowed. If repairs are not made, especially to ceilings, gravity will simply cause chunks of plaster to fall to the floor.

Settlement/Vibration. Cracks in walls can also result when houses settle. Houses built on clay soils are especially vulnerable. Many types of clay (such as montmorillonite) are highly expansive.

In the dry season, water evaporates from the clay particles, causing them to contract. During the rainy season, the clay swells. Thus, a building can be riding on an unstable footing. Diagonal cracks running in opposite directions suggest that house settling and soil conditions may be at fault. Similar symptoms occur when there is a nearby source of vibration-blasting, a train line, busy highway, or repeated sonic booms.

Lath movement. Horizontal cracks are often caused by lath movement. Because it absorbs moisture from the air, wood lath expands and contracts as humidity rises and falls. This can cause cracks to appear year after year. Cracks can also appear between rock lath panels. A nail holding the edge of a piece of lath may rust or loosen, or structural movement in the wood framing behind the lath may cause a seam to open. Heavy loads in a storage area above a rock-lath ceiling can also cause ceiling cracks.

Errors in initial building construction such as improper bracing, poor corner construction, faulty framing of doors and windows, and undersized beams and floor joists eventually "telegraph" through to the plaster surface.

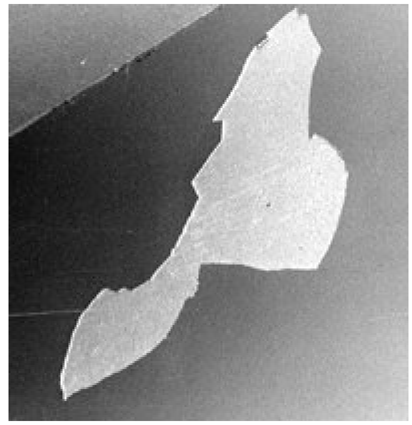
Poor Workmanship

In addition to problems caused by movement or weakness in the structural framework, plaster durability can be affected by poor materials or workmanship.

Poorly proportioned mix. The proper proportioning and mixing of materials are vital to the quality of the plaster job. A bad mix can cause problems that appear years later in a plaster wall. Until recently, proportions of aggregate and lime were mixed on the job. A plasterer may have skimped on the amount of cementing material (lime or gypsum) because sand was the cheaper material. Over sanding can cause the plaster to weaken or crumble. Plaster made from a poorly proportioned mix may be more difficult to repair.

Incompatible base coats and finish coats. Use of perlite as an aggregate also presented problems. Perlite is a lightweight aggregate used in the base coat instead of sand. It performs well in cold weather and has a slightly better insulating value. But if a smooth lime finish coat was applied over perlited base coats on wood or rock lath, cracks would appear in the finish coat and the entire job would have to be redone. To prevent this, a plasterer had to add fine silica sand or finely crushed perlite to the finish coat to compensate for the dramatically differing shrinkage rates between the base coat and the finish coat.

Improper plaster application. The finish coat is subject to "chip cracking" if it was applied over an excessively dry base coat, or was insufficiently troweled, or if too little gauging plaster was used. Chip cracking looks very much like an alligatored paint surface. Another common problem is called map cracking--fine, irregular cracks that occur when the finish coat has been applied to an over sanded base coat or a very thin base coat.



The smooth-trowled lime finish has delaminated from the brown coat underneath. Photo: Marylee MacDonald.

Too much retardant. Retarding agents are added to slow down the rate at which plaster sets, and thus inhibit hardening. They have traditionally included ammonia, glue, gelatin, starch, molasses, or vegetable oil. If the plasterer has used too much retardant, however, a gypsum plaster will not set within a normal 20 to 30 minute time period. As a result, the surface becomes soft and powdery.

Inadequate plaster thickness. Plaster is applied in three coats over wood lath and metal lath--the scratch, brown, and finish coats. In three-coat work, the scratch coat and brown coat were sometimes applied on successive days to make up the required wall thickness. Using rock lath allowed the plasterer to apply one base coat and the finish coat--a two-coat job.

If a plasterer skimped on materials, the wall may not have sufficient plaster thickness to withstand the normal stresses within a building. The minimum total thickness for plaster on gypsum board (rock lath) is 1/2 inch. On metal lath the minimum thickness is 5/8 inch; and for wood lath it is about 3/4 to 7/8 inch. This minimum plaster thickness may affect the thickness of trim projecting from the wall's plane.

Improper Curing

Proper temperature and air circulation during curing are key factors in a durable plaster job. The ideal temperature for plaster to cure is between 55 to 70 degrees Fahrenheit. However, historic houses were sometimes plastered before window sashes were put in. There was no way to control temperature and humidity.

Dry outs, freezing, and sweat-outs. When temperatures were too hot, the plaster would return to its original condition before it was mixed with water, that is, calcined gypsum. A plasterer would have to spray the wall with alum water to reset the plaster. If freezing occurred before the plaster had set, the job would simply have to be redone. If the windows were shut so that air could not circulate, the plaster was subject to sweat-out or rot. Since there is no cure for rotted plaster, the affected area had to be removed and replastered.

Moisture

Plaster applied to a masonry wall is vulnerable to water damage if the wall is constantly wet. When salts from the masonry substrate come in contact with water, they migrate to the surface of the plaster, appearing as dry bubbles or efflorescence. The source of the moisture must be eliminated before replastering the damaged area.

Sources of Water Damage. Moisture problems occur for several reasons. Interior plumbing leaks in older houses are common. Roofs may leak, causing ceiling damage. Gutters and downspouts may also leak, pouring rain water next to the building foundation. In brick buildings, dampness at the foundation level can wick up into the above-grade walls. Another common source of moisture is splashback. When there is a paved area next to a masonry building, rainwater splashing up from the paving can dampen masonry walls. In both cases water travels through the masonry and damages interior plaster. Coatings applied to the interior are not effective over the long run. The moisture problem must be stopped on the outside of the wall.

Repairing Historic Plaster

Many of the problems described above may not be easy to remedy. If major structural problems are found to be the source of the plaster problem, the structural problem should be corrected. Some repairs can be made by removing only small sections of plaster to gain access. Minor structural problems that will not endanger the building can generally be ignored. Cosmetic damages from minor building movement, holes, or bowed areas can be repaired without the need for wholesale demolition. However, it may be necessary to remove deteriorated plaster caused by rising damp in order for masonry walls to dry out. Repairs made to a wet base will fail again.

Canvassing Uneven Wall Surfaces

Uneven wall surfaces, caused by previous patching or by partial wallpaper removal, are common in old houses. As long as the plaster is generally sound, cosmetically unattractive plaster walls can be "wallpapered" with strips of a canvas or fabric-like material. Historically, canvassing covered imperfections in the plaster and provided a stable base for decorative painting or wallpaper.

Filling Cracks

Hairline cracks in wall and ceiling plaster are not a serious cause for concern as long as the underlying plaster is in good condition. They may be filled easily with a patching material. For cracks that reopen with seasonal humidity change, a slightly different method is used. First the crack is widened slightly with a sharp, pointed tool such as a crack widener or a triangular can opener. Then the crack is filled. For more persistent cracks, it may be necessary to bridge the crack with tape. In this instance, a fiberglass mesh tape is pressed into the patching material.

After the first application of a quick setting joint compound dries, a second coat is used to cover the tape, feathering it at the edges. A third coat is applied to even out the surface, followed by light sanding. The area is cleaned off with a damp sponge, then dried to remove any leftover plaster residue or dust.

When cracks are larger and due to structural movement, repairs need to be made to the structural system before repairing the plaster. Then, the plaster on each side of the crack should be removed to a width of about 6 inches down to the lath. The debris is cleaned out, and metal lath applied to the cleared area, leaving the existing wood lath in place. The metal lath usually prevents further cracking. The crack is patched with an appropriate plaster in three layers (i.e., base coats and finish coat). If a crack seems to be expanding, a structural engineer should be consulted.

Replacing Delaminated Areas of the Finish Coat

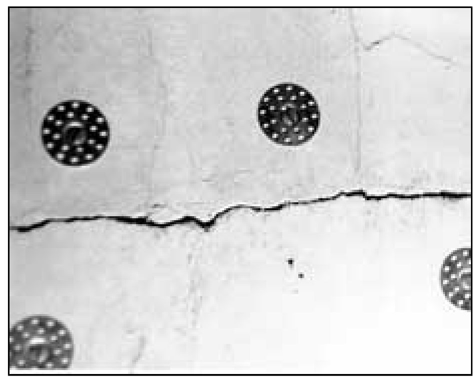
Sometimes the finish coat of plaster comes loose from the base coat. In making this type of repair, the plasterer paints a liquid plaster-bonding agent

In this New Hampshire residence dating from the 1790s, the original plaster was a single coat of lime, sand, and horsehair applied over split lath. A one-coat repair, in this case, is appropriate. Photo: John Leeke.

onto the areas of base-coat plaster that will be replastered with a new lime finish coat. A homeowner wishing to repair small areas of delaminated finish coat can use the methods described in "Patching Materials."

Patching Holes in Walls

For small holes (less than 4 inches in diameter) that involve loss of the brown and finish coats, the repair is made in two applications. First, a layer of base coat plaster is troweled in place and scraped back below the level of the existing plaster. When the base coat has set but not dried, more plaster is applied to create a smooth, level surface. One-coat patching is not generally recommended by plasterers because it tends to produce concave surfaces that show up when the work is painted. Of course, if the lath only had one coat of plaster originally, then a one-coat patch is appropriate.



Flat-head wood screws and plaster washers were used to reattach loose ceiling plaster to the wood lath. After the crack is covered with fiberglass mesh tape, all will be skim-coated with a patching compound. Photo: John Obed Curtis.

For larger holes where all three coats of plaster are damaged or missing down to the wood lath, plasterers generally proceed along these lines. First, all the old plaster is cleaned out and any loose lath is re-nailed. Next, a water mist is sprayed on the old lath to keep it from twisting when the new, wet plaster is applied, or better still, a bonding agent is used.

To provide more reliable keying and to strengthen the patch, expanded metal lath (diamond mesh) should be attached to the wood lath with tie wires or nailed over the wood lath with lath nails. The plaster is then applied in three layers over the metal lath, lapping each new layer of plaster over the old plaster so that old and new are evenly joined. This stepping is recommended to produce a strong, invisible patch. Also, if a patch is made in a plaster wall that is slightly wavy, the contour of the patch should be made to conform to the irregularities of the existing work. A flat patch will stand out from the rest of the wall.

Patching Holes in Ceilings

Hairline cracks and holes may be unsightly, but when portions of the ceiling come loose, a more serious problem exists. The keys holding the plaster to the ceiling have probably broken. First, the plaster around the loose plaster should be examined.

Keys may have deteriorated because of a localized moisture problem, poor quality plaster, or structural overloading; yet, the surrounding system may be intact. If the areas surrounding the loose area are in reasonably good condition,

This beaded ceiling in one of the bedrooms of the 1847 Lockwood House, Harpers Ferry, West Virginia, is missing portions of plaster due to broken keys. Photo: NPS files.

the loose plaster can be reattached to the lath using flathead wood screws and plaster washers. To patch a hole in the ceiling plaster, metal lath is fastened over the wood lath; then the hole is filled with successive layers of plaster, as described above.

Establishing New Plaster Keys

If the back of the ceiling lath is accessible (usually from the attic or after removing floor boards), small areas of bowed-out plaster can be pushed back against the lath. A padded piece of plywood and braces are used to secure the loose plaster. After dampening the old lath and coating the damaged area with a bonding agent, a fairly liquid plaster mix (with a glue size retardant added) is applied to the backs of the lath, and worked into the voids between the faces of the lath and the back of the plaster. While this first layer is still damp, plaster-soaked strips of jute scrim are laid across the backs of the lath and pressed firmly into the first layer as reinforcement. The original lath must be secure, otherwise the weight of the patching plaster may loosen it.

Loose, damaged plaster can also be re-keyed when the goal is to conserve decorative surfaces or wallpaper. Large areas of ceilings and walls can be saved. This method requires the assistance of a skilled conservator--it is not a repair technique used by most plasterers.

The conservator injects an acrylic adhesive mixture through holes drilled in the face of the plaster (or through the lath from behind, when accessible). The loose plaster is held firm with plywood bracing until the adhesive bonding mixture sets. When complete, gaps between the plaster and lath are filled, and the loose plaster is secure.

When ceiling repairs are made with wet plaster or with an injected adhesive mixture, the old loose plaster must be supported with a plywood brace until re-keying is complete. Photo: John Leeke.

Replastering Over the Old Ceiling

If a historic ceiling is too cracked to patch or is sagging (but not damaged from moisture), plasterers routinely keep the old ceiling and simply relath and replaster over it. This repair technique can be used if lowering the ceiling slightly does not affect other ornamental features. The existing ceiling is covered with 1x3-inch wood furring strips, one to each joist, and fastened completely through the old lath and plaster using a screw gun. Expanded metal lath or gypsum board lath is nailed over the furring strips. Finally, two or three coats are applied according to traditional methods. Replastering over the old ceiling saves time, creates much less dust than demolition, and gives added fire protection.

When Damaged Plaster Cannot be Repaired --Replacement Options

Partial or complete removal may be necessary if plaster is badly damaged, particularly if the damage was caused by long-term moisture problems. Workers undertaking demolition should wear OSHA-approved masks because the plaster dust that flies into the air may contain decades of coal soot. Lead, from lead based paint, is another danger. Long-sleeved clothing and head-and-eye protection should be worn. Asbestos, used in the mid-twentieth century as an insulating and fireproofing additive, may also be present and OSHA-recommended precautions should be taken. If plaster in adjacent rooms is still in good condition, walls should not be pounded--a small trowel or pry bar is worked behind the plaster carefully in order to pry loose pieces off the wall.

When the damaged plaster has been removed, the owner must decide whether to replaster over the existing lath or use a different system. This decision should be based in part on the thickness of the original plaster and the condition of the original lath. Economy and time are also valid considerations. It is important to ensure that the wood trim around the windows and doors will have the same "reveal" as before. (The "reveal" is the projection of the wood trim from the surface of the plastered wall). A lath and plaster system that will give this required depth should be selected.

Replastering--Alternative Lath Systems for New Plaster

Replastering old wood lath. When plasterers work with old lath, each lath strip is re-nailed and the chunks of old plaster are cleaned out. Because the old lath is dry, it must be thoroughly soaked before applying the base coats of plaster, or it will warp and buckle; furthermore, because the water is drawn out, the plaster will fail to set properly. As noted earlier, if new metal lath is installed over old wood lath as the base for new plaster, many of these problems can be avoided and the historic lath can be retained. The ceiling should still be sprayed unless a vapor barrier is placed behind the metal lath.

Replastering over new metal lath. An alternative to reusing the old wood lath is to install a different lathing system. Galvanized metal lath is the most expensive, but also the most reliable in terms of longevity, stability, and proper keying. When lathing over open joists, the plasterer should cover the joists with kraft paper or a polyethylene vapor barrier. Three coats of wet plaster are applied consecutively to form a solid, monolithic unit with the lath. The scratch coat keys into the metal lath; the second, or brown, coat bonds to the scratch coat and builds the thickness; the third, or finish coat, consists of lime putty and gauging plaster.

Replastering over new rock lath. It is also possible to use rock lath as a plaster base. Plasterers may need to remove the existing wood lath to maintain the woodwork's reveal. Rock lath is a 16x36-inch, 1/2-inch thick, gypsum-core panel covered with absorbent paper with gypsum crystals in the paper. The crystals in the paper bond the wet plaster and anchor it securely. This type of lath requires two coats of new plaster--the brown coat and the finish coat. The gypsum lath itself takes the place of the first, or scratch, coat of plaster.

repair with metal lath, base coats, and finish coat

Repairs are being made to the historic plaster. Expanded metal lath is cut to fit the hole, then attached to the wood lath with a tie-wire. Two ready-mix gypsum coats are applied, then a smooth-trowled coat of gauged lime. Photo: Walter Jowers.

Painting New Plaster

The key to a successful paint job is proper drying of the plaster. Historically, lime plasters were allowed to cure for at least a year before the walls were painted or papered. With modern ventilation, plaster cures in a shorter time; however, fresh gypsum plaster with a lime finish coat should still be perfectly dry before paint is applied--or the paint may peel. (Plasterers traditionally used the "match test" on new plaster. If a match would light by striking it on the new plaster surface, the plaster was considered dry.) Today it is best to allow new plaster to cure two to three weeks. A good alkaline-resistant primer, specifically formulated for new plaster, should then be used. A compatible latex or oil-based paint can be used for the final coat.

A Modern Replacement System

Veneer Plaster. Using one of the traditional lath and plaster systems provides the highest quality plaster job. However, in some cases, budget and time considerations may lead the owner to consider a less expensive replacement alternative. Designed to reduce the cost of materials, a more recent lath and plaster system is less expensive than a two-or-three coat plaster job, but only slightly more expensive than drywall. This plaster system is called veneer plaster.

The system uses gypsum-core panels that are the same size as drywall (4x8 feet), and specially made for veneer plaster. They can be installed over furring channels to masonry walls or over old wood lath walls and ceilings. Known most commonly as "blue board," the panels are covered with a special paper compatible with veneer plaster. Joints between the 4-foot wide sheets are taped with fiberglass mesh, which is bedded in the veneer plaster. After the tape is bedded, a thin, 1/16-inch coat of high-strength veneer plaster is applied to the entire wall surface. A second veneer layer can be used as the "finish" coat, or the veneer plaster can be covered with a gauged lime finish-coat--the same coat that covers ordinary plaster.

Although extremely thin, a two-coat veneer plaster system has a 1,500 psi rating and is thus able to withstand structural movements in a building or surface abrasion. With either a veneer finish or a gauged lime putty finish coat, the room will be ready for painting almost immediately. When complete, the troweled or textured wall surface looks more like traditional plaster than drywall.

The thin profile of the veneer system has an added benefit, especially for owners of uninsulated masonry buildings. Insulation can be installed between the pieces of furring channel used to attach blue board to masonry walls. This can be done without having to fur out the window and door jambs. The insulation plus the veneer system will result in the same thickness as the original plaster. Occupants in the rooms will be more comfortable because they will not be losing heat to cold wall surfaces.

Patching Materials

Plasterers generally use ready-mix base-coat plaster for patching, especially where large holes need to be filled. The ready-mix plaster contains gypsum and aggregate in proper proportions. The plasterer only needs to add water.

Another mix plasterers use to patch cracks or small holes, or for finish-coat repair, is a "high gauge" lime putty (50 percent lime; 50 percent gauging plaster). This material will produce a white, smooth patch. It is especially suitable for surface repairs.

Although property owners cannot duplicate the years of accumulated knowledge and craft skills of a professional plasterer, there are materials that can be used for do-it-yourself repairs. For example, fine cracks can be filled with an all-purpose drywall joint compound. For bridging larger cracks using fiberglass tape, a homeowner can use a "quicksetting" joint compound. This compound has a fast drying time--60, 90, or 120 minutes. Quick-setting joint compound dries because of a chemical reaction, not because of water evaporation. It shrinks less than all-purpose joint compound and has much the same workability as ready-mix base-coat plaster. However, because quick-set joint compounds are hard to sand, they should only be used to bed tape or to fill large holes. All-purpose point compound should be used as the final coat prior to sanding.

Homeowners may also want to try using a ready-mix perlited base-coat plaster for scratch and brown coat repair. The plaster can be hand-mixed in small quantities, but bagged ready-mix should be protected from ambient moisture. A "millmixed pre-gauged" lime finish coat plaster can also be used by homeowners. A base coat utilizing perlite or other lightweight aggregates should only be used for making small repairs (less than 4 ft. patches). For large-scale repairs and entire room replastering, see the precautions in Table 1 for using perlite.

Homeowners may see a material sold as "patching plaster" or "plaster of Paris" in hardware stores. This dry powder cannot be used by itself for plaster repairs. It must be combined with lime to create a successful patching mixture.

When using a lime finish coat for any repair, wait longer to paint, or use an alkaline-resistant primer.

Summary

The National Park Service recommends retaining historic plaster if at all possible. Plaster is a significant part of the "fabric" of the building. Much of the building's history is documented in the layers of paint and paper found covering old plaster. For buildings with decorative painting, conservation of historic flat plaster is even more important. Consultation with the National Park Service, with State Historic Preservation Officers, local preservation organizations, historic preservation consultants, or with the Association for Preservation Technology is recommended. Where plaster cannot be repaired or conserved using one of the approaches outlined in this Brief, documentation of the layers of wallpaper and paint should be undertaken before removing the historic plaster. This information may be needed to complete a restoration plan.

Plaster Terms

Scratch coat. The first base coat put on wood or metal lath. The wet plaster is "scratched" with a scarifier or comb to provide a rough surface so the next layer of base coat will stick to it.

Brown coat. The brown coat is the second application of wet, base-coat plaster with wood lath or metal systems. With gypsum board lath (rock lath, plasterboard), it is the only base coat needed.

Finish coat. Pure lime, mixed with about 35 percent gauging plaster to help it harden, is used for the very thin surface finish of the plaster wall. Fine sand can be added for a sanded finish coat.

Casing Bead. Early casing bead was made of wood. In the 19th century, metal casing beads were sometimes used around fireplace projections, and door and window openings. Like a wood ground, they indicate the proper thickness for the plaster.

Corner Bead. Wire mesh with a rigid metal spline used on

Outside corners. Installing the corner bead plumb is important.

Cornerite. Wire mesh used on inside corners of adjoining walls and ceilings. It keeps corners from cracking.

Ground. Plasterers use metal or wood strips around the edges of doors and windows and at the bottom of walls. These grounds help keep the plaster the same thickness and provide a stopping edge for the plaster. Early plaster work, however, did not use grounds. On early buildings, the woodwork was installed and primed before plastering began. Some time in the early 19th century, a transition occurred, and plasterers applied their wall finish before woodwork was installed.

Gypsum. Once mined from large gypsum quarries near Paris (thus the name plaster of Paris), gypsum in its natural form is calcium sulfate. When calcined (or heated), one-and-a-half water molecules are driven off, leaving a hemi-hydrate of calcium sulfate. When mixed with water, it becomes calcium sulfate again. While gypsum was used in base-coat plaster from the 1890s on, it has always been used in finish coat and decorative plaster. For finish coats, gauging plaster was added to lime putty; it causes the lime to harden. Gypsum is also the ingredient in moulding plaster, a finer plaster used to create decorative moldings in ornamental plaster work.

Lime. Found in limestone formations or shell mounds, naturally occurring lime is calcium carbonate. When heated, it becomes calcium oxide. After water has been added, it becomes calcium hydroxide. This calcium hydroxide reacts with carbon dioxide in the air to recreate the original calcium carbonate.

Screed. Screeds are strips of plaster run vertically or horizontally on walls or ceilings. They are used to plumb and straighten uneven walls and level ceilings. Metal screeds are used to separate different types of plaster finishes or to separate lime and cement plasters.

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Washington, D.C. October, 1989

Home page logo: Plasterers applying rough and finish coats of plaster. Drawing: From the "Book of Trades."

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF#38
REMOVING GRAFFITI FROM HISTORIC MASONRY

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38 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

Removing Graffiti from Historic Masonry

Martin E. Weaver

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Removing graffiti as soon as it appears is the key to its elimination--*and* recurrence. Thus, the intent of this Preservation Brief is to help owners and managers of historic masonry structures find the best way to remove exterior, surface-applied graffiti* quickly, effectively, and safely. The Brief will discuss the variety of materials used to apply graffiti, and offer guidance on how to remove graffiti from all types of historic masonry without harming either the surface or the substrate. Suggestions will also be given regarding the use of physical barriers to protect masonry surfaces from graffiti, and the application of barrier coatings to facilitate graffiti removal. Building managers and owners of historic properties will be advised on the importance of being prepared for rapid graffiti removal by testing different cleaning techniques in advance in order to select the most appropriate and sensitive cleaning technique. Health and safety and environmental concerns are addressed, as well as regulatory matters. Removing graffiti without causing damage to historic masonry is a job for trained maintenance crews, and in some cases, professional conservators, and generally should not be attempted by untrained workers, property owners or building managers. Although the focus of this Preservation Brief is on *historic* masonry, the same guidance may be applied equally to removing graffiti from non-historic masonry.

Identifying the Graffiti and the Masonry

Successful graffiti removal from historic masonry depends on achieving a balance between breaking the bond between the graffiti and the masonry surface without damaging the masonry.

This generally requires knowledge both of the materials used to make the graffiti and the masonry on which the graffiti has been executed, as well as knowledge of cleaning methods and materials. Without this, masonry surfaces can be badly disfigured or damaged during graffiti removal.

*The word *graffito* (*graffiti*, plural) -- is derived from the old Italian diminutive of *graffio*-to scratch, and the Latin *graphire*-to write. *Graffiti* in contemporary usage has come to mean an inscription, drawings, or markings. Except in very formal or technical applications, *graffiti* is generally considered a "mass" noun and paired with a singular verb.

Inappropriate abrasive blasting to remove the graffiti has permanently etched the graffiti into the stone. Photo: NPS files.

Graffiti. Most graffiti is made with spray paints. Although a number of solvents and paint strippers are capable of dissolving or breaking down these paints, some may permanently discolor or stain the masonry surface if not used correctly. As a result, the remaining paint may become more difficult, or even impossible, to remove. Poorly thought-out and generally hasty attempts to remove graffiti using harsh chemicals or abrasives can also cause permanent damage to the masonry that may be worse than the graffiti.

The ability to identify the graffiti material is an important step in successful removal. Numerous kinds of spray paint (polyurethanes, lacquers, and enamels), and brush-applied paints (oils and synthetic resins such as vinyls, acrylics, acetates, methacrylates, or alkyds), as well as permanent felt markers are the materials most often used to make graffiti. But other materials are also used for graffiti, including water-soluble felt markers, ballpoint pens, chalk, graphite and colored pencils, pastels, wax and oil crayons, liquid shoe polish, and lipstick. The range of materials adopted by graffitists continues to expand.

Paints are composed of pigments that provide color and hiding power; binder that holds the pigments together and to the substrate; and a solvent that allows the pigment/binder mixture to flow. Some spray paints and markers may contain dyes instead of pigments. Paints are applied wet. Generally, as the solvent evaporates, the binder solidifies. The greater the solvent content of the paint, the greater the flow rate, and thus, the greater the ability of the paint to penetrate into masonry pores.

The two primary components contained in most graffiti materials--pigment or dye, and binder--may simply remain on the masonry surface, or penetrate into the masonry to varying depths depending on a number of factors, including the surface tension of the substrate and viscosity of the solvent or vehicle. Thus, even the total removal of the pigment or the binder may leave residues of the other component actually in, or below, the surface of the stone. Residual stains, or graffiti "ghosts," such as those from any kind of red paint or the fine black pigments used in spray paints, may be particularly difficult to remove. With painted graffiti, it is helpful to establish how long it has been on the surface. For most paints that have been on the surface for
several weeks or months, hardening processes are likely to be

complete or well-advanced; the solubility of the paint is proportionately reduced and it will be more difficult to remove.

Removing this densely painted graffiti will require several applications of paint remover. Photo: NPS files.

Masonry. The historic masonry substrate must also be identified. As used here, the term *masonry* encompasses all types of natural stones; manufactured clay materials, including brick and terra cotta; and cementitious materials, such as cast stone, concrete and mortar. The common factor among masonry materials is that they are porous, to a greater or lesser extent, and sensitive to abrasion. After identifying the masonry, its condition, including fragility, porosity and permeability, must also be assessed prior to beginning graffiti removal. For example, a smooth, newly-polished granite surface is comparatively easy to clean because it is relatively impermeable and paint vehicles tend to stay on the surface rather than penetrate into microscopic pores. A very smooth, polished surface also has no pits or crevices that will retain particles of pigment or binder. In contrast, weathered marble or limestone may be extremely porous and permeable, with a rough surface on which particles of pigment can easily lodge. The fragility of such a surface can make it impossible to clean the surface even with a bristle brush without risking severe surface loss. A difference in surface texture or finish may also be the reason that a particular cleaning agent will work in one situation but not another.

Spray painted graffiti defaces this historic brick building. Photo: NPS files.

Some types of masonry may react adversely to contact with the various cleaning agents required to break or dissolve the bond between the graffiti and the masonry surface. Thus, for purposes of cleaning, masonry types are often categorized according to whether they are acid-sensitive, non-acid sensitive, or alkali-sensitive. *Acid-sensitive* stones consisting of carbonate materials may be damaged or even destroyed by contact with acids. Although, in many instances, acidic cleaning compounds are not effective for graffiti removal and generally should not be used for this purpose, it is useful to know that some acid-sensitive materials include: stones such as limestone, marble, travertine, calcareous sandstones and shales; most polished stones; and glazed architectural terra cotta and glazed brick. *Non-acid sensitive* masonry materials include slate, granite, unglazed architectural terra cotta and unglazed brick. *Alkali-sensitive* stones may contain silicates, or ferrous, soluble iron compounds that can react with alkalis or water to form severe staining. *Alkali-sensitive* stones include some granites, Indiana limestone, and many types of sandstone, especially those that are green or grey in color. Glazed and polished surfaces tend to be damaged by both strong acids and strong alkalis.

Graffiti Removal Methods and Materials

A variety of treatments are available from which to choose the most appropriate method of graffiti removal that will not damage the surface of historic masonry. Removal techniques, which are chosen according to the type of graffiti and the masonry, range from simply erasing pencilled graffiti with soft erasers, or removing chalked graffiti with soft brushes, to poulticing with water (with or without detergents), poulticing with organic solvents or alkali-based paint removers, or applying bleach to remove painted graffiti. In very limited situations, it may mean using very delicate and controlled abrasive means. Successful graffiti removal often requires a combination of cleaning materials and methods.

A poultice is ofen the preferred method of graffiti removal. Photo: NPS files.

Poulticing

The most effective method of removing graffiti from masonry usually involves the use of a poultice. A poultice consists of an absorbent material or powder-inert clays such as kaolin or sepiolite, diatomaceous earth (fuller's earth); or cellulose products such as fluff pulp cellulose or shredded paper-mixed with a cleaning solution (a liquid reagent such as water, organic solvent, paint stripper or bleach) to form a paste or slurry. The purpose of a poultice is twofold: it enables a cleaning solution to be kept in contact with the stained area as long as possible, while allowing the cleaning solution to pull the staining material out of the substrate via the poultice without redepositing it in, or restaining, the masonry. A poultice is often covered with a plastic sheet to retard evaporation. With some extremely porous types of stone, such as marble, although a poultice may remove a stain from one side of the stone, stains can pass completely through the stone and be redeposited on the other side of the masonry slab. Thus, caution should always be exercised in stain and graffiti removal.

Painting over graffiti on stone is not a recommended maintenance treatment. Photo: NPS files.

Water and Detergent. Graffiti removal from historic masonry should always begin with the gentlest means possible. In some instances, this means low-pressure water washing. Fresh graffiti-one or two days old-made with water-soluble markers may sometimes be removed with water, possibly aided by a neutral or non-ionic detergent. (Non-ionic detergents which do not ionize in solution, do not deposit a solid, visible residue.) Ammonia can also be effective in removing fresh graffiti. Any detergent should be approached with caution and tested before using because most commercial laundry detergents are not neutral and contain substances which may leave undesirable residues on masonry materials. Usually, the water and detergent should be mixed with an absorbent material and applied in the form of a poultice. Although water washing is often likely to be the gentlest cleaning method for historic masonry, it may not be as effective for removing graffiti because many graffiti materials are not soluble in water.

Organic Solvents and Paint Removers. Most graffiti can be removed without damaging the masonry with proprietary graffiti-removal products and commercial paint strippers containing organic solvents. But, these products should always be tested and used in accordance with manufacturer's instructions included in the product literature. Normally, solvents should be used in a poultice form to prevent them from penetrating into the substrate, and permanently discoloring or staining the masonry. A number of paint-removers are manufactured as thick gels or pastes that cling to the surface, and some commercial paint-removal products include a tough fiber-reinforced paper or cloth backing that retards evaporation and also facilitates neat and clean removal of the used stripper. The advantage of using organic solvents is that they evaporate completely, leaving no residual material in the masonry. However, organic solvents may present a severe health hazard, and workers using them must wear adequate protection. "Off-the-shelf" aerosol graffiti removers generally should not be used because the dissolved paint being removed may run down the wall "staining" a previously clean area; or pigments may also be redistributed by the rinsing and scrubbing recommended by the product manufacturer.

Alkaline Compounds. Alkaline compounds may be used to remove some oils and greases, and waxes from *non-alkali sensitive* masonry. Like organic solvents, alkaline compounds should generally be used in conjunction with a poultice when removing graffiti. The use of alkaline compounds should always be followed by a weak acid wash and a water rinse in order to neutralize-or remove-all the alkaline residues from the masonry. Strong alkalies (pH13-14), such as sodium hydroxide-based paint removers (caustic soda or lye), generally should not be used as they can cause efflorescence and staining on masonry surfaces, if not properly neutralized. Potassium and other hydroxide paint removers may react with iron compounds in some masonry, particularly Indiana limestone, to form dark brown (rust-colored), or black ferric hydroxide stains, which are very difficult to remove.

Bleaches. Alkali-based bleaches such as calcium hypochlorite can sometimes be used very successfully in a poultice to bleach or decolorize certain dyes contained in some paints and inks that cannot readily be removed by other means.

Damaging graffiti removal methods have scarred the marble. Photo: NPS files.

Mechanical or Abrasive Methods. Mechanical treatments include dry or wet blasting, using abrasive grits, such as sand, dolomite powder, aluminum oxide, ground-walnut shells, sodium bicarbonate (baking soda), and others; high-pressure water washing; and mechanical sanding or grinding. All of these abrasive methods will cause damage to masonry and, in most instances, should never be considered as a method of removing graffiti from historic masonry. Abrasive methods used mistakenly by untrained workers to remove graffiti usually result in etching the outline of the graffiti permanently into the masonry. Some historic masonry materials can be easily damaged by pressure washing even at low or moderate pressures (100-400 psi). Occasionally, however, under very controlled circumstances, a *micro-abrasive* technique may be appropriate for removing graffiti from delicate masonry surfaces, if used at low pressures of 35-40 psi with fine abrasives.

This treatment, which must be done very slowly and carefully to avoid damaging the masonry, should be tested first, and undertaken only by a professional conservator. Another exception, even though it is not strictly an abrasive treatment, is using a razor blade as a first step to remove spray paint or felt-tip marker from polished granite. However, this too, should be undertaken only by a *professional conservator*, and only on *polished granite*, which is very hard and generally impervious to scratches.

Laser Cleaning. Although not in general use as a cleaning technique, laser technology offers great promise in the future as a non-damaging method of graffiti removal.

Testing

Before selecting a removal method, all cleaning materials and techniques for removing graffiti from a historic masonry building should be tested on mock-ups or areas of the resource that are not highly visible, but which are representative of typical conditions. Visual observation should be supplemented by the use of a magnifying glass, and spot tests should be carried out with various solvents to help identify the specific graffiti medium, which will aid in its removal. More complex testing using laboratory equipment and more scientific analytical processes may sometimes be necessary in complex situations. Sample areas that represent the desired degree of "cleanliness" should be approved in writing by client, architect, conservator or other appropriate authority. The materials and all the other data necessary to reproduce the desired cleaning results should be meticulously recorded and the accepted sample area preserved for reference until the end of the job. The existence of a "clean" sample for comparison and a signed agreement can avoid unpleasant surprises, misunderstandings, and perhaps legal actions.

When a type of graffiti appears for the first time that was executed with a material not immediately recognizable and for which no countermeasures have been developed, tests may need to be carried out by an architectural conservator to identify the material and to determine effective removal treatments. Agencies with large inventories of graffiti-prone buildings and structures should watch for graffiti made with new materials and experiment with different cleaning methods in order to be prepared when it appears. Such early action can save large sums of money in the long term. (See "Development of a Treatment Plan.")

Health and Safety Considerations

Most of the chemicals used for graffiti removal are dangerous to workers, as well as to others who may be in the vicinity. Organic solvents are toxic by ingestion, inhalation, and skin contact. Material Safety Data Sheets (MSDS), available from the product manufacturer for all paint-removal products, should always be consulted and followed. Identification of hazardous components and checking with chemical reference works will help assure that the least hazardous, but most effective, products are selected.

Generally speaking, it is a sensible policy to carry out all graffiti removal in well-ventilated conditions. Some solvents can be used only outdoors, and sometimes forced ventilation may be necessary even there, requiring workers to use air-fed respiratory equipment to avoid wind-blown fumes. Smoking, eating or drinking must not be allowed when cleaning is in progress.

Some materials used for graffiti removal are so corrosive that accidental contact can cause serious, permanent scarring and painful injuries. Wearing appropriate protective clothing must be strictly enforced. Mandatory personal protective equipment (PPE) normally includes face shields or safety glasses; long, chemical-resistant gloves; face masks with respirators for organic solvents; and possibly, full protective clothing with an independent air supply.

All smoking and open flames should be rigorously excluded from work areas; many solvents are flammable or highly explosive in vapor or liquid form when mixed with air. Solvent residue, used swabs, cloths, overalls and all other solvent-contaminated items should be safely and legally disposed of, or properly stored-even overnight-away from potential sources of fire. Electrical equipment may require explosion-proof fittings when used with certain solvents.

When electric pumps and pressure-spraying equipment are used, it is especially important that all necessary precautions be taken to avoid electric shock. Water sprays and puddles on the ground present a potentially dangerous situation, if they come into contact with temporary wiring at worksites where graffiti is being removed. Such hazards must be carefully monitored and controlled.

As with any construction project, attention should always be directed toward the general safety of the workers and passers-by, but also toward possible damage to the resource itself that might result from careless placement of ladders, or scaffolding. Chemicals used for masonry cleaning can also damage adjacent metals, glass, and painted surfaces, as well as vegetation. Product manufacturers' instructions should always be closely followed to avoid such inadvertent "collateral" damage.

Environmental Considerations

To protect against environmental contamination, including the formation of unwanted ozone at ground level and damage to the ozone layer in the earth's outer atmosphere, legislation has been enacted in some states making it illegal to use even moderate quantities of some solvents--*volatile organic compounds (VOCs)* contained in paint removers. In response to this legislation, many new products are being developed that do not contain VOCs.

After completing graffiti removal, the disposal of chemical products and rinsing effluent must be taken into account. Arrangement for disposal of the cleaning waste should be made *prior* to beginning graffiti removal, especially if it is a project of considerable size. In many places it is illegal to discharge solvents and/or paint residues into sewers or storm drains. The owner or manager of a historic property, or in some cases the individual or firm doing the cleaning or graffiti removal, is responsible for being informed of, and complying with, relevant laws and regulations. Under provisions of the National Historic Preservation Act of 1966, as amended, approval may be required from a state or federal preservation agency before any work can be undertaken on buildings or structures listed in or eligible for listing in the National Register of Historic Places, if such a project involves federal funding or licensing. Many state and local historic district commissions and review boards have their own regulations that require approval for cleaning or graffiti removal work that is undertaken on landmarks or properties in locally designated historic districts.

Barrier Coatings

Anti-graffiti or barrier coatings are intended to facilitate the removal of graffiti from porous as well as non-porous surfaces. These coatings are most commonly transparent, but may also be pigmented. They are available in a variety of formulations designed to serve different needs. The use of barrier coatings to protect graffiti-prone historic masonry surfaces may seem to be an easy preventive solution to a persistent graffiti problem. However, for the most part, these coatings are not the panacea that some advertising might suggest. Some of them simply do not work, and others may cause physical or aesthetic changes or damage to the masonry.

Transparent Coatings. Transparent coatings serve as a barrier between the masonry surface and graffiti, preventing graffiti from penetrating into the masonry. They are also intended to make graffiti removal easier since most graffiti does not adhere well to them. Generally, graffiti applied over transparent barrier coatings can be removed with low-pressure water and a detergent, or with a solvent.

There are basically two kinds of transparent barrier coatings: temporary and permanent. Temporary, or "sacrificial" coatings are removed when graffiti is removed and then must be reapplied. Permanent transparent barrier coatings are more resistant to the water or solvents used to remove graffiti, and remain on the masonry surface when graffiti is removed (although this type of coating also must usually be reapplied after several cleanings). A third type of transparent barrier coating combines temporary and permanent coatings, based on a two-part system.

The difference in color between the bottom and the top of the stone spandrel is the only clue to the presence of a clear barrier coating. Photo: NPS files.

A water-based acrylic sealer is first applied to the masonry surface, after which a sacrificial layer consisting of a polyethylene wax emulsion or dispersion coat is applied over the sealer. When graffiti is removed, the sealer coat remains on the masonry, but the sacrificial coat dissolves and is removed with the graffiti, and thus must be reapplied. (With this two-part system, even the first coat will eventually wear off after multiple cleanings, and must also be reapplied.)

Unfortunately, in application, there are a number of negative aspects of transparent barrier coatings that generally prevent their being recommended for use on historic masonry. First, clear coatings may alter the color of the masonry surface and add a gloss that may be highly visible, or apparent only in certain lighting conditions or when it rains. Second, clear coatings may reduce the water-vapor permeability of the masonry, thereby contributing to possible water-related deterioration. Third, the coating may discolor and change over time. Exposure to ultra-violet light can cause a coating to yellow; dirt build-up may darken the treated surface; and some coatings acquire a sheen when rubbed or brushed against. Such changes are especially noticeable when only a portion of the building has been coated. Furthermore, if coatings are not maintained on a regular basis, usually through periodic removal and reapplication, many coatings tend to fail. What often results is an uneven, "patchy" look to the masonry that can have a very negative impact on the character of the historic building.

Despite these potential drawbacks, there may be some instances in which the graffiti problem or frequency of occurrence is so severe that application of a transparent barrier coating on historic masonry may be worth considering. Some water-base polysaccharide coatings, and silicone and silicone-base coatings have been used with success on masonry structures. They are essentially invisible, and do not change the natural appearance of the masonry. Although less durable than solvent-borne coatings, they are water-vapor permeable (breathable), and may be reapplied to the masonry surface immediately after removing graffiti, while the surface is still damp.

However, extreme caution must be exercised before applying a transparent barrier coating. Experimental test applications should always be tried first on discrete areas that are not highly visible, and the treated areas evaluated over a period of time. Laboratory test results on the performance of coatings applied to samples of like masonry types may be useful to some extent. But because the tests are carried out in a controlled environment, they may not be as accurate or reliable as tests actually carried out on-site where the factors of weather and pollution are the same as those at the location where the coating will be used. If circumstances warrant, and the use of a barrier coating is determined necessary, an architectural conservator should evaluate the test performance of a variety of coatings before selecting one to be applied to historic masonry. Because of the potential for disfigurement, owners of landmark-designated buildings are required by some preservation review boards and landmark commissions to obtain approval before they apply a barrier coating.

Pigmented Coatings. A pigmented barrier coating may be used on masonry as a *permanent*, preventive barrier coating, or as a *temporary* means of concealing graffiti until it can be removed.

This formerly clear barrier coating is very shiny and has discolored as it has aged. Photo: NPS files.

Like a transparent barrier coating, a pigmented barrier coating facilitates the removal of graffiti because graffiti does not adhere well to it. Pigmented barrier coatings that are water-vapor permeable may sometimes be used as a *permanent* barrier coating on non-historic masonry where there is frequent recurrence of graffiti, and when constant surveillance is not possible. Although there are some instances in which pigmented barrier coatings may be appropriate on painted historic masonry, they are **not** recommended for unpainted historic masonry because they will change the appearance of the masonry. There is also another kind of pigmented coating that is specially formulated to be used as a *temporary* measure to conceal graffiti that cannot be removed right away. This temporary, vapor-permeable paint is removed when the graffiti is removed.

Pigmented coatings are also not generally recommended as a permanent measure to cover up graffiti. Some graffiti materials, particularly felt markers, bleed through the coating; and repeated applications of the coating or paint can result in a heavy paint build-up on a masonry surface. Another disadvantage of using paint or a pigmented coating to hide graffiti is that it usually appears as an obvious patch on unpainted masonry and tends to attract more graffiti unless the paint can be applied in a discrete, and well-defined area. If incompatible with either the masonry or the graffiti, such a coating may peel off the masonry surface in an unsightly manner. Like transparent coatings, pigmented coatings may be difficult or impossible to remove completely once their performance or appearance is no longer satisfactory.

Preventing and Controlling Graffiti

Experience shows that prompt removal of graffiti is one of the most effective measures against its recurrence. Graffiti that is not removed quickly tends to attract more graffiti.

Often motivated by a need to have their work seen, graffitists tend to be discouraged from repeating their efforts in a location where their work is quickly removed.

Apart from removal, effective graffiti-prevention measures can be considered under two headings. The first consists of physical measures involving maintenance, lighting, security and the erection of barriers on or around the property itself. The second focuses on community awareness programs that include neighborhood patrols, community service programs and educational programs in the schools.

Maintenance and Security. Neglect invites vandalism, whereas a well-maintained property encourages civic pride. Thus, careful attention should be given to establishing regular maintenance programs which do not allow properties to reach a point of obvious deterioration or abandonment. Cyclical maintenance also makes good sense economically.

Graffiti is less likely to occur if graffitists can be clearly seen. It is often recommended that accessible, graffiti-prone areas be illuminated with floodlighting or spotlights. Graffiti may also be reduced or prevented by the presence of security guards, park rangers or police officers, or by the visible presence of surveillance cameras. Publicity about arrests and punitive measures against the graffitists, and the general vigilance of the security system may also reduce graffiti.

If they are historically appropriate and compatible with the historic property, soft barriers in the form of low, possibly thorny, shrubs and bushes or other forms of landscaping and planting may be effective deterrents. Such plantings can make it difficult to reach the property by any route other than the approved secure one. Hard barriers provided by fences and transparent screens or shields, such as clear acrylic or other polycarbonate sheets, may also afford some degree of protection. But these can have a negative aesthetic impact on the property's appearance, particularly if the barriers themselves become disfigured by graffiti.

Community Awareness. Community action and education often play an important role in a successful anti-graffiti program. Neighborhood watches can effectively deter graffitists, and can help police and other security agencies in the detection and prevention of graffiti. Intensive public campaigns against graffiti, including presentations in schools, developing programs to foster community pride, and sentencing offenders to remove graffiti in their own community can also be useful. Publicity concerning arrests of graffitists can be a useful preventive tool. (But, on the other hand, frequent newspaper coverage of graffiti outbreaks or even of new community efforts at deterring graffiti can sometimes have the opposite effect by challenging the "creativity" of graffitists.) Community groups trained in proper cleaning techniques can also assist property owners in prompt and non-damaging graffiti removal.

Summary

Although rapid graffiti removal is the most effective weapon in eliminating graffiti and preventing its recurrence in the same location, hasty, untested removal attempts can disfigure and cause harm to historic masonry. Thus, it is important that the owner or manager of a historic masonry building or structure be prepared with a plan to ensure the prompt removal of graffiti when it occurs. Regularly scheduled maintenance and cleaning programs to eliminate graffiti from historic masonry properties may be assisted by the installation of physical barriers, security systems and lighting, as well as increased community involvement. Successful graffiti removal from historic masonry requires knowledge of a variety of cleaning methods and materials, and an awareness that what works to remove graffiti from one kind of masonry surface may not remove it from another. By testing different cleaning methods in advance, treatment plans will be available, when needed, to provide guidance for safe and sensitive graffiti removal from historic masonry.

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Development of a Treatment Plan.

For managers or owners of historic masonry buildings, or agencies responsible for large inventories of graffiti-prone properties, including parks, highway and railroad bridges and viaducts, bus, train and subway stations, and cemeteries, the development of a treatment plan may be the first step toward an effective graffiti-removal program. It is becoming increasingly common for large or important historic properties to have regular maintenance and disaster plans that include graffiti removal.

When feasible, a separate treatment plan should be prepared for each structure. However, if this is not possible, it is advisable to prepare a variety of treatment plans for specific masonry types. Plans should be prepared to cover all types of masonry that fall under one jurisdiction, management or ownership that are potential targets for graffiti.

Guidance contained in treatment plans should be based on the results of carefully controlled testing to remove a wide variety of common graffiti materials safely, and without damaging the various types of masonry. Individual treatment plans should address all parts of the building or structure that could be disfigured by graffiti, and any features too fragile to be cleaned by anyone other than a conservator should be noted on the plan.

A treatment plan is essentially a cleaning specification, but it should also include information on the following:

- the types and conditions of masonry likely to be targeted by graffiti;
- methods, materials and techniques known to work most successfully in the removal of specific types of graffiti from the surface of each type of masonry;
- sources for materials;
- a list of contractors with expertise in graffiti removal, including names, telephone numbers, information on emergency access to the property, and storage location of materials;
- graffiti-removal methods which may be harmful to the masonry surface;
- contractors or consultants who are **not acceptable** and should not be considered for graffiti removal;
- scaffolding, pumps, or safety equipment that might be required, where it is available, and costs involved; and
- health and safety concerns regarding specific removal treatments, product literature and Material Safety Data Sheets (MSDS).

Criteria to Consider Before Selecting a Barrier Coating as the Primary Protective Means of Combating Graffiti

What to look for in a Barrier Coating:

- Water-vapor permeable, or "breathable".
- "Invisible" without gloss or sheen, when applied to masonry.
- No change in appearance from uncoated areas when masonry is wet.
- Does not discolor or attract dirt.
- Weathers evenly.

Questions to Ask:

- Will the coating last long enough to offset its cost?
- Will the application and reapplication of the coating be cost effective?
- Will the coating be effective against more than one type of graffiti?
- Can the coating be completely and thoroughly removed, so that, if necessary, paint, or another coating will adhere to the masonry surface?
- Will the building ever need to be repointed or patched? A barrier coating may make this difficult or even impossible.

Before Application:

- Seek advice of an architectural conservator.
- Test coating on an inconspicuous area of masonry, or study the success/failure of the coating in other locations where it has been used.

Tips for Successful Graffiti Removal

- It is important to pre-wet the masonry surface when using an alkaline paint remover; it is also advisable to pre-wet the masonry surrounding a graffitied area to dilute the effect of any cleaning agents that might be inadvertently splashed or spilled on the unsoiled surface. **Do not wet the area to be cleaned if the cleaning agent is solvent-based or incompatible with water.**

- Always rinse the cleaning agent off the masonry surface starting at the bottom and moving up. This prevents the cleaning agent from running down and staining a lower surface.

- Air temperature can be a factor in graffiti removal. Most paint removers do not work when the air temperature is either very cold or very hot. This may sometimes explain why a method that worked in one instance may not be effective again in another, similar situation.

- Variations within the same type of stone, such as bedding planes, density, finish, or degree of weathering, may explain why some areas of the same stone sometimes clean better that others.

- Even if advance testing has been done and a treatment plan exists, at least some on-the-spot testing will probably be necessary.

- Mortar joints react differently from masonry units, and may require a different cleaning material and/or method to be cleaned effectively.
- Graffiti removal may result in an obviously "clean" spot. Always clean the entire masonry unit that is bounded by mortar joints (but not the joints themselves, unless necessary). The prominence of the clean spot may be minimized by fanning the cleaning out from the spot, and "feathering" it by gradually reducing the strength or thoroughness of the cleaning.
- If it is not possible to completely remove all traces of graffiti without removing some of the masonry surface, it may be preferable to leave the masonry alone. Some graffiti ghosts become less noticeable with time due to fading of the dyes used in paints and markers. Sometimes it may be possible to conceal more obvious graffiti ghosts with carefully-matched paint.
- After graffiti removal, the masonry surface should always be tested with Ph strips to make sure all the cleaning materials have been completely removed. Non-staining Ph strips, available from chemical supply companies, will indicate whether acids or alkalis remain on the masonry surface.
- Although alkaline paint removers are sometimes ineffective on modern formulations of aerosol paints, they can work well in removing multi-layered graffiti because they last longer.
- What removes graffiti in one instance may not always work again even in what appears to be an identical situation.
- More than one cleaning material and technique may be required to clean a heavily graffitied area if different materials were used to make the graffiti. For example, shapes are often outlined with broad-tipped felt markers and then filled in with spray paint.
- Effective graffiti removal often depends on trial-and-error testing, as well as a knowledge of masonry materials, graffiti materials and cleaning techniques.

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Washington, DC. October, 1995

Home page logo: Poultice to remove pig graffiti. Photo: NPS files.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), Heritage Preservation Services Division, National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

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PRESERVATION BRIEF #39
CONTROLLING UNWANTED MOISTURE IN HISTORIC BUILDINGS

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39 Preservation Briefs

Technical Preservation Services
National Park Service
U.S. Department of the Interior

Holding the Line
Controlling Unwanted Moisture in Historic Buildings

Sharon C. Park, AIA

A NOTE TO OUR USERS: The web versions of the **Preservation Briefs** differ somewhat from the printed versions. Many illustrations are new, captions are simplified, illustrations are typically in color rather than black and white, and some complex charts have been omitted.

Uncontrolled moisture is the most prevalent cause of deterioration in older and historic buildings. It leads to erosion, corrosion, rot, and ultimately the destruction of materials, finishes, and eventually structural components. Ever-present in our environment, moisture can be *controlled* to provide the differing *levels* of moisture necessary for human comfort as well as the longevity of historic building materials, furnishings, and museum collections. The challenge to building owners and preservation professionals alike is to understand the patterns of moisture movement in order to better manage it-not to try to eliminate it. There is never a single answer to a moisture problem. Diagnosis and treatment will always differ depending on where the building is located, climatic and soil conditions, ground water effects, and local traditions in building construction.

Remedial Actions within an Historic Preservation Context

In this Brief, advice about controlling the sources of unwanted moisture is provided within a preservation context based on philosophical principles contained in the *Secretary of the Interior's Standards for the Treatment of Historic Properties.* Following the Standards means significant materials and features that contribute to the historic character of the building should be preserved, not damaged during remedial treatment.

It also means that physical treatments should be reversible, whenever possible. The majority of

Applying a waterproof coating to an above-ground masonry wall can trap moisture underneath, causing further damage to the historic material. Photo: NPS files.

treatments for moisture management in this Brief stress preservation maintenance for materials, effective drainage of troublesome ground moisture, and improved interior ventilation.

The Brief encourages a systematic approach for evaluating moisture problems which, in some cases, can be undertaken by a building owner. Because the source of moisture can be elusive, it may be necessary to consult with historic preservation professionals prior to starting work that would affect historic materials. Architects, engineers, conservators, preservation contractors, and staff of State Historic Preservation Offices (SHPOs) can provide such advice. Regardless of who does the work, however, these are the principles that should guide treatment decisions:

- Avoid remedial treatments without prior careful diagnosis.
- Undertake treatments that protect the historical significance of the resource.
- Address issues of ground-related moisture and rain run-off thoroughly.
- Manage existing moisture conditions before introducing humidified/dehumidified mechanical systems.
- Implement a program of ongoing monitoring and maintenance once moisture is controlled or managed.
- Be aware of significant landscape and archeological resources in areas to be excavated.

Finally, mitigating the effects of catastrophic moisture, such as floods, requires a different approach and will not be addressed in this Brief.

How and Where to Look for Damaging Moisture

Finding, treating, and managing the sources of damaging moisture requires a systematic approach that takes time, patience, and a thorough examination of all aspects of the problem-including a series of variable conditions.Moisture problems may be a direct result of one of these factors or may be attributable to a combination of interdependent variables.

Factors Contributing to Moisture Problems

A variety of simultaneously existing conditions contribute to moisture problems in old buildings. For recurring moisture problems, it may be necessary for the owner or preservation professional to address many, if not all, of the following variables:

- Types of building materials and construction systems
- Type and condition of roof and site drainage systems and their rates of discharge
- Type of soil, moisture content, and surface /subsurface water flow adjacent to building
- Building usage and moisture generated by occupancy
- Condition and absorption rates of materials
- Type, operation, and condition of heating, ventilating, cooling, humidification/ dehumidification, and plumbing

systems
- Daily and seasonal changes in sun, prevailing winds, rain, temperature, and relative humidity (inside and outside), as well as seasonal or tidal variations in groundwater levels
- Unusual site conditions or irregularities of construction
- Conditions in affected wall cavities, temperature and relative humidity, and dewpoints
- Amount of air infiltration present in a building
- Adjacent landscape and planting materials

Debris will impede the normal flow of water from the roof's gutter and downspout system to the ground and result in moisture problems. Photo: NPS files.

Diagnosing and treating the cause of moisture problems requires looking at both the localized decay, as well as understanding the performance of the entire building and site. Moisture is notorious for traveling far from the source, and moisture movement within concealed areas of the building construction make accurate diagnosis of the source and path difficult. Obvious deficiencies, such as broken pipes, clogged gutters, or cracked walls that contribute to moisture damage, should always be corrected promptly. For more complicated problems, it may take several months or up to four seasons of monitoring and evaluation to complete a full diagnosis. Rushing to a solution without adequate documentation can often result in the unnecessary removal of historic materials-and worse-the creation of long-term problems associated with an increase, rather than a decrease, in the unwanted moisture.

Looking for Signs

Identifying the type of moisture damage and discovering its source or sources usually involves the human senses of sight, smell, hearing, touch, and taste combined with intuition. Some of the more common signs of visible as well as hidden moisture damage, include:

- Presence of standing water, mold, fungus, or mildew
- Wet stains, eroding surfaces, or efflorescence (salt deposits) on interior and exterior surfaces
- Flaking paint and plaster, peeling wallpaper, or moisture blisters on finished surfaces
- Dank, musty smells in areas of high humidity or poorly ventilated spaces
- Rust and corrosion stains on metal elements, such as anchorage systems and protruding roof nails in the attic
- Cupped, warped, cracked, or rotted wood
- Spalled, cracked masonry or eroded mortar joints
- Faulty roofs and gutters including missing roofing slates, tiles, or shingles and poor condition of flashing or gutters
- Condensation on window and wall surfaces
- Ice dams in gutters, on roofs, or moisture in attics

Uncovering and Analyzing Moisture Problems

Moisture comes from a variety of external sources. Most problems begin as a result of the weather in the form of rain or snow, from high ambient relative humidity, or from high water tables. But some of the most troublesome moisture damage in older buildings may be from internal sources, such as leaking plumbing pipes, components of heating, cooling, and climate control systems, as well as sources related to use or occupancy of the building. In some cases, moisture damage may be the result of poorly designed original details, such as projecting outriggers in rustic structures that are vulnerable to rotting, and may require special treatment. The five most common sources of unwanted moisture include:

- Above grade exterior moisture entering the building
- Below grade ground moisture entering the building
- Leaking plumbing pipes and mechanical equipment
- Interior moisture from household use and climate control systems
- Water used in maintenance and construction materials.

Above grade exterior moisture generally results from weather related moisture entering through deteriorating materials as a result of deferred maintenance, structural settlement cracks, or damage from high winds or storms. Such sources as faulty roofs, cracks in walls, and open joints around window and door openings can be corrected through either repair or limited replacement. Due to their age, historic buildings are notoriously "drafty," allowing rain, wind, and damp air to enter through missing mortar joints; around cracks in windows, doors, and wood siding; and into uninsulated attics. In some cases, excessively absorbent materials, such as soft sandstone, become saturated from rain or gutter overflows, and can allow moisture to dampen interior surfaces. Vines or other vegetative materials allowed to grow directly on building materials without trellis or other framework can cause damage from roots eroding mortar joints and foundations as well as dampness being held against surfaces. In most cases, keeping vegetation off buildings, repairing damaged materials, replacing flashings, rehanging gutters, repairing downspouts, repointing mortar, caulking perimeter joints around windows and doors, and repainting surfaces can alleviate most sources of unwanted exterior moisture from entering a building above grade.


Damp interior plaster around windows generally indicates moisture has entered from the outside. Photo: NPS files.

Below grade ground moisture is a major source of unwanted moisture for historic and older buildings. *Proper handling of surface rain run-off is one of the most important measures of controlling unwanted ground moisture.* Rain water is often referred to as "bulk moisture" in areas that receive significant annual rainfalls or infrequent, but heavy, precipitation. For example, a heavy rain of 2" per hour can produce 200 gallons of water from downspout discharge alone for a house during a one hour period. When soil is saturated at the base of the building, the moisture will wet footings and crawl spaces or find its way through cracks in foundation walls and enter into basements. Moisture in saturated basement or foundation walls-also exacerbated by high water tables-will generally rise up within a wall and eventually cause deterioration of the masonry and adjacent wooden structural elements.

Builders traditionally left a working area, known as a builder's trench, around the exterior of a foundation wall. These trenches have been known to increase moisture problems if the infill soil is less than fully compacted or includes rubble backfill, which, in some cases, may act as a reservoir holding damp materials against masonry walls.

A clogged or broken downspout causes the water to pour directly into the ground. NPS files. Photo: NPS files.

Broken subsurface pipes or downspout drainage can leak into the builder's trench and dampen walls some distance from the source. Any subsurface penetration of the foundation wall for sewer, water, or other piping also can act as a direct conduit of ground moisture unless these holes are well sealed. A frequently unsuspected, but serious, modern source of ground moisture is a landscape irrigation system set too close to the building. Incorrect placement of sprinkler heads can add a tremendous amount of moisture at the foundation level and on wall surfaces.

The ground, and subsequently the building, will stay much drier by 1) re-directing rain water away from the foundation through sloping grades, 2) capturing and disposing downspout water well away from the building, 3) developing a controlled ground gutter or effective drainage for buildings historically without gutters and downspouts, and 4) reducing splash-back of moisture onto foundation walls. The excavation of foundations and the use of dampproof coatings and footing drains should only be used after the measures of reducing ground moisture listed above have been implemented.

Leaking plumbing pipes and mechanical equipment can cause immediate or long-term damage to historic building interiors. Routine maintenance, repair, or, if necessary, replacement of older plumbing and mechanical equipment are common solutions. Older water and sewer pipes are subject to corrosion over time. Slow leaks at plumbing joints hidden within walls and ceilings can ultimately rot floor boards, stain ceiling plaster, and lead to decay of structural members. Frozen pipes that crack can damage interior finishes. In addition to leaking plumbing pipes, old radiators in some historic buildings have been replaced with water-supplied fan coil units which tend to leak. These heating and cooling units, as well as central air equipment, have overflow and condensation pans that require cyclical maintenance to avoid mold and mildew growth and corrosion blockage of drainage channels. Uninsulated forced-air sheet metal ductwork and cold water pipes in walls and ceilings often allow condensation to form on the cold metal, which then drips and causes bubbling plaster and peeling paint. Careful design and vigilant maintenance, as well as repair and insulating pipes or ductwork, will generally rid the building of these common sources of moisture.

Interior moisture from building use and modern humidified heating and cooling systems can create serious problems. In northern U.S. climates, heated buildings will have winter-time relative humidity levels ranging from 10%-35% Relative Humidity (RH). A house with four occupants generates between 10 and 16 pounds of water a day (approximately 1 ½- 2 gallons) from human residents. Moisture from food preparation, showering, or laundry use will produce condensation on windows in winter climates. When one area or floor of a building is air-conditioned and another area is not, there is the chance for condensation to occur between the two areas. Most periodic condensation does not create a long-term problem.

Humidified climate control systems are generally a major problem in museums housed within historic buildings. They produce between 35%-55% RH on average which, as a vapor, will seek to dissipate and equalize with adjacent spaces. Moisture can form on single-glazed windows in winter with exterior temperatures below 30° F and interior temperatures at 70°F with as little as 35%

If adequate ventilation is installed,

RH. Frequent condensation on interior window surfaces is an indication that moisture is migrating into exterior walls, which can cause long-term damage to historic materials. Materials and wall systems around climate controlled areas may need to be made of moisture resistant finishes in order to handle the additional moisture in the air. Moist interior conditions in hot and humid climates will generate mold and fungal growth. Unvented mechanical equipment, such as gas stoves, driers, and kerosene heaters, generate large quantities of moisture. It is important to provide adequate ventilation and find a balance between interior temperature, relative humidity, and airflow to avoid interior moisture that can damage historic buildings.

damage to interior walls such as this can be prevented. NPS files.Photo: NPS files.

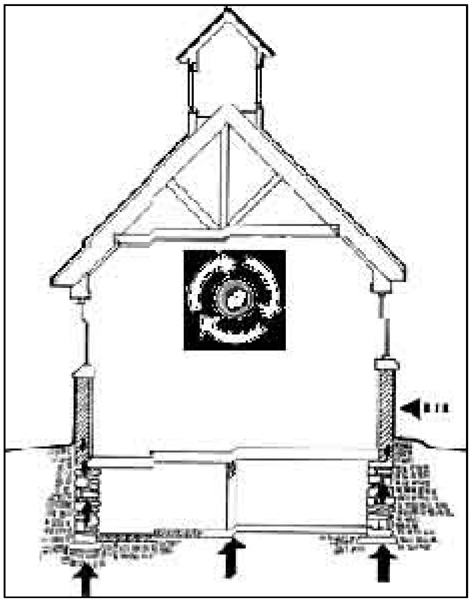
Moisture from maintenance and construction materials can cause damage to adjacent historic materials. Careless use of liquids to wash floors can lead to water seepage through cracks and dislodge adhesives or cup and curl materials. High-pressure power washing of exterior walls and roofing materials can force water into construction joints where it can dislodge mortar, lift roofing tiles, and saturate frame walls and masonry. Replastered or newly plastered interior walls or the construction of new additions attached to historic buildings may hold moisture for months; new plaster, mortar, or concrete should be fully cured before they are painted or finished. The use of materials in projects that have been damaged by moisture *prior* to installation or have too high a moisture content may cause concealed damage.

Transport or Movement of Moisture

Knowing the five most common sources of moisture that cause damage to building materials is the first step in diagnosing moisture problems. But it is also important to understand the basic mechanisms that affect moisture movement in buildings. Moisture transport, or movement, occurs in two states: liquid and vapor. It is directly related to pressure differentials. For example, water in a gaseous or vapor state, as warm moist air, will move from its high pressure area to a lower pressure area where the air is cooler and drier. Liquid water will move as a result of differences in hydrostatic pressure or wind pressure. *It is the pressure differentials that drive the rate of moisture migration in either state.* Because the building materials themselves resist this moisture movement, the rate of movement will depend on two factors: the permeability of the materials when affected by vapor and the absorption rates of materials in contact with liquid.

The mechanics, or physics, of moisture movement is complex, but if the driving force is difference in pressure, then an approach to reducing moisture movement and its damage is to reduce the difference in pressure, not to increase it. That is why the treatments discussed in this Brief will look at *managing moisture by draining bulk moisture and ventilating vapor moisture* before setting up new barriers with impermeable coatings or over-pressurized new climate control systems that threaten aging building materials and archaic construction systems.

Three forms of moisture transport are particularly important to understand in regards to historic buildings-*infiltration, capillary action, and vapor diffusion*--remembering, at the same time, that the subject is infinitely complex and, thus, one of



The dynamic forces that move air and moistue through a building are important to understand, particularly when selecting a treatment to correct a moisture problem. This drawing shows how moisture can invade "inward" from the exterior; "upward" from the ground; and be generated from "within" the interior. All have damaging effects. Drawing: NPS files.

continuing scientific study. Buildings were traditionally designed to deal with the movement of air. For example, cupolas and roof lanterns allowed hot air to rise and provided a natural draft to pull air through buildings. Cavity walls in both frame and masonry buildings were constructed to allow moisture to dissipate in the air space between external and internal walls. Radiators were placed in front of windows to keep cold surfaces warm, thereby reducing condensation on these surfaces. Many of these features, however, have been altered over time in an effort to modernize appearances, improve energy efficiency, or accommodate changes in use. The change in use will also affect moisture movement, particularly in commercial and industrial buildings with modern mechanical systems. Therefore, the way a building handles air and moisture today may be different from that intended by the original builder or architect, and poorly conceived changes may be partially responsible for chronic moisture conditions.

Moisture moves into and through materials as both a visible liquid (capillary action) and as a gaseous vapor (infiltration and vapor diffusion). Moisture from leaks, saturation, rising damp, and condensation can lead to the deterioration of materials and cause an unhealthy environment. Moisture in its solid form, ice, can also cause damage from frozen, cracked water pipes, or split gutter seams or spalled masonry from freeze-thaw action. Moisture from melting ice dams, leaks, and condensation often can travel great distances down walls and along construction surfaces, pipes, or conduits. The amount of moisture and how it deteriorates materials is dependent upon complex forces and variables that must be considered for each situation.

Determining the way moisture is handled by the building is further complicated because each building and site is unique. Water damage from blocked gutters and downspouts can saturate materials on the outside, and high levels of interior moisture can saturate interior materials. Difficult cases may call for technical evaluation by consultants specializing in moisture monitoring and diagnostic evaluation. In other words, it may take a team to effectively evaluate a situation and determine a proper approach to controlling moisture damage in old buildings.

Infiltration is created by wind, temperature gradients (hot air rising), ventilation fan action, and the stack or chimney effect that draws air up into tall vertical spaces. Infiltration as a dynamic force does not actually move liquid water, but is the vehicle by which dampness, as a component of air, finds its way into building materials. Older buildings have a natural air exchange, generally from 1 to 4 changes per hour, which, in turn, may help control moisture by diluting moisture within a building. The tighter the building construction, however, the lower will be the infiltration rate and the natural circulation of air. In the process of infiltration, however, moisture that has entered the building and saturated materials can be drawn in and out of materials, thereby adding to the dampness in the air. Inadequate air circulation where there is excessive moisture (i.e., in a damp basement), accelerates the deterioration of historic materials. To reduce the unwanted moisture that accompanies infiltration, it is best to incorporate maintenance and repair treatments to close joints and weatherstrip windows, while providing controlled air exchanges elsewhere. The worst approach is to seal the building so completely, while limiting fresh air intake, that the building cannot breathe.

Capillary action occurs when moisture in saturated porous building materials, such as masonry, wicks up or travels vertically as it evaporates to the surface. In capillary attraction, liquid in the material is attracted to the solid surface of the pore structure causing it to rise vertically; thus, it is often called "rising damp," particularly when found in conjunction with ground moisture. It should not, however, be confused with moisture that laterally penetrates a foundation wall through cracks and settles in the basement. Not easily controlled, most rising damp comes from high water tables or a constant source under the footing. In cases of damp masonry walls with capillary action, there is usually a whitish stain or horizontal tide mark of efflorescence that seasonally fluctuates about 1- 3 feet above grade where the excess moisture evaporates from the wall. This tide mark is full of salt crystals, that have been drawn from the ground and building materials along with the water, making the masonry even more sensitive to additional moisture absorption from the surrounding air. Capillary migration of moisture may occur in any material with a pore structure where there is a constant or recurring source of moisture. The best approach for dealing with capillary rise in building materials is to reduce the amount of water in contact with historic materials. If that is not possible due to chronically high water tables, it may be necessary to introduce a horizontal damp-proof barrier, such as slate course or a lead or plastic sheet, to stop the vertical rise of moisture. Moisture should not be sealed into the wall with a waterproof coating, such as cement parging or vinyl wall coverings, applied to the inside of damp walls. This will only increase the pressure differential as a vertical barrier and force the capillary action, and its destruction of materials, higher up the wall.

Vapor diffusion is the natural movement of pressurized moisture vapor through porous materials. It is most readily apparent as humidified interior air moves out through walls to a cooler exterior. In a hot and humid climate, the reverse will happen as moist hot air moves into cooler, dryer, air-conditioned, interiors. The movement of the moisture vapor is not a serious problem until the dewpoint temperature is reached and the vapor changes into liquid moisture known as *condensation*. This can occur within a wall or on interior surfaces. Vapor diffusion will be more of a problem for a frame structure with several layers of infill materials within the frame cavity than a dense masonry structure. Condensation as a result of vapor migration usually takes place on a surface or film, such as paint, where there is a change in permeability.

The installation of climate control systems in historic buildings (mostly museums) that have *not* been properly designed or regulated and that force pressurized damp air to diffuse into perimeter walls is an ongoing concern. These newer systems take constant monitoring and back-up warning systems to avoid moisture damage.

Long-term and undetected condensation or high moisture content can cause serious structural damage as well as an unhealthy environment, heavy with mold and mildew spores. Reducing the interior/exterior pressure differential and the difference between interior and exterior temperature and relative humidity helps control unwanted vapor diffusion. This can sometimes be achieved by reducing interior relative humidity. In some instances, using vapor barriers, such as heavy plastic sheeting laid over damp crawl spaces, can have remarkable success in stopping vapor diffusion from damp ground into buildings. Yet, knowledgeable experts in the field differ regarding the appropriateness of vapor barriers and when and where to use them, as well as the best way to handle natural diffusion in insulated walls.

Adding insulation to historic buildings, particularly in walls of wooden frame structures, has been a standard modern weatherization treatment, but it can have a disastrous effect on historic buildings. The process of installing the insulation destroys historic siding or plaster, and it is very difficult to establish a tight vapor barrier. While insulation has the benefit of increasing the efficiency of heating and cooling by containing temperature controlled air, it does not eliminate surfaces on which damaging moisture can condense. For insulated residential frame structures, the most obvious sign of a moisture diffusion problem is peeling paint on wooden siding, even after careful surface preparation and repainting. Vapor impermeable barriers such as plastic sheeting, or more accurately, *vapor retarders*, in cold and moderate climates generally help slow vapor diffusion where it is not wanted.

In regions where *humidified* climate control systems are installed into insulated frame buildings, it is important to stop *interstitial,* or in-wall, dewpoint condensation. This is very difficult because humidified air can penetrate breaches in the vapor barrier, particularly around electrical outlets. Improperly or incompletely installed retrofit vapor barriers will cause extensive damage to the building, just in the installation process, and will allow trapped condensation to wet the insulation and sheathing boards, corrode metal elements such as wiring cables and metal anchors, and blister paint finishes. Providing a tight wall vapor barrier, as well as a ventilated cavity behind wooden clapboards or siding appears to help insulated frame walls, if the interior relative humidity can be adjusted or monitored to avoid condensation. Correct placement of vapor retarders within building construction will vary by region, building construction, and type of climate control system.

Surveying and Diagnosing Moisture Damage: Key Questions to Ask

It is important for the building to be surveyed first and the evidence and location of suspected moisture damage systematically recorded before undertaking any major work to correct the problem. This will give a baseline from which relative changes in condition can be noted.

When materials become wet, there are specific physical changes that can be detected and noted in a record book or on survey sheets. Every time there is a heavy rain, snow storm, water in the basement, or mechanical systems failure, the owner or consultant should note and record the way moisture is moving, its appearance, and what variables might contribute to the cause. *Standing outside to observe a building in the rain may answer many questions and help trace the movement of water into the building.* Evidence of deteriorating materials that cover more serious moisture damage should also be noted, even if it is not immediately clear what is causing the damage. (For example, water stains on the ceiling may be from leaking pipes, blocked fan coil drainage pans above, or from moisture which has penetrated around a poorly sloped window sill above.) Don't jump to conclusions, but use a systematic approach to help establish an educated theory-or hypothesis-of what is causing the moisture problem or what areas need further investigation.

Surveying moisture damage must be systematic so that relative changes can be noted. Tools for investigating can be as simple as a notebook, sketch plans, binoculars, camera, aluminum foil, smoke pencil, and flashlight. The systematic approach involves looking at buildings from the top down and from the outside to the inside. Photographs, floor plans, site plan, and exterior elevations-even roughly sketched-should be used to indicate all evidence of damp or damaged materials, with notations for musty or poorly ventilated areas. Information might be needed on the absorption and permeability characteristics of the building materials and soils. Exterior drainage patterns should be noted and these base plans referred to on a regular basis in different seasons and in differing types of weather. It is best to start with one method of periodic documentation and to use this same method each time. Because moisture is affected by gravity, many surveys start with the roof and guttering systems and work down through the exterior walls. Any obvious areas of water penetration, damaged surfaces, or staining should be noted. Any recurring damp or stain patterns, both exterior and interior, should also be noted with a commentary on the temperature, weather, and any other facts that may be relevant (driving rains, saturated soil, high interior humidity, recent washing of the building, presence of a lawn watering system, etc.).

The interior should be recorded as well, beginning with the attic and working down to the basement and crawl space. It may be necessary to remove damaged materials selectively in order to trace the path of moisture or to pinpoint a source, such as a leaking pipe in the ceiling. The use of a basic resistance moisture meter, available in many hardware stores, can identify moisture contents of materials and show, over time, if wall surfaces are drying or becoming damper. A smoke pencil can chart air infiltration around windows or draft patterns in interior spaces. For a quick test to determine if a damp basement is caused by saturated walls or is a result of condensation, tape a piece of foil onto a masonry surface and check it after a day or two; if moisture has developed behind the foil, then it is coming from the masonry. If condensation is on the surface of the foil, then moisture is from the air.

Comparing current conditions with previous conditions, historic drawings, photographs, or known alterations may also assist in the final diagnosis. A chronological record, showing improvement or deterioration, should be backed up with photographs or notations as to the changing size, condition, or features of the deterioration and how these changes have been affected by variables of temperature and rainfall. If a condition can be related in time to a particular event, such as efflorescence developing on a chimney after the building is no longer heated, it may be possible to isolate a cause, develop a hypothesis, and then test the hypothesis (by adding some temporary heat), before applying a remedial treatment. If the owner or consultant has access to moisture survey and monitoring equipment such as resistance moisture meters, dewpoint indicators, salt detectors, infrared thermography systems, psychrometer, fiber-optic boroscopes, and miniaturized video cameras, additional quantified data can be incorporated into the survey. If it is necessary to track the wetting and drying of walls over a period of time, deep probes set into walls and in the soil with connector cables to computerized data loggers or the use of long-term recording of hygrothermographs may require a trained specialist. Miniaturized fiber-optic video cameras can record the condition of subsurface drain lines without excavation. It should be noted, however, that *instrumentation, while extremely useful, cannot take the place of careful personal observation and analysis.* Relying on instrumentation alone rarely will give the owner the information needed to fully diagnose a moisture problem. To avoid jumping to a quick-potentially erroneous-conclusion, a series of questions should be asked first. This will help establish a theory or hypothesis that can be tested to increase the chances that a remedial treatment will control or manage existing moisture.

How is water draining around building and site? What is the effectiveness of gutters and downspouts? Are the slopes or grading around foundations adequate? What are the locations of subsurface features such as wells, cisterns, or drainage fields? Are there subsurface drainage pipes (or drainage boots) attached to the downspouts and are they in good working condition? Does the soil retain moisture or allow it to drain freely? Where is the water table? Are there window wells holding rain water? What is the flow rate of area drains around the site (can be tested with a hose for several minutes)? Is the storm piping out to the street sufficient for heavy rains, or does water chronically back up on the site? Has adjacent new construction affected site drainage or water table levels?

How does water/moisture appear to be entering the building? Have all five primary sources of moisture been evaluated? What is the condition of construction materials and are there any obvious areas of deterioration? Did this building have a builder's trench around the foundation that could be holding water against the exterior walls? Are the interior bearing walls as well as the exterior walls showing evidence of rising damp? Is there evidence of hydrostatic pressure under the basement floor such as water percolating up through cracks? Has there been moisture damage from an ice dam in the last several months? Is damage localized, on one side of the building only, or over a large area?

What are the principal moisture dynamics? Is the moisture condition from liquid or vapor sources? Is the attic moisture a result of vapor diffusion as damp air comes up through the cavity walls from the crawl space or is it from a leaking roof? Is the exterior wall moisture from rising damp with a tide mark or are there uneven spots of dampness from foundation splash back, or other ground moisture conditions? Is there adequate air exchange in the building, particularly in damp areas, such as the basement? Has the height of the water table been established by inserting a long pipe into the ground in order to record the water levels?

How is the interior climate handling moisture? Are there areas in the building that do not appear to be ventilating well and where mold is growing? Are there historic features that once helped the building control air and moisture that can be reactivated, such as operable skylights or windows? Could dewpoint condensation be occurring behind surfaces, since there is often condensation on the windows? Does the building feel unusually damp or smell in an unusual way that suggest the need for further study? Is there evidence of termites, carpenter ants, or other pests attracted to moist conditions? Is a dehumidifier keeping the air dry or is it, in fact, creating a cycle where it is actually drawing moisture through the foundation wall?

Does the moisture problem appear to be intermittent, chronic, or tied to specific events? Are damp conditions occurring within two hours of a heavy rain or is there a delayed reaction? Does rust on most nail heads in the attic indicate a condensation problem? What are the wet patterns that appear on a building wall during and after a rain storm? Is it localized or in large areas? Can these rain patterns be tied to gutter over-flows, faulty flashing, or saturation of absorbent materials? Is a repaired area holding up well over time or is there evidence that moisture is returning? Do moisture meter readings of wall cavities indicate they are wet, suggesting leaks or condensation in the wall?

The owner used long black extender pipes to test a theory that it was faulty roof drainage causing the problem. Photo: NPS files.

Once a hypothesis of the source or sources of the moisture has been developed from observation and recording of data, it is often useful to prove or disprove this hypothesis with interim treatments, and, if necessary, the additional use of instrumentation to verify conditions. For damp basements, test solutions can help determine the cause. For example, surface moisture in low spots should be redirected away from the foundation wall with regrading to determine if basement dampness improves. If there is still a problem, determine if subsurface downspout collection pipes or cast iron boots are not functioning properly. The above grade downspouts can be disconnected and attached to long, flexible extender pipes and redirected away from the foundation. If, after a heavy rain or a simulation using a hose, there is no improvement, look for additional ground moisture sources such as high water tables, hidden cisterns, or leaking water service lines as a cause of moisture in the basement. New data will lead to a new hypothesis that should be tested and verified. *The process of elimination can be frustrating, but is required if a systematic method of diagnosis is to be successful.*

Selecting an Appropriate Level of Treatment

The treatments that follow this section in chart format are divided into levels based on the degree of moisture problems. Level I covers preservation maintenance; Level II focuses on repair using historically compatible materials and essentially mitigating damaging moisture conditions; and Level III discusses replacement and alteration of materials that permit continued use in a chronically moist environment. It is important to begin with Level I and work through to a manageable treatment as part of the control of moisture problems. Buildings in serious decay will require treatments in Level II, and difficult or unusual site conditions may require more aggressive treatments in Level III. Caution should always be exercised when selecting a treatment. The treatments listed are a guide and not intended to be recommendations for specific projects as the key is always proper diagnosis.

Start with the repair of any obvious deficiencies using sound preservation maintenance. If moisture cannot be managed by maintenance alone, it is important to reduce it by mitigating problems *before* deteriorated historic materials are replaced. Treatments should not remove materials that can be preserved; should not involve extensive excavation unless there is a documented need; and should not include coating buildings with waterproof sealers that can exacerbate an existing problem. Some alteration to historic materials, structural systems, mechanical systems, windows, or finishes may be needed when excessive site moisture cannot be controlled by drainage systems, or in areas prone to floods. These changes, however, should, be sensitive to preserving those materials, features, and finishes that convey the historic character of the building and site.

Level I Preservation Maintenance

Exterior: Apply cyclical maintenance procedures to eliminate rain and moisture infiltration.


Installing ventilating fans can improve damp conditions or reduce cooling loads. Photo: NPS files.

Roofing/ guttering: Make weather-tight and operational; inspect and clean gutters as necessary depending on number of nearby trees, but at least twice a year; inspect roofing at least once a year, preferably spring; replace missing or damaged roofing shingles, slates, or tiles; repair flashing; repair or replace cracked downspouts.

Walls: Repair damaged surface materials; repoint masonry with appropriately formulated mortar; prime and repaint wooden, metal, or masonry elements or surfaces; remove efflorescence from masonry with non-metallic bristle brushes.

Window and door openings: Eliminate cracks or open joints; caulk or repoint around openings or steps; repair or reset weatherstripping; check flashing; repaint, as necessary.

Ground: Apply regular maintenance procedures to eliminate standing water and vegetative threats to building/site.

Grade: Eliminate low spots around building foundations; clean out existing downspout boots twice a year or add extension to leaders to carry moisture away from foundation; do a hose test to verify that surface drains are functioning; reduce moisture used to clean steps and walks; eliminate the use of chlorides to melt ice which can increase freeze/thaw spalling of masonry; check operation of irrigation systems, hose bib leaks, and clearance of air conditioning condensate drain outlets.

Crawl space: Check crawl space for animal infestation, termites, ponding moisture, or high moisture content; check foundation grilles for adequate ventilation; seasonally close grilles when appropriate-in winter, if not needed, or in summer if hot humid air is diffusing into air conditioned space.

Foliage: Keep foliage and vines off buildings; trim overhanging trees to keep debris from gutters and limbs from rubbing against building; remove moisture retaining elements, such as firewood, from foundations.

A vent may be added if there is none. Close grilles in the summer, if hot humid air is getting into air conditioned spaces. Photo: NPS files.

Basements and foundations: Increase ventilation and maintain surfaces to avoid moisture.

Equipment: Check dehumidifiers, sump pump, vent fans, and water detection or alarm systems for proper maintenance as required; check battery back-up twice a year.

Piping/ductwork: Check for condensation on pipes and insulate/seal joints, if necessary.

Interior: Maintain equipment to reduce leaks and interior moisture.

Plumbing pipes: Add insulation to plumbing or radiator pipes located in areas subject to freezing, such as along outside walls, in attics, or in unheated basements.

Mechanical equipment: Check condensation pans and drain lines to keep clear; insulate and seal joints in exposed metal ductwork to avoid drawing in moist air.

Cleaning: Routinely dust and clean surfaces to reduce the amount of water or moist chemicals used to clean building; caulk around tile floor and wall connections; and maintain floor grouts in good condition.

Ventilation: Reduce household-produced moisture, if a problem, by increasing ventilation; vent clothes driers to the outside; install and always use exhaust fans in restrooms, bathrooms, showers, and kitchens, when in use.

Level II Repair and Corrective Action

Exterior: Repair features that have been damaged. Replace an extensively deteriorated feature with a new feature that matches in design, color, texture, and where possible, materials.

Roofing: Repair roofing, parapets and overhangs that have allowed moisture to enter; add ice and water shield membrane to lower 3-4 feet or roofing in cold climates to limit damage from ice dams; increase attic ventilation, if heat and humidity build-up is a problem. Make gutters slope @ 1/8" to the foot. Use professional handbooks to size gutters and reposition, if necessary and appropriate to historic architecture. Add ventilated chimney caps to unused chimneys that collect rain water.

New drainage systems for roof run-off may be installed in order to remove

Walls: Repair spalled masonry, terra cotta, etc. by selectively installing new masonry units to match; replace rotted clapboards too close to grade and adjust grade or clapboards to achieve adequate clearance; protect or cover open window wells.

moisture from the base of the building. Photo: NPS files.

Ground: Correct serious ground water problems; capture and dispose of downspout water away from foundation; and control vapor diffusion of crawlspace moisture.

Grade: Re-establish positive sloping of grade; try to obtain 6" of fall in the first 10' surrounding building foundation; for buildings without gutter systems, regrade and install a positive subsurface collection system with gravel, or waterproof sheeting and perimeter drains; adjust pitch or slope of eave line grade drains or French drains to reduce splash back onto foundation walls; add subsurface drainage boots or extension pipes to take existing downspout water away from building foundation to the greatest extent feasible.

Crawl space: Add polyethylene vapor barrier (heavy construction grade or Mylar) to exposed dirt in crawlspace if monitoring indicates it is needed and there is no rising damp; add ventilation grilles for additional cross ventilation, if determined advisable.

Foundations and Basements: Correct existing high moisture levels, if other means of controlling ground moisture are inadequate.

Mechanical devices: Add interior perimeter drains and sump pump; add dehumidifiers for seasonal control of humidity in confined, unventilated space (but don't create a problem with pulling dampness out of walls); add ventilator fans to improve air flow, but don't use both the dehumidifier and ventilator fan at the same time.

Walls: Remove commentates coatings, if holding rising damp in walls; coat walls with vapor permeable lime based rendering plaster, if damp walls need a sacrificial coating to protect mortar from erosion; add termite shields, if evidence of termites and dampness cannot be controlled.

Framing: *Reinforce existing floor framing weakened by moisture by adding lolly column support and reinforcing joist ends with sistered or parallel supports. Add a vapor impermeable shield, preferably non-ferrous metal, under wood joists coming into contact with moist masonry.*

Interior: Eliminate areas where moisture is leaking or causing a problem

Plumbing*: Replace older pipes and fixtures subject to leaking or overflowing; insulate water pipes subject to condensation.*

Ventilation*: Add exhaust fans and whole house fans to increase air flow through buildings, if areas are damp or need more ventilation to control mold and mildew.*

Climate*: Adjust temperature and relative humidity to manage interior humidity; Correct areas of improperly balanced pressure for HVAC systems that may be causing a moisture problem.*

Level III Replacement / Alterations For Chronically Damp Conditions

Exterior: Undertake exterior rehabilitation work that follows professional repair practices-i.e., replace a deteriorated feature with a new feature to match the existing in design, color, texture, and when possible, materials. In some limited situations, non-historic materials may be necessary in unusually wet areas

Roofs: Add ventilator fans to exhaust roofs but avoid large projecting features whose designs might negatively affect the appearance of the historic roof. When replacing roofs, correct conditions that have caused moisture problems, but keep the overall appearance of the roof; for example, ventilate under wooden shingles, or detail standing seams to avoid buckling and cracking. Be attentive to provide extra protection for internal or built-in gutters by using the best quality materials, flashing, and vapor impermeable connection details.

Walls: If insulation and vapor barriers are added to frame walls, consider maintaining a ventilation channel behind the exterior cladding to avoid peeling and blistering paint occurrences.

Windows: Consider removable exterior storm windows, but allow operation of windows for periodic ventilation of cavity between exterior storm and historic sash. For stained glass windows using protective glazing, use only ventilated storms to avoid condensation as well as heat build-up.

Ground: Control excessive ground moisture. This may require extensive excavations, new drainage systems, and the use of substitute materials. These may include concrete or new sustainable recycled materials for wood in damp areas when they do not impact the historic appearance of the building.

Grade: Excavate and install water collection systems to assist with positive run-off of low lying or difficult areas of moisture drainage; use drainage mats and under finished grade to improve run-off control; consider the use of column plinth blocks or bases that are ventilated or constructed of non-absorbent substitute materials in chronically damp areas. Replace improperly sloped walks; repair non-functioning catch basins and site drains; repair settled areas around steps and other features at grade.

Foundations: Improve performance of foundation walls with damp-proof treatments to stop infiltration or damp course layers to stop rising damp. Some substitute materials may need to be selectively integrated into new features.

Walls: excavate, repoint masonry walls, add footing drains, and waterproof exterior subsurface walls; replace wood sill plates and deteriorated structural foundations with new materials, such as pressure treated wood, to withstand chronic moisture conditions; materials may change, but overall appearance should remain similar. Add dampcourse layer to stop rising damp; avoid chemical injections as these are rarely totally effective, are not reversible, and are often visually intrusive.

Interior: Control the amount of moisture and condensation on the interiors of historic buildings. Most designs for new HVAC systems will be undertaken by mechanical engineers, but systems should be selected that are appropriate to the resource and intended use.

Windows, skylights: Add double and triple glazing, where necessary to control condensation. Avoid new metal sashes or use thermal breaks where prone to heavy condensation.

Mechanical systems: Design new systems to reduce stress on building exterior. This might require insulating and tightening up the building exterior, but provisions must be made for adequate air flow. A new zoned system, with appropriate transition insulation, may be effective in areas with differing climatic needs.

Control devices/Interior spaces: If new climate control systems are added, design back-up controls and monitoring systems to protect from interior moisture damage.

Walls: If partition walls sit on floors that periodically flood, consider spacers or isolation membranes behind baseboards to stop moisture from wicking up through absorbent materials.

Ongoing Care

Once the building has been repaired and the larger moisture issues addressed, it is important to keep a record of additional evidence of moisture problems and *to protect the historic or old building through proper cyclical maintenance*. In some cases, particularly in museum environments, it is critical to monitor areas vulnerable to moisture damage. In a number of historic buildings, in-wall moisture monitors are used to ensure that the moisture purposely generated to keep relative humidity at ranges appropriate to a museum collection does not migrate into walls and cause deterioration. The potential problem with all systems is the failure of controls, valves, and panels over time. Back-up systems, warning devices, properly trained staff and an emergency plan will help control damage if there is a system failure.

Ongoing maintenance and vigilance to situations that could potentially cause moisture damage must become a routine part of the everyday life of a building. The owner or staff responsible for the upkeep of the building should inspect the property weekly and note any leaks, mustiness, or blocked drains. Again, observing the building during a rain will test whether ground and gutter drainage are working well.

For some buildings a back-up power system may be necessary to keep sump pumps working during storms when electrical power may be lost. For mechanical equipment rooms, condensation pans, basement floors, and laundry areas where early detection of water is important, there are alarms that sound when their sensors come into contact with moisture.

Conclusion

Moisture in old and historic buildings, though difficult to evaluate, can be systematically studied and the appropriate protective measures taken. Much of the documentation and evaluation is based on common sense combined with an understanding of historic building materials, construction technology, and the basics of moisture and air movement. Variables can be evaluated step by step and situations creating direct or secondary moisture damage can generally be corrected. The majority of moisture problems can be mitigated with maintenance, repair, control of ground and roof moisture, and improved ventilation. For more complex situations, however, a thorough diagnosis and an understanding of how the building handles moisture *at present*, can lead to a treatment that solves the problem without damaging the historic resource.

It is usually advantageous to eliminate one potential source of moisture at a time. Simultaneous treatments may set up a new dynamic in the building with its own set of moisture problems. Implementing changes sequentially will allow the owner or preservation professional to track the success of each treatment.

Moisture problems can be intimidating to a building owner who has diligently tried to control them. Keeping a record of evidence of moisture damage, results of diagnostic tests, and remedial treatments, is beneficial to a building's long-term care. The more complete a survey and evaluation, the greater the success in controlling unwanted moisture now and in the future.

Holding the line on unwanted moisture in buildings will be successful if 1) there is constant concern for signs of problems and 2) there is ongoing physical care provided by those who understand the building, site, mechanical systems, and the previous efforts to deal with moisture. For properties with major or difficult-to-diagnose problems, a team approach is often most effective. The owner working with properly trained contractors and consultants can monitor, select, and implement treatments within a preservation context in order to manage moisture and to protect the historic resource.

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Glossary

Air flow/ infiltration: The movement that carries moist air into and through materials. Air flow depends on the difference between indoor and outdoor pressures, wind speed and direction as well as the permeability of materials.

Bulk water: The large quantity of moisture from roof and ground run-off that can enter into a building either above grade or below grade.

Capillary action: The force that moves moisture through the pore structure of materials. Generally referred to as rising damp, moisture at or below the foundation level will rise vertically in a wall to a height at which the rate of evaporation balances the rate at which it can be drawn up by capillary forces.

Condensation: The physical process by which water vapor is transformed into a liquid when the relative humidity of the air reaches 100% and the excess water vapor forms, generally as droplets, on the colder adjacent surface.

Convection: Heat transfer through the atmosphere by a difference in force or air pressure is one type of air transport. Sometimes referred to as the "stack effect," hotter less dense air will rise, colder dense air will fall creating movement of air within a building.

Dewpoint: The temperature at which water vapor condenses when the air is cooled at a constant pressure and constant moisture content.

Diffusion: The movement of water vapor through a material. Diffusion depends on vapor pressure, temperature, relative humidity, and the permeability of a material.

Evaporation: The transformation of liquid into a vapor, generally as a result of rise of temperature, is the opposite of condensation. Moisture in damp soil, such as in a crawl space, can evaporate into the air, raise the relative humidity in that space, and enter the building as a vapor.

Ground moisture: The saturated moisture in the ground as a result of surface run-off and naturally occuring water tables. Ground moisture can penetrate through cracks and holes in foundation walls or can migrate up from moisture under the foundation base.

Monitoring instrumentation: These devices are generally used for long term diagnostic analysis of a problem, or to measure the performance of a treatment, or to measure changes of conditions or environment. In-wall probes or sensors are often attached to data-loggers which can be down-loaded into computers.

Permeability: A characteristic of porosity of a material generally listed as the rate of diffusion of a pressurized gas through a material. The pore structure of some materials allows them to absorb or adsorb more moisture than other materials. Limestones are generally more permeable than granites.

Relative humidity (RH): Dampness in the air is measured as the percent of water vapor in the air at a specific temperature relative to the amount of water vapor that can be held in a vapor form at that specific temperature.

Survey instrumentation: technical instrumentation that is used on-site to provide quick readings of specific physical conditions. Generally these are hand-held survey instruments, such as moisture, temperature and relative humidity readers, dewpoint sensors, and fiber optic boroscopes.

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Home page logo: Invasive vegetation on a brick wall. Photo: Richard Wagner, AIA.

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