Stone Restoration and Preservation Philosophy:

A case study of brownstone restoration at 951 Boylston Street, Boston, MA.

By Patti Vaughn

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Thank you to Kathy Rood for permitting me the time and the opportunity to work towards the attainment of my Master of Design Studies Degree in Historic Preservation. To Carl Jaspersohn for being there when my computer crashed and I'd thought I'd lost everything, your support to retrieve all my information was invaluable! I'm so grateful to you!! To the Media crew who assisted and supported me to have me back up and running again so I could continue forward in writing my paper, Janet McClain, Avelino DosReis, Greg Scott, Rony Aguilar, many thanks!! Many Thanks go out to all of my BAC colleagues, staff and students who have wished me well in entering the MDS-HP program, who have supported me over the last two and a half years in the program, and who couldn't wait to see me complete my degree and graduate in the 2016 Commencement Ceremony, instead of normally having to run the ceremonies! Becoming a BAC Alumni will be the "icing on the cake"

Finally, to my family, my parents, Sandy and Dave Vaughn, my brother David Vaughn, my sister Sherri O'Brien, my niece Stephanie O'Brien and nephew Danny O'Brien, thank you for all your love and support, your encouragement during my struggles, cheering for me when I did well and just being there for me, comforting me through it all. Thank you for reminding me it's okay to take some time to be with family and friends, and then forge ahead again to complete the program. Thanks also go out to all the rest of my family, my brother-in-laws, my Aunts, Uncles, cousins, and friends who I feel like I've neglected due to so much time spent on classes and assignments but who have offered me encouraging words, cheering me on and reminding me they'd be waiting to enjoy more quality time with them again once I've obtained my degree. My heartfelt Thanks to all of you!

BIOGRAPHICAL NOTE

Currently Director of Administrative Operations at the Boston Architectural College 2007-2015

Currently a member of the Dorchester Historical Society assisting in cataloguing items bequeathed to the Dorchester Historical Society, 2015.

Bachelor of Fine Arts degree in restoration of Art Objects earned Magna Cum Laude at the Fashion Institute of Technology, N.Y.C, N.Y., 1998-2000

Associates in Applied Science degree in Jewelry Design earned Magna Cum Laude at the Fashion Institute of Technology, N.Y.C, N.Y., 1996-1998

Limestone Restoration: Traveled to the Villa Bologna, in Attard, Malta with the Boston Architectural College in June 2014 as part of the Materials and Conservation class where we worked on the documentation, restoration and repointing of mortar on a limestone wall located on the grounds of the Villa. I also completed documentation for restoration of a limestone "throne" chair located outside the residence.

Object Restoration: Freelanced for Amy Kalina's Ceramic Restoration studio where I restored various objects September 1999 – February 2000

Glass Restoration: July 1999 I worked with a restoration company as a freelance restorer to restore the glass façade on the front of the GE building located in Rockefeller Center. We removed and cleaned the glass facade, cleaned the metal bracings which the glass was set in, and restored the gold gilding to the glass panels, replacing the panels once completed.

TABLE OF CONTENTS: **PAGES**

WORD ABSTRACT

For my capstone project I will discuss both stone restoration and preservation philosophies, focusing on the brownstone of the 951 Boylston Street building as my case study. I will be reviewing the history of brownstone and the various areas, such as Massachusetts and Connecticut, where brownstone was quarried for use in the Back Bay area of Boston. The Back Bay was known for its residential homes primarily built of brownstone which were created for the wealthy Boston residents when brownstone became popular during the time the marshlands of the Back Bay were being built up to attract this demographic of Boston's elite. Brownstone was also used in the Back Bay area, not only in residential homes but in the construction of churches, like Trinity Church in Copley Square, as well as the Museum of Natural History. The 941 and 951 Boylston Street Fire House and Police Station were built later as the Back Bay grew street by street. I will be discussing the qualities of these brownstone materials, in color, structural makeup and their advantages and disadvantages as a stone material due to where they were quarried. I'll reference how the installation of brownstone can cause it to withstand weather or how, if laid incorrectly, it can deteriorate more rapidly due to its absorption of moisture and the freeze-thaw effects of Boston's ever changing climate. The mortars used in between the stones will be reviewed and how a "hard" mortar or "soft" mortar can affect the brownstone's structural integrity. In observing the brownstone structures around the Back Bay area I will document some of the deterioration along with the various techniques used in repair and restoration which can be clearly seen today, some of which show the disadvantages of earlier restoration. I will be reviewing the International Council on Monuments and sites (ICOMOS) Glossary to document the various issues with the deterioration of the brownstone. Environmental conditions of the area will be discussed in regards to how they've affected the brownstone facade. How have the pollutants, which have changed over time caused damage, if

any? I've chosen to use the 951 Boylston Street building as my case study, since I was interested in brownstone and its qualities in regards to restoration, along with this area of Boston, since it is an architectural historic district which also has to abide by the Back Bay Guidelines, being known as the Back Bay Historic District. It is also beneficial due to the fact that the 941 Boylston Street had restoration work completed on the façade and in viewing the buildings as one you can see the aesthetic differences in the brownstones. With 941 Boylston Street having been cleaned and restored I can use 951 and 941 Boylston as a side-by-side comparison. I have chosen various stones on the front façade of the 951 Boylston Street building for testing of a variety of cleaning options. I will be interviewing the company, Gale Associates of Weymouth, Massachusetts who had completed the restoration work at 941 Boylston Street, along with various restorers who have worked in the field of brownstone restoration. I will reach out to Dr. Judy Selwyn of Preservation Technology Associates and Mike Riegert a BAC faculty member who has worked on restoration of brownstone in Savannah, Georgia, to research their methods for cleaning, restoring and repairing of brownstone along with testing of mortar and recreating mortar for repointing. I will discuss with them their philosophies and issues which they've dealt with in restoring brownstone. I will be asking them about the philosophical aspects of historic preservation and whether they support restoring brownstone and what they think are the best methods for preserving historic brownstone buildings in the Back Bay area, if different from where they have worked. In reviewing all the information I've obtained I will submit a proposal and recommendations giving the best guidelines for the restoration of the 951 Boylston Street brownstone.

PRESERVATION OF BROWNSTONE IN THE BACK BAY DISTRICT OF BOSTON, MASSACHUSETTS

The philosophies of preservation, restoration and conservation and how it is implemented in preserving such materials as brownstone, have been questioned throughout time. In the Back Bay area of Boston, Massachusetts, many brownstone structures are slowly deteriorating due to a variety of reasons. With the lack of brownstone quarries producing newly cut brownstone to replace lost or destroyed pieces, it opens the question, what will become of this historic district's quintessential brownstones? Can we preserve the existing brownstone structures and protect them for future generations, or will the stones slowly be replaced by a new similar stone, or possibly a stone created to look like brownstone? When investigating the philosophical aspects of preservation, restoration and conservation what is the correct method, if any? Mike Riegert, Architectural Restorer and Instructor at the Boston Architectural College states, "*because brownstone buildings from this period (ca. 1887) all over New England have in the last 25 years or so met a serious threshold in their durability/ability to withstand deterioration, there is much need to repair and/or replace brownstone as much of it is in really bad shape!"*[1]

A case study will be completed focusing on 951 Boylston Street, Boston, Massachusetts as an example of a Back Bay brownstone structure and the deterioration that it has endure since it was first built. In comparing many of the brownstone structures located in the Back Bay area the 951 Boylston Street building is in quite good condition, this could be due to the location of where the brownstone was originally quarried. Further research will be completed to investigate the history of brownstone and the local areas in which it was quarried. A review of the philosophies of preservation along with the methods of restoration and preservation will be presented keeping in mind feedback I have obtained from local preservationists. Dr. Judith E. Selwyn of Preservation Technology Associates, LLC, of Chestnut Hill states, *"I do not like to clean brownstone, I*

[1] Riegert, Mike, interview by Patti Vaughn. Architectural Restorer and Instructor at the Boston Architectural (August 2015)

believe historic buildings should be left as is (sic).”[2] She also prefers that testing not occur, that research be done to identify where brownstone originated from, she felt this was the best way to understand its composition.[3] In beginning my research I was in agreement with Dr. Judith Selwyn, why change the façade of the 951 Boylston Street building? I believed the buildup on the façade of 951 Boylston Street, from its surrounding urban environment over the years, offered up evidence of how the building has “lived” throughout history. From the early coal burning trains that passed in front of this structure to the cars of today. The brownstone has stood the test of time so why change it?

Mr. Edward Stewart of Gale Associates, Weymouth, Massachusetts supported the restoration of 951 Boylston Street. Mr. Stewart’s company restored 941 Boylston Street, Boston, Massachusetts, which is adjoined to 951 Boylston Street by a central entrance, he stated “brownstone is a soft stone therefore soft mortars and cleaning agents should only be used so as not to create any further damage”[4]. In making a decision as to whether 951 Boylston Street should be left as is or restored, further research and a conditions assessments will be created for 951 Boylston Street. Supporting information as to the best methods for preserving 951 Boylston Street, will be presented taking into consideration philosophies, best practices in the Back Bay area, and results of tests completed on brownstone in the Back Bay area and on the 951 Boylston Street, Boston, Massachusetts brownstone.

[2] Selwyn, Dr. Judy, interviewed by Patti Vaughn. Principle at Preservation Tech. Assoc.
[3] Selwyn, Dr. Judy, interview by Patti Vaughn. Principle at Preservation Tech. Assoc.
[4] Stewart, Edward, interview by Patti Vaughn. *Gale Associates of Weymouth Massachusetts restoration of 941 Boylston Street* (August 18, 2015).

BROWNSTONE AS A CONSTRUCTION MATERIAL

HISTORY OF BROWNSTONE

Brownstone is a sandstone found in the specific geographic areas of the eastern states which border the mid-Atlantic shores. This is where brownstones of the Triassic age formed a belt which roughly paralleled the Atlantic Ocean's coast. A portion of this belt runs through East Longmeadow in Hampden County, Massachusetts. It continues down through Connecticut along the Connecticut River Valley, where an extensive amount can be found at Middlesex County, in Portland, Connecticut. In the northern half of New Jersey outcrops of these Triassic brownstones are abundant in Bergen, Hudson, Essex, Passaic, Somerset, Huntingdon, and Merces Counties, New Jersey. Further south it can be found in southern Pennsylvania, central Maryland, east central Virginia, North Carolina and some of this sedimentary stone is said to have been found as far west as the Rocky Mountain States.[5]

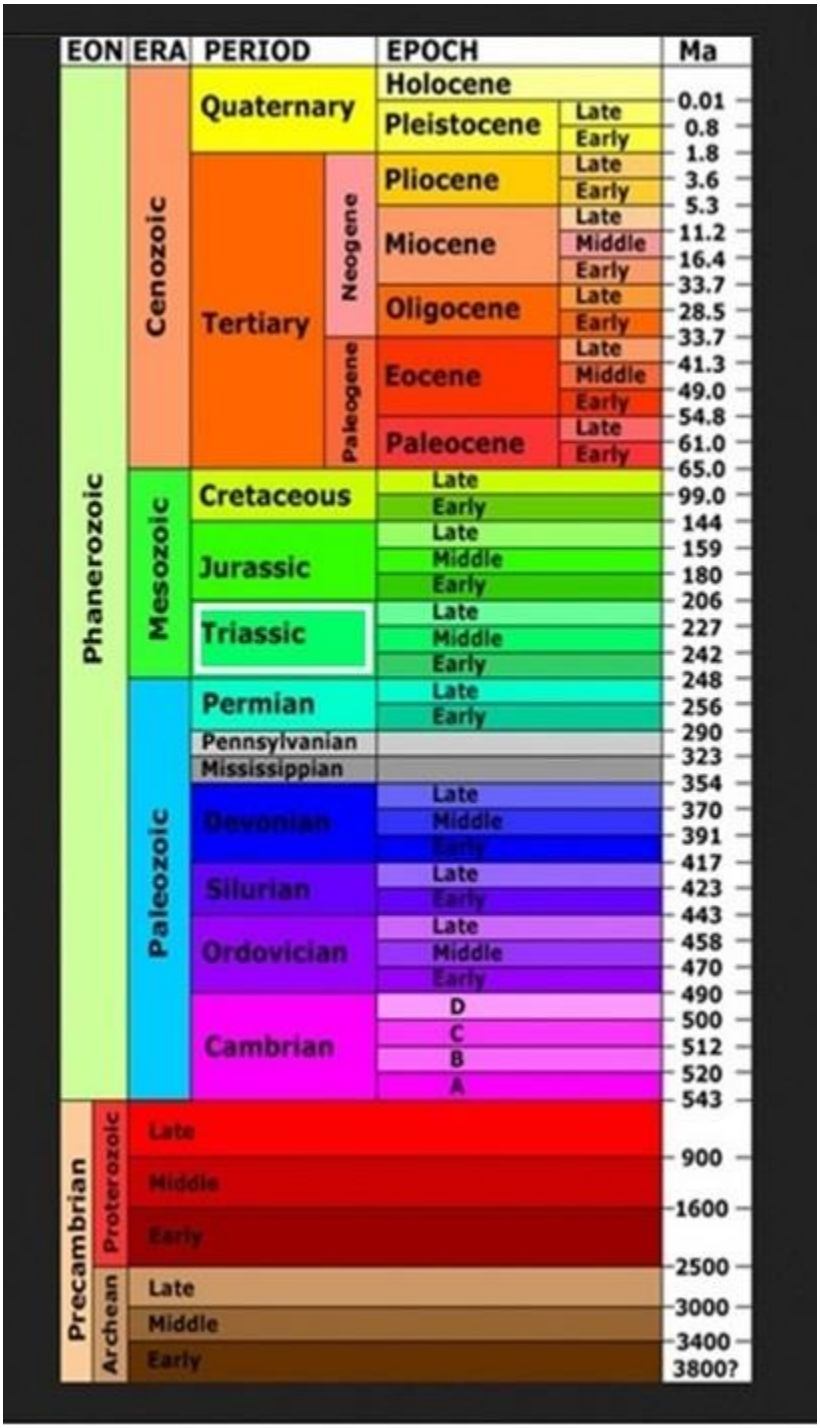
Specific geographic areas of the eastern Unites States which border the mid-Atlantic where brownstone from the Triassic Period formed.[6]

[5] Bowles, Oliver. "Distribution of Sandstone in the United States, General Distribution." *Sandstone quarrying in the United States*, 1917: 118, 123-128.

[6] Powell, Wayne G. *Portland Brownstone.* 2005. http://academic.brooklyn.cuny.edu/geology/powell/613webpage/NYCbuilding/PortlandBrownstone/PortlandBrownstone.htm (accessed September 2015).

In Portland, Connecticut the brownstone located in this area was created during the early Mesozoic era, 220 million to 195 million years ago. This area of Connecticut was once known as a super continent called Pangaea. When it began to break apart the Atlantic floor started to spread and the Eastern Border Fault formed a wedged-shaped depression called the Connecticut rift valley. Over time, this valley filled with sediments which had eroded from the ancient Eastern Highlands. The brownstone you find today is found at the bottom of the Portland, Connecticut quarry and around the rim, made up of the youngest layers of sediment which settled in the rift zone.[7]

[7] Boyle, Doe. "The Quarry that Built Boston and New York City." *Hog River Journal*, 2015, January



Brownstone of the Mesozoic era formed during the Triassic Period [8]

[8] Guertin, Dr. Laura. "Part 2: USGS Geologic Time Scale." *Environment and Health in Africa.* June 26, 2011. www.personal.psu.edu/uxg3/blogs/envhealthafrica/geologic_time_scale.jpg (accessed August 24, 2015).

QUALITIES OF BROWNSTONE MATERIAL

In 1876, at the United States Centennial Commission's International Exhibition, brownstone was referenced in their reports of geology on the brownstone of the Eastern State's freestones. The exhibition included brownstone from various quarries including Norcross Brothers, East Longmeadow, Massachusetts, from Shaler & Hull, and the Portland Brownstone Quarry Company of Portland, Connecticut. Brownstone from Connecticut and New Jersey known as being sandstone from the Triassic period can vary in color and quality.[9]

Advantages

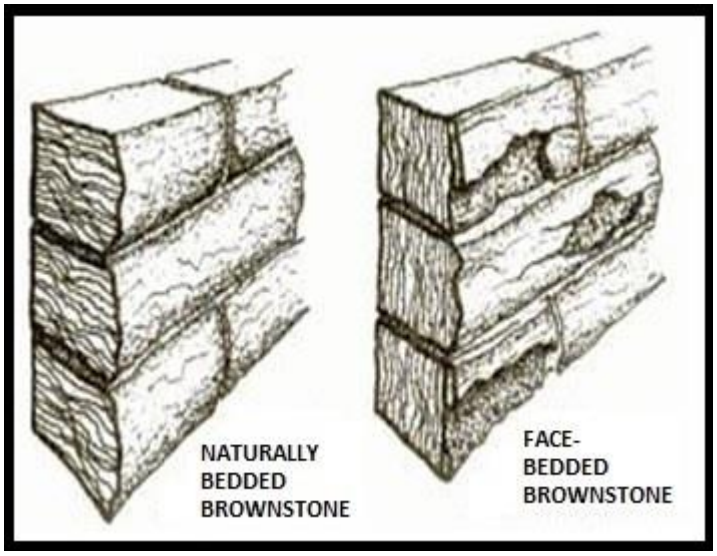
Some of the main advantages of brownstone were due to its availability during its height of popularity in the mid to late 1800's. Stonecutters and builders knew there were parts of a quarry which contained stronger more durable brownstone which would be the most useful for structural facades. The placement of the brownstone, and if it were laid as it naturally bedded, were key to brownstone withstanding the climatic elements and to maintaining its permanency through time.

Disadvantages

Brownstone varieties also had is disadvantages in that it will deteriorate due to its makeup and if it is incorrectly cut and laid into a structure.[10] Varieties with a laminated structure, when cut into a squared stone and set on edge, will cause exfoliation, which is a "subtype of delamination characterized by a detachment of multiple thin stone layers sub-parallel to the stone surface."[11] "Face-bedding" is the term used for brownstone when its layers are set on their vertical edge and with brownstone being a sedimentary stone, this means it consists of sheets of stone layered one

[9] Walker, Francis Amasa. *United States Centennial Commission International Exhibition, 1876.* Reports and Awards Group I, Philadelphia: J.B. Lippincott & Co., 1878.
[10] Walker, Francis Amasa. *United States Centennial Commission International Exhibition, 1876.*
[11] Cartwright, Tamara Anson, et al. "ICOMOS." *ISCS-International Scientific Committee for Stone.* September 2008. Pg 19

above the other. Consequently if the stone is not laid naturally bedded but face-bedded, this being the incorrect way, it will cause flaking of the stone over time due to water damage.[12]



Naturally bedded stones (left) suffer less damage from the weather than face-bedded stones (right)[13]

Therefore brownstone needed to be selected knowing how to cut and lay it, along with how it would deteriorate over time. The weathering of brownstone can have many negative effects if not laid correctly, from exfoliation of the stone to pitting and spalling. Brownstone quarried from various regions can react differently to weather in the Back Bay district of Boston and over time these various types of deterioration can be seen in the variety of structures in this area. There are often parts of a quarry where brownstone material is strong durable and useful for structural facades whereas other areas and types of brownstone do not hold their structure well. Most brownstone, which essentially consists of grains of sand consolidated by the pressure of overlying sediments and the presence of a cementing matrix, can fail due to the breakdown of the cementing matrix. As mortar joints deteriorate, water can get into the interior bedding and then freezing of the water

[12] Ref. Old-House Journal August 1982, "Patching Brownstone" by Lynette Strangstad, https://books.google.com/books?id=y-Kxw6ZOq9UC&pg=PA162&lpg=PA162&dq=weathering+brownstone&source=bl&ots=QufATAT-2u&sig=3mtQpllynAaf6gGSNXeaTXgWPm0&hl=en&sa=X&ved=0CEwQ6AEwCmoVChMIpYbCudX_xwIVCzU-Ch1iEgHI#v=onepage&q=weathering%20brownstone&f=false]

[13] Ref. Old-House Journal August 1982, "Patching Brownstone" by Lynette Strangstad,

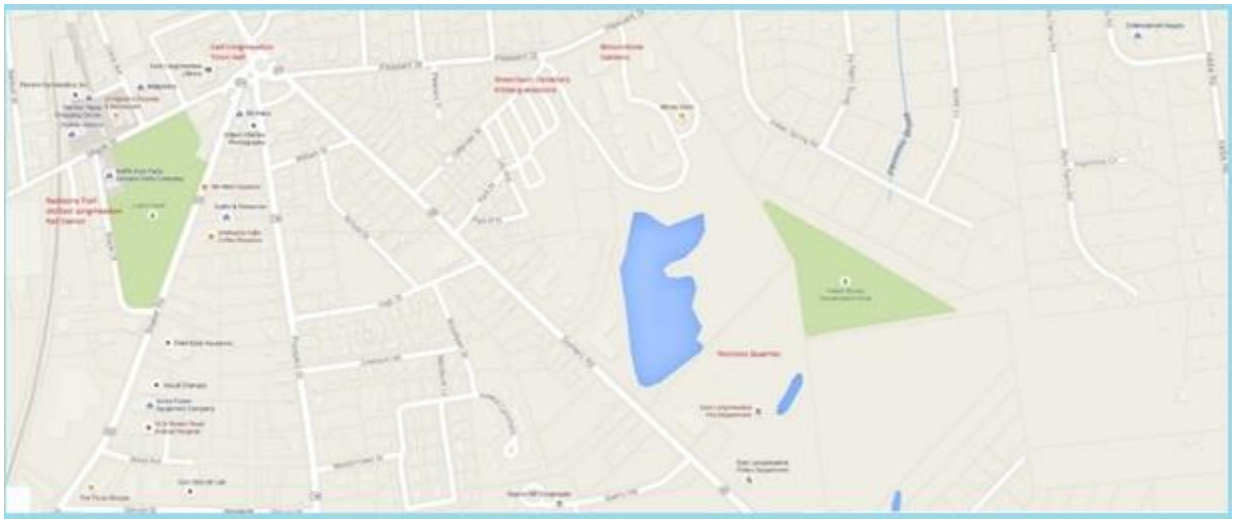
causes an expansion, destroying and deteriorating the stone.[14] Therefore the quality and placement of brownstone in building a structure is key to its longevity.

QUARRIES OF NEW ENGLAND

Quarries in New England were used to build many of the structures in the Back Bay district of Boston. It is believed that brownstone from Portland, Connecticut built many of the Back Bay residential homes. The brownstone located in East Longmeadow, Massachusetts, built the Trinity Church and is believed to have built the 941 and 951 Boylston Street structures.

East Longmeadow, Massachusetts

In an attempt to discover where the various brownstone in the Back Bay area of Boston originated I visited two New England quarries. East Longmeadow, Massachusetts located in western Massachusetts is where the Norcross Brownstone Quarries were located. Settled in the 1740's East Longmeadow had outcroppings of brown and red sand-stone which small landowners quarried.[15]



East Longmeadow, Massachusetts town center, Google map 2015

[14] Bryan, Roy, and Kobe Z. "Valerie Haboush Brownstone City."
[15] Goodlatte, Jeanne P. *Longmeadow Historical Society, East Village of Longmeadow, design by LongmeadowBiz, LLC.*

The East Longmeadow Town Hall was erected in the center of the East Village and completed in 1882, made of native brownstone donated by the Norcross Brownstone Company.[16] The Town Hall has arched brownstone entrances similar to the 941 and 951 Boylston Street buildings. This was interesting to discover due to the fact that preservation expert Dr. Judy Selwyn believes the brownstone used in the 941 and 951 Boylston Street structures came from a Massachusetts brownstone quarry. [17]

East Longmeadow Town Hall, East Longmeadow Massachusetts, 2015 [18]

For many years the sandstone in East Longmeadow was considered public property and any person had a right to it. Beginning in the 1800's the brownstone quarry business was being carried on by owners of the land or by quarrying companies who would lease these quarries, with 50 or more quarries in operation. In 1894 only 12 quarries remained in operation. The Kibbe Quarry, was known for its reddish brownstone, the Maynard Quarry was known for its rich red sandstone which was considered of unequaled color, texture and durability, and then there was

[16] Goodlatte, Jeanne P. *Longmeadow Historical Society, East Village of Longmeadow*
[17] Selwyn, Dr. Judith, interview by Patti Vaughn. *Principal at Preservation Technology Associates, LLC*
[18] Vaughn, Patti. n.d. *photos were taken by*

the Worcester Quarry of which produced the brownstone we're most familiar with seeing in Boston's Back Bay today. Once the stone was quarried it was removed in huge blocks of 10 to 20 tons each and then cut and finished before being shipped to every part of the United States.[19]

Not far from the town center, on Maple Street, was the old railroad station depot on the Red Stone trail. The depot along with remnants of the original railroad track ties can still be see here today.

The East Longmeadow Railroad Station
near the center of East Longmeadow Massachusetts, 1910[20]

The East Longmeadow Railroad Station
near the center of East Longmeadow Massachusetts, 2015 [21]

[19] Goodlatte, Jeanne P. *Longmeadow Historical Society, East Village of Longmeadow*
[20] Derek. 2015. *Lost New England, Railroad Station, East Longmeadow, Mass.* April 20. Accessed September 6, 2015. http://lostnewengland.com/category/massachusetts/east-longmeadow-massachusetts/
[21] Vaughn, Patti. n.d. *photos were taken by, September 2015*

"A century ago the Armory Branch of the New York, New Haven & Hartford Railroad passed through the town. The line connected East Hartford and Springfield and passed by the water shops of the Springfield Armory, which gave the branch its name." The name "Red Stone Trail" came from the fact that the railroad once provided the quarries in town a way to ship the brownstone around the country.[22]

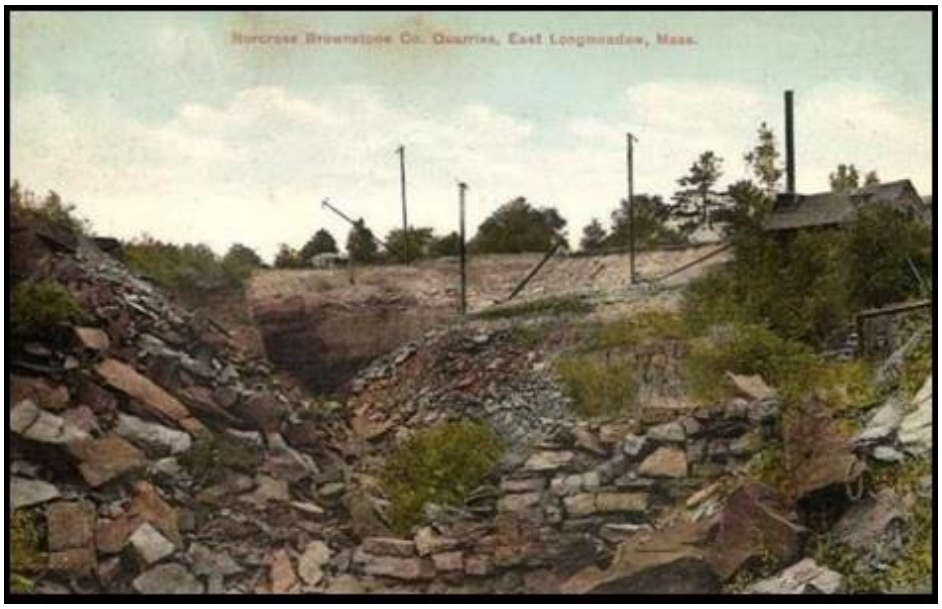
The Norcross Quarries of East Longmeadow were located not far from the town center on Somers Road located where the East Longmeadow DPW service station and Police Station are currently located. On the north east side of the quarries you'll find Kibbe Road named after the Kibbe family which ran the Kibbe quarries known for their red brownstone. At the Greenlawn Cemetery on Callendar Avenue in East Longmeadow, MA an example of Kibbe red brownstone can be found in the shape of an obelisk gravestone with the KIBBE name standing tall near the street commemorating the Kibbe family.

Kibbe brownstone, East Longmeadow, MA 2015[23]

[22] Derek. *Lost New England, Railroad Station, East Longmeadow, Mass. April 20, 2015.*
[23] Vaughn, Patti. n.d. *photos were taken by September 2015*

On the northwest side of where the Norcross quarries were located is an apartment complex called Brownstone Gardens, located off of Pleasant Street in East Longmeadow, Massachusetts. Though the quarries are now closed, brownstone can still be seen here strewn along a stream and in brownstone walls are sprinkled throughout the town.

East Longmeadow, Massachusetts, brownstone remnants found along a stream [left photo] near the site where Norcross Quarries was once located. (Brownstone Gardens apartment complex, Pleasant Street), [right photo] a brownstone wall, East Longmeadow, MA, 2015 [24]



Norcross Brownstone Co. Quarries, East Longmeadow, Hampden Co., Massachusetts USA[25]

[24] Vaughn, Patti. n.d. *photos were taken by, September 2015*

[25] Cristofono, Peter. 2010. "Norcross Brownstone Co. Quarries, East Longmeadow, Hampden Co., Massachusetts, USA." *mindat.org.* April 10. Accessed August 22, 2015. http://www.mindat.org/loc-216059.html.

Portland, Connecticut

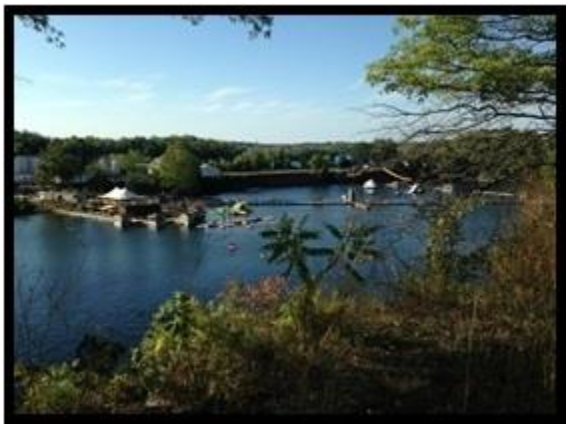
Portland, Connecticut was originally inhabited by the Wangunk tribe of Native Americans some 8,000 to 10,000 years ago. "Wangunk translated as "bib bend," referred to the Connecticut River which curves around half the Town's perimeter."[26] Around the 1650's the first European-Americans arrived, one of them being James Stanclift, an English stonecutter. Having a stonecutter's experience and due to the brownstone quarries being located in this area, in close proximity to the river, Portland became a valuable resource for the construction of structures and gravestones. "Portland supplied brownstone to New York, Boston and San Francisco. The Portland Quarries employed 1,500 people during the 1850's. More than 25 ships transported the stone to major population centers in the United States, Canada and even to England."[27] Unfortunately brownstone began to fall into decline at the turn of the 20th century and concrete was beginning to be used as a less expensive and more versatile construction material. "In 1936, the Connecticut river flooded into the quarry sites, effectively ending the brownstone industry."[28]

"In May 2000 the National Park Service designated the Portland, Connecticut quarry as a National Historic Resource and with preservation efforts Brownstone Exploration and Discovery Park was developed. The Park has now become a visitor's destination for hiking, swimming, biking, rock climbing and wake boarding as well as Red Cross Lifeguard Training Programs.[29]

[26] Town of Portland, Connecticut. *Town of Portland, Connecticut, A Brief History of Portland.* 2015.
[27] Town of Portland, Connecticut. *Town of Portland, Connecticut, A Brief History of Portland.* 2015.
[28] Town of Portland, Connecticut. *Town of Portland, Connecticut, A Brief History of Portland.* 2015.
[29] Connecticut Humanities. *Connecticut History.org.* October 30, 2015.

Portland quarry pit full of water 1928 – Connecticut Historical Society and Connecticut History Online.[30]

Portland, Connecticut quarry, Brownstone Exploration & Discovery Park, 2015 [31]



Portland, Connecticut quarry, Brownstone Exploration & Discovery Park, 2015 [32]

[30] Connecticut Humanities. 2015. *Connecticut History.org.* October 30. Accessed October 30, 2015. http://connecticuthistory.org/portland-puts-its-stamp-on-an-architectural-era/.
[31] Vaughn, Patti. n.d. *photos were taken by, September 2015*
[32] Vaughn, Patti. n.d. *photos were taken by, September 2015*

Brownstone quarries supplied the need for brownstone structures which were prevalent during the 1870's and 1880's.[33] With the Back Bay area of Boston having been filled in beginning in 1857, structures began to be built using brownstone as early as 1860. The structures at 941 and 951 Boylston Street were built around 1887.[34] By the 1900's brownstone was so common it was no longer of structural interest and due to the disadvantage of it being a soft, sedimentary stone it was no longer in demand. By the 1960's, when brownstone structures were now in need of repair, the stone became sought after again. In 1994 Mike, a geologist by trade began work with two more gentlemen, Rick and Mark to open Mike's Portland Brownstone Quarry yard. Most of the brownstone quarried were used for repairing historic buildings, to create stair treads, in replacement lintels and more.[35] Unfortunately this quarry closed its doors in 2012 leaving restorers to return to salvaging brownstone from demolished buildings for any restoration needs.

[33] Cole, Regina. *Brownstone Rides Again.* 2015.
[34] The Neighborhood Association of the Back Bay. *Timeline of the History of the Back Bay.* July 2015.
[35] Cole, Regina. *Brownstone Rides Again.* 2015.

HISTORY AND CREATION OF BOSTON'S Back Bay DISTRICT

THE BACK BAY

In 1814 the development of the Back Bay area of Boston began. The Massachusetts Legislature chartered the Boston and Roxbury Mill Corporation, and approved construction of a long mill dam to cut off 430 acres of tidal flats from the river, which also served as a toll road to Watertown. The dam is under what is now Beacon Street. In 1821 the basin was subdivided into Upper or Fill Basin, Lower or Receiving Basin to power water mills. In 1841 the US Harbor Commission established a line beyond which the Back Bay could not be filled and thus encroach on the harbor. In 1849 the Health Department demanded the area be filled in. In 1850 the US Harbor Commission was appointed to investigate the Back Bay and recommend development options. In July of 1852 the Commission on Harbor and Back Bay Lands was appointed and in 1853 Commissioners on Boston Harbor and Back Bay Lands begin writing annual reports. By 1855 the Name of Commission on Harbor and Back Bay Lands was changed to Commissioners on Public Lands and in 1856 the Tripartite Agreement of 1856 between the Commonwealth of Massachusetts, the City of Boston, and the Boston and Roxbury Mill Corporation – dividing up the lands was created. Part of the city land went to the development of the Boston Public Garden.

In 1857 filling in of the Back Bay marshlands began. The average depth of the fill was 20 feet deep with more than 450 acres of fill being brought from Needham, Massachusetts. Streets were filled to 17 feet above mean low tide, lots were filled to grade 12 so basements would be below street level.[36]

Boston's Back Bay is known for its residential homes primarily built of brownstone. This area was created for wealthy Boston residents, attracting Boston's elite. Brownstone structures

[36] The Neighborhood Association of the Back Bay. *Timeline of the History of the Back Bay.* July 2015.

became popular during this time and as the marshlands of the Back Bay were being filled in, land would be purchased and a new brownstone residence or structure would be built. Brownstone was used in the Back Bay area not only in residential homes but in the construction of public buildings as well. Many structures were built as the Back Bay was filled in and grew, these structures can still be seen today. The Gibson House built in 1860 of brownstone and brick is located at 137 Beacon Street. It was donated as a house museum and opened to the public in 1957 and in 2001 designated a National Historic Landmark by the National Park Service[37]. By 1860 the filling in of the Back Bay had reached Clarendon Street. Arlington Church was the new Unitarian church the congregation had agreed to have designed by Charles Bulfinch and was built on the corner of Arlington and Boylston Street.[38] Currently work is being done on the Arlington Church due a handicap ramp being added. A large piece of brownstone was removed, to be returned to the original structure, which was of brownstone having been quarried in New Jersey. Unfortunately the façade of this structure has not weather well over the years and portions of the brownstone are falling away from the façade.

Arlington Church, the corner of Boylston and Arlington Street, Boston, MA. Brownstone has been removed to install handicap ramps, 2015. [39]

[37] Gibson House Museum. *The Gibson House History.* October 31, 2015. http://www.thegibsonhouse.org/history.html
[38] The Neighborhood Association of the Back Bay.
[39] Vaughn, Patti. n.d. *photos were taken by August 2015*

The Museum of the Society of Natural History built in 1864 is located on Berkeley Street between Boylston and Newbury Street which still exists today. Dr. Judith Selwyn assisted in the restoration project of this structure which is currently Restoration Hardware. Dr. Selwyn stated, "The majority of brownstone used in the Back Bay to build residential homes had been primarily quarried from the Portland Quarry in Portland, Connecticut."[40] By 1870 the filling of the Back Bay had reached Exeter Street. The Old South Church was built in 1875 on the corner of Dartmouth and Boylston Street built of "Roxbury pudding stone." In October 1873 the designer of Trinity Church, H.H. Richardson, revised the plans for the structure and Norcross Brothers Quarry in East Longmeadow, Massachusetts reduced their bid to build it, to the total of $435,000. A contract was signed and work resumed in full and in 1877 the church was completed. [41] By 1882 the filling in of the Back Bay had now been completed as far as Charlesgate East. In 1887 the 941 and 951 Boylston Street Fire and Police Station structures were built. By 1900 the filling of the Back Bay was completed with the last few acres of the Fens, by Fenway Park. In 1955 the Neighborhood Association of the Back Bay was formed and in 1966 the Massachusetts Legislature established the Back Bay Architectural District with the Back Bay Architectural Commission holding its first meeting in 1967. In 1973 the Back Bay is added to the National Registry of Historic Places.[42]

HISTORY OF THE 941-951 BOYLSTON STREET BUILDINGS

In 1886 city architect Arthur H. Vinal began the design and construction of the 941 and 951 Boylston Street Fire and Police Station structures completing them in 1887. The firehouse

[40] Selwyn, Dr. Judy, interview by Patti Vaughn
[41] Quotations taken from "The Consecration of Trinity Church," published by the Vestry on the occasion of the dedication of the new Trinity Church in Back Bay. "Art & History, Building History." *Trinity Church Boston.* October 29, 2015. http://trinitychurchboston.org/art-history/building-history (accessed October 29, 2015)
[42] The Neighborhood Association of the Back Bay

opened its doors February 20, 1888.[43] Vinal designed the structures in the popular Richardsonian Romanesque style of the time which was known for its thick, rough textured walls of warm-toned stone and brick. These structures included deeply recessed round arches and window groupings as seen on the 941 and 951 structures.[44] The Romanesque Revival style had its beginnings in religious architecture. Americans traveling throughout the Mediterranean found churches from the Middle Ages attractive and wanted to replicate them when creating their own parishes. Beginning in 1840, this began 60 years of a Romanesque Revival in American churches, public and commercial buildings as well as residential buildings. Henry Hobson Richardson was the well know architect who recreated French and Spanish Romanesque into eclectic and dramatic stonework which began to be referred to as the "Richardsonian Romanesque". This style included a masonry construction, semi-circular arches for wall openings and decoration, quatrefoil windows and geometric brickwork. The stone was often "rough-cut" or "rusticated creating a fortress-like form".[45]

951-941 Boylston Street, The Police Station (left) and Fire Station (right) on the corner of Boylston Street and Hereford Street, October 17, 1911. [46]

[43] Boston Fire Historical Society, Inc. *Active Fire House 941 Boylston Street, Back Bay, Engine Company 33/Ladder Company 15.* August 15, 2015. www.bostonfirehistory.org/activefirehouseengine33.html

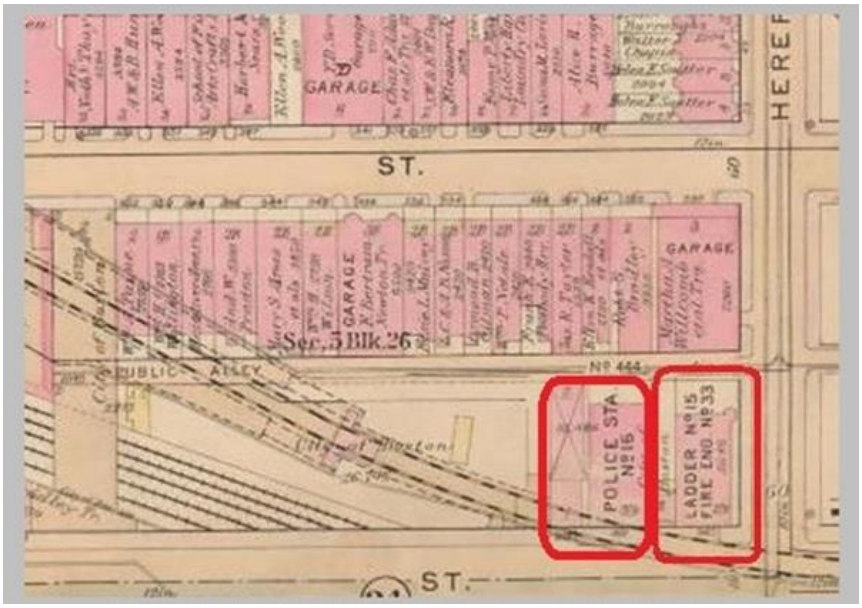
[44] Boston Preservation Alliance's. *Boston Preservation, Architectural Style Guide.* June 30, 2015. http://www.bostonpreservation.org/advocacy/architectural-style-guide.html

[45] Baches, Mallory B. E. *A Matter of Style: Richardsonian Romanesque.* 2003. http://www.tndtownpaper.com/Volume5/richardsonian_romanesque.htm

[46] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street, Back Bay, Engine Company 33/Ladder Company 15.* August 15. Accessed October 11, 2015.

In observing the 941-951 Boylston Street building one can easily see the Richardsonian Romanesque qualities of the structure, from its fortress-like, rough-cut stone, and a turret on the northeast corner of 941 Boylston Street. The entrances having rounded archways with the second level having semi-circular arches. At the very top of the building above the highest most windows are a geometric brickwork.

The 941-951 Boylston Street Fire and Police Station were built as one and is located on Boylston Street at the corner of Hereford Street in the Back Bay neighborhood of Boston. This was the first combined fire station and police station in the city of Boston. The firehouse initially could not be occupied due to the grading of the street not reaching the apparatus front doors. Once raised and leveled to cross the nearby railroad tracks the firehouse was occupied.[47]



A Back Bay street map from 1922 identifying the Police Station and Fire Station at the corner of Boylston Street and Hereford Street, Boston, MA.[48]

[47] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street*
[48] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street,*

A 1925 aerial photo of the Back Bay area of Boston, 941 and 951 Boylston Street are outlined in red. [http://www.flickr.com/photos/boston_public_library/ / CC_BY-NC_3.0][49]

The center bay between the 941 and 951 Boylston Street structures led to the stable yards for the Police and Fire house horses. The turret tower located on the northeast corner of Hereford Street were used for drying firehoses.

941 Boylston Street and stable entrance for Engine 33/ Ladder 15 Firehouse, Back Bay Boston circa 1940's [50]

[49] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street,*
[50] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street*

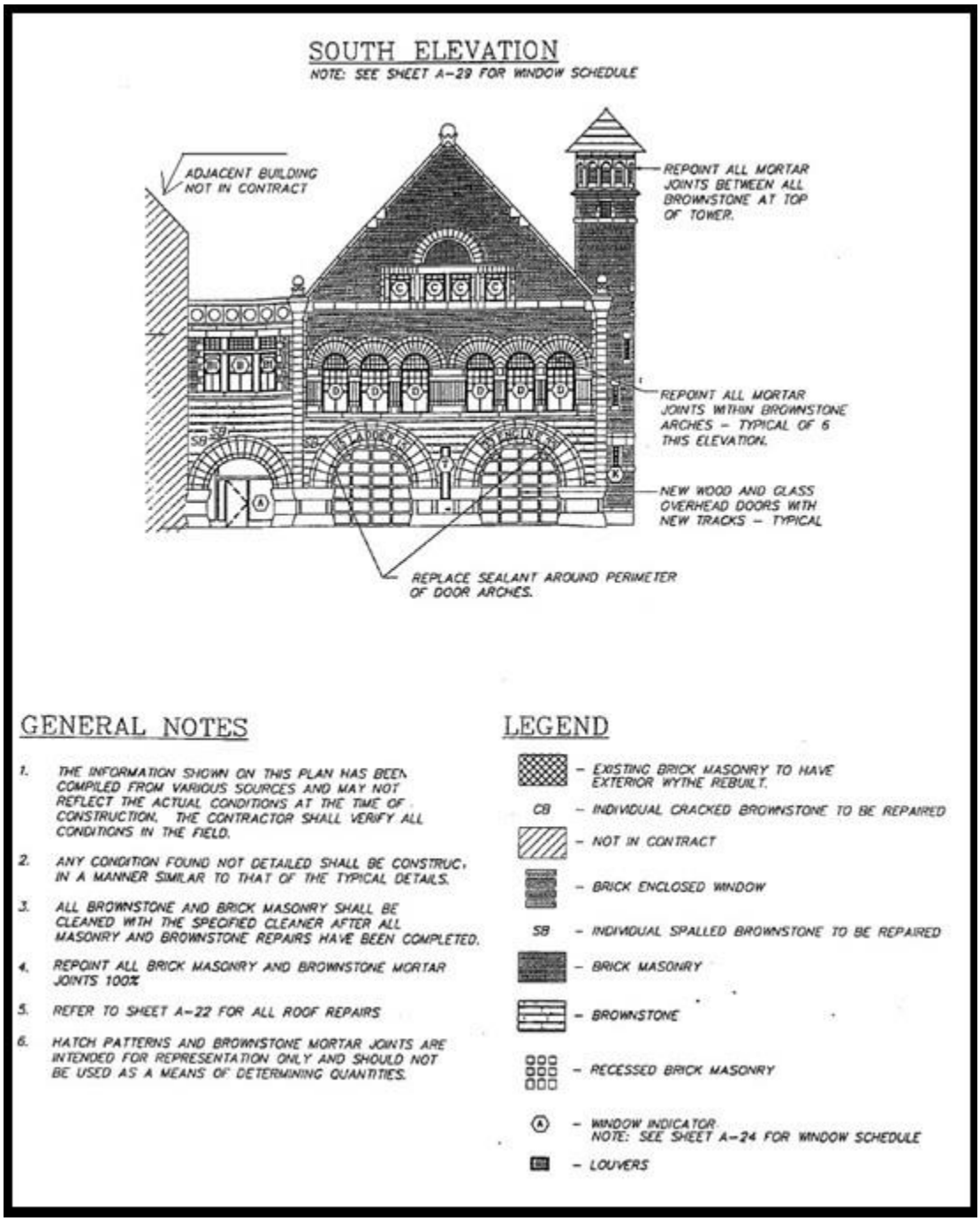
"This fire station is recognized for several fire-fighting innovations, it housed the first ladder truck in Boston equipped with a 3-horse hitch and was the first to acquire a turntable aerial truck."[51] This landmarked building is still in use today as Company 33 and Ladder Company 15 and is located in the 941 Boylston Street building.

In 1976, the 951 Boylston Street police station 16 was renovated to include galleries when it became the Institute of Contemporary Art and in 2007 it was acquired by Boston Architectural College and renovated for reuse as studio space, offices and a lecture hall. [52]

Restoration of 941 Boylston Street

In 1997 repair work on 941 Boylston Street was undertaken by Gale Associates of Weymouth, Massachusetts. They were to handle extended repair and repointing work along with windows. With respect to the brownstone repairs, the goal was to clean all brownstone and brick masonry with a specified cleaner, once all repairs to each stone had been completed. Spalling did appear on individual brownstone so brownstone repair work included these repairs as well. Repointing of all brick and brownstone mortar joints including the arches above windows and the mortar joints at the top of the tower were also completed.[53]

[51] Boston Fire Historical Society, Inc. *Active Fire House 941 Boylston Street, Back Bay, Engine Company 33/Ladder Company 15.*
[52] Bostonian Society. *Historical Markers: Back Bay, Boylston Street Fire Station - 941 Boylston Street.* 2014. http://www.bostonhistory.org/?s=education&p=histmarkers&sub=m_backbay
[53] Stewart, Ed, interview by Patti Vaughn. *Gale Associates*



The south elevation key created by Gale Associates of Weymouth, Massachusetts for 941 Boylston Street restoration work.[54]

[54] Stewart, Edward, interview by Patti Vaughn. *Gale Associates of Weymouth Massachusetts*

On Tuesday, August 18, 2015 I interviewed Mr. Edward Stewart of Gale Associates Weymouth, Massachusetts by phone. We discussed the 941 Boylston Street building project and I was able to ask him questions regarding the restoration work completed by Gale Associates. During the interview I asked Mr. Stewart if he knew what the black buildup could be on the front façade of the 941 and 951 Boylston Street brownstone. I explained that during a group discussion about the building we discussed whether it could be pollutants that had built up over time. We wondered if it could be layers of coal in earlier years from the trains which use to pass by the front of the building. Mr. Stewart stated, "We found it was a buildup of environmental pollutants due to the high carbon content in the air from the building's early years and therefore had used non-harsh cleaning agents to remove the black crust. We also did not use aggressive chemicals or abrasive cleaners due to the brownstone being porous. These chemicals would break down the brownstone which is meant to absorb liquids. Brownstone absorbs and takes on moisture and acts as a sponge, brownstone needs to dry out. There was a company that had used a clear finish to protect the brownstone but later found this actually caused more damage since the water was getting trapped behind the clear finish, inside the stone, so when there were freeze-thaw weather conditions this caused more spalling damage and further deterioration."[55]

In further discussion I asked Mr. Stewart if there are any new procedures that have recently come into use which can be used for restoring brownstone, mentioning a D/2 biological cleaning agent. Mr. Stewart said "My colleagues have used it but not on brownstone." He also mentioned that replacement of stone is another option. "There are other materials used to mimic the texture and color of the brownstone. The only issue is when it rains the replacement stone normally doesn't have the same porosity as the brownstone so the replacement stone looks different in color. Sometimes they've stained the replacement stone to match but it still stands

[55] Stewart, Edward, interview by Patti Vaughn. *Gale Associates*

out in an obvious way. Also there are 'dutchman repairs' this is where a piece of stone is set into a larger stone to replace a damaged or missing section."[56] Dutchmen repairs are adhered with pins and adhesives are used more frequently with granites and marbles. 'Full face' dutchman may be used for brownstone repair when the face of a unit is deteriorated to a significant depth and the stone surface must be durable. A Dutchman might be used, for instance, where an exposed repair overhangs an entry or sidewalk, and the failure of a composite would be hazardous.[57]

USAGE OF BROWNSTONE IN BACK BAY STRUCTURES

The Back Bay Historic District which extends from the Charles River, includes Arlington Street, Providence Street, Boylston Street, Newbury Street and Charlesgate East. There are a variety of structures built in the surrounding Back Bay area which used brownstone as a structural and decorative material. When walking through the Back Bay area, you will unfortunately see the ongoing deterioration of these historic brownstone buildings. Weather and pollutants can be seen to have caused damage over time with flaking, peeling and crumbling of the brownstone. Many brownstone quarries closed as the need for brownstone declined due to declining interest in the once popular stone. Repairs that were initially done to protect or preserve the brownstone, at times caused more damaged. When walking through the Back Bay area some of the brownstone deterioration which can visibly be seen is patching, repointing and painting, often completed on stairs and brownstone facades. Pollutants over the years, along with various modes of transportation, from horse and carriages to trains and trolleys, cars, buses, subways and the highway, all have had their impact on these structures. The Back Bay now

[56] Stewart, Edward, interview by Patti Vaughn. *Gale Associates*
[57] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide.* 2012. http://www.mzarchitects.com/wp-content/uploads/2012/04/BrownstoneGuide.pdf

being an architectural historic district and on the National Register of Historic Places (NRHP) currently has the Back Bay Guidelines to abide by before any type of restoration can be undertaken.

The brownstone used to build these various structures came from a variety of brownstone quarries. Consequently this can make it difficult for a restorer trying to match a replacement piece, since it is not also known from which quarry the brownstone originated. Trinity Church's brownstone comes from the Norcross quarries in East Longmeadow Massachusetts. Arlington Church records show their brownstone is from a New Jersey quarry and in speaking with Dr. Judith Selwyn of Principal Preservation Technology she stated the brownstone used to build 941 and 951 Boylston Street had been quarried in western Massachusetts.[58]

[58] Selwyn, Dr. Judith, interview by Patti Vaughn. *Principal at Preservation Technology Associates, LLC*

PHILOSOPHIES OF PRESERVATION

ICONIC PHILOSOPHIES OF PRESERVATION

When involved in preservation, prior to initiating any restoration or conservation work on a structure, one should take into account the philosophical aspects of a historic structure. This is not a new idea and has been debated throughout the years. In regards to a preservation policy, there is no hard rule that exists detailing how far to go when doing restoration work. The intended Restorer should present the owner with options, keeping the owner aware of the historic integrity of the structure to be restored. The most basic and common belief of many professional preservationists has been to keep as much of the original as possible. Unprofessional preservationist have destroyed old buildings doing restoration work when recreating what they believe would have been part of a structure during its era.[59]

Eugene Emmanuel Viollet-le-Duc, the influential French writer, architect and leader of the romantic rationalists of the Second Empire, defined the restoration process as the effort "to establish a completed state which may never have existed at any particular time."[60]

This philosophy is somewhat overenthusiastic, with Viollet-le-Duc replacing and enhancing the original elements to produce a finished project which would perhaps have embodied the age and aesthetic of the period in which it was originally created. An example of Viollet-le-Duc's work where this can be see is at Carcassonne in southern France. Viollet-le-Duc's late nineteenth century additions along with the patina built up over time encourages the perception that the structure is authentic when in reality it was reconstructed. [61]

[59] Murtagh, William J. *Keeping Time: The History and Theory of Preservation in America.* Hoboken, New Jersey: John Wiley & Sons, Inc., 2006Murtagh, *(page 6)*
[60] Murtagh, William J. *Keeping Time: The History and Theory of Preservation in America.*
[61] Murtagh, William J. *Keeping Time*

Carcassonne, France (2014)[62]

Personally I don't agree with Viollet-le-Duc's methods due to the fact that a person would be taking artistic license to recreate what they've decided to add or remove to a historic structure. I've struggled with how much restoration should be accomplished on a site, I believe each site will have its own variables to consider. Another issue is whether to repair the structure to make it appear as if there were no damage. Or should it merely be the specific area in which a repair is a necessity to prevent further damage?

Preservationists and restorers have taken very different views throughout time, John Ruskin and William Sumner Appleton being among a few well known preservationist. John Ruskin, a nineteenth-century English architectural critic and social reformer perceived restoration at the opposite extreme of Viollet-le-Duc. "Restoration," he wrote, "is always alive. It means the most total destruction which a building can suffer. It's as impossible to raise the dead as to restore a building."[63] Ruskin believed in what has become known as the "let-it-alone" form of

[62] Gwen. 2014. *London Preppy : Carcassonne, London-preppy.blogspot.com.* January 24. Accessed September 8, 2015. https://images.search.yahoo.com/images/view;_ylt=AwrB8qFS7RlWX2YA1OgunIlQ;_ylu=X3oDMTIzN3FvcTNlBHNlYwNzcgRzbGsDaW1nBG9pZAMzYzgwNjY1ZGI5MWVlMzlhOTliZDVlODQyMTI3YjE0MwRncG9zAzM5BGl0A2Jpbmc-?.origin=&back=https%3A%2F%2Fimages.search.yahoo.com%2Fyhs%2Fsearch%.

[63] Murtagh, William J. *Keeping Time*

preservation. He felt restoration destroyed the original fabric of the structure and also destroyed the patina which builds up over time.[64]

John Ruskin along with his colleague and English critic William Morris helped to influence Americans in architectural preservation. In 1849 Ruskin wrote the "Seven Lamps of Architecture, in which he presented the belief that only Beauty, Truth and Memory, were a key to the importance of the past.[65]

William Sumner Appleton was a New England architectural historian, preservationist and proper Bostonian. He founded the Society for the Preservation of New England Antiquities in 1910, now known as Historic New England. From his extensive travels he learned to understand the lessons of restoration and created public enthusiasm for historic architecture. He perceived a building as an evolving organism. Since a building changed throughout time the structure was a historic records of the many eras in which it survived.[66]

William Sumner Appleton was the person who brought awareness and interest into the architectural aesthetics as a criteria for preserving property. He encouraged communities to not only recognize the historical values associated with the location but the significance of the structure itself. In establishing historic buildings for educational purposes this brought an awareness of preservation to a larger audience. Americans began to perceive historic buildings, "villages", sites and monuments as educational, celebratory, commemorative and patriotic. Many women in the community became involved in these preservation efforts.[67]

Appleton promoted the historic house museum as a vital link in the chain of material culture, equal in importance to the written documentation of history. Appleton, having been inspired by

[64] Murtagh, William J. *Keeping Time*
[65] Murtagh, William J. *Keeping Time (page 19)*
[66] Historic New England. *Historic New England, Founder and History.* 2015. http://www.historicnewengland.org/about-us/founder-and-history-1
[67] Murtagh, William J. *Keeping Time (page 22)*

Ruskin's philosophies encouraged the acceptable, broad standards of professionalism on how a historic house museum and historic buildings are treated today when considering the restoration process. Appleton was an advocate for keeping a historic house as whole and intact as possible during the restoration process. He supported maintaining the structure in situ at all costs, keeping the integrity of aesthetic quality intact.[68] I find Appleton's beliefs coincide more closely with my philosophy of restoration of a historic structure. The structure itself has a story to tell therefore why change it? Put it on display and allow for the discussion of the materials which were used to create the structure, the wood, stone, paint and other materials, and why they were used when the structure was first built, and have any changes been made over the course of years in which the structures has existed?

[68] Murtagh, William J. *Keeping Time (page 64)*

PHILOSOPHIES OF HISTORIC RESTORATION AND THEIR IMPLICATIONS FOR BROWNSTONE RESTORATION

	SIGNATURE PRESERVATION ADVOCATES			
	John Ruskin "Let-it-alone"	**William Morris "Restoration is Desecration"**	**Eugene Emmanuel Viollet-le-Duc "Restore and Recreate to its era"**	**William Sumner Appleton "Architecture, excellence, old age, and connection to significant historical events"[69]**
RESTORATION STRATEGIES				
Do Nothing	Yes	Yes	No	Yes
Repointing mortar	No	No	Yes	Yes
Patch material	No	No	Yes	No
Painting brownstone	No	No	Yes	No
Use of stucco or cement to restore	No	No	Yes	No
Restore to its original structure using new material	No	No	Yes	No
Restore to its original, sometimes recreating new elements	No	No	Yes	No
Composite Repairs - repairs used to replace missing parts	No	No	Yes	No
Repairs due to structural necessity	No	No	Yes	Yes
Strategies for halting deterioration	No	No	Yes	Yes
Strategies for restoring historic elements	No	No	Yes	Yes

[70]

[69] Dedek, Peter B. *Historic Preservation for Designers, "Society for the Preservation of New England Antiquities".* New York City, NY: Bloomsbury, 2014 (page 10)

[70] Murtagh, William J. *Keeping Time*

ATTITUDES OF CURRENT PRESERVATIONISTS

Upon interviewing Dr. Judith Selwyn, Principle at Preservation Technology Associates, Edward Stewart of Gale Associates and Mike Riegert, Architectural Restorer and instructor at the Boston Architectural College I received feedback on their philosophies on preservation and more specifically their philosophy on the preservation of 941 and 951 Boylston Street, Boston.

Dr. Judith Selwyn stated, "Holistically speaking I do not like to clean brownstone, but it's a twin [941 and 951 Boylston Street] to the other building and aesthetically it would look better cleaned due to its location and traffic. For the most part, the brownstone is in good shape so just cleaning would most likely be all that is needed. But normally speaking I don't like to clean historic buildings."[71]

Mike Riegert stated in his written response, "Because brownstone buildings from this period all over New England have in the last ~25 years or so met a serious threshold in their durability/ability to withstand deterioration, there is much need to repair and/or replace brownstone as much of it is in really bad shape! I actually think that 951, however, is in quite good condition compared to many other comparative buildings of the period."[72]

Mr. Stewart stated, "relative to the 941 Boylston Street brownstone. We recommended non-harsh cleaning agents. These were carefully selected to determine what would work for each individual brownstone. From the mildest, soap and water, to various cleaning agents, those of which depended upon whether it was carbon staining or if it was a harsher buildup like for rust staining. Do not use aggressive chemicals or abrasive cleaners due to the brownstone being porous" in doing so he recommended restoring 951 Boylston Street but that we should maintain its aesthetic appearance.[73]

[71] Selwyn, Dr. Judy, interviewed by Patti Vaughn. Principle at Preservation Tech. Assoc.
[72] Riegert, Mike, interview by Patti Vaughn. Architectural Restorer and Instructor at the Boston Architectural
[73] Stewart, Edward, interview by Patti Vaughn. Gale Associates of Weymouth Massachusetts restoration

BROWNSTONE TESTING

SAMPLES OF BROWNSTONE FOUND AT EAST LONGMEADOW, MASSACHUSETTS

Brownstone found at the Old East Longmeadow Rail Road Station, East Longmeadow, Massachusetts [74]

Brownstone found at Brownstone Gardens apartment complex, site of the Norcross Quarries, East Longmeadow, Massachusetts [75]

SAMPLES OF BROWNSTONE FOUND AT PORTLAND, CONNECTICUT

Brownstone found at the site of the flooded Portland Quarry, Portland, Connecticut [76]

[74] Vaughn, Patti. n.d. *photos were taken by, September 2015*
[75] Vaughn, Patti. n.d. *photos were taken by, September 2015*
[76] Vaughn, Patti. n.d. *photos were taken by, September 2015*

Color analysis of brownstone for East Longmeadow, MA and Portland, CT quarries

Color analysis for brownstone from East Longmeadow, MA [77]

Color analysis for brownstone from Portland, Connecticut [78]

[77] Vaughn, Patti. n.d. *photos were taken by, September 2015*
[78] Vaughn, Patti. n.d. *photos were taken by, September 2015*

COLOR ANALYSIS SAMPLES MATCHED AGAINST BACK BAY STRUCTURES

Color analysis of Back Bay structures[79]

[79] Vaughn, Patti. n.d. *photos were taken by, October 2015*

ANALYSIS OF BROWNSTONE HARDNESS

There are various ways of testing brownstone. How strong is brownstone? Brownstone material used in the Back Bay area to build many residential homes is said to have been cut from the quarries of Portland, Connecticut. Some of the religious structures in the area are documented to have been built of brownstone which had been quarried from the Norcross Bros. Quarry in East Longmeadow, Massachusetts.

When comparing brownstone from local quarries, to brownstone structures throughout the Back Bay area, and finally to the brownstone used to build 941 and 951 Boylston Street, testing can be done to determine the hardness scale of each brownstone. Since different degrees of deterioration can be seen along with the different treatments used on the diverse brownstone structures, a hardness test on the original stone may assist in determining where the brownstone for a structure originated. This may assist a restorer in knowing the matrix of the brownstone itself and the information could contribute to their understanding how to restore a brownstone structure depending upon its origins. In researching the levels of hardness of a stone, "Testing Engineers International" gave an example of a test they had completed for brownstone which had been quarried in Colorado. The company used what is commonly known as the "Mohs Hardness Scale.[80]

The Mohs hardness scale is a testing system that was developed by a German mineralogist, Friedrich Mohs in 1812. Mohs selected ten minerals of distinctly different hardness that ranged from a very soft mineral (talc) to a very hard mineral (diamond). These kits are affordable to obtain, with the exception of diamond, and the minerals are all fairly common.[81]

[80] Gee, Merrill. *Stone Wholesale Corp.* brownstone test, http://www.stonewholesalecorp.com/PDF/brown_tests.pdf, Salt Lake City, Utah: Testing Engineers International Inc., 2002

[81] King, Hobart. *Mohs Harness Scale.* 2005-2015. http://geology.com/minerals/mohs-hardness-scale.shtml (accessed October 5, 2015).

The Mohs Hardness Test uses the 10 minerals to prove whether a stone is harder or softer then that mineral. To test the "hardness" of brownstone, for example, you would take one of these minerals and test it by scratching the surface of the brownstone. If the first mineral, Talc is scratched against the surface of the brownstone and the Talc doesn't leave a scratch then the brownstone is harder than talc on the Mohs hardness scale. You would then continue to work your way through the minerals until you either found a mineral of equal hardness, where they would not be able to scratch each other. Or if for example the brownstone is able to scratch the Fluorite (4), but the Apatite (5) is able to scratch the brownstone, it would then have a hardness of 4.5 because it falls between the two minerals on the Mohs Hardness Scale.

Table 1 Mohs Hardness Scale	
Mineral	**Hardness**
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Orthoclase	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

Mohs Hardness scratch test [82]

[82] King, Hobart. 2005-2015. *Mohs Harness Scale.* Accessed October 5, 2015. http://geology.com/minerals/mohs-hardness-scale.shtml.

Testing of East Longmeadow, Massachusetts brownstone

The East Longmeadow rail station, now closed, is known as the "Redstone rail trail", a path now used for walkers and bikers. A piece of brownstone was found near the trail (left), another found near the old Norcross quarry site (right).[83]

Testing of Portland, Connecticut brownstone

Multiple pieces and colors of brownstone were found at the Portland, Connecticut quarry, now the Brownstone Exploration and Discovery Park. Here brownstone is laid out from left to right in the order of the "hardest" stone to the "softest" stone.

[83] Vaughn, Patti. n.d. *photos were taken by, September 2015*

Testing of Back Bay brownstone structures

The following hardness test was created referencing the various Back Bay test sites, and the brownstone's hardness test results. If more than one stone was collected or tested from a site, or in situ, it is noted along with the hardness results. For example, the "BAC 951 Boylston Street, Boston, Massachusetts – light brownstone" was harder than #3-calcite which means the calcite rubbed off onto the brownstone because it was a weaker stone, whereas it was softer then the #4-flourite which means the fluorite left a scratch mark on the 951 Boylston Street brownstone.

HARDNESS ANALYSIS TEST RESULTS FOR VARIOUS BACK BAY BROWNSTONE STRUCTURES	
TEST SITES	**Brownstone hardness results**
Arlington Church, 351 Boylston St., Boston, Massachusetts - composite patch	1.5
Restoration Hardware (originally the Museum of Natural History) 234 Berkeley Street, Boston, Massachusetts	2.5
BAC, 951 Boylston Street, Boston, Massachusetts - light brownstone	**3.5**
Arlington Church, 351 Boylston St., Boston, Massachusetts	3.5
brownstone building located at 198 Commonwealth Avenue, Boston, Massachusetts (the Back Bay neighborhood)	3.5
Portland Quarries, 161 Brownstone Ave, Portland, Connecticut (Visibly larger pores in stone)	**3.5**
BAC, 951 Boylston Street, Boston, Massachusetts - dark brownstone	**4.5**
Fire Station, 941 Boylston Street, Boston, Massachusetts	4.5
Trinity Church 206 Clarendon Street, Boston, Massachusetts - dark brownstone	4.5
Trinity Church 206 Clarendon Street, Boston, Massachusetts - light brownstone	4.5
Train depot which delivered quarried brownstone, Maple Street, East Longmeadow, Massachusetts	**4.5**
Portland Quarries, 161 Brownstone Ave, Portland, Connecticut (Visibly more dense stone)	**4.5**
Brownstone Gardens apartments, (the old Norcross quarry site) located on Pleasant Street, East Longmeadow, Mass.	**5.5**
Portland Quarries, 161 Brownstone Ave, Portland, Connecticut (Visibly more sheen, as if a quartz exterior)	**6.5**

CONCLUSION FROM COLOR AND HARDNESS TEST RELATIVE TO BROWNSTONE QUARRIES

941-951 BOYLSTON STREET, BOSTON, MA – Fire Station and Boston Architectural College

- A color match completed on the darker, reddish brownstone from 951 Boylston Street, Boston suggests an East Longmeadow source.

- A second color match completed on a peachy orange colored stone from 941 and 951 Boylston Street suggests a Portland, CT quarry.

- A Mohs hardness test completed on two brownstones on the 951 Boylston Street building and one brownstone on the 941 Boylston Street building suggests both a Portland, CT quarry and an East Longmeadow quarry.

- This data does not definitively allow us to determine which location the brownstone for this structure originated.

351 BOYLSTON STREET, BOSTON, MA – Arlington Church

- A color match completed on the slate grey stone with a tinge of red did not match any quarry stones

- A second color match completed on what appears to be a reddish brown composite patch did not match the texture or color of a quarry stone.

- A Mohs hardness test completed on Arlington Church's brownstone suggests a Portland, CT quarry.

- This data does not definitively allow us to determine which location this brownstone originated. It is documented with the church that their brownstone was originally quarried in New Jersey.

243 BERKELEY STREET, BOSTON, MA – Restoration Hardware Gallery at the Museum of Natural History

- A color match completed on reddish-pink stone did not match any quarry stones. The color was very similar in texture to the composite patch found at the Arlington Church site.

- A Mohs hardness test completed at 243 Berkeley Street was softer then the Portland and East Longmeadow quarry brownstone.

- This data does not definitively allow us to determine which location this brownstone originated.

206 CLARENDON STREET – BOSTON, MA – Trinity Church

- A color match completed on the pale, tan stone suggests a Portland, CT source.
- A color match completed on a second stone which was a dark, chocolate brown suggest a Portland, CT source.
- A Mohs hardness test was completed on both stones and one example suggests a Portland, CT source the second example suggests an East Longmeadow, MA source.
- The data suggests that this brownstone most likely came from Portland, CT.

198 COMMONWEALTH AVENUE, BOSTON, MA – private brownstone building currently under construction

- A color match completed on the pale peachy, orange colored stone which also had flecks of black suggest a Portland, CT source.
- The Mohs hardness test completed on the brownstone suggests a Portland, CT source.
- The data suggests this brownstone most likely came from Portland, CT.

TYPES OF BROWNSTONE DETERIORATION AND THEIR CAUSES

There are several sources for a glossary of stone, ICOMOS is the most comprehensive one.
http://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf [84]

Others examples of "glossaries" of stone are:
"A Glossary of Historic Masonry Deterioration Problems and Preservation Treatments"
http://www.nps.gov/tps/how-to-preserve/preservedocs/Historic-Masonry-Deterioration.pdf

"Stone Conservation and overview of current research"
http://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/stoneconservation.pdf

The following are from the ICOMOS stone glossary. Images from 951 Boylston Street have been included, when possible, as examples of types of deterioration.
Other examples of brownstone deterioration throughout the Back Bay have been included as well.

CRACK & DEFORMATION

1. *CRACK: Individual fissure, clearly visible by the naked eye, resulting from separation of one part from another.*
   Example:

Crack [85]

   a) *FRACTURE: Crack that crosses completely the stone piece*
   b) *STAR CRACK: Crack having the form of a star. Rusting iron or mechanical impact are possible causes of this type of damage.*
   c) *HAIR CRACK: Minor crack with width dimension <0.1mm*
   d) *CRAQUELE: Network of minor cracks also called crack network. The term crazing is not appropriate for stone, as this term should be used for describing the development of a crack network on glazed terracotta*
   e) *SPLITTING: Fracturing of stone along planes of weakness such as micro cracks of clay/silt layers, in case where the structural elements are orientated vertically. For instance, a column may split into several parts along bedding planes if the load above it is too high.*

2. *DEFORMATION: Change in shape without losing integrity, leading to bending, buckling or twisting of a stone block*
3.

[84] Cartwright, Tamara Anson, et al. "ICOMOS." *ISCS-International Scientific Committee for Stone.* September 2008. http://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf (accessed August 7, 2015).
[85] Vaughn, Patti. n.d. *photos were taken by, August 31, 2015*

DETACHMENT

1. *BLISTERING: Separated, air-filled, raised hemispherical elevations on the face of stone resulting from the detachment of an outer stone layer. This detachment is not related to the stone structure.*

2. *BURSTING: Local loss of the stone surface from internal pressure usually manifesting in the form of an irregularly sided crater.*

3. *DELAMINATION: Detachment process affecting laminated stones (most of sedimentary rocks, some metamorphic rocks…). It corresponds to a physical separation into one of several layers following the stone laminae. The thickness and the shape of the layers are variable. The layers may be orientated in any direction with regards to the stone surface.*
    a) *EXFOLIATION: Detachment of multiple thin stone layers (cm scale) that are sub-parallel to the stone surface. The layers may bend, twist in a similar way as book pages.*

4. *DISINTEGRATION: Detachment of single grains of aggregates of grains.*
    a) *CRUMBLING: Detachment of aggregates of stone from the substrate. These aggregates are generally limited in size (less than 2 cm). This size depends on the nature of the stone and its environment*
    b) *GRANULAR DISINTEGRATION: Occurs in granular sedimentary (e.g. sandstone) and granular crystalline (e.g. granite) stones. Granular disintegration produces debris referred to as a rock meal and can often be seen accumulating at the foot of wall actively deteriorating. If the stone surface forms a cavity (coving), the detached material may accumulate through gravity on the lower part of the cavity. The grain size of the stone determines the size of the resulting detached material. The following specific terms, all related to granular disintegration , refer either to the size, or to the aspect of corresponding grains:*
        ***Powdering, chalking**: terms sometimes employed for describing granular disintegration of finely grained stones.*
        ***Sugaring**: employed mainly for white crystalline marble,*
        ***Sanding**: used to describe granular disintegration of sandstones and granites.*

5. *FRAGMENTATION: The complete or partial breaking up of a stone, into portions of variable dimensions that are irregular in form, thickness and volume.*
    a) *SPLINTERING: Detachment of sharp, slender pieces of stone, split or broken off from the main body.*
    b) *CHIPPING: Breaking off of pieces, called chips, from the edges of a block. Example:*

Chipping [86]

[86] Vaughn, Patti. n.d. *photos were taken by, October 2015*

6. *PEELING: Shedding, coming off, or partial detachment of a superficial layer (thickness: submillimetric to millimetric) having the aspect of a film or coating which has been applied on the stone surface.*

7. *SCALING: Detachment of stone as a scale or a stack of scales, not following any stone structure and detaching like fish scales or parallel to the stone surface. The thickness of scale is generally of millimetric to centimetric scale, and is negligible compared to its surface dimension.*
    a) *FLAKING: Scaling in thin flat or curved scales of submillimetric to millimetric thickness, organized as fish scales.*
    Example:

Flaking [87]

    b) *CONTOUR SCALING: scaling in which the interface with the sound part of the stone is parallel to the stone surface. In the case of flat surfaces, contour scaling may be called* ***spalling****.*
    Example:

Spalling [88]

FEATURES INDUCED BY MATERIAL LOSS

1. *ALVEOLIZATION: Formation, on the stone surface, of cavities (alveoles) which may be interconnected and may have variable shapes and sizes (generally centimetric, sometimes metric).*
    Example:

Alveolization [89]

[87] Vaughn, Patti. n.d. *photos were taken by, August 2015*
[88] Vaughn, Patti. n.d. *photos were taken by, August 2015*
[89] Vaughn, Patti. n.d. *photos were taken by, October 2015*

a) *Coving: Disaggregation of individual geologically weaker sandstone blocks due to the consequential effect of repointing the joint and beds with a too hard and durable mortar containing cement. This is an erosion feature consisting in a single alveole developing from the edge of the stone block.*
Example:

Coving [90]

2. *EROSION: Loss of original surface, leading to smoothed shapes.*
   a) *Differential Erosion: to be preferred to differential deterioration: occurs when erosion does not proceed at the same rate from one area of the stone to the other. As a result, the stone deteriorates irregularly. This feature is found on heterogeneous stones containing harder and/or less porous zones. It may also occur as a result of selective lichen attack on calcitic stones. Differential erosion is generally found on sedimentary and volcanic stones. Differential erosion is synonymous with relief formation, i.e., to the formation of irregularities on the stone surface. Differential erosion may result in loss of components or loss of matrix of stone.*

      1) *Loss of components: Partial or selective elimination of soft (clay lenticels, nodes of limonite, etc.) or compact stone components (pebbles, fossil fragments, geological concretions, lava fragments).*
      2) *Loss of matrix: Partial or selective elimination of the stone matrix, resulting in protruding compact stone components.*

   b) *Rounding: Preferential erosion of originally angular stone edges leading to a distinctly rounded profile. Rounding can especially be observed on stones which preferably deteriorate through granular disintegration, or when environmental conditions favor granular disintegration.*
   c) *Roughening: Selective loss of small particles from an originally smooth stone surface. The substrate is still sound. Roughening can appear either progressively in case of long term deterioration process (for instance in case of granular disintegration), or instantaneously in case of inappropriate actions, such as aggressive cleaning.*

[90] Cartwright, Tamara Anson, et al. "ICOMOS." *ISCS-International Scientific Committee for Stone.* September 2008. http://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf (accessed August 7, 2015).

3. *MECHANICAL DAMAGE: Loss of stone material clearly due to a mechanical action. Example:*

Mechanical damage [91]

a) *IMPACT BREAKAGE: Mechanical damage due to the impact of a projectile (bullet, shrapnel) or of a hard tool.*
Example:

Impact Damage [92]

b) *CUT: Loss of material due to the action of an edge tool. It can have the appearance of an excavated cavity, an incision, a missing edge, etc….Tool marks can be considered as special kinds of cuts but should not be considered as damage features.*

c) *SCRATCH: Manually induced superficial and line-like loss of material due to the action of some pointed object. It can be accidental or intentional. Usually it appears as a more or less long groove. Tool marks can have the appearance of scratches, but should not be taken as damage features.*
Example:

Scratch [93]

[91] Vaughn, Patti. n.d. *photos were taken by, August 10, 2015*
[92] Vaughn, Patti. n.d. *photos were taken by, August 8, 2015*
[93] Vaughn, Patti. n.d. *photos were taken by, August 2015*

d) *ABRASION: Erosion due to wearing down or rubbing away by means of friction, or to the impact of particles.*

e) *KEYING: Impact damage resulting from hitting a surface with a pointed tool, in order to get an irregular surface which will assist the adhesion of an added material, a mortar for instance.*

4. *MICROKARST: Network of small interconnected depressions of millimetric to centimetric scale, sometimes looking like hydrographic network, Microkarst patterns are due to a partial and/or selective dissolution of calcareous stone surfaces exposed to water run-off.*

5. *MISSING PART: Empty space, obviously located in the place of some formerly existing stone part. Protruding and particularly exposed parts of sculptures (nose, fingers….) are typical locations for material loss resulting in missing parts.*
   a) *GAP: hollow place in the stone surface, a hole.*

6. *PERFORATION: A single or series of surface punctures, holes or gaps, made by a sharp tool or created by an animal. The size is generally of millimetric to centimetric scale. Perforations are deeper than wide, and penetrate into the body of the stone.*

7. *PITTING: Point-like millimetric or submillimetric shallow cavities. The pits generally have a cylindrical or conical shape and are not interconnected, although transitions patterns to interconnected pits can also be observed.*
   Example:

Pitting [94]

DISCOLORATION & DEPOSIT

1. *CRUST: Generally coherent accumulation of materials on the surface. A crust may include exogenic deposits in combination with materials derived from the stone. A crust is frequently dark colored (black crust) but light colors can also be found. Crusts may have a homogenous thickness, and thus replicate the stone surface, or have irregular thickness and disturb the reading of the stone surface details.*

[94] Vaughn, Patti. n.d. *photos were taken by, October 2015*

a) *BLACK CRUST: Kind of crust developing generally on areas protected against direct rainfall or water runoff in urban environment. Black crusts usually adhere firmly to the substrate. They are composed mainly of particles from the atmosphere, trapped into a gypsum (CaSO4.2H20) matrix.*
Example:

Black Crust [95]

b) *SALT CRUST: Crust composed of soluble salts, which develop in the presence of high salt levels, and form from wetting and drying cycles.*

2. *DEPOSIT: Accumulation of exogenic material of variable thickness. Some examples of deposits: splashes of paint or mortar, sea salt aerosols, atmospheric particles such as soot or dust, remains of conservation materials such as cellulose poultices, blast materials etc...*
Example:

Deposits [96]

3. *DISCOLORATION: Change of the stone color in one to three of the color parameters: hue, value and chroma.*
   I. *Hue corresponds to the most prominent characteristic of a color (blue, red yellow, orange, etc.)*
   II. *Value corresponds to the darkness (low hues) or lightness (high hues) of a color.*
   III. *Chroma corresponds to the purity of a color. High chroma colors look rich and full. Low chroma colors look dull and grayish. Sometimes chroma is called saturation.*

      a) *COLORATION (to be preferred to coloring): change in hue, value and/or a gain in chroma*
      b) *BLEACHING (or fading): gain in value due to chemical weathering of minerals (e.g. reduction of iron and manganese compounds) or extraction of coloring matter (leaching, washing out), or loss of polish, generally very*

[95] Vaughn, Patti. n.d. *photos were taken by, August 12, 2015*
[96] Vaughn, Patti. n.d. *photos were taken by, August 2015*

superficial. Dark and bright color marbles often show bleaching as a result of exposure to weather.

c) *MOIST AREA: corresponds to the darkening (lower hue) of a surface due to dampness. The denomination moist area is preferred to moist spot, moist zone or visible damp area.*

d) *STAINING: kind of discoloration of limited extent and generally of unattractive appearance.*
Example:

Staining [97]

4. *EFFLORESCENCE: Generally whitish, powdery or whisker-like crystals on the surface. Efflorescence's are generally poorly cohesive and commonly made of soluble salt crystals.*
EXAMPLE:

Efflorescence [98]

5. *ENCRUSTATION: Compact, hard, mineral outer layer adhering to the stone. Surface morphology and color are usually different from those of the stone.*

a) *Concretion: Kind of encrustation having a specific shape: nodular, grape-like or raspberry like. Concretions may even have conic shapes of form drapery-like vertical sheets. Stalagmites and stalactites are kinds of concretions. In general, concretions do not outline, contour the surface of the stone, and are of limited extent.*

6. *FILM: Thin covering or coating layer generally of organic nature, generally homogeneous, follows the stone surface. A film may be opaque or translucent.*

[97] Vaughn, Patti. n.d. *photos were taken by, September 10, 2015*
[98] Vaughn, Patti. n.d. *photos were taken by, September 2015*

7. *GLOSSY ASPECT: Aspect of a surface that reflects totally or partially the light. The surface has a mirror-like appearance.*

8. *GRAFITTI: Engraving, scratching, cutting or application of paint, ink or similar matter on the stone surface.*

9. *PATINA: Chromatic modification of the material, generally resulting from natural or artificial ageing and not involving in most cases visible surface deterioration.*

    a) *IRON RICH PATINA: Natural black to brown thin layer enriched in iron/clay minerals, which can be found on iron containing sandstones. This kind of patina is generally observed in outdoor environments, and develops quite uniformly on the stone surface.*

    b) *OXALATE PATINA: Orange to brown thin layer enriched in calcium oxalates. This kind of patina may be found in outdoor environments, often on marble and limestone substrates.*

10. *SOILING: Deposit of a very thin layer of exogenous particles (example: soot) giving a dirty appearance to the stone surface.*

11. *SUBFLORESCENCE: Poorly adhesive soluble salts, commonly white, located under the stone surface.*

BIOLOGICAL COLONIZATION

1. *BIOLOGICAL COLONIZATION: Colonization of the stone by plants and micro-organisms such as bacteria, cyanobacteria, algae, fungi and lichen (symbioses of the latter three). Biological colonization also includes influences by other organisms such as animals nesting on and in stone.*

2. *ALGA(E): Algae are microscopic vegetal organisms without stems or leaves which can be seen outdoors and indoors, as powdery or viscous deposits (thickness: tenth of a mm to several mm). Algae form green, red, brown, or black veil like zones and can be found mainly in situations where the substrate remains moistened for long periods of time. Depending on the environmental conditions and substrate type, algae may form solid layers or smooth films. On monuments, algae are constituted of unicellular to plural-cellular clusters, and they never form macro organisms.*

3. *LICHEN: A vegetal organism forming rounded millimetric to centimetric crusty or bushy patches, often having a leathery appearance, growing generally on outside parts of a building. Lichen are most commonly grey, yellow, orange, green or black and show no differentiation into stem, root and leaf.*

4. *MOSS: A vegetal organism forming small, soft and green cushions of centimetric size. Mosses look generally like dense micro-leaves (sub- to millimetric size) tightly packed together. Mosses often grow on stone surface open cavities, cracks, and in any place permanently or frequently wet (masonry joints), and usually shady.*

5. *MOULD (MOLD): Microscopic fungus which colonies, to the naked eye, look like a downy film or a network or star-like millimetric patches of filaments of diverse colors (white, grey, and black).*

6. *PLANT: A vegetal living being, having, when complete, root, stem, and leaves, though consisting sometimes only of a single leafy expansion (example: Tree, fern, herb).*[99]

ENVIRONMENTAL DETERIORATION CAUSES

Climate deterioration causes

Climate changes affect stone if the way they are positioned in their original habitat is not taken into consideration. Therefore when using brownstone in building a structure the stone should be laid on its "bed," not on its "edge". Deterioration will occur in the earlier years, such as flaking and pitting.[100] Over many years of exposure to the elements, especially water and frost, the exposure to the stone going through a "freeze-thaw" cycle, can cause even more serious issues of flaking, contour scaling or spalling where portions of the stone will detach from themselves or slowly disintegrate the stone. It has been mentioned in many conversations that brownstone needs to "breathe". Deterioration varies depending upon the strength of the stone as well, therefore you will see around the Back Bay district how some brownstone structures have stood the test of time whereas others have had severe brownstone deterioration.

[99] Cartwright, Tamara Anson, et al. "ICOMOS." *ISCS-International Scientific Committee for Stone.* September 2008.
[100] Smock, John C. "Bulletin of the New York State Museum of Natural History No. 7, Issue 7-10." *First Report on the Iron Mines and Iron-Ore Districts in the State of New York.* June 1889. https://books.google.com/books?id=DrQWAQAAIAAJ&pg=PA391&lpg=PA391&dq=climate+effects+on+brownstone&source=bl&ots=-nh263_37j&sig=bQkLxlUMjHJP_pOzPuY7s4-JSvU&hl=en&sa=X&ved=0CEAQ6AEwBmoVChMI5oO85Mz_xwIVRm4-Ch2hJQsP#v=onepage&q=climate%20effects%20on%20brown (accessed September 2015). Pg 380-384

Urban pollution deterioration causes

 [101]

941-951 Boylston Street across from the Boston & Albany Railroad Line, Boston, Massachusetts

In 1912 the 941 and 951 Boylston Street Fire House and Police Station were situated across from what was once the Boston & Albany Railroad line, now the MBTA railroad tracks. These trains ran on coal and over time a buildup of layers of black crust appeared on the 951 Boylston Street building.[102] Upon interviewing Mr. Stewart, of Gale Associates located in Weymouth, MA, of whom restored the 941 Boylston structure, he claimed, the black buildup is believed to be from environmental pollutants due to the high carbon content in the air from the buildings early years. Carbon staining and rust staining were also found on the exterior and were restored dependent upon these causes of deterioration.[103]

Mortar deterioration causes

Over time mortar, which is used to bind the brownstone blocks, filling and sealing the gaps, will break down. This is to be expected but mortar is easier to recreate than the replacement of the physical brownstone. Mortar needs to be created of a "softer" matrix than brownstone, if the

[101] Boston Fire Historical Society, Inc. 2015. *Active Fire House 941 Boylston Street*

[102] Nicholson, J. M. "Railway Age and Railway Review, Volume 66, Issue 2 - Locomotive Fuel Losses at Terminals." *google books.* May 23, 1919. https://books.google.com/books?id=gkE_AQAAMAAJ&pg=PA1253&dq=Boston+%26+Albany+Railroad+train+did+they+run+on+coal+or+steam?&hl=en&sa=X&ved=0ahUKEwin-tLBtKLJAhWFOT4KHbfHCDcQ6AEIIjAB#v=onepage&q=Boston%20%26%20Albany%20Railroad%20train%20did%20they%20run%20 (accessed November 21, 2015).

[103] Stewart, Edward, interview by Patti Vaughn. *Gale Associates of Weymouth Massachusetts*

mortar is "harder" it will cause deterioration to the brownstone itself over time. In most cases mortar has been repointed in structures throughout the years. The question today is whether or not the current mortar is compatible to the old mortar and is the mortar "soft" or "hard". A mortar which is "softer" then the brownstone is needed so the brownstone can maintain its structural makeup.

Contemporary stone restoration experts have differing attitudes about the process for mortar restoration. Mr. Ed Stewart of Gale Associates, Weymouth, MA, whose company did the restoration work on the 941 Boylston Street, Boston, MA fire station, informed me during our interview, "We generally do a petrographic analysis; a test of the mortar's hardness. We would check the porosity and analyze the content of the mortar to see if it had a high lime content. We found the mortar at 941 Boylston Street, Boston, Massachusetts had a "hard" composition and because of this, deterioration was occurring on the brownstone instead of the mortar. We then created a mortar that was a softer "hardness" to resolve this issue so there would be less damage over time to the brownstone material**."**[104]

When it comes to mortar testing, Dr. Judith Selwyn, Principle at Preservation Technology Associates, holds that it "is not scientific and quite useless [to do a petrographic analysis], look at the building and see if it has been repointed. In many cases it has been repointed in years past. Are those mortars compatible to the old mortar and what was repointed? Are the mortars soft mortars and how has it been applied? Was it cut out properly? Sometimes we test the mortar, the question is, what information are we trying to get from testing the mortar? Clearly understand the purpose of the testing and what info are you trying to get. Also if there's a crack, how far into the material do the cracks extend? How deep are they? If they are superficial there shouldn't be an issue, if there is structural concern this is when further investigation needs to

[104] Stewart, Edward, interview by Patti Vaughn. *Gale Associates*

occur."[105] The mortar on portions of 951 Boylston has most likely been repointed in the past. Deterioration can be seen in various areas where mortar would need to be restored. If the existing mortar had been created to be too "hard" then it would need to be repointed and recreated to be a similar color and at a level of "softness" to be consistent with the original mortar which had appeared on the facade.

106

Mortar missing between the brownstone column pieces

Mike Riegert, Architectural Restorer and Instructor at the Boston Architectural College informed me, "A critical fact to know about brownstone (sandstone) is that it has a completely different pH than calcareous stone. It is more acidic on the pH scale. Why this is critical to know is for the specifying of mortars and if called for, cleaners (and I hope cleaning is not chemical in nature)! Natural Hydraulic Lime is more basic in pH, meaning in theory, it is less compatible and possibly leaning toward harmful in brownstone. This means testing for the current level of the brownstone's pH before and during the mortar trial should definitely take place, followed by monitoring, and continued testing to ensure there is not further deterioration from using a mortar that is on the pH scale that is a different material."[107]

[105] Selwyn, Dr. Judy, interview by Patti Vaughn. Principle at Preservation Tech. Assoc.
[106] Vaughn, Patti. n.d. *photos were taken by.*
[107] Riegert, Mike, interview by Patti Vaughn. Architectural Restorer and *Instructor at the Boston Architectural*

Companies such as US Heritage, do petrographic mortar analysis which is time consuming and expensive but provides the most data. Modern mortars are analyzed, if accurate binder proportions are required, since their unbound lime content makes acid digestion analysis inconclusive. They do state that "*Analysis of historic mortars based on petrographic analysis alone can result in inappropriate mix design as early Portland cement was not nearly as strong/reactive or consistent as modern Portland cement."*[108] Mortar color matching can be done as well. This is where the company will add pigments to reproduce a replacement mortar that is close in color to the original mortar samples.[109]

AGE DETERIORATION CAUSES

Age deterioration can have many different effects on brownstone. Mike Riegert informed me that case hardening could occur. This is where "There is something a bit more unique with brownstone that happens compared (somewhat) to other stones. What this is, is that after it is quarried and presumably properly seasoned to allow the moisture to escape, prior to being used in construction, it forms a kind of skin of sorts that is referred to by scientists (geologists and physical geographers) as 'case hardening'[110]." "Essentially, the outer layers of the stone become harder than the inner matrix of the stone. I think this explains why for approximately 150 years brownstone seemed as if it were a "good" and durable stone; the surface appeared hard and in good condition. However, behind this appearance, the inner matrix of the stone was probably deteriorating until the "moment" when the outer surface could no longer hold this all together, and voila, the results are what often is present in a bad case of brownstone decay phenomenon."[111]

[108] US Heritage Group, Inc. *US Heritage Group - Mortar Analysis and Matching Services.* September 2015. http://usheritage.com/services/mortar-analysis-and-matching-services/
[109] US Heritage Group, Inc. *US Heritage Group - Mortar Analysis and Matching Services*
[110] Riegert, Mike, interview by Patti Vaughn. Architectural
[111] Riegert, Mike, interview by Patti Vaughn. Architectural

Tablet style tombstones made of brownstone are an example of stone that tends to have case hardening issues. Since it is created of one piece of brownstone and is partially buried underground, it acts like a sponge, absorbing moisture from the ground up into the stone. If the portion that is above ground has been sealed it will still wick up moisture and salts and won't be able to dry out. This is when case hardening occurs. A harder protective crust will form on the outside of the stone which will weaken the interior of the stone and portions of the stone over time will fall away.[112]

Savannah, Georgia, brownstone tombstone where an example of case hardening can be seen [113]

[112] Apell, Jonathan. *Gravestone Preservation.Info.* November 27, 2010. http://www.gravestonepreservation.info/articles/sealing-stone (accessed September 15, 2015)
[113] Vaughn, Patti. n.d. *photos were taken by., November 2014*

TECHNIQUES FOR REPAIR, RESTORATION AND CLEANING OF BROWNSTONE

TECHNIQUES FOR REPAIR AND RESTORATION

Composite Repairs

The most common repair and restoration needed on brownstone is due to exfoliation, contour scaling and coving. In certain instances composite repairs can be applied. This is when the tinted mortar-like patch is made to fill in the surface of deteriorated stone. Primarily used for areas where there is mechanical damage or an entire face of an area has been exfoliated. These composite repairs last better in areas where they are not exposed to extreme weather conditions.[114]

For this type of repair to adhere to the surface it requires the removal of all deteriorated stone down to its solid surface. A rough texture is then created in the solid surface, this way the composite repair patch will adhere and be anchored to the wall. The composite repair must be at least ¾" thick to be durable. For large repairs armature can be used for additional support, rods can be made of fiberglass, nylon, or stainless steel. In some instances entire facades have been refaced and covered with a tinted stucco. This is not recommended unless a façade is extremely deteriorated or the refacing has already been done as a previous repair.[115] The proper repair mixture and proper color matching can be difficult but is essential to create a cohesive finish on the brownstone's façade. Even with a good color matching, a repair can look artificial if the surface grains aren't created to closely resemble the natural sandstone. This is commonly achieved with acid etching or rubbing stones to remove the thin outer film of pigmented cement binder exposing the shape, size, color and distribution of the aggregate grains at the surface of

[114] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide.* 2012. http://www.mzarchitects.com/wp-content/uploads/2012/04/BrownstoneGuide.pdf
[115] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide.* 2012.

the repair. Patches can also be stippled with a sponge or dry-troweled to create surface effects. Tool marks and patterns can also be created to match the surface of the original stone.[116]

Unit replacement

Occasionally a portion of a brownstone façade needs to be replaced. If this is the case "unit replacement" is an appropriate approach. Natural stone or cast stone can be used as a replacement unit. Unfortunately brownstone material is harder to obtain with so many quarries closed, another option for replacement is salvaged material from buildings which have been demolished. Another option would be to obtain a similar stone which closely resembles brownstone. When the stone is attached to the façade, always make sure it's laid as it was naturally bedded so as not have immediate weathering issues. Cast stone is a third option where precast concrete is tinted and refinished to resemble the original brownstone. This is an economical and more durable option especially for such areas as stair treads. The use of crushed brownstone can be used in the cement mixture along with sand and coarse aggregate, this will create a durable color match to the original brownstone. The natural stone replacement would be the appropriate choice for a unit replacement repair.[117]

A missing piece of brownstone from 951 Boylston Street, Boston [118]

[116] Bryan, Roy, and Kobe Z. "Valerie Haboush Brownstone City." *Brownstone Restoration and Repair.* October 12, 2013. http://www.valeriehaboush.com/brownstone.pdf (accessed September 2015).
[117] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide*
[118] Vaughn, Patti. n.d. *photos were taken by. November 2015*

Dutchmen Repairs

When a composite repair is not feasible, or unlikely to last, a "dutchman" repair is used. A stone dutchman is when a piece of stone is cut and set into a larger piece of stone which has been damaged or is missing a piece of its original stone. A dutchman is beneficial to use in areas that are exposed to wet conditions because it will generally be more durable and more visually appealing then a composite repair. A "full face" dutchman may be used for deterioration which has occurred to a significant depth and the stone surface needs to be durable. Oftentimes a dutchman is used where an exposed repair overhangs an entry or sidewalk and the failure of a composite repair could create a hazard.[119]

Dutchman Repair [120]

Retooling

Retooling of the surface of stone can be achieved when the area of deterioration is too shallow for a composite repair. Reworking the deteriorated surface of an individual stone by retooling can be successful when the original surface is roughly tooled and the plane of the surface is not extremely important. If the stones surface is smooth or finely tooled this type of

[119] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide*

[120] vertical-access.com. "Vertical Access." *Vertical Access, Technical Highlight, Conditions Glossary.* February 8, 2012. Referring www.google.com, http://www.vertical-access.com/download/conditions%20glossary.pdf (accessed November 22, 2015).

repair is more difficult. Retooling a surface is only advisable if the outcome will be similar to the original surface.[121]

An example of a retooled brownstone surface [122]

Consolidation Repairs

In more recent years liquid preservatives have been developed to "consolidate" or strengthen deteriorated stone. These are currently only recommended when a stone surface is slowly eroding or where an original carving or retooling is presently threatened. They are not useful for adhering separated surface layers or to repair severe damage.[123]

Painting

Painting is generally not recommended because even vapor permeable paints can retard the passage of moisture through brownstone which can cause the underlying, inner matrix of the stone to deteriorate. When brownstone has a crack or open joint this allows water to enter the masonry but painting could then trap the water and not allow it to dry out. If there are numerous

[121] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide*
[122] Diocese of Paterson. 2015. "December 2014 - Masonry & Roof Structure." *Diocese of Paterson.* November 22. Accessed November 22, 2015. http://rcdop.org/news/december-2014-roof-structure-repair.
[123] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide*

layers of paint added over time this buildup can also lead to future damage by trapping moisture behind the stone. Paint won't preserve decayed stone either, since the paint will only adhere to sound material on the exterior of the facade.[124]

 [125]

[124] Bryan, Roy, and Kobe Z. "Valerie Haboush Brownstone City." *Brownstone Restoration and Repair.* October

[125] Vaughn, Patti. n.d. *photos were taken by. 2015*

TECHNIQUES FOR CLEANING OF BROWNSTONE

Preservationists currently tend to recommend no cleaning or minimal cleaning of historic brownstone structures. When cleaning is to be done, the mildest cleaners are recommended. Mr. Edward Stewart of Gale Associates recommended the mildest soap and water, then various mild cleaning agents depending upon the type of stains which needed to be removed from the stone. No aggressive chemicals or abrasive cleaners should be used due to the porous nature of brownstone. Gale Associates carefully selects various cleaning agents dependent upon the degree of buildup on the surface. Brownstone absorbs and takes on moisture, acting like a sponge, the brownstone then needs to dry out. Sometimes companies like to use finishes to protect stone, unfortunately some companies have tried using a clear finish to protect the brownstone but this actually causes more damage since the water will get trapped inside the stone. During a freeze-thaw cycle of weather conditions this can cause more spalling damage.[126] The Brownstone guide recommends careful cleaning to protect brownstone from pollutants or excess dirt build-up. A cleaner created using water and a non-ionic detergent wash should be the tested first. Do not do any harsh cleaning such as sand blasting or any high pressure water blasting. No abrasive cleaning or paint removal techniques should be used, as they could cause further damage. If a brownstone has been painted, paint removal can be detrimental to the stone, so make sure to test a location prior to stripping any built up paint so as not to damage the stone.[127]

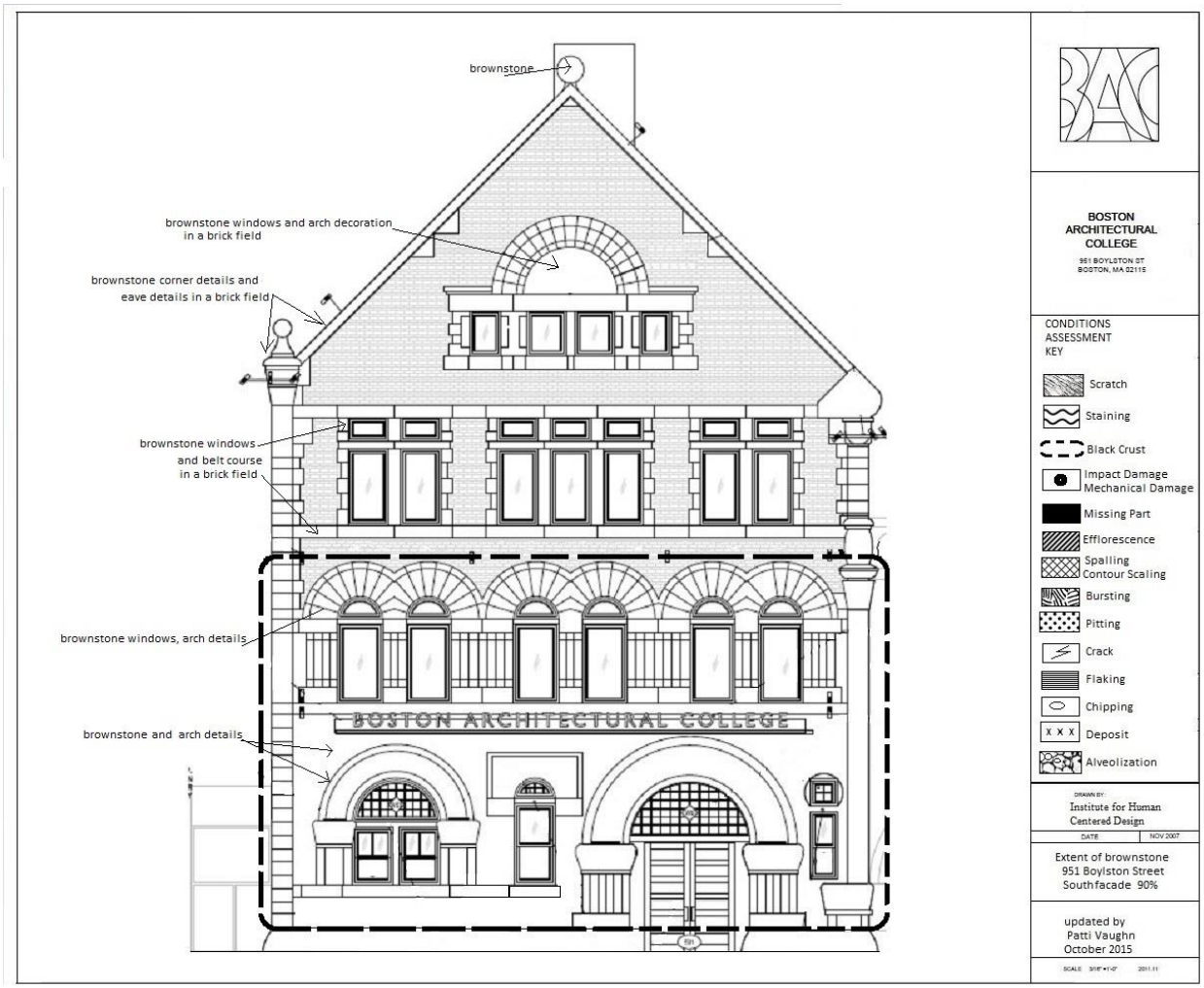
[126] Stewart, Edward, Gale Associates
[127] Pieper, Richard D., Ward Dennis, and William J. Higgines. *The Brownstone Guide*

CASE STUDY: REPAIRING THE BROWNSTONE AT 951 BOYLSTON STREET, BOSTON, MA

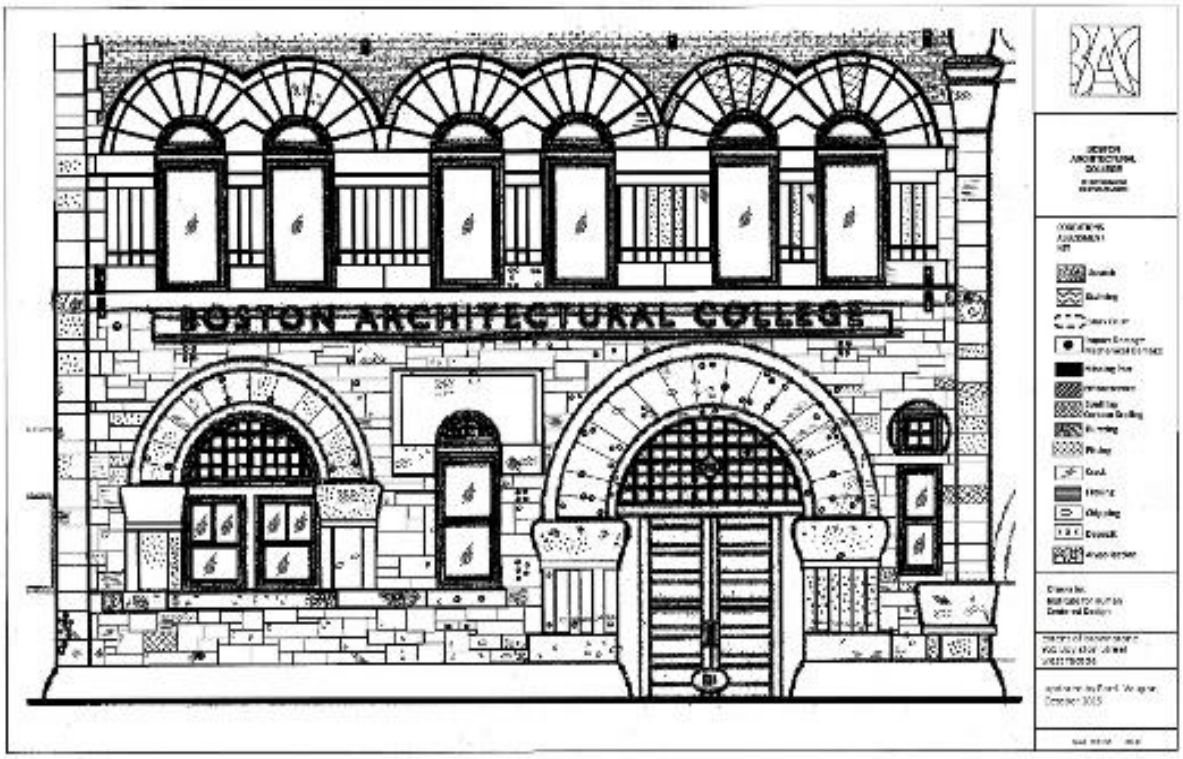
EXTENT OF BROWNSTONE AND CONDITIONS ASSESSMENTS

The National Park Service, U.S. Department of Interior website, presents a preservation brief on "The Preparation and Use of Historic Structure Reports," by Deborah Slaton, where she informs the public of when preservation, rehabilitation, restoration or reconstruction work is to be done to document a historic building, such as 951 Boylston Street, which is part of Boston's Back Bay historic district. Prior to making a decision whether to restore 951 Boylston Street, certain information needs to be accumulated before a decision can be made. The history of the building is collected, its existing condition is documented including photographs, measured drawings and the possible approach and treatment that is to be undertaken to the structure.[128] On the following pages the extent of brownstone on each façade: north, south, east and west, of the 951 Boylston Street building has been documented along with a conditions assessment report. [Please note: The treatment of the brick on the 951 Boylston Street building is not covered in this report.] General recommendations of treatment to the areas of deterioration on the brownstone will be presented in reference to the findings of the conditions assessment reports.

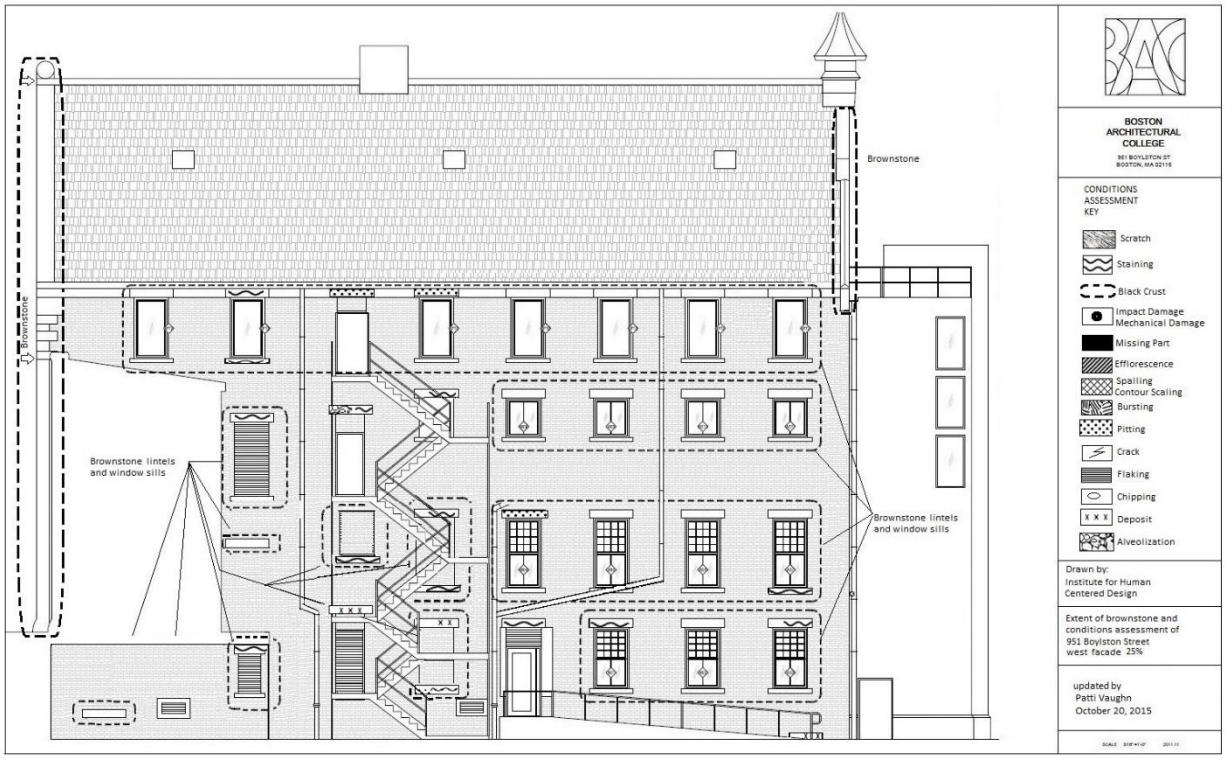
[128] Slaton, Deborah. *The Preparation and Use of Historic Structure Reports.* August 27, 2005. http://www.nps.gov/tps/how-to-preserve/briefs/43-historic-structure-reports.htm (accessed August 27, 2015).



951 Boylston Street, south façade, extent of brownstone

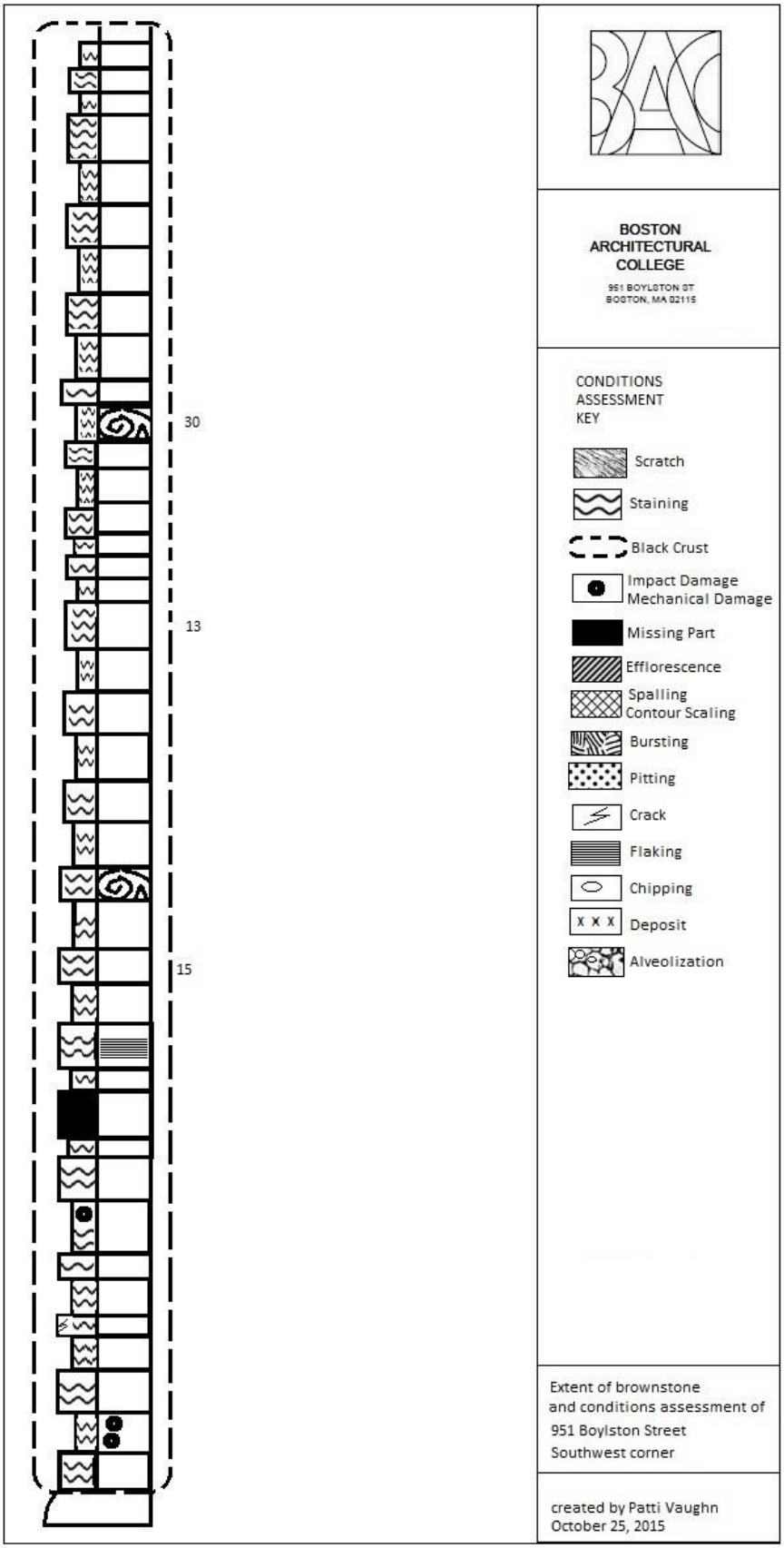


951 Boylston Street, south façade, conditions assessment

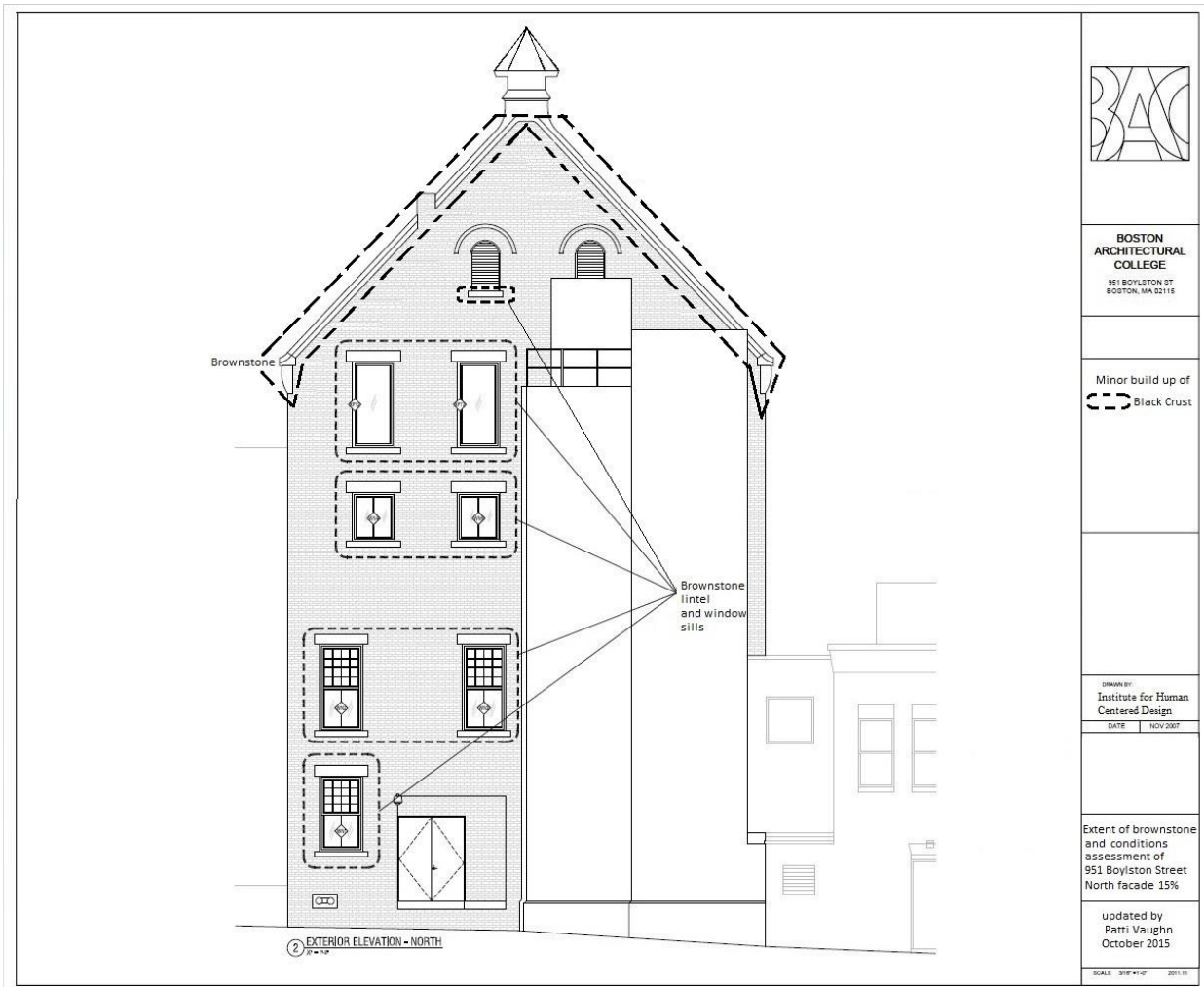


951 Boylston Street, east façade, extent of brownstone and conditions assessment

951 Boylston Street, west façade, extent of brownstone and conditions assessment



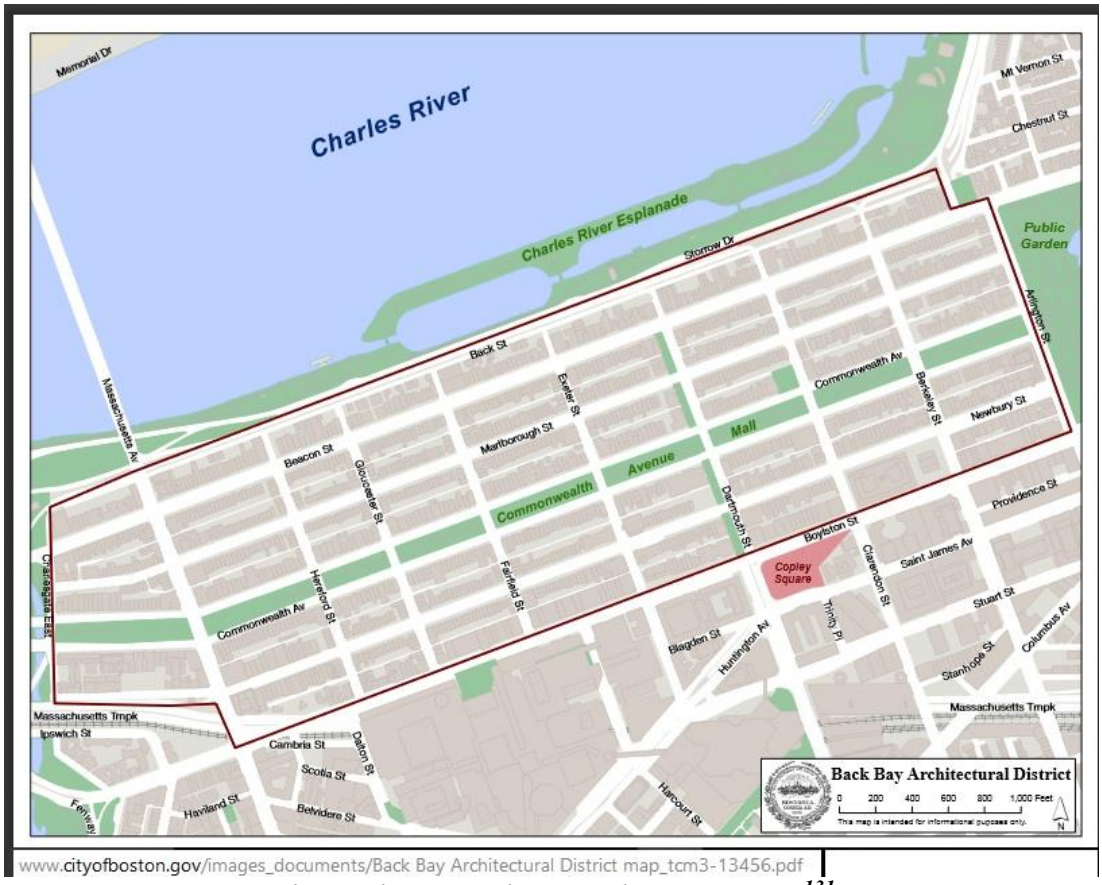
951 Boylston Street, southwest corner, extent of brownstone and conditions assessment



951 Boylston Street, north façade, extent of brownstone and conditions assessment.

LEGAL RESTRICTIONS OR PROCEDURES

In 1966 by Act of the Massachusetts Legislature (Chapter 625 of the Acts of 1966, as amended). The Back Bay Architectural District was designated. Due to this designation the city of Boston requires all exterior work, whether visible to the public or not, be reviewed before the Back Bay Architectural Commission.[129] "A Certificate of Appropriateness, Design Approval, or Exemption Application must be submitted to and approved by the Commission prior to beginning any exterior work."[130]



The Back Bay Architectural District map [131]

[129] City of Boston.gov. *Back Bay History.* August 6, 2015. http://www.cityofboston.gov/landmarks/historic/backbay.asp (accessed August 6, 2015).
[130] City of Boston.gov. *Back Bay History.* August 6, 2015. http://www.cityofboston.gov/landmarks/historic/backbay.asp (accessed August 6, 2015).
[131] City of Boston. "City of Boston.gov." *Back Bay, History, Back Bay Architectural District map.* October 30, 2015. http://www.cityofboston.gov/landmarks/historic/backbay.asp (accessed August 2015)

The "*BACK BAY ARCHITECTURAL DISTRICT COMMERCIAL GUIDELINES*" were created in 1974 when the Back Bay Residential District, enlarged by Chapter 463, Acts of 1974 (effective August 3, 1974), to include the commercial district of the Back Bay. Now called the Back Bay Architectural District this includes Newbury Street, the north side of Boylston Street from Dartmouth Street to Massachusetts Avenue, along with the intervening connecting streets.

The area was further expanded upon, under Chapter 645 of the Acts of 1979, to include Newbury Street, the north side of Boylston streets from Dartmouth Street to Arlington Street, again including the intervening cross streets. Under Chapter 624 of the Acts of 1981 the Commissions guidelines' jurisdiction was expanded further to include all exterior features of buildings. This included alley elevations even those not visible from a public way. These guidelines present an overview of what details are to be included: Façade changes, extensions into front and side yards, demolition, entrances; first-floor retail conversions of originally residential spaces, original facades, fire escapes, existing store fronts, signage, lighting and paving along with many more. If a color is to be changed, samples are required to be submitted for approval. In order to maintain compliance with the Back Bay Architectural Commission (BBAC) any changes to be made or cleaning and restoration to the 951 Boylston Street building must be submitted to the BBAC for review and approval.[132]

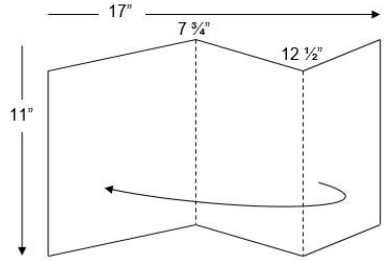
[132] City of Boston.gov. *Back Bay History.* Commercial District Guidelines, August 6, 2015. http://www.cityofboston.gov/landmarks/historic/backbay.asp (accessed August 6, 2015)

ALTERNATIVE GOALS AND PHILOSOPHIES OF BROWNSTONE REPAIR OF 951 BOYLSTON STREET

A grid has been created of the various philosophies of restoration and how they would relate to 951 Boylston Street, taking into account Iconic preservationists and their philosophy on preservation and restoration as well as taking into account restoration work that has been recently completed in restoring brownstone structures. I found the majority of my decisions when compared to the various brownstone cleaning and restoration options, tended to be on the conservative side. Viollet-le-Duc was extreme in his restoration work and I would not support his philosophy in the restoration of 951 Boylston Street. John Ruskin and William Morris's approach of "Let-it-Alone" doesn't allow for maintaining a viable structure for future use. William Sumner Appleton is more in line with my philosophy regarding preservation, restore only as a necessity, and maintain what exists for future generations. Since 951 Boylston Street brownstone has remained consistently durable over the years with only minimal damage and deterioration I felt any change to the exterior from cleaning or even removing mechanical damage may create issues which could cause a more rapid deterioration then if the stone were left alone, only minor cleaning and repairs to stabilize materials, I felt would be beneficial. I do feel a conservative approach should be taken to preserve the history of the 951 Boylston Street brownstone.

The following grid will need to be printed out sideways to fit correctly in the capstone book, the measurements will need to be: 17" wide, but must maintain 8 ½"x11" these sheets cannot overlap either the 1 ¼" binding margin or the ¾" margin on the unbound side (two folds may be necessary to prevent pages from being sewn into the binding, or cut through their fold when the unbound edge is trimmed)

Example of folds



RESPONSE TO TYPE OF DETERIORATION BY RESTORATION REFERENCING PHILOSOPHICAL INTENT

	Philosophies of notable advocates				
	John Ruskin/ William Morris		William Sumner Appleton (do nothing, clean/repair only out of necessity)	Eugene Emmanuel Viollet-le-Duc	The restoration approach I agree with is marked in the same grey color
	Summary of Approach to brownstone restoration				
TYPE OF DETERIORATION & DAMAGE	DO NOTHING	CLEAN BROWNSTONE	CLEAN AND REPAIR	RETURN TO ERA	SUMMARY OF HOW I WOULD APPROACH 951 BOYLSTON STREET BROWNSTONE
SCRATCH	Minor scratches can be left as is due to further deterioration being minimal	Use water, or soap and water which could remove any discoloration left by the scratch with only a superficial indentation remaining	Clean the scratch with water or soap and water. If the scratch is not deep possible fine grade sanding could be done to remove any remnants of the scratch	Clean the scratch, if still noticeable sand the scratch to match the surface, if scratch is deep create a composite repair to match the brownstone returning it to it's original façade, the concern would be correctly matching the color of the composite material	Use water, or soap and water which could remove any discoloration left by the scratch with only a superficial indentation remaining
STAINING	For stains if nothing is done then more build up of staining could occur but there are currently no detrimental effects being caused to the brownstone's surface	Test a spot with dry brush, if this doesn't work use water, if needed soap and water, increase the strength of cleaners as needed without doing damage to the stones surface	Clean the stain using a cleaning agent that won't cause any damage. If staining is being caused by waterflow from upper levels, if possible repair the upper levels to try to prevent further staining	Cleaning using water or soap and water could remove the stain with minimal, if any damage. If staining is caused by waterflow from upper levels create a repair to control water flow to avoid further staining. If unable to remove stain, stain the area to the brownstone's original color	Test a spot with dry brush, if this doesn't work use water, if needed soap and water, increase the strength of cleaners as needed without doing damage to the stones surface
BLACK CRUST	The black crust will continue to build up if nothing is done, currently it has had no detrimental deterioration effects	Test a spot with dry brush, if this doesn't work use water, if needed soap and water, increase the strength of cleaners as needed without doing damage to the stones surface	Test a spot with dry brush, if this doesn't work use use a cleaning agent which will create minimal damage. Add a laminate that will allow for absorption of water so water doesn't become trapped but will prevent future black crust	Clean black crust using any cleaning agent until it is no longer visible or sand of the black crust to create a consistently clean façade	Test with dry brush, if this doesn't work use water, if needed soap and water, keep testing until a mild cleaning agent is found that will not damage the façade
IMPACT DAMAGE	Impact damage could create further damage due to the freeze-thaw weathering, this could cause bursting of the stone and loss of material	Cleaning the area of damage using a dry brush, water or soap and water can be done but loss could occur by removing smaller pieces which may be keeping the damage stone in place	Clean area using a dry brush, water or soap and water can be done. Create a small composite repair to stabilize the stones and protect it from water entering behind the brownstone during a freeze-thaw cycle.	Clean the gap, create a composite repair patch made with a similar color and texture or, if available, replace the stone with a new piece of brownstone. If brownstone is unavailable replace it with a cast stone made of similar color and texture.	Clean area using a dry brush, water or soap and water can be done. Create a small composite repair to stabilize the stones and protect it from water entering behind the brownstone during a freeze-thaw cycle.
MECHANICAL DAMAGE	Mechanical damage could create further damage due to the freeze-thaw weathering and this could cause bursting of the stone around the mechanical damage	Clean the area using a dry brush, water or soap and water no bursting or deterioration seems to be occuring, so leave the mechanical piece in place, more loss could still occur during a freeze-thaw cycle causing further damage	Using a dry brush, water or soap and water, clean the area. The mechanical parts could be removed and the hole "plugged" with a composite repair so that water does not enter and cause damage during a freeze-thaw cycle	Remove mechanical damage. Clean the gap then fill it in with a new piece of brownstone or patch the gap with a composite repair of similar color and texture	Clean the area using a dry brush, water or soap and water no bursting or deterioration seems to be occuring, so leave the mechanical piece in place
MISSING PART	The missing part leaves the area susceptible to water which could cause damage to the area where the brownstone is missing. A freeze-thaw cycle could cause further damage	The brownstone around the missing parts could still see further damage due to water and a freeze-thaw cycle, cleaning most likely would have no impact	Cleaning the area using a dry brush, water or soap and water and remove debris, replace the empty area with a brownstone of similar color and texture	Clean the area where there is the missing part, replace with a new piece of brownstone or create a cast stone of similar color and texture	Cleaning the area using a dry brush, water or soap and water and remove debris, replace the empty area with a brownstone of similar color and texture
EFFLORESCENCE	Efflorescence on the brownstone could continue to build up over time	The use of a dry brush, water or soap and water can be done to clean the efflorescence to prevent further buildup	Cleaning using a dry brush, water or soap and water, use a laminant that allows for the absorption of water to prevent further buildup	Cleaning using a dry brush, water or soap and water, use a laminant that allows for the absorption of water to prevent further buildup	The use of a dry brush, water or soap and water can be done to clean the efflorescence to prevent further buildup
CONTOUR SCALING (SPALLING)	Contour scaling will continue with time causing further disintegration	Cleaning could cause further spalling and pitting	Cleaning the area using a dry brush, water or soap and water, use a laminant that allows for the absorption of water to slow down further spalling issues	Remove spalling brownstone and replace with a new stone or create a cast stone of similar color and texture	Cleaning the area using a dry brush, water or soap and water, use a laminant that allows for the absorption of water to slow down further spalling issues
PITTING	Further pitting could occur over time along with flaking and spalling	Cleaning could create more pitting or spalling issues	Clean using a dry brush, water or soap and water, use a laminant that allows for the absorption of water to delay further pitting	Clean using a dry brush, water or soap and water can be done then a patchwork of brownstone material can be used to cover the pitted area (A parging over of "stucco" or "plaster" to cover over the pitting using a trowel) may require more extensive parging for consistent color	Take no action, although unlikely more pitting could take place over time
CRACK	The crack could have more damage created by water. During a freeze-thaw cycle this could force the broken portion away from the stone and creating a gap	Cleaning could open the crack to water causing further damage during a freeze-thaw cycle	Clean using a dry brush, water or soap and water then fill in with a patch of composite material of similar color and texture	Remove the cracked piece of brownstone, clean using a dry brush, water or soap and water then fill in with a patch of composite material of similar color and texture	If cracked stone is stable leave alone.
FLAKING	The flaking could cause contour scaling or spalling over time	If cleaned this could cause further flaking and possible spalling	Clean using a dry brush, water or soap and water then fill in with a patch of composite material of similar color and texture	Clean the area then parge over the area with a composite material that has a consistent color and texture	Leave the area alone
CHIPPING	The Chipping appears to cause no further detrimental damage	Clean the area, there doesn't appear to be any concern for further damage	Clean the chipped area. If the chip is not deep possible sanding could be done	Clean the chipped area. If the chip is not deep possible sanding could be done. It the chip is deep, perhaps a composite repair could be created of similar color and texture	Take no action, there doesn't appear to be any concern for further damage
DEPOSIT	The deposits on the brownstone appear to be causing no damage	Clean the area so as to delay any possible future damage.	Clean the area, no repairs are needed.	Clean the area, no repairs are needed.	Clean the area so as to delay any possible future damage.
ALVEOLIZATION	The alveolization could cause contour scaling over time	Clean with a dry brush or water, or soap and water, this could stop the alveolization from occuring and delay any further damage	Clean the area then parge over the area with a composite material that has a consistent color and texture	Clean the area then parge over the area with a composite material that has a consistent color and texture	Clean with a dry brush or water, or soap and water, this could stop the alveolization from occuring and delay any further damage

951 Boylston Street, Boston, Massachusetts, 2015[133]

"Let-it-alone"

Preservationists such as John Ruskin and William Morris believe a structure should not be interfered with since doing so would change the original creation. We could leave 951 Boylston Street alone and allow time to take its toll on the brownstone, allowing the mortar to breakdown and in turn cause deterioration to the brownstone itself over time. This could cause a structural hazard for those inside the building as well as any passerby on the sidewalk in front of this heavily trafficked location. Since the 951 Boylston Street building is currently in use today, this option would not make sense therefore to "Let-it-Alone" would not be of benefit to this structure.

[133] Vaughn, Patti. n.d. *photos were taken by, 2015*

Cleaning of brownstone

In researching whether to clean brownstone, William Sumner Appleton supported the philosophy and the historic belief that maintenance of a site was beneficial for protecting the site. I agree with his belief that historic sites should be protected for future generations as an educational tool and minimal maintenance should be supported. The 951 Boylston Street structure is a physical representation of our history. Preserving this history is beneficial, with 951 Boylston being an example of how a Boston Police Station, no longer in use, has been repurposed and is currently being used today, as the Boston Architectural College containing thesis studios, a lecture hall and office space. Therefore maintenance of the building to prevent it from further deterioration would be beneficial. The cleaning of 951 Boylston Street is where the question begins, currently the cleaning that would need to be undertaken is due to years of urban pollution. If the building had any graffiti markings, we would definitely want to clean it. Since the historic buildup of external urban pollutants is in question, we need to ask whether it is negatively affecting the structure, or would cleaning the brownstone façade of its urban pollutants cause detrimental damage?

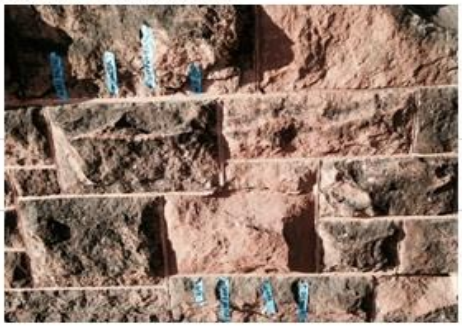
Dry brush, water, soap and water, and D/2 Biological Solution

Spot tests, using various cleaning agents, were completed on four brownstones, three of which are located on the front south façade and the fourth located on the east façade windowsill of 951 Boylston Street. The first stone was covered with a thick layer of black crust while the second brownstone had what appears to be coving deterioration. Spot tests were completed on these two differing brownstones using a dry brush, water, soap and water, and D/2 biological cleaner to research what results would occur. Unfortunately all four attempts held very minimal results. The dry brush cleaned a minor amount of black crust from stone. The D/2 Solution showed a very small amount of change a week later. Perhaps there had been a biological element among the black crust.

The stone with coving showed no change. Overall the cleaning did not appear to have much of an effect on these stones.

CLEANING TECHNIQUES TESTED ON 951 BOYLSTON STREET BROWNSTONE

1. STONE PRIOR TO CLEANING
951 Boylston Street, Boston, MA
2 brownstones for test cleaning
November 2, 2015, 2:53pm, 64 degrees F.
Prior to cleaning – one stone covered with black crust, one stone spalling



2. STONE DURING CLEANING
951 Boylston Street, Boston, MA
2 brownstones tested
November 2, 2015, 3:15pm, 63 degrees F
stones are damp after marked portions of each stone have been cleaned with a
Soft dry brush, lukewarm water, 1 Tablespoon of non-ionic liquid ivory soap & 1 cup of lukewarm water and D/2 Biological Solution-soaked for 10 minutes

Cleaning to stone with black crust
Soft dry brush, water, soap & water, D/2

D/2, soap & water, soft dry brush
Cleaning to stone with spalling

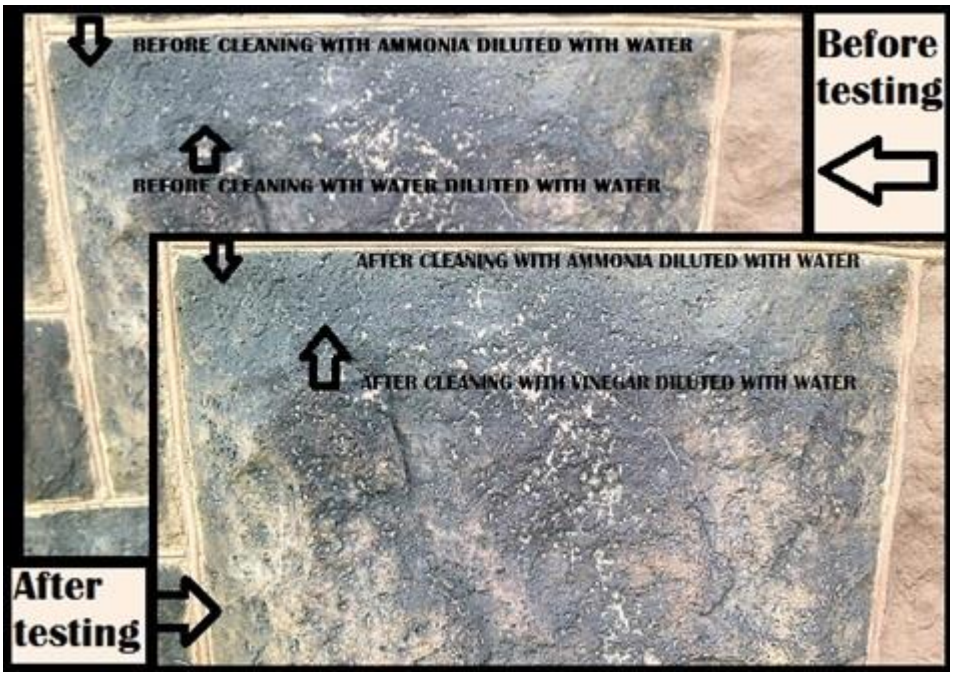
3. STONE ONE DAY AFTER CLEANING
951 Boylston Street, Boston, MA
2 brownstones tested
November 3, 2015, 3:00pm, 61 degrees F
After being cleaned with:
Soft dry brush, lukewarm water, non-ionic liquid soap & lukewarm water, D/2
Cleaning to stone with black crust

Spot tests completed on the first two brownstones using a dry brush, water, soap and water, and D/2 biological solution[134]

[134] Vaughn, Patti. n.d. *photos were taken by, November 2015*

Diluted ammonia and water, diluted vinegar and water

A second test was completed on a third stone located on the front, south façade of 951 Boylston Street using a diluted mixture of ammonia and water for the first spot test. A diluted mixture of vinegar and water for the second spot test was completed. Unfortunately neither mixture showed any results once the stone had dried. The buildup of black crust appears to be from years of urban pollution that built up in layers over time. Further testing would need to be completed to find the best cleaning results for this stone.



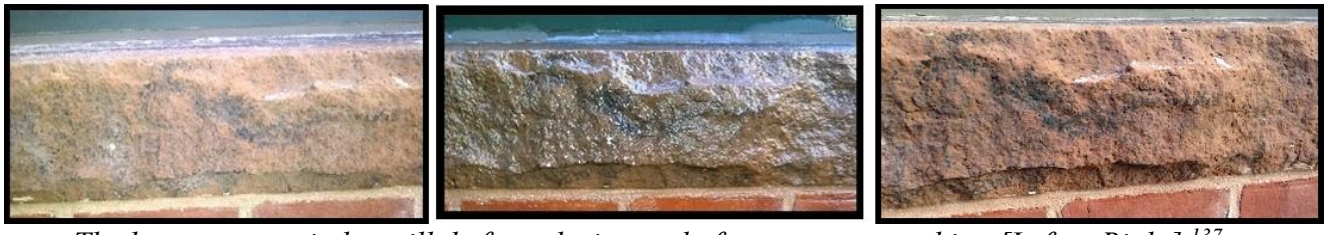
A spot test using ammonia diluted with water and a second spot test using vinegar diluted with water[135]

[135] Vaughn, Patti. n.d. *photos were taken by*

Brownstone Pressure washing

A pressure washing attempt was made on the east façade of the 951 building using a "TROY-BILT, Briggs & Stratton 500 Series 5.0" pressure washing equipment. A brownstone window sill was chosen with a small amount of black crust and this area was tested. Pressure washing is not recommended to clean brownstone so a low setting was in use for 5 minutes, with no results and then continued to ten minutes with no results. The testing resulted in no change to the original amount of black crust on the brownstone even after returning to investigate the site a week later.

Patti Vaughn pressure washing the brownstone window sill, 951 Boylston Street, Boston, MA[136]



The brownstone window sill, before, during and after pressure washing [Left to Right] [137]

[136] Vaughn, Patti. n.d. *photos were taken by, November 2015*
[137] Vaughn, Patti. n.d. *photos were taken by, November 2015*

Clean and Repair Brownstone

Minimal cleaning and repair work may be necessary for the maintenance of the 951 Boylston Street building. Keeping in mind William Sumner Appleton's belief of maintaining a structure out of necessity, not to change its original integrity. Therefore after much research it appears valid to complete minor cleaning, restoration and repairs to 951 Boylston Street with the knowledge that maintenance is key. The goal is not to change the appearance but to retain the integrity of the structure.

Restoration work on brownstone, returning it to its original era

I would not recommend Eugene Emmanuel Viollet-le-Duc's approach of returning this structure to its original era. I believe if given the opportunity a restorer might want to change the current look of the 951 Boylston Street façade not taking into account the history of the generations in which this building has endured. I think if restoration were completed to its original era a restorer would parge over many of the mechanical damaged areas and by doing so this would cover much of the original brownstone. Any cleaning, if too harsh, could remove a layer of the brownstone's exterior and in turn remove the rough finish, leaving a sanded, flat finish if not cared for properly. Viollet-le-Duc supported changing structures to how he believed the original structure should have been built, in doing so I believe there would be a loss of historic integrity and I would not recommend this. I'm sure the Back Bay Architectural Commission would not support any changes to the 951 Boylston Street façade either.

951 and 941 Boylston Street, Boston, MA[138]

THE PHILOSOPHICAL APPROACH AND TECHNICAL GUIDELINES FOR RESTORING BROWNSTONE ON 951 BOYLSTON STREET

In researching brownstone I learned about its history, how it should and should not be cleaned along with varying degrees of deterioration. Brownstone has become harder to replace due to the lack of open quarries therefore making it even more important to preserve. Taking this into consideration along with the historic philosophy of past and current preservationists it has allowed

[138] Vaughn, Patti. n.d. *photos were taken by, August 2015*

me to review my initial thoughts about how to restore 951 Boylston Street. I appreciate the historic aspect of the brownstone, the 951 Boylston Street structure's history and the philosophy of "Let-it-alone." In beginning my research I had initially believed that my final recommendation would be to "Let-it-alone". Why not allow the black crust to remain? This is part of its history, the residue of urban pollution on the façade of the structure from when the Boston & Albany trains, fueled by coal, passed across the street in front of these buildings. The building itself is a physical piece of history. Many preservationists compare 951 Boylston Street to its "twin" 941 Boylston Street. The 941 Boylston Street structure having been restored in 1997 by Gale Associates of Weymouth, Massachusetts, now in 2015 it still retains its pinkish-brown color but even with passing time there is some evidence of black crust building up on the façade.

Upon investigation and research of 951 Boylston Street I have realized there are some areas where I would support minor cleaning and repair work on the brownstone. Elements of deterioration that could cause further damage should be cleaned, possibly repaired or removed where needed. There are areas on the building where mortar has deteriorated and needs to be replaced or the brownstone could fall into further disrepair. A piece of brownstone is missing near the south west corner which, if environmental damage is not occurring, could be left alone. Or, if necessary, a replacement could be found from salvaged brownstone to protect the underlying stone from the elements. The areas where there is impact damage could be stabilized so there is no further damage during a freeze-thaw cycle. As far as the black crust is concerned, I did not see that it was causing any damage, so "let it alone" could be an option to retain the historic facade of the structure.

CONCLUSION: PROPOSAL AND RECOMMENDATION FOR BEST GUIDELINES FOR THE RESTORATION OF BROWNSTONE ON 951 BOYLSTON STREET, BOSTON, MA.

The proposal and recommendations which I have presented take into account the philosophies, best practices and testing completed on the brownstone at 951 Boylston Street, Boston, MA.

- The 951 Boylston Street structure appears to be built of a very durable brownstone material. The minor damage, such as the black crust, scratches, pitting, and staining all seem to be superficial I would "Let-it-alone"

- Relative to the pitting, flaking and chipping, I would not recommend any parging, composite repairs or patches. I do not think it is necessary or would be beneficial, I believe it would only be done to give a uniform appearance to the brownstone and would take away from the appearance of this historic structure.

- There are numerous locations where mechanical damage appears, they do not appear to have created any structural issues as a result I would advise these remain untouched.

- A mild cleaning of the building is advised, primarily in areas where aveolization, deposits, and efflorescence can be found.

Repointing, missing piece of brownstone, and impact damage located on 951 Boylston Street, Boston, MA. [Photos Left to Right]

- Repointing of the mortar is needed, making sure to create a new mortar of similar texture and color comparable to what currently exists, making sure the mortar is "softer" then the stone to prevent any water damage to the brownstone.

- Replacement of the missing piece of brownstone on the south west façade of the building would be beneficial to deter further environmental damage. Use of a salvaged piece of brownstone would be preferably. If unattainable, a stone of similar color and textured is recommended with a cast stone as the last option.

- On the south west corner of 951 Boylston Street impact damage has occurred. If feasible I would recommend replacing the stone with a salvaged piece of brownstone. If this is not possible, I would recommend a stone of similar color and texture. My concern is for future structural issues from this column, these stones could break loose overtime due to freeze-thaw cycles, and therefore I would recommend a unit replacement.

In conclusion any restoration work on this structure should be minimal, requiring only mild cleaning and repairs to be completed on areas to maintain the durability of the brownstone to support this structure into the future. From a philosophical standpoint the 951 Boylston Street façade should retain as much of the original brownstone as possible to preserve the historical integrity of this structure.

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