EXECUTIVE SUMMARY

On May 19th 2008, Ivan Myjer of Building and Monument Conservation and Amy Cole Ives of Sutherland Conservation, working as a consultant to Building and Monument Conservation, surveyed the interior and exterior of the New Point Comfort Lighthouse. The survey team was assisted greatly by discussions with Earl Soles prior to the site visit and the accompaniment of Will Gwilliam on the trip to the island.

The purpose of the survey was to assess the condition of the cast iron and masonry components of the lighthouse in order to develop preliminary recommendations for the stabilization, restoration and maintenance of the lighthouse. An additional goal of the assessment was to identify areas where additional study, probes or testing would be required in order to move from preliminary treatment recommendations to a final set of recommendations followed by construction documents.

The current survey was restricted to observations of the above grade portions of the lighthouse as well as the surface conditions of the masonry and cast iron. Very limited probes were undertaken to remove small samples of mortar for analysis. The existing study scope did not include probes into the walls or non destructive testing to verify how the lighthouse was constructed and modified over time. The time spent on the island was limited to only a couple of hours due to the difficulty of landing the small craft at the dock or on the shore with the high winds that accompanied our visit.

Our initial survey found that the lighthouse tower is basically sound but experiencing problems resulting from deferred maintenance and the ongoing weathering of the exterior sandstone facing units and setting/pointing mortars. Our review of the exterior conditions indicated that the materials used in previous restoration work, completed in the 1980s, reached the end of their service life some time ago. The primary agent of deterioration is water infiltration through open and failed mortar joints in the masonry as well as gaps in the windows, doors and glazing of the lantern. The most critical area of concern is the multi-faceted deterioration of the supporting structure for the gallery deck and lantern parapet assemblies where cast iron elements interface with different masonry materials including the exterior gallery deck stones, the sandstone ashlar and cornice units of the tower, the interior rubble construction of the tower, and the brick vault under the lantern room. Our survey was not able to distinguish the specific impact of past hurricane events on the overall condition of the lighthouse currently, but it is important to keep in mind the potentially devastating impact future hurricanes could have on this structure if it is not repaired and maintained.

The challenge in restoring the New Point Comfort Lighthouse will be in arriving at an approach to working on a 66 foot tall structure located on a very small island that does not have any level ground on which to construct scaffolding. We believe that it is possible to make repairs to the upper tower masonry and the cast iron lantern and gallery deck without removing the lantern, the parapet, the gallery deck and the upper four or five feet of the tower masonry. However, this approach should be subject to a constructability review. It may be more efficient, less expensive and more practical to create a work deck either on the island or floating on the water and remove the lantern, parapet, gallery deck and upper level masonry or some portions of them in order to facilitate the repairs that are required.

PART 1: INTRODUCTION

The New Point Comfort Lighthouse is located in Mathews County, Virginia on the west side of the Chesapeake Bay and the north side of the entrance to Mobjack Bay. Constructed in 1804-1808 on approximately 2 acres at New Point Comfort, the light station was originally comprised of the lighthouse and a keeper's house. The keeper's house was removed from the station in 1920, and two hurricanes in 1933 permanently separated the lighthouse from the mainland. The peninsula has continued to recede and today the lighthouse is approximately a half mile offshore surrounded by riprap that was installed over the course of the second half of the 20th century. It is readily visible from the end of the boardwalk of the Nature Conservancy's New Point Comfort Preserve.

1.0 Historic Significance Listed in the National Register of Historic Places in 1972, the New Point Comfort Lighthouse is significant for being one of the earliest surviving towers in the United States, and for its association with significant national events including occupation and vandalism by the enemy during both the War of 1812 and the Civil War. The 58 foot octagonal sandstone tower was constructed by Elzy Burroughs, who had also built the nearby Old Point Comfort lighthouse (1802) and Smith Point lighthouse (1803).

1.1 New Point Comfort Preservation Task Force Acquired by Mathews County in 1975, the County Board of Supervisors named the Mathews County Historical Society as its agent to create a master-plan for the long term preservation of the lighthouse. In 2001 the Society formed a committee chaired by Earl Soles called the New Point Comfort Preservation Task Force. The mission of the Task Force is: "To develop a plan to preserve the New Point Comfort Lighthouse as a permanent historic sentinel representing American navigation, transportation, commerce, craftsmanship, engineering, and Americans' perseverance through peace and war." The Task Force, working with the Board of Supervisors, has facilitated the commissioning of this Conservation Plan for the historic New Point Comfort Lighthouse.

1.2 Conservation Plan Team Ivan Myjer of Building and Monument Conservation was the lead investigator and conservator for this report. Ivan is a recognized authority on sandstone deterioration and historic masonry construction. Amy Cole Ives of Sutherland Conservation assisted with the investigation and provided consulting on the historic construction and preservation of lighthouses. John Walsh of Testwell, Inc. provided the mortar analysis.

1.3 Acknowledgements The team was greatly assisted by Earl Soles prior to the site visit to the lighthouse, by Will Gwilliam during and after the survey site visit, and by Stephen Burnett who graciously provided the transportation out to the lighthouse.

PART 2: CONSERVATION PLAN DEVELOPMENT

The purpose of this conservation plan is to provide Mathews County and the Task Force with preliminary recommendations for the stabilization, restoration and maintenance of the lighthouse. Development of the recommendations has been informed by review of the chronology of construction and alterations to the lighthouse over the past 200+ years and an on-site survey of the existing conditions of the materials and building assemblies of the lighthouse. The subsequent recommendations are based on conservation and repair methods and materials appropriate to the construction and condition of the cast iron and masonry components of the lighthouse. An additional goal of the assessment was to identify areas where additional study, probes or testing would be required in order to move from preliminary treatment recommendations to a final set of recommendations followed by construction documents.

2.0 Methodology Prior to the site visit to the lighthouse, the survey team reviewed published and on-line documentation on the past and recent history of the New Point Comfort Light Station, Aquia Creek sandstone, and 19th century lighthouse construction technology. See Bibliography for complete list. The on-site survey was restricted to observations of the above grade portions of the lighthouse as well as the surface conditions of the masonry and cast iron. Very limited probes were undertaken to remove small samples of mortar for analysis. The existing study scope did not include probes into the walls or non destructive testing to verify how the lighthouse was constructed and modified over time. Approximately 200 photographs of the exterior and interior of the lighthouse were taken for later study and analysis. In order to refer to the specific locations of exterior wall conditions composite photographs were made of most of the eight facets of the tower and then assigned numbers. A key is provided on each sheet to the numbering system. The mortar joints in the composite photographs were traced to illuminate the joint patterns. An annotated photo index of conditions is included in the appendix and referenced in the body of the text of Part 3.

2.1 Chronology of Construction and Alterations The following chronology of the early construction and alterations of the New Point Comfort Lighthouse is excerpted from Candace Clifford's *Historic Documentation* report dated December 2001. Twentieth century repairs and alterations are based on the 1983 Grant Completion Report submitted to the Virginia Historic Landmarks Commission and www.NewPointComfort.com/history.

1789 – 1851 Lighthouse Establishment Lighthouse construction and maintenance overseen by the Lighthouse Establishment under the Secretary of the Treasury.

1804 – Elzy Burroughs awarded contract to build New Point Comfort Light.

1805 – New Point Comfort Light is lit for the first time on January 17th.

1814 – British leave New Point Comfort with much damage after four weeks possession.

1815 – Sand around the base of the tower reported to have been washed away by recent gales and water also reaching the base every full tide. Efforts to stem ongoing erosion and protect the tower are documented in Lighthouse Establishment records through 1851.

1841 – Winslow Lewis installs new lamps and reflectors. Reports lantern leaking badly and consequently it would have been a useless expense to install new stone deck at the same time.

1852 – 1910 Lighthouse Board In response to an investigation into the inferior construction and optics of United States light stations, the Lighthouse Board was established with engineers and scientists to completely reorganize and modernize the country's system of light stations. New Point Comfort Light is located in the 5th District. A notable achievement of the Board was the installation of Fresnel lenses in all the lighthouses by 1859. Many of the towers built under the Lighthouse Establishment were structurally unsound and had to be rebuilt in order to support the weight of the Fresnel lens.

1855 – Illuminating apparatus replaced by fourth-order lens.

1858 – Old lantern replaced by "a cast iron one with cast iron deck and brick parapet wall laid in plaster with cement."

1861 – 1865 New Point Comfort Light extinguished during Civil War.

1865 – Lighthouse Board *Annual Report* confirms that the light station has been repaired, a new lens provided, and the light re-established.

1910 – 1939 Lighthouse Service The successor agency to the Board was the Lighthouse Service under the Department of Commerce. During this period several technological advances contributed to the automation of lighthouse operations. The operations of the Lighthouse Service were moved into the U.S. Coast Guard in 1939.

1919 – New Point Comfort Light automated by switching the illuminating apparatus from oil to acetylene gas, which did not require a full-time light keeper.

1920 – Wood frame keeper's house sold and dismantled.

1933 – Two successive hurricanes in August and September damage the tower and permanently separate it from the peninsula.
1950 – U.S. Coast Guard converts New Point Comfort Light into electrical four season flashing beacon.
1963 – 1976 New Point Comfort Light abandoned. Brick parapet wall of lantern room damaged by lightning on south side above the top window of the tower.
1975 – 1976 Mathews County acquires New Point Comfort Lighthouse, New Point Comfort Restoration Committee established and restoration work begins.
1977 – Phase I Virginia Historic Landmarks Commission (VHLC) grant funded work was for the construction of a dock.
1979 – Phase II VHLC grant funded work was for masonry stabilization and painting, replacement of windows and doors, replacement of lantern window panes and installation of a grounding cable.
1980 – Phase III VHLC grant funded work was for the installation of additional rock riprap on the east side of the island for further erosion control.
1999 – New Point Lighthouse Lantern Committee of Mathews County installs solar powered fixed beacon.

2.2 On-Site Survey The time spent on the island was limited to only a couple of hours due to the difficulty of landing the small craft at the dock or on the shore with the high winds that accompanied our visit. In order to utilize the time that was available most efficiently, each member of the survey team focused on one component of the structure. Ivan Myjer focused on the masonry and sampling of interior and exterior mortars, Amy Cole Ives focused on the cast iron lantern and cast iron and masonry parapet and deck, while Will Gwilliam took measurements at the door and window openings. The exterior masonry was inspected from the ground with binoculars and the telephoto lens of a camera, as well as from the vantage point provided by the exterior deck. The interior masonry was inspected from the stairs and landings and the cast iron components were inspected from the interior of the lantern and from the exterior deck. Samples were taken of exterior stone pointing and setting mortars as well as interior brick and stone pointing and parging mortars. Samples were also taken of the parapet parging and pointing mortars. The samples were sent to Dr. John Walsh at Testwell, Inc for analysis. The complete mortar analysis report with documentation of the location of the sampling sites is located in the appendix.

2.3 Physical Components of the Lighthouse Physically and functionally the New Point Comfort Lighthouse is comprised of three distinct components: tower, lantern room and gallery deck, and the lantern. The tower is constructed almost entirely of sandstone with a brick arched top and functions as the base for the lantern and provides physical access to the lamp(s) that served as the aid to navigation. The lantern room is comprised of an iron interior deck enclosed by a parged brick parapet wall and an iron door leading out to the exterior gallery deck which is made from flat wedge shaped stones and has an iron perimeter railing. This middle zone served the primary function of the lighthouse in supporting and providing human access to the lighted aid to navigation and exterior access to service the glazing of the lantern. The lantern rises from the brick parapet wall of the lantern room and is a self contained cast iron unit manufactured offsite. Functionally it provided protection to the lamp(s) from the weather, allowed for the magnified light to be projected in a clear arc range and prior to electricity, provided adequate ventilation for optimum performance of flame based lamps.

2.4 Field Observations Our initial survey found that the lighthouse tower is basically sound but experiencing problems resulting from deferred maintenance and the ongoing weathering of the exterior sandstone facing units and setting/pointing mortars. Our review of the exterior conditions indicated that the materials used in previous restoration work, completed in the 1980s, reached the end of their service life some time ago. The remnants of those materials; primarily the cement/lime pointing mortar and the masonry paint coating are now contributing to the ongoing deterioration of the masonry. These materials will have to be removed as part of any new round of restoration or maintenance work. The fact that the lighthouse has survived as long as it has under extreme environmental conditions and the ravages of two wars can be attributed directly to the maintenance and repairs that the lighthouse received on a regular basis when it was still operational. The lack of cyclical maintenance in the quarter century since the previous work was completed as well as for a number of years prior to that restoration has resulted in the advanced deterioration of the iron and masonry.

The primary agent of deterioration is water infiltration through open and failed mortar joints in the masonry as well as gaps in the windows, doors and glazing of the lantern. The most critical area of concern is the multi-faceted deterioration of the supporting structure for the gallery deck and lantern parapet assemblies where cast iron elements interface with different masonry materials including the exterior gallery deck stones, the sandstone ashlar and cornice units of the tower, the interior rubble construction of the tower, and the brick vault under the lantern room. Our survey was not able to distinguish the specific impact of past hurricane events on the overall condition of the lighthouse currently, but it is important to keep in mind the potentially devastating impact future hurricanes could have on this structure if it is not repaired and maintained.

PART 3: CONSTRUCTION NOTES & CONDITIONS SURVEY

Each of the lighthouse components discussed in section 2.3 above was built with materials and assemblies that have construction and weathering conditions specifically unto them. As such, the following section documenting and discussing the construction and conditions of the lighthouse will be broken into three sections by the components tower, lantern room and gallery deck, and lantern. The sections will first summarize the documented and field observed construction of each component followed by the field survey condition assessment of each component. The construction notes and conditions survey reference the annotated photographs in the appendix.

3.0 Tower On March 6, 1804, Elzy Burroughs signed a proposal that called for the masonry tower to be constructed in the following manner:

> "The Light House to be of hewn stone; the form to be octagon. The foundation to be sunk 6 feet below the surface of the ground, or whatever greater depth may be sufficient to render the whole fabric perfectly secure. From the commencement of the foundation to the bottom of the water table, the wall to be 5 feet thick; the diameter of the base from the bottom of the water table to the top thereof where the octagonal pyramid is to commence, to be twenty feet; from the surface of the earth or bottom of the water table to the top of the building, the wall to be fifty feet and to be graduated as follows: the first fourteen feet after bearing the water table to be 3 1/2 feet, the next 13 to be 3 feet, the next 12 to be 2 1/2 feet & the next 11 feet to be a foot thick. At the top of the stone work whereon the lantern to be placed the diameter of the building to be 12 feet. The water table to be capped with stone at least 7 inches wide sloped to turn off water. The floor to be paved with stone and a flight of substantial stone steps from the floor to the lantern; one end of each step to be worked into the wall, the other to go up plumb. The top of the building to be arched (reserving a place for a trap door which is to be fitted to serve as an entrance to the lantern) and to have a stone cornice to be covered with copper so as to preserve it from the weather. On the top of the stone work are to be a sufficient number of substantial iron [sleepers?] bedded therein and sloping from the centre… A complete iron lantern in the octagon form to rest thereon, . . . the eight corner posts or stanchions of the lantern to be built in the wall to the depth of 6 feet; the ends within the wall to be secured by large anchors: these posts are to be 2 inches square in the lower end, and one & half inch square above the stone work."

In 1882 John Lewis created section drawings of the lighthouse from on-site measurements. His measurements and drawings confirm that the wall thicknesses called for in the 1804 contract were completed as contracted. (See appendix for copy of drawing.)

3.0.1 Aquia Creek Sandstone Various secondary sources indicated that the sandstone used to build the tower originated from a quarry owned or leased by Elzy Burroughs or his family in Stafford County, Virginia. Stafford County is the location of the sandstone quarries at Aquia Creek. Pierre L'Enfant, who had been hired to design the new city of Washington D.C., purchased an Aquia quarry in 1791 which later became known as Government Island. Sandstone from this quarry was used to construct parts of the White House, the US Capitol and the Old Patent Office. The location of the quarry Elzy Burroughs used for the New Point Comfort Lighthouse stone relative to the better known quarry on Government Island has not been established. Differences or similarities of the New Point Comfort Lighthouse sandstone to the Government Island sandstone likewise have not yet been established. However, the color as well as the quality of Aquia Creek sandstone varied considerably.

In February of 1807, Benjamin Latrobe, second architect of the capitol, gave a detailed account of the Aquia Creek sandstone in an address to the American Philosophical Society. He listed the components of the stone as: sand, clay in nodules, rounded pebbles of quartz, sandstone and granite; pyrite, mud mixed with iron minerals as well as bits of decayed and carbonized wood." A modern petrographic analysis of Aquia Creek sandstone has not been located during the research conducted for this study. The stone is of the Lower Cretaceous age "with rounded, coarse to fine grains of quartz, cemented with silica and containing scattered pellets of clay as much as 1 inch in diameter" according to the US Geological Survey publication "Building Stones of Our Nation's Capital" which can be found online at http://pubs.usgs.gov/gip/stones/stones3.html.

3.0.2 Construction Notes The exterior walls are faced with sandstone ashlar units that vary slightly in course height. **(Photo 12 for typical conditions)** The placement of vertical joints is somewhat difficult to determine under the existing coating, but they do not appear to be strictly regular in placement. Corner units are one piece with alternating long and short returns. The length of the corner returns was probably varied intentionally to create better bonding. The shape and depth of corner stones inside the walls is a crucial piece of information that still has to be collected. The stone cornice is comprised of eight profiled stones each with a short return resulting in an offset vertical joint which avoids mitered corner edges and increases the structural integrity of the top of the tower.

The facing stones that are visible at the base of the structure through the deteriorated coating appear to be primarily naturally bedded. While some of the surface loss elsewhere on the tower may be the result of bedding delamination, no such losses were observed at ground level. The mortar analysis indicates that the facing stones were originally set and pointed with a non-hydraulic lime mortar made from oyster shells containing roughly equal parts lime and beach sand. **(Samples 1 and 2 in Mortar Analysis Report).**

Back up masonry, visible on the interior, consists of random laid, roughly worked pieces of sandstone set in mortar with smaller pieces of chinking stone used to fill the gaps between the larger units. In at least one location bricks were used as infill in the back up masonry. It has not been determined if the bricks are original to the construction or part of a later repair.

Door and window openings were created using a relatively shallow lintel made up of one or more stones that was set flush with the exterior wall. Behind the shallow door and window lintels are arches constructed from stone. **(photos 23 and 24 are typical interior window arches)** The degree that the shallow exterior lintel is carrying the load of the masonry above still has to be determined. If the facing stones are relatively shallow then the lintels are picking up more weight. If the facing stones above the window are deeper than the lintel, the arches behind the lintels may be picking up some of the load of the facing stones as well as that of the back-up masonry.

At the top of the tower interior there is a shallow brick vault with an opening for the lantern room above. **(photos 14-16)** The lantern room is accessed via a metal ladder that lands on a shallow wooden platform set on the top stone step. The opening provides a cross-section view of the brick vault which appears to be four bricks tall at the outer edge sloping up to one or two bricks thick in the middle. It has not yet been determined if this vault is the "arched top with an opening" referred to in the 1804 contract, or if the eight iron sleepers also referenced in the contract are still in place above the vault. Mortar analysis of the brick vault setting mortar points towards a later date of construction. The analysis indicated that the brick setting mortar contains a non-hydraulic lime made from the burning of a high calcium marble rather than the oyster shell lime found between the stone units. **(sample 3 in report)** The brick mortar is very similar to the mortar removed from the jamb of the window directly below the vault. Since archival documentation records that the window openings were repaired more than once, it appears that the brick vault dates from the time of one of those repairs.

Of particular note, however, are eight highly deteriorated ties that penetrate the vault and return into the rubble masonry. These ties or cramps may originally have been an up-side-down F in shape that functioned to tie the stone cornice units to the masonry below and/or anchor the original iron lantern.

3.0.3 Field Survey Conditions Assessment Starting at about six feet above the watertable and extending for the next fifteen to twenty feet to roughly the midpoint of the tower, there is a band of severely weathered ashlar units that goes around the tower. (photos 1, 7-11) We were unable to draw a conclusion as to why the surface loss is concentrated in this area, or what the loss of section means for the overall structural stability of the tower. In the short time that we were on the island we were unable to verify the thickness of the facing stones in the locations where they are most severely eroded. This measurement is crucial for evaluating if the loss of stone section in the facing stones has the potential, if left unchecked, to undermine the stability of the tower. This dimension is also crucial for establishing a data point that can be used to determine the rate of surface loss in the future.

The exterior stone units, in addition to being part of the structure are also part of the water-shedding skin of the lighthouse. While replacement or repair of weathered units may not be required for structural purposes at this time, it may still be critical for maintaining the water tightness of the exterior skin of the tower.

We do not currently have an explanation as to why the stone within this zone is more severely weathered than the stone above and below it. The possible causes that need to be investigated further include: a) salt crystallization damage resulting from salt spray that reaches only these courses, b) wind/sand erosion dating back to when the lighthouse was surrounded by a large expanse of beach, c) surface loss related to wetting and drying cycles, d) weathering due to the washing out of clay components in the stone, e) some combination of some or all of these factors.

The masonry walls are the thinnest precisely at the locations where they are penetrated by the iron ties. While the upper walls may be gaining some additional strength from the shallow brick vault that is located directly under the lantern room, the ongoing corrosion and subsequent expansion of the iron ties buried in the walls (photos 14-16) is undermining both the stone walls and the brick vault. The displacement of the exterior stone facing units at the top of the tower that can be observed in Photograph 2 and is probably the result of the expansion of the corroding iron ties. The widened joints that have resulted from the displacement of the exterior facing stones have in turn become additional avenues for additional water infiltration into the masonry below.

3.0.4 Tower Masonry Details That Require Verification

1. The depth of the facing stones at various courses still has to be determined. Since the walls tapper from 3 1/2 feet thick at the water table to one foot thick at the top of the tower, it makes sense that the facing units at the base of the tower would be substantially

thicker than those at the top. This however may not be the case; the facing units for all of the thicker wall sections may be the same, or close to the same thickness.

2. What cannot be determined from either the contract language or the section drawings is what portion of the wall consists of well laid coursed ashlar stone and what portion is rubble back up. It is very likely that even within wall sections of consistent thickness that the ashlar units vary in depth - as varying the depth of a wall's facing stones was a standard way to key the exterior stone to the back up masonry.
3. The manner in which the walls were constructed still needs to be determined. One possibility is that that three or four feet of the inner and outer wythes of stone were set first and then the space in between was filled with masonry rubble consisting of mortar and broken pieces of stone. In this type of wall system the inner and outer wythes are bonded to the rubble core with stretcher stones but not to each other. A second, less likely possibility is that inner and outer wythes contain some very deep units of stone that overlap each other at the center. A third possibility is that the outer wythe of stones are very deep and the inner wythe is relatively shallow. A fourth possibility is that the corner stones are very deep and the stones between the corner stones are relatively shallow. Each possible wall configuration – and there are other possible wall configurations – has a different implication of the stability of the structure and the need to repair or replace deeply weathered facing stones.
4. Measurement of surface loss of facing stones in various locations. The wall thickness was intentionally reduced as the tower was constructed to reduce the overload on the masonry. The stability of the lighthouse masonry is principally derived from its tapered octagonal shape and the manner in which the stones were laid not from the bond strength of the setting mortar. Unlike the natural cements or Portland Cements that were used to construct later structures, the lime setting mortar that was used to construct the New Point Comfort Light is relatively low in strength. Therefore the loss of section from an exterior ashlar unit laid in lime mortar poses more of a risk to the overall structure than a similar loss in a cement laid structure would.
5. The manner in which the shallow brick vault is let into the stonework still has to be determined. The brickwork appears to be resting on a course of stone that is corbelled out from the interior wall. At the window opening the brick vault appears to be bearing on the stones that form an arch inboard of the rectilinear window head that is visible on the outside of the lighthouse.
6. The thickness of the vault can be measured at the opening – it is very likely that this thickness was held throughout the entire vault but this means that the thickness of the stone walls where the arch meets the wall has been reduced by a dimension close to the thickness of the brickwork. A section drawing of the upper wall in the location where the

brick vault is let into the stonework and the cast iron deck braces penetrate the masonry is essential for understanding the options for repairing the upper tower masonry.

7. Identification of the presence or absence of the original iron sleepers above the brick vault.

3.1 Lantern Room and Exterior Gallery Deck In October 1841 Winslow Lewis made the following report:

> " on the 8th I was at new Point Comfort, at which place I was to put on a new stone deck to the Light house & put up a new sett of lamps & reflectors etc. I found that lantern leaking in every part. .. & that it would be a useless expense to put on the stone deck until the new lantern was up. I put in the new lamps & reflectors & landed the stone deck & the bricks for the arch…"

The 1856 U.S. Lighthouse Board *Light List* indicates that the New Point Comfort Light was refitted with a fourth-order lens, and records of the fifth lighthouse district engineer in 1858 document that "The old lantern has been replaced by a cast iron one with cast iron deck and brick parapet wall laid in plaster with cement." The 1882 drawing by J. Lewis documents the gross dimensions of the lantern room, gallery deck and lantern, but does not provide construction details (Appendix B). Curiously, the section I-J locates the parapet door and lantern room hatchway on the opposite side of the tower than they are currently located. It also documents the presence of three ventilators in the brick parapet wall. The gallery deck railing and lantern are clearly the same elements in the drawing as they are today. At this time no further documentary evidence related to the materials and construction of the lantern room and exterior gallery deck have been located. One source, the website www.NewPointComfort.com/history, has a photograph c. 1963-1976 courtesy Steve Brownley and Mrs. Leona Brownley of Port Haywood that shows a portion of the south side of the brick parapet wall of the lantern room collapsed and missing. This photograph shows that the lantern sill sits on the brick parapet wall with no vertical members at regular intervals which the brick would have been built up between.

3.1.1 Construction Notes Comparison of the 1882 drawing and the depth of the lantern room parapet wall gallery door opening indicates the parapet wall is approximately two brick wythes thick (photo 34). The cast iron lantern sits on top of the brick with an L shaped sill flush with the face of the wall on the interior (photos 33, 45, 47, 49) and overlapping the top brick on the exterior (photo 36). There may be a flange that extends down into the masonry from the middle of the sill. The parapet wall gallery door opening originally would have had an interior and an exterior door. The exterior door pintels are still in place (photo 35). The interior face of the brick parapet wall appears to sit on the iron plate lantern room floor (photos 32, 33). The iron pedestal for the fourth-order Fresnel lens remains in place in the center of the lantern room floor (photo 44). Remnants of two of the three original ventilators are visible in the brick parapet wall (photos 45, 47).

At least two black painted parging layers are visible over the brick on the exterior of the parapet (photos 36, 37) and at least two parging layers are visible on the interior with numerous limewash coatings (photo 45). The parging directly over the bricks **(sample 6)** is a natural cement and therefore likely dates from the second half of the 19th century. The parapet brick setting mortar has not been sampled yet.

The completion report for the grant funded work from the 1980s indicates that some repair work was undertaken on the parapet wall at that time but does not specify the location, extent or materials. However, the portion of the brick parapet wall that was lost in the 1960s and rebuilt in the 1970s or 1980s is readily visible on the interior of the lantern room by the disparate appearance of the parging coat (photo 46).

The exterior gallery deck is constructed with wedge shaped stones (photos 38, 39) that look similar to arkosic sandstone, commonly known as bluestone, quarried in Pennsylvania and NY. Each side of the octagonal deck is comprised of two wedge shaped stones with the exception of the east (elevation 2) side which appears to be made up of three wedge shaped pieces (photo 4). The face of the brick parapet wall appears to have originally sat on the gallery deck stones. The stanchions for the gallery deck railing are set on the joints between every other deck stone aligned with the eight corners of the masonry tower (photos 2, 4, 38). The stanchion base appears to line up with a piece of iron of similar width that can be seen at a couple of the joints where they intersect with the base of the parapet wall.

3.1.2 Field Survey Conditions Assessment The condition of the iron floor of the lantern room is fair in terms of its structural integrity and poor in terms of its surface condition (photos 32, 44). Progressive rusting caused by ongoing water infiltration and condensation will have a long-term negative effect on the structural integrity of this floor. Likewise, the iron door frame and threshold set in the brick parapet wall are in fair to poor condition from rust deterioration (photos 33, 51). The existing door with ventilator is probably a 20th century steel replacement which is in fair to good condition (photo 51). Unfortunately the exterior door to the gallery is missing, which allows for considerable ingression of water at the bottom of the inner door that in turn has accelerated the deterioration of the door frame and threshold, lantern floor and interior ladder.

The condition of the parged brick parapet wall ranges from fair to poor (photos 33, 45-47). Roughly 70% of the wall appears to be in fair condition with deterioration localized primarily in the parging layers due to the break-down of the coatings from exposure to moisture, wind, freeze-thaw and light. The remaining 30% (middle of the northeast side, entire east side and most of the southeast side – elevations 1-3) are in poor condition with questionable structural integrity due to excessive water infiltration. There are a number of conditions at these three sides that are not evident on the other five. The sequence of events that led to the initial development of these conditions is not immediately clear, but the existing conditions are all resulting in ongoing and continuing deterioration of the parapet wall, gallery deck and masonry tower.

The exterior of the parapet wall on the northeast, east and southeast sides of the lantern has cracking, bulging and losses in the parging layers to the extent that they extend out beyond the bottom of the lantern sill (photo 52). There is a section of the exterior part of the sill on the southeast side that has broken off, revealing the brick masonry behind it (photo 36). The interior of the parapet indicates through-wall water infiltration by cracking and spalling of the parging and coatings as well as green biological growth along the major cracks (photos 45, 47). One source of water that may be affecting this section of the tower greater than other sections is the open drain hole for the lantern roof gutter above this area. This area may also be affected by a micro-climatic difference caused by prevailing winds and the path of the sun in the first half of the day. This portion of the tower may also have been damaged at some point in time by a lightning strike, a common cause of damage to light towers.

In general the gallery deck and railing are in fair condition. The deck stones appear to be painted with the same black paint as the brick parapet wall and cast iron lantern. In various small locations there is evidence of prior patching repairs to the deck to fill in stone losses. There is no apparent vertical displacement of the deck stones (the top plane of the stones is pretty flat) but there is some horizontal (space between the stones) and lateral (exterior edges of the stones do not line up) displacement of the deck stones (photo 39). The iron railing appears to be well attached and structurally sound, however, the iron should be treated to halt further deterioration of the railing by advancing rust.

3.1.3 Lantern Room and Exterior Gallery Deck Details That Require Verification

1. Construction of lantern room brick parapet wall: how thick, how are bricks laid, mortar, type and condition of bricks.
2. How does the brick parapet wall relate to the interior iron deck and exterior stone gallery deck – do the interior and exterior decks meet in the middle under the brick parapet wall?
3. ID gallery deck stones – arkosic sandstone (bluestone) or other?
4. How are the railing stanchions attached to the gallery deck?
5. Do the gallery deck stones sit on the interior brick vault or do they sit on iron sleepers?

3.2 Lantern As previously noted in Section 3.1, records of the 5^{th} district engineer indicate that the lantern was replaced in 1858. This is confirmed by the 1858 5^{th} district lighthouse inspection report that lists the lantern as "circular, 6' diameter, cast iron by Hayward & Bartlet with (interior) iron deck and ventilator, 12 trapezoidal lights 3' tall." Hayward, Bartlett & Company was a partnership formed in 1849 of two stove manufacturers, one from Baltimore and the other from Boston, who moved to Baltimore. This company manufactured stoves, architectural iron work, plumbing and heating apparatus and locomotives. Grant funded work in the early 1980s installed new 5/16" Lexan polycarbonate glazing held in place with stainless steel "stops" and screws and the exterior and interior of the lantern were painted.

3.2.1 Field Survey Conditions Assessment The paint coating on the lantern is well beyond the end of its service life and the resulting progression of rust ranges from moderate to extensive (photos 41, 43, 44). The caulking at the Lexan glazing and stainless steel stops is deteriorated or missing which has allowed considerable ingression of water which has accelerated the rusting of the lantern mullions and sill (photo 40). The lantern sill (exterior and interior) has the greatest amount of damage with loss of material due to rust jacking and breakage (photos 33, 36, 47-49). The lantern ventilator (photo43) and the interior surface of the lantern roof are in fair condition (photo 50).

PART 4: PRELIMINARY CONSERVATION RECOMMENDATIONS

Defining the Scope of a Lighthouse Restoration Project

The challenge in restoring the lighthouse will be in arriving at an approach to working on a 66 foot tall structure located on a very small island that does not have any level ground on which to construct scaffolding. We believe that it may be possible to make repairs to the upper tower masonry and the cast iron lantern and deck without removing the lantern, the parapet, the deck and the upper four or five feet of the tower masonry. However, this approach is based on a partial understanding of the placement of the upper ends of the 8 iron cramps in relationship to the inboard side of the cornice stones and the positioning of the brick vault. Once these details have been established the overall approach should be subject to a constructability review. It may be more efficient, less expensive and more practical to create a work deck either on the island or floating on the water and remove the lantern, parapet, deck and upper level masonry or some portions of them in order to facilitate the repairs that are required. It may not be possible to establish the overall approach until the questions concerning the original construction details outlined in the previous sections have been resolved.

It is easier to state the type of repairs that are required to stabilize the lighthouse for an extended period of time than it is to state with any authority how long the lighthouse will remain stable if restoration is delayed for an extended period of time. At this point information on the rate of stone cracking, weathering and displacement is lacking. If it is possible to locate the original before treatment photographs from the 1981 restoration program it should be possible to determine at least some of the changes that have taken place in the past twenty- seven years. The rate of masonry deterioration generally accelerates as conditions brought on by the deterioration manifest themselves as wider joints, stone cracks and corroding and expanding iron elements.

Critical Next Steps to be Completed

1. Complete the probes and investigations that are necessary to determine the answers to the questions raised in the masonry and cast iron sections of the report. Of particular importance is developing a section drawing that documents the wall construction from at least the watertable to the lantern. An understanding of the intersection of the brick vault, the sandstone and the iron cramps is critical to developing a scope of work.

2. Perform petrographic analysis on the existing sandstone to determine mineralogy as well as modes of stone failure. Petrographic analysis may help to determine why some areas of the lighthouse are deteriorating preferentially. It may also help determine the causes of the deterioration and point towards or, eliminate, potential treatments such as chemical consolidation.

3. Research and/or testing to determine the properties of the Aquia Creek sandstone that cannot be determined through petrographic analysis. Properties such as compressive strength, flexural strength, water absorption and water vapor permeability have to be determined in order to select a replacement stone if salvaged Aquia Creek sandstone is not available. The most likely candidates for replacement sandstones are stone currently quarried in Ohio and Nova Scotia/New Brunswick.

4. Evaluate the sequencing of repairs to the lighthouse relative to the work that is required to shore up the island against further erosion. Some of the equipment such as cranes required to shore up the island may be able to do double duty and contribute to the dismantling of the cast iron lantern.

5. Undertake a constructability review to determine the optimal way to approach the work that is required to stabilize and restore the lighthouse. While it is possible to bid out the restoration work and let the bidders decide the optimal approach, it would be beneficial to know this prior to bidding.

Preliminary Treatment Recommendations

1. **Removal of the remnants of the coating applied in 1981.** The type of paint used in 1981 is not indicated in the final grant report. From the manner in which the paint is coming off, it is probably an acrylic or alkyd paint that was selected for its compatibility with masonry substrates. The coating should be removed down to the bare stone to facilitate recoating with a traditional limewash. Procedures for removing the 1981 coating should be tested to determine the process that is most effective but does not damage the substrate.

2. **100% Repointing of all exterior mortar joints.** The binder in the original setting and pointing mortar was a slaked lime without hydraulic properties that was made by burning oyster shells. There is a least one company, located in Virginia that has revived this process and is supplying this type of lime for the building trades (see Virginia Lime Works at www.virginialimeworks.com). An important question to ask is whether a traditional non-hydraulic lime is the optimal lime to use for the restoration of the New Point Comfort Lighthouse. There are two considerations; first the durability of this type of lime in a marine environment and second, the cost of the material and installation as well as the availability of this type of lime in the future. While purists would insist on a lime binder that closely matches the original lime, it is reasonable to consider whether a weakly hydraulic lime might be more durable, less costly and easier to use. An important factor to consider is that the mortar joints are deeply eroded and because non-hydraulic limes require atmospheric carbon dioxide to complete the setting process, the depth of each individual lift is very limited in order to ensure that carbon dioxide in the atmosphere is able to reach the mortar.

3. **Repair of severely deteriorated sandstone units utilizing sandstone “dutchmen” set in a lime grout rather than epoxy.** Until the depth of the facing stones at various locations has been determined it is not possible to state the number of stones that will require this type of repair. A small amount of Aquia Creek sandstone is available in salvage form but it appears unlikely that any of the historic quarries will become viable sources of stone again. If salvaged Aquia Creek stone cannot be located when the project goes forward then a suitable replacement stone will be required. Since the lighthouse has always been coated with a white wash or paint the appearance of the replacement stone is less important than its physical properties. The replacement stone should have physical properties that are comparable to the original stone in order to avoid the preferential deterioration of the remaining original stones adjacent to any replacement stones. The

processes that result in the preferential deterioration of some stones on a structure and not others have many potential causes; some of which can be traced to the properties of the stone. Salt crystallization damage for example is related to a stone's pore size, the connectedness of the pores as well as the type of binder that cements the grains of sand to each other. Current stone restoration practices generally rely on the use of an epoxy adhesive to secure a dutchman repair in place. In order not to inhibit water vapor transmission through the masonry, the use of epoxy should be restricted or avoided altogether. The traditional method for stone dutchmen repairs is to use a lime based grout and mechanical keying to secure the dutchmen repair in place.

4. **Resetting of displaced facing stones at the top of the tower.** The displacement of the facing stones that is visible at the top of the tower is most likely the result of water infiltration at the top of the tower. It may also be related to the corrosion and expansion of the 8 iron ties that are visible on the interior or to ties buried in the wall that are not visible.

5. **Inter-wall grouting and pinning**. Water infiltration at the top of the tower through open mortar joints and openings in the lantern has probably resulted in the deterioration or loss of mortar within the upper walls. It is possible to re-establish bonding between wythes without removing and resetting the units by either grouting the void space and/or by installing mechanical anchors. If either of these treatments is required the use of polymer or polymer modified cementitious grouts should be avoided. The use of a the wrong type of grout or anchor will accelerate the deterioration of the stone and mortar and because it is not a reversible treatment will dictate that the masonry will have to be disassembled and rebuilt to correct the problems created by the selection of an inappropriate grout or anchor.

6. **Galley deck repairs.** The manner in which the stone deck is secured to and supported by the masonry has not been determined. The deck projects roughly two feet over the masonry. The sandstone cornice below the deck is providing support at the outboard side but does not appear to project enough to keep the deck stones from rotating out. It is possible that these stones may be long enough to bear on the brick vault or it may be that they are relatively short but counterweighted by the brick parapet.

7. **Lantern parapet wall repairs.** The scope of the repairs to the parapet will be dictated in part by the repairs that are required to the deck. While it is possible to removing the failing parging on the parapet and repair the damaged sections of brick without

completely dismantling the parapet, complete disassembly may be required in order to facilitate repairs to the deck.

8. **Removal and replacement of the 8 iron cramps visible just below the brick vault.** The visible portions of the iron cramps are extremely corroded. The expansion of the corroded iron cramps is responsible for the cracks that are visible in the brick vault. The upper portions of the cramps are probably equally deteriorated. If, as we surmise, they are securing the inboard ends of the cornice stones, the corrosion and jacking where they enter the cornice stones will have cracked or spalled those units. In order to gain access to the upper portions of the cramps, the brick vault will have to be taken apart and rebuilt in sections. Repairs may be required to the cornice stone before new cramps can be installed.

9. **Lantern repairs.** If the cast iron lantern is repaired in place it should be repainted with an industrial marine grade coating appropriate for rusted cast such as a moisture cure urethane system (example: Sherwin-Williams marine coatings Corothane line). These pre-primers, primers and top coats can be applied with minimal hand preparation on rusted surfaces. Final selection of the coating system should be made in consultation with the technical representative of the marine coatings division. The stainless steel stops that were installed in the 1980s have weathered well and are still in a serviceable condition. However, if there is sufficient funding available, a stop with a more historically appropriate profile should be installed with a better caulking detail for shedding water. Finally, the fabrication and installation of an exterior gallery door would help limit water infiltration at the base of the interior lantern door.

10. **Window repairs.** The windows have been replaced several times since the lighthouse was constructed. The existing windows appear to date from the 20th century. All of the windows have at least one missing pane that is allowing rain and birds to enter the structure. Some of the window frames have gaps between the frame and the masonry that is permitting wind blown rain to enter. Some, but not all, of the windows have interior iron bars in front of the window to prevent access to the window. These bars are severely corroded and have reached the end of their service life. If bars are required for the purpose of visitor safety, then new bars with a rust inhibiting coating applied before the bars are installed should be set in the masonry window openings without the use of expansion anchors.

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9. **"Building Stones of our Nation's Capital"** US Geological Survey publication available on line at: http://pubs.usgs.gov/gip/stones/stones3.html
10. **Wikipedia entries on Elzy Burroughs and Aquia Creek Sandstone**

APPENDICES

A. **Glossary of Lighthouse Terms**

B. **1882 J. Lewis drawing of New Point Comfort Lighthouse**

C. **Elevation Photographs**

D. **Photo Index of Construction and Conditions**

E. **Mortar Samples and Analysis**

Appendix A: Glossary of Lighthouse Terms

The following glossary of lighthouse specific terms comes from the Historic Lighthouse Preservation Handbook Part VI

Fresnel lens – A system of annular prisms that refract and reflect into a beam; invented in 1821 by Augustine Fresnel; this system captures and focuses up to 70% of the light emitted from the illuminant. Fresnel designed a variety of lens system sizes which he defined by orders. Today, there are 9 modern equivalents to his original orders, first through sixth (including a 3 ½ order), a meso radial, and hyper radial. The sizes of the lenses and their effective range decrease as the order number increases.

Gallery deck – The exterior walkway outside the lantern.

Lamp – The oil lighting apparatus inside a lens. A lamp was used before electricity powered the illuminant.

Lantern – The portion of the lighthouse structure that houses and protects the lens and illuminant; relative size described/defined by the size of the lens based on the 7 Fresnel orders. Also referred to as the lantern room.

Lantern glass – Glass panes in the lantern that protect the lens and illuminant while allowing the maximum amount of light to pass. Also referred to as "lantern glazing."

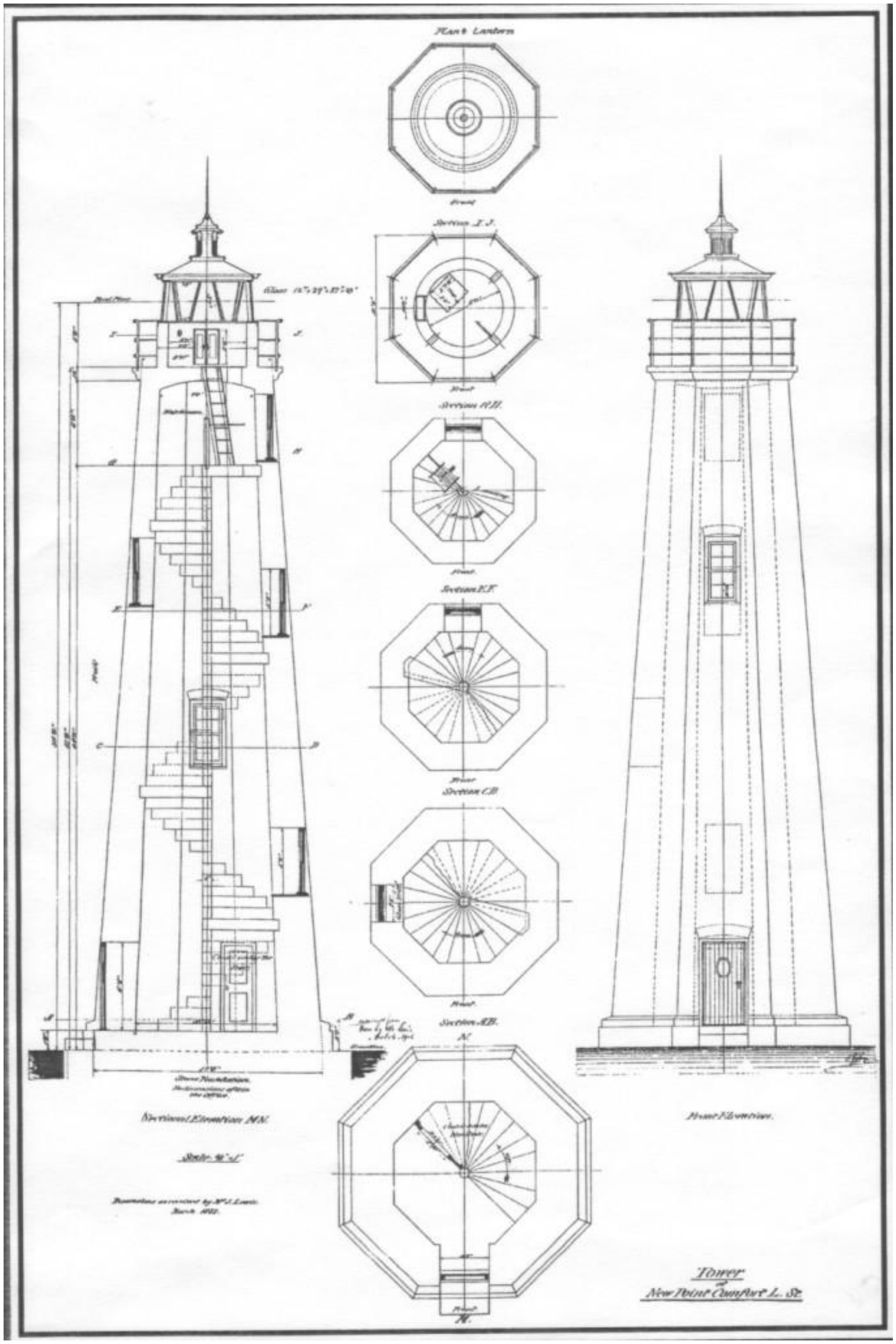
Light Station – Refers not only to the lighthouse but to all the buildings at the installation supporting the lighthouse including keepers quarters, oil house, fog signal building, cisterns, boathouse, workshop, etc.

Parapet – In third through sixth-order lighthouses, the low wall in the lantern room that supports the storm panel frame and roof.

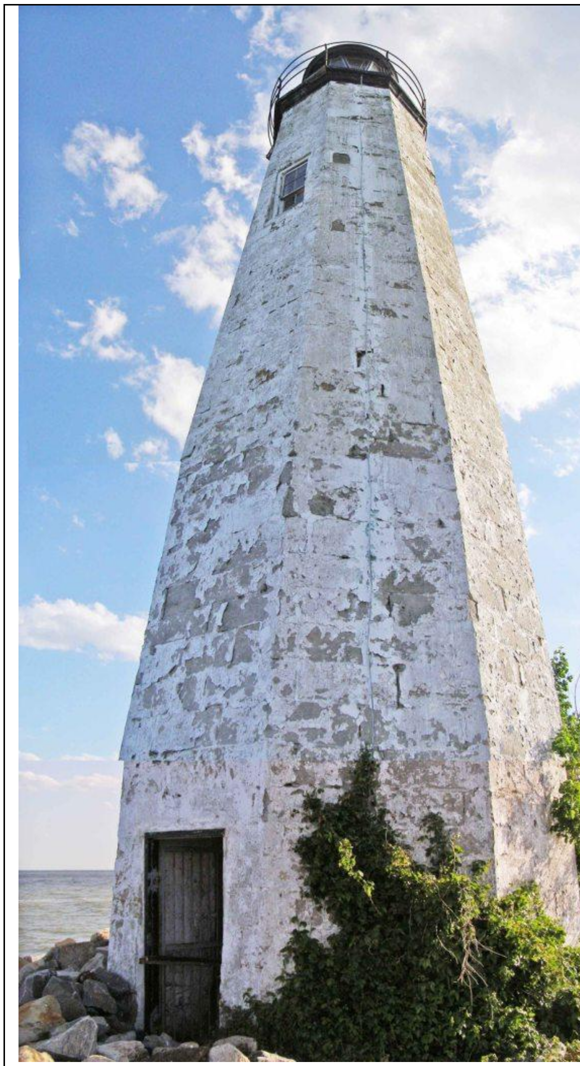
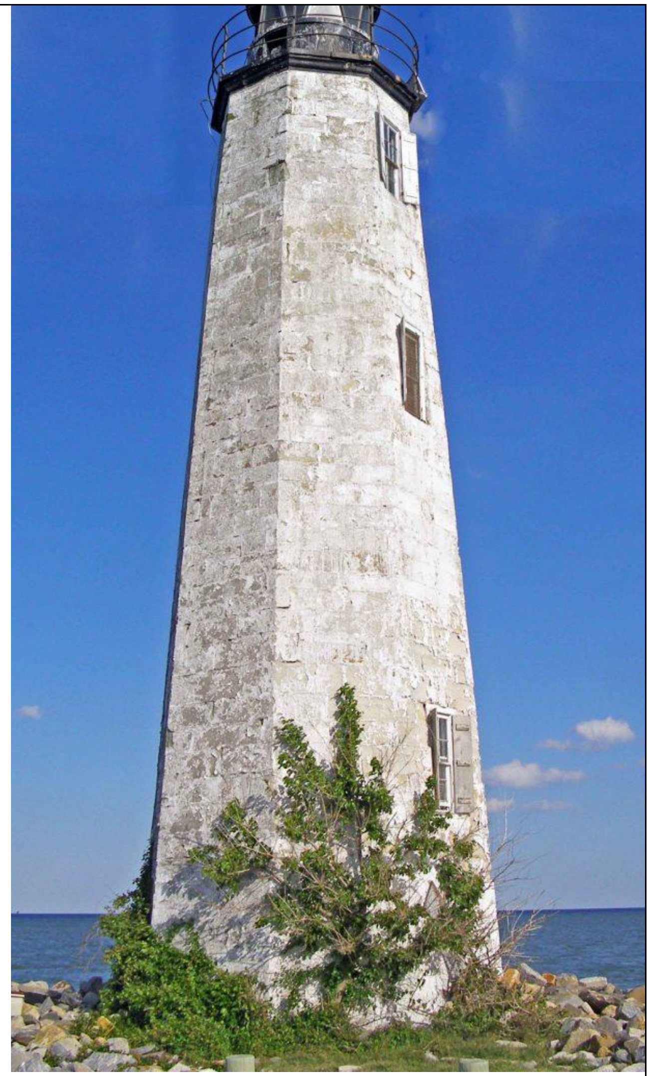
Tower – The portion of the lighthouse that supports the lantern.

Ventilation ball – The perforated spherical ball at the apex of the lantern roof that originally provided ventilation for the oil-fired illuminant.

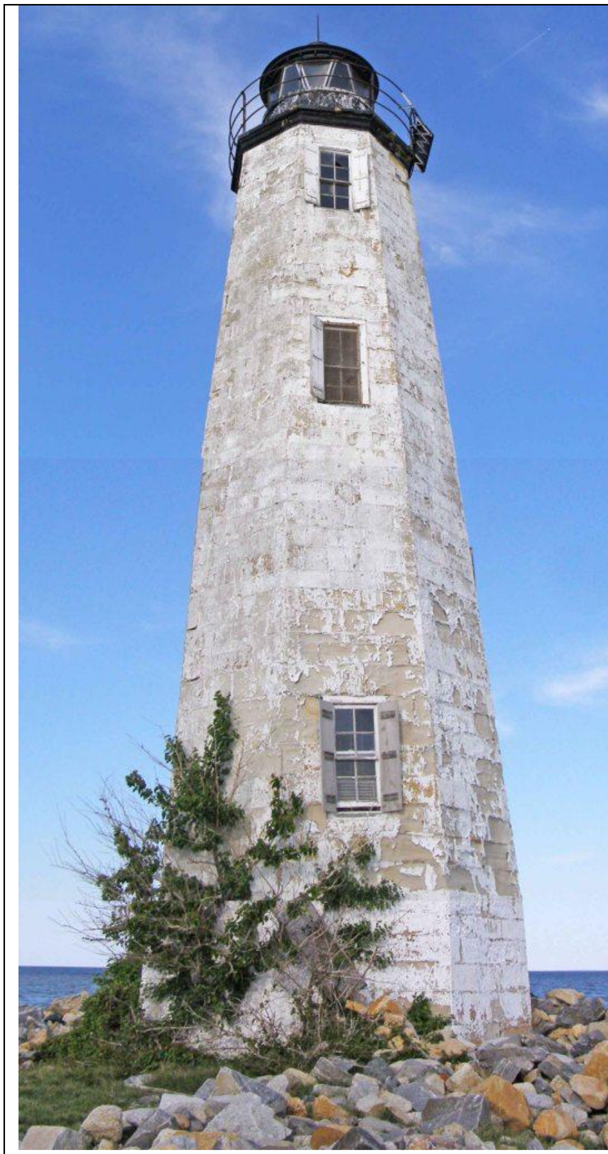
Appendix B: 1882 J. Lewis drawing of New Point Comfort Lighthouse



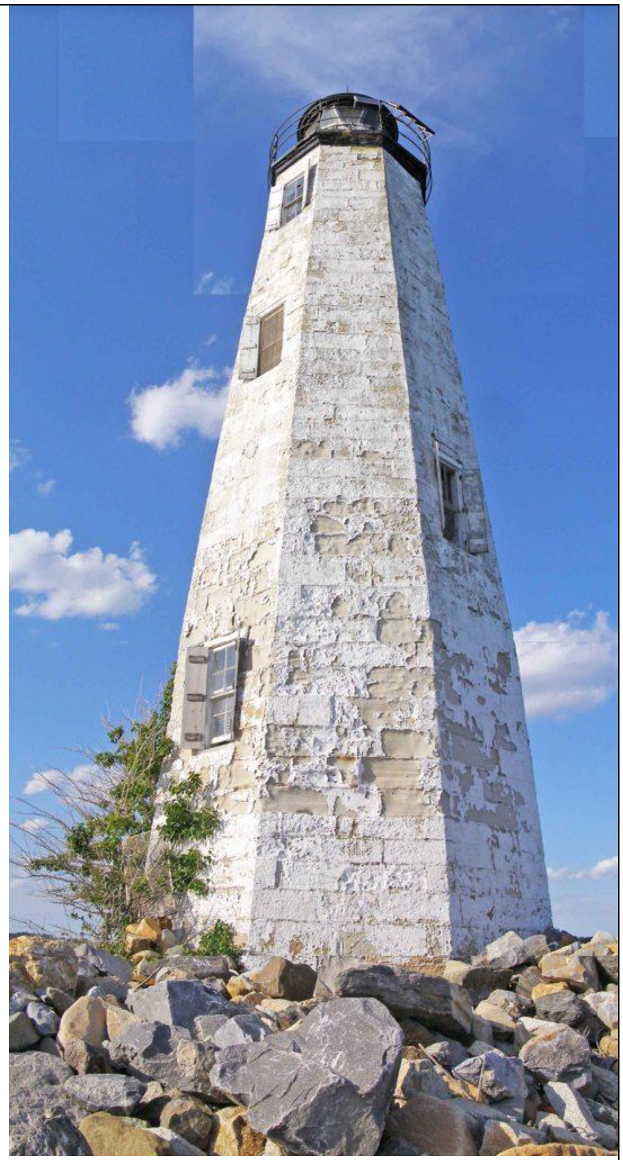
Appendix C: Elevation photographs

	
Elevations 1 – 8 – 7	**Elevations 7 – 6 - 5**

Appendix C: Elevation photographs cont.



Elevations 6 – 5 – 4



Elevations 5 – 4 – 3

Appendix D: Photo Index of Construction and Conditions

Photo 1: Elevation 5 – Note zone of severely weathered facing stone units and degraded coating starting about six feet above grade and extending to almost the mid-point of the tower masonry.

Photo 2: Elevations 6 & 7: Note network of open and failing mortar joints at upper seven courses as well as erosion of the edges of the stone units – possibly related to the use of an incompatible pointing mortar. Also note small losses at the corners of stone units.

Photo 3: Top of Elevation 5: Note open joints/step cracks above window head. Note secondary lintel above window lintel that might possibly be a wood replacement instead of stone. Note edge spalling at iron/stone interface as well as broken window pane.

Photo 4: Top of Elevation 1, 2 and 8: Note diagonally cracked unit under cornice and open joints/step crack through mortar.

Photo 5: Window at Elevation 1, 2 and 8: Note gap in masonry directly above window. Window head was made from more than one unit of stone and it appears that one unit or a piece of a unit has fallen. Load of back up masonry is picked up by interior stone arch that sits behind the lintel **(See Photos 21-24)** for typical conditions. If the window heads are carrying a load from the facing stones, part of that load may be being transferred to the window frames in the locations where the multi-stone lintels are damaged. This condition requires further investigation.

Photo 6: Mid Point of Elevation 1, 2 and 8: Note large gaps at horizontal and vertical joints as well as spalls and diagonal cracks in facing stones.

Photo 7: Lower Elevation 1, 2, 8: Note severe erosion of coating and stone in this area as well as open and failed mortar joints.

Photo 8: View of Elevation 2 looking up: Note spalls that are visible from this angle but not as visible when the wall is viewed head on.

Photo 9: Elevations 6, 5 at lower window: Note severe erosion and natural iron streaking in sandstone units to the left of the window. Note large gaps in horizontal joints on side 6 as well as general weathering patterns in this zone of the tower.

Photo 10: Elevation 5 below window: Note clear line of demarcation where zone of severe erosion starts three courses below window.

Photo 11: Corner of Elevations 5 and 4: Note original mortar standing proud of eroded face of sandstone units.

Photo 12: Note slight outward displaced at open vertical joint.

Photo 13: Note crack at unit directly over door. The weight of the back up masonry is picked up by the stone arch located behind the cracked stone but this condition requires further investigation to determine the cause of the cracking as well as a possible repair. Also note open joints and spalling and erosion of the edges of the adjacent units.

Photo 14: Brick Vault below lantern deck with opening to lantern: Note blistering from water infiltration at coating that was applied circa 1981. Note remnants of lime wash on brick where coating has failed.

Photo 15: Brick Vault and stone interface below lantern. Note three of the eight iron ties that penetrate the masonry below the lantern. Corrosion of ties is responsible for cracking in the brickwork and spalling at the window jambs. Also note active biological growth on the stone and failing coating from water infiltration above the vaulting. The brick vault appears to be let into the wall directly above the stone window arch. The window head directly in front of the arch appears to be broken. The configuration and condition of the walls at this location requires further investigation.

Photo 16: Note Connected cracks and displaced bricks were two iron ties penetrate the brick vault. Multiple cracks from the eight iron ties are undermining the structural integrity of the brick vault.

Photo 17: Note spalling of window jamb unit, biological growth and erosion of the jamb units from water infiltration at the window frame.

Photo 18: Close up of cracking caused by the corrosion and expansion of the iron ties.

Photo 19: Close up of cracking, spalling and displacement of bricks at the location where the cracks created by two ties have connected. Mortar sample 3 was taken at the location where the brick was spalled in order to reach original brick setting mortar.

Photo 20: Note corrosion of iron grate and erosion of jamb units below interior stone arch.

Photo 21: Close up of interior stone arch and inboard side of exterior window head. Exterior lintel appears to be a jack arch formed from multiple units of stone mortared together. The erosion of the setting mortar in this location is undermining the integrity of the jack arch. This condition requires additional investigation.

Photo 22: Sealant repair at gap between masonry and window frame to prevent water infiltration.

Photo 23: Intact stone arch at window opening with single piece stone exterior stone lintel. Contrast with lintel in photo 21.

Photo 24: Wood platform held up by supplemental wood post.

Photo 25: Underside of circular stairs. The amount that the stone treads are let into the wall still has to be determined. Steps were reportedly damaged by the British during the War of 1812 and the repaired. Degree of repair/replacement has not been determined.

Photo 26: Note gray cement patches at edges of stair treads as well as biological staining on stone and coating. Natural color or stone with distinctive iron streaks can be see where coating is missing.

Photo 27: Note cracks in wall units under steps just above the starting point of the steps.

Photo 28: Note wood deterioration where platform is let into the stone masonry.

Photo 29: Note settlement of wood platform relative to its original position.

Photo 30: Note erosion of facing stone just above the water table.

Photo 31: Close up of sample sites for setting/pointing mortar at open joints. **(Samples 1 and 2)** Note erosion of sandstone relative to the soft lime mortar as well as failure of the exterior coating.

Photo 32: Hatchway in iron lantern room floor showing access ladder, cross-section of brick vault under the floor and brick parapet wall sitting on iron floor.

Photo 33: The interior face of the parged brick parapet wall is flush with the iron sill of the lantern and the iron frame of the gallery door. Interior face of brick parapet wall is sitting on iron lantern room floor.

Photo 34: Gallery deck door frame in brick parapet wall of lantern room showing the depth of the parapet wall brick masonry.

Photo 35: Exterior gallery door frame showing pintel for original (now removed) exterior door.

Photo 36: The exterior edge of the iron lantern sill overlaps the top course of the brick parapet wall. Detail showing section of lantern sill where it has broken to reveal the brick underneath.

Photo 37: Two black painted parging layers are visible over the brick on the exterior of the parapet wall in a location were parging has been lost.

Photo 38: Exterior gallery deck constructed with wedge shaped stones. Note gallery railing stanchions set on joints between every other deck stone aligned with the eight corners of the tower.

Photo 39: Exterior gallery deck stones exhibiting horizontal and lateral displacement.

Photo 40: Rusted bottom of mullion. Stainless steel stop installed in 1980s repairs.

Photo 41: Looking up towards top of lantern glazing and underside of roof eave.

Photo 42: Top surface of lantern roof exposed and rusting.

Photo 43: Roof top ventilator.

Photo 44: Base of pedestal for fourth-order Fresnel lens remains in place in the center of the lantern room floor.

Photo 45: Ventilator in brick parapet wall, currently provides access for electrical cord between exterior solar array panel and interior lamp set on pedestal. Note parging layers with limewash.

Photo 46: Interior parged surface of lantern room parapet wall. Re-built section of wall readily visible in right facing side of photograph.

Photo 47: Lantern sill set on brick parapet wall.

Photo 48: Looking down on top edge of interior lantern sill.

Photo 49: Detail view of interior rusting lantern sill and mullion base.

Photo 50: Interior surface of lantern roof in fair to good condition, detail of ventilator vent hole.

Photo 51: Interior side of lantern room gallery door.

Photo 52: Bulge in exterior parapet wall results in exterior face protruding out beyond lantern sill.

Appendix E: Mortar Samples and Analysis

Description of Sample Locations

Samples 1 and 2 were taken respectively from the vertical joint and bed joint of the same unit. I took samples from very deep inside the joint on sample 1, and a little shallower on Sample 2. I did not notice any difference in the mortar at the face of the joint compared with the inside of the joint while I was sampling. Both samples appear to have a fiber component and appear to me to be the same mortar. I believe that these samples represent the original bedding/pointing mortar. While there are some notes in the documentation that there were repairs to the masonry in the 19^{th} and 20^{th} century, I believe that most of those repairs have eroded away – at least at ground level. I would like to do a full petrographic and chemical analysis of the mortar from Sample Site 1. I have included sample 2 as a reference.

Sample 4 (two bags) contains fragments of sandstone and mortar taken from the interior of the lighthouse close to the top of the structure. I would like to compare this mortar to Sample 1 to see if it is the same bedding/pointing mortar. Since sample 4 was taken from a window jamb it is possible that the jambs were rebuilt at some point – as the project documentation indicates that the windows were often damaged or missing.

Sample 3 comes from the underside of the shallow brick vault at the top of the structure. The brick vault supports the platform of the lantern. It may possibly be part of Elzy Burroughs's original construction or it may date from the mid 19^{th} century (circa 1841-1858) when the lantern was replaced. We would like to identify this mortar and see it relates to either sample 1 or sample 6.

Sample 6: Taken from exterior parging over bricks at the lantern level. Sample appears to contain at least two distinct mortars – an earlier one on the interior that may include fragments of the brick setting/pointing mortar and a later one that appears to be the parge coat. Documentation from 1858 describes the parapet as constructed of brick "laid in plaster with cement". We would like to see if the inner mortar relates to sample 3 and determine if the outer parge coat is compatible with a circa 1841-1858 date.

Summary of Sample Locations:

Sample 1: Exterior sandstone pointing/bedding mortar from Vertical Joint side F.

Sample depth: Up to 5".

Sample 2: Exterior sandstone pointing/bedding mortar from Bed Joint side F.

Sample depth: Up to 1.75". Sample taken from bed joint of same unit as Sample 1. Fibers noted in sample.

Sample 3: Interior Brick Setting Mortar from Underside of Shallow Brick Vault. Sample includes fragment of brick.

Sample 4: 2 Bags: Stone and Mortar from right facing interior jamb of 5th Window. Sample bags include mortar, Acquia Creek Sandstone and coating over sandstone.

Sample 5: Not sent

Sample 6: Exterior parging over brick at lantern – taken from behind solar panels.

Summary of Mortar Analysis – John J. Walsh, Testwell Inc.:

General Discussion

The provided samples represent an interesting spectrum of binder usage interpreted to span approximately one hundred years with four distinctly different campaigns represented. Samples 1 and 2 contain oyster shell limes that likely represent the original 1804 construction. Samples 3 and 4 while quite similar in appearance to Sample 1 and 2 contain a lime burned from marble. The distinct differences in the binder provenance argue strongly for different campaigns and the use of rock lime is believed to be more typical of mid-nineteenth century construction. The earlier parging and possible bedding mortar in Sample 6 comprises an American natural cement binder. The mortar must post-date approximately 1830 and likely predates 1890 given the waning popularity of such materials after this date. The later parging in Sample 6 is portland cement-based and the texture of the cement is indicative of clinkered cements post-dating the introduction of the rotary kiln. The binder is unlikely to predate 1890 given the texture but is unlikely to postdate the first quarter of the twentieth century given the lack of lime gauging.

In contrast to the wide variety of binder types, the aggregate is constant throughout the samples indicating a consistent sand source. Sand samples are recovered for Samples 1 and 4. Comparison with the other samples using thin section petrography indicate that all contain more or less identical aggregate. The sand is a fine-grained and bright-lustered aggregate characterized as a siliceous natural sand. With the exception of trace heavy minerals the sand is composed almost exclusively of quartz. Shell fragments are found only in Samples 1 and 2 but the given the oyster shell source of the lime and the otherwise identical mineralogy and gradation of the sand with the other samples, these fragments are interpreted to represent unburned particles of lime. Traces of carbon soot and brick fragments are found in Samples 1 and 2 but these are considered contaminants. The gradation is very narrow in all samples with a majority of material found between the No. 50 and No. 100 sieve sizes. The fine-grained sands have a nominal top size estimated at the No. 30 sieve. Grain shapes are relatively soft. The softness, narrow gradation, and limited mineralogy of the sand are all consistent with a well-sorted and mature beach sand. The sand is obviously local and was used consistently throughout the various construction campaigns. Details of the gradation may be found in Section 4 above. Recovered sands for Samples 1 and 4 are provided with this report. It should be noted that if replication for aesthetic purposes is desired for the mortar represented by Samples 1 and 2, a small addition of crushed shell up to roughly 1/4" may be necessary to more closely match the mortar appearance. This should be an additive rather than a replacement of sand as the sand to binder ratio is underestimated due to these soluble shells.

Samples 1 and 2

Both samples are determined to represent common non-hydraulic lime mortars. No hydraulic binders or pozzolans are detected. The binder is identified by the presence of relict carbonated lime grains. These have internal structures that retain original textures consistent with those typical of oyster shells. No burned silicates or aluminates are detected within the relict grains. Additionally, unburned and partially burned shell fragments are observed petrographically in the matrix. The chemical analysis also indicates a high-calcium binder with only minor impurities consistent with an oyster shell lime. Such lime is considered a fat lime or one with energetic slaking characteristics and high bulking properties upon water addition. Burning of the lime was not complete resulting in fine shell fragments incorporated in the mortar. Such textures are common in early nineteenth century shell lime mortars and the examined samples are considered consistent with the original 1804 construction date of the lighthouse. It is possible the lime-burning was performed very near the site.

Chemical analysis was performed on Sample 1 in order to estimate material proportions and details of the calculations are given in the notes of Section 5 above. The chemical procedures are determined to have separated the sand and binder efficiently. Assuming typical bulk material densities, the sand to binder ratio is estimated at 1.0 : 1 by volume with the lime calculated as a dry hydrate and the sand in damp, loose condition. The same weight of lime mixed as a putty would result in a lime volume approximately 40% less than that of the dry hydrate and adjustment for this results in an estimated sand to binder ratio of 1.6 : 1 by volume. The vintage of the mortar as well as the texture of the lime residuals clearly discount lime originally added as a dry hydrate. The calculations consider all components of the lime as a binder addition including the fragments of unburned shell. Technically, these inert grains may be effectively considered a part of the sand both aesthetically as well as volumetrically. If considered a part of the aggregate, the actual sand to binder ratio may be somewhat higher than reported. Due to the chemical similarity of the shell fragments and the lime binder it is difficult to quantify the contribution of these unburned shell fragments.

The samples exhibit typical carbonation of the matrix due to reaction of atmospheric carbon dioxide with the slaked lime. No significant deleterious chemical reactions are detected in the examined mortar samples.

Samples 3 and 4

Samples 3 and 4 are both common non-hydraulic lime mortars considered identical and representative of the same campaign. No hydraulic binders or pozzolans are detected. As with Samples 1 and 2, the binder is identified by the presence of relict carbonated lime grains. However, relict rock textures that survived the lime burning process are quite different than those of the previous samples. In this case, traces of partially burned coarse-grained calcite crystals contain deformation features typical of metamorphic rock. Additionally, many lime grains contain unburned or partially burned silicates including white mica and pyroxenoid minerals. These textures and mineralogies are inconsistent with oyster shells as well as sedimentary limestones. They are however, common features of metamorphic marbles and the lime has clearly been manufactured from this type of carbonate rock. The high calcium and low magnesium values measured chemically indicate the marble to have been calcic rather than dolomitic. As with Samples 1 and 2, these would have been fast-slaking, fat limes though the estimated chemistries (Table 5.2) indicate a somewhat higher level of impurities and a slightly higher hydraulicity index. Still, with an index much less than 0.1, the lime would not have exhibited any hydraulic property.

It seems unlikely that both oyster shell lime and marble lime would have been used during the same construction campaign. If oyster shells were available on site then these may have been burned on or near site during the original construction. Smaller-scale repairs at a later date would likely have made use of purchased materials. While little documentation is available on the subject, it is the author’s experience that marble limes are not common in construction predating approximately 1830 particularly in southern states. The client questions whether Sample 3 relates to a mid nineteenth century repair and it is the author’s opinion that both are more likely related to this repair rather than the original 1804 construction.

Chemical analysis was performed on Sample 4 in order to estimate material proportions and details of the calculations are given in the notes of Section 5 above. The chemical procedures are determined to have separated the sand and binder efficiently. Assuming typical bulk material densities, the sand to binder ratio is estimated at 1.6 : 1 by volume with the lime calculated as a dry hydrate and the sand in damp, loose condition. The same weight of lime mixed as a putty would result in a lime volume approximately 40% less than that of the dry hydrate and adjustment for this results in an estimated sand to binder ratio of 2.7 : 1 by volume. The vintage of the mortar as well as the texture of the lime residuals clearly discount lime originally added as a dry hydrate. The higher sand contents are consistent with petrographic comparisons between these samples and Samples 1 and 2.

Both samples exhibit typical carbonation of the matrix due to reaction of atmospheric carbon dioxide with the slaked lime. Fragments of lime wash were included in the thin section used for petrographic analysis of Sample 3. Recrystallized gypsum (calcium sulfate) is found in association with these small fragments although no secondary mineralization is found in the larger mortar fragments. Layers of lime wash were observed petrographically in Sample 4 though no such mineral deposits were found in association.

Sample 6

Sample 6 is a parging sample that contains two distinct materials. The underlying mortar and/or parging consists of a natural cement mortar while the overlying parging is a portland cement mortar. While sand extraction was not performed for this sample, petrographic observations indicate that the same siliceous sand used in the lime mortars is present in both materials comprising Sample 6.

The underlying portion of Sample 6 contains a natural cement binder. No lime gauging or pozzolanic additions are found. The cement is identified petrographically by the presence of relict grains consistent with the low temperature calcination of an impure dolomitic or magnesian limestone. High magnesium values measured chemically clearly indicate a typical American rather than European cement. A calcium to magnesium ratio of 1.9 near the pure dolomitic ratio of 1.4 is typical of the more pervasive American cements such as those produced in Rosendale, NY and Louisville, KY. Materials such as these were not available until at least 1828 and begin to wane in popularity in the late 19th century as production of American portland cements become dominant. The client requests a comparison of this material with Sample 3. While there is nothing about the binder components that preclude their being contemporaneous, they are certainly different in composition. It should be noted that it is not uncommon for natural cement mortars and lime mortars to be used in the same construction during the mid to late nineteenth century.

Chemical analysis was performed on an underlying portion of Sample 6 in order to estimate material proportions and details of the calculations are given in the notes of Section 5 above.

The chemical procedures are determined to have separated the sand and binder efficiently. Assuming typical bulk material densities, the sand to binder ratio is estimated at 1.0 : 1 by volume. Such low sandings are quite common for nineteenth century natural cement mortars and should not necessarily be considered deficient. However, some evidence for plastic shrinkage cracking is observed in one fragment and this might be related to the lower sand content. Several pieces of the underlying mortar or parging were included in the thin section examined petrographically and some fragments exhibit a higher sanding than others. It is difficult to establish the relationship of these natural cement mortar pieces but some were clearly mixed with sand to binder ratios closer to 2 : 1 by volume.

The overlying parging layers were examined by petrography alone. These include several thin lifts of a pure portland cement stucco. No lime gauging is detected in any layer. The cement is identified by abundant clinkered relicts of well crystallized calcium silicate. The granular texture of the paste and the low hydration characteristics of the residual cement indicate a mortar placed in a relatively dry and stiff condition. The textural consistency of the cement is typical of cements produced in a rotary kiln and this would date the outer parging very roughly at post-1890. The lack of lime gauging is considered typical of mortars and stuccoes predating approximately 1930 and the texture and composition would seem to bracket the vintage to within several decades. More modern cement mortars would not suffer an absence of lime as well given the increased strength and brittleness of more contemporary materials. This fact should also be considered if replication of this mix is desired.

The client requests commentary on whether the outer parge coat is compatible with a circa 1841-1858 date. Given the discussion above, these outer layers are not considered compatible with this vintage. The inner natural cement mortars could be compatible with this date range. Furthermore, these disparate materials are almost certainly representative of different construction campaigns. The presence of secondary carbonate precipitation along the surface of the underlying natural cement mortar indicates significant weathering of the material prior to the placement of the portland cement stucco.